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# OPERATING INSTRUCTIONS FOR

# MODEL 3000ZA

## Trace Oxygen Analyzer



P/N M75739  
4/10/04



**DANGER**



Toxic gases and or flammable liquids may be present in this monitoring system.  
Personal protective equipment may be required when servicing this instrument.  
Hazardous voltages exist on certain components internally which may persist for a time even after the power is turned off and disconnected.  
Only authorized personnel should conduct maintenance and/or servicing. Before conducting any maintenance or servicing, consult with authorized supervisor/manager.

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This equipment is sold subject to the mutual agreement that it is warranted by us free from defects of material and of construction, and that our liability shall be limited to replacing or repairing at our factory (without charge, except for transportation), or at customer plant at our option, any material or construction in which defects become apparent within one year from the date of shipment, except in cases where quotations or acknowledgements provide for a shorter period. Components manufactured by others bear the warranty of their manufacturer. This warranty does not cover defects caused by wear, accident, misuse, neglect or repairs other than those performed by Teledyne or an authorized service center. We assume no liability for direct or indirect damages of any kind and the purchaser by the acceptance of the equipment will assume all liability for any damage which may result from its use or misuse.

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### Important Notice

This instrument provides measurement readings to its user, and serves as a tool by which valuable data can be gathered. The information provided by the instrument may assist the user in eliminating potential hazards caused by his process; however, it is essential that all personnel involved in the use of the instrument or its interface, with the process being measured, be properly trained in the process itself, as well as all instrumentation related to it.

The safety of personnel is ultimately the responsibility of those who control process conditions. While this instrument may be able to provide early warning of imminent danger, it has no control over process conditions, and it can be misused. In particular, any alarm or control systems installed must be tested and understood, both as to how they operate and as to how they can be defeated. Any safeguards required such as locks, labels, or redundancy, must be provided by the user or specifically requested of Teledyne at the time the order is placed.

Therefore, the purchaser must be aware of the hazardous process conditions. The purchaser is responsible for the training of personnel, for providing hazard warning methods and instrumentation per the appropriate standards, and for ensuring that hazard warning devices and instrumentation are maintained and operated properly.

Teledyne Analytical Instruments, the manufacturer of this instrument, cannot accept responsibility for conditions beyond its knowledge and control. No statement expressed or implied by this document or any information disseminated by the manufacturer or its agents, is to be construed as a warranty of adequate safety control under the user's process conditions.



### Specific Model Information

The instrument for which this manual was supplied may incorporate one or more options not supplied in the standard instrument. Commonly available options are listed below, with check boxes. Any that are incorporated in the instrument for which this manual is supplied are indicated by a check mark in the box.

**Instrument Serial Number:** \_\_\_\_\_

#### Options Included in the Instrument with the Above Serial Number:

- 3000ZA-C:** In addition to all the standard features, this model also has separate ports for zero and span gases, and built-in control valves. The internal valves are entirely under the control of the 3000ZA electronics to automatically switch between gases in synchronization with the analyser's operation.
- 3000ZA-Rack Mnt:** The 19" Relay Rack Mount units are available with either one or two 3000 series analyzers installed in a standard 19" panel and ready to mount in a standard rack.



## Important Notice

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Model 3000ZA complies with all of the requirements of the Commonwealth of Europe (CE) for Radio Frequency Interference, Electromagnetic Interference (RFI/EMI), and Low Voltage Directive (LVD).

The following International Symbols are used throughout the Instruction Manual. These symbols are visual indicators of important and immediate warnings and when you must exercise CAUTION while operating the instrument. See also the Safety Information on the next page.



**STAND-BY:** Instrument is on Stand-by, but circuit is active



**GROUND:** Protective Earth



**CAUTION:** The operator needs to refer to the manual for further information. Failure to do so may compromise the safe operation of the equipment.



**CAUTION:** Risk of Electrical Shock



### Safety Messages

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Your safety and the safety of others is very important. We have provided many important safety messages in this manual. Please read these messages carefully.

A safety message alerts you to potential hazards that could hurt you or others. Each safety message is associated with a safety alert symbol. These symbols are found in the manual and inside the instrument. The definition of these symbols is described below:



**GENERAL WARNING/CAUTION:** Refer to the instructions for details on the specific danger. These cautions warn of specific procedures which if not followed could cause bodily Injury and/or damage the instrument.



**CAUTION: HOT SURFACE WARNING:** This warning is specific to heated components within the instrument. Failure to heed the warning could result in serious burns to skin and underlying tissue.



**WARNING: ELECTRICAL SHOCK HAZARD:** Dangerous voltages appear within this instrument. This warning is specific to an electrical hazard existing at or nearby the component or procedure under discussion. Failure to heed this warning could result in injury and/or death from electrocution.



**Technician Symbol:** All operations marked with this symbol are to be performed by qualified maintenance personnel only.

No  
Symbol

**NOTE:** Additional information and comments regarding a specific component or procedure are highlighted in the form of a note.



**CAUTION:** THE ANALYZER SHOULD ONLY BE USED FOR THE PURPOSE AND IN THE MANNER DESCRIBED IN THIS MANUAL.



**IF YOU USE THE ANALYZER IN A MANNER OTHER THAN THAT FOR WHICH IT WAS INTENDED, UNPREDICTABLE BEHAVIOR COULD RESULT POSSIBLY ACCOMPANIED WITH HAZARDOUS CONSEQUENCES.**

This manual provides information designed to guide you through the installation, calibration and operation of your new analyzer. Please read this manual and keep it available.

Occasionally, some instruments are customized for a particular application or features and/or options added per customer requests. Please check the front of this manual for any additional information in the form of an Addendum which discusses specific information, procedures, cautions and warnings that may be peculiar to your instrument.

Manuals do get lost. Additional manuals can be obtained from Teledyne at the address given in the Appendix. Some of our manuals are available in electronic form via the internet. Please visit our website at: [www.teledyne-ai.com](http://www.teledyne-ai.com).



This is a general purpose instrument designed for use in a non-hazardous area. It is the customer's responsibility to ensure safety especially when combustible gases are being analyzed since the potential of gas leaks always exist.

The customer should ensure that the principles of operation of this equipment is well understood by the user. Misuse of this product in any manner, tampering with its components, or unauthorized substitution of any component may adversely affect the safety of this instrument.

Since the use of this instrument is beyond the control of Teledyne, no responsibility by Teledyne, its affiliates, and agents for damage or injury from misuse or neglect of this equipment is implied or assumed.

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## Introduction

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### 1.1 Overview

The Teledyne Analytical Instruments Model 3000ZA Trace Oxygen Analyzer is a versatile microprocessor-based instrument for detecting oxygen at the parts-per-million (ppm) level in a variety of gases. This manual covers the Model 3000ZA General Purpose flush-panel and/or rack-mount units with CE mark. These units are for indoor use in a non-hazardous environment.

### 1.2 Typical Applications

A few typical applications of the Model 3000ZA are:

- Monitoring inert gas blanketing
- Air separation and liquefaction
- Chemical reaction monitoring
- Semiconductor manufacturing
- Petrochemical process control
- Quality assurance
- Gas analysis certification.

### 1.3 Main Features of the Analyzer

The Model 3000ZA Trace Oxygen Analyzer is sophisticated yet simple to use. The main features of the analyzer include:

- A 2-line alphanumeric display screen, driven by microprocessor electronics that continuously prompts and informs the operator.
- High resolution, accurate readings of oxygen content for low ppm levels. Large, bright, meter readout.
- Zirconium oxide sensor designed for trace analysis. It has a 0-10 ppm low range with less than a 0.2 ppm



offset and six months warranty and an expected lifetime of more than three years. 0-1 ppm range is possible too.

- No reference gas required
- Versatile analysis over a wide range of applications.
- Microprocessor based electronics: 8-bit CMOS microprocessor with 32 kB RAM and 128 kB ROM.
- Three user definable output ranges (from 0-1 ppm through 0-250 ppm) allow best match to users process and equipment.
- Auto ranging allows analyzer to automatically select the proper preset range for a given measurement. Manual override allows the user to lock onto a specific range of interest.
- Two adjustable concentration alarms and a system failure alarm.
- Extensive self-diagnostic testing, at startup and on demand, with continuous power-supply monitoring.
- CE compliance
- RS-232 serial digital port for use with a computer or other digital communication device.
- Four analog outputs: two for measurement (0–1 VDC and Isolated 4–20 mA DC) and two for range identification.
- Convenient and versatile, steel, flush-panel or rack-mountable case with slide-out electronics drawer.

## 1.4 Model Designations

**3000ZA:** Standard model for sample under pressure

**3000ZA-C:** In addition to all the standard features, this model also has separate ports for zero and span gases, and built-in control valves. The internal valves are entirely under the control of the 3000ZA electronics to automatically switch between gases in synchronization with the analyser's operation.



- 3000ZA-M:** This model has current output signals (4-20-mA) for ppm range and range ID, in addition to voltage outputs.
- 3000ZA-V:** Gas flow through the cell block in this model is driven by vacuum downstream from the cell block instead of upstream pressure. The internal restrictor is located downstream from the cell block to support this configuration. All other standard features are present in this model.

### 1.5 Front Panel (Operator Interface)

The standard 3000ZA is housed in a rugged metal case with all controls and displays accessible from the front panel. See Figure 1-1. The front panel has thirteen buttons for operating the analyzer, a digital meter, an alphanumeric display, and a window for viewing the sample flowmeter.

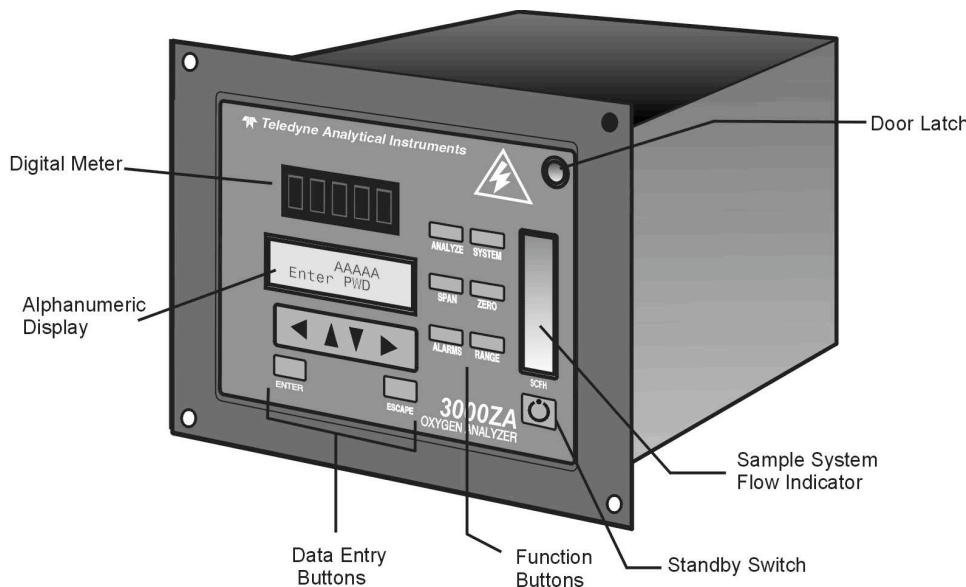


Figure 1-1: Model 3000ZA Front Panel

**Function Keys:**

Six touch-sensitive membrane switches are used to change the specific function performed by the analyzer:

- **Analyze** Perform analysis for oxygen content of a sample gas.
- **System** Perform system-related tasks (described in detail in chapter 4, *Operation*).
- **Span** Span calibrate the analyzer.
- **Zero** Zero calibrate the analyzer.
- **Alarms** Set the alarm setpoints and attributes.
- **Range** Set up the 3 user definable ranges for the instrument.

**Data Entry Keys:**

Six touch-sensitive membrane switches are used to input data to the instrument via the alphanumeric VFD display:

- **Left & Right Arrows** Select between functions currently displayed on the VFD screen.
- **Up & Down Arrows** Increment or decrement values of functions currently displayed.
- **Enter** Advances VFD display to the next screen in a series or returns to the *Analyze* screen if none remain.
- **Escape** Backs VFD display to the previous screen in a series or returns to the *Analyze* screen if none remain.

**Digital Meter Display:**

The meter display is a Light Emitting Diode (LED) device that produces large, bright, 7-segment numbers that are legible in any lighting. It produces a continuous readout from 0-250 ppm. It is accurate across all analysis ranges without the discontinuity inherent in analog range switching.

**Alphanumeric Interface Screen:**

The VFD screen is an easy-to-use interface from operator to analyzer. It displays values, options, and messages that give the operator immediate feedback.

**Flowmeter:**

Monitors the flow of gas past the sensor. Readout is 0.2 to 2.4 standard





**Standby Button** 

The Standby turns off the display and outputs but circuitry is still operating.

**CAUTION:** THE POWER CABLE MUST BE UNPLUGGED TO FULLY DISCONNECT POWER FROM THE INSTRUMENT. WHEN CHASSIS IS EXPOSED OR WHEN ACCESS DOOR IS OPEN AND POWER CABLE IS CONNECTED, USE EXTRA CARE TO AVOID CONTACT WITH LIVE ELECTRICAL CIRCUITS.

**Access Door:**

For access to the ZrO<sub>2</sub> sensor, the front panel swings open when the latch in the upper right corner of the panel is pressed all the way in with a narrow gauge tool. Accessing the main circuit board requires unfastening rear panel screws and sliding the unit out of the case.

## 1.6 Rear Panel (Equipment Interface)

The rear panel, shown in Figure 1-2, contains the gas and electrical connectors for external inlets and outlets. Some of those depicted are optional and may not appear on your instrument. The connectors are described briefly here and in detail in Chapter 3 *Installation*.

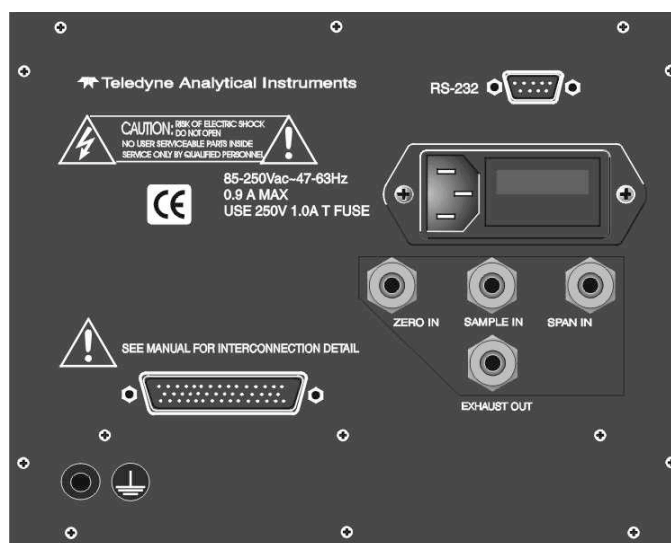


Figure 1-2: Model 3000ZA Rear Panel

- **Power Connection** Universal AC power source.
- **Gas Inlet and Outlet** One inlet (must be externally valved) and one exhaust out. Three inlets when option “C” is ordered.
- **9-Pin RS-232 Port** Serial digital concentration signal output and control input.

- **50-Pin Equipment Interface Port**

**Analog Outputs:** 0–1 VDC oxygen concentration plus 0-1 V dc range ID

**Alarm Connections:** 2 concentration alarms and 1 system alarm.

**Remote Valve:** Used in the 3000ZA for controlling external solenoid valves only.

**Remote Span/Zero:** Digital inputs allow external control of analyzer calibration.

**Calibration Contact:** To notify external equipment that instrument is being calibrated and readings are not monitoring sample.

**Range ID Contacts:** Four separate, dedicated, range relay contacts. Low, Medium, High, Cal.

**Network I/O:** Serial digital communications for local network access. For future expansion. Not currently implemented.

### Optional

- **Calibration Gas Ports:** Separate fittings for zero, span, and sample gas input, internal valves for automatic gas switching.
- **Current Signal Output:** Additional isolated 4–20 mA DC plus optional 4–20 mA DC range ID.

*Note: If you require highly accurate Auto-Cal timing, use external Auto-Cal control where possible. The internal clock in the Model 3000ZA is accurate to 2-3 %. Accordingly, internally*



*scheduled calibrations can vary 2-3 % per day.*

## Operational Theory

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### 2.1 Introduction

The analyzer is composed of three subsystems:

1. Zirconium Oxide ( $ZrO_2$ ) Sensor
2. Sample System
3. Electronic Signal Processing, Display and Control

The sample system is designed to accept the sample gas and transport it through the analyzer without contaminating or altering the sample prior to analysis. The  $ZrO_2$  sensor is a device that translates the amount of oxygen present in the sample into an electrical current. The electronic signal processing, display and control subsystem simplifies operation of the analyzer and accurately processes the sampled data. The microprocessor controls all signal processing, input/output and display functions for the analyzer.

### 2.2 $ZrO_2$ Sensor

#### 2.2.1 Principles of Operation

Teledyne's zirconium oxide sensor is a miniature solid state sensor. It uses a stabilized zirconia disc as an electrolyte with a sensing electrode (the cathode) and a counter electrode (the anode) on each side of the disc. The zirconia is heated to a temperature of about  $500^\circ C$  via a built-in heater. By applying a suitable reference voltage (approximately 0.75 volt) across the cathode and anode, the heated zirconia acts as an electrolyte which is capable of moving oxygen ions within its crystalline structure. This allows for the reduction of oxygen molecules reaching the cathode and the generation of a current equivalent to the parts per million oxygen in the sample gas.

This sensor has been modified to sense low levels of oxygen—less than 1 ppm and generate a current proportional to the concentration. The sensor is designed for long term stability and an operating life of 5 years.



## 2.3 Sample System

The sample system delivers gases to the  $ZrO_2$  sensor from the analyzer rear panel inlet. Depending on the mode of operation either sample or calibration gas is delivered.

The Model 3000ZA sample system is designed and fabricated to ensure that the oxygen concentration of the gas is not altered as it travels through the sample system.

The sample system for the standard instrument incorporates compression tube fittings for sample inlet and 1/4" outlet tube connections at the rear panel. The sample or calibration gas that flows through the system is monitored by a flowmeter downstream from the cell. Figure 2-1 shows the piping layout for the standard model.

Figure 2-2 shows the flow diagram for sampling systems used for the three configurations offered as options for this instrument. In the standard instrument, calibration gases can be connected directly to the Sample In port by teeing to the port with appropriate valves.

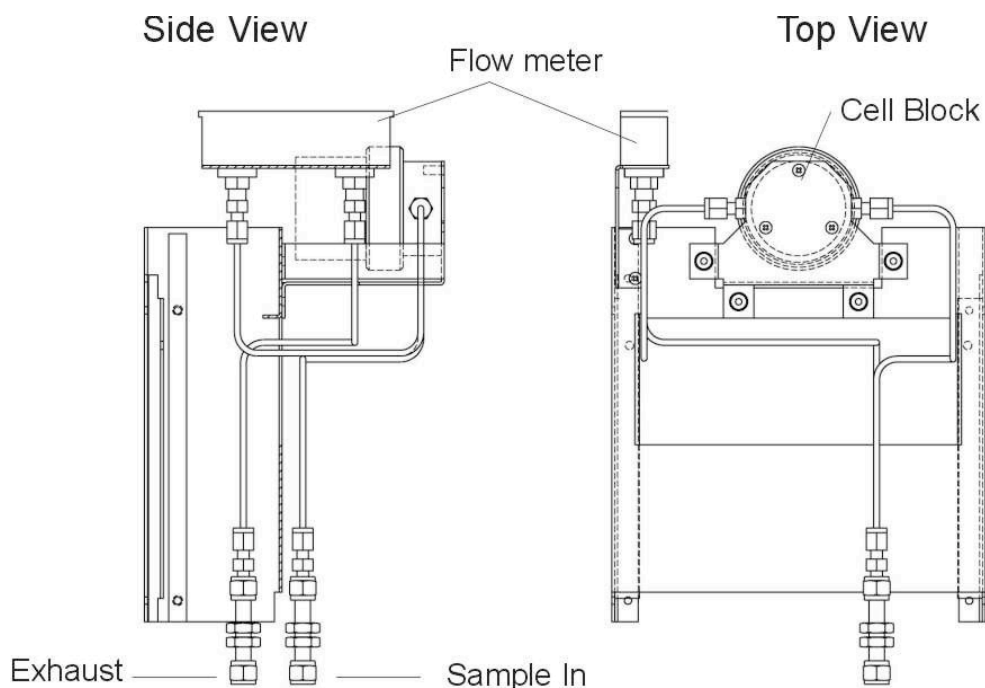


Figure 2-1: Model 3000ZA Sample System

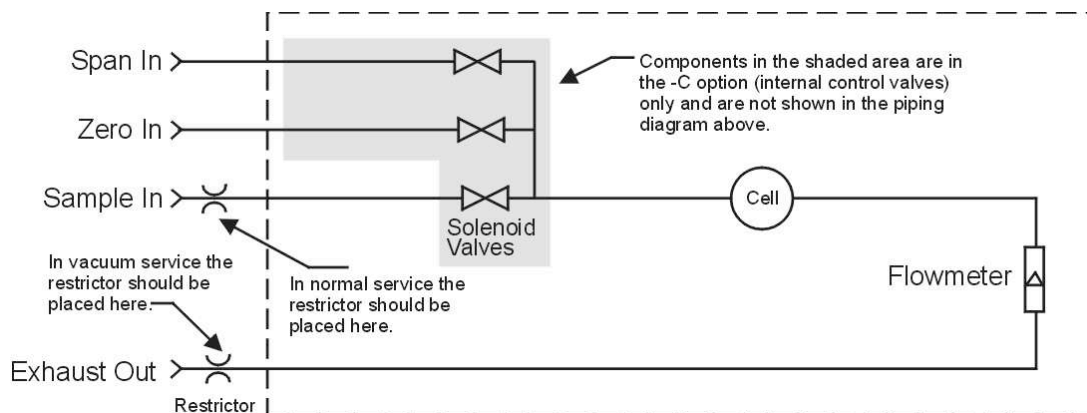


Figure 2-2: Flow Diagram with Options

## 2.4 Zirconium Oxide Sensor Application Notes

The following sample gases require conditioning prior to entering the sensor:

- Flammable gases such as methane, alcohol and carbon monoxide may cause a measurement error. They must be filtered from the sample gas before entering the cell.
- Gases containing halogen atoms (F, Cl, Br, etc.) such as Freon, must be filtered before entering the cell. The sensor will be damaged by the decomposition of Freon.
- Gases containing SO<sub>x</sub>, H<sub>2</sub>S, silicone vapor and adhesives must not enter the sensor. These components adversely affect the performance of the sensor.
- Dust and oil should be filtered from the sample gas.
- Water vapor in contact with the sensor will damage the sensor. Use a moisture trap or filter to remove any water vapor in the sample.

## 2.5 Electronics and Signal Processing

The Model 3000ZA Trace Oxygen Analyzer uses an 8031 microcontroller with 32 kB of RAM and 128 kB of ROM to control all signal processing, input/output, and display functions for the analyzer. System power is supplied from a universal power supply module designed to be compatible with any international power source. Figure 2-3 shows the location of the power supply and the main electronic PC boards.



The signal processing electronics including the microprocessor, analog to digital, and digital to analog converters are located on the motherboard at the bottom of the case. The preamplifier board is mounted on top of the motherboard as shown in the figure. These boards are accessible after removing the back panel. Figure 2-4 is a block diagram of the analyzer electronics.

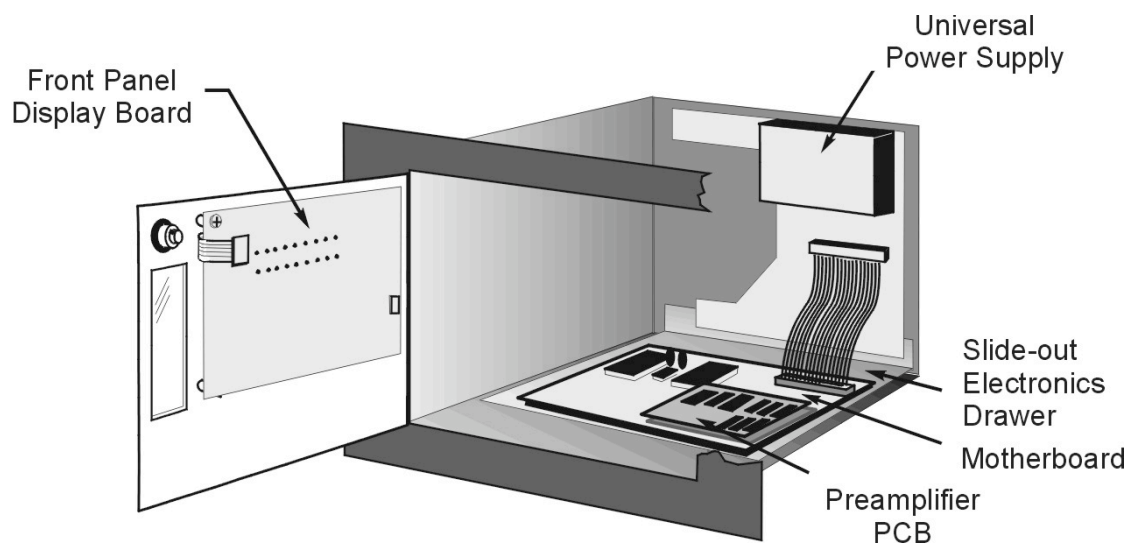
In the presence of oxygen the cell generates a current. A current to voltage amplifier converts this current to a voltage, which is amplified in the second stage amplifier. The output from the second stage amplifier is sent to an 18 bit analog to digital converter controlled by the microprocessor.

The high operating temperature of the  $ZrO_2$  sensor is required for proper operation of the sensor. The amplifier PCB contains a circuit that drives the heater embedded in the sensor. The voltage across the heater rises slowly to avoid damaging the heater/sensor assembly. After a few minutes, the sensor will be at the proper operating temperature.

The digital concentration signal along with input from the control panel is processed by the microprocessor, and appropriate control signals are directed to the display, alarms and communications port. The same digital information is also sent to a 12 bit digital to analog converter that produces the 4-20 mA dc and the 0-1 VDC analog concentration signal outputs, and the analog range ID outputs.

Signals from the power supply are also monitored, and through the microprocessor, the system failure alarm is activated if a malfunction is detected.







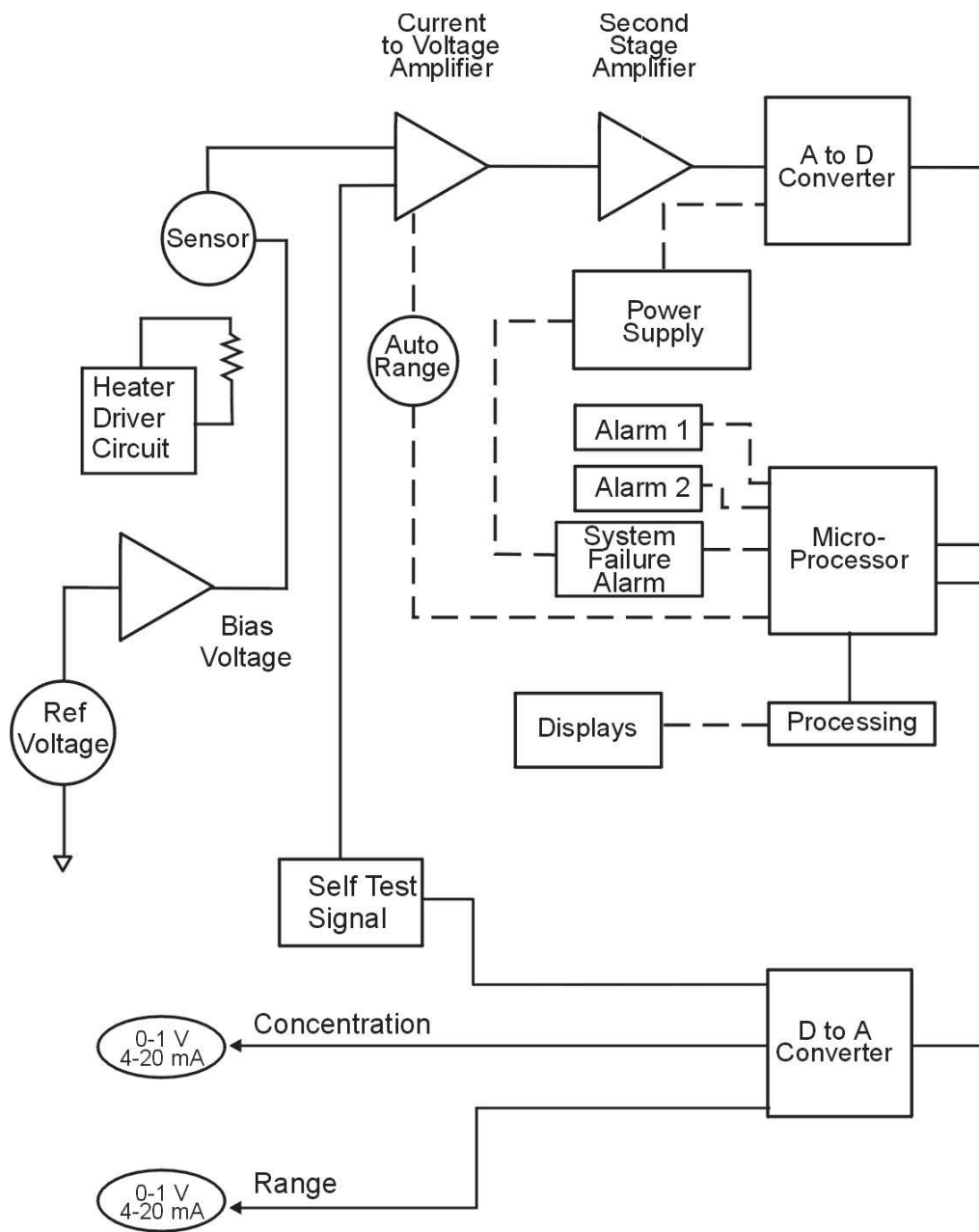


Figure 2-4: Electronic Block Diagram

## Installation

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Installation of the Model 3000ZA Analyzer includes:

1. Unpacking
2. Mounting
3. Gas connections
4. Electrical connections
5. Installing the sensor
6. Testing the system.

### 3.1 Unpacking the Analyzer

The analyzer is shipped with all the materials you need to install and prepare the system for operation. Carefully unpack the analyzer and inspect it for damage. Immediately report any damage to the shipping agent.

### 3.2 Mounting the Analyzer

The Model 3000ZA is for indoor use in a general purpose area. It is NOT for hazardous environments of any type.

The standard model is designed for flush panel mounting. Figure 3-1 is an illustration of the 3000TA standard front panel (the 3000ZA is similar) and mounting bezel. There are four mounting holes—one in each corner of the rigid frame. Drawings at the back of this manual illustrate the dimensions and mounting hole spacing for this unit.

On special order, a 19" rack-mounting panel can be provided. For rack mounting, one or two 3000 series analyzers can be flush-panel mounted on the rack panel. See Appendix for dimensions of the mounting panel.



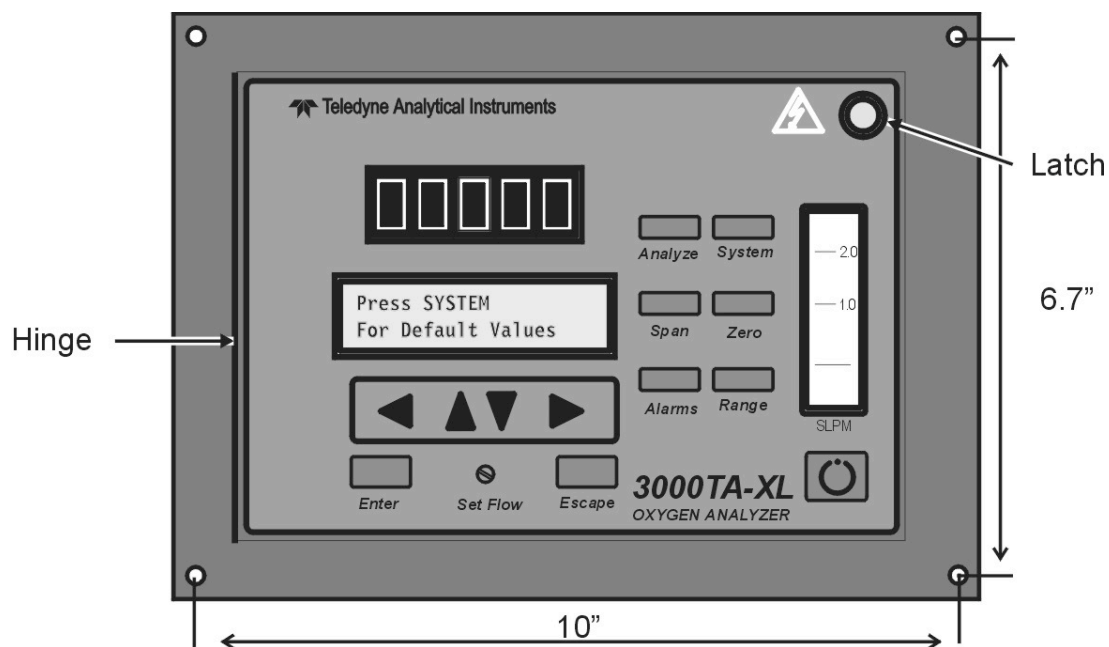


Figure 3-1: Front Panel of the Model 3000TA (Model 3000ZA similar)

All operator controls, except the flow control needle valve, are mounted on the control panel, which is hinged on the left edge and doubles as the door that provides access to the sensor and cell block inside the instrument. The door latch is spring loaded and will swing open when the button in the center of the latch (upper right corner) is pressed all the way in with a narrow gauge tool (less than 0.18 inch wide). Allow clearance for the door to open in a 90-degree arc of radius 7.125 inches. See Figure 3-2.

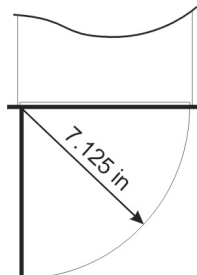


Figure 3-2: Required Front Door Clearance

### 3.3 Rear Panel Connections

Figure 3-3 shows the Model 3000ZA rear panel. There are ports for gas, power, and equipment interface. The Zero In and Span In ports are not included on the standard model but are available as options.

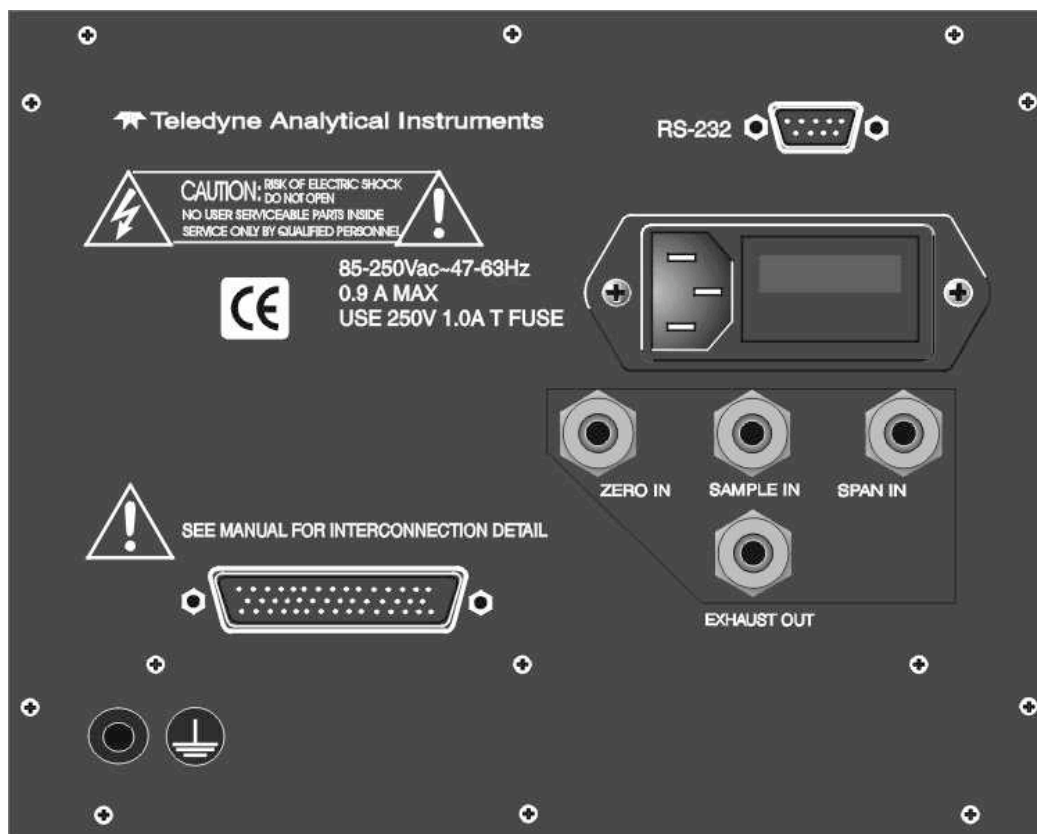


Figure 3-3: Rear Panel of the Model 3000ZA with Span and Zero Ports

#### 3.3.1 Gas Connections

Before using this instrument, it should be determined if the unit will be used for pressurized service or vacuum service and low pressure applications. The kit included with the instrument contains two restrictors and a union for 1/4" diameter tubing. Notice that there are two 1-3/4" long, 1/4" diameter restrictors. There is an open end and a closed end with a small circular orifice. The restrictor without the blue sticker is for low pressure applications and vacuum service. For high

pressure applications (5-50 psig) use the restrictor that has a blue sticker on the body.

- **Pressurized service:** Connect the restrictor with the blue dot to the Sample In port. The small circular orifice should face *AWAY* from the back of the unit (against the direction of gas flow).

*Note: Remove the blue sticker from the restrictor before using.*

- **Low pressure applications:** Connect the restrictor without the blue sticker in the same manner (less than 5 psig).
- **Vacuum Service:** For applications involving pressure less than 5-10 in Hg) connect the restrictor without the blue sticker to the Exhaust Out port. The small circular orifice should face *TOWARD* the back of the unit (against the direction of gas flow).

**CAUTION: OPERATING THE UNIT WITHOUT RESTRICTORS CAN CAUSE DAMAGE TO THE SENSOR.**



The unit is manufactured with 1/4" tube fittings and includes 6 mm adapters for metric system installations. For a safe connection:

1. Insert the tube into the fitting and finger tighten the nut until the tubing cannot be rotated freely by hand in the fitting. This may require an additional 1/8 turn beyond finger tight.
2. Hold the fitting body steady with a backup wrench. using another wrench, rotate the nut another 1-1/4 turns.

#### **SAMPLE IN:**

In the standard model, gas connections are made at the SAMPLE IN and EXHAUST OUT connections. Calibration gases must be tee'd into the Sample inlet with appropriate valves.

The inlet gas pressure should be reasonably regulated. Pressures between 2 and 50 psig are acceptable as long as the pressure, once established, will keep the front panel flowmeter reading in an acceptable range (0.5 to 2.0 SLPM). For non-pressurized sample or very low pressure, (less than 2 psig) vacuum service plumbing is recommended. Exact figures will depend on your process.

If greater sample flow is required for improved response time, install a bypass in the sampling system upstream of the analyzer input.

**EXHAUST OUT:**

Exhaust connections must be consistent with the hazard level of the constituent gases. Check local, state, and federal laws, and ensure that the exhaust stream vents to an appropriately controlled area, if required.

**ZERO IN and SPAN IN (Optional):**

These are additional ports for inputting span and zero gas. There are electrically operated valves inside for automatic switching between calibration and sample gases. These valves are completely under control of the 3000ZA electronics. They can be externally controlled only indirectly through the remote cal inputs as described below.

Pressure, flow, and safety considerations are the same as prescribed for the SAMPLE IN inlet above.

### 3.3.2 Electrical Connections

For safe connections, no uninsulated wiring should be able to come in contact with fingers, tools or clothing during normal operation.

**CAUTION:**

**USE SHIELDED CABLES. ALSO, USE PLUGS THAT PROVIDE EXCELLENT EMI/RFI PROTECTION. THE PLUG CASE MUST BE CONNECTED TO THE CABLE SHIELD, AND IT MUST BE TIGHTLY FASTENED TO THE ANALYZER WITH ITS FASTENING SCREWS. ULTIMATELY, IT IS THE INSTALLER WHO ENSURES THAT THE CONNECTIONS PROVIDE ADEQUATE EMI/RFI SHIELDING.**

#### 3.3.2.1 Primary Input Power

The power cord receptacle and fuse block are located in the same assembly. Insert the power cord into the power cord receptacle.

**CAUTION:**

**POWER IS APPLIED TO THE INSTRUMENT'S CIRCUITRY AS LONG AS THE INSTRUMENT IS CONNECTED TO THE POWER SOURCE. THE RED ⓪ SWITCH ON THE FRONT PANEL IS FOR SWITCHING POWER ON OR OFF TO THE DISPLAYS AND OUTPUTS ONLY.**

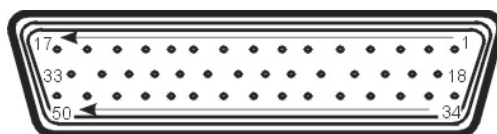
The universal power supply requires a n 85–250 VAC, 47-63 Hz power source.



**Fuse Installation:** The fuse block, at the right of the power cord receptacle, accepts US or European size fuses. A jumper replaces the fuse in whichever fuse receptacle is not used. Fuses are not installed at the factory. Be sure to install the proper fuse as part of installation. (See *Fuse Replacement* in Chapter 5, *Maintenance*.)

### 3.3.2.2 50-PIN EQUIPMENT INTERFACE CONNECTOR

Figure 3-4 shows the pin layout of the Equipment Interface Connector. The arrangement is shown as seen when the viewer faces the rear panel of the analyzer. The pin numbers for each input/output function are given where each function is described in the paragraphs below.



*Figure 3-4: Equipment Interface Connector Pin Arrangement*

**Analog Outputs:** There are four DC output signal pins—two pins per output. For polarity, see Table 3-1. The outputs are:

- 0–1 VDC % of Range: Voltage rises linearly with increasing oxygen, from 0 V at 0 ppm to 1 V at full scale ppm. (Full scale = 100% of programmable range.)
- 0–1 VDC Range ID: 0.25 V = Low Range, 0.5 V = Medium Range, 0.75 V = High Range.
- 4–20 mA DC % Range: Current increases linearly with increasing oxygen, from 4 mA at 0 ppm to 20 mA at full scale ppm. (Full scale = 100% of programmable range)
- (optional) 4–20 mA DC Range ID: 8 mA = Low Range  
12 mA = Medium Range  
16 mA = High Range

*Table 3-1: Analog Output Connections*

<b>Pin</b>	<b>Function</b>
3	+ Range ID, 4-20 mA, floating
4	– Range ID, 4-20 mA, floating
5	+ ppm Range, 4-20 mA, floating (optional)
6	– ppm Range, 4-20 mA, floating (optional)
8	+ Range ID, 0-1 VDC
23	– Range ID, 0-1 V dc, negative ground
24	+ ppm Range, 0-1 VDC
7	– ppm Range, 0-1 VDC, negative ground

**Alarm Relays:** The nine alarm-circuit connector pins connect to the internal alarm relay contacts. Each set of three pins provides one set of Form C relay contacts. Each relay has both normally open and normally closed contact connections. The contact connections are shown in Table 3-2. They are capable of switching up to 3 amperes at 250 V ac into a resistive load. The connectors are:

**Threshold Alarm 1:**

- Can be configured as high (actuates when concentration is above threshold), or low (actuates when concentration is below threshold).
- Can be configured as failsafe or non-failsafe.
- Can be configured as latching or non-latching.
- Can be configured out (defeated).

**Threshold Alarm 2:**

- Can be configured as high (actuates when concentration is above threshold), or low (actuates when concentration is below threshold).
- Can be configured as failsafe or non-failsafe.
- Can be configured as latching or non-latching.
- Can be configured out (defeated).

**System Alarm:**





- Actuates when DC power supplied to circuits is unacceptable in one or more parameters. Permanently configured as failsafe and latching. Cannot be defeated. Actuates if self test fails.
- (Reset by pressing  button to remove power. Then press  again and any other button EXCEPT **System** to resume.
- Further detail can be found in Chapter 4, Section 4-5.

Table 3-2: Alarm Relay Contact Pins

Pin	Contact
45	Threshold Alarm 1, normally closed contact
28	Threshold Alarm 1, moving contact
46	Threshold Alarm 1, normally open contact
42	Threshold Alarm 2, normally closed contact
44	Threshold Alarm 2, moving contact
43	Threshold Alarm 2, normally open contact
36	System Alarm, normally closed contact
20	System Alarm, moving contact
37	System Alarm, normally open contact

**Digital Remote Cal Inputs:** Accept 0 V (off) or 24 VDC (on) inputs for remote control of calibration. (See *Remote Calibration Protocol* below.) See Table 3-3 for pin connections.

**Zero:** Floating input. 5 to 24 V input across the + and – pins puts the analyzer into the **Zero** mode. Either side may be grounded at the source of the signal. 0 to 1 volt across the terminals allows **Zero** mode to terminate when done. A synchronous signal must open and close the external zero valve appropriately. See *Remote Probe Connector*. (The –C option internal valves operate automatically.)



**Span:** Floating input. 5 to 24 V input across the + and – pins puts the analyzer into the *Span* mode. Either side may be grounded at the source of the signal. 0 to 1 volt across the terminals allows *Span* mode to terminate when done. A synchronous signal must open and close external span valve appropriately. See Figure 3-5 Remote Probe Connector. (The –C option internal valves operate automatically.)

**Cal Contact:** This relay contact is closed while analyzer is spanning and/or zeroing. (See *Remote Calibration Protocol* below.)

*Table 3-3: Remote Calibration Connections*

Pin	Function
9	+ Remote Zero
11	– Remote Zero
10	+ Remote Span
12	– Remote Span
40	Cal Contact
41	Cal Contact

**Remote Calibration Protocol:** To properly time the Digital Remote Cal Inputs to the Model 3000ZA Analyzer, the customer's controller must monitor the Cal Relay Contact.

When the contact is OPEN, the analyzer is analyzing, the Remote Cal Inputs are being polled, and a zero or span command can be sent.

When the contact is CLOSED, the analyzer is already calibrating. It will ignore your request to calibrate, and it will not remember that request.

Once a zero or span command is sent, and acknowledged (contact closes), release it. If the command is continued until after the zero or span is complete, the calibration will repeat and the Cal Relay Contact (CRC) will close again.

For example:

1. Test the CRC. When the CRC is open, Send a zero command until the CRC closes (The CRC will quickly close.)
2. When the CRC closes, remove the zero command.



3. When CRC opens again, send a span command until the CRC closes. (The CRC will quickly close.)
4. When the CRC closes, remove the span command.

When CRC opens again, zero and span are done, and the sample is being analyzed.

*Note: The Remote Valve connections (described below) provides signals to ensure that the zero and span gas valves will be controlled synchronously. If you have the –C Internal valve option—which includes additional zero and span gas inputs—the 3000ZA automatically regulates the zero, span and sample gas flow.*

**Range ID Relays:** Four dedicated Range ID relay contacts. The first three ranges are assigned to relays in ascending order—Low range is assigned to Range 1 ID, Medium range is assigned to Range 2 ID, and High range is assigned to Range 3 ID. The fourth range is reserved for the Air Cal Range (25%). Table 3-4 lists the pin connections.

*Table 3-4: Range ID Relay Connections*

Pin	Function
21	Range 1 ID Contact
38	Range 1 ID Contact
22	Range 2 ID Contact
39	Range 2 ID Contact
19	Range 3 ID Contact
18	Range 3 ID Contact
34	Spare Contact
35	Spare Contact

**Network I/O:** A serial digital input/output for local network protocol. At this printing, this port is not yet functional. It is to be used for future options to the instrument. Pins 13 (+) and 29 (–).

**Remote Valve Connections:** The 3000ZA is a single-chassis instrument, which has no Remote Valve Unit. Instead, the Remote Valve connections are used as a method for directly controlling external sample/zero/span gas valves. See Figure 3-5.

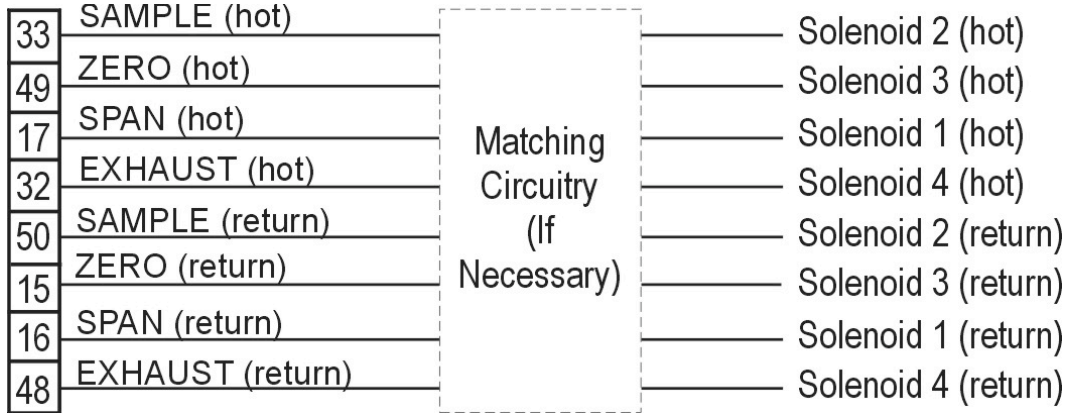


Figure 3-5: Remote Probe Connections

The voltage from these outputs is nominally 0 V for the OFF and 15 VDC for the ON conditions. The maximum combined current that can be pulled from these output lines is 100 mA. (If two lines are ON at the same time, each must be limited to 50 mA, etc.) If more current and/or a different voltage is required, use a relay, power amplifier, or other matching circuitry to provide the actual driving current.

In addition, each individual line has a series FET with a nominal ON resistance of 5 ohms (9 ohms worst case). This can limit the obtainable voltage, depending on the load impedance applied. See Figure 3-6.

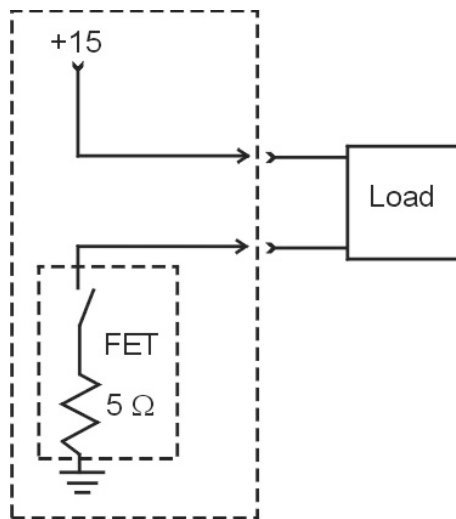


Figure 3-6: FET Series Resistance

### 3.3.2.3 RS-232 PORT

The digital signal output is a standard, full duplex RS-232 serial communications port used to connect the analyzer to a computer, terminal, or other digital device. It requires a standard 9-pin D connector.

The output data is status information, in digital form, updated every two seconds. Status is reported in the following order:

- The concentration in ppm or percent
- The range in use (HI, MED, LO)
- The span of the range (0-100 ppm, etc)
- Which alarms—if any—are disabled (AL-x DISABLED)
- Which alarms—if any—are tripped (AL-x ON).

Each status output is followed by a carriage return and line feed.

Three input functions using RS-232 have been implemented to date. They are described in Table 3-5.

*Table 3-5: Commands via RS-232 Input*

Command	Description
<b>as</b> <enter>	Immediately starts an autospan.
<b>az</b> <enter>	Immediately starts an autozero.
<b>st</b> <enter>	Toggling input. Stops/Starts any status message output from the RS-232, until <b>st</b> <enter> is sent again.

The RS-232 protocol allows some flexibility in its implementation. Table 3-6 lists certain RS-232 values that are required by the 3000ZA implementation.

*Table 3-6: Required RS-232 Options*

Parameter	Setting
Baud	2400
Byte	8 bits



Parity	none
Stop Bits	1
Message Interval	2 seconds. When CRC opens again, zero and span are done, and the sample is being analyzed.

**Range ID Relays:** There are three dedicated Range ID relay contacts. Three ranges are assigned to relays in ascending order—Low range is assigned to Range 1 ID, Medium range is assigned to Range 2 ID, and High range is assigned to Range 3 ID.

**Network I/O:** A serial digital input/output for local network protocol. At this printing, this port is not yet functional. It is to be used in future options to the instrument.

**RS-232 Port:** The digital signal output is a standard RS-232 serial communications port used to connect the analyzer to a computer, terminal, or other digital device. It requires a standard 9-pin D connector.

The data is status information, in digital form, updated every two seconds. Status is reported in the following order:

- The concentration in ppm or percent
- The range in use (HI, MED, LO)
- The span of the range (0-100 ppm, etc)
- Which alarms—if any—are disabled (AL-x DISABLED)
- Which alarms—if any—are tripped (AL-x ON).

### 3.4 Installing the Zirconium Oxide Sensor

The ZrO<sub>2</sub> sensor may not be installed in the cell block when the instrument is shipped. It must be installed before the analyzer is placed in service.

When the ZrO<sub>2</sub> sensor needs to be installed or replaced, follow the procedures in Section 5.2.

### 3.5 Testing the System

Before plugging the instrument into the power source:



- Check the integrity and accuracy of the gas connections. Make sure there are no leaks.
- Check the integrity and accuracy of the electrical connections. Make sure there are no exposed conductors.
- Check that inlet sample pressure is within the accepted range (see Section 3.3.1).
- Power up the system, and test it by repeating the Self-Diagnostic Test as described in Chapter 4, Section 4.3.5.

## Operation

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### 4.1 Introduction

Once the analyzer has been installed, it can be configured for your application. To do this you will:

- Set system parameters.
- Establish a security password, if desired, requiring Operator to log in.
- Establish and start an automatic calibration cycle, if desired.
- Calibrate the instrument.
- Define the three user selectable analysis ranges, then choose autoranging or select a fixed range of analysis, as required.
- Set alarm setpoints, and modes of alarm operation (latching, failsafe, etc).

Before you configure your 3000ZA, these default values are in effect:

**Ranges:** LO = 10 ppm, MED = 100 ppm, HI = 250 ppm.

**Auto Ranging:** ON

**Alarm Relays:** Defeated, 10.00 ppm, HI, Not failsafe, Not latching.

**Zero:** Auto, every 0 days at 0 hours.

**Span:** Auto, at 000,008.00 ppm, every 0 days at 0 hours.

If you choose not to use password protection, the default password is automatically displayed on the password screen when you start up, and you simply press *Enter* for access to all functions of the analyzer.





## 4.2 Using the Data Entry and Function Buttons

**Data Entry Buttons:** The **←** arrow buttons select options from the menu currently being displayed on the VFD screen. The selected option blinks.

When the selected option includes a modifiable item, the **←** arrow buttons can be used to increment or decrement that modifiable item.

The **Enter** button is used to accept any new entries on the VFD screen. The **Escape** button is used to abort any new entries on the VFD screen that are not yet accepted by use of the **Enter** button.

Figure 4-1 shows the hierarchy of functions available to the operator via the function buttons. The six function buttons on the analyzer are:

- **Analyze.** This is the normal operating mode. The analyzer monitors the oxygen content of the sample, displays the percent of oxygen, and warns of any alarm conditions.
- **System.** The system function consists of seven sub functions that regulate the internal operations of the analyzer:
  - Track or hold values during calibration
  - Auto-Cal setup
  - Password assignment
  - Self -test initiation
  - Checking software version
  - Logging out.
  - Show Negative
- **Zero.** Used to set up a zero calibration.
- **Span.** Used to set up a span calibration.
- **Alarms.** Used to set the alarm setpoints and determine whether each alarm will be active or defeated, HI or LO acting, latching, and/or failsafe.
- **Range.** Used to set up three analysis ranges that can be switched automatically with auto-ranging or used as individual fixed ranges.



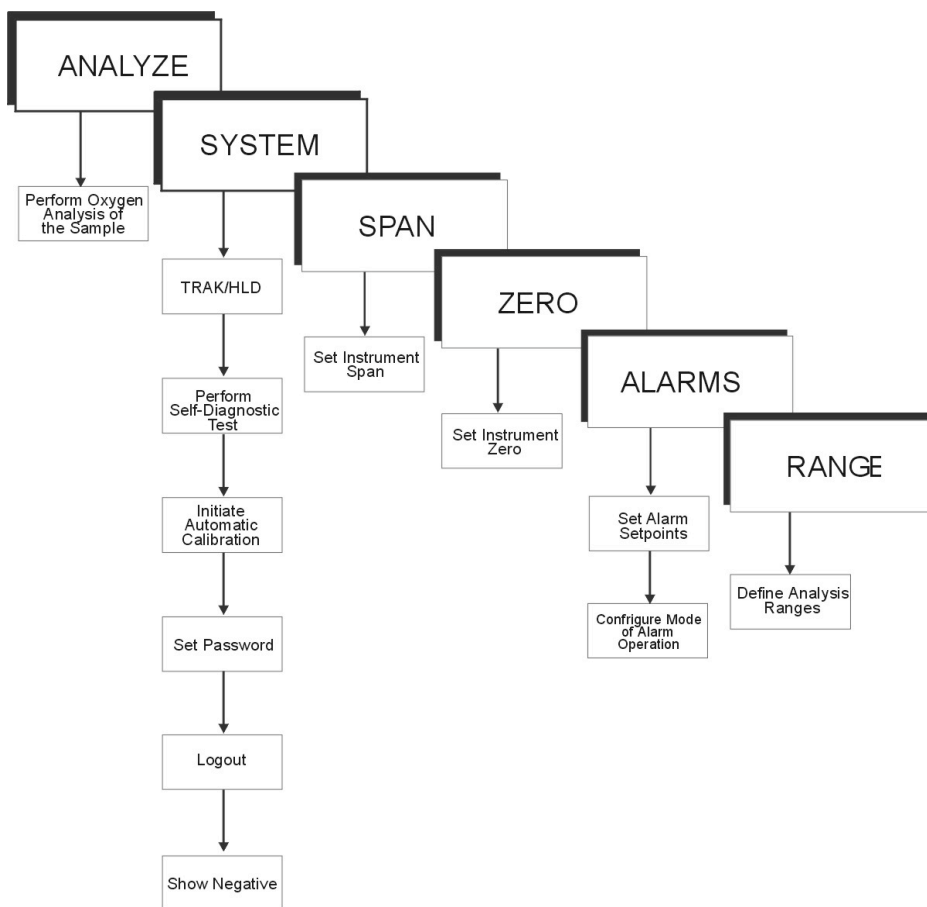


Figure 4-1: Hierarchy of Available Functions

Any function can be selected at any time by pressing the appropriate button (unless password restrictions apply). The order as presented in this manual is appropriate for an initial setup.

Each of these functions is described in greater detail in the following procedures. The VFD screen text that accompanies each operation is reproduced, at the appropriate point in the procedure, in a **Ariel Narrow Bold** type style. Pushbutton names are printed in *Oblique* type.

### 4.3 The System Function

The sub functions of the *System* function are described below. Specific procedures for their use follow the descriptions:

- **Auto-Cal:** Used to define an automatic calibration sequence and/or start an Auto-Cal.
- **PSWD:** Security can be established by choosing a 5 digit password (PSWD) from the standard ASCII character set. (See *Installing or Changing the Password*, below, for a table of ASCII characters available.) Once a unique password is assigned and activated, the operator **MUST** enter the **UNIQUE** password to gain access to set-up functions which alter the instrument's operation, such as setting the instrument span or zero setting, adjusting the alarm setpoints, or defining analysis ranges.
  - After a password is assigned, the operator must log out to activate it. Until then, anyone can continue to operate the instrument without entering the new password.
  - Only one password can be defined. Before a unique password is assigned, the system assigns TETAI by default. This allows access to anyone. After a unique password is assigned, to defeat the security, the password must be changed back to TETAI.
- **Logout:** Logging out prevents unauthorized tampering with analyzer settings.
- **More:** Select and enter More to get a new screen with additional sub functions listed.
- **Self-Test:** The instrument performs a self-diagnostic test to check the integrity of the power supply, output boards and amplifiers.
- **Version:** Displays Manufacturer, Model, and Software Version of instrument.
- **Show Negative:** The operator selects whether display can show negative oxygen readings or not.
- **TRAK/HLD:** The operator sets whether the instrument analog outputs track the concentration change during calibration and sets a time delay for the concentration alarms after calibration



#### 4.3.1 *Tracking the Oxygen Readings during Calibration and Alarm delay*

The user has the option of setting the preference as to whether the analog outputs track the display readings during calibration or not. To set the preference, press the System key once and the first System menu will appear in the VFD display:

**TRAK/HLD Auto-Cal**

**PSWD Logout More**

**TRAK/HLD** should be blinking. To enter this system menu press the Enter key once:

**Output Sttng: TRACK**

**Alarm Dly: 10 min**

—or—

**Output Sttng: HOLD**

**Alarm Dly: 10 min**

In the first line, **TRACK** or **HOLD** should be blinking. The operator can toggle between **TRACK** and **HOLD** with the Up or Down keys. When **TRACK** is selected, the analog outputs (0-1 VDC and 4-20 ma) and the range ID contacts will track the instrument readings during calibration (either zero or span). **TRACK** is the factory default.

When **HOLD** is selected, the analog outputs (0-1 VDC and 4-20 ma) and the range ID contacts will freeze on their last state before entering one of the calibration modes. When the instrument returns to the Analyze mode, either by a successful or an aborted calibration, there will be a three-minute delay before the analog outputs and the range ID contacts start tracking again.

The concentration alarms freeze on their last state before entering calibration regardless of selecting **HOLD** or **TRACK**. But, when **HOLD** is selected the concentration alarms will remain frozen for the time displayed in the second line of the **TRAK/HLD** menu after the analyzer returns to the Analyze mode.



The factory default is three minutes, but the delay time is programmable. To adjust to delay time use the Left or Right arrow keys. When the time displayed on the second line blinks, it can be adjusted by Pressing the Up or Down keys to increase or decrease its value. The minimum delay is 1 minute, the maximum is 30.

This preference is stored in non-volatile memory so that it is recovered if power is removed from the instrument.

### 4.3.2 Setting up an Auto-Cal

When proper automatic valving is connected (see Chapter 3, *Installation*), the Analyzer can cycle itself through a sequence of steps that automatically calibrates the instrument.

*Note: If you require highly accurate Auto-Cal timing, use external Auto-Cal control where possible. The internal clock in the Model 3000ZA is accurate to 2-3 %. Accordingly, internally scheduled calibrations can vary 2-3 % per day.*

To setup an Auto-Cal cycle:

Choose **System** from the Function buttons. The LCD will display five sub functions.

TRAK/HLD Auto-Cal  
PSWD Logout More

Use    arrows to blink **Auto-Cal**, and press *Enter*. A new screen for **Span/Zero** set appears.

Span OFF Nxt: 0d 0h  
Zero OFF Nxt: 0d 0h

Press    arrows to blink Span (or Zero), then press *Enter* again. (You won't be able to set OFF to ON if a zero interval is entered.) A **Span Every ...** (or **Zero Every ...**) screen appears.

Span Every 0 d  
Start 0 h from now

Use    arrows to set an interval value, then use    arrows to move to the start-time value. Use    arrows to set a start-time value.

To turn ON the Span and/or Zero cycles (to activate Auto-Cal): Press **System** again, choose **Auto-Cal**, and press *Enter* again. When the Span/Zero values screen appears, use the    arrows to blink the Span (or

Zero) OFF/ON field. Use    arrows to set the OFF/ON field to ON. You can now turn these fields ON because there is a nonzero span interval defined.

### 4.3.3 Password Protection

If a password is assigned, then setting the following system parameters can be done only after the password is entered: span and zero settings, alarm setpoints, analysis range definitions, switching between autoranging and manual override, setting up an auto-cal, and assigning a new password. However, the instrument can still be used for analysis or for initiating a self-test without entering the password.

If you have decided not to employ password security, use the default password TETAI. This password will be displayed automatically by the microprocessor. The operator just presses the *Enter* key to be allowed total access to the instrument's features.

*Note: If you use password security, it is advisable to keep a copy of the password in a separate, safe location.*

#### 4.3.3.1 ENTERING THE PASSWORD

To install a new password or change a previously installed password, you must key in and *Enter* the old password first. If the default password is in effect, pressing the *Enter* button will enter the default TETAI password for you.

Press *System* to enter the System mode.

TRAK/HLD Auto—Cal  
PSWD Logout More

Use the    arrow keys to scroll the blinking over to **PSWD**, and press *Enter* to select the password function. Either the default TETAI password or AAAAA place holders for an existing password will appear on screen depending on whether or not a password has been previously installed.

T E T A I  
Enter PWD

—or—

A A A A A  
Enter PWD



The screen prompts you to enter the current password. If you are not using password protection, press *Enter* to accept TETAI as the default password. If a password has been previously installed, enter the password using the `←` arrow keys to scroll back and forth between letters, and the `→` arrow keys to change the letters to the proper password. Press *Enter* to enter the password.

If the password is accepted, the screen will indicate that the password restrictions have been removed and you have clearance to proceed.

**PSWD Restrictions  
Removed**

In a few seconds, you will be given the opportunity to change this password or keep it and go on.

**Change Password?  
<ENT>=Yes <ESC>=No**

Press *Escape* to move on, or proceed as in *Changing the Password*, below.

#### **4.3.3.2 INSTALLING OR CHANGING THE PASSWORD**

If you want to install a password, or change an existing password, proceed as above in *Entering the Password*. When you are given the opportunity to change the password:

**Change Password?  
<ENT>=Yes <ESC>=No**

Press *Enter* to change the password (either the default TETAI or the previously assigned password), or press *Escape* to keep the existing password and move on.

If you chose *Enter* to change the password, the password assignment screen appears.

**T E T A I  
<ENT> To Proceed**

—or—

**A A A A A  
<ENT> To Proceed**



Enter the password using the    arrow keys to move back and forth between the existing password letters, and the    arrow keys to change the letters to the new password. The full set of 94 characters available for password use are shown in the table below.

Characters Available for Password Definition:

A	B	C	D	E	F	G	H	I	J
K	L	M	N	O	P	Q	R	S	T
U	V	W	X	Y	Z	[	¥	]	^
_	`	a	b	c	d	e	f	g	h
i	j	k	l	m	n	o	p	q	r
s	t	u	v	w	x	y	z	{	
}	®	!	"	#	\$	%	&	'	(
)	*	+	'	-	.	/	0	1	2
3	4	5	6	7	8	9	:	;	<
=	>	?	@						

When you have finished typing the new password, press *Enter*. A verification screen appears. The screen will prompt you to retype your password for verification.

A A A A A  
Retype PWD To Verify

Wait a moment for the entry screen. You will be given clearance to proceed.

A A A A A  
<ENT> TO Proceed

Use the arrow keys to retype your password and press *Enter* when finished. Your password will be stored in the microprocessor and the system will immediately switch to the Analyze screen, and you now have access to all instrument functions.

If all alarms are defeated, the Analyze screen appears as:

0.0 ppm Anlz  
Range: 0 — 100





If an alarm is tripped, the second line will change to show which alarm it is:

0.0 ppm Anlz  
AL—1

*Note: If you log off the system using the logout function in the system menu, you will now be required to re-enter the password to gain access to Span, Zero, Alarm, and Range functions.*

#### 4.3.4 Logout

The Logout function provides a convenient means of leaving the analyzer in a password protected mode without having to shut the instrument off. By entering Logout, you effectively log off the instrument leaving the system protected against use until the password is reentered. To log out, press the **System** button to enter the System function.

TRAK/HLD Auto—Cal  
PSWD Logout More

Use the **\_\_** arrow keys to position the blinking over the Logout function, and press **Enter** to Log out. The screen will display the message:

Protected Until  
Password Reentered

#### 4.3.5 System Self-Diagnostic Test

The Model 3000ZA has a built-in self-diagnostic testing routine. Pre-programmed signals are sent through the power supply, output board and sensor circuit. The return signal is analyzed, and at the end of the test the status of each function is displayed on the screen, either as OK or as a number between 1 and 3. (See *System Self Diagnostic Test* in Chapter 5 for number code.)

The self diagnostics are run automatically by the analyzer whenever the instrument is turned on, but the test can also be run by the operator at any time. To initiate a self diagnostic test during operation:

Press the **System** button to start the System function.



TRAK/HLD Auto—Cal  
PSWD Logout More

Use the    arrow keys to blink **More**, then press *Enter*.

**Version Self—Test**

Use the    arrow keys again to move the blinking to the **Self—Test** function. The screen will follow the running of the diagnostic.

**RUNNING DIAGNOSTIC**  
Testing Preamp — 83

During preamp testing there is a countdown in the lower right corner of the screen. When the testing is complete, the results are displayed.

**Power: OK Analog: OK**  
**Preamp: 3**

The module is functioning properly if it is followed by OK. A number indicates a problem in a specific area of the instrument. Refer to Chapter 5 *Maintenance and Troubleshooting* for number-code information. The results screen alternates for a time with:

**Press Any Key**  
**To Continue...**

Then the analyzer returns to the initial System screen.

#### **4.3.6 Version Screen**

Move the    arrow key to More and press *Enter*. With **Version** blinking, press *Enter*. The screen displays the manufacturer, model, and software version information.

#### **4.3.7 Showing Negative Oxygen Readings**

For software version 1.4.4 or later, the instrument only displays oxygen readings that are positive or zero. The instrument can be reconfigured to show negative readings if sensor output drifts below zero. This situation may arise after the instrument has been zeroed. As time progresses, the sensor may drift below the zero calibration setpoint.

To show negative oxygen readings on the display:

Press the *System* key



TRAK/HLD Auto—Cal

PSWD Logout More

Use the `__` arrow keys to blink **More**, then press *Enter*.

Version Self—Test

Show\_Negative=NO

Use the `__` arrow keys and select “ Show\_Negative = NO”.

Use the `__` arrow keys to toggle from NO to YES.

Press the *Escape* key twice to return to the analyze mode.

This preference is stored in non-volatile memory so the configuration is remembered after a power shutdown. If the instrument is cold started, it will go back to the default case where negative oxygen readings are not shown.

#### 4.4 The Zero and Span Functions

Zeroing is not required in order to achieve the published accuracy specification of this unit however, zeroing will eliminate offset error contributed by the sensor, electronics and the internal and external sampling systems. It will improve performance beyond published specification limits.

The analyzer is calibrated using zero and span gases.

Any suitable oxygen-free gas can be used for zero gas as long as it is known to be oxygen free and does not react adversely with the sample system.

A span gas with a known oxygen concentration in the range of 70–100% of full scale of the range of interest is recommended. In the 0-10 ppm range, 8 ppm span gas would be best suited.

Connect the calibration gases to the analyzer according to the instructions given in Section 3.3.1, Gas Connections, observing all the prescribed precautions.

**Shut off the gas pressure before connecting it to the analyzer, and be sure to limit the pressure to 40 psig or less when turning it back on.**

Readjust the gas pressure into the analyzer until the flowrate (as read on the analyzer’s SLPM flowmeter) settles between 0.1 and 2.4 SLPM (approximately 0.2 - 5 SCFH).



If you are using password protection, you will need to enter your password to gain access to either of these functions. Follow the instructions in sections 4.3.3 to enter your password. Once you have gained clearance to proceed, you can enter the *Zero* or *Span* function.

#### 4.4.1 Zero Cal

The *Zero* button on the front panel is used to enter the zero calibration function. Zero calibration can be performed in either the automatic or manual mode. In the **automatic** mode, an internal algorithm compares consecutive readings from the sensor to determine when the output is within the acceptable range for zero. In the **manual** mode, the operator determines when the reading is within the acceptable range for zero. Make sure the zero gas is connected to the instrument. If you get a CELL FAILURE message skip to Section 4.4.1.3.

##### 4.4.1.1 AUTO MODE ZEROING

Press *Zero* to enter the zero function mode. The screen allows you to select whether the zero calibration is to be performed automatically or manually. Use the `__` arrow keys to toggle between **AUTO** and **MAN** zero settling. Stop when **AUTO** appears, blinking, on the display.

```
Zero: Settling: AUTO
<ENT> To Begin
```

Press *Enter* to begin zeroing.

```
#### PPM Zero
Slope=#### ppm/s
```

The beginning zero level is shown in the upper left corner of the display. As the zero reading settles, the screen displays and updates information on Slope (unless the Slope starts within the acceptable zero range and does not need to settle further).

Then, and whenever Slope is less than 0.08 for at least 3 minutes, instead of Slope you will see a countdown: 5 Left, 4 Left, and so fourth. These are five steps in the zeroing process that the system must complete, AFTER settling, before it can go back to Analyze.

```
#### PPM Zero
4 Left=### ppm/s
```



The zeroing process will automatically conclude when the output is within the acceptable range for a good zero. Then the analyzer automatically returns to the Analyze mode.

#### 4.4.1.2 MANUAL MODE ZEROING

Press **Zero** to enter the Zero function. The screen that appears allows you to select between automatic or manual zero calibration. Use the **\_** keys to toggle between **AUTO** and **MAN** zero settling. Stop when **MAN** appears, blinking, on the display.

**Zero: Settling: Man**  
**<ENT> To Begin**

Press **Enter** to begin the zero calibration. After a few seconds the first of five zeroing screens appears. The number in the upper left hand corner is the first-stage zero offset. The microprocessor samples the output at a predetermined rate. It calculates the differences between successive samplings and displays the rate of change as Slope= a value in parts per million per second (ppm/s).

#### ppm Zero  
Slope=#### ppm/s

*Note: It takes several seconds for the true Slope value to display. Wait about 10 seconds. Then, wait until Slope is sufficiently close to zero before pressing Enter to finish zeroing .*

Generally, you have a good zero when Slope is less than 0.05 ppm/s for about 30 seconds. When Slope is close enough to zero, press **Enter**. In a few seconds, the screen will update.

Once zero settling is completed, the information is stored in the microprocessor, and the instrument automatically returns to the Analyze mode.

#### 4.4.1.3 CELL FAILURE

Cell failure in the 3000ZA is usually associated with inability to zero the instrument down to a satisfactorily low ppm reading. When this occurs, the instrument will still Zero, but the 3000ZA system alarm trips, and the LCD displays a failure message.

## ppm Anlz



### CELL FAIL/ ZERO HIGH

Before replacing the cell:

- a. Check your span gas to make sure it is within specifications.
- b. Check for leaks up-stream from the cell, where oxygen may be leaking into the system.

If there are no leaks and the span gas is within specification, replace the cell as described in chapter 5, *Maintenance*.

#### 4.4.2 Span Cal

The *Span* button on the front panel is used to span calibrate the analyzer. Span calibration can be performed using the automatic mode, where an internal algorithm compares consecutive readings from the sensor to determine when the output matches the span gas concentration. Span calibration can also be performed in manual mode, where the operator determines when the span concentration reading is acceptable and manually exits the function.

##### 4.4.2.1 AUTO MODE SPANNING

Press *Span* to enter the span function. The screen that appears allows you to select whether the span calibration is to be performed automatically or manually. Use the `__` arrow keys to toggle between **AUTO** and **MAN** span settling. Stop when **AUTO** appears, blinking, on the display.

Span: Settling: AUTO  
<ENT> For Next

Press *Enter* to move to the next screen.

Calib. Holding time  
Cal hold: 5 min

This menu allows the operator to set the time the analyzer should be held in the **AUTO** span mode, after the readings of the analyzer settle. Five minutes is the default, but it could be adjusted anywhere from 1 to 60 minutes by using the `__` keys.

Press *Enter* to move to the next screen.

Span Val: 000008.00  
<ENT>Span <UP>Mod #



Use the **←** arrow keys to enter the oxygen-concentration mode. Use the **←** arrow keys to blink the digit you are going to modify. Use the **→** arrow keys again to change the value of the selected digit. When you have finished typing in the concentration of the span gas you are using, press **Enter** to begin the Span calibration.

```
#### ppm Span
Slope=#### ppm/s
```

The beginning span value is shown in the upper left corner of the display. As the span reading settles, the screen displays and updates information on Slope. Spanning automatically ends when the span output corresponds, within tolerance, to the value of the span gas concentration. Then the instrument automatically returns to the analyze mode.

#### 4.4.2.2 MANUAL MODE SPANNING

Press **Span** to start the Span function. The screen that appears allows you to select whether the span calibration is to be performed automatically or manually.

```
Span: Settling:MAN
<ENT> For Next
```

Use the **←** keys to toggle between **AUTO** and **MAN** span settling. Stop when **MAN** appears, blinking, on the display. Press **Enter** to move to the next screen.

Press **Enter** to move to the next screen.

```
Calib. Holding time
Cal hold: 5 min
```

This menu allows the operator to set the time the analyzer should be held in the AUTO span mode. It does not have any effect in the MANUAL mode. Just press **Enter** key to continue.

```
Span Val: 000008.00
<ENT>Span <UP>Mod #
```

Press **←** (<UP>) to permit modification (**Mod #**) of span value.

Use the arrow keys to enter the oxygen concentration of the span gas you are using. The **←** arrows choose the digit, and the **→** arrows choose the value of the digit.

Press *Enter* to enter the span value into the system and begin the span calibration.

Once the span has begun, the microprocessor samples the output at a predetermined rate. It calculates the difference between successive samplings and displays this difference as a Slope on the screen. It takes several seconds for the first Slope value to display. Slope indicates the rate of change of the Span reading. It is a sensitive indicator of stability.


```
####    % Span  
Slope=#### ppm/s
```

When the Span value displayed on the screen is sufficiently stable, press *Enter*. (Generally, when the Span reading changes by 1% or less of the full scale of the range being calibrated, for a period of ten minutes it is sufficiently stable.) Once *Enter* is pressed, the Span reading changes to the correct value. The instrument then automatically enters the Analyze function.

#### 4.4.3 Span Failure

The analyzer checks the output of the cell at the end of the span. If the raw output of the cell is too low, the span will not be accepted. The analyzer will return to the previous calibration values, trigger the System Alarm, and display in the VFD:

**Span Failed!!**

This message will be shown for five seconds and the instrument shall return to the Analyze mode. In the upper right hand corner of the VFD display “**FCAL**” will be shown. This message flag will help the operator troubleshoot in case calibration was initiated remotely. To reset the alarm and the flag message, the unit must be turned off by cycling the standby key . It will not reset if the next span cycle is correct.

A trace cell is unlikely to fail span. As explained before, when the sensor reaches the end of its useful life, the zero offset begins to rise until the analyzer finds the zero unsatisfactory. Nevertheless, feeding the wrong span gas or electronics failure could set this feature off at the end of the span. Consider this before replacing the cell.





## 4.5 The Alarms Function

The Model 3000ZA is equipped with 2 fully adjustable concentration alarms and a system failure alarm. Each alarm has a relay with a set of form "C" contacts rated for 3 amperes resistive load at 250 VAC. See Table 3-2 in Chapter 3, *Installation* and/or the Interconnection Diagram included at the back of this manual for relay terminal connections.

The system failure alarm has a fixed configuration as described in chapter 3 *Installation*.

The concentration alarms can be configured from the front panel as either *high* or *low* alarms by the operator. The alarm modes can be set as *latching* or *non-latching*, and either *failsafe* or *non-failsafe*, or, they can be *defeated* altogether. The setpoints for the alarms are also established using this function.

Decide how your alarms should be configured. The choice will depend upon your process. Consider the following four points:

1. Which if any of the alarms are to be high alarms and which if any are to be low alarms?
2. Setting an alarm as HIGH triggers the alarm when the oxygen concentration rises above the setpoint. Setting an alarm as LOW triggers the alarm when the oxygen concentration falls below the setpoint.
3. Decide whether you want the alarms to be set as:
  - Both high (high and high-high) alarms, or
  - One high and one low alarm, or
  - Both low (low and low-low) alarms.
4. Are either or both of the alarms to be configured as failsafe?
5. In failsafe mode, the alarm relay de-energizes in an alarm condition. For non-failsafe operation, the relay is energized in an alarm condition. You can set either or both of the concentration alarms to operate in failsafe or non-failsafe mode.
6. Are either of the alarms to be latching?
7. In latching mode, once the alarm or alarms trigger, they will remain in the alarm mode even if process conditions revert



back to non-alarm conditions. This mode requires an alarm to be recognized before it can be reset. In the non-latching mode, the alarm status will terminate when process conditions revert to non-alarm conditions.

8. Are either of the alarms to be defeated?
9. The defeat alarm mode is incorporated into the alarm circuit so that maintenance can be performed under conditions which would normally activate the alarms.
10. The defeat function can also be used to reset a latched alarm. (See procedures, below.)

If you are using password protection, you will need to enter your password to access the alarm functions. Follow the instructions in Section 4.3.3 to enter your password. Once you have clearance to proceed, enter the Alarm function.

Press the *Alarm* button on the front panel to enter the Alarm function. Make sure that **AL-1** is blinking.

**AL-1 AL-2**  
**Choose Alarm**

Set up alarm 1 by moving the blinking over to AL-1 using the \_\_\_ arrow keys. Then press *Enter* to move to the next screen.

**AL-1 10 ppm HI**  
**Dft-N Fs-N Ltch-N**

Five parameters can be changed on this screen:

- Value of the alarm setpoint, **AL-1 #####** ppm (oxygen); value can be set from 0 to 10,000.00 ppm although the sensor output is good only to 250 ppm
- Out-of-range direction, **HI** or **LO**
- Defeated? **Dft-Y/N** (Yes/No)
- Failsafe? **Fs-Y/N** (Yes/No)
- Latching? **Ltch-Y/N** (Yes/No).

To define the setpoint, use the \_\_\_ arrow keys to move the blinking over to **AL-1 #####**. Then use the \_\_\_ arrow keys to change the number. Holding down the key speeds up the incrementing or decrementing. (Remember, the setpoint units are ppm O<sub>2</sub>.)



To set the other parameters use the **←** arrow keys to move the blinking over to the desired parameter. Then use the **→** arrow keys to change the parameter.

Once the parameters for alarm 1 have been set, press **Alarms** again, and repeat this procedure for alarm 2 (**AL-2**).

To reset a latched alarm, go to **Dft-** and then press either **→** two times or **←** two times. (Toggle it to Y and then back to N.)

—or—

Go to **Ltch-** and then press either **→** two times or **←** two times. (Toggle it to N and back to Y.)

## 4.6 The Range Function

The Range function allows the operator to program up to three concentration ranges to correlate with the DC analog outputs. If no ranges are defined by the user, the instrument defaults to:

Low = 0–10 ppm

Med = 0–100 ppm

High = 0–250 ppm.

The Model 3000ZA is set at the factory to default to autoranging. In this mode, the microprocessor automatically responds to concentration changes by switching ranges for optimum readout sensitivity. If the current range limits are exceeded, the instrument will automatically shift to the next higher range. If the concentration falls to below 85% of full scale of the next lower range, the instrument will switch to that range. A corresponding shift in the DC percent-of-range output, and in the range ID outputs, will be noticed.

The autoranging feature can be overridden so that analog output stays on a fixed range regardless of the oxygen concentration detected. If the concentration exceeds the upper limit of the range, the DC output will saturate at 1 VDC (20 mA at the current output).

However, the digital readout and the RS-232 output of the concentration are unaffected by the fixed range. They continue to read accurately with full precision. See *Front Panel* description in Chapter 1.

### 4.6.1 Setting the Analog Output Ranges

To set the ranges, enter the range function mode by pressing the **Range** button on the front panel.



L—10 M—100  
H—250 Mode—AUTO

Use the    arrow keys to blink the range to be set: low (L), medium (M), or high (H).

Use the    arrow keys to enter the upper value of the range (all ranges begin at 0 ppm). Repeat for each range you want to set. Press **Enter** to accept the values and return to Analyze mode. (See note below.)

*Note: The ranges must be increasing from low to high, for example, if range 1 is set as 0–10 ppm and range 2 is set as 0–100 ppm, range 3 cannot be set as 0– 50 ppm since it is lower than range 2.*

#### 4.6.2 Fixed Range Analysis

The autoranging mode of the instrument can be overridden, forcing the analyzer DC outputs to stay in a single predetermined range.

To switch from autoranging to fixed range analysis, enter the range function by pressing the **Range** button on the front panel.

Use the    arrow keys to move the blinking over **AUTO**.

Use the    arrow keys to switch from **AUTO** to **FX/LO**, **FX/MED**, or **FX/HI** to set the instrument on the desired fixed range (low, medium, or high).

L—10 M—100  
H—250 Mode—FX/LO

—or—

L—10 M—10 0  
H—250 Mode—FX/MED

—or—

L—10 M—10 0  
H—250 Mode—FX/HI

Press **Escape** to re-enter the Analyze mode using the fixed range.

*Note: When performing analysis on a fixed range, if the oxygen concentration rises above the upper limit (or default value)*



*as established by the operator for that particular range, the output saturates at 1 VDC (or 20 mA). However, the digital readout and the RS-232 output continue to read the true value of the oxygen concentration regardless of the analog output range.*

## 4.7 The Analyze Function

Normally, all of the functions automatically switch back to the Analyze function when they have completed their assigned operations. Pressing the **Escape** button in many cases also switches the analyzer back to the Analyze function. Alternatively, you can press the **Analyze** button at any time to return to analyzing your sample.

## 4.8 Signal Output

The standard Model 3000ZA Trace Oxygen Analyzer is equipped with two 0–1 VDC analog output terminals accessible on the back panel (one concentration and one range ID), and two isolated 4–20 mA DC current outputs (one concentration and one range ID).

See *Rear Panel* in Chapter 3, *Installation* for connection details.

The signal output for concentration is linear over the currently selected analysis range. For example, if the analyzer is set on range that was defined as 0–100 ppm O<sub>2</sub>, then the output would be:

*Table 4-1: Output Signals*

ppm O <sub>2</sub>	Voltage Signal	Current Signal
	Output (VDC)	Output (mA DC)
0	0.0	4.0
10	0.1	5.6
20	0.2	7.2
30	0.3	8.8
40	0.4	10.4
50	0.5	12.0
60	0.6	13.6
70	0.7	15.2



80	0.8	16.8
90	0.9	18.4
100	1.0	20.0

The analog output signal has a voltage which depends on the oxygen concentration AND the currently activated analysis range. To relate the signal output to the actual concentration, it is necessary to know what range the instrument is currently on, especially when the analyzer is in the autoranging mode.

To provide an indication of the range, a second pair of analog output terminals are used. They generate a steady preset voltage (or current when using the current outputs) to represent a particular range. The following table gives the range ID output for each analysis range:

*Table 4-2: Range ID Output Voltage*

	Range	Voltage (V)	Current (mA)
LO	0.25		8
MED	0.50		12
HI	0.75		16

**IMPORTANT:** In the event of loss of flow through the analyzer, if the vent is vented to a location of high oxygen content, oxygen will back diffuse through the vent line and enter the cell. This can saturate the cell with oxygen and require a long purge down time before the sensor can recover. However, the ZrO<sub>2</sub> sensor recovers faster than the microfuel oxygen sensor. In the event that flow is to be interrupted into the analyzer, it is suggested that the user do one of the following:

1. Bag the sensor in nitrogen during this time
2. Install a shut off valve on the vent port of the analyzer or somewhere within the users sample system.





## Maintenance

---

### 5.1 Routine Maintenance

Aside from normal cleaning and checking for leaks at the gas connections, routine maintenance is limited to replacing the sensor and fuses, and recalibration. For recalibration, see Section 4.4 *Calibration*.

**WARNING:** SEE WARNINGS ON THE TITLE PAGE OF THIS MANUAL.



### 5.2 Cell Replacement

The ZrO<sub>2</sub> sensor is a sealed transducer with no electrolyte to change or electrodes to clean. When the cell reaches the end of its useful life, it is replaced. The spent sensor should be discarded according to local regulations.

#### 5.2.1 Removing the Sensor

The ZrO<sub>2</sub> sensor is located inside the nylon cell block behind the front panel.

To remove an existing cell (refer to Figure 5-1):

1. Remove power to the instrument by unplugging the power cord at the power source.
2. Open the front panel door by pressing the release button on the top right corner of the door all the way in with a narrow gauge tool.
3. Unscrew the collar on the top assembly of the cell block from the bottom section of the cell block assembly. The sensor is attached to pin sockets on the bottom assembly.





4. Remove the old sensor and install a new sensor by matching the orientation notch on the sensor to the silkscreen on the sensor holder.

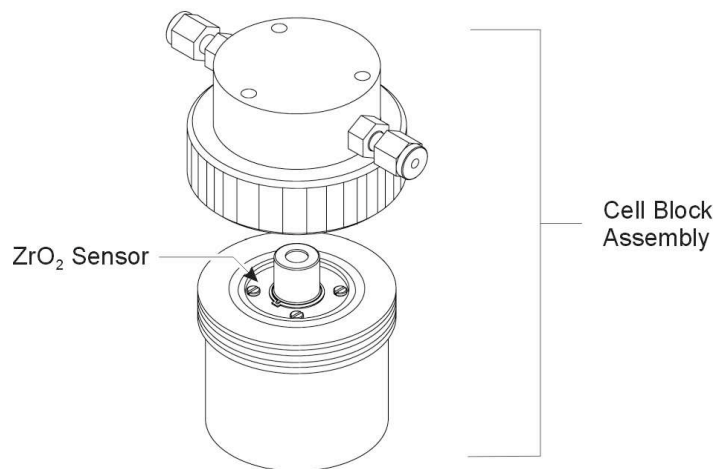


Figure 5-1: Replacing the ZrO<sub>2</sub> Sensor

### 5.3 Fuse Replacement

1. Place small screwdriver in notch, and pry cover off, as shown in Figure 5-2.

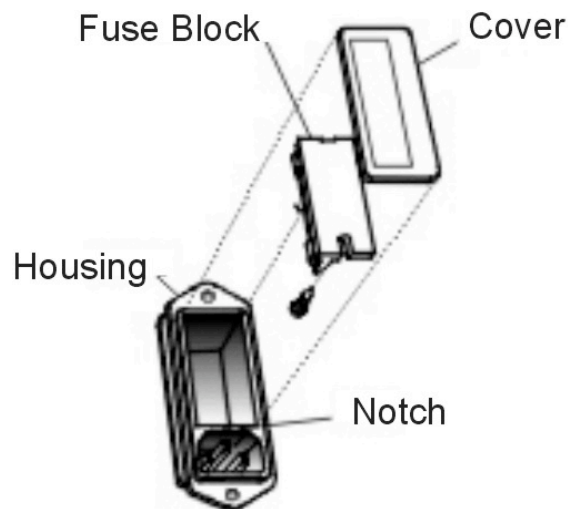


Figure 5-2: Removing Fuse Block from Housing

2. To change between American and European fuses, remove the single retaining screw, flip Fuse Block over 180 degrees, and replace screw.
3. Replace fuse as shown in Figure 5-3.
4. Reassemble Housing as shown in Figure 5-2.

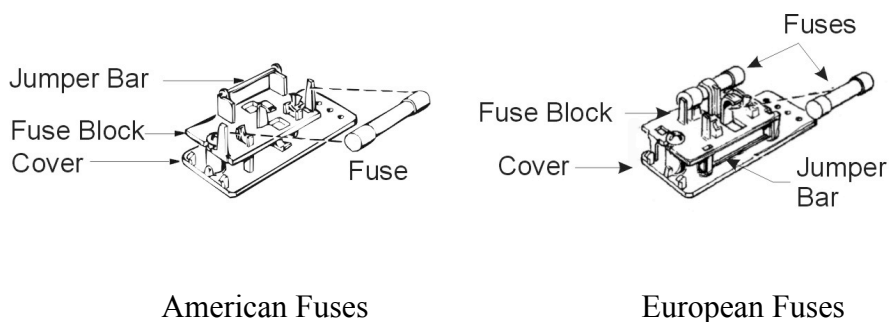


Figure 5-3: Installing Fuses

## 5.4 System Self Diagnostic Test

1. Press the **System** button to enter the system mode.
2. Use the **\_\_** arrow keys to move to More, and press **Enter**.
3. Use the **\_\_** arrow keys to move to Self-Test, and press **Enter**.

The following failure codes apply:

Table 5-1: Self-Test Failure Codes

<b>Power</b>	
0	OK
1	5 V Failure
2	15 V Failure
3	Both Failed
<b>Analog</b>	
0	OK
1	DAC A (0–1 V Concentration)
2	DAC B (0–1 V Range ID)
3	Both Failed



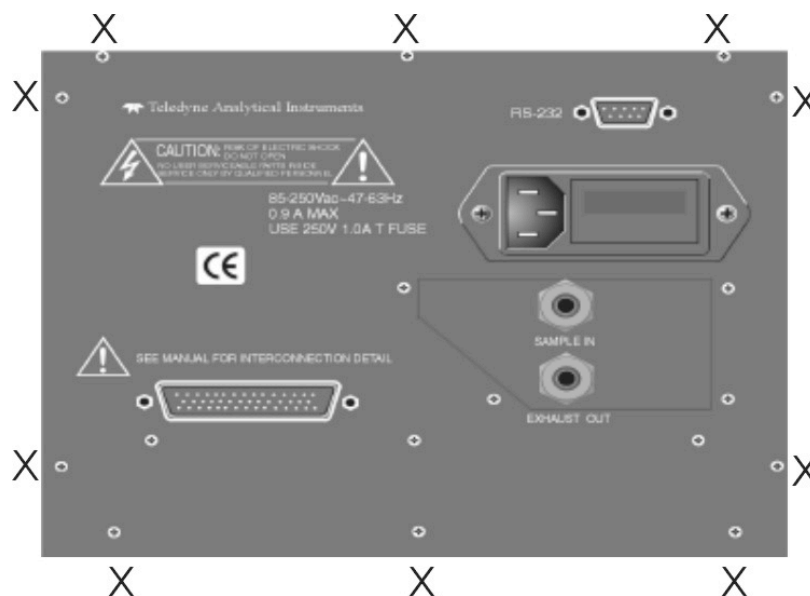
**Preamp**

0	OK
1	Zero too high
2	Amplifier output doesn't match test input
3	Both Failed

**5.5 Major Internal Components**

The zirconium sensor is accessed by unlatching and swinging open the front panel, as described earlier. Other internal components are accessed by removing the rear panel and sliding out the entire chassis. See Figure 5-4, below. The gas piping is illustrated in Figures 2-1 and Figure 2-2 and the major electronic components locations are shown in Figure 2-3, in Chapter 2.

**WARNING:** SEE WARNINGS ON THE TITLE PAGE OF THIS MANUAL.



*Figure 5-4: Rear Panel Removal  
(Remove only those screws marked with an X)*

The 3000ZA contains the following major components:

- Analysis Section
  - Zirconium oxide sensor
  - Cell block
  - Sample system
- Power Supply
- Microprocessor
- Displays
  - 5 digit LED meter
  - 2 line, 20 character, alphanumeric, VFD display
- RS-232 Communications Port

See the drawings in the Drawings section in back of this manual for details.

## 5.6 Cleaning

If instrument is unmounted at time of cleaning, disconnect the instrument from the power source. Close and latch the front-panel access door. Clean outside surfaces with a soft cloth dampened slightly with plain clean water. Do not use any harsh solvents such as paint thinner or benzene.

For panel-mounted instruments, clean the front panel as prescribed in the above paragraph. DO NOT wipe front panel while the instrument is controlling your process.

## 5.7 Troubleshooting

*Table 5-2: Troubleshooting*

Problem	Possible Cause	Solution
Erratic readings of the oxygen concentration as reported by the analyzer	Analyzer may have been calibrated in an inaccurate fashion.	1. Turn analyzer off, then back on again. Press <b>System</b> key when prompted by analyzer “ <b>Press System for Default Values</b> ”. This will return the default settings to the



		analyzer. 2. If erratic behavior continues, replace sensor.
	Atmospheric oxygen diffusing through vent and altering the oxygen level the sensor sees	Increase flow rate and/or length of vent tubing to dilute or minimize oxygen diffusion from vent to sensor.
Inaccurate zero operation (i.e. user has zeroed the instrument using a gas concentration much higher than normal for a zero gas).		Turn analyzer off, then back on again. Press <b>System</b> key when prompted by analyzer “ <b>Press System for Default Values</b> ”. This will return the analyzer to default calibration and zero settings. Now proceed to carefully calibrate and zero the analyzer.



## Appendix

---

### A-1 Specifications

**Packaging:** General Purpose

- Flush panel mount (Standard)
- Relay rack mount. Contains either one or two instruments in one 19" relay rack mountable plate (Optional).

**Sensor:** Zirconium oxide sensor.

**Cell Block:** Nylon

**Sample System:** All wetted parts of 316 stainless steel.

**90 % Response Time:** 65 seconds at 25 °C (77 °F) on 10 ppm range, 100 seconds on 1 ppm range

**Ranges:** Option a:  
0–10 to 0–200 ppm O<sub>2</sub> (0-1 ppm analysis possible)

Option b:  
0–10 to 0–1000 ppm O<sub>2</sub>

Autoranging with range ID output.

**Alarms:** One system-failure alarm contact to detect power failure or sensor-zero failure.

Two adjustable concentration threshold alarm contacts with fully programmable setpoints.

**Displays:** 2-line by 20-character, VFD screen, and one 5 digit LED display.

**Digital Interface:** Full duplex RS-232 communications port.

**Power:** Universal power supply 85-250 V ac, at 47-63 Hz.

**Operating Temperature:** 5-35 °C

**Accuracy:** ±2% of full scale at constant temperature (at calibrated range).

±5% of full scale over operating temperature range, except 0-1 ppm analysis range, once thermal equilibrium is reached.

±0.2 ppm on 0-1 ppm analysis range, once thermal equilibrium is reached.

**Analog outputs:** 0-1 VDC percent-of-range,

0-1 VDC range ID.

4-20 mA DC (isolated) percent-of-range,

4-20 mA DC (isolated) range ID (optional).

**Dimensions:** 19 cm high, 24.9 cm wide, 31 cm deep (6.96 in high, 8.7 in wide, 12.2 in deep).

## A-2 Recommended 2-Year Spare Parts List

Qty.	Part Number	Description
1	C65507A	Back Panel Board
1	C62371-A	Front Panel Board
1	C75734A	Trace Preamplifier Board
1	C73870-A	Main Computer Board
1	F10	Fuse, 2A, 250V 3AG Slow Blow
2	F1296	Fuse, 2A, 250V 5x20mm Slow Blow
1	A68314	Back Panel Connector Kit
1	A68729	Restrictor kit

A minimum charge is applicable to spare parts orders.

*Note: Orders for replacement parts should include the part number (if available) and the model and serial number of the instrument for which the parts are intended.*

Orders should be sent to:

### **TELEDYNE Analytical Instruments**

16830 Chestnut Street  
City of Industry, CA 91749-1580

Phone (626) 934-1500, Fax (626) 961-2538

Web: [www.teledyne-ai.com](http://www.teledyne-ai.com)  
or your local representative.

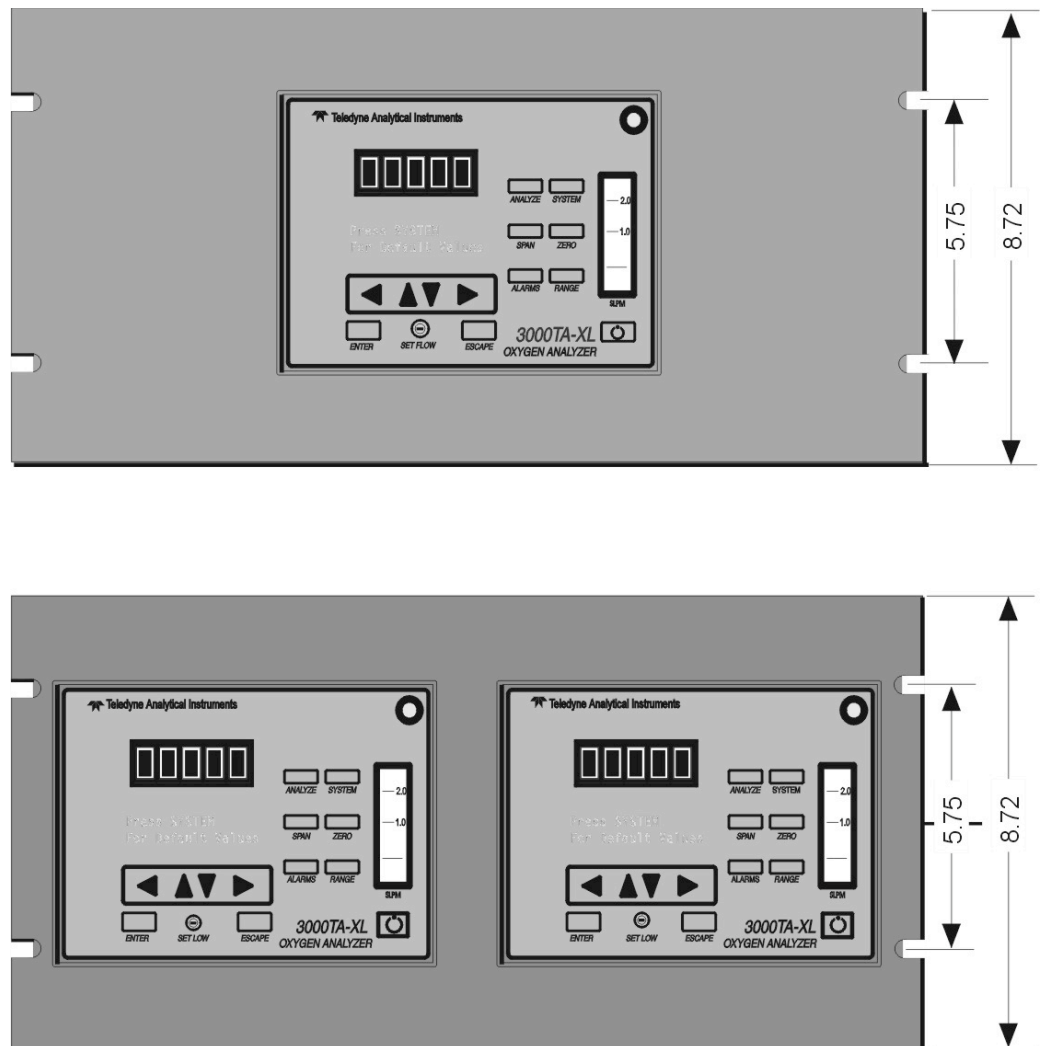


### A-3 Drawing List

D-75739 Final Assembly

D-75738 Outline Drawing

### A-4 19-inch Relay Rack Panel Mount



*Figure A-1: Single and Dual 19" Rack Mounts  
(dimensions in mm)*

## A.5 Application Notes

### 3000 SERIES ANALYZERS APPLICATION NOTES ON RESTRICTORS, PRESSURES, AND FLOW RECOMMENDATIONS

The 3000 series analyzers require reasonably regulated sample pressures. While the 3000 analyzers are not sensitive to variations of incoming pressure (provided they are properly vented to atmospheric pressure) the pressure must be maintained to provide a useable flow rate through the analyzer. Any line attached to sample vent should be 1/4 or larger in diameter.

#### FLOW RATE RECOMMENDATIONS:

A usable flow rate for a 3000 series analyzer is one which can be measured on the flowmeter. This is basically 0.2 - 2.4 SLPM . The optimum flow rate is 1 SLPM (mid scale). Note that response time is dependent on flow rate; a low flow rate will result in slow response to O<sub>2</sub> changes in the sample stream. The span flow rate should be the approximately same as the sample flow rate.

#### RESTRICTION DEVICES:

For proper operation, all 3000 series analyzers require a flow restriction device. This device is typically a restrictor or a valve. The restriction device serves two functions in the sample path.

1. It is used to limit the flow rate of the sample through the analyzer. A restrictor is chosen to operate over a range of pressures and provide a useable flow rate over that range.
2. The restriction device provides a pressure drop. This device is selected to provide the only significant pressure drop in the sample path.

#### RESTRICTOR KIT

The current revision of the 3000 series analyzers are supplied with a kit containing two restrictors and a union which are user installed. These parts are supplied to give the end user more flexibility when installing the analyzer. The restrictor kit is suitable for high and low

positive pressure applications as well as vacuum service applications (see manual for installation instructions).

The standard restrictor (BLUE DOT) is recommended for pressures between 5 and 50 PSIG. For positive low pressure application (5 psig or less) the unmarked restrictor is better suited. For unpressurized sample applications the marked restrictor should be used and configured for vacuum service.

*Note: For extremely low positive pressure applications (less than 2 psig) the vacuum service configuration should provide higher performance (higher flow rates).*

For vacuum service, the end user must supply a vacuum pump and a by-pass valve for the pump. A vacuum level of 5–10 inches of mercury should provide the optimum flow rate. **CAUTION: flow restrictors have very small orifices and may be plugged by small particles (.005" dia or larger)** A sample filter must be included in the sample line prior to the restrictor! (A 60 micron filter is recommended).

#### **3000TA EXAMPLES:**

**Example 1:** With a incoming pressure of 10 psig the std restrictor (blue dot) will provide a flow rate of 0.76 SLPM. Upstream of the restrictor the sample line pressure will be 10 psig, while down stream (including the cell) the pressure will be at atmospheric pressure (analyzer vented to atmospheric pressure). Note, all other pressure drops in the sample path are insignificant at these flow rates. This insures that the cell operates at atmospheric pressure. At very high flow rates (off scale of flow-meter), pressure drops other than the restriction device could become significant, and result in pressurizing the cell.

**Example 2:** A 3000TA is configured for vacuum service as follows. The unmarked restrictor is placed in the sample vent port. The down stream end of the restrictor is then connected to a vacuum pump and by-pass valve. The by-pass valve is adjusted to provide a flow rate of 1 SLPM. The sample pressure between the pump and the restrictor will be approximately -7 inches of mercury, while the pressure in the balance of the sample system including the cell will be approximately at atmospheric pressure (provided the sample flow into the analyzer is not blocked).

#### **BY-PASS:**

To improve the system response, a by-pass can be added to increase the sample flow rate to the analyzer by a factor of ten. A by-pass provides a sample flow path around the analyzer of 2 - 18 SCFH. typically.

### **CALIBRATION GAS:**

3000 series analyzer requirements for units with Auto-Cal options are as follows:

The customer must supply control valves (or restrictors) for any SPAN or ZERO gas source which is attached to the Auto-Cal ports. The valve should be adjusted to the same flow rate as the sample gas. When restrictors are used, the gas pressure must be adjusted to achieve the proper flow rate.

### **OPERATION WITHOUT A RESTRICTOR DEVICE:**

Operation without a restrictor device is not recommend as mentioned above. A 3000TA without any flow restrictor device was tested on 11-19-97. This results in a flow rate of 2.4 SLPM @ 1 PSIG. This is a cv of 0.023 for the standard sample system.

REFERENCE: FLOW\_1.XLS & FLOW\_2.XLS for information on flow rates at various pressures.

### **TAI PART NUMBERS**

Restrictor kit:	A68729	
Union (SS)	U11	
LP Restrictor	R2323	(low pressure / vac. service)
Std. Restrictor	R2324	Blue dot
Nut	N73	
Ferrule	F73	
Ferrule	F74	Both ferrules are required

### **CONVERSIONS:**

1 PSI = 2.04 inches of mercury (in. Hg.)

1 SCFH = 0.476 SLPM

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