OPERATING INSTRUCTIONS FOR

Model
BDS 3000

Oxygen Analyzer

DANGER

HIGHLY TOXIC AND OR FLAMMABLE LIQUIDS OR GASES MAY BE PRESENT IN THIS MONITORING SYSTEM.

PERSONAL PROTECTIVE EQUIPMENT MAY BE REQUIRED WHEN SERVICING THIS SYSTEM.

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.

P/N M71903
06/22/00
ECO # 00-0256

Teledyne Analytical Instruments

Warranty

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.

We reserve the right to employ any suitable material in the manufacture of our apparatus, and to make any alterations in the dimensions, shape or weight of any parts, in so far as such alterations do not adversely affect our warranty.

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:

- ❑ **BDS 3000-V:** Instrument configured for Vacuum Service
- ❑ **19" Rack Mnt:** The 19" Relay Rack Mount units are available with one BDS 3000 series analyzers installed in a standard 19" panel and ready to mount in a standard rack.

Table of Contents

Maintenance

Appendix

DANGER

COMBUSTIBLE GAS USAGE WARNING

This is a general purpose instrument designed for use in a nonhazardous 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.

Introduction

1.1 Overview

The Teledyne Analytical Instruments Model BDS 3000 Trace Oxygen Analyzer is a versatile microprocessor-based instrument for detecting oxygen at the parts-per-billion (ppb) level in a variety of gases. This manual covers the Model BDS 3000 General Purpose flush-panel and/or rack-mount units only. These units are for indoor use in a nonhazardous environment.

1.2 Typical Applications

A few typical applications of the Model BDS 3000 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 BDS 3000 Oxygen Analyzer is sophisticated yet simple to use. The main features of the analyzer include:

- A 2-line alphanumeric vacuum fluorescent display (VFD) screen, driven by microprocessor electronics, that continuously prompts and informs the operator.
- High resolution, accurate readings of oxygen content from low ppb levels through 100ppm. Large, bright, meter readout.

- New BDS Sensing technology, Patent pending.
- 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 0-100 ppb through 0-100 ppm) allow best match to users process and equipment, plus a fixed 100 ppm over range.
- 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.
- Two way RFI protection.
- RS-232 serial digital port for use with a computer or other digital communication device.
- Four analog outputs: two for measurement (0–1 V dc 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

BDS 3000: Standard model for sample under pressure

1.5 Front Panel (Operator Interface)

The standard BDS 3000 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.

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

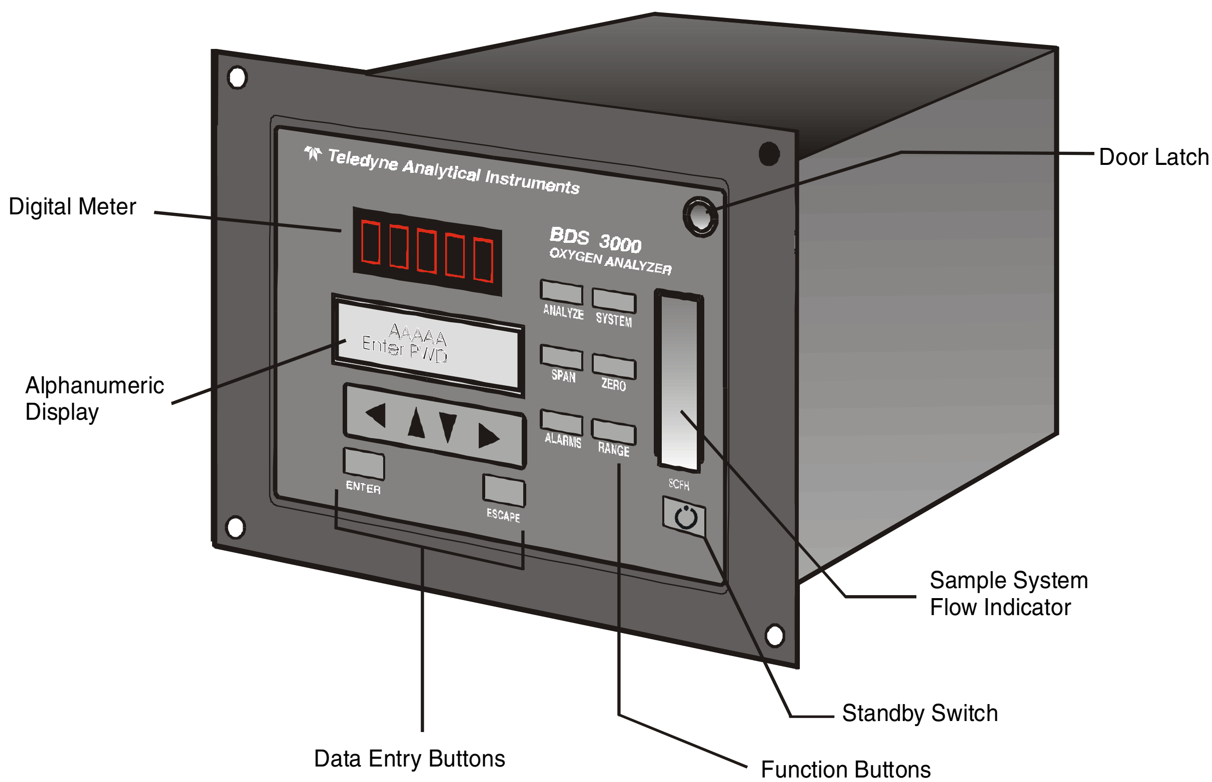


Figure 1-1: Model BDS 3000 Front Panel

- **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** Moves VFD display on to the next screen in a series. If none remains, returns to the *Analyze* screen.
- **Escape** Moves VFD display back to the previous screen in a series. If none remains, returns to the *Analyze* screen.

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 0-999.9 ppb and then switches to a continuous ppm readout from 0-100.00 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 0.1 to 2.0 standard liters per minute (SLPM) of nitrogen

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 BDS 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*.

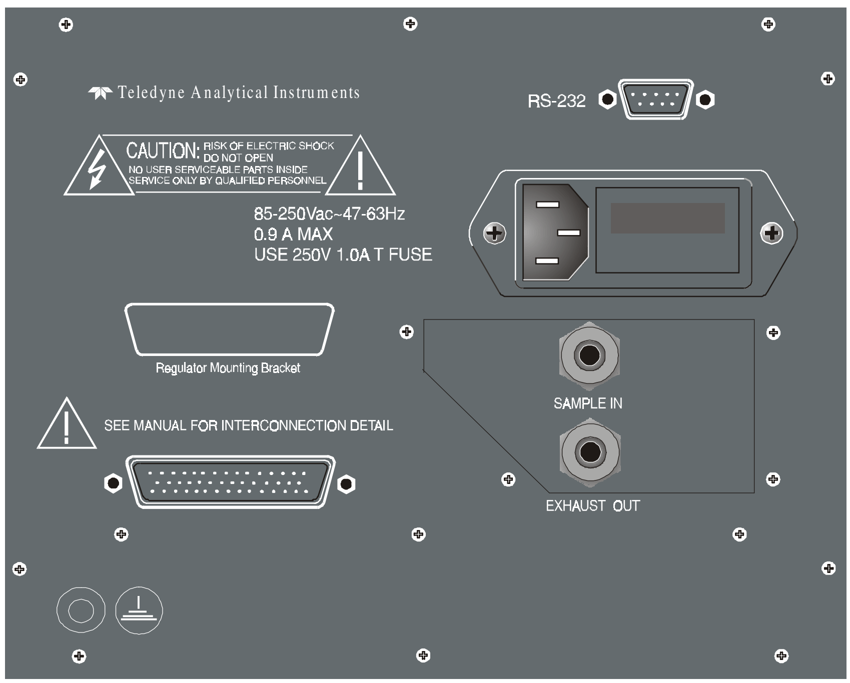


Figure 1-2: Model BDS 3000 Rear Panel

- **Power Connection** Universal AC power source.
- **Gas Inlet and Outlet** One inlet and one exhaust out.
- **Analog Outputs** 0–1 V dc oxygen concentration plus 0-1 V dc range ID, and isolated 4–20 mA dc oxygen concentration plus 4-20 mA dc range ID.
- **Alarm Connections** 2 concentration alarms and 1 system alarm.

- **RS-232 Port** Serial digital concentration signal output and control input.
- **Remote Probe** Used in the BDS 3000 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 implemented at this printing.

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

Operational Theory

2.1 Introduction

The analyzer is composed of three subsystems:

1. BDS 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 BDS Sensor is an electrochemical 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 BDS Sensor

2.2.1 Principles of Operation

The BDS oxygen sensor technology developed at Teledyne Analytical Instruments is a result of TAI's heavy investment on R&D and expertise established during the half-century's manufacturing of electrochemical oxygen sensor. It stands for Bipotentiostat Driven Sensor. A BDS oxygen sensor accurately translates the oxygen level in the sample gas into to an electrical current signal.

A Bipotentiostat is a combination of two potentiostats that share the reference electrode and the counter electrode. A potentiostat contains three electrodes: a working electrode, a reference electrode and a counter electrode. The potential at the working electrode is precisely controlled with respect to the reference electrode. The counter electrode is used to carry the current that flow through the sensor. A potentiostat is typically constructed with several operational amplifiers. The three electrodes in an electrochemical cell and the operational amplifiers in the potentiostat constitute a feedback-control loop. The potentiostat technology have been well accepted in the field of electrochemistry, and proven effective in eliminating polarization of the reference electrode and automatic compensating electric resistance in the cell.

In a BDS oxygen sensor, the sensing electrode is a working electrode that is under precise potential control as discussed above. A stable sensing electrode potential is very critical for an oxygen sensor to achieve high stability, low noise and large dynamic range. The reference electrode in a BDS sensor is a Ag/Ag_2O electrode which is well known for its stable electrode potential and compatibility with the KOH electrolyte in an oxygen sensor. The counter electrode is made of a Platinum wire.

The sensing process involves electrochemical reactions inside the sensor. At the sensing electrode, oxygen is reduced at the controlled potential:

$$O_2 + 2H_2O + 4e^- \qquad 4OH^- \qquad (1)$$

There is no net electrochemical reaction at the reference electrode since it is connected to the high impedance input of the operation amplifier.

The electrochemical reaction at the counter electrode is:

$$4OH^- \qquad O_2 + 2H_2O + 4e^- \qquad (2)$$

It is noteworthy that reaction (2) is reverse of the reaction (1). Therefore, nothing is changed inside a BDS sensor throughout the sensing process. This feature is beneficial for the sensor to achieve a long-term stability.

There are two resources of oxygen being reduced at the sensing electrode: from the sample gas and from the electrolyte (dissolved oxygen). The oxygen molecules in the sample gas diffuse to the sensing electrode through a diffusion barrier (controlled diffusion) to produce a current signal which is proportional to the oxygen level in the sample gas. However, the dissolved oxygen in the electrolyte also diffuse through the electrolyte to be reduced at the sensing electrode to cause a background current. This background current usually limits the detection limit of an oxygen sensor.

The merit of the BDS technology is the best use of the second potentiostat. The working electrode in the second potentiostat (the second working electrode) is positioned adjacent to the sensing electrode, and its potential is also precisely controlled to remove the dissolved oxygen and other possible impurities in the electrolyte efficiently. A novel material, Reticulated Vitreous Carbon (RVC) is used here for the second electrode. As the result, the BDS sensor manufactured according to the described technology achieves an outstanding feature of absolute zero – if there is no oxygen present in the sample gas, there will be no current output from the sensor.

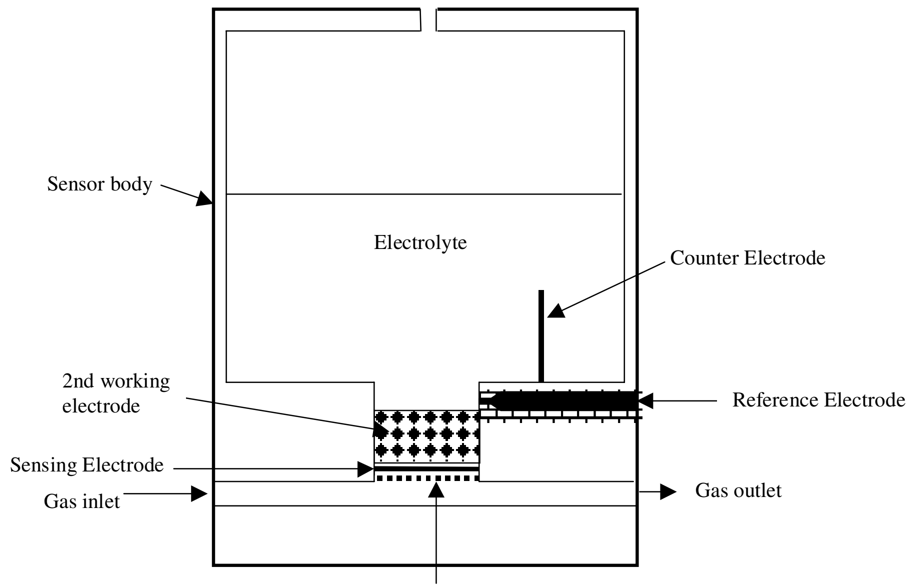


Figure 2.1 Schematic of a BDS oxygen sensor

Figure 2.1 shows the schematic of a BDS oxygen sensor. The sample gas enters the sensor through the Gas inlet port and exhaust at the Gas outlet. A portion of oxygen in the sample gas diffuses through the diffusion barrier to be reduced at the sensing electrode to form OH^- in the electrolyte. OH^- can move freely through the porous 2nd working electrode. At the Counter Electrode, OH^- is oxidized back to oxygen. While the 2nd working electrode allows OH^- to move through, it prevents the dissolved oxygen from the top portion of the sensor to reach the sensing electrode. The reference electrode provides a potential reference for both the sensing electrode and the 2nd working electrode.

NOTE: BDS technology and sensor is patent pending to Teledyne Analytical Instrument in the United State of America and many foreign countries.

To learn more about BDS technology, please visit TAI's web page at http://www.Teledyne-AI.com
To learn more about potentiostat, visit Electrochemical Society's web page at http://www.electrochem.org

2.2.2 Gas Flow Rate

The output from a BDS oxygen sensor is relatively insensitive to change of gas flow rate if operated in the range of 1 - 3 SCFH (in nitrogen). The output drops when the flow rate is below 1 SCFH. Figure 2.2 is a typical curve showing the sensor outputs at different flow rate.

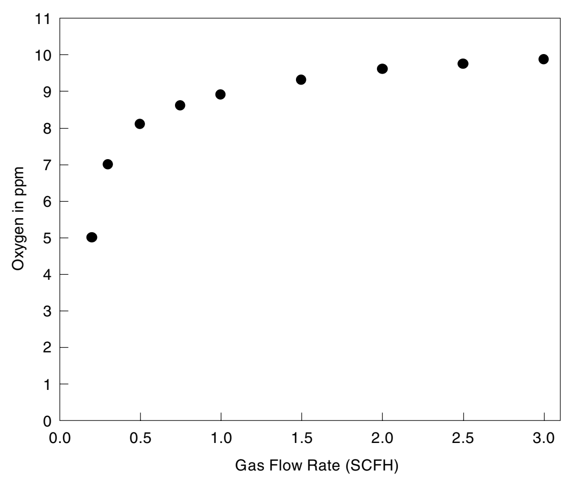


Figure 2.2 BDS sensor output at different gas flow rate

2.2.3 Gas Pressure

There is a flow restriction tube (from the back panel of the analyzer to the left side of the BDS sensor) built-in the analyzer. There should be no concern with sensor pressure effects if the analyzer vents to atmosphere. If the analyzer is not vented to atmosphere, it is important to make sure that the downstream pressure doesn't exceed 10 inch of water. A clogged vent or excessive pressure will force gas into the electrolyte and cause damage to the BDS sensor.

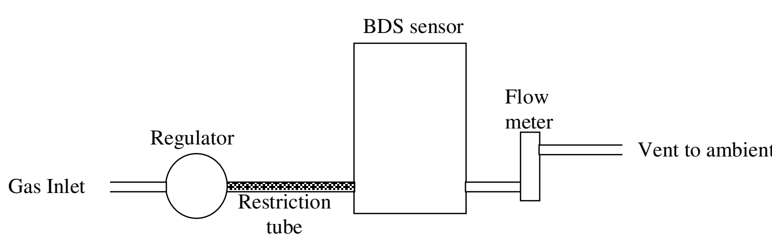


Figure 2.3 The gas sampling system of the BDS oxygen analyzer

2.2.4 Temperature effect

The raw output from a BDS oxygen sensor has a temperature coefficient about 0.25% /^{0}C. This temperature effect is compensated by the software throughout the operation temperature range (5 – 40^{0}C).

2.2.5 Recovery from high level oxygen exposure

The ambient air contains about 210,000,000 ppb oxygen. Figure 2.4 is a typical purge-down curve for a new BDS sensor (air saturated). It is normal to take several hours, even days for an air saturated BDS to be purged down to a low ppb level.

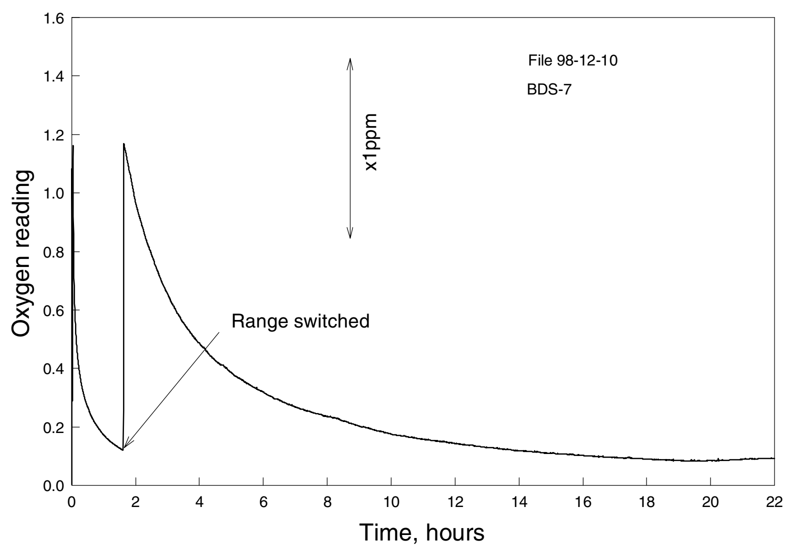


Figure 2.4 A typical purge-down curve for an air-saturated BDS sensor

The shorter air exposure, the faster will the sensor recover. A typical BDS sensor will recover to1ppm in ~25min, to 100ppb in ~80min, to 10ppb in ~8 hours after ten minute air exposure.

2.2.6 Background gas compatibility

The BDS oxygen sensor will work in inert gas backgrounds, including Nitrogen, Hydrogen, Argon, Helium and Ethane. However, the sensor output is different in different background gases. For example, the sensor output in hydrogen background is twice as much as in a nitrogen background. It is recommended to calibrate the analyzer with an oxygen standard that has a similar background as the sample gas. If an oxygen standard is unavailable for a particular background, a Gas Factor which is determined at TAI could be used to correct the sensor output in different background (see section 4.3.9).

Note: the gas flow meter in the analyzer is calibrated for air. The error for measuring nitrogen is usually negligible. But for hydrogen, it reads 100% lower. For example, when the float ball in the flow meter is at 0.5 SLPM, the actual flow rate of hydrogen is about 1 SLPM.

The BDS oxygen sensor can tolerate exposure to acidic gases. Up to 0.2% CO_2 has no effect to ppb level oxygen measurement.

2.2.7 Stability

The BDS sensor is essentially drift free. Typically a BDS sensor requires no re-calibration over an entire year period.

However, there may be some intrusion to the zero during the maintenance. See next section for details.

2.2.8 Maintenance

The only maintenance required on the BDS sensor is to replenish distilled or de-ionized water every three to four months. It is not necessary to take the analyzer off the service while adding water to the sensor. Caution should be taken that water should not be spilled on the PC boards or other area inside the analyzer.

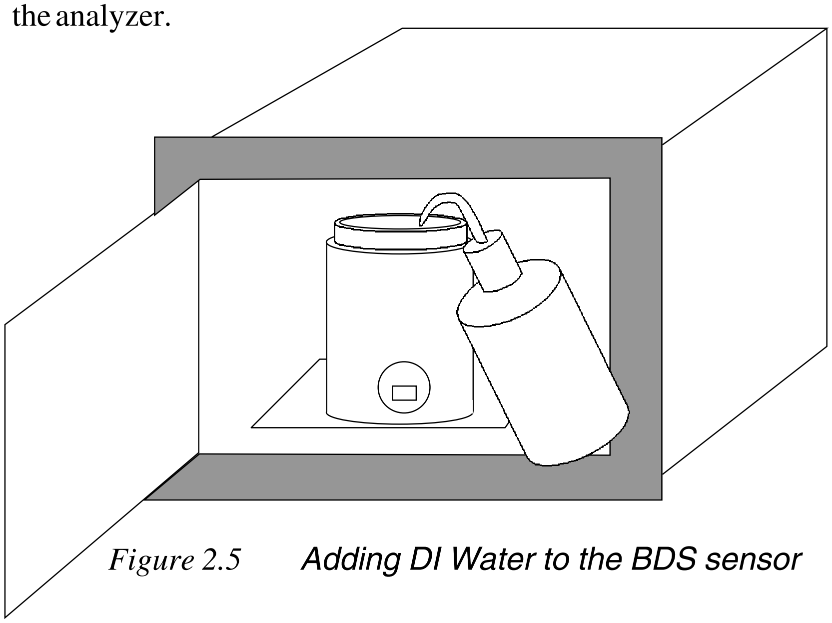


Figure 2.5 *Adding DI Water to the BDS sensor*

There is a Max line and Min Line clearly marked on the BDS sensor body. It is a good practice to check the electrolyte level every month and add de-ionized water into the sensor whenever it is convenient.

When running dry gas through the sensor, the gas carries out moisture from the sensor. Therefore, the electrolyte (10% KOH in water) inside the sensor is gradually concentrated during the sensor operation. It typically take about four months for the electrolyte level to drop from the Max line to Min line. When adding water to increase the electrolyte level from the Min line to the Max line, it is typical that the oxygen reading will drift down about 10ppb in an hour. If the oxygen content in the sample gas is very close to zero, the analyzer may display a negative reading during this period. However, the sensor will recover by itself during the following week. This drift-down then recover-back phenomenon is caused by the quick dilution of the electrolyte and re-establishment of a new equilibrium inside the sensor. To minimize this effect, add a small amount of water at a time and do it before the electrolyte level reaches the Min line.

2.3 Sample System

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

The Model BDS 3000 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 1/4" VCR for sample inlet and swagelock for 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 Sensor.

Figure 2-5 is the flow diagram for the sampling system. In the standard instrument, calibration gases can be connected directly to the Sample In port by teeing to the port with appropriate valves.

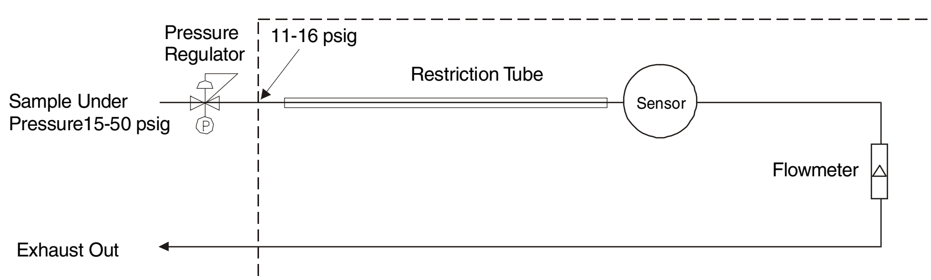


Figure 2-6: Flow Diagram-Sample Under Pressure

2.4 Electronics and Signal Processing

The Model BDS 3000 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 an universal power supply module designed to be compatible with any international power source. Figure 2-6 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 2-7 is a block diagram of the Analyzer electronics.

In the presence of oxygen the sensor generates a current. A current to voltage amplifier converts this current to a voltage, which is further 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 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 V dc 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.

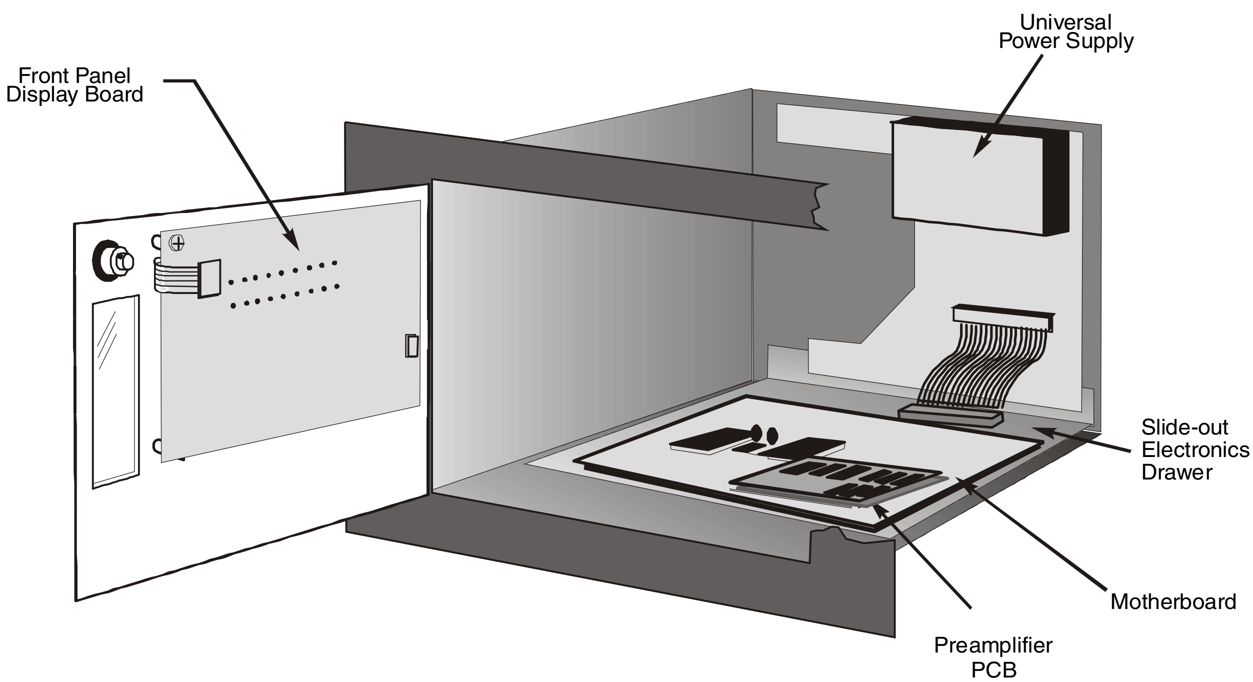


Figure 2-6: Electronic Component Location Inside the Model Ultra Trace 3000

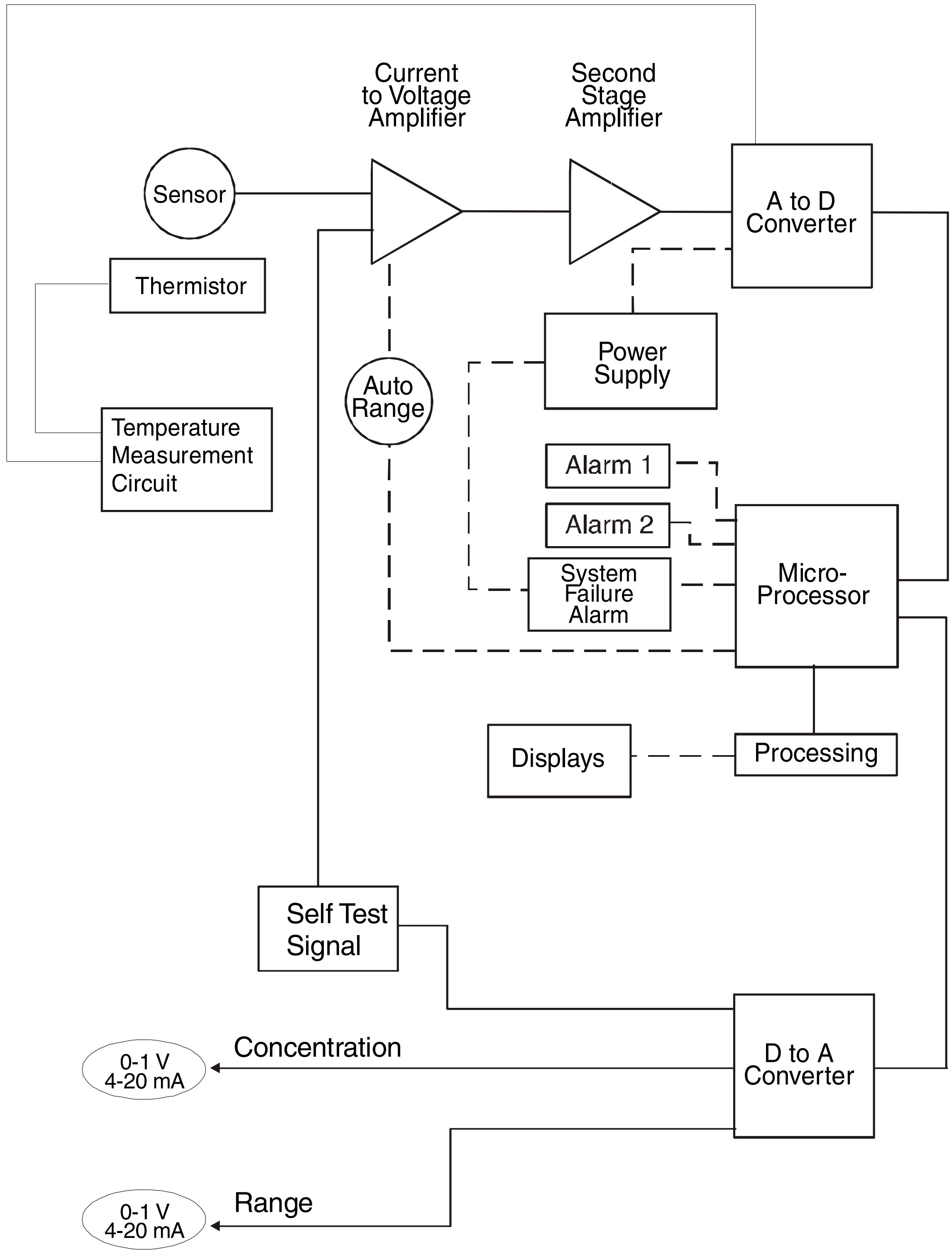


Figure 2-7: Block Diagram of the Model BDS 3000 Electronics

Installation

Installation of the Model BDS 3000 Analyzer includes:

1. Unpacking
2. Mounting
3. Gas connections
4. Electrical connections
5. Filling the Sensor with Electrolyte.
6. Testing the system.

3.1 Unpacking the Analyzer

Although the analyzer is shipped complete, certain parts, such as the electrolyte, are wrapped separately to be installed on site as part of the installation. Carefully unpack the analyzer and inspect it for damage. Immediately report any damage or shortages to the shipping agent.

3.2 Mounting the Analyzer

The Model BDS 3000 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 BDS 3000 standard front panel and mounting bezel. There are four mounting holes—one in each corner of the rigid frame. The drawings section in the rear of this manual contains outline dimensions and mounting hole spacing diagrams.

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

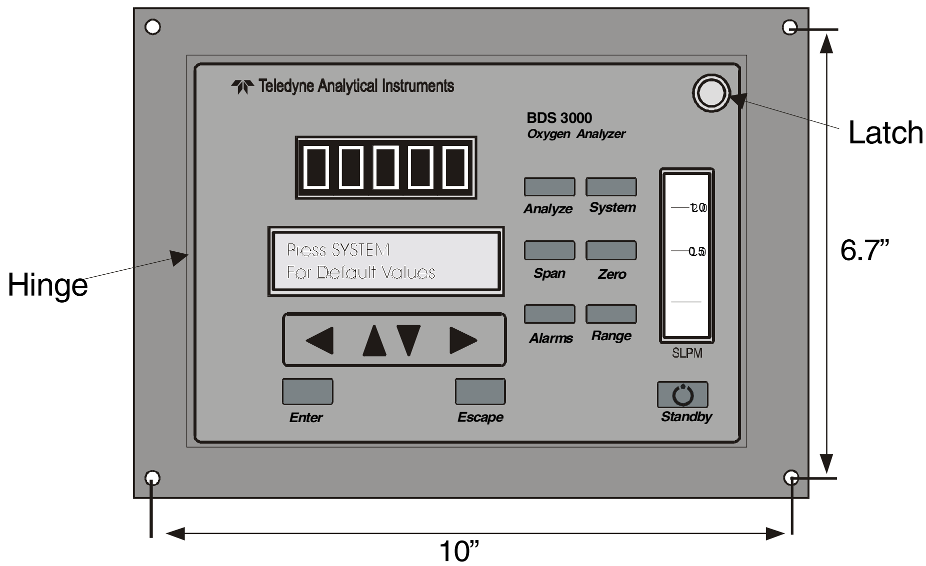
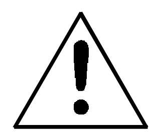


Figure 3-1: Front Panel of the Model BDS 3000

All operator controls 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 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), such as a small hex wrench or screwdriver Allow clearance for the door to open in a 90-degree arc of radius 7.125 inches. See Figure 3-2.



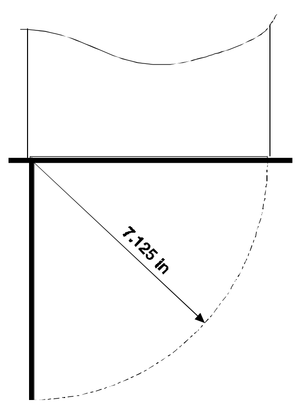


Figure 3-2: Required Front Door Clearance

3.3 Rear Panel Connections

Figure 3-3 shows the Model BDS 3000 rear panel. There are ports for gas inlet and outlet, power, communication, and both digital and analog concentration output.

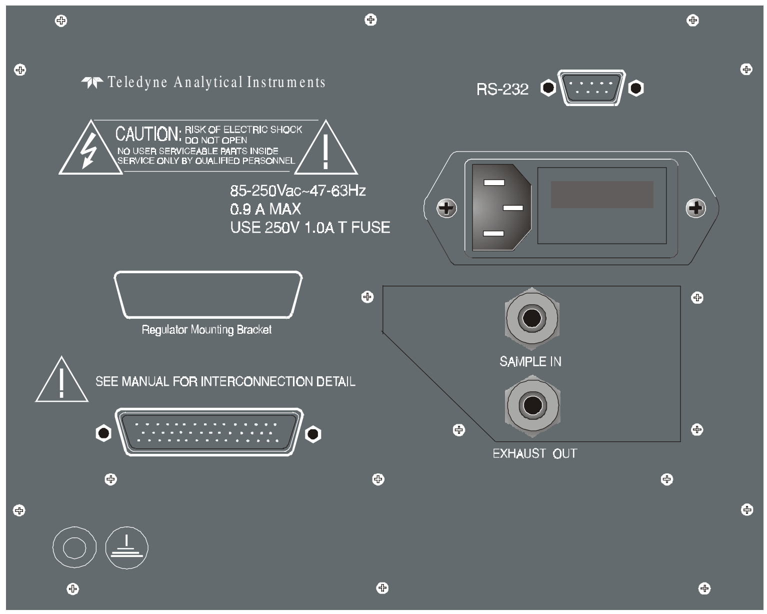


Figure 3-3: Rear Panel of the Model Ultra Trace 3000

3.3.1 Gas Connections

The unit is manufactured with 1/4 inch VCR fittings. For a safe connection:

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. A VCR fitting is provided for the inlet connection.

The inlet gas pressure should be regulated to pressures between 11 to 16 psig to maintain a flow between 0.5 to 1.0 SLPM. If pressure is too low, the flow will drop below 0.5 SLPM at which the output of the sensor is sensitive (see section 2.2.2). If pressure is too high, it will force gas into the electrolyte and cause damage to the sensor. A pressure regulator must be used if sample pressure varies farther than the recommended range.

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

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 sielding.

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 switch on the front panel is for switching power on or off to the displays and outputs only.

The universal power supply requires a 85–250 V ac, 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.

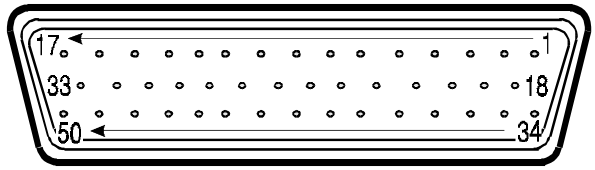


Figure 3-4: Equipment Interface Connector Pin Arrangement

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

0–1 V dc % 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 V dc Range ID: 0.25 V = Low Range, 0.5 V = Medium Range, 0.75 V = High Range, 1 V = 100ppm.

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.)

4–20 mA dc Range ID: 8 mA = Low Range, 12 mA = Medium Range, 16 mA = High Range, 20 mA = 100ppm.

Table 3-1: Analog Output Connections

Pin	Function
3	+ Range ID, 4-20 mA, floating
4	– Range ID, 4-20 mA, floating
5	+ % Range, 4-20 mA, floating
6	– % Range, 4-20 mA, floating
8	+ Range ID, 0-1 V dc
23	– Range ID, 0-1 V dc, negative ground
24	+ % Range, 0-1 V dc
7	– % Range, 0-1 V dc, 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 nonfailsafe.
- Can be configured as latching or nonlatching.
- 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 nonfailsafe.
- Can be configured as latching or nonlatching.
- 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 V dc (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 BDS 3000 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.

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	Range 4 ID Contact (Air Cal)
35	Range 4 ID Contact (Air Cal)

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 Ultra Trace 3000 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.

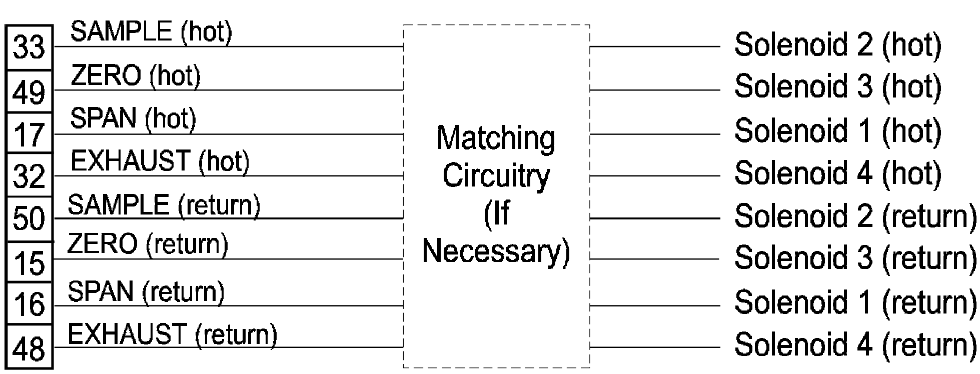


Figure 3-5: Remote Probe Connections

The voltage from these outputs is nominally 0 V for the OFF and 15 V dc 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.

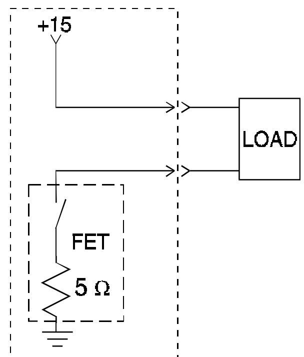


Figure 3-6: FET Series Resistance

3.4 Electrolyte Refill of BDS Sensor

The BDS sensor was shipped dry. It must be filled with the electrolyte before operation. The electrolyte is a caustic solution (10% KOH), supplied in a 125ml bottles. Review the Material Safety Data Sheet (MSDS) in Section A-6 before handling the electrolyte.

1. Remove the sensor from the analyzer
   a. Open the front door and swing it open
   b. Loosen up the gas fitting at both sides of the sensor
   c. Loosen up two finger nuts that hold the sensor in place
   d. Slide the sensor out

2. Unscrew the sensor cap.

3. Ref. to Figure 3.7 for the method of adding electrolyte to the sensor. It is important that the sensor is being filled with the electrolyte without trapping gas bubbles in the lower part of the sensor.

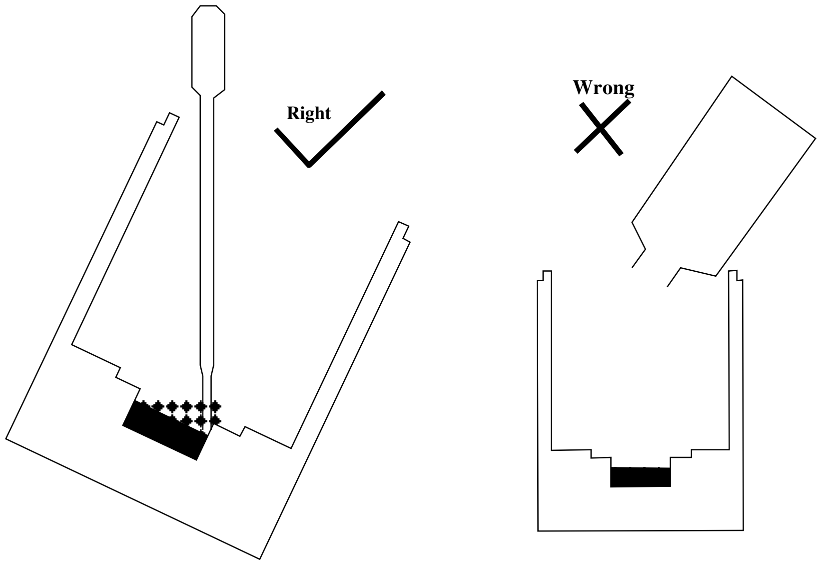


Figure 3.7 Adding Electrolyte to the BDS sensor

Use the pipette provided to transfer the electrolyte from the bottle to the bottom-edge of the BDS sensor. Do it slowly until the bottom parts of the sensor are fully immersed in the electrolyte.

4. Pour the rest of the electrolyte into the sensor. Gas bubbles in the top portion of the sensor would not affect the sensor performance. One bottle of electrolyte is sufficient to rise the electrolyte level to the MAX line. **For the rest of sensor life, no further electrolyte addition is needed.**

5. Install the sensor cap, and then reinstall the sensor onto the unit. Use new VCR gasket on both sides of the sensor. When tighten the VCR fittings, use a 5/8 inch wrench on the sensor side to protect the fitting.

6. Do not connect the sensor's electric connector at this stage.

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

- Purge the system for 3 minutes. Make sure the gas flow rate is within 0.5-1 SLPM..

Power up the system, and conduct the Self-Diagnostic Test as described in chapter 4, section 4.3.5. It takes two minutes for the microprocessor to test various sections of the analyzer.

3.6 Sensor Protection Mode

The BDS sensor is a very sensitive device for measuring ultra trace level of oxygen. When the oxygen level in the gas exceeds 100ppm (in nitrogen background) for one minute, the analyzer will enter a self-protection mode and show temporary shut down on the display. It indicates a high level oxygen intrusion into the system. Check the gas line and other related parts, and fix them if there is any leaks found.

The analyzer will try to reconnect the sensor in one minute. If it is still over range for one minute, the analyzer will enter a temporary shut down mode again for three minutes. The analyzer will try the third time to reconnect the sensor, and will enter a System Shut Down mode to protect the sensor if it is still over range.

Press the Escape key will return the analyzer into operation.

For operations that is known to see oxygen level above 100ppm frequently, TAI's Micro-Fuel-Cell type of oxygen sensor is recommended.

The maximum working range with a background of nitrogen gas is 100ppm. But it changes for different gas backgrounds. Please refer to section 4.3.9.

Operation

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 BDS 3000, these default values are in effect:

Ranges: LO = 100ppb ppm, MED = 1000 ppb, HI = 10 ppm.
Auto Ranging: ON
Alarm Relays: Defeated, Alarm 1 at10.000 ppm, Alarm 2 at 1.000 ppm HI, Not failsafe, Not latching.
Zero: Auto, every 0 days at 0 hours.
Span: Auto, at 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 $\Delta\nabla$ 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 six subfunctions that regulate the internal operations of the analyzer:
  - Auto-Cal setup
  - Password assignment
  - Self-Test initiation
  - Checking software version
  - Logging out.
  - Show negative readings
  - Set digital filter
- *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.

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 `Monospaced` type style. Pushbutton names are printed in *Oblique* type.

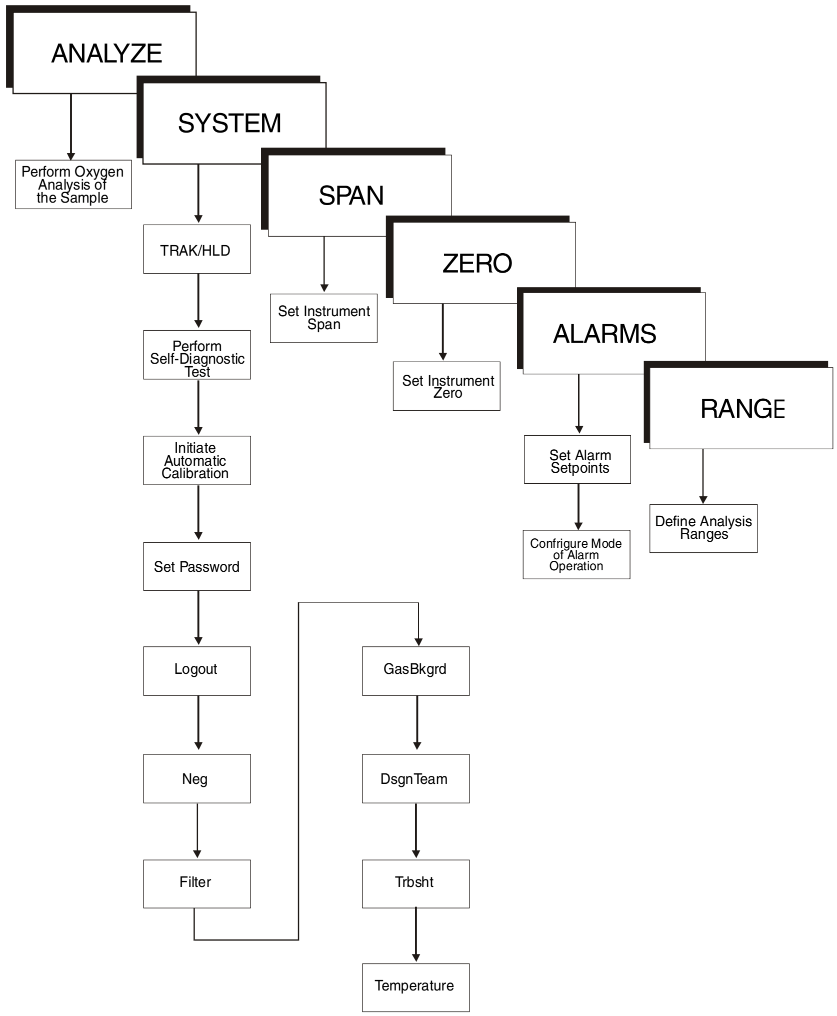


Figure 4-1: Hierarchy of Functions and Subfunctions

4.3 The *System* Function

The subfuctions 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 subfunctions 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.
- Neg: 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.
- Filter: This is to set the response time of the digital filter in the LO range.
- GasBkgn: Set the gas correction factor. This function adjusts the calibration of the sensor when the background gas is changed.
- DsgnTeam: Not an analyzer function. Displays design team members.
- Trbsht: Displays useful information for troubleshooting purposes.
- Temperature: Displays sensor temperature.

4.3.1 Tracking the Oxygen Readings during Calibration and Alarm delay

The user has the option of setting the preferenc 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 BDS 3000 is

acurate to 2-3 %. Accordingly, internally scheduled calibrations can vary 2-3 % per day.

To setup an Auto–Cal cycle:

CAUTION:

We do not recommend frequent Zero adjustments of the cell. A newly installed cell may take 7-10 days of operation to reach a steady Zero (typically less than 5 ppb). If required, the instrument may be zeroed after this initial stabilizing period and may be checked again after a additional 7-10 day frequency of zero adjustment is at the discretion of the user (once a month is suggested).

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

```
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 $\Delta\nabla$ arrows to set an interval value, then use < > arrows to move to the start-time value. Use $\Delta\nabla$ 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 $\Delta\nabla$ 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 **ΔΛ** 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
```

<u>or</u>

```
     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 **Δ∇** 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 BDS 3000 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 will. 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

Neg-N   Filter-5 More
```

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 Filter Function

The response time on the most sensitive range (ppb range) is user definable from approximately 1-60 minutes. The adjustable filter allows the user to tune the response of the analyzer to best balance sensor noise and response time requirements. The factory default setting is 5 minutes. The actual response time will depend on the user's sample system (the length and size the tubing of tubing as well as the sample flow rate).

The filter setting can be accessed by selecting **SYSTEM** on the keypad followed by **MORE** on the display with the <> keys. The filter function is then selected and changed using the arrow keys. Press **ENTER** and **ANALYZE** to return to analyze mode.

In the event of an over-range condition, the filter rate will automatically switch to a faster setting (approximately 45 sec. response time) for the duration of the over-range or upset condition. This feature allows the analyzer to quickly respond to and track an upset condition.

4.3.8 Negative Value Display

The operator is able to set the display not to show negative readings. To access this option, Press the System key and access the second screen of the System menu:

Version Self-Test
Neg-N Filter-5 More

By using the Left or Right keys, the Neg- field can be accessed. Once that field is selected, use the Up or Down keys to toggle from N to Y or Y to N. Setting to N means that when the reading of the sensor drifts negative, the display will stay at zero. To follow negative upsets, set this field to Y. The default setting is Y.

4.3.9 The Gas Correction Factor

When the background gas is changed. this function can adjust the calibration of the instrument to compensate for the sensor change of output. This is helpful when the gas background needs to be changed and only a calibration bottle with Nitrogen background is used. The default setting is 1.00, for Nitrogen gas background. To set this factor, press the System key and access the third screen:

GasBkgnd DsgnTeam
Trbsht temp: 21.0 °C

Select GasBkgnd and press the Enter key to see the function screen:

Gas Background
Correction: 1.00

Use the Up or Down keys to adjust the value. The working range is 0.25 to 2.50. This factor will divide the output. For example if the factor is set to 2.00, the output of the sensor, when read by the electronics will be divided by two.

Special consideration on the working range: Changing the gas correction factor has an effect on the maximum working range of the analyzer, e.g.: if a gas factor of 2.00 is selected the maximum working range of the analyzer is 50 ppm. Any reading above this, may saturate the amplifier. The automatic sensor shutdown function will become active automatically when the reading goes over 50 ppm as described in section 3.6.

4.3.10 Design Team

Design Team Screen. Found in the third screen of the System Menu. No function for the analyzer.

4.3.11 Troubleshooting Screen

This System function provides access to troubleshooting information. This information will be helpful to TAI technical support staff. To use this function, it is recommended that known span gas be flowing through the system before entering this function. Once the span gas has been flowing for at least five minutes, Press the System key and access the Trbsht on the third screen.

GasBkgnd DsgnTeam
Trbsht

Press the Enter key. The VFD display will scroll through four screens with a five seconds delay each. **The values shown are frozen from the moment**

the System key was pressed (that is why is important not to enter the System menu until span gas has flowed for a while)**.**

First Screen:

FCalib_factor = 4.581	(slope calibration, default value shown)
AtoD_Ave =115810	(Average ADC count reading of sensor amplifier on the span gas, range:0 to 260,000)

Second Screen:

lOffset[0] = 2480	(ADC count of offset of the first gain of sensor amplifier)
lOffset[1] = 2430	(ADC count of offset of the second gain of sensor amplifier)

Third Screen:

lOffset[2] = 2327	(ADC count of offset of the third gain of sensor amplifier)
lOffset[3] = 2330	(ADC count of offset of the fourth gain of sensor amplifier)

Fourth Screen:

tempOffset = 2190	(ADC count of offset of temperature amplifier)
Current_gain= 1	(current gain of sensor amplifier on span gas)

4.3.12 Temperature

The temperature of the sensor is displayed on the third screen or system menu, and is shown in degrees centigrade.

4.4 Calibration of the Analyzer

The analyzer must be calibrated prior to its use. For most applications where the desired range of measurement is 0 to 10 ppm, or less we recommend the analyzer be calibrated using a span gas as detailed below:

Span Gas Calibration

Before the cell is ready for calibration, it must be purged with sample gas to a low oxygen level preferably below 0.1 ppm. However, if the oxygen contact of the sample gas is higher than 0.1 ppm, a zero gas such as nitrogen with oxygen level below 0.1 ppm may be required.

The recommended span gas concentration is between 7.0 to 9.0 ppm oxygen in nitrogen, and will require calibration be performed in the 0-10 ppm analyzer range.

4.4.1 Zero Cal

The BDS Sensor has a zero offset of less than 5 ppb oxygen. Normally, the offset slowly decreases during the first 7 to 10 days of operation, and is expected to reach a steady value after this time.

Generally, the value of the zero offset is part of the oxygen reading of the sample gas as shown by the analyzer readout. As an example, a reading of 5 ppb oxygen may include 0.4 ppm oxygen in the sample gas and a 5 ppb zero offset.

The determination of the zero offset requires the use of oxygen free gas to the analyzer. We recommend the use of nitrogen gas with a scrubber to assure oxygen levels below 0.1 ppb.

The user may decide to eliminate the zero offset for improved accuracy. If so desired the analyzer is equipped to provide this function. However, we do not recommend carying out the cal zero during the first 10 days of the operation of the cell.

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 ΔΔ arrow keys to toggle between AUTO and MAN zero setting. 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.

Because the reading of the slope is not very sensitive, it is recommended that zero gas be purging a few minutes before starting the Auto mode zeroing. This will ensure cell stability on the new Zero settings.

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 Δ∇ 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 BDS 3000 is usually associated with inability to zero the instrument down to a satisfactorily low ppm reading corresponding to a current of 0.23 microamps (approx. 50 ppb). When this occurs, the instrument returns back to analyzer mode without taking the zero calibration. The BDS 3000 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.

c. Check if more purging time with Zero calibration gas is needed.

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

The failure alarm and failure message will reset after entering the Zero mode.

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 ΔΔ 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 UP or DOWN keys.

Press *Enter* to move to the next screen.

```
Span Val:  008.00 ppm
<ENT>Span <UP>Mod #
```

Use the ΔΔ arrow keys to enter the oxygen-concentration mode (999.99 ppm is maximum value of span gas allowed). Use the < > arrow keys to blink the digit you are going to modify. Use the ΔΔ 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 Δ∇ 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:  008.00ppm
<ENT>Span <UP>Mod #
```

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

Use the arrow keys to enter the oxygen concentration of the span gas you are using (999.99 is maximum value of span gas). The < > arrows choose the digit, and the ΔV 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 less than 1.5 nA/ppb or more than 13.5 nA/ppb O_2, 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 analyzer must be properly spanned.

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 BDS 3000 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 V ac. See Figure 3-5 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?

   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.

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.

2. Are either or both of the alarms to be configured as failsafe?

   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.

3. Are either of the alarms to be latching?

   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.

4. Are either of the alarms to be defeated?

   The defeat alarm mode is incorporated into the alarm circuit so that maintenance can be performed under conditions which would normally activate the alarms.

   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 10.000   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 999 ppb + 1.000-1000.00 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 Δ∇ arrow keys to change the number. Holding down the key speeds up the incrementing or decrementing. (Remember, the setpoint units are ppm O_2.)
- To set the other parameters use the **< >** arrow keys to move the blinking over to the desired parameter. Then use the Δ∇ 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 Δ two times or ∇ two times. (Toggle it to Y and then back to N.)

  –OR –

  Go to Ltch– and then press either Δ two times or ∇ two times. (Toggle it to N and back to Y.

Alarm Hysterisis: There is alarm hysterisis to prevent chatter of the alarm contacts. It is set to 0.2 ppm for alarms set above 1 ppm, and 10 ppb for alarms set below 1 ppm.

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 = 0–100 ppb
Med = 0–1 ppm
High = 0–10 ppm.

The Model BDS 3000 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 90% 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 V dc (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.

The automatic fourth range is always 0-1000 ppm and is not programmable.

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—100 ppb    M—1 ppm
H—10 ppm   Mode—AUTO
```

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

Use the ΔΔ∇ arrow keys to enter the upper value of the range (all ranges begin at 0). 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 0–500 ppb and range 2 is set as 0–10 ppm, range 3 cannot be set as 0– 5 ppm since it is lower than range 2.

Ranges, and alarms, are set in ppb or ppm units depending on concentration. All concentration-data outputs change from ppb units to ppm when the concentration is above 1.0 ppm. Range Low (L) is always a ppb range and cannot be set higher than 1000 ppb nor lower than 10 ppb. Ranges medium (M) and High (H) can only be set in ppm. The Medium (M) range can be set between 1 and 10 ppm, while the high (H) range can be set between 10 and 1000 ppm.

Note: Refer to section 4.3.9 to find maximum working range.

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 Δ∇ arrow keys to switch from AUTO to FX/L, FX/M, or FX/H to set the instrument on the desired fixed range (low, medium, or high).

```
L—250ppb      M—1 ppm
H—10 ppm   Mode—FX/L
```

or

```
L—250 ppb      M—1 ppm
H—10 ppm   Mode—FX/M
```

or

```
L—250 ppb      M—1 ppm
H—10 ppm   Mode—FX/H
```

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 V dc (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 BDS 3000 Oxygen Analyzer is equipped with two 0–1 V dc 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 illustration.

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_2, then the output would be:

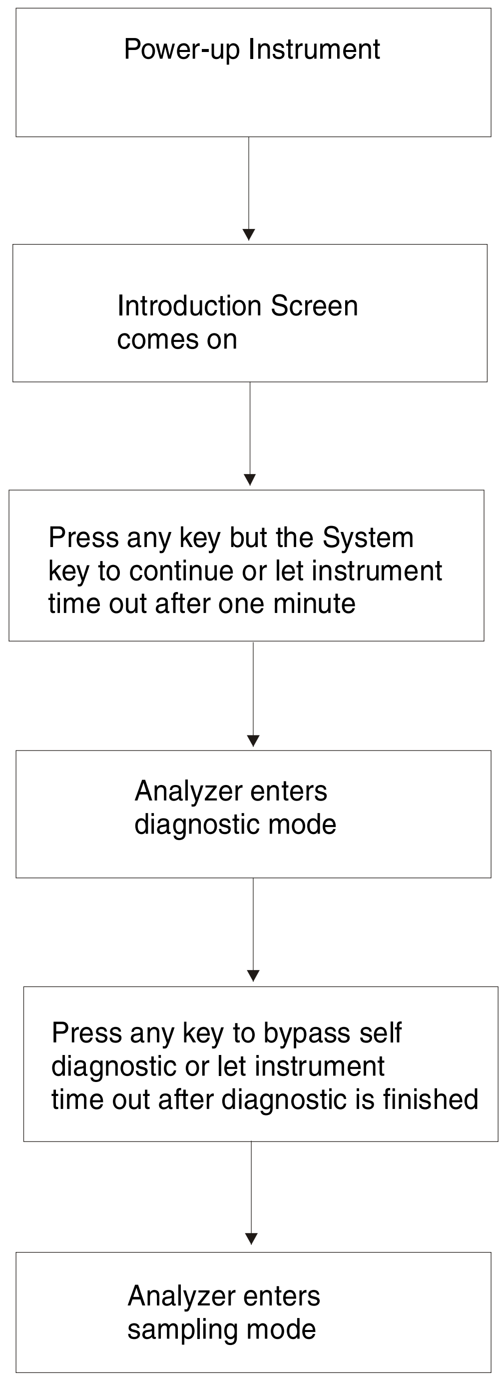
ppm O_2	Voltage Signal Output (V dc)	Current Signal Output (mA dc)
0	0.0	4.0
10	0.1	5.6
20	0.2	7.2
30	0.3	8.8
40	0.4	10.4
50	0.5	12.0
60	0.6	13.6
70	0.7	15.2
80	0.8	16.8
90	0.9	18.4
100	1.0	20.0

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.

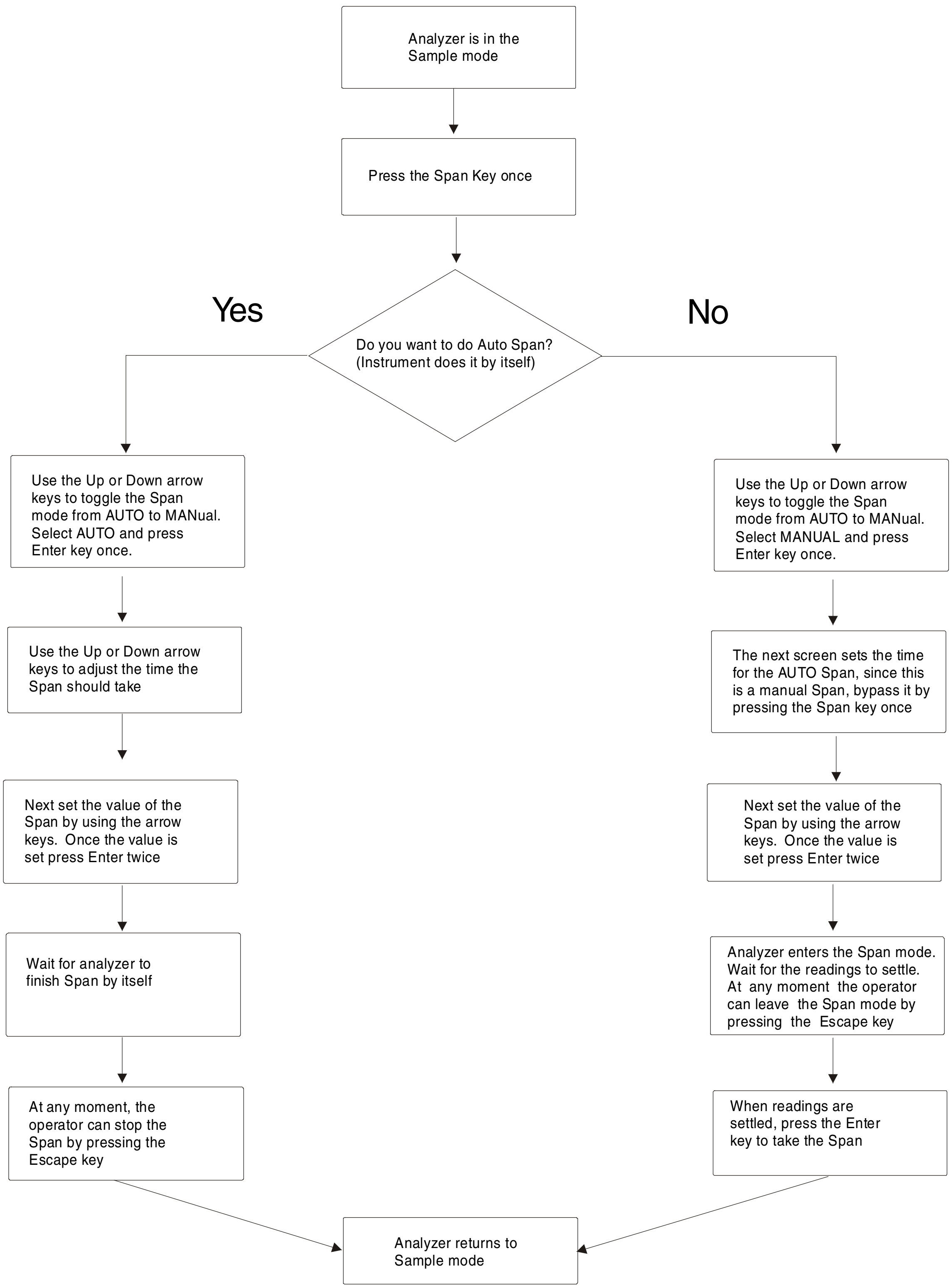
To provide an indication of the range, a second pair of analog output terminals are used. They generate a steady preset voltage (or current when using the current outputs) to represent a particular range. The following table gives the range ID output for each analysis range:

Range	Voltage (V)	Current (mA)
LO	0.25	8
MED	0.50	12
HI	0.75	16
(0-1000ppm)	1.00	20

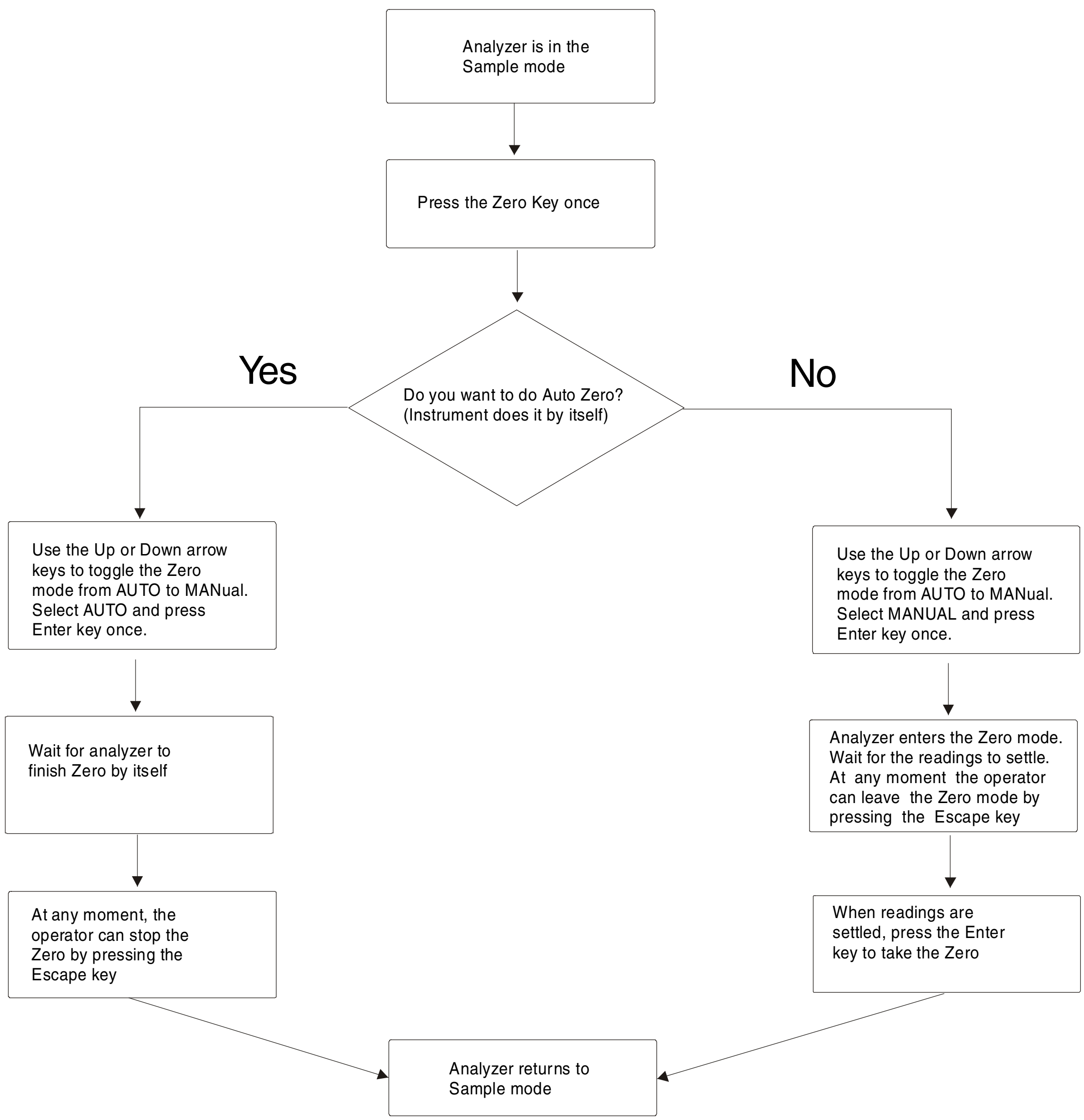
Analyzer Power-up Sequence:



Analyzer Span Sequence:



Analyzer Zero Sequence:



Maintenance

5.1 Routine Maintenance

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

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

5.2 Adding Water to the BDS Sensor

When running dry gas through the sensor, water is extracted from the electrolyte. Therefore, the electrolyte level should be checked periodically. When the electrolyte level is low, only de-ionized water or distilled water should be added into the sensor. It typically takes about four months to dry the electrolyte from the MAX line to the MIN line when the sensor is operated on a bone dry gas line.

It is not necessary to turn off the power to the analyzer while adding water, but care should be taken that no water is splashed outside the sensor. Spilling water on the PC board could cause serious damage to the analyzer and electric shock to the personal.

Unscrew and take the sensor cap off. Use the wash bottle provided to squeeze de-ionized water into the sensor, as shown in Figure 5.1. It is a good practice that water is added before reaching the MIN line. Reinstall the cap after adding water.

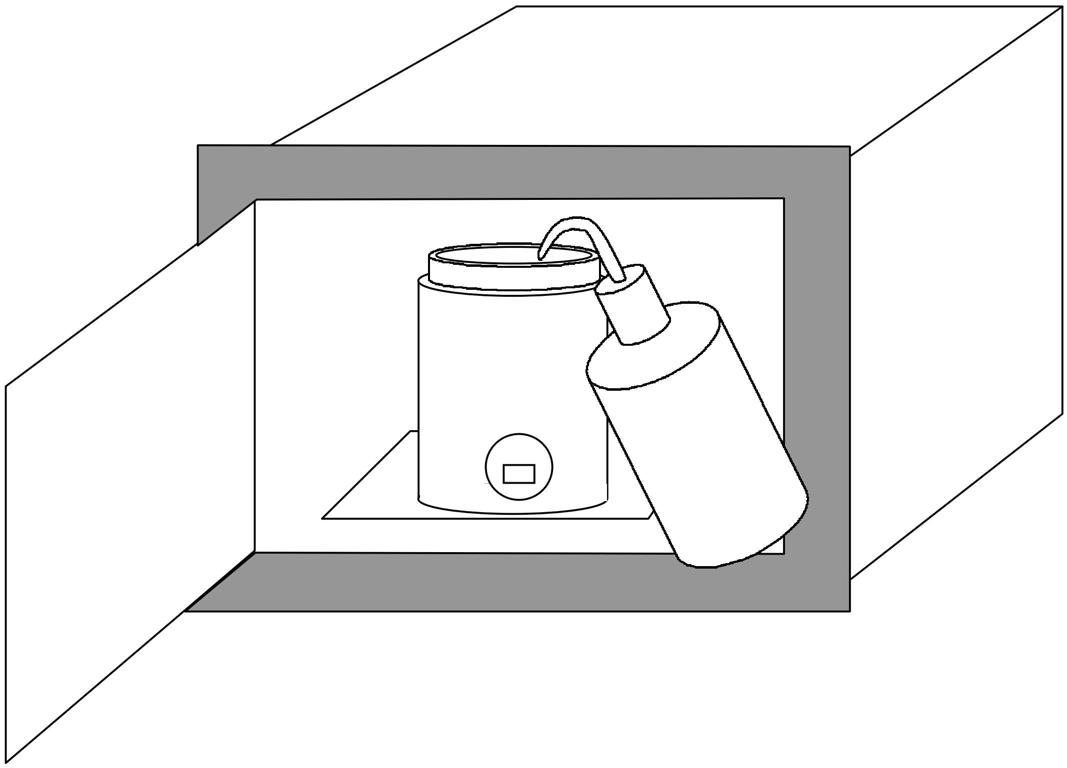


Figure 5.1 Adding water into the BDS sensor

WARNING: THE SENSOR USED IN THE MODEL BDS 3000 OXYGEN ANALYZER USES ELECTROLYTE WHICH CONTAINS POTASSIUM HYDROXIDE, THAT CAN BE HARMFUL IF TOUCHED, SWALLOWED, OR INHALED. AVOID CONTACT WITH ANY FLUID OR POWDER IN OR AROUND THE UNIT. WHAT MAY APPEAR TO BE PLAIN WATER COULD BE THE ELECTROLYTE. IN CASE OF EYE CONTACT, IMMEDIATELY FLUSH EYES WITH WATER FOR AT LEAST 15 MINUTES. CALL PHYSICIAN. (SEE APPENDIX, MATERIAL SAFETY DATA SHEET.)

5.3 Fuse Replacement

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

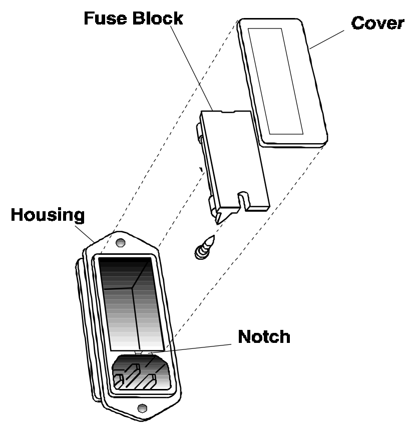


Figure 5-2: Removing Fuse Block from Housing

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.

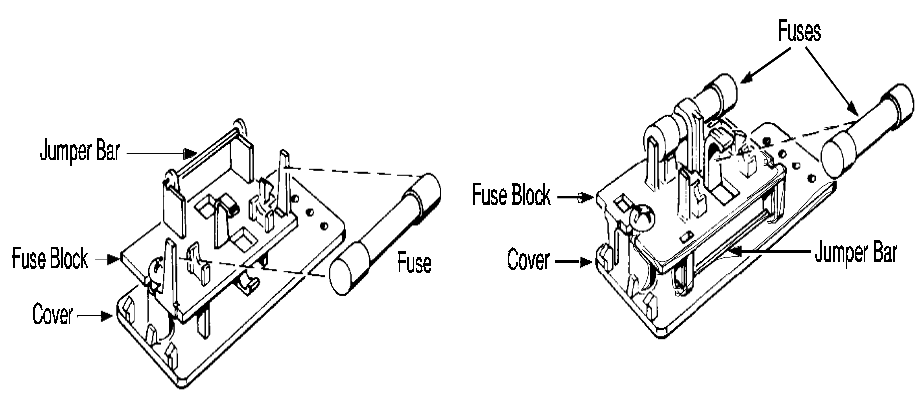


Figure 5-3: Installing Fuses

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

Power

0	OK
1	5 V Failure
2	15 V Failure
3	Both Failed

Analog

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 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 Figure 2-4, and the major electronic components locations are shown in Figure 2-5, in chapter 2.

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

The BDS 3000 contains the following major components:

- Analysis Section
  - Sensor with stainless steel wetted parts
  - Sample system

- Power Supplys
- 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.

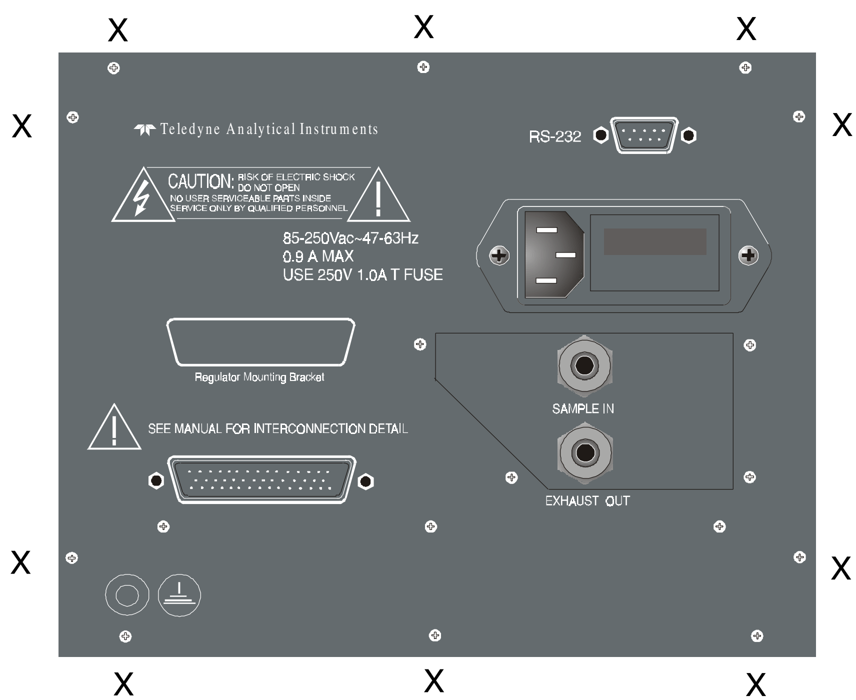


Figure 5-4: Rear-Panel Screws

To detach the rear panel, remove only the 14 screws marked with an X.

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

Symptoms	Possible causes and Solutions
Read higher than expected	(1), (2), (3)
Read lower than expected	(2), (3)
Read negative	(3), (4)
Noise signal	(3), (5)
Slow response	(5)

Causes and solution keys:

(1). **Gas leak:** Make sure to use new VCR gaskets, high quality valves and gas regulator for the sampling system. Tighten each connection.

(2). **Improper gas flow rate:** adjust the inlet pressure to obtain 0.5 – 1 SLPM flow rate.

(3). **Improper calibration of the analyzer:** Turn the analyzer off, then turn back on again. Press the System Key when prompted by the analyzer "Press the System for default Values". This will return the analyzer to its defaults settings in calibration and zero values. Recalibrate the analyzer with a high quality standard gas if it is necessary.

(4). **Just after adding water:** The analyzer will recover by itself.

(5). **Gas entered and been trapped in the sensor:** It could happen if the sensor is filled with the electrolyte improperly, or the sensor is pressurized because of a clogged vent. If this is what happened, uninstall the sensor and take off the cap carefully, then apply a vacuum degas process as shown in the figure 5-5. 28 inch mercury vacuum for 5 minutes is sufficient to remove the gas bubbles. A low cost vacuum degas kit (TAI P/N B72098) is available from Teledyne Analytical Instruments. Reinstall the sensor into the analyzer.

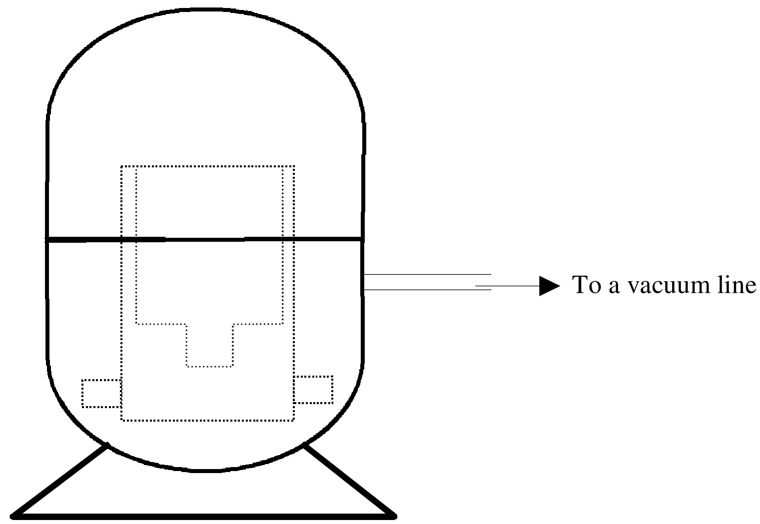


Figure 5-5: Vacuum degas for the BDS oxygen sensor

Appendix

A-1 Specifications

Packaging: **General Purpose**

- Flush panel mount (Standard).
- Relay rack mount. Contains one instrument in one 19" relay rack mountable plate (Optional).

Sensor: Teledyne BDS Sensor, patent pending.

Sample System: All wetted parts of 316 stainless steel with built-in restrictor.

90 % Response Time: Less than 90 seconds at 25 °C (77 °F) on 10, and 100 ppm range. 90 seconds on 1000ppb range.

Software programmable response in 100 ppb range from 1 minute to 60 minutes. Default is 5 minutes response time.

Ranges: Three user definable ranges from 0–100 ppb to 0–100 ppm, plus over range of 0-100 ppm.

Autoranging with range ID output.

Alarms: One system-failure alarm contact to detect power failure or sensor-zero and span 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: 5-40 °C

Accuracy: ±2% of full scale for all ranges at constant temperature.

All accuracy specifications are contingent upon the completion of zero ans span calibration.

All accuracy is established at constant pressure and equilibrium has been established.

Analog outputs: 0-1 V dc percent-of-range,
0-1 V dc range ID.
4-20 mA dc (isolated) percent-of-range,
4-20 mA dc (isolated) range ID.

Dimensions: 19 cm high, 24.9 cm wide, 31 cm deep (6.96 in high, 8.7 in wide, 12.1 in deep).

A-2 Recommended 2-Year Spare Parts List

QTY.	PART NUMBER	DESCRIPTION
1	C65507	Back Panel Board
1	C62371-B	Front Panel Board
1	C71528	Preamplifier Board (Instruction)
1	C62365-A	Main Computer Board
3	F9	Fuse, 1A, 250V 3AG Slow Blow
3	F1275	Fuse, 1A, 250V 5x20mm (European) Slow Blow
1	CP1798	50 pin D-sub interface connector
50	CP1799	Pins for CP1798 connector
1	B597	125ml wash bottle for DI water
1	B598	125ml electrolyte bottle
1	P1076	Pipet
1	B72098	BDS sensor recovery 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
TWX (910) 584-1887 TDYANYL COID

Web: www.teledyne-ai.com

or your local representative.

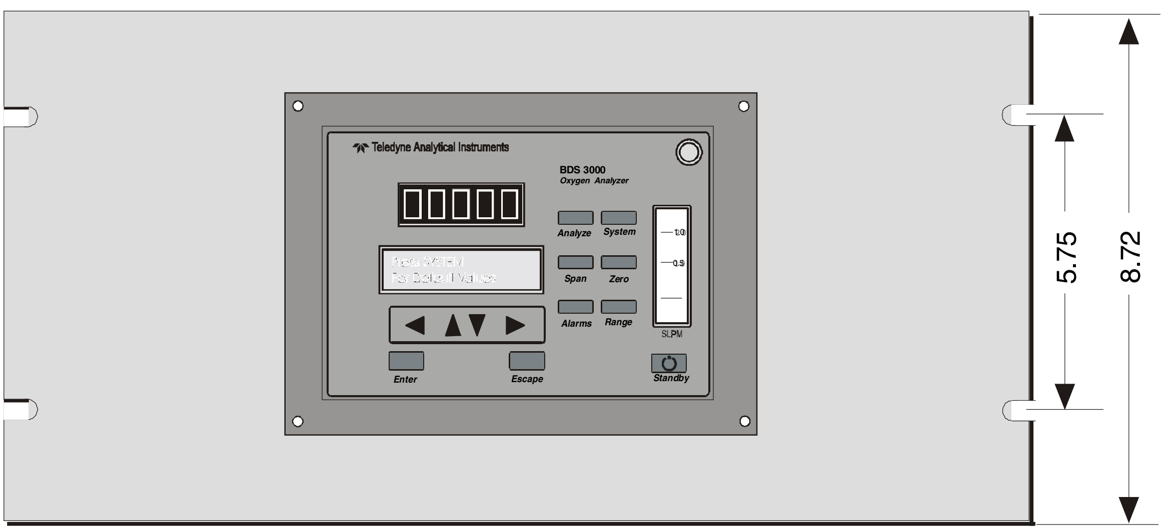
A-3 Drawing List

D-71902 Outline Diagram

A-4 19-inch Relay Rack Panel Mount

Figure A-1: Single 19" Rack Mounts

(dimensions in mm)



A-5

BDS 3000 SERIES ANALYZERS
APPLICATION NOTES ON
PRESSURES AND FLOW RECOMMENDATIONS

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 as to provide a useable flow rate trough 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 0.5 - 1.0 SLPM . The optimum flow rate is 1 SLPM (mid scale). Note: response time is dependent on flow rate, a low flow rate will result in slow response to O2 changes in the sample stream. The span flow rate should be the approximately same as the sample flow rate.

CELL PRESSURE CONCERNS:
The sensors used in 3000 series analyzers are optimized to function at atmospheric pressure.

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.

CONVERSIONS:

1 PSI	=	2.04 INCHES OF MERCURY (in. Hg.)
1 SCFH	=	0.476 SLPM

NOTE: The MSDS on this material is available upon request through the Teledyne Environmental, Health and Safety Coordinator. Contact at (626) 934-1592