PLATINUM SERIES

NANOTRACE OXYGEN ANALYZER

INSTRUCTION MANUAL

DELTA F CORPORATION

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PLATINUM NANOTRACE ADDENDUM

A1 Introduction

This addendum includes information that supplements or supersedes the manual. The following pages are affected by this addendum:

Page 2-5	Caution Regarding Sensor Over-pressure (Refer to Section A3, below)
Page 2-7	Sensor Isolation Requirement (Refer to Section A2, below)
Page 6-3	Note 1 (Refer to Section A4 and A4A, below)
Page 7-3	Effects Of Flow on Sensor Performance - Recommended Flowmeter Reading (Refer to Section A4 and A4A, below)
Page 10-1	Specifications - Return Pressure (Refer to Section A3, below)

A2 Sensor Isolation

The warning on page 2-7 of the manual, cautioning against isolating the instrument from sample flow for more than four hours, is now obsolete. Extensive testing has demonstrated that there are no restrictions on how long the instrument may be isolated with no gas flowing. Also, sensor isolation will not cause an elevated zero base line after flow is reestablished.

A3 Gas Sample Line Pressure Limits

The limits for gas sample return line pressurization have been changed from ±3 psig to the following:

For Helium and Hydrogen the limit is ±1 psig

For Nitrogen, Argon and all other gases the limit is ±2 psig

Gas sample return line pressure is defined as the pressure difference between the atmosphere and the pressure in the line connected to the outlet of the instrument.

A4 Background Gas Effects On Indicated Flow Rate

If the background gas kinematic viscosity is much different from Nitrogen, then the flowmeter reading may need to be compensated for. This compensation is not to be confused with the Gas Scale Factor, which corrects for background gas effects on the oxygen reading. For reference, Gas Scale Factor information appears in section 5.4.5.1 on page 5-20 of the instruction manual.

Primarily, indicated flow compensation is only required when either Hydrogen or Helium background gases are sampled. The analyzer is not particularly sensitive to flow rate, so a small flow error will not cause the oxygen reading to be inaccurate as long as the flow remains within the recommended range of 1.0 to 3.0 scfh.

The rotameter type flowmeter used in the NanoTrace Oxygen Analyzer is calibrated for use in air (or Nitrogen). Most other gases have kinematic viscosities within ±25% of air. Since the required flow rate is not extremely critical, only those background gases whose kinematic viscosities fall much outside that range are affected, such as Hydrogen and Helium.

A4A Indicated Flow Corrections for Hydrogen Or Helium

Light gases, such as Hydrogen and Helium, will have a much higher actual flow rate than that indicated on the flowmeter, which has been calibrated for air or nitrogen. As a result, the flow rate observed on the flowmeter, when sampling either Hydrogen or Helium, should be maintained at a level three times smaller than all recommended flow values found in this manual.

For example:

The recommended flow rate range in Nitrogen is 1.0 to 3.0 scfh. In Hydrogen or Helium service, the recommended flow rate (***as indicated on the analyzer***) should be 0.3 to 1.0 scfh, with the preferred value being roughly 0.7 scfh. Since the two hash marks on the flowmeter, below the 1.0 scfh mark, are 0.8 and 0.6 scfh, target the rotameter ball to float evenly between these two marks. For reference purposes, the indicated flow (in Air or Nitrogen) when the ball is centered even with the "SCFH" labeling on the rotameter is about 0.5 scfh, and about 0.25 scfh when the ball is just below the "SCFH" labeling (top of the ball is even with the bottom of the lettering).

Addendum

Platinum Series
NanoTrace Oxygen Analyzer

CE Compliance Option

The Platinum Series NanoTrace Oxygen Analyzer is available in a version that conforms with the directives, established by the European Union, for CE Compliance. This version includes modifications that bring the analyzer into compliance with EU Directives 89/336/EEC.

The Platinum Series NanoTrace Oxygen Analyzer has met the requirements of:

EN55011, Group 1, Class A.
EN61000-4-2 Electrostatic Discharge Susceptibility
ENV50140:1993, Radiated Susceptibility-Electric Field (Amplitude Modulated)
ENV50140:1993, Radiated Susceptibility-Electric Field (Pulse Modulated)
IEC 801-4, Conducted Transients Susceptibility
IEC 50141, Conducted Electromagnetic Field Susceptibility
EN61000-4-8, Magnetic Field Susceptibility
EN61000-4-11, Voltage Variation Dropout
EN50081-2 Generic Emission Standard, Part 2: Industrial Environment
EN50082-2 Generic Immunity - European Requirements
EN61010-1:1990, Safety Requirements, Including Amendment Number 1:1992

This Addendum describes changes to the standard NanoTrace Analyzer that bring these analyzers into CE Compliance. Special installation and operation considerations are also discussed. Information contained in this document supersedes the information in the *Platinum Series NanoTrace Oxygen Analyzer Instruction Manual.*

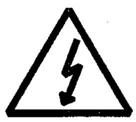
1.0 General Configuration Changes

Figures A1 and A2 illustrate some of the features that have been added to the enclosure for CE Compliance. These components consist of electrical contacts located around the door/cabinet flange and at the rear panel edges. A shield has been added to the display PCB mounted to the door.

A multilayer backplane PCB is used in all CE Compliant analyzers. This board incorporates filters on the I/O lines. Additional filtering is included on the power receptacle.

Silk screened notations on the power panel and on the backplane were revised to conform to the required standards.

CAUTION



Analyzers equipped with the Nitrogen Purge Panel ***must not*** have the voltage selector switch changed from the factory set position. A label appears next to the switch indicating that the switch position must not be changed. The reason why the switch should not be moved is that there are internal components, for this option, that will operate only on the line voltage specified at time of order. Operation at a line voltage other than specified will cause a loss of safety and/or component failure.

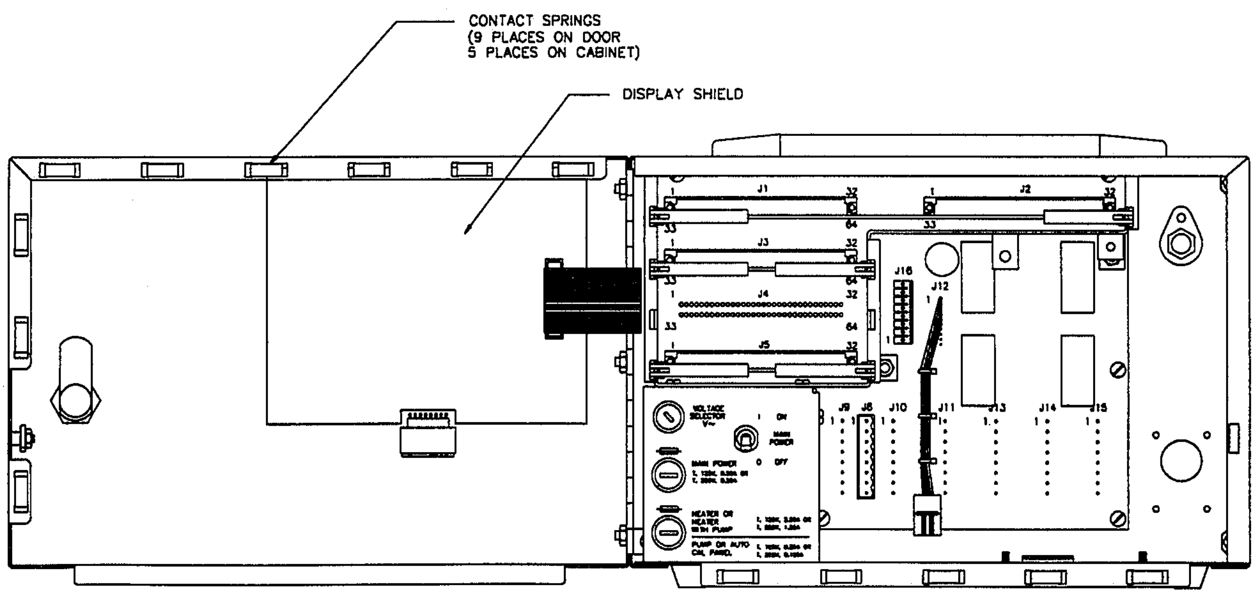


FIGURE A1. PLATINUM SERIES ENCLOSURE MODIFICATIONS FOR CE CONFORMANCE

2.0 Connectors

On the back of the instrument, see Figure A3, connector J11 has been clearly marked to indicate that remote sensor operation has not been tested to meet CE Conformance. Figure A3 replaces Figure 2-2 in the NanoTrace Instruction Manual. A label has been placed beside connector J9 to reflect revised functions at these pinouts.

Section 4.5, Options Port, in the Manual is revised to show the CE Compliant pin call-outs as follows:

		Key
J9-1	UNUSED	
J9-2	Relay 5 +	Sample/Calibration Relay 5 +
J9-3	Relay 5 -	Sample/Calibration Relay 5 -
J9-4	Relay 6 +	Sample/Calibration Relay 6 +
J9-5	Relay 6 -	Sample/Calibration Relay 6 -
J9-6	UNUSED	
J9-7	FLOW-NC	Flow Switch (Opens on Low Flow)
J9-8	FLOW-COM	Flow Switch Common

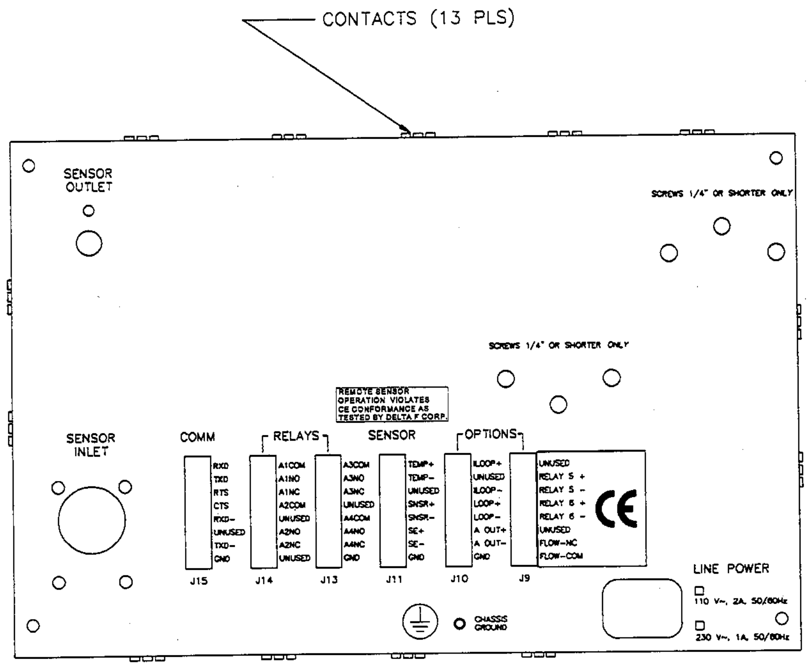


FIGURE A2. MODIFICATIONS TO BACK PANEL FOR CE CONFORMANCE

3.0 Input/Output Connections

All customer I/O cables used with CE Compliant instruments must have an outside shield that is grounded to the Chassis Ground stud, shown in Figure A3. This shield protects the analyzer from conduction of electromagnetic interference into the signal lines. The use of unshielded cable will result in a system that does not comply with CE standards.

Alarm relay switching specifications, found in sections 3.10 and 10.0 of the Instruction Manual, have been derated to 5 Amps @ 30 VDC or 30 VAC. EMI filters used to protect the Alarm relay signal lines will be damaged if these ratings are exceeded.

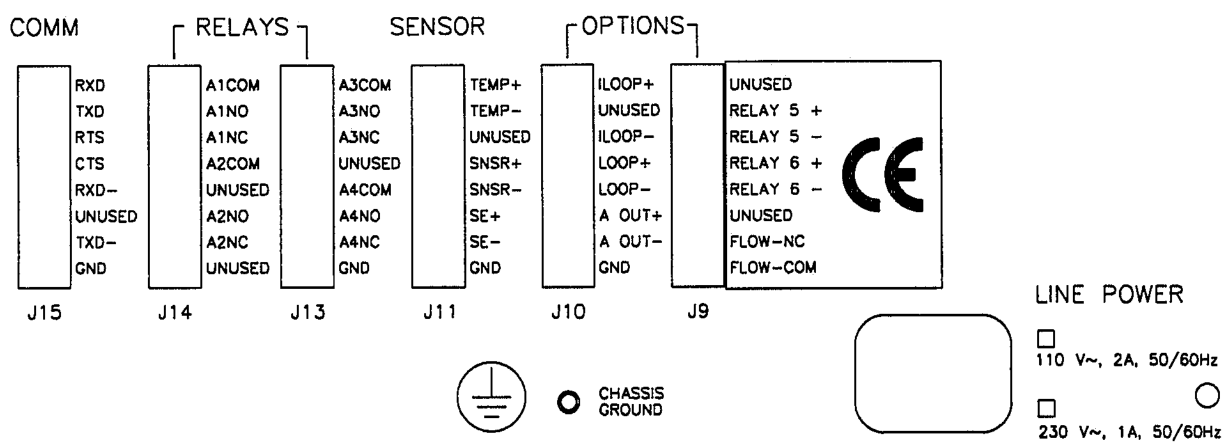


FIGURE A3. PINOUTS AT ENCLOSURE REAR FOR CE COMPLIANCE
NOTE: CONNECTOR J-11 IS NOT AVAILABLE ON CE COMPLIANT ANALYZERS

3.1 RS-485 Grounding Requirements

When making RS-485 connections to the instrument it is necessary to connect the instrument DC common to earth ground at the back of each analyzer connected to the loop. This grounding is needed to solidly reference every RS-485 transceiver to a common ground. If this grounding requirement is not followed, data communication may disturb the stability of oxygen readings. Delta F has installed a ground connection between pin 8 of J15 and the earth ground stud located below J10 on the back panel. It is important that this ground connection stay in place.

4.0 Automated Calibration System

The back connector, J9, is revised to the following: Relay 5 and 6 provide 6 VDC signals to operate external solenoids for an optional, externally-mounted Automated Calibration System, or to operate a user-supplied calibration system

Figure A4 shows a Schematic of the Automated Calibration System. This figure supersedes Figure 5-15 in the Instruction Manual. In *Section 5.4.5.2.3 Logic Table*, reference is made in the Key: to AC voltage. These references should be changed to indicate the presence of 6 VDC.

In *Section 3.13.2 Automated Control of External/User-Supplied Calibration Components*, it states that switched line level signals are provided to control user's equipment. For CE Compliant instruments, the switched signal level is 6 VDC.

In *Section 5.4.5.3 Check/Adj Zero*, the paragraph on ZERO GAS selection references AC HI and AC LO voltages at Relay 5. For CE Compliant instruments, the voltage available at Relay 5 is 6 VDC.

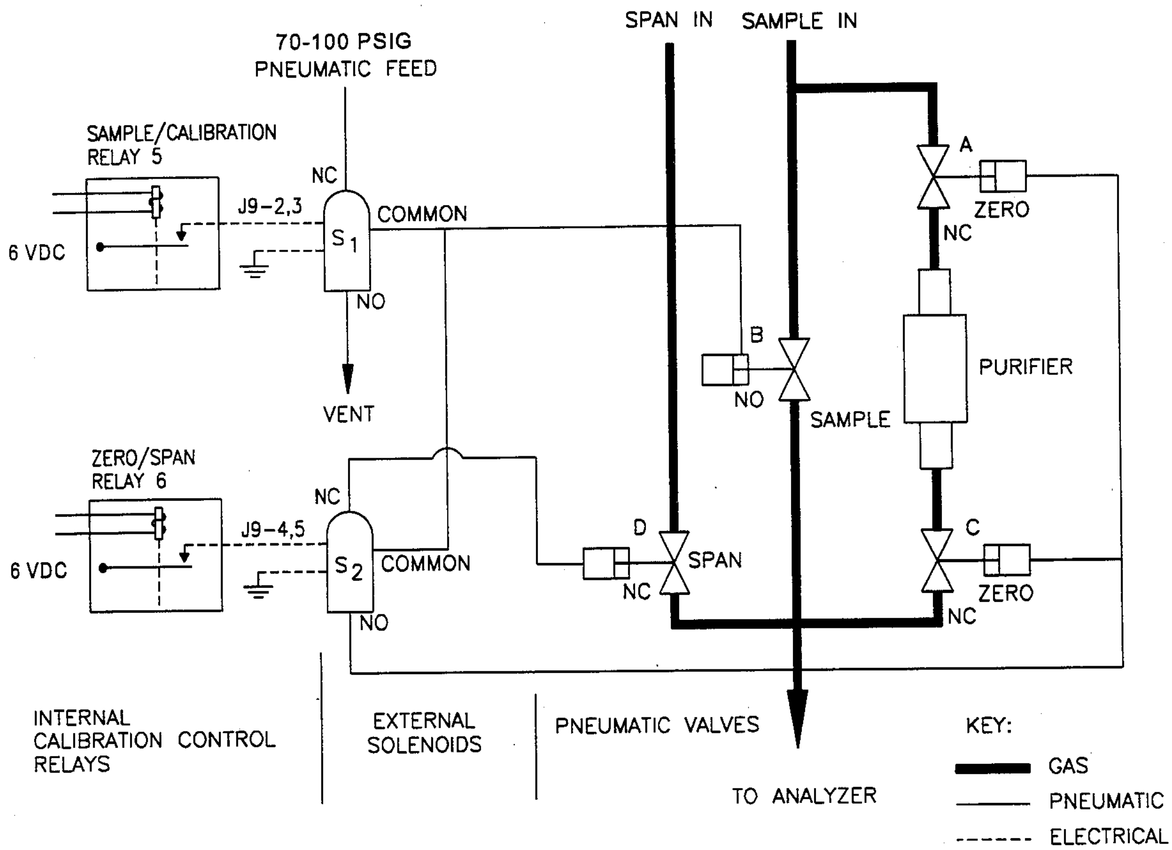


FIGURE A4. SCHEMATIC OF AUTOMATED CALIBRATION SYSTEM FOR CE COMPLIANT ANALYZERS

5.0 Nitrogen Case Purge with AC Power Interlock

Figure A5 shows the CE compliant Nitrogen Case Purge with AC Power Interlock. This figure supersedes Figures 3-7 in the Instruction Manual. AC power is supplied to the IEC320 receptacle located at the back of the purge housing. The housing contains a hermetically-sealed mercury relay which controls power to the Analyzer. The purge gas flow switch has been relocated from inside the analyzer enclosure to inside the purge housing. Operation of the CE purge is the same as for the standard purge panel. See Section 3.14 in the Manual.

DANGER

If the analyzer is equipped with an optional Nitrogen Case Purge with AC Power Interlock, the operating voltage supplied to the purge receptacle **must** match the analyzer's factory preset operating voltage. Safety will not be maintained if the analyzer is operated at a voltage different from that specified at the time of order. The factory setting is indicated on the back of the analyzer near the line power receptacle. Do **not** remove the plug at the analyzer line power receptacle. Customer supplied AC power **must** be connected **only** to the AC receptacle on the Nitrogen Case Purge with AC Power Interlock. Application of AC power to the analyzer line power receptacle will defeat the operation of the Nitrogen Case Purge with AC Power Interlock, which will result in a hazardous condition.

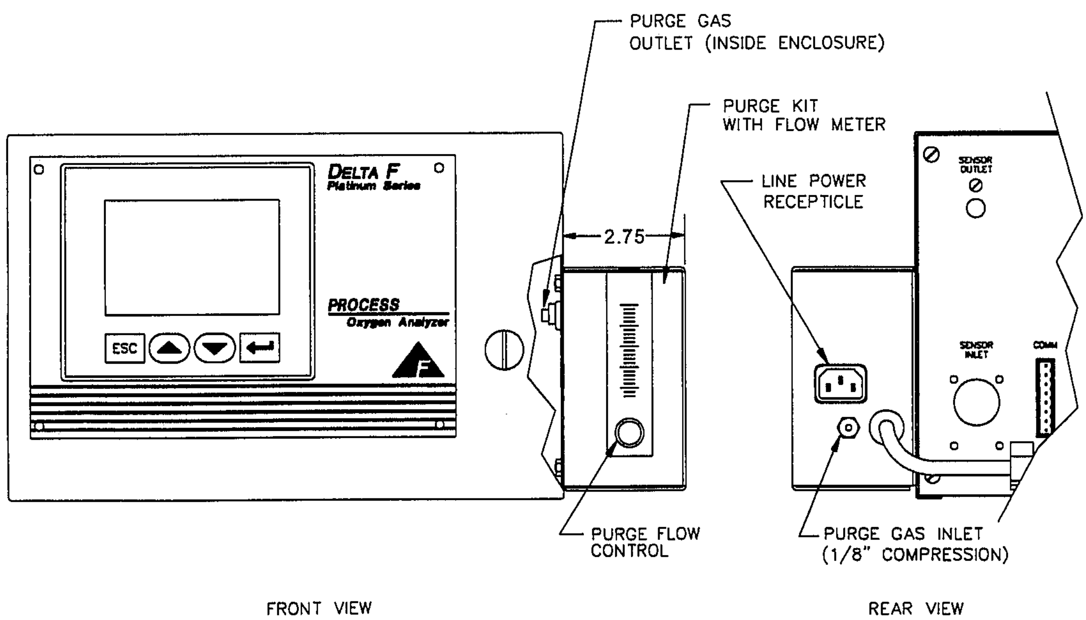


FIGURE A5. NITROGEN CASE PURGE WITH AC POWER INTERLOCK

6.0 Line Voltage

The operating voltage of the NanoTrace Analyzer is specified at time of order. This voltage is indicated on the rear panel, to the right of the power inlet connector. A mark has been placed in the box that corresponds to the specified voltage. If the Analyzer does not have Nitrogen Case Purge, it is possible to field change the operating voltage by moving the voltage selector switch (on the power panel to the left of the power switch) to a different position. See Figure A1 for details. It is suggested that the voltage selection switch be examined to determine the actual analyzer operating voltage.

When the voltage selection switch is set to the 110 VAC position the analyzer line voltage specification is 110 VAC, 50/60 Hz, at a maximum power draw of 2 Amps. When the voltage selection switch is set to the 220 VAC position the analyzer line voltage specification is 230 VAC, 50/60 Hz, at a maximum power draw of 1 Amp.

7.0 User Replaceable Fuses

All fuses within the NanoTrace Analyzer are user replaceable. The main power fuse is located on the power panel to the left of the power switch. See Figure A1 for details. For 110 VAC operation the main power fuse is a 5 X 20 mm, 125 VAC, 0.5 Amp time delay (IEC sheet III, Type T) device. For 230 VAC operation the main power fuse is a 5 X 20 mm, 250 VAC, 0.25 Amp time delay (IEC sheet III, Type T) device.

The optional calibration panel fuse is not used on this instrument. A calibration panel uses a six volt supply that is protected by the main fuse.

Analog output protection fuses are located on the Output Board in slot J3 of the card cage. See Figure A1 for details. Fuse F2 is for the 4-20 mA output, and F1 is for the 0-10 VDC output. If the Analyzer is equipped with an optional isolated 4-20 mA output there will be a daughter board plugged into the Output board. This daughter board contains a fuse. All fuses on the Output and daughter board are 5 X 20 mm, 250 VAC, 100 mA, fast acting fuses.

8.0 Protective Earth

Protective Earth grounding is provided through the AC power cord. The IEC320 power receptacle ground connection is internally connected to the case of the Analyzer. It is important that the power cord be properly connected to AC ground.

9.0 Optional Batteries

If equipped with the Supplemental Ni-Cd Battery Power option the Analyzer includes a Nickel-Cadmium battery pack. The pack contains six 1.25 VDC, 4400 mAHr, batteries in a series configuration. Charging current is supplied through a thermal cut-out. If the battery temperature exceeds 40±5°C the thermal cut-out will open and stop charging.

Platinum Series

NanoTrace Oxygen Analyzer

Instruction Manual

P/N 99000018
Revision B

Covers Firmware
Versions 2.90 - 3.00

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DANGER

Line voltage exists in the Oxygen Analyzer Enclosure. DO NOT REACH INTO THE ENCLOSURE when the Analyzer is connected to AC power.

CAUTION

Do not operate the Platinum Series NanoTrace Oxygen Analyzer at oxygen concentrations that are over-range for extended periods of time. Sensors may be damaged if exposed to high levels of oxygen, e.g. air, for long periods of time (>15 minutes) while on power.

If an exposure is unavoidable, turn-off power to the instrument, or deactivate the sensor polarization circuit (Section 5.3.3).

1.0 Overview of This Manual

This manual is organized into sections that will provide progressively more detailed information about the features and capabilities of the Delta F Platinum Series NanoTrace Oxygen Analyzer. Section 1.0 provides information about this manual, and defines some terms that will occur throughout the manual.

The Platinum Series NanoTrace Oxygen Analyzer is a sophisticated instrument with many features that will be discussed later. In Section 2.0 of this manual we will describe a procedure to get the Analyzer up-and-running quickly. Later we will delve into the details to help you customize the operation of the Analyzer for your particular application.

Section 2.0 assumes that the user has an instrument that does not include options. If your instrument has any of the options listed below, some minor changes to the Quick Set-Up Procedure in Section 2.0 may be necessary. These changes can be found in Section 3.0, under the selected option.

Option	Section	Change to Quick Start-up Procedure
Regulator	3.2	Plumbing Set-up
Stainless Steel Outlet	3.5	Removal of Sensor
Panel/Rack Mount	3.12	Enclosure Mounting

Section 3.0 briefly discusses optional equipment and features. Useful information about specific options for the Analyzer can be found in this section. Section 4.0 describes how the Analyzer can be connected to external devices. Details about communication ports, relay ports and other optional ports can be found in this section of the manual. Programming the Analyzer for specific requirements is covered in Section 5.0. The user will be taken step-by-step through the screen menus. Section 6.0 discusses Calibration Systems.

The remainder of the manual covers Theory of Operation (Section 7.0), Service (Section 8.0), Safety (Section 9.0), Specifications (Section 10.0), and Warranty (Section 11.0).

1.1 Introduction

Many factory options are available for the Platinum Series NanoTrace Oxygen Analyzer. However, the Quick Set-Up procedure in Section 2.0 assumes that the user has a Basic Analyzer without options.

The Basic Analyzer can send a signal to an external device. The output signal can be scaled for custom needs. Standard outputs are non-isolated 4-20 mA and 0-10 VDC. Over- and under-range conditions are also indicated on the display panel. Standard components include a flowmeter, quick-disconnect sample outlet gas line, a VCR®-type sample inlet gas line, four oxygen alarms, one temperature alarm, and one electrolyte alarm. Non-standard equipment includes a flow switch, a regulator, sensor isolation valves, alarm relays, portable battery pack, mounting configurations, and gas calibration systems. Figure 1-1 shows the basic Analyzer. Figure 1-2 shows some of the major internal components.

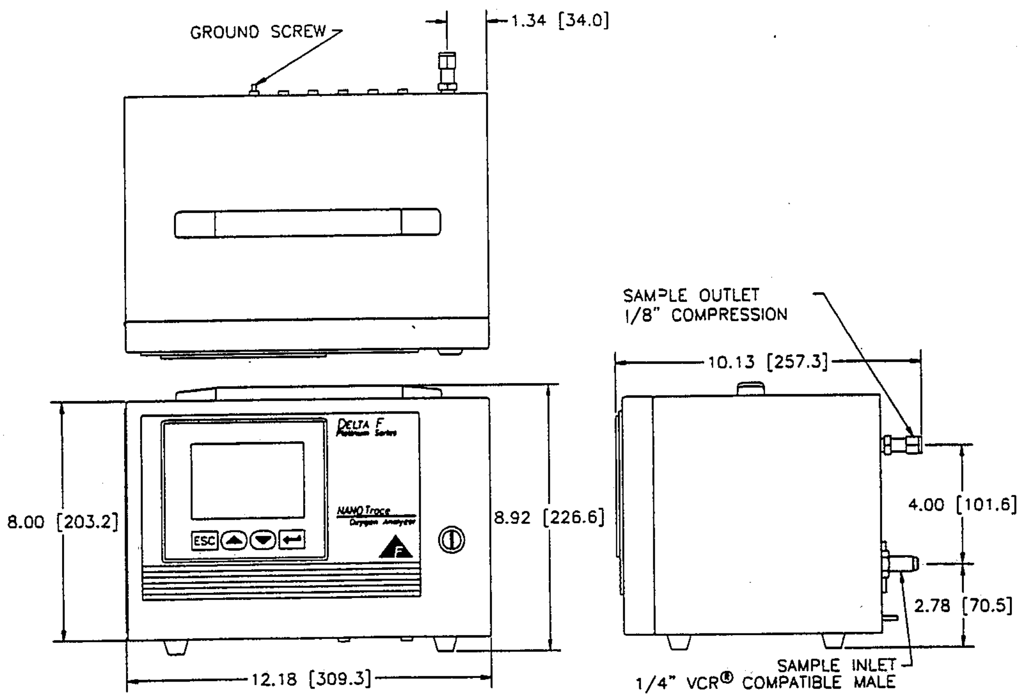


FIGURE 1-1 DELTA F PLATINUM SERIES NANOTRACE OXYGEN ANALYZER

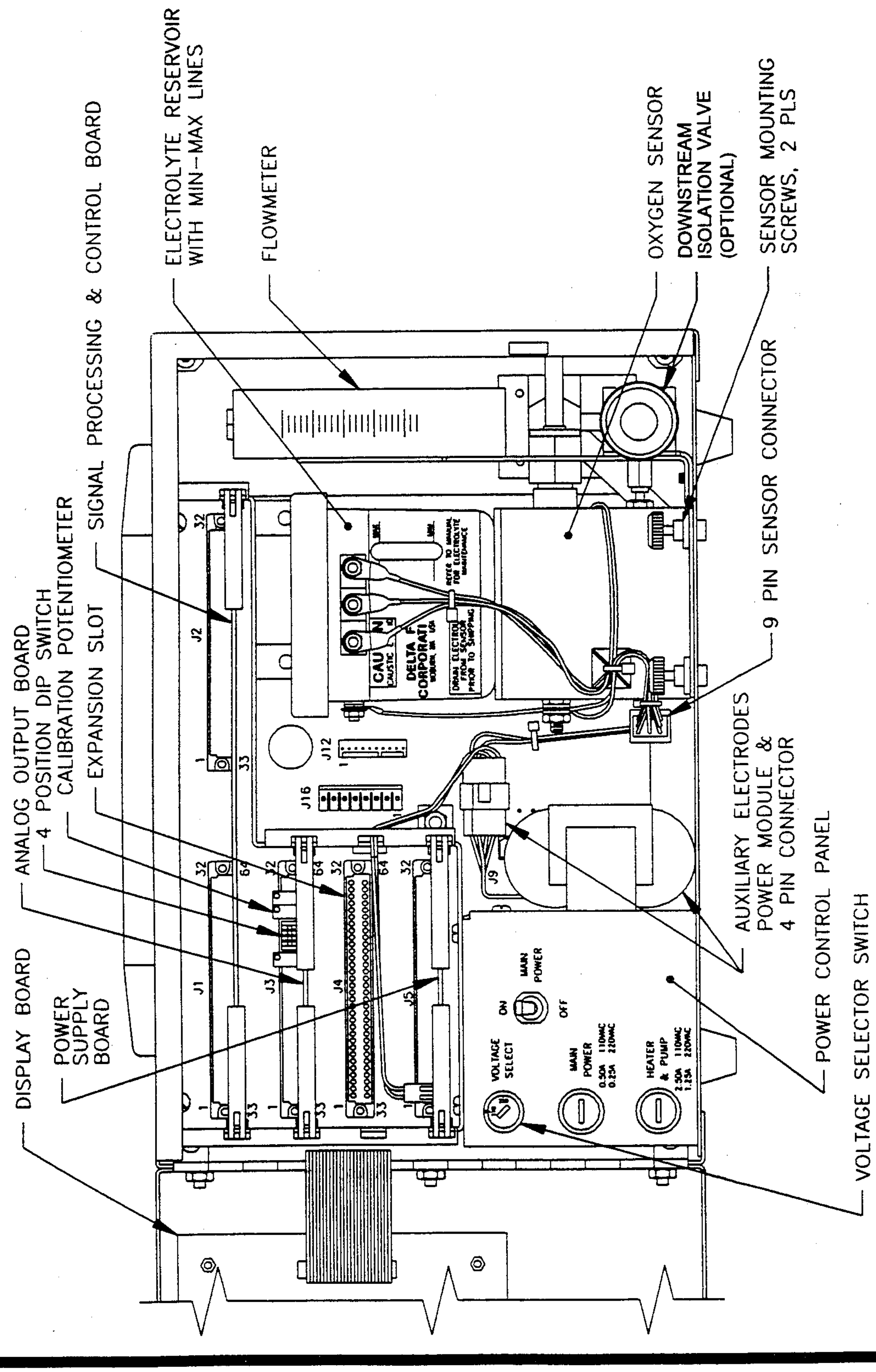


FIGURE 1-2 MAJOR INTERNAL COMPONENTS

1.2 Definitions and Warnings

Before setting-up the Analyzer, some definitions and warnings need to be stated.

1.2.1 Explanation of Graphic Symbols

This symbol alerts you to the presence of "Dangerous Voltage" within the Analyzer's enclosure. This voltage may be of sufficient magnitude to cause a risk of electrocution. It also alerts the user that damage to the Analyzer may result if procedures are not followed.

This symbol alerts you to the presence of important operations and/or maintenance instructions in this manual.

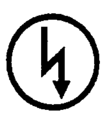
1.2.2 Definitions

DANGER: Indicates that the information is provided to alert the user to a potential personal hazard, or the potential of damage to the product.

CAUTION: Indicates that the information is provided to alert the user to the potential of damage to the instrument, or an incorrect result if the procedures are not followed.

NOTE: Indicates that the information is provided to increase the efficiency, accuracy or reliability of the Analyzer.

DANGER



Potentially hazardous AC voltages are present within this instrument. Leave all servicing to qualified personnel. Disconnect the AC power source when installing or removing: external connections, the sensor, the electronics, or when charging or draining electrolyte.

CAUTION

Do not set-up or operate the Oxygen Analyzer without a complete understanding of the instructions in this manual. Chapter 9.0 Safety, contains safety instructions and the electrolyte Material Safety Data Sheet (MSDS).

Do not connect this Analyzer to a power source until all signal and plumbing connections are made.

EMI DISCLAIMER

This Analyzer generates and uses small amounts of radio frequency energy. There is no guarantee that interference to radio or television signals will not occur in a particular installation. If interference is experienced, turn-off the Analyzer. If the interference disappears, try one or more of the following methods to correct the problem:

1. Reorient the receiving antenna.
2. Move the instrument with respect to the receiver.
3. Place the Analyzer and receiver on different AC circuits.

1.3 Unpacking

When unpacking the instrument, notice the condition of the package and its contents. If any damage is apparent, immediately notify the carrier and Delta F Corporation (617) 935-4600. Do not proceed with the installation.

Check the contents against the packing slip to make sure that the shipment is complete. Unattached equipment may be included with the Analyzer in supplemental packaging.

All Analyzers are shipped with the following parts:

Two Bottles of DF-EO7 Electrolyte	P/N DF-E07
Power Cord w/Connector (115 VAC)	P/N 59017237
or w/o Connector (230 VAC)	P/N 59036140
Water Bottle	P/N 67002401
Auxiliary Electrodes Power Module	P/N DF-B52
This Manual	P/N 99000018

NOTE: Any damage claims and shortage reports must be reported to Delta F Corporation (617) 935-4600 within 10 days after receipt of the shipment.

Keep the packing carton for future use. The carton is designed to protect the Analyzer and should be used if reshipping becomes necessary.

Open the Analyzer door and inspect the inside of the unit to be sure that no components have loosened or dislodged. Check the printed circuit boards (PCBs) to be sure they are seated properly. Remove any shipping materials.

1.4 Verify Operating Voltage

The Platinum Series NanoTrace Oxygen Analyzer is configured at the factory to operate on 90-120 VAC or 220-250 VAC as specified on the purchase order. The factory setting is indicated on the back panel of the Analyzer near the power receptacle. The user can also check the position of the voltage selector switch on the internal power control panel, Figure 1-2.

To change the operating voltage replace the main fuse and move the position of the voltage selector switch. For 115 VAC operation, a 0.5 Amp fuse (P/N 45002361) is required; for 230 VAC operation, a 0.25 Amp fuse (P/N 45002301) is required. The Analyzer uses less than 25 watts of power.

NOTE: If the Analyzer is equipped with an optional automated calibration system, the operating voltage must not be changed from the factory setting.

2.0 Quick Setup Procedure

In this procedure it is assumed that the Analyzer is not equipped with options (Basic Analyzer Configuration), and the voltage output is set to 0-10 VDC. Options may affect the set-up procedure described in this section. If your Analyzer is equipped with options, refer to Section 1.0 and Section 3.0 to determine changes to the set-up.

NOTE: The representative screens shown throughout this manual have values that may not necessarily match with the actual values displayed during your set-up.

The Auxiliary Electrodes Power Module (AEPM), Figure 1-2, is shipped unconnected to conserve power. Plug the connector into its mate at this time.

NOTE: It is especially important to disconnect the AEPM when the sensor does not contain electrolyte for extended periods, (8 hours or more) to prevent quickly discharging the AEPM. Whenever the Analyzer is not in service for extended periods (even with electrolyte), disconnect the AEPM.

Connect the module as follows:

1. Open the enclosure door. Locate the Auxiliary Electrodes Power Module, Figure 1-2.
2. Plug the four pin female connector on the module into the male connector located on the nearby cable harness.

2.1 Tools Required

For a Basic Analyzer Configuration, a 13/16" open end wrench is required for the inlet bulkhead retainer nut. Additional wrenches will be needed for mating fittings.

2.2 Electrolyte Maintenance

DANGER

The electrolyte is a caustic solution. Review the Material Safety Data Sheet (MSDS) in Section 9.2 before handling the electrolyte solution.

The sensor is shipped dry and must be charged with electrolyte before it is operated:

DANGER

Use only Electrolyte DF-EO7 for the Platinum Series NanoTrace Oxygen Analyzer. Failure to do so will void warranty.

a. Remove the 13/16" inlet bulkhead retainer nut from the inlet bulkhead fitting at the back of the Analyzer, ref. Fig. 3-2. Do not remove the four small socket screws.

CAUTION

Always place a plastic protective cap (supplied) over the exposed bulkhead face sealing surface before removing the sensor assembly. It is imperative that the metal face seal not be damaged. If the plastic cap is not available, protect the fitting with a gasket and retainer.

b. Inside the enclosure, disconnect the nine-pin sensor connector located near the front of the sensor, see Figure 1-2.
c. Unscrew both sensor mounting screws at the front of the sensor mounting bracket.

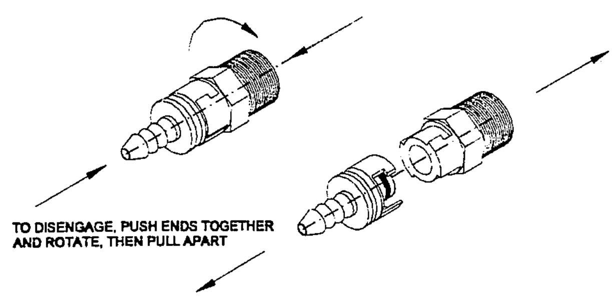


FIGURE 2-1 QUICK DISCONNECT FITTING AT FLOWMETER OUTLET

d. Pull the Sensor Assembly forward a few inches.
e. Disconnect the "quick-disconnect" fitting at the top of the flowmeter by pushing both halves of the fitting together and rotating one to the release position, see Figure 2-1.
f. Remove the Sensor Assembly from the instrument.
g. Unscrew the grey cap from the electrolyte reservoir.

NOTES:

1. If the sensor is being charged with the electrolyte for the first time, the reservoir should be filled with deionized or distilled water up to the maximum level line on the reservoir label.

   Allow the sensor to sit for 15 minutes. Check for leaks. If a leak is found, report it to the factory, (617) 935-4600, before proceeding. Invert the Sensor Assembly to drain. Proceed to step h.

2. If the electrolyte is being changed, remove the reservoir cover and drain the electrolyte into a suitable (polyethylene, etc.) container for proper disposal. Thoroughly flush the sensor 2 or 3 times with distilled or deionized water before recharging. Properly dispose of the spent electrolyte and rinse water.

3. **Do not apply power before adding electrolyte and thoroughly purging sample line.** See Section 8.1.3 for refill procedures, and Section 2.7 on the start-up sequence.

h. Add the entire contents of one bottle of electrolyte (DF-EO7) to the sensor. Replace the screw cap and hand tighten securely.
i. Install the sensor by repeating steps a. to f. in the reverse order.

NOTE: The flats on the inlet bulkhead fitting are oriented to seat in an anti-torque plate on the inside back of the enclosure. When reinstalling the Sensor Assembly, be sure the flats on the bulkhead fitting seat in the slot of the anti-torque plate before replacing the 13/16" retainer nut.

2.3 Sample Gas Connections

The sample gas inlet and outlet lines at the back of the instrument have stainless steel bulkhead fittings. The inlet fitting uses a VCR®-type metal seal; the 1/8" compression outlet fitting accepts a tube. Before connecting your outlet gas tube to the Analyzer, fully install the supplied gas nut and compression ferrule on your tubing. Connect the inlet and outlet lines to the bulkhead fittings at the back of the Analyzer. A backup wrench is not needed since the bulkhead fittings are secured by anti-torque plates that are inside the cabinet. Do not over-tighten the fittings.

If your installation requires long tubing runs or has many bends or fittings downstream of the Analyzer, the pressure loss may impose a pressure at the sensor that exceeds 0.5 psig. If this is the case, use larger outlet tubing and/or reduce the complexity of the outlet gas line.

2.4 Electrical Connections

Make sure the power switch in the Analyzer is in the OFF position, Figure 1-2. Plug the supplied line cord into the receptacle at the back of the Analyzer before connecting the line cord to the power. Verify the operating voltage, Section 1.4, and that the AEPM has been connected, Section 2.0.

2.5 Standard Outputs

An output signal can be sent to other instruments by using the non-isolated 4-20 mA output and the 0-10 VDC output at the back of the Analyzer. The Analyzer is shipped with required mating connectors plugged into the back panel.

The outputs use the Options Port, J10 shown in Figure 2-2. A standard feature of the Analyzer is the 4-20 mA output which is isolated from earth (chassis) ground. This output is not electrically isolated from the voltage output. An internal 28 VDC loop supply is provided.

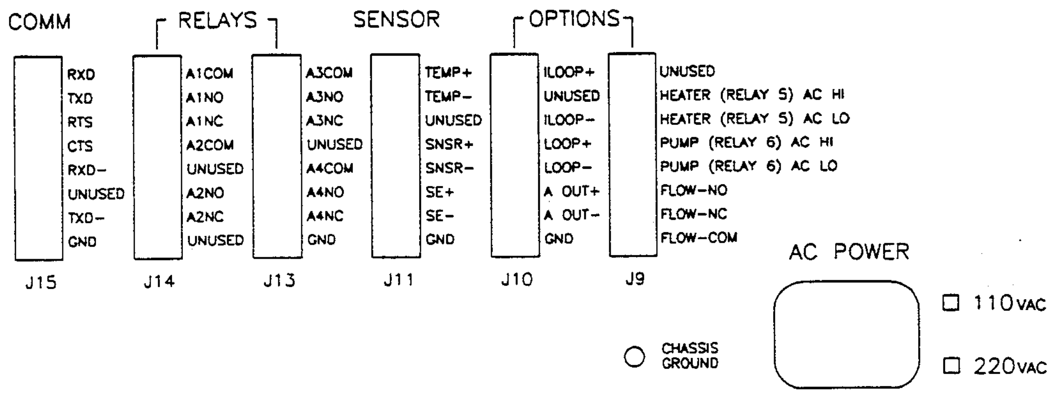


FIGURE 2-2 PINOUTS AT ENCLOSURE REAR

The 4-20 mA output is connected to pins J10-4 (LOOP+) and J10-5 (LOOP-); the 0-10 VDC output is connected to pins J10-6 (A OUT+) and J10-7 (A OUT-).

2.6 Powering Up

The NanoTrace Analyzer is equipped with an orifice in the sample line at the sensor inlet connection. The orifice is sized to provide approximately 2.0 scfh at an inlet pressure of 15 psig to the instrument when the Analyzer outlet is vented to atmosphere. All NanoTrace Analyzers are designed to operate at approximately 15 psig sample gas pressure. Delta F recommends using a high integrity valve or a pressure regulator on the inlet to control flow rate and provide isolation capability. If the line pressure exceeds 15 psig, install a pressure regulator.

If the Analyzer outlet is at atmospheric pressure, the regulator can be used to set the flow rate at 2.0 standard cubic feet per hour (scfh) without danger of over-pressurizing the sensor. The back pressure on the instrument should not exceed ±3.0 psig.

CAUTION

Over-pressurizing the sensor can result in permanent damage to the sensor. Limit the back-pressure to the Analyzer to 3 psig.
Be sure the downstream isolation valve (if so equipped) is opened at least one full turn **before** gas flow is started.

NOTE: Allow a low ppb gas to flow through the Analyzer for approximately 30 minutes before powering-up.

Turn on the power using the main power switch on the internal power panel, see Figure 2-1. The unit will undergo a series of diagnostic procedures for approximately 5 seconds, and then it will display the Delta F Corporation logo.

After 15 seconds, the display will appear similar to Figure 2-3 (values shown are only representative).

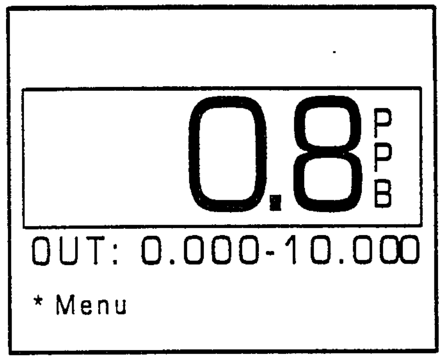


Figure 2-3

The Analyzer should take less than 5 minutes to come on-scale (<10 ppm). During this time the Analyzer will display the message **Invalid Data**.

The concentration of oxygen is shown in parts per million (ppm) or parts per billion (ppb).

This completes the set-up of the Basic Analyzer.

2.7 Additional Notes for Start-up and Initial Operation

1. **DO NOT** use DF-EO5 electrolyte. NanoTrace units must use DF-EO7 electrolyte or damage will result. Install one bottle.

2. For short start-up time, pre-purge the sensor and sample system (all tubing runs) with zero gas for 30 minutes before starting the Analyzer. It should take less than 5 minutes for the Analyzer to come on-scale. Expect to see an **Invalid Data** message during this time.

3. Supply the Analyzer with an N_2 sample that is as low in O_2 as possible. When the Analyzer is equipped with a calibration system, the purifier's life will be greatly reduced if the supply gas is over 0.5 ppm. If a bottled gas must be used, please obtain a cylinder with $O_2 < 1$ ppm.

4. If the Analyzer is equipped with a zero purifier, flow gas through the purifier during the initial cleanup period. The Analyzer will require 2-3 days of operating on zero gas in order to make readings at the low ppb area. Once

the rate of descent of the O_2 level is < 1 ppb/day, the Analyzer can be zero set using the "User Zero" screen, and accurate low ppb readings can be made. Gradually over 1-2 weeks, the sensor will react-out the last traces of residual O_2 from the electrolyte. When the zero baseline stabilizes, the O_2 level will decrease closer to the factory zero level and need to be reset, or the factory calibrated zero value can be restored, see Section 5.4.5.3.

5. A portable NanoTrace Analyzer equipped with NT-ISO-DSV (Downstream Sensor Isolation Valve), NT-NiCad (Battery Backup Power), and either NT-FCV-UHP (High Purity Bellows Valve) or NT-PR1-5V (Regulator) options, is designed to quickly equilibrate at low ppb measurements after being transported from sample tap to sample tap while running on battery power.

CAUTION

To avoid damage to the sensor, limit extended periods with the sensor isolated (without gas flowing) to ***less than 4 hours per day,*** whether power is ON or OFF. Always maintain a UHP sample gas purge on the analyzer when not in use.

Extended periods of sensor isolation and / or frequent isolation can cause an elevated zero base line after flow is reestablished. ***Minimize the duration and frequency of running while isolated.***

Simply equilibrate the Analyzer near zero (< 10 ppb), shut off flow using the upstream valve or regulator, and ***immediately*** close the downstream isolation valve. The O_2 readings will begin to rise and eventually stabilize at between 20 and 150 ppb (which represents the rate that O_2 molecules are leaking into the sensor and plumbing). Readings higher than 150 ppb indicate an unacceptable leak rate, and valve seats, packing, and fittings should be checked. See Section 8.0.

Once moved to the new tap location, the connecting tubing should be connected to the valve or regulator with a new VCR gasket. The system should be pressure cycled by using the following procedure:

Hand tighten only. Allow gas to leak from the connection. By alternately tightening and loosening the fitting, the fitting and tube will be purged by pressure cycling. Perform a minimum of 20 cycles, over a 15 minute period before wrench-tightening the last VCR connection, and restarting flow.

CAUTION

Always open the downstream valve just BEFORE opening the upstream valve to avoid pressurizing the sensor.

6. Always check for leaks by achieving steady, low ppb readings at 2 scfh or higher, and then decreasing flow to about 0.5 scfh. Readings should rise by no more than 1.0 ppb. Larger increases in O_2 are caused by an "actual leak" (from atmosphere) or a "virtual leak" (dead spaces). See Section 7.0

7. If the Analyzer is supplied with a calibration system option, then the sample can be switched through the purifier to obtain a stable reading on zero gas. Even if the unit is still settling out after initial startup, or an electrolyte change, or a high ppm exposure, as long as the rate that the zero base line is falling is less than the accuracy of measurement needed over a one hour period, the unit can be zero set and an accurate measurement made immediately thereafter.

   For example, if the required accuracy of the reading is within 0.3 - 0.4 ppb, wait until the hourly rate of descent is less than 0.3 ppb . A low ppb reading will take between 20-40 minutes.

8. Average Filter settings are different for different operating conditions. Section 5.4.5.10 provides some recommended settings. Always start with **RESP: FASTER** and **THRESHOLD: 0.01**. In general, apply only as much **WEIGHT** as necessary to keep readings from bouncing unacceptably. All three adjustments will act to slow O_2 reading stabilization times.

   For readings taken after an upset or after a new sample has been connected (as is common for portable applications) start with a **WEIGHT: 50**. After reconnection, add more filtering by increasing the **WEIGHT: 100** to **200** only if the readings appear too unstable.

CAUTION

The gas purifier supplied by Delta F Corporation has a finite life which is greatly affected by the source gas oxygen level, flow rate, and duration of sampling. Always minimize the time sampling from the purifier and ensure that the source gas is below 50 ppb for optimal life expectancy. See Section 6.5.1.

3.0 The Options

As indicated in the Introduction, many options are available with the Analyzer at the time of purchase. Some options can be retrofitted in the field. If your Analyzer has options, this section will help you during its set-up.

NOTE: Check your packing list to determine whether a particular option is installed, or attempt to select it via the menus. If it is not available on your instrument, the display will indicate so by not accepting your entry.

The Analyzer has four slots for printed circuit boards, one larger slot at the top and three smaller slots below. The larger slot at the top holds the Main Circuit Board (Signal Processing and Control). The upper-most smaller slot holds the Analog Output PCB. The smaller slot at the bottom holds the Power Supply Board, Figure 1-2. The unused middle slot is reserved for future options.

CAUTION

The Power Supply Board must be inserted in the bottom smaller slot.

Set-up procedures for the following options can be found in the listed Section.

Option	Section
Low Flow Alarm	3.1
Installation of the Pressure Regulator	3.2
UHP Bellows Shutoff Valve/Flow Control Valve	3.3
Sensor Downstream Isolation Valve	3.4
Stainless Steel Outlet Tubing	3.5
NiCad Battery Pack	3.6
Key Lock	3.7
4-20 mA Fully Isolated Output	3.8
Gas Scale Factor	3.9
Relay Contact Closures	3.10
Panel/Rack Mount	3.11
Comm Ports	3.12

3.1 Low Flow Alarm

The optional low flow alarm includes a flow switch which is located in the enclosure on the right side. It is connected with vinyl tubing to the outlet of the flowmeter. The switch sounds an alarm when flow drops below a factory-set value, see Section 5.4.1.3. The switch can also be used with an optional alarm relay.

Figure 3-1 shows schematics of the gas flow path in the Analyzer for various configurations. The optional low-flow switch is included in configurations c and d.

If the stainless steel outlet option is ordered with a low flow alarm, the flow switch is mounted in the sample outlet line as part of the sensor assembly. A 2-pin connector is used to disconnect the switch from the sensor.

3.2 Installation of the Pressure Regulator

If the Analyzer is not equipped with a calibration system, the optional gas pressure regulator is user-installed. Three PEM nuts are installed in the back panel of the Analyzer for mounting the regulator bracket. Use the supplied screws with the PEM nuts. The regulator is mounted to the supplied bracket with two 1/4-20 truss head screws (supplied). The assembly mounts on the back panel as shown in Figure 3-2.

DANGER

It is very important to use the supplied screws (or their equivalent - steel pan head 10-32 by 1/4" long) to mount the bracket. Longer screws will damage the backplane printed circuit board.

An optional formed tube is available. The welded assembly consists of a formed tube and fittings to connect the outlet of the mounted regulator to the Analyzer inlet.

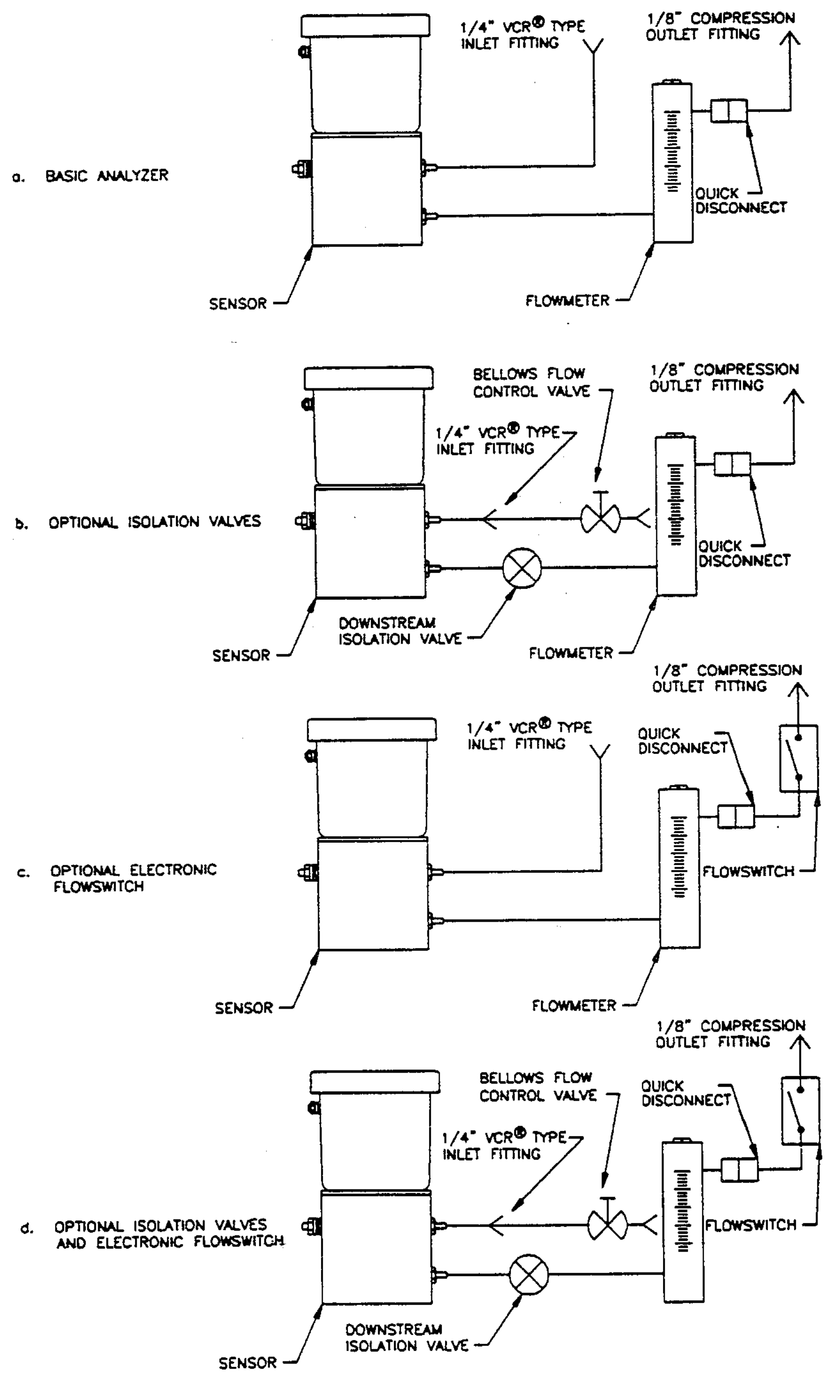


FIGURE 3-1 PLUMBING CONFIGURATIONS

3.3 UHP Bellows Shutoff Valve/Flow Control Valve

A stainless steel bellows valve is an option that can be provided for use as a flow control valve and an upstream isolation valve. The Ultra High Purity (UHP) flow control valve is recommended when the upstream pressure does not exceed 20 psig.

The valve also can be used in conjunction with the optional Sensor Downstream Isolation Valve, Section 3.4, to completely isolate the sensor.

DANGER

To avoid over-pressurizing the Analyzer, always be certain to shut off the external upstream valve **before** closing the internal downstream isolation valve.

Always open the internal downstream valve at least two full turns **before** restoring flow to the Analyzer.

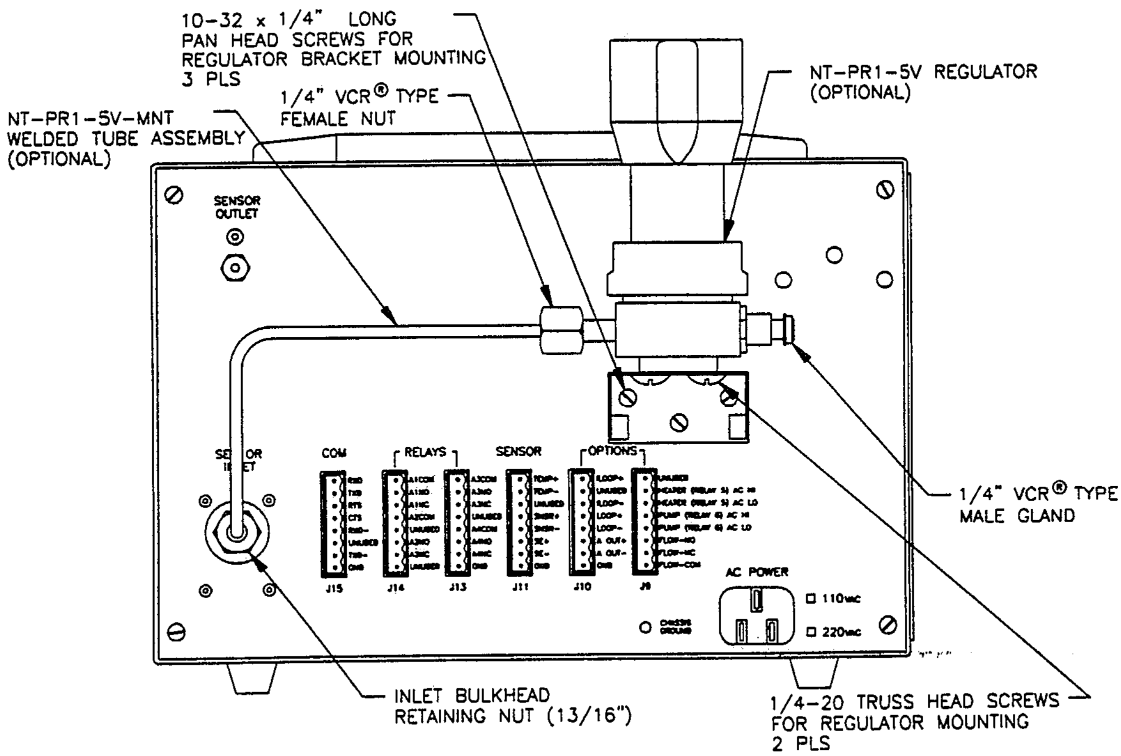


FIGURE 3-2 REGULATOR INSTALLATION

3.4 Sensor Downstream Isolation Valve

For Analyzers that are used in multiple locations, an optional downstream outlet valve can be fitted to the sensor. When used with the optional Regulator or upstream UHP Shutoff/Flow Control Valve, the sensor can be completely isolated from ambient air when transporting the Analyzer to other test locations. An isolated sensor will rapidly return to zero after reconnection.

DANGER

The Sensor Downstream Isolation Valve must not be used to control process flow rate to the Analyzer. This valve must be *fully* open when making measurements.

3.5 Stainless Steel Outlet Tubing

Analyzers can be equipped with a 1/8 inch compression stainless steel outlet tube. When this option is provided, the Analyzer cannot be equipped with the quick-disconnect fitting at the flowmeter outlet. Because of the rigid outlet tube, the Sensor Assembly can only be removed after both inlet and outlet bulkhead retainer nuts are removed. A 1/4" wrench is needed for the inlet nut; a 1/2" wrench is used on the outlet nut. When reinstalling the sensor, make sure both bulkhead fitting hex sections are oriented to seat in the retainer blocks on the inside rear of the enclosure.

3.6 NiCad Battery Pack

Analyzers equipped with a battery pack can be operated on battery power for up to 12 hours (up to 8 hours when driving the 4-20 mA output.) Battery charging occurs only while the Analyzer is connected to AC power ***with the power switch turned on***. The batteries can be charged while the instrument is not in service by turning off power to the sensor, see Section 5.3.4.

Approximately 15 hours is required to fully charge a battery pack . The charger PCB is mounted on the wall of the card cage, to the left of the sensor. It has two LEDs. When illuminated, the top (red) LED indicates operation on batteries; an illuminated lower (green) LED indicates high charge rate (as opposed to a trickle charge).

The annunciator line in the Analyzer's display (Figure 5-1) indicates low battery power, "**[BAT LOW]**". When the BAT LOW signal comes on, approximately 10 minutes of operating time remain.

3.7 Key Lock

An optional key lock can be installed in the door of the Analyzer to prevent access to the power switch and other internal components. The lock is supplied with two keys.

If the Analyzer is operating, the key lock will not prevent adjustments from the front panel. Password Protection, described in Section 5.5, must be used to lock-out front panel control changes.

3.8 4-20 mA Fully Isolated Output

The Analyzer can be equipped with an optional 4-20 mA, 550 Ω maximum loop resistance, fully isolated output which is completely isolated from all other analog outputs and earth ground. An internal 28 VDC compliance voltage is provided.

Connections are made at pin J10-1 (ILOOP+) and J10-3 (ILOOP-) at the back of the instrument, Figure 2-2. Analyzers equipped with this option still have the Standard 4-20 mA non-isolated output located at pins J10-4 (LOOP+) and J10-5 (LOOP-).

3.9 Gas Scale Factor

The optional Gas Scale Factor (GSF) is used to correct for changes in the rate of oxygen diffusion when background gases other than nitrogen are present in the sample gas. The GSF can be entered manually. Alternatively, the GSF can be calculated by the NanoTrace Oxygen Analyzer and entered automatically. The calculated GSF requires the user to enter the volumetric composition of the sample gas as described in Section 5.4.5.1.

3.10 Relay Contact Closures

Up to four optional form C (SPDT) relays (contact closures) are available to assign to alarms. One or more alarms can be assigned to one or more relays. The contacts are rated at 5 amps @ 250 VAC and 30 VDC under a resistive load. Pin assignments are shown in Figure 2-2; Section 4.3 provides relay connecting details.

3.11 Panel/Rack Mount

A panel mount and a 19" rack mount are available for the Analyzer. The panel mount requires a cut-out for installation. Figures 3-3, 3-4 and 3-5 show the rack and panel mounts, and the cut-out for mounting the panel.

3.12 Comm Ports

Either of two communication ports are available at the time of order: RS232C or RS485. This allows interfacing between the Analyzer and other operating systems using a PC-based software utility package supplied by Delta F Corporation. A "C" language software library package is available for customized development of communication software.

3.13 Calibration Systems

A variety of automated calibration systems and one manual system are available for the Platinum Series NanoTrace Oxygen Analyzer. See Section 6.0 for details.

3.13.1 Automated Calibration System

The Automated Calibration System is designed for dedicated zero and span calibration of a single Analyzer. The Calibration System is integrated with the Analyzer and is automatically controlled by the firmware to perform user-initiated zero and span calibrations. High-integrity, pneumatically controlled valves are provided for attaching process gas and a span gas. The system includes an in-line purifier to provide zero gas for calibration. This system requires a supply of instrument or plant air at 70 to 100 psig.

3.13.2 Automated Control of External/User-Supplied Calibration Components

For users who wish to design their own calibration system, this option provides all the necessary internal components and firmware to control the user-supplied equipment. Two switched AC line level signals are provided to control the user's external zero and span solenoids and pneumatic valves. See Section 5.4.5.2 for details on operation.

3.13.3 Automated Stand-Alone Calibration Station

An optional Stand-Alone Calibration Station is available that has all the features of the Automated Calibration System for use with NanoTrace Analyzers equipped with the Automated Control of External/User calibration Components option (NT-CAL-EXT). This system provides calibration support for a number of Analyzers installed without dedicated calibration equipment. The Calibration Station is attached to a NanoTrace Oxygen Analyzer with a high-integrity bellows tube. The Analyzer automatically controls the Automated Calibration Station for performing user-initiated zero and span calibrations. High-integrity, pneumatically controlled valves are provided for attaching process gas and a span gas. The system includes an in-line purifier to provide zero gas for calibration. This system requires a supply of instrument or plant air at 70 to 100 psig.

3.13.4 Manual Calibration System

The Analyzer can be equipped with a high-integrity, Manual Calibration System for portable use. This system is provided with manual, 1/4-turn springless, diaphragm valves and a zero purifier for verifying zero baseline or recalibrating the Analyzer.

3.14 Purge System with AC Power Interlock

Platinum Series Analyzers can be equipped with an inert gas enclosure purge for applications with combustible background gas such as hydrogen. The purge system offers limited explosion protection by diluting combustible gases that could possibly accumulate inside the enclosure to levels below the lower explosion limit.

The Cabinet Purge system is designed to provide a minimum of ten volume changes per hour of the atmosphere inside the Analyzer's enclosure. The failsafe feature is controlled by a low-flow switch. In the event of a partial or full loss of purge gas flow, the low-flow switch will open causing a hermetically sealed relay to disconnect power to the Analyzer.

The major components of the purge system, shown in Figure 3-6, are a purge gas flowmeter with an integral flow control valve, a low-flow switch (mounted inside the Platinum Series enclosure), and a hermetically sealed relay.

Purge gas flows through the flowmeter into the low-flow switch. The low-flow switch vents the purge gas into the enclosure. Sealed contacts inside the low-flow switch are electrically connected to the hermetically sealed relay.

AC power is connected to the relay and powers the Analyzer as long as the low-flow switch contacts are closed. If the purge gas flow rate falls to less than 5 scfh, the contacts in the low-flow switch open. When the contacts open, the coil in the relay de-energizes opening the AC high and AC low line contacts in the relay which disconnects power to the Analyzer.

Figure 3-7 shows the electrical and purge gas connections at the rear of the Analyzer. The purge system has a maximum supply pressure rating of 100 psig. Purge gas is connected via a 1/8 inch compression fitting.

NOTE: Nitrogen is recommended as the purge gas.

AC power is connected by the user at the three-terminal connector block next to the purge gas inlet. AC high, AC low and ground terminations are labeled at the connector as shown in Figure 3-7.

The Platinum Series NanoTrace Oxygen Analyzer Instruction Manual describes connecting and setting-up the Analyzer. Follow the instructions as described but **DO NOT APPLY POWER.** After purge gas and electrical connections are made, set the purge gas flow rate to 10 scfh. This flow rate will provide an enclosure volume change every three minutes.

CAUTION

Allow purge gas to flow for 15 minutes before turning on the power to the Analyzer.

Once power is applied, refer to the Section 2.0 for the balance of the set-up procedure and for operating instructions.

NOTE: If the purge flow rate falls below 5 scfh, **all** AC power to the analyzer will be disconnected. Analyzers equipped with an optional Automated Calibration System will lose solenoid power. A calibration that is in-progress will terminate and the system will resort to the default mode which allows sample gas to flow to the analyzer.

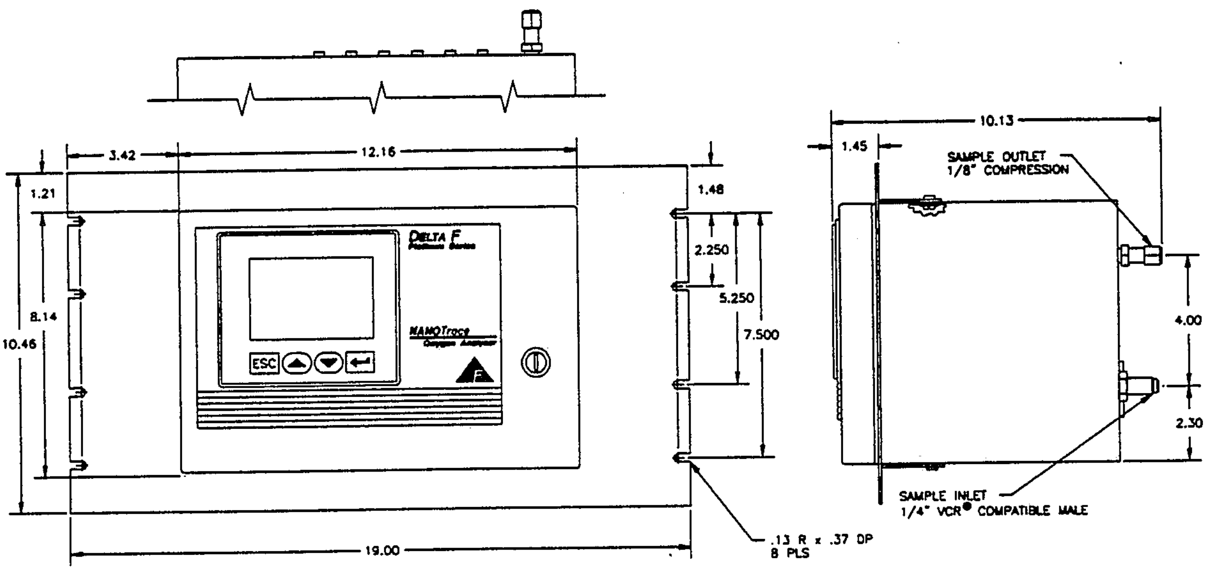


FIGURE 3-3 RACK MOUNT CONFIGURATION

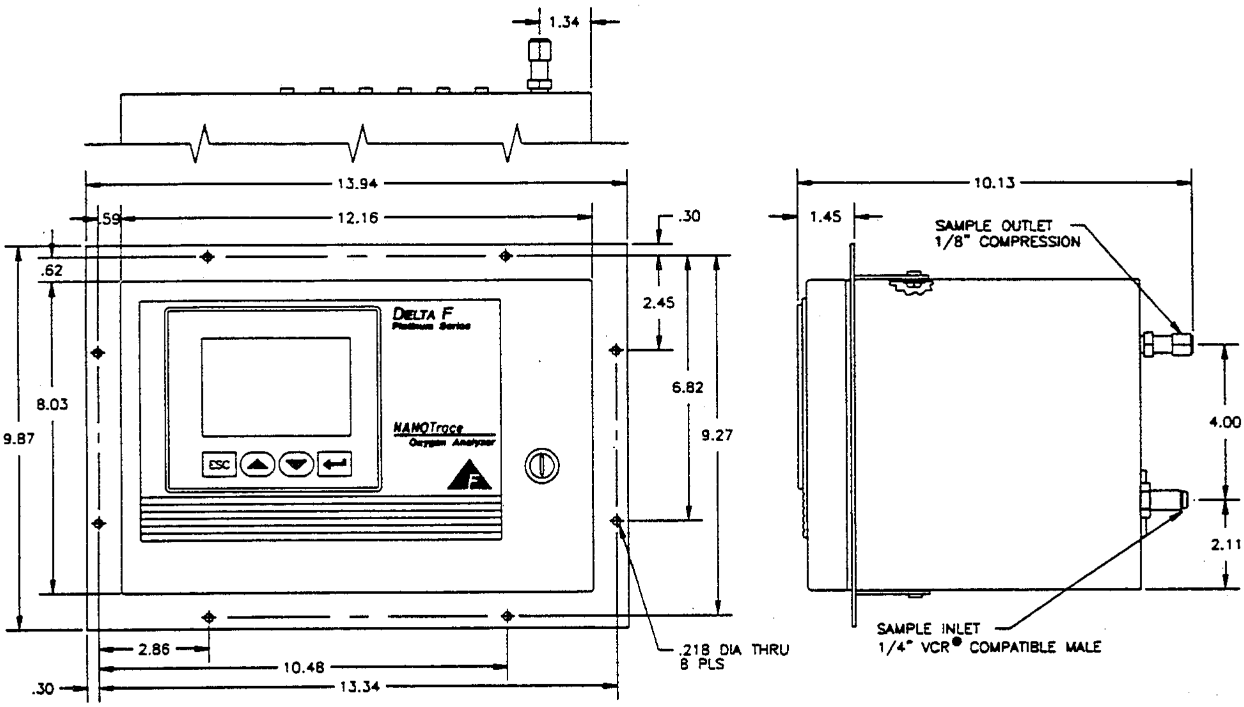


FIGURE 3-4 PANEL MOUNT CONFIGURATION

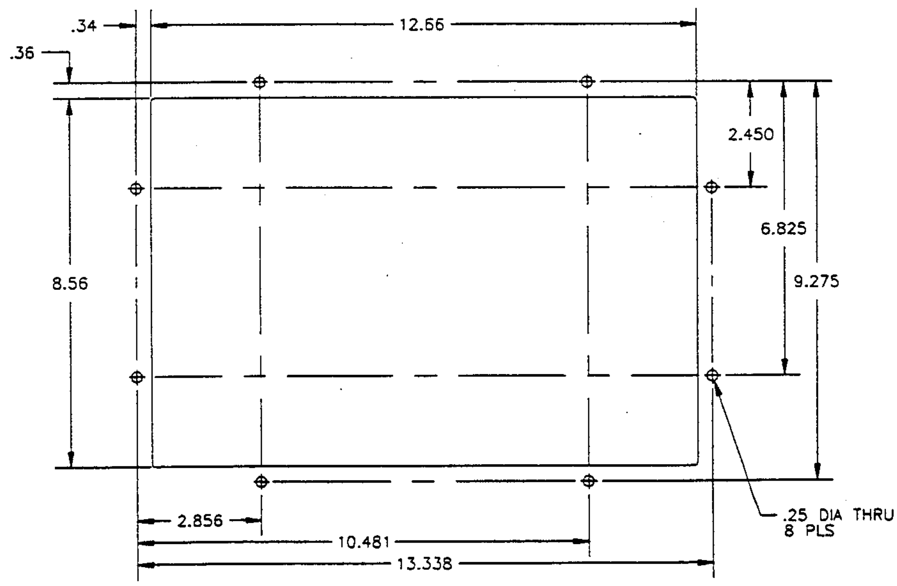


FIGURE 3-5 CUTOUT DIMENSIONS FOR PANEL MOUNT

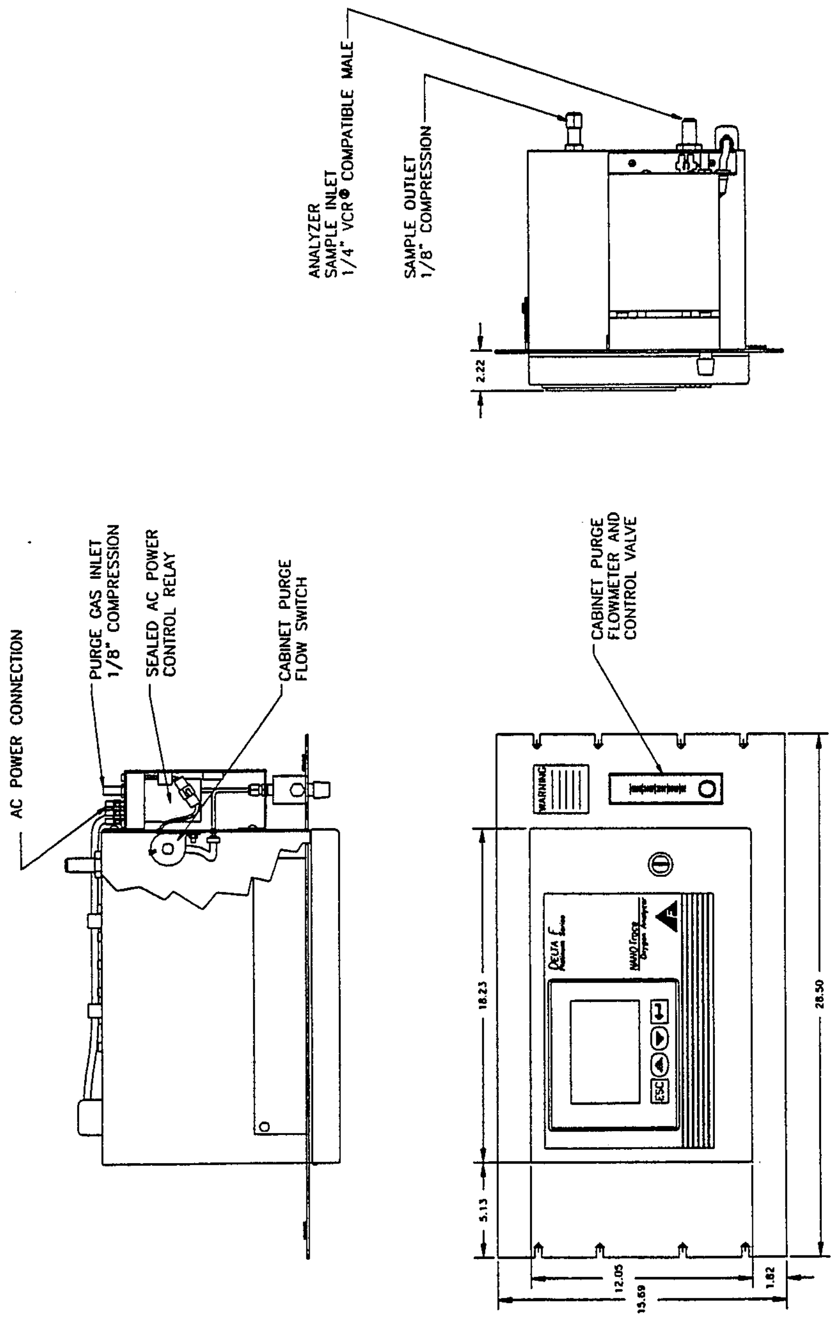


FIGURE 3-6 RACK MOUNT CONFIGURATION AND PURGE SYSTEM WITH AC POWER INTERLOCK

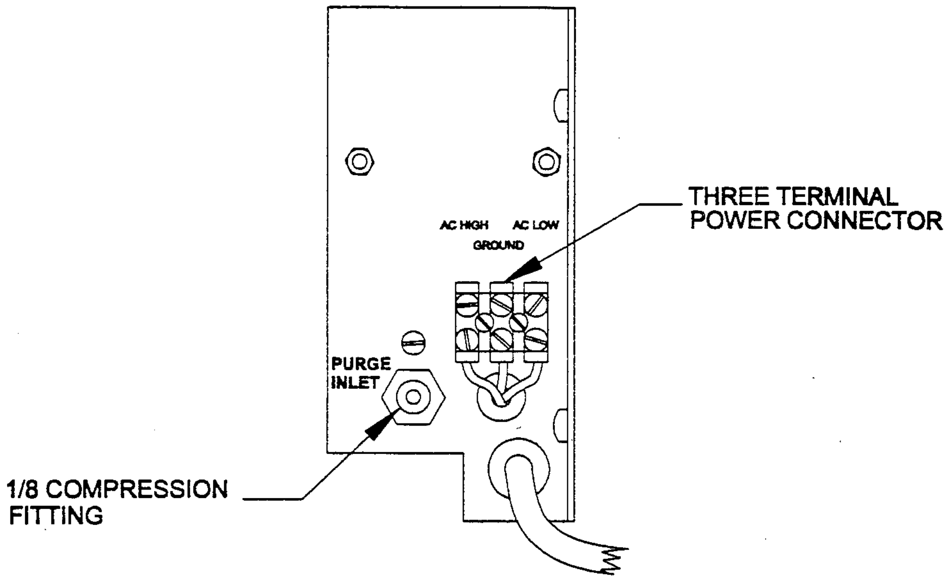


FIGURE 3-7. ELECTRICAL AND PURGE GAS CONNECTION AT REAR OF PURGE SYSTEM

4.0 Connecting to External Devices

4.1 Introduction

The Platinum Series NanoTrace Oxygen Analyzer can be interfaced to a variety of external devices via the ports on the rear panel (see Figure 2-2). Alarm contacts, voltage and current outputs, and serial communications are supported.

4.2 The Comm Port

The optional Comm port is used for communication via the RS-232C or the RS-485 protocol. Up to 32 units may be accessed via RS-485. Operating parameters are 8 bits, no parity, and one stop bit. Baud rate may be selected from the front panel; refer to Section 5.4.3. Data format is a custom binary packet-based request/response protocol for interface with an optional PC Software Utility Package (part number NT-SW2) available from Delta F. This PC-based software features a menu driven interface that provides access to the same functions available from the front panel of the instrument. Also, the program allows Oxygen data to be logged in ASCII format to a hard disk, or printer, at user specified intervals. Using RS-485 it is possible to control multiple analyzers from one PC. A detailed operators manual is included with the software package.

A library of interface functions, written in "C", is available to allow programmers to create their own interface program for accessing the communication port. The Serial Interface "C" Library Reference Manual comes with a disk containing Microsoft and Borland versions of the object code, and all code examples appearing in the manual.

The Comm Port (J15) terminals are defined as follows:

J15-1	RXD	Data received by the Analyzer from the device (RS-232 or RS-485)
J15-2	TXD	Data transmitted from the Analyzer to the device (RS-232 or RS-485)
J15-3	RTS	Request to Send (Not used)
J15-4	CTS	Clear to Send (Not used).
J15-5	RXD-	4 wire RS-485 Received Data (Paired with RXD)
J15-6	UNUSED	Key
J15-7	TXD-	4 wire RS-485 Transmitted Data (Paired with TXD)
J15-8	GND	Ground

CAUTION

To avoid ground-loop conflicts when using RS-232C for communications, make connections to external recorders or data acquisition systems through a differential input, or a single-ended input that is NOT referenced to earth.

Use of the optional isolated 4-20 mA output or RS485 output avoids the ground-loop conflict.

The Material Safety Data Sheet for the Gas Purifier Packing is available upon request.

4.3 Relay Ports

Up to four optional form C (SPDT) relays (contact closures) are provided on the Platinum Series NanoTrace Oxygen Analyzer. These are used in conjunction with up to seven alarms. The contacts are rated at 5 amps @ 250 VAC and 30 VDC under a resistive load.

The relay ports can be programmed for up to four Oxygen Alarms, Temperature, Low Flow, and Electrolyte Condition. A relay can be assigned to any alarm or alarms as described in Section 5.4.1.

Relay nomenclature defines "Normal" as the "No Alarm" condition. The Normally Open contact connects to common when an alarm occurs or when power to the instrument is lost.

The Relay Ports (J14 and J13) terminals are defined as follows:

J14-1	A1COM	Alarm 1 Common
J14-2	A1NO	Alarm 1 Normally Open
J14-3	A1NC	Alarm 1 Normally Closed
J14-4	A2COM	Alarm 2 Common
J14-5	UNUSED	Key
J14-6	A2NO	Alarm 2 Normally Open
J14-7	A2NC	Alarm 2 Normally Closed
J14-8	UNUSED	

J13-1	A3COM	Alarm 3 Common
J13-2	A3NO	Alarm 3 Normally Open
J13-3	A3NC	Alarm 3 Normally Closed
J13-4	UNUSED	Key
J13-5	A4COM	Alarm 4 Common
J13-6	A4NO	Alarm 4 Normally Open
J13-7	A4NC	Alarm 4 Normally Closed
J13-8	GND	Ground

4.4 Sensor Port

The Sensor Port (J11) is currently not used with the Platinum NanoTrace Analyzer.

4.5 Option Ports

Two option port connectors, J10 and J9, are provided. Connector J10 is the interface for an analog recorder (0-0.1 VDC, 0-1 VDC, 0-5 VDC, or 0-10 VDC, see Section 4.6) and drives two 4-20 mA loops. Connector J9 interfaces with the optional automated calibration systems.

J10 is defined as follows:

J10-1	ILOOP+	Fully isolated 4-20 mA output (+), optional
J10-2	UNUSED	Key
J10-3	ILOOP-	Fully isolated 4-20 mA output (-), optional
J10-4	LOOP+	Standard 4-20 mA output (+)
J10-5	LOOP-	Standard 4-20 mA output (-)
J10-6	A OUT+	Voltage Output + (0-10 VDC Standard, See Section 4.6)
J10-7	A OUT-	Voltage Output - (0-10 VDC Standard, See Section 4.6)
J10-8	GND	Ground

J9 is defined as follows:

J9-1	UNUSED	Key
J9-2	HEATER (RELAY 5) ACHI	Sample/Calibration Relay 5 AC Hi
J9-3	HEATER (RELAY 5) ACLO	Sample/Calibration Relay 5 AC Lo
J9-4	PUMP (RELAY 6) ACHI	Zero/Span Relay 6 AC Hi
J9-5	PUMP (RELAY 6) ACLO	Zero/Span Relay 6 AC Lo
J9-6	FLOW-NO	Not Used

J9-7	FLOW-NC	Flow Switch (Opens on Low Flow)
J9-8	GND	Flow Switch Common

Terminals J9-2, J9-3, J9-4 and J9-5 are used with the Delta F Corporation Automated Calibration System. J9-2 and J9-3 provide line output voltage at up to 1.0 amp to control the sample/calibrate mode. J9-4 and J9-5 provide line output voltage at up to 1.0 amp to control the zero/span mode. More details are in Sections 5.4.5.2.1 through 5.4.5.2.7.

4.6 Changing the Analog Voltage Output Selection

The Analyzer is shipped from the factory with the analog output voltage range set to 0-10 VDC unless otherwise specified at time of order. However, the user can field-adjust the analog output to be one of the following: 0-0.1 VDC, 0-1 VDC, 0-5 VDC, or 0-10 VDC. To change the voltage output, a digital voltmeter with the following accuracy is required:

RANGE	ACCURACY
0-0.1 VDC	± 0.00001 VDC
0-1.0 VDC	± 0.0001 VDC
0-5.0 VDC	± 0.0006 VDC
0-10 VDC	± 0.001 VDC

a. Connect your digital voltmeter to J10-6 (A OUT+) and J10-7 (A OUT-).

b. Turn off the main power switch. Above the power switch is a card cage with three narrow slots and one wide slot. Locate the Analog Output PCB which is the upper of the two smaller boards, see Figure 1-2.

c. Locate the calibration adjustment potentiometer that is immediately to the right of the 4-position DIP switch at the front edge of the Analog Output PCB.

d. Each position on the DIP switch is labeled with a full scale voltage selection. Open all the switches, by placing them in the upward position. Close the desired voltage-output switch.

CAUTION

Only one switch should be closed at any time.

e. Turn on the Analyzer.

f. When the oxygen display comes up, press ⇦ to reach the Main Menu. Select **Diagnostics** and then select **Test Output**. Set the desired output level to 100.00%. This will provide a full scale analog output.

g. Observe your Digital Voltmeter. Using the calibration adjusting potentiometer, adjust the output to within the following limits:

RANGE	SETTING LIMITS
0-0.1 VDC	0.09999 to 0.10001 VDC
0-1.0 VDC	0.9999 to 1.0001 VDC
0-5.0 VDC	4.9994 to 5.0006 VDC
0-10 VDC	9.999 to 10.001 VDC

h. The Analog Output is now calibrated for the new range.

5.0 User Interface

5.1 Introduction

On power-up the Platinum Series NanoTrace Oxygen Analyzer goes through a series of internal diagnostic tests which take about ten seconds. After the tests, the Delta F logo appears for a few seconds. The display then shows the Data Display Screen, Figure 5-1.

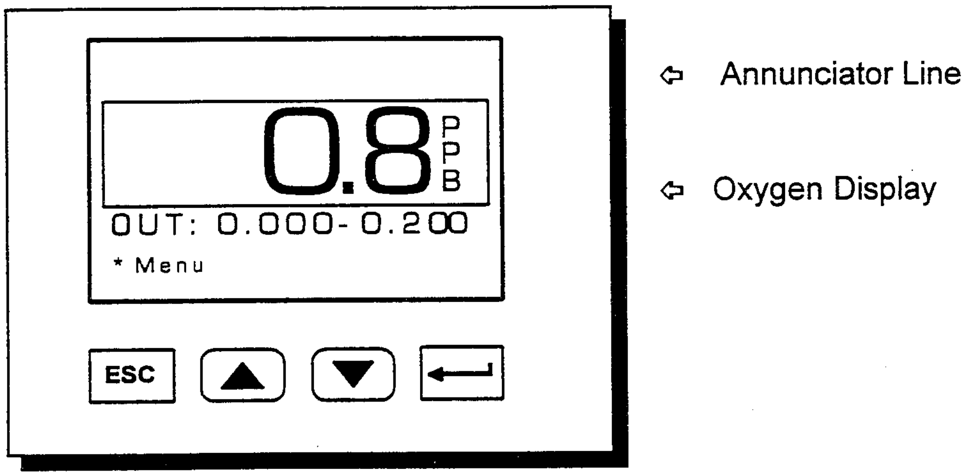


Figure 5-1. Data Display Screen

The numerical information shown in Figure 5-1 is representative, you will probably observe different values.

There are four pressure sensitive keys below the display, shown in the lower part of Figure 5-1. The keys are used as follows:

- ESC - Returns the display to the previous screen.
- ▲ - Scrolls up in a menu or data selection.
- ▼ - Scrolls down in a menu or data selection.
- ⇦ - Accepts the selected (asterisk) entry, and allows data field selection.

The **Annunciator Line** provides specific alarm information about the status of the Analyzer. In the Data Display screen, the annunciator line displays the alarm number (or letter) of any active alarm after the audible or overwrite message has been cancelled. See below for more details.

The **Data Line** indicates the measured oxygen concentration (e.g. 0.8 ppb). In this manual, concentrations will be indicated in ppb O_2 unless otherwise indicated.

The legend **INVALID DATA** will overwrite the digital display if the instrument's analog-to-digital converter reads a value which is over or under its full scale range. When **INVALID DATA** is displayed, the last valid oxygen reading will remain frozen in the display, and the analog output will hold the same value.

The legend **Alms: "X"** will overwrite the digital display if an alarm condition exists. **"X"** refers to any of the seven alarms: Oxygen (1,2,3,4), Temperature (T), Flow (F), and Electrolyte (E). The overwrite also indicates if a high- or low-state alarm exists. The overwrite and the annunciation (if activated) will remain until ESC is pressed.

For simultaneous alarms, each will alternately overwrite the display. A successive press of ESC (as each overwrite is displayed) is necessary to clear the overwrite and annunciation. **This will not clear the alarm.** Only a restoration of the condition that existed prior to the alarm will clear the alarm.

Once an alarm has been acknowledged, its number or letter will be continuously displayed in the Data Display screen on the Annunciator Line. The numbers are assigned as follows:

Alarm Number "X"	Function
1	Oxygen 1
2	Oxygen 2
3	Oxygen 3
4	Oxygen 4
T	Temperature
F	Flow
E	Electrolyte

The alarm number will clear only after the alarm is cleared.

OUT: - Indicates the oxygen range that is scaled over the recorder output full-scale value. The factory default settings are 0-10 VDC and 4-20 mA (non-isolated). Setting the output is described in Section 5.4.2. Output value is displayed in ppm.

Several other messages may be displayed on the Data Display Screen:

BAT LOW - Indicates that the optional backup battery should be recharged.

OVER RANGE - Indicates that the oxygen level exceeds the range of the Analyzer (10 ppm).

SPAN RELAY - Indicates that the calibration relays are in the Span mode. Relay 5 (Terminals J9-2 and J9-3) and Relay 6 (Terminals J9-4 and J9-5) will now be connected to line voltage.

TEMP CAL - Notifies the user that an internal electronic compensation is in process that corrects for a sensor temperature change > 5°C from the current calibration temperature. The compensation may take up to 10 minutes to complete.

UNCALIBRATED - Warns that the Analyzer is not calibrated, or that NOVRAM data has been corrupted.

UNDER RANGE - Indicates that the output level has fallen below the electronic zero, or the sensor or its temperature probe are electrically disconnected.

ZERO RELAY - Indicates that the calibration relays are in the Zero mode. Relay 5 (Terminals J9-2 and J9-3) will now be connected to line voltage. Relay 6 (Terminals J9-4 and J9-5) is not energized.

FILTER OFF - Appears in the annunciator line for 10 seconds after the Average Filter Reset feature has been used in the Controls Menu to clear the signal filter registers.

ELCTRN ZERO - Appears when the instrument measures its internal amplifier offsets. This occurs when the Analyzer is powered up.

If any alarm has been acknowledged, it will be shown on the Annunciator Line. If an alarm is shown on the annunciator line, a Low Battery indication **BT** will show in the upper left corner of the oxygen display box. Similarly, Over Range shows **OR**, Under Range shows **UR,** an active Span Relay shows **SR**, and an active Zero Relay shows **ZR**, and Temp Cal shows **TC**.

Pressing ⇦ will bring up the Main Menu display (Figure 5-2).

GSF indicates the value of the installed Gas Scale Factor. The Gas Scale Factor is described in Section 5.4.5.1. If a GSF value has been entered or calculated by the Analyzer, **GSF: X.XX** will appear in the Data Display Screen next to ***Menu**. If the GSF is not shown in the Data Display screen, the Analyzer is using the default value of 1.00.

5.2 The Main Menu

The Platinum Series NanoTrace Oxygen Analyzer can display many different screens. To help the user quickly locate a particular screen, this manual includes a "Button Map" in each subsection near the screen illustration.

For example, to get to the Main Menu from the Data Display Screen, follow the Button Map:

Data Display ☞ Main Menu

The Main Menu, Figure 5-2 is accessed by pressing ⇦ when Figure 5-1, the Data Display screen is displayed. Annunciated information and Alarm Overwrite information will display over the Main Menu.

```
      NT      Ver 2.90

*  Controls...                      ⇦ Annunciator Line
   Set-Up Menu...
   Password Level...
   Diagnostics...
```

Figure 5-2. Main Menu

Each selection leads to a different display from which the following functions can be controlled:

Controls - to momentarily clear the signal filtering registers, or to turn on (or off) the zero relay, span relay, and sensor polarizing voltage (Section 5.3).

Set-Up Menu - to set alarm parameters, to set the recorder output level, to set communication ports, to enter gas scale factors, to adjust signal filtering, and to calibrate the Analyzer (Section 5.4).

Password Level - to set passwords and indicate which menus are password-protected (Section 5.5).

Diagnostics - to report sensor temperature, adjust temperature compensation, and to test functions such as the output, relays, memory and screen. (Section 5.6).

The diagram in Figure 5-3 shows the "Menu Tree" for the operator interface. Sufficient detail is provided to orient the user during instrument set-up; however, not all the program details are illustrated in this diagram.

Each level in the Main Menu allows the user to access options for setting and testing instrument parameters. Ellipses (...) after a menu entry indicate that additional screens follow.

5.2.1 Programming Protocol

The following protocols are used to program the Analyzer:

To access a level, use the ▲ or ▼ key to move the asterisk (*) to the desired level and press ⇦.

To edit a numerical value, use the ⇦ key to highlight (reverse video) the digit to be changed. Successive presses of ⇦ will highlight the digits on a left to right basis. Use ▲ or ▼ to set the numeric value. At the desired numerical value, press the ⇦ key until the number no longer appears in reverse video. The ESC key will move the highlighting back to the left and eventually cancel any adjustment.

The ESC key is used to return to the previous screen without changing any parameters that may have been altered. If any parameters have been edited without updating memory, the display will present the message: **ABANDON CHANGES? ⇦ FOR YES.** All parameter changes will be **lost** if the ⇦ key is pressed.

The ESC key can also be used to de-select highlighted digits. ESC cancels the action that occurred when the ⇦ key was pressed. With ESC, the highlight moves from right to left de-selecting digits.

Select **UPDATE & QUIT** using ⇦ to save your changes and automatically return to the previous menu.

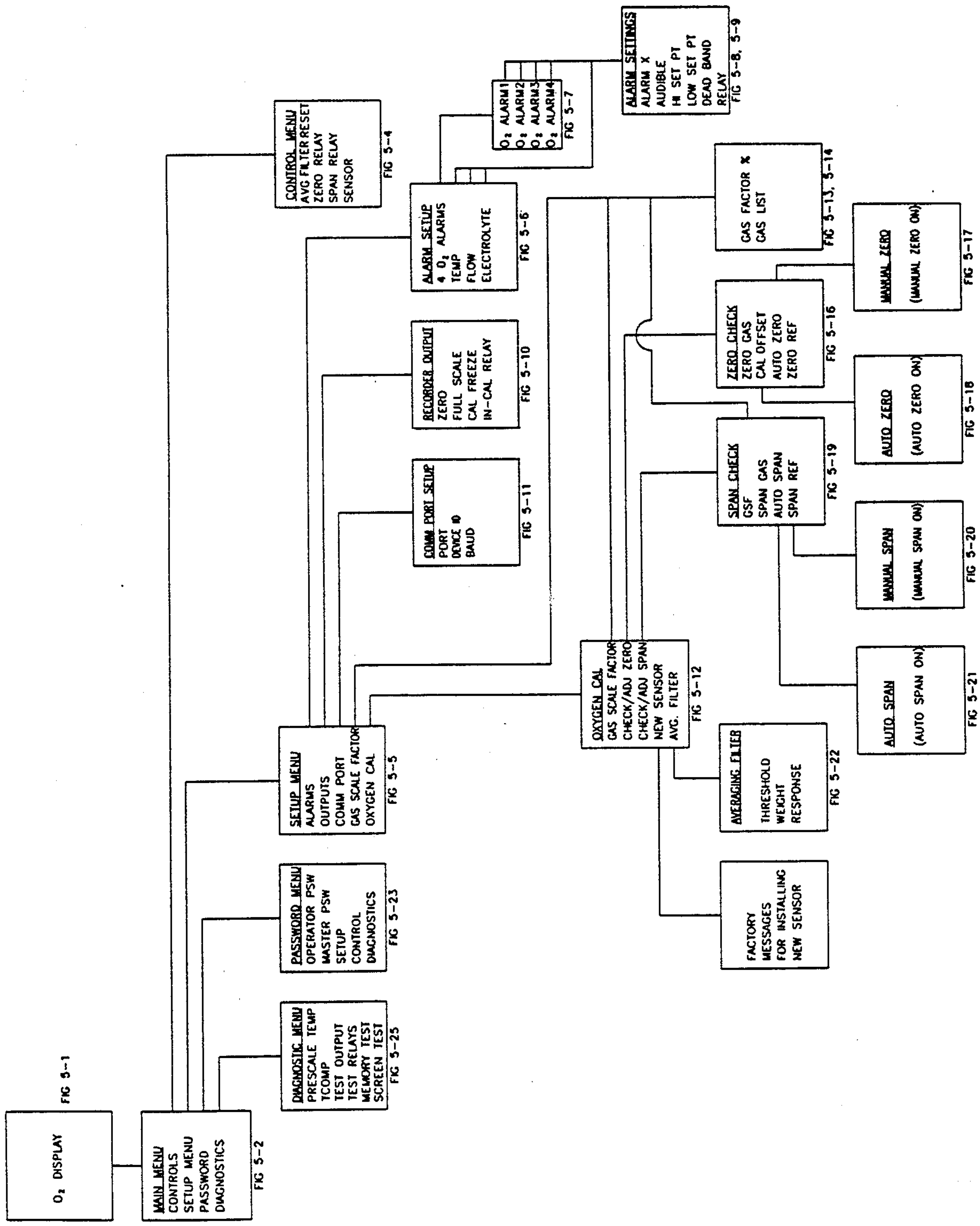


FIGURE 5-3 MENU TREE - OPERATOR INTERFACE, PLATINUM NANOTRACE OXYGEN ANALYZER

5.3 Controls

The Controls menu is used to turn on or off a number of optional features. When the Controls menu is selected (and the password is entered if required) the display will show Figure 5-4.

Data Display ☞ Main Menu ☞ Controls

```
CONTROL

* AvgFilter Reset
  Zero Relay (OFF)
  Span Relay (OFF)
  Sensor (ON)
  ESC to Quit
```

Figure 5-4. Control Menu

5.3.1 AvgFilter Reset

Selecting **AvgFilter Reset** will instantaneously clear the signal filter registers of all data used to average the readings, and will display an unfiltered reading for approximately ten seconds. When selected, **Filter OFF** will flash above the oxygen output shown on the Display Screen. During the 10 second cycle, all filtering (if selected, See Section 5.4.5.10) is removed from the output signal and the displayed reading.

At the end of the 10 second cycle, or if **ESC** is pressed during the cycle, the instantaneous oxygen reading is used to refill the filter registers. This feature may be useful to reduce time lags as a result of heavy filtering, or if the data in the filter registers is known to be corrupt (such as from a momentary spike.)

5.3.2 Zero Relay

The Analyzer can be equipped with a relay to manually control external valves for zero calibration. The relay is rated for 125/250 VAC @ 1.0 Amp. When the CONTROL menu is accessed, an asterisk will be located next to **Zero Relay**. Pressing ⇦ toggles the zero gas relay ON or OFF. When the Zero Relay is ON, line voltage is switched to the relay terminals J9-2 and J9-3, (relay 5) only. See Section 4.5 Option Ports for relay terminal pin-outs. Toggling the Zero Relay ON will automatically toggle the Span Relay OFF.

The instrument does not store the zero relay state (ON or OFF). If AC power is lost, and then restored, the zero relay will default to OFF. Battery equipped instruments use AC power to control the calibration panel. Consequently the calibration panel cannot be controlled if AC power is lost.

5.3.3 Span Relay

The Analyzer can be equipped with a relay to manually control a valve for span calibration. The relay is rated for 125/250 VAC @ 1.0 Amp. By moving the * to the **Span Relay** position, the Span Relay can be toggled ON or OFF by pressing ⇦. When the Span Relay is ON, line voltage is available at the relay terminals J9-2 and J9-3, (relay 5) and at relay terminals J9-4 and J9-5, (relay 6). See Section 4.5 Option Ports for relay terminal pin-outs. Toggling the Span Relay ON will automatically toggle the Zero Relay OFF.

The instrument does not store the span relay state (ON or OFF). If AC power is lost, and then restored, the span and zero relays will default to OFF. Battery equipped instruments use AC power to control the calibration panel. Consequently the calibration panel cannot be controlled if AC power is lost.

5.3.4 Sensor

After accessing the **Sensor** entry, the sensor power is toggled ON or OFF by pressing ⇦. The sensor ON command applies the required polarizing voltage to the sensor.

NOTE: The Analyzer has been programmed to protect the sensor from extended operation in an over-range condition (>15 minutes). If such a condition exists, the software will turn off the polarizing voltage to the sensor. A message will be displayed indicating that the sensor has been isolated from all circuitry. The audible annunciator will sound at one-second intervals during this condition. The user should lower the oxygen concentration, and then restore power to the sensor via the Controls menu.

The instrument does not store the SENSOR OFF state (ON or OFF). If AC power is lost, and then restored, the SENSOR setting will default to ON.

5.3.5 ESC to Quit

Pressing the ESC key at any time to leave the Controls Menu. The display will return to the Main Menu screen shown in Figure 5-2.

5.4 Set-Up

The Set-Up Menu is used to set a variety of Analyzer parameters. Some of these parameters are set when initially configuring the Analyzer. Others, such as the Oxygen Calibration Menu, which contains signal filtering and calibration adjustment features, will be used during normal Analyzer operation. When this selection is made (and the appropriate password is entered if required), Figure 5-5 is displayed.

NOTE: When the **Set-up** entry is selected from the Main Menu, a DISABLING ALARMS message appears which notifies the user that the alarms have been temporarily disabled - the alarms' overwrite will not show in the display. *Relays that were in the alarm state immediately preceding the* **Disabling Alarms** *message will remain in the alarm state.*

Data Display ☞ Main Menu ☞ Setup

```
SETUP MENU

* Alarms...
  Outputs...
  Comm Port...
  GSF...
  Oxygen Cal...
```

Figure 5-5. Set-Up Menu

Each entry in Figure 5-5 leads to a sub-menu as shown in Figure 5-3. Select the desired sub-menu, by placing the asterisk next to it and then press ⇦. A new display will be shown as indicated below.

5.4.1 Alarms

The Analyzer comes with the following six alarms as standard equipment: four oxygen alarms, one sensor temperature alarm, and one electrolyte condition alarm. These alarms can be user-controlled to activate up to four optional relays. High and low set-points as well as deadbands are user-set.

The oxygen and temperature alarms have Hi and Lo set points and deadbands that can be programmed by the user. (See Section 5.4.1.1 and 5.4.1.2)

The temperature alarm indicates an out of specification temperature condition for the sensor. The maximum temperature is limited to 45°C.

The electrolyte alarm indicates a fault condition of the electrolyte. The alarm will sound if the electrolyte level is low, or if the electrolyte is contaminated. (See Section 5.4.1.4)

The Alarms screen is used to set or determine the status of alarms. **NU** indicates that an alarm is not currently assigned. When the Alarms entry is selected from Figure 5-5, the display will present Figure 5-6.

Data Display ☞ Main Menu ☞ Setup ☞ Alarms

```
ALARM SETUP

* 4 02 Alm    0  USED
  1 TEMP  Alm    NU
  1 FLOW  Alm    NU
  1 ELEC  Alm    NU
  Update and Quit
```

Figure 5-6. Alarm Selection Menu

To select an alarm for editing, use the ▲ and ▼ keys to move the asterisk and press ⇦. If **(NA)** is displayed next to **1 FLOW Alm**, that alarm option is Not Available.

5.4.1.1 O_2 Alarms

If an O_2 alarm has been selected, the display will show Figure 5-7.

Data Display ☞ Main Menu ☞ Setup ☞ Alarms ☞ 4 O2 Alm

```
        O2 ALARMS

* ALARM 1  (NU)
  ALARM 2  (NU)
  ALARM 3  (NU)
  ALARM 4  (NU)
```

Figure 5-7. Oxygen Alarm Selection Menu

After selecting an Alarm, use ⇦ to enter the Alarm Set-Up screen as shown in Figure 5-8. (Oxygen ALARM 1 is used in the example shown in Figure 5-8.)

Data Display ☞ Main Menu ☞ Setup ☞ Alarms ☞ 4 O2 Alm ☞ Alarm 1

```
  Values in PPM
  Alm 1: NU
  Audible (OFF)
* Hi Stpt:     0.0
  Lo Stpt:     0.0
  Deadbnd: 0.00
  Relay NU
  Update and Quit
```

Figure 5-8. Alarm Set-Up Screen (Alarm not used)

To indicate that the alarm is to be used, move the asterisk to **Alm 1:** and press ⇦. For the oxygen alarms the display will change: **NU** will change to **O2**, **Hi Stpt: 0.0** changes to **Hi Stpt: 0.000**, **Lo Stpt: 0.0** changes to **Lo Stpt: 0.000**, and **Deadbnd: 0.00** changes to **Deadbnd: 0.0000**.

Audible is used to toggle ON or OFF the audible feature alarm; it *does not* clear the alarm.

The **Hi Stpt** (high set point) and **Lo Stpt** (low set point) refer to the limits above and below which the alarm will be triggered.

Each oxygen alarm (and the temperature alarm) can be set for a high trip point and a low trip point. This feature gives the user the ability to operate his process between limits of high and low O_2 concentration (or temperature range) using only one alarm.

Deadbnd refers to the value from the nominal set point that an output value must exceed before an alarm is reset. For example, for a High Alarm (**Hi Stpt**) set to 0.050 ppm, a Low Alarm (**Lo Stpt**) set to 0.030 ppm, and the deadband (**Deadbnd**) set at 0.0050 ppm, the alarm will trigger at 0.050 ppm. The alarm will continue to report until the oxygen concentration falls below 0.045 ppm. At 0.045 ppm, the alarm will reset.

With the Low Alarm, the alarm would trigger at 0.030 ppm and continue to report until the O_2 concentration increased to 0.035 ppm. At 0.035 ppm the alarm would reset.

> NOTE: For very low alarm levels where a **Deadbnd** setting of less than 1.0 ppb is desirable, be certain to set **Deadbnd** greater than the peak-to-peak noise of the oxygen readings. The peak-to-peak noise is determined by the Average Filter Settings, See Section 5.4.5.10.

Relay indicates the relay to which the alarm is assigned. The options are **NU** (not used), **1**, **2**, **3** or **4**. Each relay can be assigned up to seven alarms. If more than one alarm is assigned to a relay, any assigned alarm will trip the relay, and the relay will remain tripped until ALL alarms assigned to it are cleared.

If an active alarm is accessed, the display will indicate the present values. An example of an active alarm (**Alm 1: O2**) is shown in Figure 5-9. (Values are only representative.)

Data Display ☞ Main Menu ☞ Setup ☞ Alarms ☞ 4 O2 Alms ☞ Alarm 1

```
  Values in PPM
  Alm 1: O2
  Audible (ON)
* Hi Stpt:      9.000
  Lo Stpt:      1.0
  Deadbnd:      0.5000
  Relay 2
  Update and Quit
```

Figure 5-9. Alarm Set-Up Screen
(O2 Alarm used)

5.4.1.2 Temperature Alarm

The temperature alarm is used to indicate an out of range temperature condition for the sensor. From Figure 5-6, selecting the **1 TEMP Alm (ON)** will bring a display similar to Figure 5-8. The alarm can be assigned to any optional relay(s).

The temperature alarm is programmed in the same way as an O_2 alarm. The temperature alarm cannot be set to a value greater than 45°C; 40°C is recommended for its high set point.

5.4.1.3 Low Flow Alarm

The optional low flow alarm is used to indicate a low flow condition. The flow alarm is provided with a low flow switch which trips if the flow rate drops below the value listed in Table 5-1.

Table 5-1 Approximate Trip Point for Flow Switch

Gas	Trip Point (scfh)
Ammonia	0.33
Argon	0.22
Butane	0.18
Carbon Monoxide	0.26
Ethane	0.25
Ethylene	0.26
Helium	0.69
Hexane	0.15
Hydrogen	0.96
Methane	0.34
Nitrogen	0.26
Propylene	0.21

From Figure 5-6, selecting the **1 FLOW Alm (ON)** will bring a display similar to Figure 5-8. The alarm can be assigned to any optional relay(s).

The flow alarm is programmed in the same way as an O_2 alarm. However the values for **Hi Stpt**, **Lo Stpt**, and **Deadbnd** will indicate **(NA)**. These values cannot be accessed.

5.4.1.4 Electrolyte Condition Alarm

The electrolyte condition alarm is used to indicate an electrolyte fault condition, such as low electrolyte level (add water) or electrolyte contamination if the level is above the MIN indicator line on the sensor tank (change electrolyte.) See Section 8.1.3 on Sensor Maintenance. From Figure 5-6, selecting the **1 ELEC Alm (ON)** will bring a display similar to Figure 5-8. The alarm can be assigned to any optional relay(s).

The electrolyte condition alarm is programmed in the same way as an O_2 alarm. However, the values for **Hi Stpt**, **Lo Stpt**, and **Deadbnd** have no validity **(NA)**, and cannot be accessed.

5.4.2 Outputs

The **Outputs** entry in Figure 5-5 is used to scale the full range of the analog output (voltage and current) over a partial or full range of oxygen concentration.

After accessing the Outputs Menu, the display will be as shown in Figure 5-10.

Data Display ☞ Main Menu ☞ Setup ☞ Outputs

```
      RECORDER OUTPUT
       SETUP (in PPM)

 * Zero:   0.000
     FS:  10.000
   CAL FREEZE (OFF)
   IN-CAL RELAY  NU
   Update and Quit
```

Figure 5-10. Recorder Output Set-Up Menu

From the Outputs menu, the recorder zero and full scale can be set. The units for oxygen in this menu will always be in ppm, i.e. 20 ppb = 0.020 ppm.

The **Zero:** input corresponds to the lowest voltage or current output (0 VDC, 4 mA) to a recorder, while the **FS:** (Full Scale) input corresponds up to the maximum voltage or current output (0.1/1/5/10 VDC (see Section 4.6) and 20 mA) to a recorder. The full scale point can be set from 20 ppb to 10 ppm.

NOTE: The voltage or current output will accurately track up to -5% of the full scale range selected. For example: F.S.=100 ppb, Zero=0.0 ppb, Analyzer output will track down as low as -5 ppb.

Microprocessor resolution scaling will allow a window as narrow as 20% of the Analyzer's decades (0-10 ppm, 0-1 ppm, 1-100 ppb) to be set as the full-scale analog output. Analyzers are shipped with a factory setting of 0-10 ppm. On first power-up the display shows **OUT: 0.00-10.00** underneath the oxygen reading in the Data Display Screen, Figure 5-1. The units are always expressed in ppm.

Some examples of scaling for the NanoTrace Oxygen Analyzer output are shown in the following table:

Output	Percentage of Scale Used
0.000-0.020 ppm	20% of the 0-100 ppb decade
0.020-0.040 ppm	20% of the 0-100 ppb decade
0.010-0.050 ppm	40% of the 0-100 ppb decade
0.000-10.000 ppm	100% (Factory Setting)
5.000-8.500 ppm	35% of the 0-10 ppm decade

The selected output will be displayed underneath the oxygen reading in the Data Display Screen.

5.4.2.1 In-Cal Relay (optional)

IN-CAL RELAY is used to assign one of four optional relays to signal an external device that the Analyzer is in the calibration mode. The relay will signal a change-of-state when entering the CHK/ADJ SPAN or the CHK/ADJ ZERO menus, and return to a normal state when leaving the CHK/ADJ SPAN or ZERO menus, except after completing or aborting from a Manual or Auto Span calibration (see below.) Sequentially pressing ⇦ toggles among **NU**, **1**, **2**, **3** and **4**.

The assigned relay trips when entering the CHK/ADJ SPAN or the CHK/ADJ ZERO menus. Following a successful completion of either a Manual or Auto Zero calibration process, the relay releases after about a two minute delay which allows the electronics to stabilize.

After entering the CHK/ADJ SPAN menu, and initiating a Manual or Auto Span calibration, the In-Cal Relay operates as follows after a span process has been completed (or initiated and aborted):

1. If the oxygen reading is above the Lowest Active High Alarm Set Point (minus its deadband), the instrument will release the In-Cal Relay after the oxygen reading has stabilized or increased. The interval used to judge stability depends on the level of the current reading, and how close the current reading is to the Lowest Active High Alarm Set Point. The lower and/or the closer the reading is to the set point, the longer the period.

2. When the oxygen reading falls below the Lowest Active High Alarm Set Point (minus its deadband), or when no High Alarm Set Points are active, the instrument will release the in-Cal Relay upon exiting the CHK/ADJ SPAN menu.

NOTE: The Lowest Active High Alarm Set Point, and the deadband which applies to that alarm set point, is the lowest numerical High Oxygen Alarm Value programmed in the ALARMS SETUP menu that is also switched ON (see Section 5.4.1). This alarm can be configured as just a visual alarm. No audible annunciation or relay action is needed for this alarm.

The user can control the length of time following a span calibration that the Analyzer is given before being trusted to report reliable data. By choosing a high alarm set point which is below the maximum allowable oxygen concentration for the specific gas stream (i.e. high alarm levels set for warning and shut-down), the In-Cal Relay can be used to minimize downtime following a span calibration without risk of false alarms triggered in external devices by the analog output level.

For example, if the maximum oxygen concentration specification is 10 ppb, simply set an oxygen alarm at 8 or 9 ppb. Even if the Analyzer is not responsible for alarming functions, this insures that the host control system will be informed not to trust oxygen data until the oxygen readings are safely below where the device's alarm levels are set.

Choose the highest level which is safely below the maximum contamination level to minimize the amount of time that the analyzer is signalling that it is off-line. Following a Span Calibration at approximately 7 ppm, and assuming the process gas normally reads below 1.0 ppb, the Analyzer typically requires 1-3 hours to be safely below 10 ppb. The closer the Lowest Active High Alarm Set Point (minus deadband) is set, the longer it will take to release the In-Cal relay. It is recommended that the Lowest Active High Alarm Set Point (minus deadband) value be 2.0 ppb or higher. If none of the judgement criteria to release the relay is met within 12 hours, the relay will release.

5.4.2.2 Cal Freeze

Selecting **CAL FREEZE** will hold the oxygen analog output at the last reading prior to entering the calibration sequence. Using ⇦ will toggle this feature **ON** and **OFF**. This selection allows the user to perform a calibration without tripping alarms in external data collection and control systems. It also eliminates off-range voltage or current conditions during calibrations.

5.4.3 Comm Port

The COMM PORT SETUP menu, selected from the screen shown in Figure 5-5, is used to edit information about the external communications ports. Refer to Section 4.2. After accessing the COMM PORT SETUP menu, the display in Figure 5-11 will be shown.

Data Display ☞ Main Menu ☞ Setup ☞ Comm Port

```
        COMM PORT SETUP

 *  Port (232)
    Device ID: 002
    Baud (19200)
    Update and Quit
```

Figure 5-11. Comm Port Set-Up Menu

Port - Used to indicate if the data should be sent to the RS-232C port **(232)**, the RS-485 **(485)** port or no communication port **(OFF)**. Hardware must be factory installed to support either port option.

Device ID:xxx - Used to indicate the device to which the data will be sent. The device number can be edited. **Device ID:** must be set even if the RS-232 mode is used.

Baud - Used to set the Baud rate for data transmission. Pressing ⇦ toggles among **19200**, **9600**, **4800**, **2400** or **1200**.

Update and Quit - Used to accept the values set on this screen.

5.4.4 GSF - Refer to Section 5.4.5.1

5.4.5 Oxygen Cal(ibration)

The OXYGEN CAL menu is entered from the SETUP MENU, Figure 5-5, when the user wants to check the calibration or recalibrate the Analyzer. The OXYGEN CAL menu is shown in Figure 5-12.

Data Display ☞ Main Menu ☞ Setup ☞ Oxygen Cal

```
OXYGEN CAL

* GSF: 1.00 (0 GS)
  Check/Adj Zero...
  Check/Adj Span...
  New Sensor
  Avg Filter
```

Figure 5-12. Oxygen Calibration Menu

5.4.5.1 GSF (Gas Scale Factor)

The optional **GSF** (Gas Scale Factor) is used to correct for changes in the rate of oxygen diffusion when background gases other than nitrogen are present in the sample gas. The GSF menu can be entered through Figure 5-5 or through the Oxygen Cal Menu, Figure 5-12. In many applications, the GSF does not need to be altered from the default value of 1.00. However, for some background gases with significantly different diffusivities compared to nitrogen (such as helium or hydrogen), the GSF should be applied. To use the GSF feature, enter the volumetric percentages of the sample gas as described below. The GSF is automatically calculated. Alternately, the GSF factor can be entered manually.

The software in the Analyzer supports the following gases in the GSF calculation:

Gas		GSF Value
Ammonia	NH_3	.90
Argon	Ar	1.03
Butane	C_4H_{10}	1.45
Carbon Monoxide	CO	1.01
Ethane	C_2H_6	1.15
Ethylene	C_2H_4	1.10
Helium	He	.57
Hexane	C_6H_{14}	1.75
Hydrogen	H_2	.61
Methane	CH_4	.94
Nitrogen	N_2	1.00
Propylene	C_3H_6	1.22

Contact the factory at (617) 935-4600 for assistance with gases not listed above.

When **GSF** is selected, the display in Figure 5-13 will be shown.

Data Display ☞ Main Menu ☞ Setup (☞ Oxygen Cal) ☞ GSF

```
GAS FACTOR (%)

*  Ar:    0
   C2H4:  0
   CO:    0
   CH4:   0
   N2:    0
   He:    0
```

Figure 5-13. Gas Scale Factor Menu

Entries for additional gases can be accessed by using the ▲ or ▼ key to scroll through the list. The entries spread across more than two screens. Continued pressing of ▼ will give access to the additional choices, shown in Figure 5-14. By moving the asterisk to the appropriate line and pressing ⇦, the volume percentage of the sample gas can be adjusted.

After the volumetric percent of the selected gas is entered, continue to press ⇦ until the number is no longer in reverse video. Repeat the process for the other gases in the sample gas composition.

NOTE: An error message will appear if the sum of gases does not equal **100%**. If that occurs, adjust one (or more) value(s) and press ⇦ again.

At the bottom of the list, the display will show Figure 5-14.

NOTE: Scrolling down the gas list from Figure 5-13 to Figure 5-14 will displace one line at a time. Because these two figures are presented from the top and from the bottom of the gas list, **H2** (Hydrogen) and **NH3** (Ammonia), which are in the middle of the list, do not appear in either figure. Sequentially scrolling up or down the list, however, will show **H2** and **NH3**.

```
        GAS FACTOR (%)

           C2H6:     0
           C3H6:     0
          C4H10:     0
          C6H14:     0
            GSF:  1.00
 * Update and Quit
```

Figure 5-14. Gas Scale Factor Menu (cont.)

When the composition of the gas has been entered move the asterisk to **Update and Quit** and press ⇦. The GSF will be calculated and displayed.

If the GSF of the gas used to calibrate the system is already known, it can be entered directly. To enter the GSF directly, move the asterisk to the **GSF** line and press ⇦. If the GSF menu is being used to reset all gases to 0%, just manually enter a GSF of 1.00. Use the ▲, ▼ and ⇦ keys to enter the value.

The integer next to **GS** indicates the number of gases used in the calculation of the GSF. If a value of **0** is shown, it indicates that the factor was directly entered, or the default value of GSF = 1.00 was used.

CAUTION

The gas used to calibrate the system may be different from that used during analysis. If the GSF is changed to reflect the composition of the calibrating gas, be sure to reset the GSF before analyzing samples.

Disclaimer

The method used to correct the calibration of the Platinum Series NanoTrace Oxygen Analyzer for measurement in non-nitrogen background gases is derived from a well known theoretical mass transfer equation. This equation accounts for the change in oxygen diffusion rates through different gases.

Although significant empirical work has been done in this field, it is generally accepted that the equation may be only 95% accurate. In addition, there is further error introduced when correcting for a "multi" component background gas. This may result in up to an additional 3% error. Correcting the calibration (for all combinations of background gases) using theoretical means has its limitations.

An alternate method when using a non-nitrogen or "multi" component background gas for spanning is to obtain a certified oxygen calibration standard which has been prepared in a background gas that models the average process sample. For example, if the average process sample background gas is composed of 50% hydrogen and 50% nitrogen, and a safer gas mixture can be used for calibrating such as 45% helium and 55% nitrogen. Both mixtures have approximately the same diffusivity of oxygen. In this case any possible error introduced in using the theoretically derived correction factor is eliminated. Care must still be used, however, as certified standards may also have an inaccuracy associated with them.

Questions regarding the calculation of a background gas correction factor for a specific application should be directed to Delta F Corporation (617) 935-4600.

5.4.5.2 Calibrating the Analyzer

The Analyzer can be calibrated by selecting **Oxygen Cal...** from the Main Menu, Figure 5-5. This menu leads to other menus that provide selections for automated (with optional equipment) and manual calibration. A zero and a span calibration can be independently performed in either the automated or the manual mode.

The following information should be noted on the label inside the door of the Analyzer at each zero and/or span calibration:

Date
Current Zero Ref Value
New Zero Ref Value
Span Gas Value
Current Span Ref value
New Span Ref value

CAUTION

Over-pressurizing the Analyzer can result in permanent damage to the sensor. Always be sure to open a downstream isolation valve or any similar flow restricting device **before** pressurizing the sample inlet. The sample outlet line should not add more than 3.0 psi resistance at a gas flow rate of 2.0 scfh. If the span gas supply pressure exceeds 15.0 psig, install a pressure regulator in the inlet calibration gas line to regulate the flow rate to 2.0 scfh while at the same venting (back) pressure that occurs under normal sample measurement.

Analyzer sample delivery plumbing can affect calibration. Calibration procedures for analyzers whose plumbing systems are vented to atmosphere are different compared to systems that are not vented to atmosphere. See Section 7.4 for special considerations.

5.4.5.2.1 Optional Automated Calibration System or Automated Control of External/User-Supplied Components

The Analyzer may be equipped with two output signals at line voltage (located at terminal J-9) and firmware that can be used with a user-supplied or Delta F automated calibration system option. A user-supplied automated calibration system can be fabricated from the schematic presented below.

5.4.5.2.2 Process Measurement

During normal process measurement, relays 5 and 6 on connector J-9 are not energized; no line voltage is available at the connector. Calibration valves A, B, C and D are in their normal state. Valve B is normally open when de-energized (DE); valves A, C and D are normally closed when de-energized. See the Schematic of Automated Calibration System, Figure 5-15.

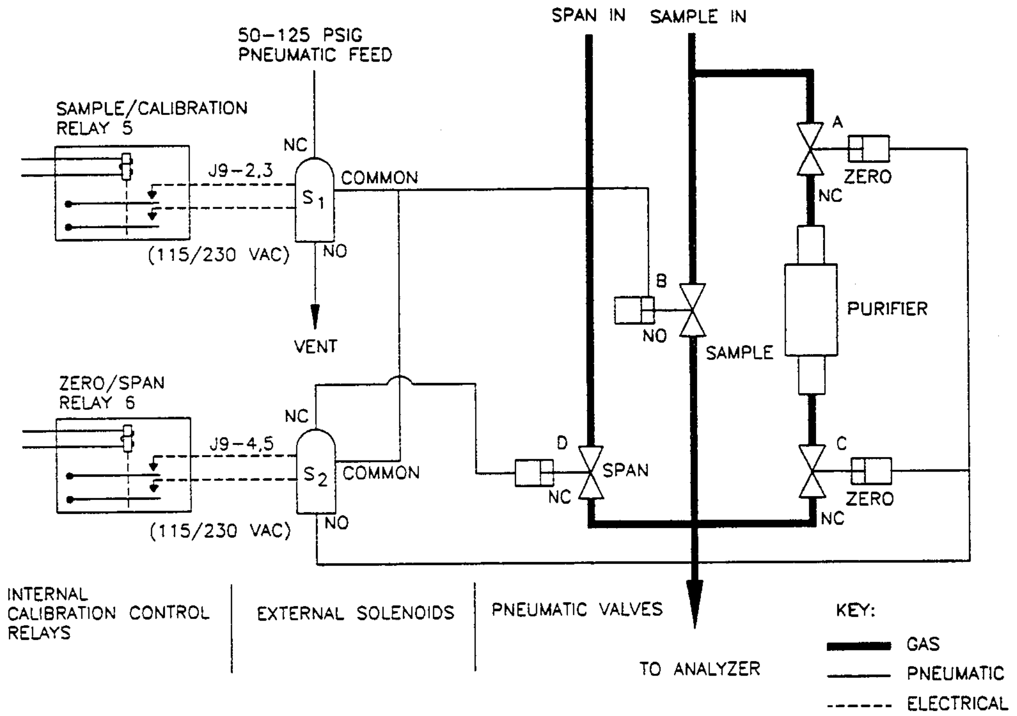


FIGURE 5-15. SCHEMATIC OF AUTOMATED CALIBRATION SYSTEM

5.4.5.2.3 Logic Table

System logic is shown in the following table. Relay 5 is connected to Solenoid S1 and Relay 6 is connected to Solenoid S2.

	Relays		Solenoids		Valves			
	Sample/Cal	Zero/Span			Zero	Process	Zero	Span
Mode	#5	#6	S1	S2	A(NC)	B(NO)	C(NC)	D(NC)
Process	ø	ø	DE	DE	C	O	C	C
Zero	1	ø	E	DE	O	C	O	C
Span	1	1	E	E	C	C	C	O

Key:
- 1 Relay Closed (AC voltage present)
- E Solenoid Energized
- O Opened
- ø Relay Opened (no AC present)
- DE Solenoid De-energized
- C Closed

5.4.5.2.4 Calibration Mode

The calibration mode is entered from the SETUP MENU, Figure 5-5. Select **Oxygen Cal**(ibration) menu, Figure 5-12, and then select either **Check/Adj Zero...** or **Check/Adj Span...** from the instrument front panel. Once one of these selections is made, a pneumatic signal is sent to the common port on 3-way Solenoid S1. S1 activates Control Valve B which closes. The pneumatic signal is also sent to Solenoid S2 via a tee in the pneumatic line.

Selecting **Check/Adj Zero...** displays the Zero Check Menu, Figure 5-16; selecting **Check/Adj Span...** displays the Span Check Menu, Figure 5-19. The features available with these Zero and Span Check Menus are discussed below.

5.4.5.2.5 Span Mode

From the Span Check Menu, selecting **SPAN GAS (ON)** will cause Relay 5, Sample/Calibrate and Relay 6 Zero/Span to close. Selecting **AUTO SPAN** will immediately display a request to enter the span gas value. After the span gas value is entered, the Auto Span Adjust Screen, Figure 5-21, will be displayed, and Relays 5 and 6 will close. The firmware first closes the Zero/Span Relay (Relay 6). The Zero/Span closure energizes Solenoid S2 connecting the Common port of S2 to the pneumatic line going to Control Valve D. The closure of the Sample/Calibrate Relay switches Solenoid S1 Common Port to the pressure side. Control Valve D opens and Control Valve B closes.

Valves A and C remain in their NC positions. The instrument is now reading the gas delivered from the span port. Process Mode can be restored manually by toggling **SPAN GAS (OFF)**, or it will automatically be restored at the end of an auto span cycle.

The firmware initiates the following sequence to return to Process Mode. The Sample/Calibration Relay opens allowing Solenoid S1 to Vent (Normal-to-Common). Since Solenoid S2 must momentarily remain connected to Control Valve D for venting through Solenoid S1, the firmware opens the Zero/Span Relay only after venting the pneumatic line to Control Valve D. A short delay of 0.5 second is necessary for venting.

CAUTION

If AC power is lost while in the span mode, solenoids will not be able to sequence when de-energized. Hence, the span pneumatic line will remain pressurized causing the **span valve to remain open**. Either reestablish power and sequence the valves to close the span valve, or remove the pneumatic line to vent the span valve.

NOTE: Protection against false high alarms after a span calibration is provided by the firmware. Following a successful or aborted Span Calibration, the Analyzer will delay reactivation of its internal alarms until oxygen readings have fallen below the lowest active high alarm level, stabilized or increased. Also, the In-Cal Relay and Cal Freeze functions can signal external devices that oxygen readings are not yet valid. See Sections 5.4.2.1 and 5.4.2.2.

5.4.5.2.6 Zero Mode

From the Zero Check Menu, selecting **ZERO GAS (ON)** will cause Relay 5, Sample/Calibrate to close; the Zero/Span Relay (relay 6) remains open. Selecting **Auto Zero** will immediately display a message about fully purging the system before proceeding with a zero calibration. Pressing ⇦ will place the Analyzer in the Auto Zero mode, display Figure 5-18, Auto Zero Adjust screen, and automatically close Relay 5, switching the Analyzer to zero gas.

Since Solenoid S2 is not energized, the NO port is open, pneumatics operate Control Valves A and C causing them to open. Process gas is diverted through the purifier to provide a zero gas for calibration. The instrument is now able to verify zero or recalibrate the zero. Process Mode can be restored manually by toggling **ZERO GAS (OFF)**, or it will automatically be restored at the end of, or by aborting, an auto zero cycle.

The firmware initiates the following sequence to return to Process Mode. A pneumatic venting cycle causes valves A, B, and C to change state. The Sample/Calibrate Relay 5 opens which returns Solenoid S1 to the NO position causing the line to vent. Since Solenoid S2 is now in the NO position, it will vent the lines connected to Valves A and C.

5.4.5.2.7 Switching from Zero to Span or Vice Versa

When switching between the Zero Mode and the Span Mode, it is necessary to vent the gas lines connecting Control Valves A, C and D just prior to switching modes.

Assume a zero check has just been completed and it is to be followed by a span check. **ZERO GAS (ON)** leaves the pneumatic lines to valves A and C pressurized. Valves A and C will be open. The firmware recognizes a mode switch and commands Solenoid S1 to the vent position momentarily to release the pressure in the pneumatic lines to Control Valves A and C. This command is executed by opening the Sample/Calibrate Relay for 0.5 seconds.

After venting, the firmware closes both relays together. Solenoid S2 switches position to the pneumatic line connected to Control Valve D for Spanning, and then Solenoid S1 switches from venting to pressurizing Solenoid S2 causing Control Valve B to close and D to open.

If the user first performs a Span followed by a Zero, the firmware will reverse the venting operation. Again, Solenoid S1 momentarily moves to the vent position to vent the pneumatic line connecting Control Valve D through Solenoid S2. Solenoid S2 then moves to the other position connecting to Control Valves A and C. This move is followed by Solenoid S1 connecting to the pneumatic source by the firmware closing the Sample/Calibrate Relay (Relay 5).

NOTE: For optimal performance, operate the Analyzer on low ppb gas for several hours before performing a span check (above 1 ppm). Setting a zero baseline after a ppm-level exposure without the purge will result in a zero baseline that will drop slightly over time. The preferred technique is to set the zero baseline prior to the ppm span exposure.

CAUTION

The gas purifier supplied by Delta F Corporation has a finite life which is greatly affected by the source gas oxygen level, flow rate, and duration of sampling. Always minimize the time sampling from the purifier and ensure that the source gas is below 50 ppb for optimal life expectancy. See Section 6.5.1.

5.4.5.3 Check/Adj Zero

NOTE: A zero calibration should be performed only after the Analyzer has been operating at least 24 hours. The door should be closed when calibrating the Analyzer.

The **Check/Adj Zero...** entry in Figure 5-12 is used to perform a zero check during calibration. Selecting **Check/Adj Zero...** will display the ZERO CHECK screen shown in Figure 5-16. Also, if configured, the IN-CAL Relay and CAL FREEZE functions will change state when entering this menu to signal external devices. See Section 5.4.2.1 and 5.4.2.2.

If the system has been previously recalibrated by the user, an additional line will be added to the ZERO CHECK screen, Figure 5-16, that states **Remove Zero Adj**(ust).

O2: Displays the current oxygen measurement.

CAL OFFSET: is used to positively bias the oxygen readings to be above zero to avoid displaying a negative oxygen concentration. Following a zero calibration and assuming that the zero baseline is not falling due to equilibrium effects (such as after a high ppm exposure), the oxygen reading during a several hour period will indicate -0.0 or -0.1 ppb almost half the time if the peak-to-peak noise of the oxygen signal is 0.2 ppb. The zero calibration will assume the average of the peak-to-peak noise to be 0.0 ppb. A Cal Offset of 0.1 or 0.2 ppb diminishes this effect.

The **ZERO GAS** selection toggles RELAY 5 **ON** and **OFF**. The relay terminals are located at the back of the instrument on connector J-9 labeled HEATER (RELAY 5) AC HI and HEATER (RELAY 5) AC LO. This function can be used to manually control the zero gas isolation valve when the instrument is equipped with Delta F's optional Automated Calibration System or Automated Control of External/User Calibration Components options.

Selecting **Remove Zero Adj** will restore the factory calibration data.

CAUTION

The gas purifier supplied by Delta F Corporation has a finite life which is greatly affected by the source gas oxygen level, flow rate, and duration of sampling. Always minimize the time sampling from the purifier and ensure that the source gas is below 50 ppb for optimal life expectancy. See Section 6.5.1.

Data Display ☞ Main Menu ☞ Setup ☞ Oxygen Cal ☞ Check/Adj Zero

```
        ZERO CHECK

  O2:              0.4 PPB
  Cal Offset: 0.0
  ZERO GAS (OFF)
  AUTO ZERO
* ZERO REF:  0.0
  Update and Quit
```

Figure 5-16. Zero Check Menu

5.4.5.4 Manual Zero Calibration

CAL Offset: - Over long periods of time, such as a 1-3 week period following initial start-up or an electrolyte change, the zero will tend to asymptote downward. This positive bias feature prevents zero drifting into a negative reading following a zero recalibration during the equilibration of the zero base line. A value from 0 to 10.0 ppb can be set. The value does not affect zero calibration; it is simply added to the calibrated zero.

ZERO REF: - By selecting **ZERO REF:**, the user can perform a *manual* zero calibration. The selection will display Figure 5-17, Manual Zero screen.

NOTE: This selection should be made only after the Analyzer has been operating on zero gas with a stable output. Use of a chart recorder to determine output stability is recommended. See Sections 4.5 and 4.6.

Data Display ☞ Main Menu ☞ Setup ☞ Oxygen Cal ☞ Check/Adj Zero ☞ Zero Ref:

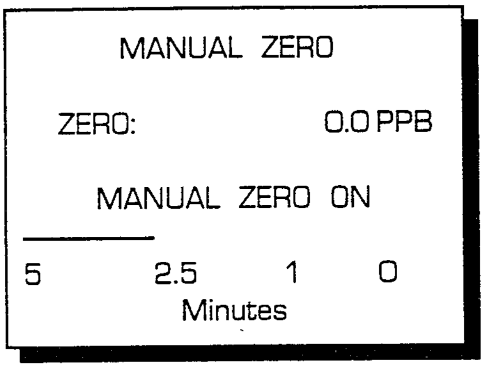


Figure 5-17. Manual Zero Adjust Screen

Selecting **ZERO REF:** initiates a 5-minute countdown, graphically displayed in Figure 5-17. At the end of the countdown, the new zero will be logged, and the display will return to Figure 5-16. If the signal is not stable, such as in the case of a rapidly falling zero baseline after an initial startup, the clock cycle will reset to 5 minutes and repeat. This process will continue indefinitely until a stable signal terminates the process. The **ZERO Ref:** value will change to reflect the deviation from the original factory calibration. A line will be added to Figure 5-16, below the **O2:** reading that says **Remove Zero Adj.** At this point, the user can choose to keep the zero calibration by selecting **Update and Quit**, return to the previously used Zero Ref value by selecting **ESC**, or return to the factory calibration by moving the * to **Remove Zero Adjust** and pressing ⇦.

The **ZERO Ref:** value should not fall outside the range of -10 to +75. If the **ZERO Ref:** value is outside this range, contact Delta F Corporation at (617) 935-4600.

NOTE: The live **O2:** reading as well as the Data Display Screen and every other location where oxygen is displayed will indicate **Zero Dly** (Delay) for approximately 2 minutes while the instrument completes an electronic zero adjustment. Following this period, the displayed oxygen may oscillate slightly, but should quickly stabilize to the value of 0.0 plus the CAL Offset.

5.4.5.5 Auto Zero Calibration

When an optional Automated Calibration System or Automated Control of External/User-Supplied Components is supplied, **AUTO ZERO** will initiate a sequence to automatically perform a zero calibration, accept the new calibration data, and then automatically return the Analyzer to the process measurement mode. Selecting this entry will bring up Figure 5-18. See Sections 5.4.5.2.1 through 5.4.5.2.7 for operational details.

If the **CAL FREEZE** selection is set to **ON** (see Recorder Output Screen, Figure 5-10), the Analyzer's recorder output will be frozen at the concentration prior to entering a calibration. The **IN-CAL RELAY** selection (also shown in Figure 5-10) can be used to signal a data acquisition system, via optional relays 1, 2, 3 or 4, that a calibration is in process.

CAUTION

Be sure the system is adequately purged and is reading close to zero. **Do not attempt to Auto Zero when the process or calibration gas exceeds 50 ppb.**

Data Display ☞ Main Menu ☞ Setup ☞ Oxygen Cal ☞ Check/Adj Zero ☞ Auto Zero

```
          AUTO  ZERO
ZERO:                 0.7 PPB
ZERO  GAS  [ON]

         AUTO ZERO ON
______
20            10     5      0
            Minutes
```

Figure 5-18. Auto Zero Adjust Screen During Automatic Zero Calibration

O2: Displays the current measurement.

ZERO GAS ON - Notification that zero gas is being supplied to the Analyzer. No user action is available.

AUTO ZERO ON - Displays a graphical timer that begins counting down from 20 minutes. During the 20 minute cycle, the Analyzer is allowing 15 minutes for equilibration before it begins to apply stability criteria. During the last five minutes, the Analyzer will monitor the stability of the reading. If the stability is acceptable, the Analyzer will automatically accept the reading, update the **ZERO REF:** described above, automatically Update and Quit, and return to the Data Display Screen to complete the calibration. If the reading is not stable, the Analyzer will reset to the 5-minute-remaining point and repeat the stability monitoring.

After the Analyzer completes the auto zero cycle, the display will return to the Data Display Screen, Figure 5-1. The automated calibration system control relays (relays 5 and 6) will de-energize returning the Analyzer to operation on process gas. The Data Display screen will indicate **ZERO DELAY** for the next 2 minutes during the electronics zero adjustment before real-time oxygen readings resume. The **CAL FREEZE** and **IN-CAL RELAY** will then be released.

5.4.5.6 Check/Adj Span

NOTE: A span calibration should be performed only after the Analyzer has been operating at least 24 hours on a zero or low-ppb gas. The door should be closed when calibrating the Analyzer. If the calibration background gas is not the same as the process gas, be sure to set the GSF (see Section 5.4.5.1) before performing a calibration and to return the GSF back to its previous value after the calibration is complete.

It is advantageous to use a span gas with the same background gas as the process gas to minimize stabilization time.

The **Check/Adj Span...** entry in Figure 5-12 is used to perform a span calibration. Selecting **Check/Adj Span...** will display the **SPAN CHECK** screen shown in Figure 5-19. Also, if configured, the IN-CAL Relay and CAL FREEZE functions will change state when entering this menu to signal external devices. See Section 5.4.2.1 and 5.4.2.2.

If the system has been previously recalibrated by the user, when the **Check/Adj Span...** selection is made, an additional line will be added to the Span Check menu,

Figure 5-19, that states **Remove Span Adj**(ust). Selecting **Remove Span Adj** will restore the factory calibration data.

Data Display ☞ Main Menu ☞ Setup ☞ Oxygen Cal ☞ Check/Adj Span

```
        SPAN CHECK
  O2:                9.83 PPM

* GSF: 1.00 (0 GS)
  SPAN GAS (OFF)
  AUTO SPAN
  SPAN REF:  1000
  Update and Quit
```

Figure 5-19. Span Check Menu

O2: Displays the current oxygen measurement.

The Gas Scale Factor (**GSF**) of the calibration gas can be entered directly or calculated by the instrument as described in Section 5.4.5.1.

The **SPAN GAS** entry toggles *both* RELAYS 5 AND 6 **ON** and **OFF**. The relay terminals are located at the back of the instrument on connector J-9 HEATER (RELAY 5) AC HI, HEATER (RELAY 5) AC LO, PUMP (RELAY 6) AC HI, and PUMP (RELAY 6) AC LO. This function is used to manually control the span gas control valve when the instrument is equipped with an optional automated calibration system. The user can use these relays to control a custom function if the Analyzer is not equipped with the automated gas calibration system

5.4.5.7 Manual Span Calibration

After the span gas is connected and the Analyzer is stable, a manual calibration can be performed.

Selecting **SPAN REF:** immediately causes an overwrite of **Span Gas: 10.00** (factory default setting) or the previous value. The user can input a span gas value up to 10 ppm for a *manual* calibration. If the Span Gas value is correct press ⇦ until the value is accepted.

After entering the span value, the analyzer will display the Figure 5-20.

It may take several minutes before convergence occurs. During convergence, the Analyzer is verifying stability of the reading before accepting the data. After convergence, two short beeps can be heard. The Analyzer's electronics can be updated to the new calibration information by selecting **Update and Quit**.

If convergence does not occur within 5-10 minutes, check the following:

a. Make sure the gas connections are leak free. See Section 6.7.
b. Make sure the sensor has had sufficient time to attain a stable reading on the calibration gas.
c. Check the electrical connections to the sensor.

NOTE: The IN-CAL Relay and CAL FREEZE function will release in the same manner as that for Auto Span (see below.)

Data Display ☞ Main Menu ☞ Setup ☞ Oxygen Cal ☞ Check/Adj Span☞ Span Ref

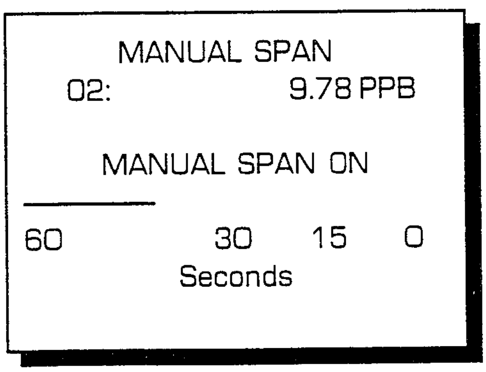


Figure 5-20. Manual Span Adjust Screen

If all items check-out, allow the Analyzer to operate an additional 30 minutes on calibration gas. Repeat the calibration. If the results are the same, contact Delta F Corporation (617) 935-4600.

To abort the calibration before completing convergence, press ESC. The previous calibration data will remain in effect.

NOTE: For optimal performance, operate the Analyzer on low ppb gas for several hours before performing a span check (above 1 ppm). Setting a zero baseline after a ppm-level exposure without the purge will result in a zero baseline that will drop slightly over time. A good technique is to set the zero baseline prior to the ppm span gas exposure.

5.4.5.8 Auto Span Calibration (Optional)

When the optional automated calibration system is installed, **AUTO SPAN** will initiate an automated span. Selecting this menu item will immediately cause an overwrite of **AUTO SPAN** with **Span Gas: (value)**. The cursor will be over the first digit for editing the value to that of the span gas that is being used for calibration. If the span gas value is correct, press ⇦ until the value is accepted.

NOTE: The calibration standard must not exceed 10.00 ppm oxygen. A calibration should be performed only after the Analyzer has been operating for 24 hours. The door should be closed when calibrating the Analyzer. If the calibration gas is not nitrogen, be sure to set the GSF (see Section 5.4.5.1) before performing a calibration.

It is preferable that the calibration be performed with a gas that has a diffusivity similar to the process background gas. For example, calibrating with N_2 when the process background gas is Ar would be acceptable, as would He for processes that have H_2 as a background gas. It not, the span gas stabilization times will be longer.

After entering the span gas value, the display automatically shows the AUTO SPAN screen, Figure 5-21.

Data Display ☞ Main Menu ☞ Setup ☞ Oxygen Cal ☞ Check/Adj Span ☞ Auto Span ☞ (enter span gas concentration)

```
        AUTO SPAN
  O2:              9.78 PPB
      SPAN GAS (ON)
     AUTO SPAN ON
_______
20          10    5     0
          Minutes
```

Figure 5-21. Auto Span Adjust Screen During Automated Span Calibration.

O2: Displays the current oxygen measurement.

SPAN GAS ON - Notification that span gas is being supplied to the Analyzer. No user action available.

AUTO SPAN ON - Displays a graphical timer that begins counting down from 20 minutes. During the 20 minute cycle, the Analyzer is allowing 15 minutes for equilibrium before it begins to apply stability criteria. During the last five minutes, the Analyzer will monitor the stability. If the stability is acceptable the Analyzer will automatically accept the reading, update the Span Ref value as in 5.4.5.7, automatically Update and Quit, and return to the Data Display screen to complete the calibration. If the reading is not stable, the Analyzer will reset to the 5-minutes-remaining point and repeat the stability monitoring.

If the **CAL FREEZE** selection, Figure 5-10, is **ON**, the Analyzer output will be frozen at the output prior to entering the calibration.

If the **IN-CAL RELAY** selection (also in Figure 5-10) is used to signal a data acquisition system via optional relays 1, 2, 3 or 4 that a calibration is in process, the designated relay will change state upon entering the OXYGEN CAL screen.

After the Analyzer completes the automated span calibration, the display will return to the Data Display Screen, Figure 5-1. The automated calibration control (relays 5 and 6), will return the Analyzer to measuring process gas immediately after the auto span cycle is complete. However, the **CAL FREEZE** and **IN-CAL RELAY** will not be released until the oxygen reading has stabilized, increased, or the oxygen value has dropped below the lowest active high alarm set point (minus the deadband) as described in Section 5.4.2.1.

SPAN REF: (n) - The Span Reference value **SPAN REF:** is a numerical indicator for calibration changes made in the field. All instruments are shipped from the factory with a **SPAN REF:** value of 1000. The number will decrease if the sensor's oxygen sensitivity decreases and vice versa.

The **SPAN REF:** value should not fall outside the range of 500 to 1500. If the **SPAN REF:** value is outside this range, contact Delta F Corporation at (617) 935-4600.

5.4.5.9 New Sensor

The **New Sensor** entry is used after a new sensor is field installed. New sensors are supplied with calibration information. The procedure for installing a new sensor is described in instructions supplied with it.

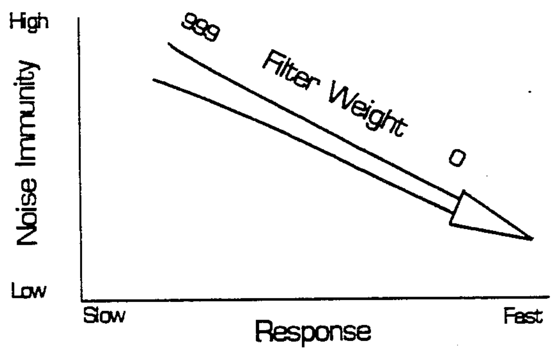
NOTE: Do not edit this entry without specific instructions from Delta F Corporation. If the entry has been accidentally accessed, press ESC.

5.4.5.10 Avg (Average) Filter

The NanoTrace Oxygen Analyzer is equipped with electronic filtering that can condition the output signal to smooth noise and spikes.

The output from the oxygen sensor can be filtered for noise by a Weighted Moving Average Filter. The filter weight is user set for optimum measuring conditions in a particular application. As the weight value is increased, noise is reduced and response time is lengthened. Filter weight should only be set high enough to give an acceptably stable output reading, based on the required analytical resolution.

A second signal conditioning filter can be added to the weighted moving average filter to provide enhanced noise suppression. The response can be selected as FASTER to use only the weighted moving average filter, or LOW NOISE to use both filters in tandem. The Response feature is a rate-of-change filter that retards a rapid rise or fall event when set to the LOW NOISE position. As a result, this LOW NOISE filter can be used with lower WEIGHT settings, and is more effective to display gradual reading changes.



A Filter Cutoff feature automatically removes filtering if the difference between the filtered moving average and new, unfiltered readings exceed the value of the user-set **Threshold**. The **Threshold** feature insures the instrument will display an upset (rapid change) and then settle down quickly. The delay from event onset to filter cutout is determined by the weight value.

It is advisable to enter only the amount of filtering that is needed. Experience with a particular application will determine optimum settings for Weight, Response and Threshold settings.

Figure 5-22 is the AVERAGING FILTER menu. This menu displays the offset between the displayed reading **AVG:** and the real-time reading **RAW:**. The difference between the two readings over time illustrates the lagging effect that filtering imposes, and the noise reduction effect of filtering. Observing the relative changes to these readings can help establish the optimum filter settings for a specific process.

Three items are used to adjust the instrument's peak-to-peak noise and response time.

THSHLD (Threshold) - The Filter Threshold setting is in ppm units. Oxygen concentration changes below the user-set value invoke the filtering functions. When the concentration change exceeds the threshold value, the filtering functions are inactive. If Threshold Filtering is inactive, a real-time rate of change to the measured value occurs. This feature allows the user to apply heavy signal dampening over a narrow range, while still maintaining real-time, high-speed response for larger oxygen changes. It is advisable not to use **THSHLD = 0.0**, since it eliminates the effects of the other settings. The smallest allowable setting of **THSHLD = 0.01**.

Weight - Weight and Response selections interact. Weight is a measure of the relative dampening (averaging) factor of the filter. The greater the weight, the more the dampening effect.

This setting affects both the speed-of-response and the time constant imposed on the real-time process signal. Weight also affects the high-frequency cut-off of the filter. The greater the weight, the lower the frequency cut-off. The value of the Weight can be from 0 to 999 (maximum filtering). The value can be related to approximately a two second time interval per unit weight to reach 99.9% of a step change. (See examples below.)

RESP(onse)**:** The user may set **RESP:** to **FASTER** or **LOW NOISE**. The LOW NOISE setting applies additional filtering (typically twice as much) on the signal.

For example: With settings of **WEIGHT: 100**, and **RESP: FASTER**, the time to reach 99.9% of a step change will be ≈ 200 seconds (≈ 2 x 100); with a setting of **RESP: LOW NOISE,** the time to reach 99.9% of a step change would be ≈ 400 seconds.

This example assumes that the oxygen change is less than the setting of **THSHLD**. As such, the filtering is not interrupted to permit quicker response. If **THSHLD** is set to 0.01 (10 ppb), then filtering will be turned off when the raw signal is more than 10 ppb different from the averaged signal. Filtering will be reapplied when sequenced raw readings fall back within the 10 ppb window. Therefore, the Analyzer responds in almost real-time, except for the last 10 ppb or so when the filtering is reapplied. With this example, it is easy to see how low **THSHLD** settings can dramatically increase the response of the Analyzer.

Data Display ☞ Main Menu ☞ Setup ☞ Oxygen Cal ☞ Avg Filter

```
AVERAGING FILTER

 AVG:           0.4 PPB
 RAW:           0.2 PPB
*THSHLD:  0.01
 WEIGHT:    200
 RESP:  FASTER
 Update and Quit
```

Figure 5-22. Averaging Filter

The following table provides nominal values for Weight, Threshold and Response for a variety of applications. These recommendations should be used as a starting point for setting the Averaging Filter. Experience with the specific application will lead to optimum settings.

Table of Nominal Averaging Filter Settings

	Stationary			**Portable**		
Impurity Requirements	**Weight**	**Threshold**	**Response**	**Weight**	**Threshold**	**Response**
<2 ppb	>500	0.02 or higher	Low Noise	100-200	.01	Fast
<10 ppb	>100	0.01 or higher	Low Noise	50-100	.01	Fast
>10 ppb	<100	.01	Either	50	.01	Fast
Upset Recovery	0 - 100	.01	Faster	20-50	.01	Fast
Hot Transport	---	---	---	999	10	Low Noise

NOTE: Use **Avg Filter Reset** in the Controls Menu to restore operation after a spike.

Table of Filter Settings' Effect on Typical Peak-to-Peak Noise

Weight	Response	Peak-to-Peak Noise
999	Low Noise	<0.1 ppb
500	Low Noise	0.15 ppb
200	Low Noise	0.2 ppb
200	Faster	0.3 ppb
100	Faster	0.35 ppb
50	Faster	0.4 ppb

5.5 The Password Menu

The Platinum Series NanoTrace Oxygen Analyzer includes password protection which can be used to limit access to the Control Menu, the Set-Up Menu, and the Diagnostics Menu.

The password operates on two levels, a Master Password to establish overall control of the system, and a Operator Password to allow partial access to the system. If the selected level requires a password, the display will present a password prompt.

The Password Menu is displayed in Figure 5-23.

NOTE: If a password has previously been entered, the Password Menu can only be accessed by using the previously entered password.

The two-letter codes adjacent to the **Set-Up**, **Control** and **Diags** entries in the display are used to indicate the level of password that is required to access the Set-Up, Controls or Diagnostics menus which are described in Sections 5.3 through 5.6. There are three possible settings for each entry:

Data Display ☞ Main Menu ☞ Password Menu

```
         PASSWORD

   Operator Paswrd
   Master Paswrd
   Set-Up (NU)
   Control (NU)
   Diags (NU)
  *Update and Quit
```

Figure 5-23. Password Menu

MA (Master) - indicates that the master password must be used to access the menu.

OP (Operator) - indicates that the operator password or master password can be used to access the menu.

NU (Not Used) - indicates that no password is required to access the menu.

NOTE: When an Analyzer is shipped from the factory with the Password Option, no password is installed. **Set-Up**, **Control** and **Diags** will show **NU.**

To set an Operator Password or Master Password, select the desired level. The display for an operator password is shown in Figure 5-24. The display for a master password is identical except the bottom line displays **MA:** instead of **OP:**.

A password consists of a series of one to four keystrokes using the ESC, ▲, and ▼ keys. Any combination of these keystrokes is acceptable. A typical password is ▲, ESC, ▼, ▼. After the fourth key is pressed for setting the Operator Password, the display will automatically return to Figure 5-23. If fewer than four keys are used to set the Operator Password, ⇦ must be pressed to return to Figure 5-23.

Data Display ☞ Main Menu ☞ Password Menu ☞ Operator Paswrd

```
Enter a new pw
using the ▲,▼
ESC keys. Use
up to 4 digits
and ↵ to end.
COPY YOUR ENTRY !
OP:
```

Figure 5-24. Password Entry Screen

After the Master Password is set (one to four keys), press ⇦ to return to Figure 5-23.

CAUTION

The master password should be recorded in a secure location. Once the master password has been accepted, the Analyzer will not display it again.

If the master password is misplaced, contact Delta F for assistance at (617) 935-4600.

The Master Password and Operator Password can be changed as desired after the present Master Password has been entered. The new password(s) are activated by pressing ⇦ when the asterisk is at **Update and Quit**.

NOTE: A Master Password must be set before an Operator Password will be recognized by the Analyzer.

To password protect a menu item (**Set-Up**, **Control**, **Diags**) use the ▲ or ▼ key to place the asterisk next to the item in Figure 5-23 and press ⇦. Subsequent pressing ⇦ will cycle through **NU**, **OP**, and **MA**. When the passwords and the settings for all three menus have been set, select **Update and Quit**.

5.6 Diagnostics

The Diagnostics Menu is used to test different functions of the Analyzer. When this menu is selected and the password is entered (if required), Figure 5-25 is displayed.

NOTE: When the **Diagnostics** entry is selected from the Main Menu, a DISABLING ALARMS message appears which notifies the user that the alarms have been temporarily disabled - the alarms' overwrite will not show in the display. *Relays that were in the alarm state immediately preceding the* **Disabling Alarms** *message will remain in the alarm state.*

Data Display ☞ Main Menu ☞ Diagnostics Menu

```
  DIAGNOSTICS MENU
  PRESCALE: 1153
  Temp:       22.7 C
  TComp . . . . . ! . . . .
  Test Outputs...
* Test Relays...
  Memory Test
  Screen Test
```

Figure 5-25. Diagnostics Menu

5.6.1 Prescale

The **PRESCALE:** factor cannot be accessed from the Diagnostics Menu. Prescale is a factory calibration value that accounts for individual sensor characteristics. The value can only be changed when installing a new sensor.

5.6.2 Temperature

The display will indicate the present sensor temperature. There is no user action with this selection. The temperature value is updated at intervals of 15 to 45 seconds while in the Diagnostics Menu.

5.6.3 TComp

If the Analyzer output appears to be drifting unacceptably, and this drift correlates with ambient temperature change, the TComp feature is useful to correct the drifting. A recorded output that shows oxygen and ambient temperature readings over time will clearly illustrate the correlation, if any. The factory setting is indicated by an inverted arrow. The present **TComp** setting is indicated by a solid line. Use ▲ and ▼ to move the vertical line for different compensation. If the Analyzer reading increases with increased temperature (under-compensation), then move the set point to the right. If the Analyzer reading decreases with increased temperature (over-compensation), move the set point to the left.

Because it is possible that processes can have real oxygen changes occurring with temperature changes, such as surface adsorption/desorption within a bulk gas delivery system, it is important to judge if the Analyzer's response is temperature dependent only while the sample is oxygen free zero gas. A point-of-use purifier at the inlet to the analyzer (as supplied with the Automated and Manual Calibration System options) is suggested.

Observe the readings over an extended period (24-72 hours) during which temperature changes occur. Refine the compensation adjustment as necessary.

NOTE: **TComp** is designed to correct temperature drift at oxygen levels close to zero (<10 ppb). At higher levels, changing **TComp** will not be very effective. A **TComp** set point is best selected while the Analyzer is on zero gas.

5.6.4 Test Output

The Test Output entry is used to calibrate the recorder output. When the Test Output option is selected, the display will show Figure 5-26.

Data Display ☞ Main Menu ☞ Diagnostics Menu ☞ Test Output

```
Press ↩ to set
DAC to desired
%FS level.

    Output:          0.00%

    ESC to Quit
```

Figure 5-26. Output Test Screen

Use the ⇦ and the ▲ and ▼ key to set the desired output level in percent of full scale. After setting the **% FS Level**, press ⇦. The analog output response should match the value of the **%FS Level** that was entered. For example, if 80% is entered for the **%FS Level**, and the output is set for 0-10 VDC, the analog output will be 8.000 VDC. See Section 4.6 to change the analog voltage output range.

5.6.5 Test Relays

The **Test Relays** selection in Figure 5-25 is used to assure that the relay outputs are functioning. When the Test Relays option is selected, the display will show Figure 5-27.

NOTE: This test is to verify that relays 1 through 4 are functioning. To test relay 5 (Sample/Calibration Relay) and relay 6 (Zero/Span Relay), use the Control Menu. Refer to Sections 5.3.2 and 5.3.3.

Select the relay to be tested, then press ⇦. The relays can be toggled with subsequent ⇦. An audible click will occur. The condition of the relays before the test will be restored when the test is concluded.

Data Display ☞ Main Menu ☞ Diagnostics Menu ☞ Test Relays

```
        RELAYS

* RELAY 1   (OFF)
  RELAY 2   (OFF)
  RELAY 3   (OFF)
  RELAY 4   (OFF)

  ESC to Quit
```

Figure 5-27. Relay Test Screen.

5.6.6 Memory Test

The Memory Test selection is used to test the internal memory of the Analyzer. When the Memory test option is selected from Figure 5-27, the display will show Figure 5-28 without the **OK**'s. Testing automatically begins.

Data Display ☞ Main Menu ☞ Diagnostics Menu ☞ Memory Test

```
     MEMORY TEST

WAIT...
   ROM:   OK
  IRAM:   OK
  XRAM:   OK

Press any Key
```

Figure 5-28. Memory Test Screen.

After the ROM test is complete, the display will indicate **ROM:OK** and IRAM (Microprocessor RAM) will be shown on the next line. When the IRAM test is complete, the indication **IRAM:OK** will be shown. XRAM (External RAM chip) is then tested. After the XRAM test is completed, **XRAM: OK** will be displayed.

If any memory test fails, repeat the test. If a failure repeats, contact Delta F Corporation at (617) 935-4600.

5.6.7 Screen Test

When the screen test option is selected from Figure 5-25, each pixel in the display is tested. A series of horizontal lines appears on the display followed by a series of vertical lines. After the test has been completed, the display returns to Figure 5-25. Pressing ESC twice will immediately abort the screen test. If an error message appears or a pixel is inactive, contact Delta F Corporation at (617) 935-4600.

6.0 Calibration Systems

Delta F Corporation offers optional calibration systems to satisfy a wide variety of operating situations. A manually operated calibration system is available for fixed or portable NanoTrace applications. Automated calibration systems which are dedicated to span and zero calibration of a single Analyzer are available in different packaging configurations to meet specific installation needs. A Stand-Alone Calibration Station version is an integrated, bench-top design that can be used to provide calibration support capabilities on an infrequent basis for a number of Analyzers installed without dedicated calibration systems. The Stand-Alone Docking Station requires each Analyzer to be equipped with the Automated Control of External/User-Supplied Calibration Components.

Firmware supplied with the Platinum Series NanoTrace Oxygen Analyzer provides full control over the automated calibration sequence.

The sections below assume that the Analyzer has been prepared for operation as described in Sections 2, 4 and 5 of this manual.

The required sample gas operating pressure is 15 psig. Bottled span gas must also be regulated down to 15 psig. An orifice located in the sample inlet line reduces the inlet pressure to the required level at 2.0 scfh. Because of the orifice, simply setting 2.0 scfh by the internal flowmeter insures proper flow conditions at 15 psig inlet gas pressure.

6.1 Manual Calibration System

The Manual Calibration System is designed to offer maximum portability in a small package. Figure 6-1 shows an outline of the Platinum NanoTrace Oxygen Analyzer with the Manual Calibration System installed.

The manual calibration system uses welded stainless steel tubing and valve assemblies with VCR®-type fittings for the instrument connection, the gas sample connection, and the purifier connections. Three springless diaphragm valves provide full control during process measurement, zero calibration, and span calibration. A replaceable purifier provides zero gas when ppb process gas is diverted through it. An optional shut-off valve may be located inside the enclosure to isolate the downstream side of the sensor from ambient air during transport from one test location to another. The manual calibration system is shipped with a gas purifier installed.

An optional sample gas pressure regulator can be installed in the Manual Calibration System as illustrated in Figure 6-1.

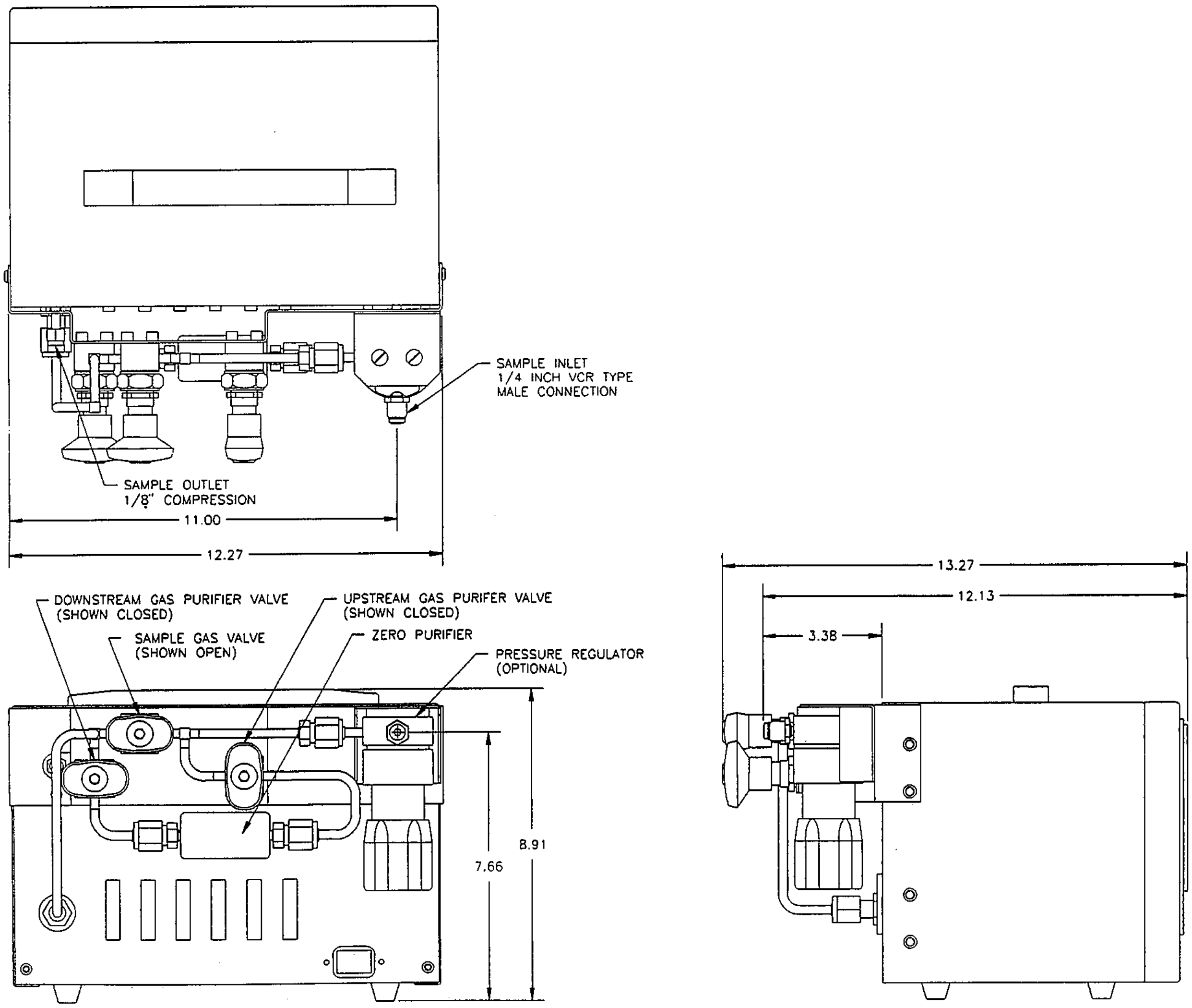


Figure 6-1. Outline of NanoTrace Oxygen Analyzer with Manual Calibration System.

6.2 Manual Calibration System Set-Up

A male VCR®-type gas connection is provided on the Manual Calibration System for connecting process gas or span gas. Flow rate is set by adjusting the upstream gas pressure via the optional regulator (or a user-supplied regulator) to obtain an indicated flow rate of 2.0 scfh for nitrogen and argon background gases, and 1.0 scfh for helium and hydrogen background gases. Refer to Section 6.2.1 First Time Operation below for detailed set-up procedures.

NOTES:

1. An indicated flow rate of 1.0 scfh with helium or hydrogen as background gas corresponds to an actual flow rate that is within acceptable limits for proper operation.
2. For gas pressures below 50 psig, the sample flow rate can be set using the optional bellows flow control valve, P/N NT-FCV-UHP.

CAUTION

The optional downstream isolation valve MUST NOT be used to control sample flow rate. Serious damage to the sensor may result if the valve is not fully open during operation. Furthermore, the downstream isolation valve must be fully closed **AFTER** the flow is stopped; and it MUST be fully opened immediately **BEFORE** the flow is restarted.

6.2.1 First Time Operation

After checking that the downstream shut-off valve, Figure 6-2 (if equipped), is fully opened (knob at the full counterclockwise position), and that all calibration system valves are closed, Figure 6-1, connect the sample gas line to the instrument.

Open the sample valve on the calibration system, Figure 6-1. While observing the flow meter inside the NanoTrace enclosure, gradually bring the flow rate to the required setting. Allow a low ppb oxygen sample gas to purge the Analyzer for ***at least*** 30 minutes before turning on power.

After purging, turn on the power to the Analyzer. The Analyzer should come on scale within 5 minutes.

Figure 6-2. Sensor Downstream Isolation Valve

6.2.2 Normal Operation and Calibration

First time operation usually includes a zero verification. The sample gas is used to perform a zero check by redirecting the gas through the gas purifier. Open both gas purifier valves and then close the sample gas valve, Figure 6-1. Leak check the sample system after thoroughly purging the system and after the oxygen reading becomes stable. Refer to Section 7.7 Sampling Considerations for a leak checking procedure. Refer to Section 5.4.5.4 Manual Zero Calibration for more information on performing a zero calibration on the Analyzer.

CAUTION

The gas purifier supplied by Delta F Corporation has a finite life which is greatly affected by the source gas oxygen level, flow rate, and duration of sampling. Always minimize the time sampling from the purifier and ensure that the source gas is below 50 ppb for optimal life expectancy. See Section 6.5.1.

The gas purifier scrubs the sample gas to a sub-ppb oxygen level that is suitable for zero checking the Analyzer. Even if the Analyzer is still equilibrating toward the factory-set zero at initial start-up, accurate low ppb measurements can be made once the rate of change on the oxygen reading per hour is within the accuracy needed for the particular measurement.

For example, if the oxygen reading on a purified zero gas is dropping at 0.5 ppb/hour, and the required reading accuracy is ± 1 ppb, then an accurate reading is assured by re-zeroing the Analyzer at the start of each measurement. If connections are thoroughly purged, each reading should only take 20 to 30 minutes. (Allowing an hour for each reading is preferable.)

After completing the zero calibration, close both purifier gas valves and then open the sample gas valve, Figure 6-1, to perform oxygen measurements directly.

A Span Calibration is performed by connecting a regulated span gas to the sample inlet fitting. Local gas suppliers can provide certified span gas between 4 and 8 ppm oxygen. It is recommended that the span gas be in a background gas that is the same as the sample background gas. Section 8.1.1 provides recommendations on the frequency of span checking.

The span gas bottle must be equipped with a regulator with a downstream shutoff valve to bring the bottled gas pressure to 15 psig. Before setting-up the Analyzer for a Span calibration close the shutoff valve at the bottle and adjust the regulator to provide 15 psig at zero flow. Crack open the shutoff valve on the bottle to allow span gas to purge through the lines. With the gas purifier valves closed, open the sample valve. Connect the span gas line (while it is still flowing) to the calibration system.

CAUTION

The downstream isolation valve must be fully opened immediately **BEFORE** the sample gas valve is opened and span gas is connected to the instrument.

Refer to Section 5.4.5.7 Manual Span Calibration in the Instruction Manual for performing a span calibration on the Analyzer.

6.3 Portable Operation

When the NanoTrace Analyzer is equipped with the optional NiCad battery power and a downstream isolation valve, it can be hand-carried from station-to-station for measurements. The following procedure is recommended for portable operation:

CAUTION

Analyzer power ***must*** be turned off if the sensor cannot be isolated from exposure to air. Isolation requires use of the optional downstream isolation valve P/N NT-ISO-DSV which is mounted inside the enclosure, Figure 6-2.

a. Close all three diaphragm valves in the calibration system.
b. If equipped, fully close the downstream isolation valve in the enclosure, Figure 6-2, by turning the knob clockwise. ***Immediately*** close the valve after Step a. to minimize back diffusion of ambient air prior to achieving sensor isolation.
c. If equipped with a pressure regulator or a flow control valve, close it.
d. With the sensor isolated by valves on each side, the oxygen concentration will likely increase. The oxygen reading at zero flow can be attributable to oxygen leaks past the valve seats and packing in the downstream valve. It is desirable that the oxygen reading remains below 150 ppb between relocations when the sensor is isolated.
e. Disconnect the sample gas line from the Analyzer. Discard the VCR®-type gasket.
f. Disconnect the power cord.

NOTE: When isolated and operating on battery power, it is possible for the reading to rise above 150 ppb during the first half-hour of isolation. If the reading does not drop after a half-hour, or if the reading exceeds 500 ppb, check the fittings for leakage, and check the downstream isolation valve packing nut.

To reconnect the Analyzer to another sample tap:

a. Reconnect the power cord.
b. Connect the sample gas line to the calibration system *just finger tight*. Use a new VCR®-type gasket.
c. Allow the sample gas to purge through the loose inlet connection for 15 minutes. Periodically lightly snug-up the fitting, then loosen the fitting to allow gas to escape. This pressure-cycling action will purge the air trapped inside the inlet tubing and/or regulator. Securely tighten the fitting after a minimum of 20 cycles and 15 minutes of purge time.
d. Open the downstream isolation valve in the enclosure, Figure 6-2, by turning the knob counter-clockwise at least two full turns.
e. Open both purifier valves so that gas will initially flow through the purifier.

f. If equipped with a pressure regulator or a flow control valve, open it slowly while observing the flow meter inside the enclosure. Set the required flow rate.

g. After 5 to 10 minutes of purging through the purifier, open the sample valve, and then close both purifier valves.

CAUTION

To avoid damage to the sensor, limit extended periods with the sensor isolated (without gas flowing) to ***less than 4 hours per day,*** whether power is ON or OFF. Always maintain a UHP sample gas purge on the analyzer when not in use.

Extended periods of sensor isolation and / or frequent isolation can cause an elevated zero base line after flow is reestablished. ***Minimize the duration and frequency of running while isolated.***

NOTES:

1. If the instrument is not equipped with a downstream isolation valve, it is important that disconnection, transportation and reconnection be done quickly to minimize oxygen intrusion into the sensor between measurements. Turn off power to the Analyzer if it cannot be reconnected within one minute.

2. When making measurements on gas streams that have different background gases, allow a few hours extra time for the previous background gas to be purged from the sensor if the molecular weight of the gases is very different.

3. Be sure to use the appropriate gas scale factor (GSF) when measuring in different background gases. Section 5.4.5.1 GSF provides the procedure for selecting the background gas scale factor.

4. Avoid any exposure that will drive the Analyzer over its upper limit of 10 ppm. This will greatly minimize the time required to reach low ppb levels.

6.4 Automated Calibration System

Delta F offers Automated Calibration Systems that all operate and function identically. The standard installation version is supplied with a rack-mounting for the Analyzer, and side supports which provide structural rigidity to the rack and base for the calibration system, see Figure 6-3. A Compact Depth design integrates all the pneumatic valves, purifier, and solenoids directly on the back of the Analyzer for installations where space is a premium, such as in analytical carts. This configuration can be optionally equipped with either rack or panel mounting, see Figure 6-5.

These versions are dedicated to one Analyzer. The Automated Stand-Alone Calibration Station version comes with a flexible VCR®-type fitting for connection to NanoTrace Analyzers not equipped with a dedicated calibration system, but with the Automated Control of External/User Calibration Components option.

Figure 6-3 shows the general arrangement of components for the Automated Calibration Systems. The automated systems can be equipped with an optional sample gas pressure regulator and an optional pneumatic gas regulator. Both versions require a pneumatic gas supply at 70 to 100 psig.

Automated systems have four pneumatically controlled, springless diaphragm valves, two three-way solenoid valves, and a replaceable gas purifier. All pneumatic lines and wiring are installed.

6.4.1 Automated Calibration System Set-Up

The Automated Calibration Systems have two separate 1/4" VCR®-type male fittings for sample and span gas connections. Sample gas is directed through the gas purifier for use as a zero reference gas. A regulated span gas bottle is connected to the separate span gas inlet fitting. Locations of the sample inlet ports will vary depending on the specific packaging. Figures 6-3, 6-4, and 6-5 show some of the configurations available.

Under de-energized conditions, the pneumatic sample gas valve is opened and the pneumatic span gas valve and both pneumatic zero gas valves are closed. Therefore Power OFF default allows process gas to flow through the sensor.

Mount the Analyzer with its Automated Calibration System before making gas connections. The Automated Stand-Alone Calibration Station should be located in its permanent position.

Filtered, dried plant air or nitrogen (recommended) at 70 to 100 psig is required for the pneumatic gas. The pneumatic gas line is connected at a 1/8" compression fitting shown in Figures 6-3, 6-4 and 6-5. If the calibration system is equipped with the optional pneumatic regulator, connect the pneumatic gas supply to the 1/8" compression port on the regulator.

CAUTION

Be certain that the downstream isolation valve (if equipped) in the Analyzer enclosure is opened at least two full turns (knob turned counter-clockwise) before connecting the Automated Calibration System to sample or span gas.

If the calibration system is equipped with the optional sample pressure regulator, close the regulator. Connect the sample line to the sample inlet fitting or to the regulator (if equipped) inlet port.

The span gas bottle must have a regulator and a downstream shutoff valve. Thoroughly pressure cycle and purge the regulator after it is attached to the span gas bottle as follows:

a. After securely attaching the regulator to the cylinder, fully open the regulator flow control valve. Open the cylinder valve. Set the regulator to give a delivery pressure of 20 psig.
b. Adjust the flow control valve to allow a modest flow rate (hissing sound).
c. Close the cylinder valve until the cylinder pressure falls to approximately 200 psig.
d. Open the cylinder valve to restore full delivery pressure.
e. On the regulator, turn the delivery pressure down to approximately 2 psig.
f. On the regulator, increase the delivery pressure to the maximum level.
g. Repeat steps c. through f. 5 to 10 times to thoroughly purge the regulator and gauges.
h. Close the flow control valve.
i. Set the delivery pressure to 5 psig.

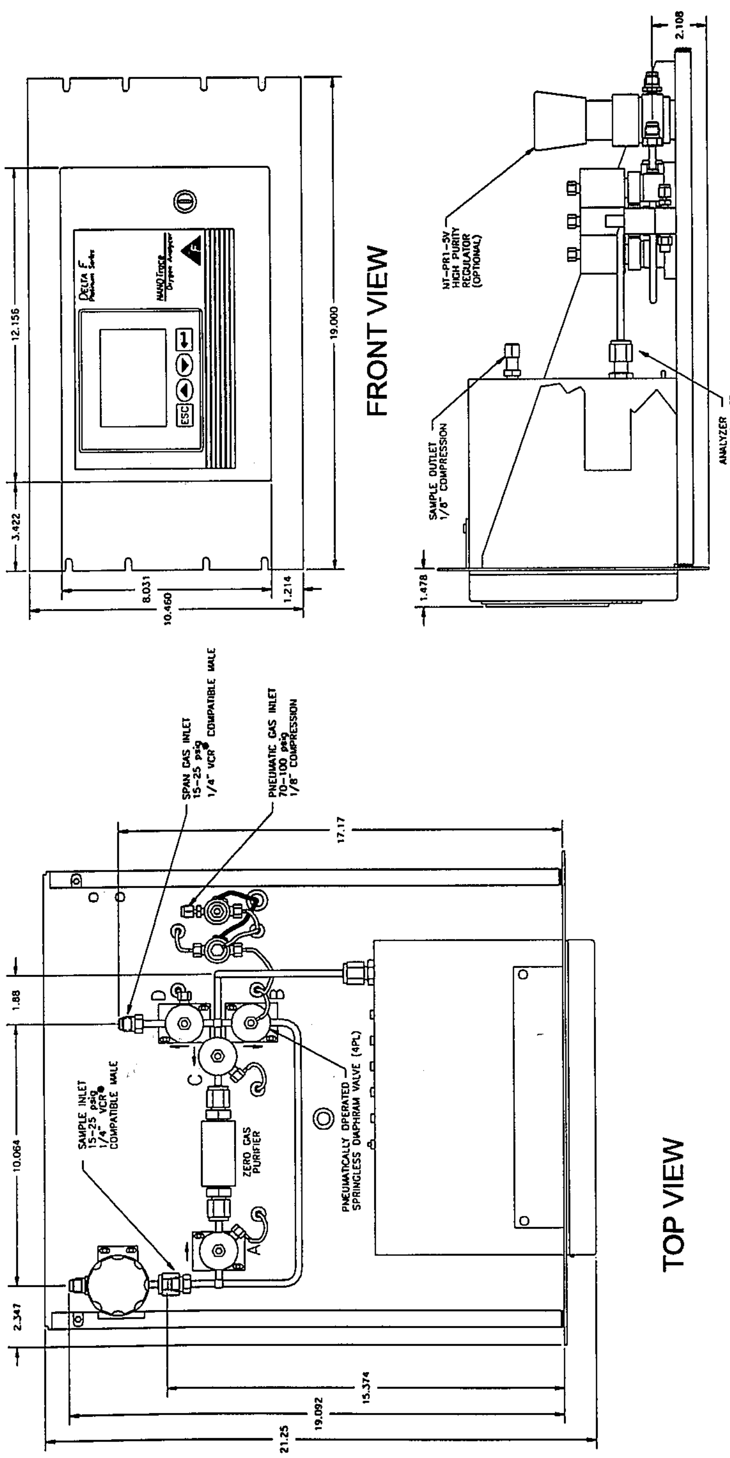


Figure 6-3. General Arrangement of Automated Calibration System (Standard Version)

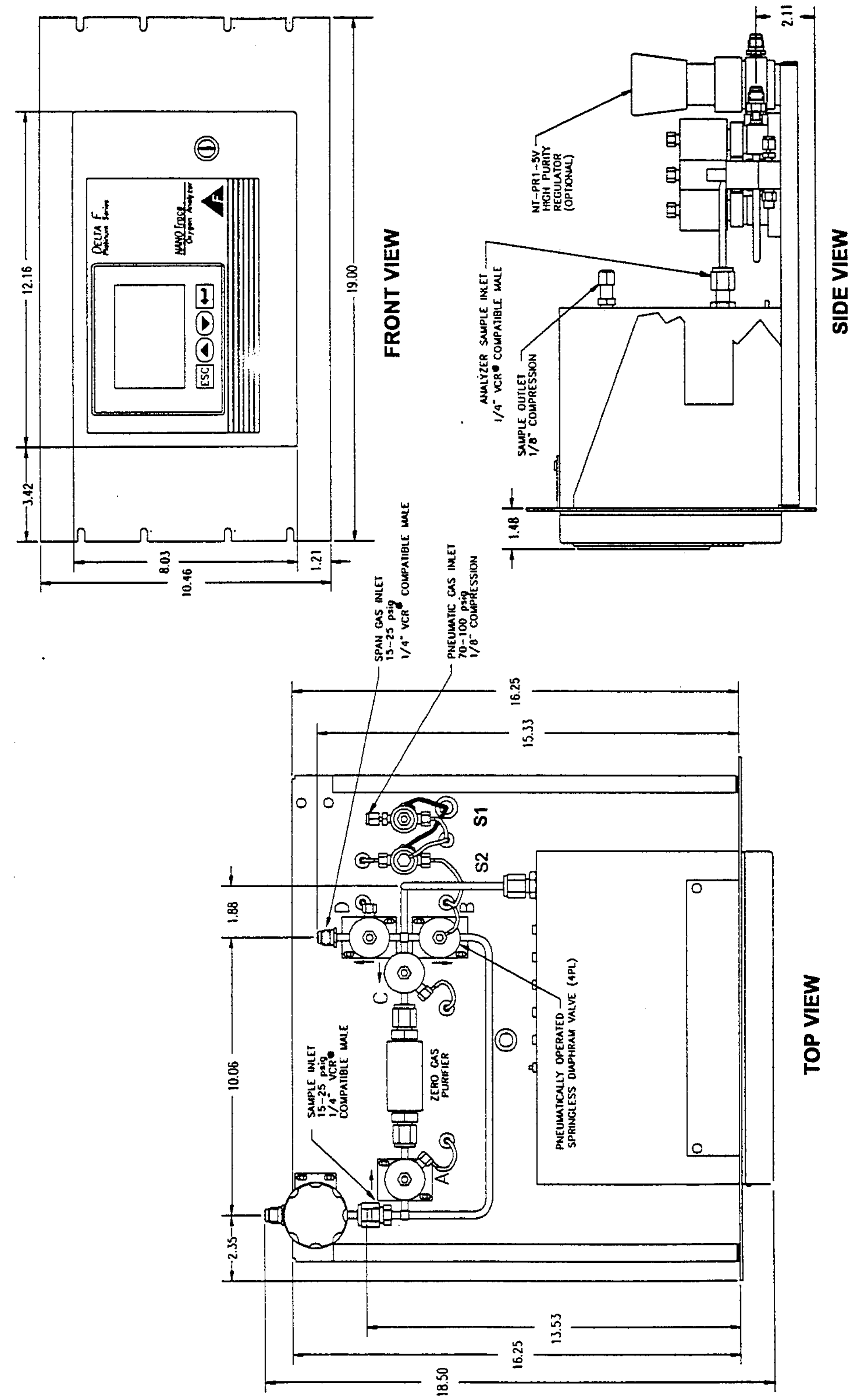


Figure 6-4. General Arrangement of Automated Calibration System (Reduced Depth Version)

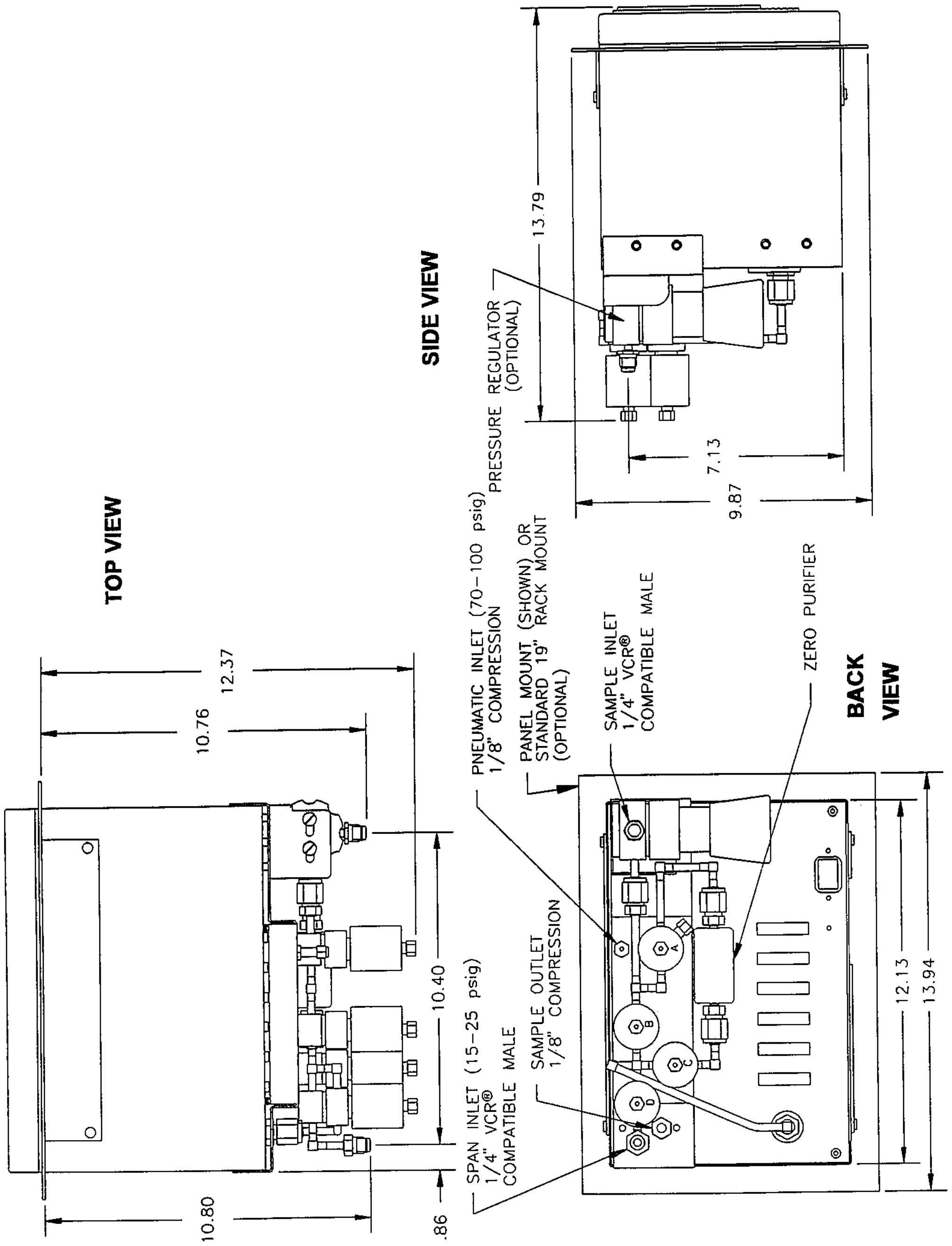


Figure 6-5. General Arrangement of Automated Calibration System (Compact Depth)

After all connections are completed, check that the downstream isolation valve is open. Gradually open the sample gas regulator until the required flow rate is observed on the flowmeter in the NanoTrace enclosure. Allow low-ppb oxygen sample gas to flow for 30 to 60 minutes **before** turning on power to the Analyzer. The Analyzer will come on scale within two minutes.

To set the span gas flow rate select the **Span Relay ON** from the Controls Menu which will operate the pneumatic valves. (See Section 5.3.3 Span Relay.) This will allow flow through the span gas line from the bottle. Gradually adjust the span gas bottle regulator until the desired flow rate is achieved.

Allow the span gas to flow for 5 minutes to purge the lines. Once readings have stabilized, leak check the span line by using the low- flow technique described in Section 7.5. Insure that span gas delivery lines are leak-free before turning off the span relay (Section 5.3.3). Do not adjust span until the Analyzer has been operating for several hours.

To perform an automated calibration, review and follow the procedures in Sections 5.4.5.2 through 5.4.5.8 in this manual.

To thoroughly purge the sample system, switch the Analyzer via the Controls Menu to alternately sample process gas (both **Span** and **Zero Relay OFF**) and zero gas (**Zero Relay ON**) for 15 minutes duration each. Continue purging for several hours while intermittently sampling process gas until readings are stable to within a reading decay of 4 to 5 ppb per hour.

Leak check the sample delivery system by lowering the sample pressure until the flow drops to 1.0 scfh. Oxygen readings should increase by no more than 1.0 ppb, assuming the system is completely purged.

6.4.2 Removing the Analyzer from the Standard Version Automated Calibration System

The Analyzer can be removed from the Standard Version calibration system by following these steps.

a. Turn off the Analyzer and disconnect electrical power at the back of the enclosure.
b. Remove the plug at connector J-9 at the back of the Analyzer.
c. Disconnect the VCR®-type fitting at the Analyzer inlet.

d. Open the door to the enclosure and remove the three printed circuit boards (PCBs) by pulling on the card ejectors.

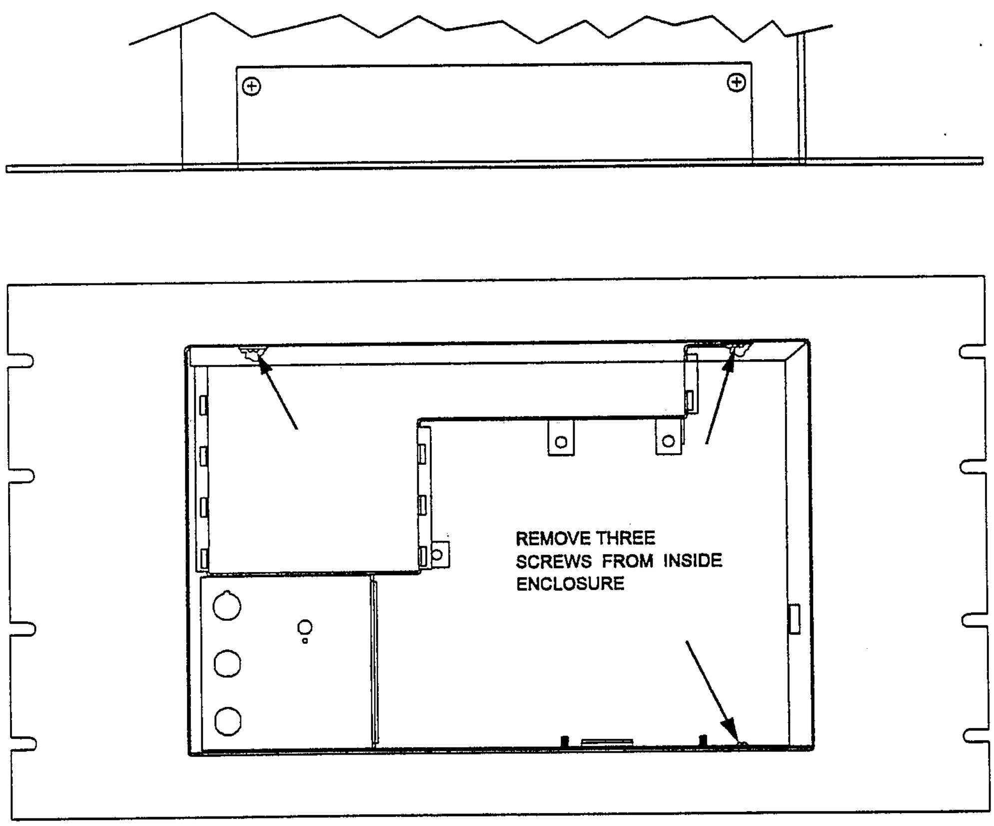


Figure 6-6. Remove 3 Screws to Separate Analyzer from Calibration System.

CAUTION

Printed Circuit Boards can be damaged by static charges. Handle them with care. Place the removed cards in protective bags.

e. Remove the Sensor Assembly as instructed in Section 2.2.
f. Remove three screws as shown in Figure 6-6.
g. Slide the Analyzer enclosure forward for removal.

Reinstallation is done by reversing this procedure.

6.4.3 Changing Analyzers at the Automated Stand-Alone Calibration System

Each Stand-Alone Calibration System comes with a VCR®-type bellows tube and a long cable. These are used to connect the calibration system to the Analyzer. The Analyzer should be placed in front of the Stand-Alone Calibration System during calibration. After connecting the bellows tube, plug the electrical connector into connector J-9 at the back of the NanoTrace Oxygen Analyzer. Plug in the power cord, but do not power up the Analyzer.

Use the procedures outlined above in Section 6.2 to set-up the gas connections and perform the calibration.

6.5 Installation Instructions for Gas Purifier

The Gas Purifier, P/N 16217280, is designed specifically for use in Delta F Corporation's Gas Calibration Systems. The purifier removes oxygen from a gas stream to provide sub-ppb oxygen concentrations for use as a zero reference gas during Analyzer calibration. Typical trace level process gas can be used as a zero reference gas after passing through the purifier. Calibration systems are supplied from the factory with a purifier installed. Purifiers are rated for 100 ppm-hrs. Replacement purifiers can be ordered from Delta F Corporation by calling (617) 935-4600.

CAUTION

The gas purifier supplied by Delta F Corporation has a finite life which is greatly affected by the source gas oxygen level, flow rate, and duration of sampling. Always minimize the time sampling from the purifier and ensure that the source gas is below 50 ppb for optimal life expectancy. See Section 6.5.1.

6.5.1 Determining When to Change the Purifier

In time the active component in the purifier will become expended. When expended, oxygen breakthrough will occur. (The oxygen content in the breakthrough gas will never be higher than the process gas.)

There are two observable signs of breakthrough:

a. When no decrease in the oxygen reading is noted after switching to zero gas. (This assumes that the process gas contains some low level of oxygen.)
b. When the zero reference value increases after each successive zero calibration, see Section 5.4.5.4. in this manual.

The following test will verify that breakthrough is occurring, and that the purifier needs to be replaced:

Establish a stable oxygen reading by diverting the low ppb process gas through the gas purifier at a flow rate of 1.0 scfh. Increase the flow rate to 3.0 scfh. If after several minutes there is an increase in the Analyzer's reading, replace the purifier.

6.5.2 Preparation for Gas Purifier Removal and Installation

CAUTION

Read the installation instruction and prepare all tools and parts for a ***quick*** installation. The new purifier must be installed rapidly to minimize exposing the purifier to ambient oxygen levels. Tools and supplies must be readily available and all preparations to the calibration system must be done ***before*** removing the new purifier from its packaging.

Removal and installation requires the following tools and parts:

7/8" open end wrench
3/4" open end wrench
9/64" hex key (Allen) wrench (Automated Calibration Systems only)
Two VCR®-type gaskets and retainers Delta F P/N 60300241. Cajon P/N SS-4-VCR-2-GR

6.5.3 Gas Purifier Change in the Pneumatically Operated Automated Calibration Systems (Except the Compact Depth Version)

Purifier Removal:

The Analyzer should be in the process measurement mode when installing a new gas purifier on an Automated Calibration System. Process gas should be flowing during this procedure (unless the process gas is hazardous).

a. Loosen the two 9/64" socket head screws in each block that secure the optional sample regulator and the pneumatic zero valve to the base plate, see Figure 6-5.
b. Using the 7/8" wrench to backup the fittings, loosen both VCR®-type end fittings on the expended purifier with the 3/4" wrench.
c. Fully unscrew both VCR®-type fittings. If necessary, spring the tubing slightly to remove the purifier.
d. Remove the gaskets with their retainers.

Purifier Installation:

Use reasonable precautions when installing the purifier. Contamination can adversely affect performance. Use new gaskets and retainers in the fittings.

CAUTION

The gas purifier is designed to operate with low ppb (<50 ppb) inlet gas. Exposure to ambient air can seriously reduce the useful life of the purifier.

a. After the expended purifier has been removed, install new gaskets and retainers on the **calibration system plumbing**.
b. Open the sealed packing bag containing the new purifier.
c. Write the installation date on the gas purifier label.
d. Quickly remove both VCR®-type cap nuts and gaskets from the new purifier. Do not reuse the gaskets.
e. Install the purifier with the flow direction arrow as shown in Figure 6-5.
f. Screw the fitting nuts at both ends finger-tight.
g. Using a backup wrench at each end of the purifier, tighten the gas nut 1/4 turn beyond finger-tight.

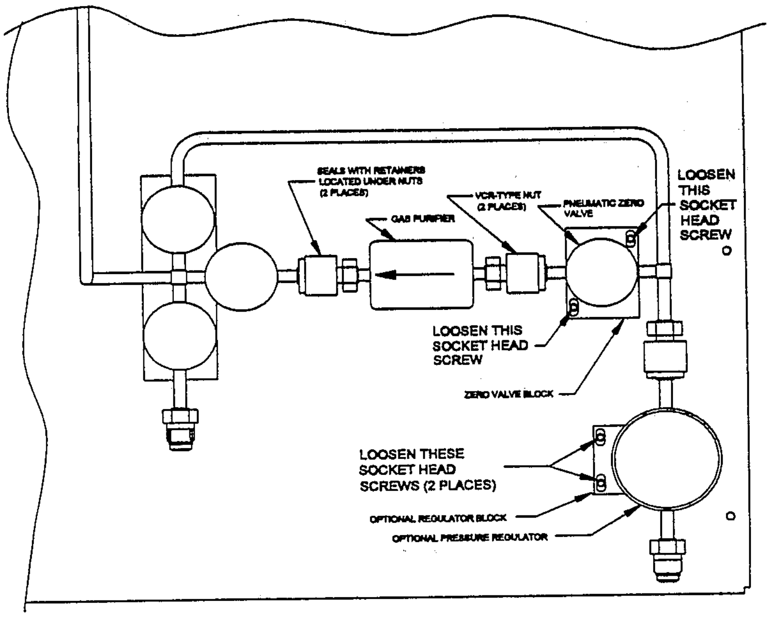


Figure 6-7. Automated Calibration System Component Arrangement

CAUTION

When installing a gas purifier be very careful. If necessary, slightly spring the plumbing apart to provide ample clearance to insert the gas purifier. The gas purifier sealing surfaces must not be dragged across the gaskets or their retainers.

h. Tighten the socket screws at the regulator and zero gas valve mounting block.
i. After installation is complete, allow low ppb process gas to flow through the gas purifier for 15 minutes to purge ambient gas from the gas lines. To accomplish the purging activate the Zero Relay to **ON** (see Section 5.4.5.3).

NOTE: Do not attempt a zero calibration immediately following a purifier exchange. Ample time for the gas line to purge is required before an accurate zero calibration can be successfully performed.

6.5.4 Gas Purifier Change in the Manual Calibration System and the Compact Depth Automated Calibration System

The Analyzer should be in the process measurement mode when installing a new gas purifier on a Manual Calibration System. Unless the process gas is hazardous, process gas should be flowing during this procedure.

Purifier Removal:

a. The Analyzer must be in the process measurement mode by placing the valve handles in the positions as shown in Figure 6-6.
b. Using the 7/8" wrench to backup the fittings, loosen both VCR®-type end fittings on the expended purifier with the 3/4" wrench.
c. Fully unscrew both VCR®-type fittings. If necessary, spring the tubing slightly to remove the purifier.
d. Remove the gaskets with their retainers.

Purifier Installation:

Use reasonable precautions when installing the purifier. Contamination can adversely affect performance. Use new gaskets and retainers in the fittings.

CAUTION

The gas purifier is designed to operate with low ppb (<50 ppb) inlet gas. Exposure to ambient air can seriously reduce the useful life of the purifier.

a. After the expended purifier has been removed, install new gaskets and retainers on the **calibration system plumbing**.
b. Open the sealed packing bag containing the new purifier.
c. Write the installation date on the gas purifier label.
d. Quickly remove both VCR®-type cap nuts from the new purifier.

CAUTION

When installing a gas purifier, be very careful. During installation slightly spring the plumbing apart to provide ample clearance to insert the gas purifier. The gas purifier sealing surfaces must not be dragged across the gaskets or their retainers.

e. Install the purifier with the flow direction arrow as shown in Figure 6-6. It may be necessary to slightly spring the calibration system plumbing to insert the gas purifier.
f. Screw the fitting nuts at both ends finger-tight.
g. Using a backup wrench at each end of the purifier. Tighten the gas nut 1/4 turn beyond finger-tight.

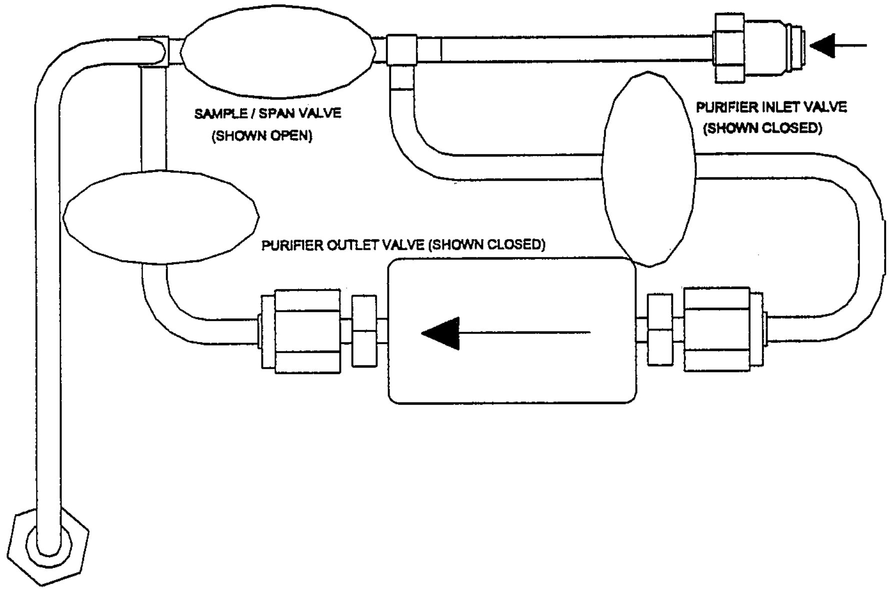


Figure 6-8. Valve Handle Positions When Changing the Gas Purifier on a Manual Calibration System

h. After installation is complete, allow low ppb process gas to flow through the gas purifier for 15 minutes to purge ambient gas from the gas lines. To accomplish the purging open the valves surrounding the purifier, and then close the process valve (see Section 5.4.5.3, in the Platinum Series NanoTrace Oxygen Analyzer Instruction Manual).

7.0 Theory of Operation

7.1 The Sensor

The sensor in the Platinum Series NanoTrace Oxygen Analyzer operates on a simple Coulometric principle in which oxygen in the sample gas is reduced by an electrochemical reaction. The use of this technique is widely recognized for its ability to provide the most accurate means of oxygen measurement.

A schematic of the sensor configuration is shown in Figure 7-1. The sample gas stream enters the sensor via the cathode cavity. Oxygen is metered to the cathode through the Bi-Strata® gas diffusion barrier. At the cathode, oxygen in the sample gas is electrochemically reduced to hydroxyl ions (OH^-).

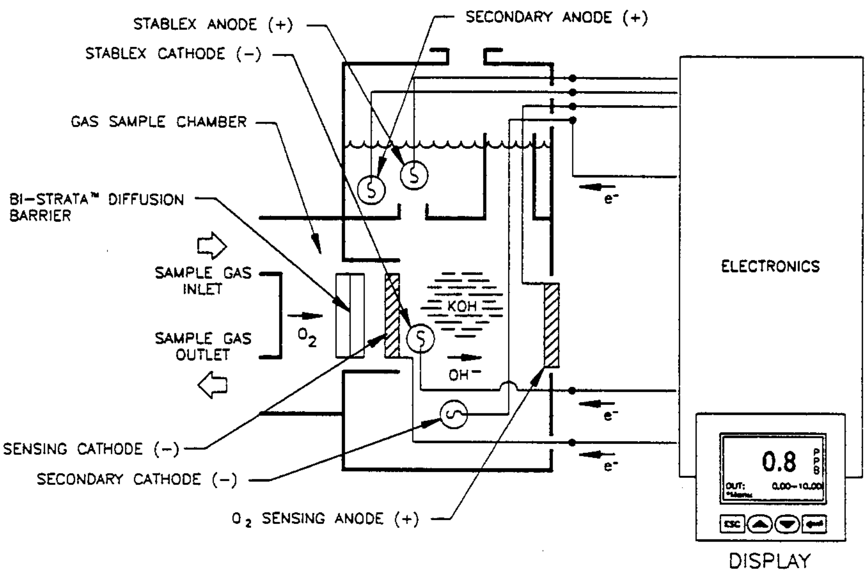


FIGURE 7-1 SCHEMATIC OF NANOTRACE OXYGEN SENSOR

The electrolyte solution contains potassium hydroxide (KOH) which assists in the migration of hydroxyl ions (OH^-) to the anode. At the anode, hydroxyl ions (OH^-) are oxidized to complete the reaction. A voltage of approximately 1.3 VDC, imposed on the sensor electrodes, drives the reduction and oxidation reactions. Each O_2 molecule reduced/oxidized generates a flow of $4e^-$. The resulting current is proportional to the oxygen content in the sample gas stream. The processed signal is then displayed on the front panel in ppm or ppb units of oxygen.

7.2 The Electrolyte Conditioning System

The Platinum Series NanoTrace Oxygen Analyzer is equipped with Delta F's patented electrolyte conditioning system. In addition to the sensing electrodes, the electrolyte conditioning system is comprised of two additional electrode pairs. Each electrode pair performs a distinct function.

The patented secondary electrode pair protects the sensing electrodes from the deleterious effects of trace impurities inevitably found in the electrolyte. In operation, the secondary electrodes attract and trap trace ionic impurities present in the electrolyte, providing an important scavenging function which results in long-term zero and span stability.

The patented Stablex electrode pair effectively isolates the sensor cathode from interference caused by oxygen that is dissolved in the electrolyte. The Stablex cathode, located directly in front of the sensor cathode, removes dissolved oxygen. Stablex provides an active dissolved oxygen barrier without the need to sparge the electrolyte. Sparging, which causes appreciable levels of electrochemical noise interference to the oxygen measurement process, is not needed.

7.3 The Gas Scale Factor

The gas scale factor corrects for the diffusion characteristics of oxygen due to the composition of the background gas being analyzed. Once the volumetric composition of the gas is entered into the software, the Gas Scale Factor is calculated and applied before reporting the concentration of the oxygen in the sample. The user has the option to manually input a Gas Scale Factor. Section 5.4.5.1 provides more information on the gas scale factor.

7.4 Effects of Pressure on Sensor Performance

Sensor output may change with sensor pressure. Typically sensor output increases as pressure increases and decreases as pressure decreases.

There should be no concern with sensor pressure effects if the flow rate is set to 2.0 scfh with the Analyzer venting to atmosphere (assuming sea level). Sensor pressure will match the factory-calibrated condition.

If the Analyzer is not vented to atmosphere, the sensor pressure will be influenced by the conditions downstream of the Analyzer. A recalibration under the user's operating condition may be desirable to remain within the stated accuracy specifications. However, in most cases the error introduced is relatively small, and may not affect the process application. The outlet pressure should be within ±3.0 psig; atmospheric venting is recommended. See Section 7.7, Sampling Considerations for more information.

7.5 Effects of Flow on Sensor Performance

The Analyzer is factory calibrated at a flow rate of 2.0 scfh. Variations in flow will cause a slight variation in the measured oxygen concentration. During normal operation, the flow rate should remain between 1.0 to 3.0 scfh. At the lowest flow rate, the oxygen reading may be as much as 3% low compared to the nominal flow rate. At the highest flow rate, the oxygen reading may be as much as 3% high.

If the Analyzer is normally operated at a flow rate other that 2.0 scfh (but within the recommended range), the Analyzer should be calibrated at that flow rate for best performance.

7.6 Effects of Temperature on Sensor Performance

The electrical current output of the oxygen sensor operating on a constant sample concentration will change with sensor temperature. Sensor output will increase with increasing sensor temperature and decrease with decreasing sensor temperature, particularly when oxygen readings are close to the sensor's zero level.

The Analyzer has software to correct the sensor output for sensor temperature changes. Temperature compensation adjustments apply to temperature drift only when the oxygen level is below 10 ppb. See Section 5.6.3 TComp.

Ideally, the Analyzer should be operated at a nominal temperature of 70°F. Calibration temperature should be close to operating temperature. If the Analyzer is to be operated at an average ambient temperature outside 65°F to 80°F, it should be recalibrated at the operating temperature for optimal performance.

NOTE: The temperature can be displayed at any time by accessing the Diagnostics Menu, Figure 5-25. This temperature value is updated at intervals of 15 to 45 seconds.

7.7 Sampling Considerations

Significant measurement error can be caused by leaks in the plumbing system. Fortunately, a simple test can be performed to identify oxygen leaks into the sample gas stream:

Observe the readout at two flow levels: 1.0 and 2.0 scfh. Flow can be adjusted by using a pressure regulator or upstream flow control valve. Only a slight increase (<2 ppb) in oxygen readout is expected in a tight system as the flow is decreased. If leakage in the plumbing system exists, then the decreased flow will result in a substantial increase in oxygen readout (>10 ppb.)

7.8 Regulators

Regulators used on bottled calibration standards will typically be equipped with two Bourdon pressure gauges, one to measure the cylinder pressure, and the other to measure the outlet pressure. The regulator must have a metal (preferably stainless steel) diaphragm. It is good practice to install a flow control valve to adjust the flow after the regulator.

All user-added upstream plumbing should be consistent with the instrument gas delivery components so that the highest level of integrity can be maintained. All connections should be welded or include metal face-seal components.

Pressure gauges are not recommended on regulators used on process sample lines because they add some measurement delay time and offer opportunities for leaks.

Before the calibration gas is connected to the Analyzer follow the procedure listed below to purge ambient air from the regulator:

a. After securely attaching the regulator to the cylinder, fully open the regulator flow control valve. Open the cylinder valve. Set the regulator to give a delivery pressure of 20 psig.
b. Adjust the flow control valve to allow a modest flow rate (hissing sound).

c. Close the cylinder valve until the cylinder pressure falls to approximately 200 psig.
d. Open the cylinder valve to restore full delivery pressure.
e. On the regulator, turn the delivery pressure down to approximately 2 psig.
f. On the regulator, increase the delivery pressure to the maximum level.
g. Repeat steps c. through f. 5 to 10 times to thoroughly purge the regulator and gauges.
h. Close the flow control valve.
i. Set the delivery pressure to 5 psig.

The above procedure insures that any ambient air trapped in the pressure gages and cavities of the regulator will be purged prior to performing a gas calibration. Once the regulator is mounted, do not remove it from the cylinder until a fresh cylinder is required.

NOTE: The procedure described above should be used at any inlet connection to minimize intrusion of ambient air in the gas lines. For ppm standards, a continuous bleed flow of approximately 0.5 lpm for 2 to 4 hours is recommended when the regulator is first connected before using the new setup for calibration.

8.0 Service

If the Analyzer is to be returned to the factory, it will be necessary to obtain a Return Material Authorization number by contacting Delta F Corporation at (617) 935-4600, Service Fax (617) 932-0053.

8.1 Maintenance

8.1.1 Calibration

All Delta F Platinum Series NanoTrace Oxygen Analyzers are calibrated with certified gas standards at the factory prior to shipment. If the Analyzer is operated within its specified conditions, no initial calibration is required upon receipt from the factory.

Depending upon the nature of the application, Delta F suggests verifying the span calibration of the Analyzer approximately every 6 months using a gas with a known level of oxygen. Span checks can be performed within the Analyzer's measurement range of 0-10 ppm. However, reliable standard gas mixtures are readily available in the 4-7 ppm range. Refer to Section 5.4.5.8 for information on using calibration standards with background gases that differ from the process background gas.

The zero calibration is most important for applications requiring accuracy below 10 ppb. For use in applications that are above 10 ppb, the zero calibration is not recommended for newly installed instruments.

By far the zero calibration is the most important calibration for the Platinum NanoTrace Oxygen Analyzer. From a stable zero calibration baseline, oxygen readings below 1 ppb can be made accurately. In many measurement cases, the accuracy of the oxygen reading will be determined by the quality of the zero calibration. It is important to check the zero periodically and make appropriate calibration adjustments.

From an initial start-up, the Analyzer may take 7 to 14 days to reach a stable zero. After achieving a stable zero baseline, the Analyzer will require periodic zero checks and possibly adjustments to ensure accuracy. For applications where the process is continuously monitored, the zero check frequency guidelines in the table below should be used.

Zero Check Frequency Guidelines

Typical Reading	or	Maximum O_2 Impurity	Zero Check Frequency
1.0 ppb and greater		10 ppb	Once every month
0.2 to 1.0 ppb		5 ppb	Twice per month
0 to 0.2 ppb		1 ppb	Once per week

Experience with a particular application will determine the optimum frequency of zero checking.

Accurate oxygen readings can be made even though the zero is not completely stabilized such as after a start-up or a high concentration oxygen exposure. Simply calculate the difference in concentration between the Analyzer output on zero gas and the sample gas. This comparison should be made over a short time span to avoid errors introduced by a stabilizing zero.

NOTE: If the Analyzer is used in a portable mode, the optional isolation valves should be used to preserve the stability of the zero calibration.

8.1.2 Storage Conditions

If the Analyzer is to be stored for extended periods of time, be sure that the temperature of storage location does not exceed 122°F (50°C). Storage in direct sunlight can cause temperatures to exceed the recommended limits even though ambient temperatures may be below the maximum temperature.

Store the Analyzer with the electrolyte removed from the sensor. Always disconnect the Auxiliary Electrodes Power Module during storage. See Section 8.1.4.2.

8.1.3 Sensor Maintenance

The Analyzer does not require routine maintenance other than water addition. Exposure to dry gas for an extended time will gradually extract water from the sensor. The water will need to be replenished occasionally.

CAUTION

If the electrolyte level is low, only distilled or deionized water needs to be added to the sensor. **Do not add electrolyte solution to restore the electrolyte level.** Do not overfill.

The Sensor Assembly consists of two connected chambers. The operation of the sensor will be satisfactory as long as the level of electrolyte is above the minimum indicator line on the reservoir label.

One bottle of electrolyte, DF-EO7 contains 100 cc. This quantity is sufficient for satisfactory operation. It is not necessary to add additional water.

Typically, bone dry sample gas can extract approximately 10 to 20 cc of water per month. The electrolyte level should be checked every 1 to 2 months. If water is needed, add water to bring the electrolyte level between the min and max indicator lines on the reservoir label. Operation with sample gases with very low dew points increases the frequency of replenishing water.

The Oxygen Analyzer is equipped with an Electrolyte Condition alarm to indicate that the electrolyte level is low. The operation of this alarm is described in Section 5.4.1.4.

To add water:

a. Open the front door.
b. Unscrew the grey sensor cover. Be careful of drips of electrolyte from the cover.
c. Slide the cover to one side (it will not fall off, nor can it be removed while the sensor is in the enclosure).
d. Add distilled or deionized water using the supplied squeeze bottle. Fill to the max level indicator line on the reservoir label. Be careful not to spill water on the electronics or on the outside of the sensor. Do not overfill.
e. Replace the cover securely.
f. Close the front door.

CAUTION

It is not necessary to turn off the instrument when replenishing water. However, care must be taken to avoid spills in the enclosure. Spills could cause damage to the electronics.

NOTE: When an Analyzer is operating at low ppb levels, adding water to replenish the electrolyte level may result in a temporary increase in the oxygen reading due to the presence of dissolved oxygen in the water and the introduction of oxygen due to agitation. More frequent water additions (using smaller quantities of water), and adding water with minimal disturbance to the electrolyte in the reservoir will minimize this effect.

If the electrolyte alarm reports while there is an adequate level of electrolyte in the sensor, the electrolyte may have been contaminated by exposure to incompatible gas components, see the Troubleshooting Guide, Section 8.1.6. The electrolyte should be drained. Flush the sensor with deionized water three times before refilling it with fresh electrolyte. **USE ONLY EO-7 Electrolyte.**

To drain the electrolyte (which is a proprietary solution of KOH), remove the sensor from the cabinet as described in Section 2.2. Remove the cap and invert the sensor over a suitable receptacle. Flush the sensor three times with deionized water. Dispose of the electrolyte and rinse water in accordance with Federal, State and Local regulations.

Refill the sensor with electrolyte as instructed in Section 2.2. If the alarm continues to report after returning the Analyzer to operation, contact the factory (617) 935-4600.

NOTE: Once the sensor has been charged with electrolyte, no further addition of electrolyte solution is required. The dissolved components in the electrolyte are neither consumed nor converted during operation, so only periodic replenishment with distilled or deionized water is necessary.

8.1.4 Auxiliary Electrode Power Module (AEPM)

NOTE: The NanoTrace can be ordered with a NiCad battery pack option for operation when AC power is not available. This section DOES NOT refer to the rechargeable NiCad battery pack.

8.1.4.1 AEPM Replacement Schedule

The sensor used in the Platinum Series NanoTrace Oxygen Analyzer is equipped with two sets of auxiliary electrodes which act to minimize background signal and improve long term sensor stability. These electrodes are energized by a replaceable battery pack (Auxiliary Electrode Power Module - Delta F Part Number NT-B52). Under normal conditions the pack will operate for at least 14 months.

To avoid the loss of performance associated with a discharged battery pack (e.g., gradual increase in ZERO reading) Delta F recommends that the pack be replaced every 12 months. Spare packs may be stored at 20°C for up to three years, with negligible loss of capacity.

8.1.4.2 Start-Up and Storage

CAUTION

Auxiliary Electrodes Power Modules are shipped disconnected to eliminate battery drain during shipment and storage. Connect the module after the sensor is charged with electrolyte and before the analyzer is placed into operation. If the instrument is to be stored, or shipped, the module should be disconnected.

Disconnect the module as follows:

1. Open the enclosure door. Locate the Auxiliary Electrode Power Module, Figure 1-2.
2. Unplug the 4-pin female connector on the module from its male connector.
3. It is not necessary to physically remove the module.

8.1.4.3 Testing the AEPM

Test the AEPM as indicated in the Troubleshooting Guide, Section 8.1.6, item C_2, C_3, D_1, and D_2.

CAUTION

Performing this test while the instrument is measuring low levels of oxygen will cause a spike in oxygen readings. If the analyzer has been set up with heavy filtering, several minutes of operation may be required for the oxygen reading to stabilize. Quicker stabilization can be accomplished by using the Average Filter reset. See Section 5.3.1.

8.1.4.4 AEPM Replacement

On analyzers that have been equipped with an optional NiCad battery pack, the installation and replacement procedure is similar to the procedure without the NiCad battery pack. The only difference is that the hook-and-loop strap secures both the NiCad battery pack and the AEPM. The AEPM is located in front of the NiCad battery pack. To replace the AEPM follow this procedure:

a. Open the enclosure door and set the main power switch to the OFF position, see Figure 1-2. Disconnect AC power to the Analyzer.
b. Examine the hook-and-loop strap that holds the AEPM in place. On early models the strap cannot be released without removal of the sensor. If the strap is accessible, skip to step 3. Otherwise, remove the sensor as described in Section 2.2, Electrolyte Maintenance.
c. Disconnect the 4-pin connector on the AEPM.
d. Release the hook-and-loop strap that holds the AEPM in place.
e. Remove the AEPM. See Power Module Disposal section below.
f. Install a new AEPM by reversing this procedure.
g. Reconnect AC Power to the analyzer and set the main power switch to the ON position.
h. Write the AEPM installation date on the label located on the inside of the door.

8.1.4.5 AEPM Disposal

A Material Safety Data Sheet, that covers the Lithium Cells used in the AEPM, is available upon request. Battery disposal regulations are in a state of change throughout the world. In the USA the Environmental Protection Agency does not appear to be regulating the disposal of of lithium batteries at this time (February, 1995). However, state and local regulations may apply. Please contact your local regulatory agency for instructions.

The battery manufacturer has provided the following suggestions:

1. To ensure safety prior to disposal it is recommended that the batteries not be crushed, short-circuited, or dismantled.
2. Lithium batteries must not be incinerated, since exposing the battery to high temperatures may induce cell venting and/or violent rupture.

8.1.5 Replaceable Spare Parts List

When Ordering spare parts, always include the analyzer's model and serial numbers. It is imperative that this information be provided in order to ensure that the correct parts are ordered.

Part Number	Part Description	Recommended Quantity
Printed Circuit Boards:		
10416640	PCB, Main	1
10413360	PCB, Display	1
10417240	PCB, Power Supply	1
10416660	PCB, Analog Output	1
10416140	PCB, Isolated 4-20 mA (Optional)	1
10413350	PCB, Backplane	1
10315210	PCB, NICAD Battery (Optional)	1
10216770	LCD Display Assembly	1
Cable Harnesses And Connectors:		
13317130	Cable, Sensor Harness (without Temp. Probe)	1
13314410	Cable, Display to Backplane, 26 pin ribbon	1
13215720	Cable, Battery PCB to Backplane	1
13217120	Cable, Auxiliary Power Module to Power Supply	1
59017300	Power Cord, 110 VAC	1
59036140	Power Cord, 220 VAC	1
50980707	Terminal Block, Plug-In I/O, 8 Pin	2
50980708	Terminal Block, Connector Key, per dozen	1
Optional Electrical/Electronic Assemblies:		
44912310	Module, RS-232 Interface	1
44912314	Module, RS-485 Interface	1
48100000	Relay, Alarm (SPDT, 5 Amp)	1
16315700	NICAD Battery Pack, Spare	1

Part Number	Part Description	Recommended Quantity
Hardware Items:		
65001000	Handle (Portable units only)	1
SNT0010	Sensor Cell	1
16217340	Orifice	4
83950001	Feet, Rubber	4
51300014	Switch, Low Flow (Optional)	1
64000003	Rotameter with Fittings	1
62000024	Valve, Downstream Sensor Isolation (Optional)	1
16016910	Cap, Sensor Tank	1
60002222	Fitting, Outlet Bulkhead, 1/8 Comp.	1
12415980	Inlet, Welded 1/4 VCR Male, Assembly	1
18416990	Bracket, Sensor Mounting	1
15313562	Keypad and Door Assembly	1
Optional Automated or Manual Calibration System:		
16217280	Purifier, Zero Gas, 1/4 VCR Male	1
69000003	Diaphragm, Pneumatic / Manual Diaphragm Valve	1
73200040	Elbow Fitting, Pneumatic, 1/8 NPT X 1/8 Barb	2
73200000	Tee Fitting, Pneumatic, 1/8 Barb	2
73000020	Tubing, Pneumatic, 1/8 OD (4' length)	1
Miscellaneous/Service Aids:		
DF-E07	Electrolyte Solution, 100 ml bottle	6
16317110	Auxiliary Electrodes Power Module	*
45002361	Fuse, Main, 110 VAC, 500 mA (5 X 20 mm)	5
45002301	Fuse, Main, 220 VAC, 250 mA (5 X 20 mm)	5
45002301	Fuse, Cal., 110 VAC, 250 mA (5 X 20 mm)	5
45002241	Fuse, Cal., 220 VAC, 125 mA (5 X 20 mm)	5
99000018	Instruction Manual	1
10217490	B-Size PCB Schematics Package	1
10315290	Single Width Extender Board	1
10315280	Double Width Extender Board	1

* Normal replacement item, changed once per year per analyzer.

Recommended quantity is for up to 12 instruments over 2 years covering nearly all contingencies of failure. Please consider the optional items on your Analyzer in order to select the applicable spare parts.

8.1.6 Troubleshooting

The following Troubleshooting Guide will help the user resolve many of the common operational situations that occur with the Analyzer. Investigate possible remedies in the listed order.

TROUBLESHOOTING GUIDE FOR THE PLATINUM NANOTRACE ANALYZER

	Observation	Possible Remedy (See Key below)
1.	Analyzer reads Over-Range	Y,C,Q,I
2.	Analyzer spikes excessively when moved using portable feature	B,K,I
3.	Analyzer output has unacceptable peak-to-peak noise	K,H,X,I
4.	Zero Offset gradually drifting positive	G,A,B,C,D,E,F,Q,H,I
5.	Zero Offset gradually drifting negative	P
6.	Zero Offset high, but stable (> 15 ppb above factory zero)	G,A,B,C,D,E,F,Q,H,I
7.	Very slow analyzer purge down (doesn't drop below 10 ppb in 7 days)	G,A,B,C,D,E,F,Q,H,I .
8.	Zero Offset drifting up and down (exclusive of temperature)	H,Q,I
9.	Repetitive negative spiking	J,X,Z,A,B,C,D,E,F,Q,H,I.
10.	Repetitive positive spiking	J,X,Z
11.	O_2 reading is drifting excessively with ambient temperature (> 0.3 ppb/C)	E,G,P,R,I
12.	Occasional positive oxygen excursions	M
13.	Electrolyte Condition Alarm "ON"	A,N,C,D,H,I
14.	O_2 reading does not decrease upon switch to on-board Delta F purifier (Assumes sample gas contains some O_2)	O
15.	Span reading is unacceptably high (> 50% high)	T,V,S,I
16.	Span reading is unacceptably low (> 50% low)	T,S,I,H
17.	Unacceptably Slow Speed of Response	L,G,H,I
18.	Analyzer reads a high ppm value while on zero gas	W

Key:

A - Add deionized water if level is near or below "MIN" mark
B - Remove some electrolyte if level is near or above "MAX" mark
C - Measure applied voltages on electrode pairs:

1. Sensor Electrodes	(wht/yel* and wht/red/blk)	1.300 ± 0.005 VDC
2. Secondary Electrodes	(wht/blue* and wht/red)	2.1 ± 0.3 VDC
3. Stablex Electrodes	(white* and blue)	1.55 ± 0.075 VDC

* is the common lead of the voltmeter.

D - Measure the DC currents on electrode pairs:
1. Secondary Electrodes 2.0 ± 0.2 mADC
(disconnect wht/red wire at reservoir terminal, and insert ammeter between wht/red wire and reservoir terminal)

2. Stablex Electrodes < 13 uADC
(disconnect white wire at reservoir terminal, and insert ammeter between white wire and reservoir terminal)

E - Check sensor temperature in Diagnostics Menu. It should be 4-6°C higher than current ambient temperature when the door is closed.
F - Replace the AEPM pack, if readings from C_2, C_3 and D_1, D_2 are out of range.
G - Perform the low flow leak test: Obtain stable oxygen readings at flow = 2.0 scfh and flow = 1.0 scfh. The reading at flow = 1.0 scfh should be no more than 2 ppb higher than that at 2.0 scfh. Locate and fix any ambient leaks upstream of the Analyzer.
H - Empty electrolyte, rinse sensor thoroughly with DEIONIZED water, and refill sensor with fresh electrolyte. Restart analyzer on zero gas and allow a minimum of 4 days for the Analyzer to purge down.
I - Contact the Delta F Customer Support Services Dept. for additional assistance with the results of the troubleshooting.

Phone # (617) 935-4600 Fax # (617) 932-0053

J - Adjust Filter Settings to Threshold ≥ 0.1. See Section 5.4.5.10.
K - Adjust Filter Settings to Weight ≥ 500, Threshold ≥ 0.1, Resp: Low Noise. See Section 5.4.5.10.
L - Adjust Filter Settings to Weight ≥ 50, Threshold ≥ 0.1, RESP: Faster. See Section 5.4.5.10.

M - Contact Delta F with your observation, you may require replacement of the upstream pressure regulator.
N - Make sure sensor cap is secure.
O - Check for purifier breakthrough. With the Delta F Corporation on-board purifier in-line, obtain stable oxygen readings at a flow rate of 2.0 scfh and at a flow rate of 0.5 scfh. The reading at 2.0 scfh should not be higher than the reading at 0.5 scfh. If it is, replace the purifier.
P - This is typical Analyzer behavior following a dry start-up. Perform a Manual or Auto (if applicable) Zero Calibration. See Sections 5.4.5.4 and 5.4.5.5
Q - Examine outside of sensor for evidence of electrolyte residue.
R - Quantify the drift effect with temperature changes (identify a ± correlation). Appropriately adjust the temperature compensation set point. See Section 5.6.3.
S - Make sure the span background gas is properly accounted for using the GSF in the menu. See Section 5.4.5.1.
T - Check the accuracy and age of the calibration reference cylinder.
V - Perform a low flow leak test while the span gas cylinder is connected. Obtain a stable reading at a flow rate of 2.0 scfh and at a flow rate of 0.5 scfh. Reading should be lower at 0.5 scfh. If not, investigate for leakage and fix.
W - Verify that the span valve is not mistakenly left open. This would result if there was a power shut-down while in span mode. In the Controls Menu switch the span relay ON for 10 seconds and then OFF. This action will shut off span valve. (only valid for the Automated Calibration Panel option)
X - Remove any devices being driven by the Analyzer output, i.e. chart recorders or Data Acquisition Systems. Also disconnect anything controlled by the Analyzer alarm relays. Verify proper operation with these devices removed.
Y - Verify that a flow rate of 2.0 scfh of zero gas has been established. Allow 10 minutes time after zero gas connection to come on scale.
Z - Assure that spiking is not due to EMI (i.e. radio communications).

8.2 Shipping

If it becomes necessary to ship the Analyzer to the factory or to another location, follow these instructions to prevent damage to the Analyzer during shipping.

CAUTION

DO NOT SHIP THE ANALYZER WITH ELECTROLYTE - THOROUGHLY DRAIN AND RINSE BEFORE SHIPPING

a. Turn off the power switch. Disconnect any source of AC power from the Analyzer.
b. Disconnect all external electrical connections (e.g. alarms, data output, etc.) Mark each for reattachment later.
c. Remove the sensor as described in Section 2.2. Be sure to protect the inlet fitting sealing surface by using the supplied green cap or a gasket retainer assembly.
d. Disconnect the Auxiliary Electrodes Power Module immediately after draining electrolyte.
e. Drain the electrolyte into a receptacle suitable for proper disposal.
f. Rinse the sensor with distilled or deionized water at least three times. Drain the water into the receptacle.
g. Securely hand tighten the cover.
h. Reinstall the sensor using the two sensor mounting screws.
i. Install the bulkhead lock nut. Cap the inlet fitting to prevent debris from entering.

When shipping use the original container if possible. Ensure that all internal components are adequately secured. Disconnect the Auxiliary Electrodes Power Module. It is recommended that bubble packing or similar protective material be added inside the enclosure for additional protection.

If you are returning the Analyzer contact Delta F at (617) 935-4600 to obtain a Return Material Authorization number. Clearly mark the Return Material Authorization number on the outside of the shipping container and on the packing list. The Analyzer should be returned (freight prepaid) to Delta F Corporation, 4 Constitution Way, Woburn, MA 01801-1087.

9.0 Safety

DANGER

Line voltage exists in the Oxygen Analyzer Enclosure. DO NOT REACH INTO THE ENCLOSURE when the Analyzer is connected to AC power.

CAUTION

Do not operate the Platinum Series NanoTrace Oxygen Analyzer at oxygen concentrations that are over-range for extended periods of time. Sensors may be damaged if exposed to high levels of oxygen, e.g. air, for long periods of time (>15 minutes) while on power.

If an exposure is unavoidable, turn-off power to the instrument, or deactivate the sensor polarization circuit (Section 5.3.4).

9.1 General Warnings

a. **The sensor must be drained and flushed prior to shipment.**
b. To reduce the risk of fire or electric shock, do not expose this equipment to rain or water spray.
c. Disconnect power before removing the Sensor Assembly.
d. Verify that the Analyzer power setting is consistent with the line voltage.
e. Over-pressurizing the Analyzer can result in permanent damage to the sensor.
f. Do not operate an Analyzer unless a sample gas is flowing through the sensor.
g. It is very important to use steel pan head 10-32 by 1/4" long screws to mount the regulator bracket. Longer screws will damage the backplane PCB.
h. The master password should be recorded in a secure location.
i. The GSF for the gas used to calibrate the system may be different from that used for analysis. If the GSF is changed to reflect the composition of the calibrating gas, be sure to reset the GSF before analyzing samples.
j. Do not edit the **New Sensor** entry without specific instructions from Delta F Corporation.
k. **USE ONLY EO-7 ELECTROLYTE**
l. **Do not** use the optional downstream isolation valve to control flow rate.

9.2 Electrolyte Material Safety Data Sheet (MSDS)

The information below is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes.

EMERGENCY CONTACT: 1-800-424-9300

To be used ONLY in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving this chemical.

SUBSTANCE IDENTIFICATION

SUBSTANCE:	Potassium Hydroxide Solution, 1N			
CAS NUMBER:	1310-58-3			
TRADE NAME:	DF-E07			
CHEMICAL FAMILY:	Inorganic Base			
MOLECULAR FORMULA:	Mixture			
CERCLA RATINGS (SCALE 0-3):	Health=3	Fire=0	Reactivity=1	Persistence=0
NFPA RATINGS (SCALE 0-4):	Health=3	Fire=0	Reactivity=1	

COMPONENTS AND CONTAMINANTS

COMPONENT:	Potassium Hydroxide	**PERCENT:**	5.0 - 6.0
COMPONENTS:	Water & Inorganic Salts	**PERCENT:**	94.0 - 95.0
OTHER CONTAMINANTS:	None		
EXPOSURE LIMITS:	Potassium Hydroxide:	2 mg/m^3 ACGIH Ceiling 2 mg/m^3 OSHA Ceiling	

PHYSICAL DATA

DESCRIPTION:	Colorless Liquid	**SPECIFIC GRAVITY:**	1.15
BOILING POINT:	104.5 °C	**SOLUBILITY IN WATER:**	Complete
MELTING POINT:	- 3.5 °C	**Vapor Pressure:**	16.1 mm Hg @ 20°C

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD:	Negligible fire and explosion hazard when exposed to heat or flame.
FLASH POINT:	Non-Combustible
FIRE FIGHTING MEDIA:	Dry chemical, carbon dioxide, water spray or foam (1987 Emergency Response Guidebook, Dot P 5800.4). For larger fires, use water spray, fog or standard foam (1987 Emergency Response Guidebook).
FIRE FIGHTING:	Move containers from fire area if possible. Cool containers exposed to flames with water from side until well after fire is out (1987 Emergency Response Guidebook, DOT P 5800.4, p.60). Extinguish using agents indicated; do not use water directly on material. If large amounts of combustible materials are involved, use water spray or fog in flooding amounts. Use water spray to absorb corrosive vapors. Cool containers with flooding amounts of water from as far a distance as possible. Avoid breathing corrosive vapors; keep upwind (Bureau of Explosives, Emergency Handling of Hazardous Materials in Surface Transportation, 1981).

TRANSPORTATION DATA

DOT Hazard Classification 49CFR172.101: Potassium Hydroxide Solution, Class 8, UN1814, Packing Group III

- Exceptions: When transported by Air 49CFR173.154 (b) (1) + (2)
- Exceptions: By Motor Vehicle or Rail Car 49CFR173.154 (d) (1)

IATA Hazard Classification 4.2: Potassium Hydroxide Solution, Class 8, UN1814, Packing Group III

- Exceptions: 2.8 (Ltd. Qty.)

TOXICITY

Potassium Hydroxide:
50 mg/24 hours skin-Human severe irritation;
50 mg/24 hours skin-Rabbit severe irritation;
50 mg/24 hours skin-Guinea Pig severe irritation;
1 mg/24 hours eye-Rabbit moderate irritation;
273/mg/Kg oral-Rat LD50;
Carcinogen status: None
Mutagenic data (RTECS).

Potassium Hydroxide Solution is a severe eye, mucous membrane, and skin irritant.

HEALTH EFFECTS & FIRST AID

Inhalation: Potassium Hydroxide: Corrosive.

Acute Exposure- Inhalation of dust or mist may cause symptoms of respiratory tract irritation, possibly including coughing, choking, and pain in the nose, mouth and throat, lesion of the nasal septum, and burns of the mucous membranes. If sufficient quantities are inhaled, pulmonary edema may develop, often with a latent period of 5-72 hours. The symptoms may include tightness in the chest, dyspnea, frothy sputum, cyanosis and dizziness. Physical findings may include weak rapid pulse, hypotension, hemoconcentration, and moist rales.

Chronic Exposure- Depending on the concentration and duration of exposure, repeated or prolonged exposure to corrosive substances may cause inflammatory and ulcerative changes in the mouth and possibly bronchial and gastrointestinal disturbances.

First Aid- Remove from exposure area to fresh air immediately. If breathing has stopped, give artificial respiration. Maintain airway and blood pressure and administer oxygen if available. Keep affected person warm and at rest. Treat symptomatically and supportively. Administration of oxygen should be performed by qualified personnel. Get medical attention immediately.

Skin Contact: Potassium Hydroxide: Corrosive.

Acute Exposure- Direct contact may cause severe pain, burns, and possibly brownish stains. The corroded areas are soft, gelatinous and necrotic, and the tissue destruction may be deep.

Chronic Exposure- Repeated or prolonged contact may cause dermatitis or effects similar to acute exposure. Frequent applications of aqueous solutions (3-6 percent) of Potassium Hydroxide to the skin of mice for 46 weeks produced tumors identical to those from coal tar; warts occurred first and then skin tumors developed.

First Aid- Remove contaminated clothing and shoes immediately. Wash affected area with soap or mild detergent and large amounts of water until no evidence of chemical remains (at least 15-20 minutes). In case of chemical burns, cover area with sterile, dry dressing. Bandage securely, but not too tightly. Get medical attention immediately.

Eye Contact: Potassium Hydroxide: Corrosive.

Acute Exposure- Direct contact with solid or solutions may cause pain and burns, possibly severe. The degree of injury depends on the concentration and duration of contact. There may be edema, destruction of epithelium, corneal opacification, and iritis. When damage is less than excessive, these symptoms tend to ameliorate. In severe burns, the full extent of the injury may not be immediately apparent. Late complications may include persistent edema, vascularization, and scarring of the cornea, permanent opacity, staphyloma, cataract and symblepharon.

Chronic Exposure- Effects depend on concentration and duration of exposure. Repeated for prolonged exposure to vapors and/or fumes may result in conjunctivitis or effects as in acute exposure.

First Aid- Wash eyes immediately with large amounts of water, occasionally lifting upper and lower lids, until no evidence of chemical remains (at least 15-20 minutes). Continue irrigating with normal saline until the pH has returned to normal (30-60 minutes). Cover with sterile bandages. Get medical attention immediately.

Ingestion: Potassium Hydroxide: Corrosive/Toxic.

Acute Exposure- Ingestion of 273 mg/Kg of Potassium Hydroxide was lethal to rats tested. Ingestion of strong alkalies may be followed by severe pain, vomiting, diarrhea, and collapse. The vomitus contains blood and desquamated mucosal lining. If death does not occur in the first 24 hours, the patient may improve for 2-4 days and then have a sudden onset of severe abdominal pain, board-like abdominal rigidity, and rapid fall of blood pressure indicating delayed gastric or esophageal perforation. Damage to esophagus and stomach after ingestion may progress for 2-3 weeks. Death from peritonitis may occur as late as 1 month after ingestion. Even though the patient recovers from the immediate damage, esophageal stricture may occur in weeks, months, or even years later to make swallowing difficult.

Chronic Exposure- The Food and Drug Administration lists Potassium Hydroxide as a direct food substance affirmed as generally recognized as safe at levels not to exceed current good manufacturing practices.

First Aid- Dilute the alkali by giving water or milk immediately and allow vomiting to occur. Avoid gastric lavage or emetics. Esophagoscopy is the only way to exclude the possibility of corrosion in the upper gastrointestinal tract; if corrosion is suspected, esophagoscopy should usually be performed within 24 hours (Dreisbach, Handbook of Poisoning, 11th Ed.). Maintain airway and treat shock. If vomiting occurs, keep head below hips to prevent aspiration. Get medical attention immediately.

Antidote: No specific antidote. Treat symptomatically and supportively.

REACTIVITY

Reactivity: Vigorous, exothermic reaction with water.

Incompatibilities: Potassium Hydroxide:

Acetic Acid:	Reacts violently
Acids:	Violent reaction
Acrolein:	Violent polymerization
Acrylonitrile:	Violent polymerization
Alcohols:	Dissolves exothermically
Aluminum:	Corrosive in the presence of moisture
Ammonium Hexachloroplatinate:	Formation of explosive product
Ammonium Salts:	Evolution of Ammonia gas
Benzoyl Chloride & Sodium Azide:	Violent exothermic reaction
P-BIS (1,2-Dibromoethyl) Benzene:	Highly exothermic reaction
Bromoform:	Violent exothermic reaction
Bromoform & Cyclic Polyethylene Oxides:	Possible explosive reaction
Calcium Carbide & Chlorine:	Formation of explosive Dichloroacetylene
Chlorine:	Explosive reaction
Chlorine Dioxide:	Explosion on contact
Chlorine & Hydrogen Peroxide:	Produces red luminescence during reaction.
Chlorine Trifluoride:	Ignition
Chloroform & Methanol:	Intense exothermic reaction
Cyclopentadiene:	Vigorous exothermic resin formation
1,2-Dichloroethylene:	Formation of explosive & spontaneously flammable Chloroacetylene
Germanium:	Incandescent reaction
Glass:	Slowly attacked
Hydrocarbons (Halogenated):	Violent reaction
Hyponitrous Acid:	Ignition reaction
Lead:	Corrosive in the presence of moisture
Magnesium:	Incandescent reaction
Maleic Anhydride:	Decomposes exothermically or explosively
Metals:	Corrosive reaction with formation of flammable Hydrogen gas
N-Methyl-N-Nitrosourea & Methylene Chloride:	Explosive reaction
Nitric Trichloride:	Explosive reaction
Nitroalkanes:	Formation of explosive salts.
Nitrobenzene & Methanol (Trace):	Violent, exothermic reaction
Nitroethane:	Formation of explosive salt
Nitrogen Trichloride:	Explosive reaction
Nitromethane:	Formation of explosive salt
O-Nitrophenol (Molten):	Reacts violently

Nitropropane:	Formation of explosive salt
N-Nitrosomethylurea & N-Butyl Ether:	Formation of explosive compound
Phosphorus:	Evolution of flammable Phosphine
Potassium Peroxodisulfate:	Ignition reaction
Potassium Persulfate & Water:	Exothermic reaction
Sugars:	Evolve Carbon Monoxide at or above 84°C
Tetrachloroethane:	Formation of flammable Chloroacetylene gas
2,2,3,3-Tetrafluoropropanol:	Exothermic reaction
Tetrahydrofuran (Peroxidised):	Possible explosive reaction
Thorium Dicarbide:	Incandescent reaction on heating
Tin:	Corrosive in the presence of moisture
Trichloroethylene:	Formation of Explosive Dichloroacetylene on heating
2,4,6-Trinitrotoluene & Methanol:	Formation of explosive product
Zinc:	Corrosive in the presence of moisture

Decomposition: Thermal decomposition products may include corrosive fumes of Potassium Oxide and toxic Oxides of Carbon.

Polymerization: Hazardous polymerization has not been reported to occur under normal temperatures and pressures.

STORAGE AND DISPOSAL

Observe all federal, state and local regulations when storing or disposing of this substance. For assistance, contact the district director of Environmental Protection Agency.

Storage: Store away form incompatible substances.

Disposal: Disposal must be in accordance with standards applicable to generators of hazardous waste, 40CFR 262. EPA Hazardous waste number D002.

CONDITIONS TO AVOID

May burn, but does not ignite readily. Flammable, poisonous gases may accumulate in tanks and hopper cars. May ignite combustibles (wood, paper, oil, etc.).

SPILL AND LEAK PROCEDURES

Soil Spill: Dig a holding area such as a pit, pond, or lagoon to contain spill and dike surface flow using barrier of soil, sandbags, foamed polyurethane or foamed concrete. Absorb liquid mass with fly ash or cement powder.

Add dilute acid to neutralize.

Air Spill: Apply water spray to knock down vapors. Knock-down water is corrosive and should be diked for containment.

Water Spill: Neutralize with dilute acid or removable strong acid.

Occupational Spill: Do not touch spilled material. Stop leak if you can do it without risk. For small spills, take up with sand or other absorbent material and place into containers for later disposal. For small dry spills, with clean shovel place material into clean, dry container and cover. Move containers from spill area. For larger spills, dike far ahead of spill for later disposal. Keep unnecessary people away. Isolate hazard area and deny entry.

PROTECTIVE EQUIPMENT

Ventilation: Provide local exhaust or process enclosure ventilation to meet published exposure limits.

Respirator: The following respirators are recommended based on information found in the physical data, toxicity and health effects sections. They are ranked in order from minimum to maximum respiratory protection.

Specific respirator selected must be based on contamination levels found in the work place, must not exceed the working limits of the respirator and be jointly approved by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration (NIOSH - MSHA).

Chemical cartridge respirator with full face piece.

Type "C" supplied air respirator with full face piece operated in pressure-demand or other positive pressure mode or with a full face piece, helmet, or hood operated in continuous flow mode.

Self-contained breathing apparatus with full face piece operated in pressure-demand or other positive pressure mode.

Fire fighting and other immediately-dangerous-to-life-and-health conditions:

Self-contained breathing apparatus with a full face piece operated in pressure-demand or other positive pressure mode.

Supplied-air respirator with full face piece and operated in pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.

Clothing: Employee must wear appropriate protective clothing and equipment to prevent any possibility of skin contact with this substance.

Gloves: Employee must wear appropriate protective gloves to prevent contact with this substance.

Eye Protection: Employee must wear splash-proof or dust-resistant safety goggles and a face shield to prevent contact with this substance.

Where there is any possibility that an employee's eyes and/or skin may be exposed to this substance, the employer shall provide an eye-wash fountain and quick drench shower within the immediate work area for emergency use.

Authorized - Delta F Corporation
4 Constitution Way
Woburn, MA 01801-1087
Tel: (617) 935-4600
Fax: (617) 938-0531

Creation Date: 08/30/90

Revision Date: 6/14/95

9.3 Material Safety Data Sheet (MSDS) for Gas Purifier Packing

The Material Safety Data Sheet for the Gas Purifier Packing is available upon request.

9.4 Material Safety Data Sheet (MSDS) for Lithium Thionyl Chloride Battery

The Material Safety Data Sheet for the Lithium Thionyl Chloride Battery is available upon request.

10.0 Specifications

Sensitivity: (Lowest Detection Level)
<0.2 ppb @ Constant Conditions

Resolution: (Smallest Detectable Change)
<0.1 ppb (Analytical)
0.1 ppb (Display)

Calibrated Accuracy:
±3% of reading or ±0.5 ppb (whichever is greater) @ Constant Conditions

Response Time:
Typically less than 20 seconds to read 90% of a step change. The equilibrium time is dependant on specific conditions.

Upset Recovery Time:
Typically less than 15 minutes from a high ppm upset to within 10 ppb of the previous stable reading.

Ambient Operating Temperature:
32°F. to 110°F. (0° C. to 45°C.)

Output Range:
0-10 ppm (max)
0-20 ppb (min)

Operating Pressure:
15 to 20 psig (1.04 to 1.38 bar) - Analyzer (Regulated by critical orifice)
0.2 to 1.0 psig (0.014 to 0.069 bar) - Sensor (with orifice removed)

Return Pressure:
Maximum ±3.0 psig (atmospheric vent recommended)

Flow Rate:
1.0 to 3.0 scfh (0.5 to 1.5 slpm)

Sample Temperature:
32°F to 122°F (0°C to 50°C)

Moisture:
No limits (avoid condensation)

Background Gas Compatibility:
All inert and passive gases including N_2, H_2, He, Ar, etc.

Storage Temperature:
Not to exceed 122°F (50°C)

Gas Flow Construction Materials:
300 series stainless steel
1/4" VCR®-type compatible inlet fitting
1/8" compression outlet fitting
orbital butt welded sample inlet assembly

Calibration System Components:
(Optional) Pneumatically or manually actuated springless diaphragm valve calibration system to provide zero and span calibrations. Orbital butt welded assembly with 1/4" VCR®-type connections.

Sensor Warranty:
Five years, limited. See Section 11.

Power Requirements:
100-120 VAC, 50/60 Hz, standard, approximately 35 Watts;
200-240 VAC, 50/60 Hz (optional), approximately 35 Watts;
NiCad battery supplemental power (optional).

Display:
2.5" by 3.75" Super twist LCD graphics

Output Signals:

Analog Output:	Menu scalable from 0-20 ppb to 0-10 ppm. Non-isolated 4-20 mADC (1K maximum loop resistance, with built in 28 VDC loop supply), 0-100 mVDC, 0-1, 0-5 VDC, or 0-10 VDC (standard - minimum load resistance is 1K). Isolated 4-20 mADC (optional - 550 Ohm maximum loop resistance, with built in 15 VDC loop supply).
Digital Output:	Two way RS232 (optional), or two way RS485 (optional).

Calibration Control:

Calibration-in-Process indication (requires an optional relay). Switched AC power for menu driven control of external, user-provided, zero/span solenoids and valves. Two lines at 115 (or 230) VAC, 1 amp each (optional.)

EMI Sensitivity:

SAMA standard PMC 33.1, Class 3A, B for EMI susceptibility.

Audible/Visual Alarm Status Indicators:

Four oxygen, one temperature, and one electrolyte condition alarm (standard)
One low flow alarm (optional)

Alarm Relays:

Up to four non-latching, independently assignable to alarms or to calibration-in-process indicator. SPDT contacts rated at 5 amps, 250 VAC; 30 VDC under resistive load. Fail safe action upon loss of power to alarm condition.

Construction:

NEMA 1.

Dimensions:

12.2" wide x 8.9" high x 10.2" deep approximate (with handle and gas fittings)

Weight:

18 lbs (approximate); with optional automated calibration system: 40 lbs (approximate).

11.0 Warranty

Delta F warrants each instrument manufactured by them to be free from defects in material and workmanship at the F.O.B. point specified in the order, its liability under this warranty being limited to repairing or replacing, at the Seller's option, items which are returned to it prepaid within one year from delivery to the carrier and found, to the Seller's satisfaction, to have been so defective.

Delta F's five (5) year Sensor Warranty offers extended protection such that, if any Sensor of a Delta F Oxygen Analyzer fails under normal use, within four (4) years after the expiration of the one-year warranty, such Sensor may be returned to the Seller and, if such Sensor is determined by the Seller to be defective, the Seller shall provide the Buyer a repaired or replacement Sensor at the then current purchase price, equal to such current price multiplied by a fraction thereof in which the numerator is the number of months from the date of shipment by the Seller of the defective Sensor to the time it is received back at Delta F Corporation and the denominator of which is sixty (60).

In no event shall the Seller be liable for consequential damages. NO PRODUCT IS WARRANTED AS BEING FIT FOR A PARTICULAR PURPOSE AND THERE IS NO WARRANTY OF MERCHANTABILITY. Additionally, this warranty applies only if: (i) the items are used solely under the operating conditions and in the manner recommended in the Seller's instruction manual, specifications, or other literature; (ii) the items have not been misused or abused in any manner or repairs attempted thereon; (iii) written notice of the failure within the warranty period is forwarded to the Seller and the directions received for properly identifying items returned under warranty are followed; and (iv) with return, notice authorizes the Seller to examine and disassemble returned products to the extent the Seller deems necessary to ascertain the cause of failure. The warranties stated herein are exclusive. THERE ARE NO OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED, BEYOND THOSE SET FORTH HEREIN, and the Seller does not assume any other obligation or liability in connection with the sale or use of said products.