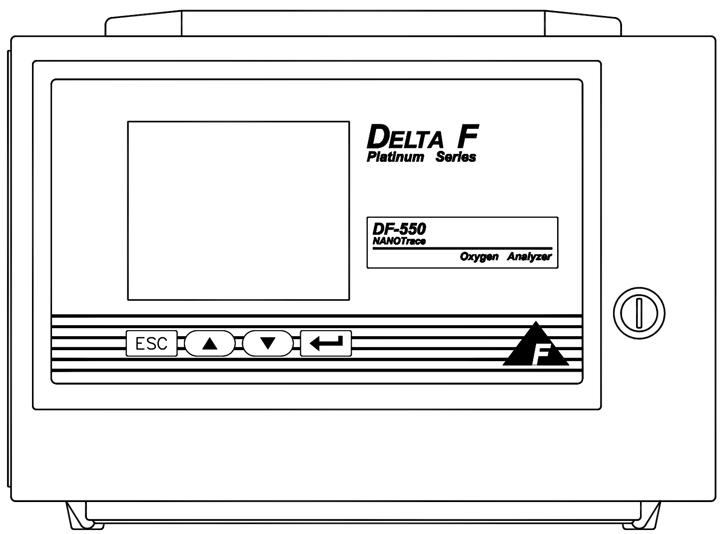
NanoTrace Oxygen Analyzer

PNT

Model DF-550



Instruction Manual

Firmware Version 20.03

DELTA F CORPORATION
4 Constitution Way, Woburn, MA 01801-1087
Telephone: (781) 935-4600 FAX: (781) 938-0531

99000042
092805

The Delta F Difference

Your NanoTrace Oxygen Analyzer has been designed, manufactured and is supported under ISO-9001 controls, thus helping to insure the highest possible standards of quality.

Every analyzer that Delta F manufactures is tested and operated on a variety of gas concentrations to insure that it functions properly when you receive it.

The certificate of calibration assures your analyzer has been calibrated on gases that are traceable to NIST standards. With proper maintenance, your analyzer should remain calibrated for years.

For a fast and successful startup, please read this manual carefully. There are important cautions and a number of helpful hints to help you to optimize the operation of your analyzer.

If you have questions, please do not hesitate to call the Delta F Service Line at (781) 935-5808, use our Service FAX Line at (781) 932-0053 or e-mail us at service@delta-f.com.

Read Me First…

Unpacking Procedure

Follow the procedure below to unpack your NanoTrace Oxygen Analyzer

1. Examine the condition of the packaging and its contents. If any damage is apparent, immediately notify the carrier and Delta F. Do not proceed with the installation.
2. Check the contents against the packing slip to make sure the shipment is complete. Unattached equipment may be shipped with the analyzer in supplemental packaging. Shortages should be reported to Delta F immediately.
3. All NanoTrace analyzers are shipped with the following:

Item	Delta F Part Number
Two bottles of EO-7 Electrolyte Bottle for water addition	P/N DF-E07 P/N 67002401
Power cord with 115 VAC connector NOTE: No power cord is supplied with 220 VAC units	P/N 59017237
Instruction Manual	P/N 99000042

4. Open the analyzer door, remove any shipping materials and verify that nothing has come loose during transit.
5. The analyzer is set at the factory to operate on 115 VAC or 220 VAC. Examine the voltage indicator on the rear panel to verify that the voltage is set as ordered.
6. <u>Save</u> the original container in the event you may need to ship the analyzer to another location or back to the factory (see Shipping in the Service section).

Installation and Maintenance

The NanoTrace Analyzer provides years of accurate and dependable service if it is set up, operated and maintained properly. It is essential to make a careful and complete installation as outlined in the *Installation and Setup* section of this manual. It is assumed that NanoTrace users are familiar with the techniques and precautions associated with Ultra-High Purity (UHP) gas, its plumbing, and devices such as UHP regulators and gas purifiers, and that the analyzer is used as designed and intended.

Unlike much UHP analytical equipment, NanoTrace does not require constant maintenance. However the maintenance intervals for zero and span calibrations, as well as water additions and purifier maintenance, must be determined and followed carefully.

Thank You

Thank you for selecting the NanoTrace Analyzer. Delta F designs, manufactures, exhaustively tests, and supports every analyzer under ISO-9001 control. You should expect every Delta F analyzer to arrive in perfect working order and, with good maintenance, provide years of trouble-free service. Please call our Service Phone Line at (781) 935-5808 if you need assistance or if you have suggestions, or use our Service Fax Line at (781) 932-0053 or e-mail us at Service@Delta-F.com.

1 Table of Contents

1.1 Table of Figures

1.2 Table of Tables

2 Cautions

There are a number of warnings and cautions that must be observed to avoid damage to the analyzer as well to insure the safety of its users. The analyzer must be operated in a manner specified in this manual. Delta F cannot be responsible for direct or consequential damages that result from installing or operating the analyzer in a manner not described in this manual. Importantly, the analyzer has been designed for use with inert, non-toxic, non-combustible sample gases only. Delta F cannot be responsible for direct or consequential damages that result from using the analyzer with these gases.

2.1 Symbols and Explanations

Following is a list of the various symbols used throughout this manual and their definitions.

CAUTION

This symbol alerts the user to the presence of physically hazardous conditions that may be dangerous to individuals or equipment.

NOTE

This symbol alerts the user to the presence of important operations and/or maintenance information.

DANGER

This symbol alerts the user to the presence of caustic liquid. Refer to the MSDS at the back of the manual for handling instructions.

2.2 Important Warnings

CAUTION

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 setup or operate the Oxygen Analyzer without a complete understanding of the instructions in this manual. Do not connect this Analyzer to a power source until all signal and plumbing connections are made.

CAUTION

This analyzer must be operated in a manner consistent with its intended use and as specified in this manual.

DANGER

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

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

CAUTION

Over-pressurizing the sensor can result in permanent damage to the sensor. Limit the backpressure to the analyzer to ±1 psig.

Be sure the downstream isolation valve (if so equipped) is toggled open ***before*** *gas flow is started.*

CAUTION

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

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:

- Reorient the receiving antenna.
- Move the instrument with respect to the receiver.
- Place the analyzer and receiver on different AC circuits.

3 Specifications

Range of Operation: 0-10ppm

Lowest Detection Level (LDL): 0.2 ppb @ Constant Conditions

Resolution (Smallest Detectable Change): 0.1 ppb

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

Response Time: Typically less than 20 seconds to read 90 percent of a step change. The equilibrium time is dependent 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: 0° C to 45° C (32° F to 110° F)

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

Operating Inlet Pressure: 15 to 20 psig (1.04 to 1.38 bar)

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: 0° C to 50°C (32° F to 122° F)

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 50° C (122° F)

Gas Flow Construction Materials:

300 series stainless steel

1/4-inch VCR-type compatible inlet fitting

1/8-inch 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 one quarter inch VCR-type connections.

Sensor Warranty: 5 years, See *Warranty* section on page 115.

Power Requirements:

100 to 120 VAC, 50/60 Hz, standard, 35 Watts

200 to 240 VAC, 50/60 Hz (optional), 35 Watts

NiCad battery supplemental power (optional)

Display: 2.5-inch by 3.75-inch super twist LCD graphics with backlighting

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),
	Isolated 4-20mADC output (Optional)
	0-1VDC, 0-2 VDC, 0-5 VDC, or 0-10 VDC (standard - minimum load resistance is 1K)
Digital Output:	Two-way RS-232 (optional), or 2-way RS-485 (optional)

Calibration Control: Calibration-in-Process indication (requires an optional relay). Switched 6 VDC @ 0.25A for menu driven control of external, user-provided, zero/span solenoids and valves.

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:

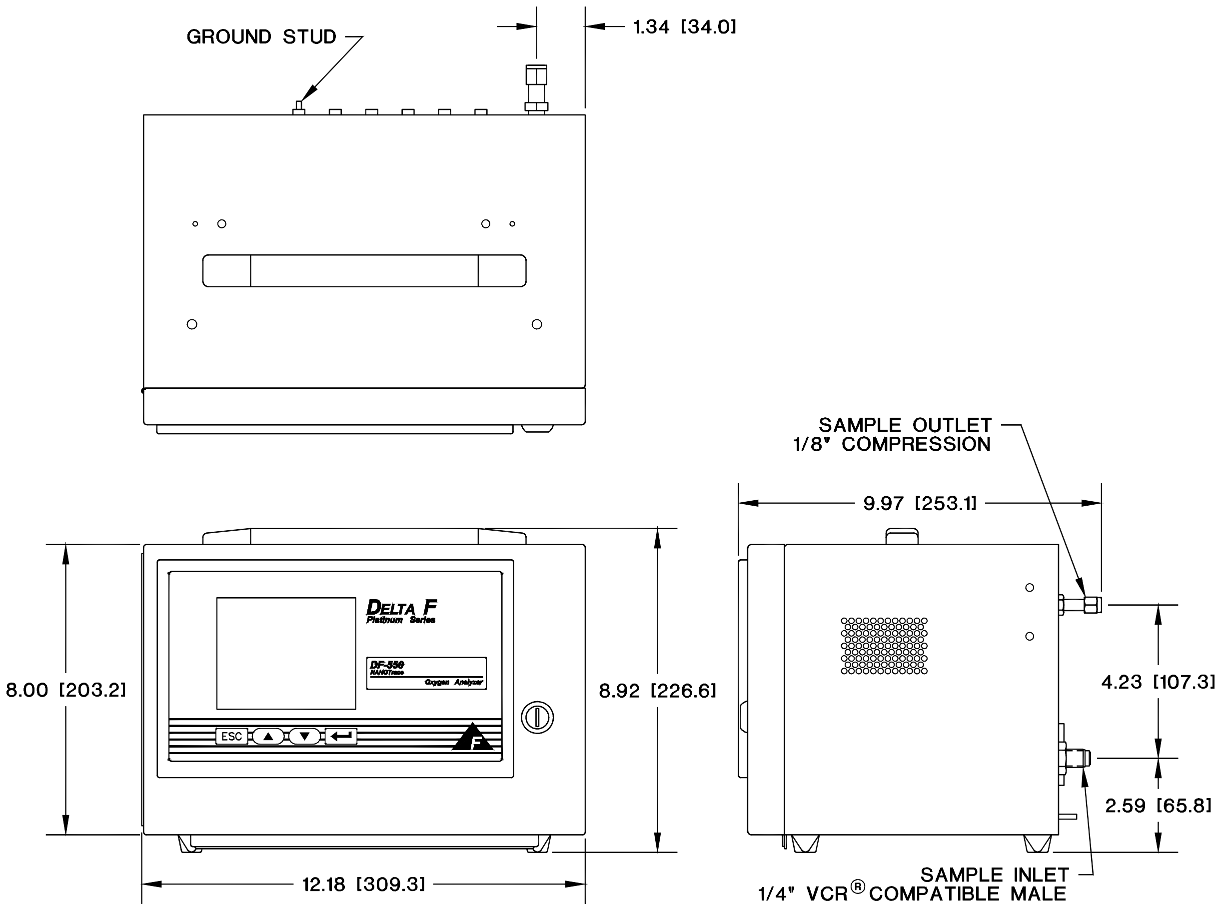
Up to 4, non-latching, independently assignable to alarms or to calibration-in-process indicators. SPDT contacts rated at 30 VDC @ 5A resistive load. (Do Not Switch AC Power) Fail safe action upon loss of power to alarm condition.

Construction: NEMA 1

Dimensions: 12.2-inch (30.9cm) wide x 8.9-inch (22.7 cm) high x 10.0-inch (25.4 cm) deep approximate (with handle and gas fittings)

Weight: 18 pounds (8.2 kg) (approximate)

- with optional manual calibration system add 2 pounds (.9 kg)
- with optional automated calibration system add 4 pounds (1.8 kg)



<u>Figure 1: PNT Oxygen Analyzer</u>

4 Installation and Setup

This procedure describes installation of the analyzer without options and with the voltage output set to 0-10 VDC. Options may affect the setup procedure described in this section. If your analyzer is equipped with options, refer to the appropriate section to determine changes to the setup.

NOTE

The screens shown in this manual have values that may not match the actual values displayed during your setup.

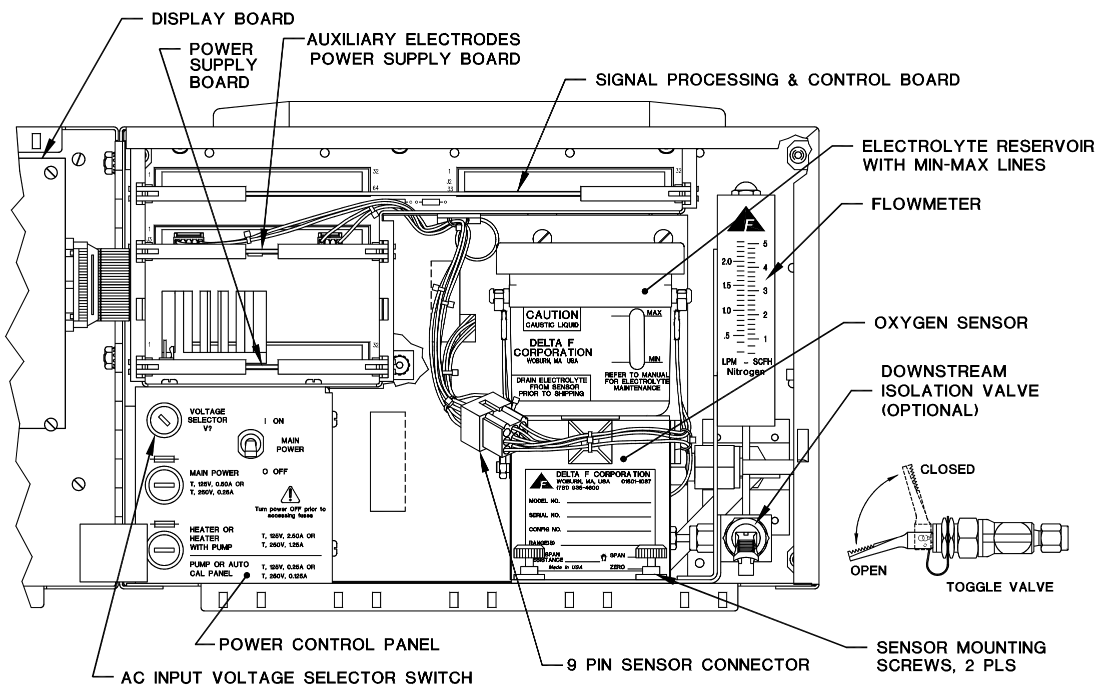


Figure 2: Major Internal Components

4.1 Adding Electrolyte

DANGER

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

NOTE

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

NOTE

*Use only Electrolyte DF-EO7 for the Platinum Series NanoTrace Oxygen Analyzer. (gray sensor cap) Failure to do so will void warranty. **DO NOT** use DF-EO5 electrolyte. NanoTrace units must use DF-EO7 electrolyte or damage will result. Install one bottle.*

NOTE

Do not apply power before adding electrolyte and thoroughly purging sample line.

4.1.1 Adding Electrolyte Procedure

Follow this procedure to add electrolyte:

1. Remove the 13/16-inch inlet bulkhead retainer nut and washer from the inlet bulkhead fitting at the back of the analyzer. Do not remove the four small socket screws.

NOTE

Always place a plastic protective cap (supplied) over the inlet fitting 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.

2. Inside the enclosure, disconnect the 9-pin sensor connector located near the front of the sensor.
3. Unscrew both sensor-mounting screws at the front of the sensor-mounting bracket.
4. Pull the sensor assembly forward a few inches.
5. Disconnect the "quick-disconnect" fitting at the top of the flowmeter (for standard downstream sensor configuration) by pushing both halves of the fitting together and rotating one to the release position. See Figure 3.

For systems equipped with the Stainless Steel Outlet Line Tubing Option that is hard plumbed to the back of the unit, disconnect using a wrench on the retaining nut.

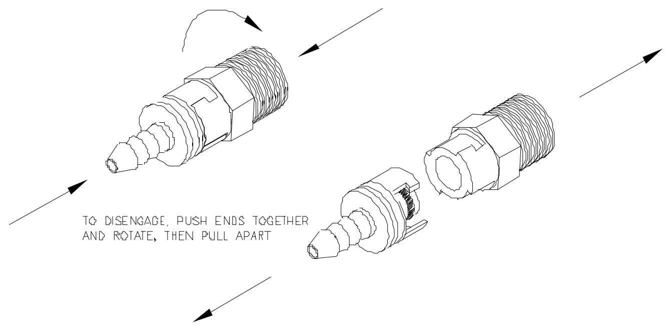


Figure 3: Quick Disconnect Fitting at Flowmeter

6. Remove the sensor assembly from the instrument.
7. Unscrew the cap from the electrolyte reservoir and add the entire contents of one bottle of electrolyte (DF-EO7) to the sensor. Replace the cap and hand-tighten securely.
8. Reinstall the sensor by repeating steps 1 through 6 in 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 properly seat in the slot of the anti-torque plate before replacing the 13/16-inch retainer nut and washer.

4.2 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-inch 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 anti-torque plates inside the cabinet secure the bulkhead fittings. Do not over-tighten the fittings.

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 is greatly reduced if the supply gas is over 0.5 ppm. If a bottled gas must be used, obtain a cylinder with $O_2 < 1$ ppm.

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 standard cubic feet per hour (scfh) at an inlet pressure of 15 pounds per square inch, gauge (psig). This flow rate to the instrument applies when the analyzer outlet is vented to atmosphere. All *NanoTrace* Analyzers are designed to operate at approximately 15 psig sample inlet gas pressure. If the line pressure exceeds 15 psig, install a high integrity pressure regulator on the sample gas inlet.

If the analyzer outlet is at atmospheric pressure, a regulator can be used to set the flow rate to 2.0 standard cubic feet per hour (scfh) without danger of over-pressurizing the sensor. The back-pressure on the instrument should not exceed ±1.0 psig.

If your installation requires long (> 4 feet) tubing runs (or has many bends or fittings) downstream of the analyzer, the resulting back-pressure may impose a pressure at the sensor that exceeds specifications. If this is the case, use larger outlet tubing (1/4-inch) and/or reduce the complexity of the outlet gas line.

NOTE

Over-pressurizing the sensor can result in permanent damage to the sensor. Limit the backpressure to the analyzer to ±1 psig.

Be sure the downstream isolation valve (if so equipped) is toggled open ***before*** *gas flow is started.*

NOTE

Allow gas with very little oxygen (<100 ppb) to flow through the analyzer for approximately 30 minutes before powering up.

4.3 Electrical Connections

Make sure the power switch in the analyzer is in the OFF position. Plug the supplied line cord into the receptacle at the back of the analyzer. Verify the operating voltage is proper and connect the line cord to the power source.

4.4 Powering Up

Turn on the power using the main power switch inside the analyzer. The unit undergoes a series of Diagnostic Procedures. After approximately 5 seconds, the Delta F Corporation logo is displayed. After 30 seconds, a TEMP CAL message appears for 1.5 minutes. A display appears that is similar to Figure 4 (values shown are only representative).

It should take less than 5 minutes for the analyzer to come on scale (<100 ppm). The concentration of oxygen is shown in parts per million (ppm) or parts per billion (ppb).

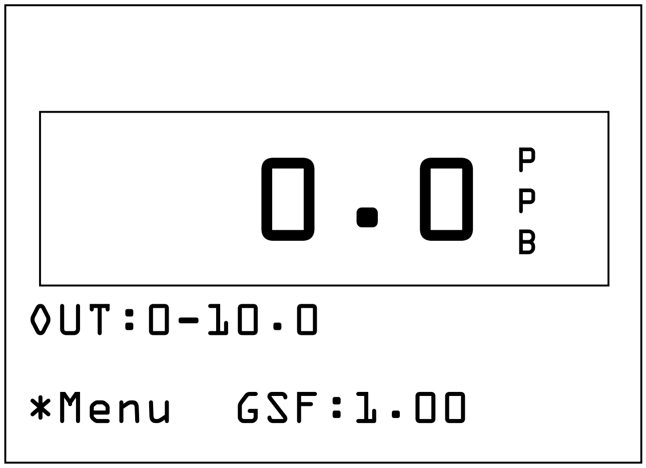


Figure 4: Data Display

4.5 Calibration Systems

The proper operation of the analyzer depends upon the reliable establishment of the zero baseline. The analyzer can be equipped with either a Manual or Automatic Calibration option to provide span and zero calibration. Both options include a gas purifier that can be switched into the sample gas path to provide a zero gas for setting zero. The Auto Calibration System also accommodates a span gas input to set the analyzer span.

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

NOTE

Zero gas is a sample gas that has been purified of all detectable oxygen by using a purifier in the sample line located as close to the analyzer as possible. The NanoTrace uses this gas to calibrate the zero baseline of the sensor with the electronics. Both Delta F calibration systems, automated or manual, create their own zero gas (<.1 ppb O2) for this purpose by purifying a sample gas of less than 100 ppb oxygen.

NOTE

Sample gas is the gas with unknown oxygen concentration that is to be measured. It may be a process gas or environment.

NOTE

Span gas is gas with a known concentration of oxygen. The NanoTrace uses the Span Gas, along with the Zero Gas to calibrate the sensor and electronics. The NanoTrace comes pre-calibrated to NIST traceable standards and as a result can be used to determine the concentration of user supplied span gases for future reference.

4.5.1 Gas Connections

Connect the process gas to the male VCR-type gas connection on the Calibration System. Check that the downstream shut-off valve, if equipped, is fully opened, and that all calibration system valves are closed. See Figure 4: Data Display. Once this is verified, open the sample valve on the calibration system. While observing the flow meter inside the *NanoTrace* enclosure, gradually bring the flow rate to the required setting.

The flow rate is set by adjusting the upstream gas pressure 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.

NOTE

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 (2 scfh) for proper operation.

For gas pressures below 20 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 toggle 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

Allow a low ppb oxygen sample gas to purge the analyzer for at least 30 minutes before turning the power on. After purging, turn the power on to the analyzer. The analyzer should come on scale within 5 minutes.

The analyzer requires 2 to 3 days of operating on zero gas to make readings at low ppb of oxygen. Once the rate of descent of the O_2 level is < 1 ppb/day, the zero on the analyzer can be set using the “Chk Adj Zero” screen and accurate low ppb readings can be made.

NOTE

Gradually over 1 to 2 weeks, the sensor cleans the last traces of residual O_2 from the electrolyte. At this point, the zero needs to be reset, or the factory calibrated zero value can be restored..

4.5.2 Manual Calibration System Setup

The Manual Calibration System is designed to offer maximum portability in a small package. shows an outline of the Platinum *NanoTrace* Oxygen Analyzer with the Manual Calibration System installed. Details on the operation of the manual calibration system can be found in the *User Interface* section.

An optional sample gas pressure regulator can be installed in the manual calibration system as illustrated in Figure 5.

The label on the rear side of the manual calibration panel shows how the valves can be positioned to direct sample gas through the purifier to provide a zero reference gas. This panel can be combined with an optional downstream shut-off valve located inside the enclosure to isolate the sensor from ambient air during transport.

NOTE

Make sure the downstream isolation valve (if equipped) in the analyzer enclosure is open before connecting the analyzer to span or sample gas.

NOTE

The analyzer requires 2 to 3 days of operating on zero gas to make readings in the low ppb area. Once the rate of oxygen reading descent is <1 ppb per day, the analyzer zero can be set using the "Check/Adjust Zero" function on the (Chk Adj Zero) screen. Gradually, after 1 to 2 weeks, the sensor cleans the last traces of residual oxygen form the electrolyte. At this point, the zero needs to be reset, or the factory calibrated zero can be restored.

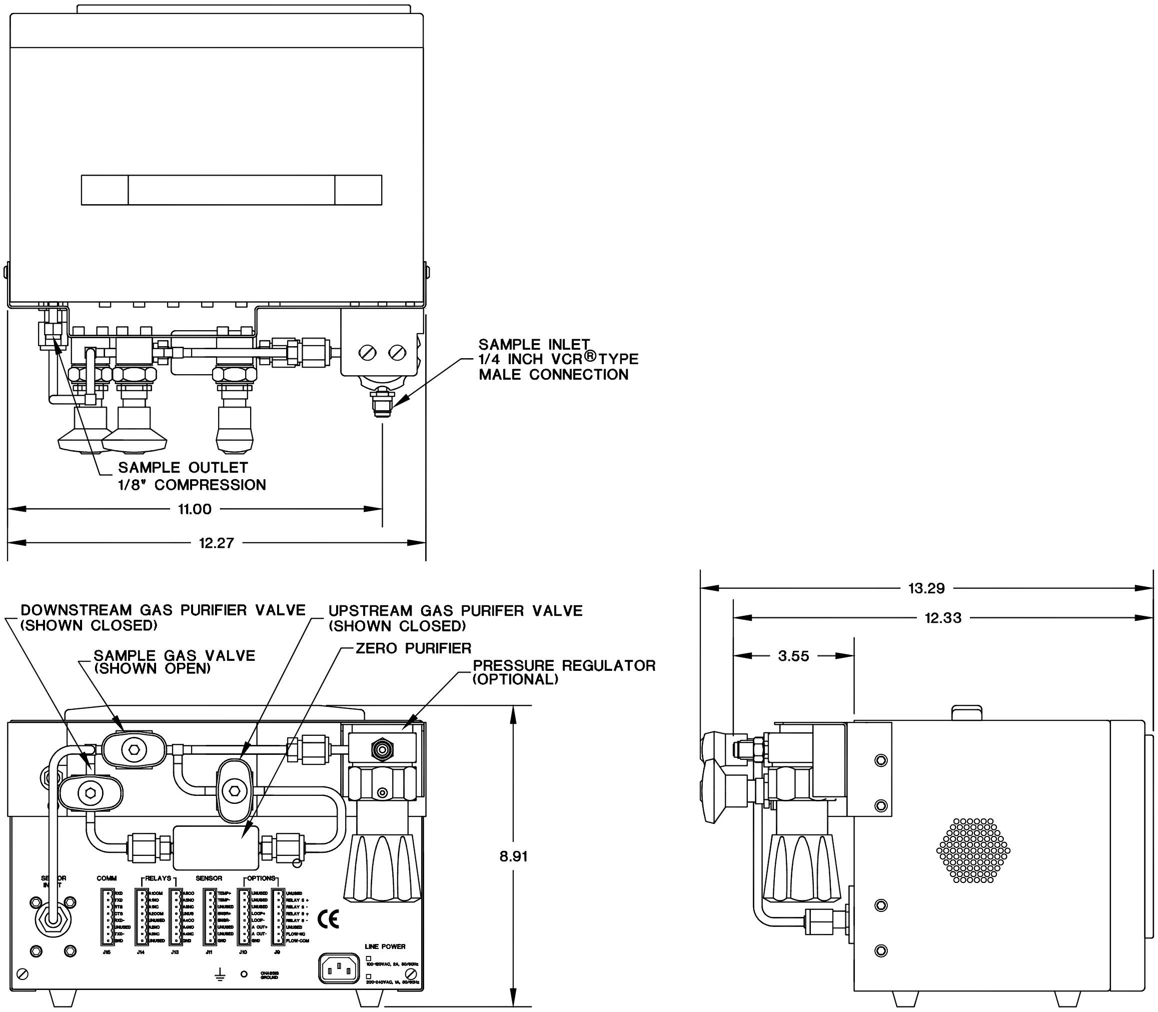


Figure 5: Outline of NanoTrace Oxygen Analyzer with Manual Calibration System

4.5.2.1 Use of the Manual Calibration System

First-time analyzer operation usually includes a zero verification but does not require a span calibration. A zero check is performed by redirecting the sample gas through the gas purifier. Open both gas purifier valves and then close the sample gas valve.

Before attempting a zero calibration, leak check the sample system after thoroughly purging it by observing the oxygen readout at two flow rates: 1.0 and 2.0 scfh (flow can be adjusted by using a pressure regulator or upstream flow control valve.) If leakage in the plumbing system exists, the decreased flow results in a substantial increase in oxygen readout (>10 ppb.) Fix all leaks before proceeding.

NOTE

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

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.

4.5.3 Automatic Calibration System Setup

The Automated Calibration System has two separate ¼-inch 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 are shown.

Under deenergized 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.

Filtered, dried plant air or nitrogen (recommended) at 70 to 100 psig is required for the pneumatic gas supply. The pneumatic gas line is connected at a 1/8-inch compression fitting shown.

The Automatic Calibration System enables user initiated zero and span calibrations to occur automatically. Zero calibration is accomplished when the analyzer activates a set of pneumatically actuated valves, (70 to 100 psig pneumatic service is required), to direct the sample gas through the built in purifier to provide a zero reference gas. Span calibration is achieved when the analyzer switches the analyzer inlet from sample gas to a user provided span gas.

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 2 minutes.

To perform an automated calibration, review and follow the procedures in *the Automated Calibration System Setup* section 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 Valves OFF**) and zero gas (**Zero Valves 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.

NOTE

Make sure the downstream isolation valve (if equipped) in the analyzer enclosure is open before connecting the analyzer to span or sample gas.

NOTE

The analyzer requires 2--3 days of operating on zero gas to make readings in the low ppb area. Once the rate of oxygen reading descent is <1 ppb per day, the analyzer zero can be set using the "Check/Adjust Zero" function on the (Chk Adj Zero) screen. Gradually, after 1--2 weeks, the sensor cleans the last traces of residual oxygen from the electrolyte. At this point, the zero needs to be reset, or the factory calibrated zero can be restored.

NOTE

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.

4.5.4 Automated Control of 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 6 VDC .25A signals are provided. As an aid in the design of the required calibration system, the system logic and diagram of the Delta F automatic calibration system are shown below. The construction of such a system must be of the highest quality, located as close as possible to the analyzer and must be free from dead legs and excessive runs or the software dwells and sequencing will not be adequate for a successful calibration.

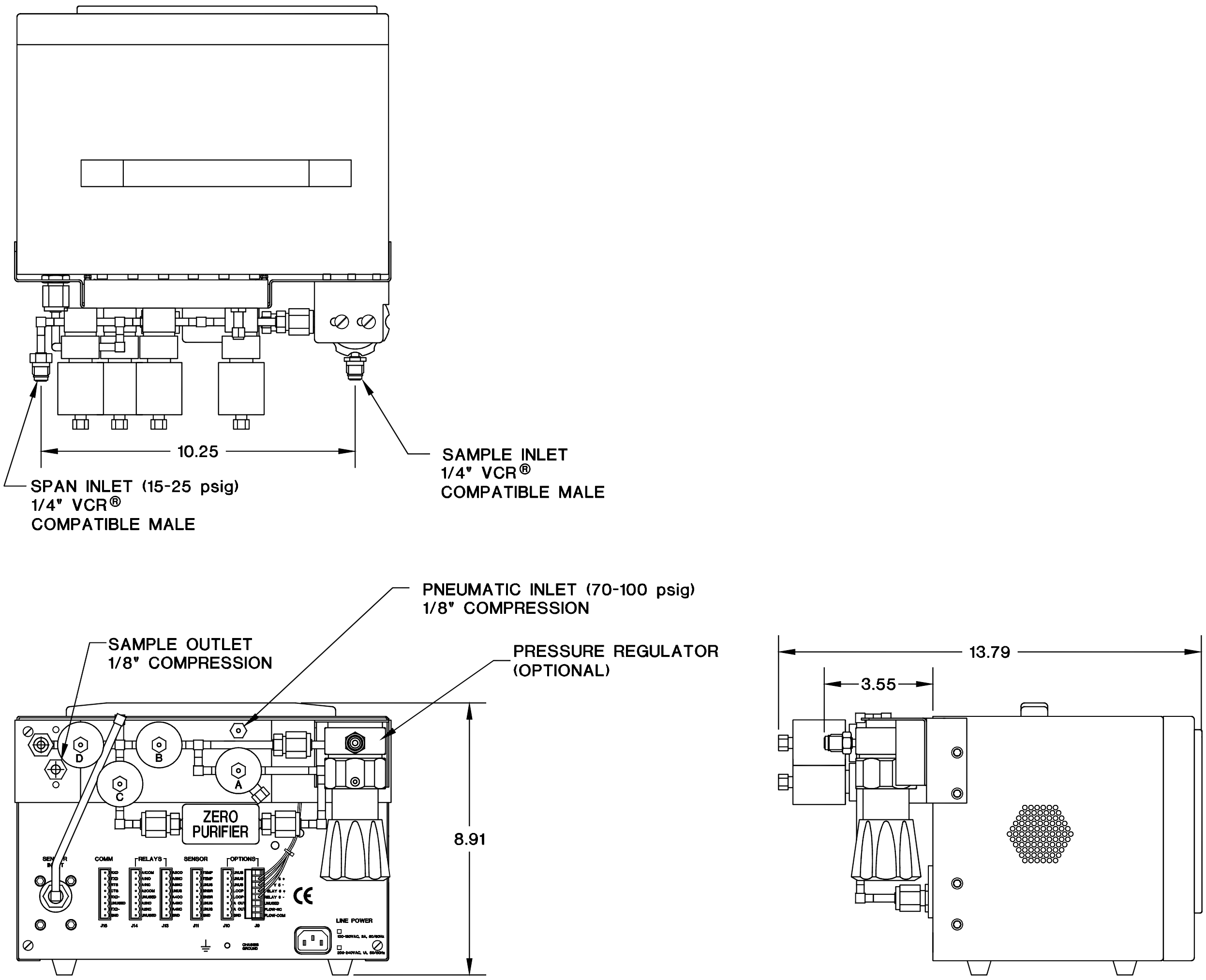


Figure 6: Outline of NanoTrace Oxygen Analyzer with Automatic Calibration System

	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	∅	∅	DE	De	C	O	C	C
Zero	1	∅	E	De	O	C	O	C
Span	1	1	E	E	C	C	C	O

Table 1: Calibration System Logic

NOTE

Relay 5 is connected to Solenoid S1 and Relay 6 is connected to Solenoid S2.

4.5.4.1 Key:

1	Relay Closed	∅	Relay Opened
E	Solenoid Energized	DE	Solenoid De-energized
O	Opened	C	Closed

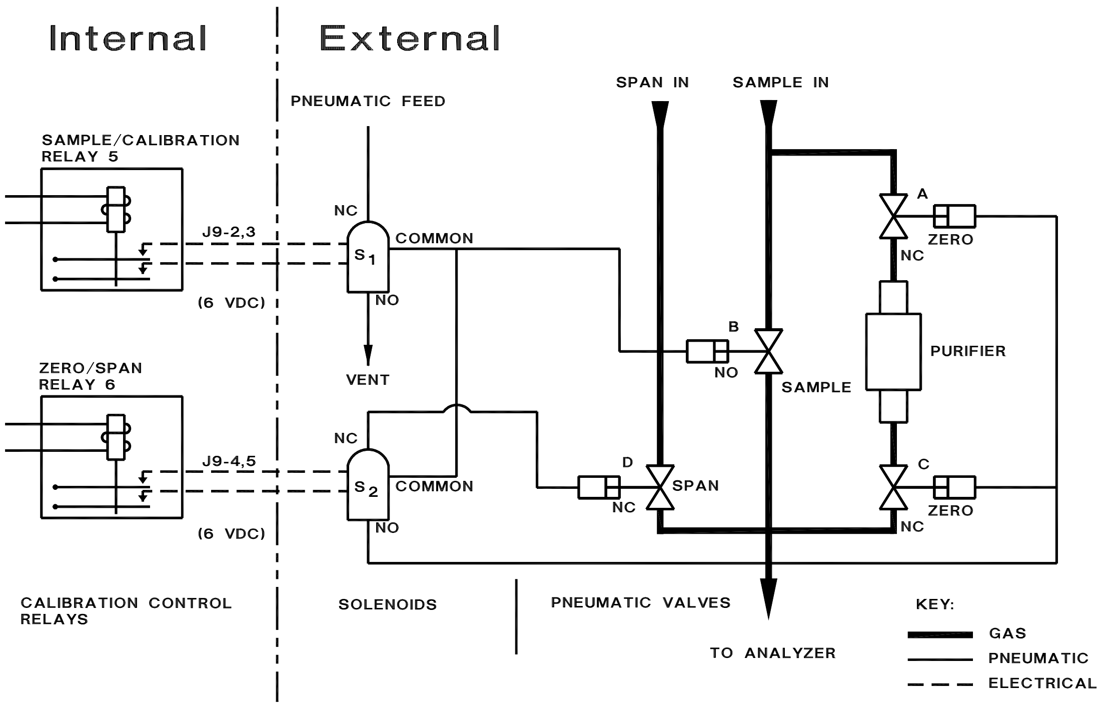


Figure 7: Cal System Design

4.6 Standard Outputs

An output signal indicating oxygen concentration can be sent to other instruments by using the non-isolated 4-20 mA output or the 0-10 VDC output at the back of the analyzer. When shipped from the factory the required mating connectors are plugged into the back panel.

The outputs are wired to the Options Port, J10 shown in Figure 8. A standard feature of the analyzer is the 4-20 mA output that is isolated from earth (chassis) ground. The maximum loop resistance is 1K ohms and the internal 28 VDC loop supply is provided. This output is not electrically isolated from the voltage output or the communications output (RS232 or RS485).

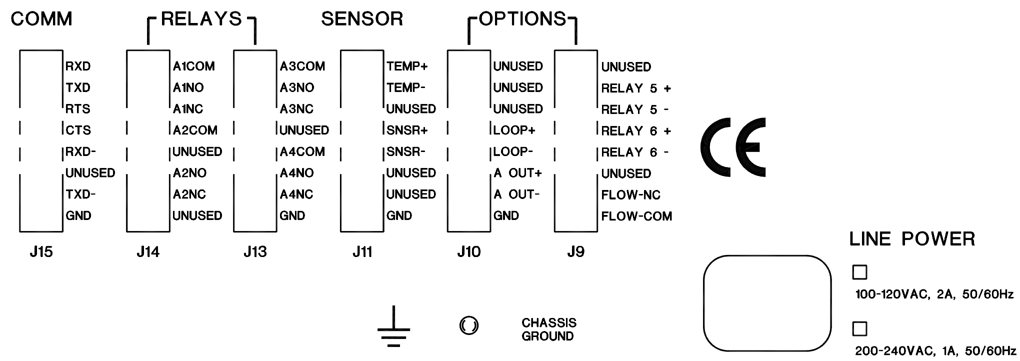


Figure 8: Rear Panel Connector Pinouts

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

Use the Expanded Range output to automatically switch the analog output to a pre-selected higher range when the normal range has been exceeded. See page 58.

4.7 Low Flow Alarm

The optional low flow alarm includes a flow switch that 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. The switch can also be used with an optional alarm relay.

Figure 9 shows schematics of the gas flow path for various Analyzer 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 analyzer.

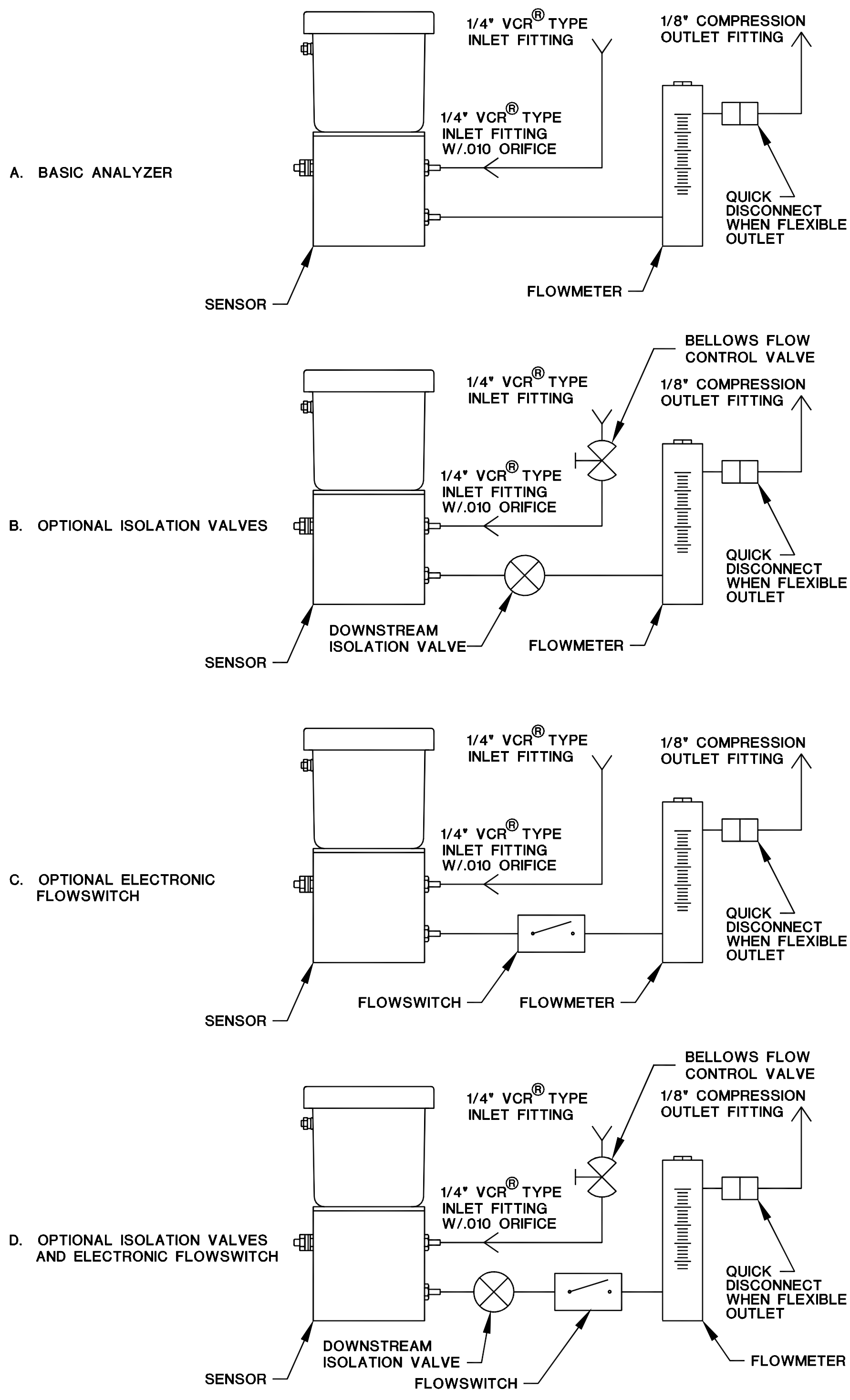


Figure 9: Plumbing Configuration Options

4.8 Pressure Regulator Installation

If your Analyzer is not equipped with a calibration system, you may need to install the optional gas pressure regulator. Three PEM nuts are installed in the back panel of the analyzer for mounting the regulator bracket. Mount the regulator to the supplied bracket with two ¼-20 truss head screws and PEM nuts (supplied). The assembly mounts on the back panel as shown below.

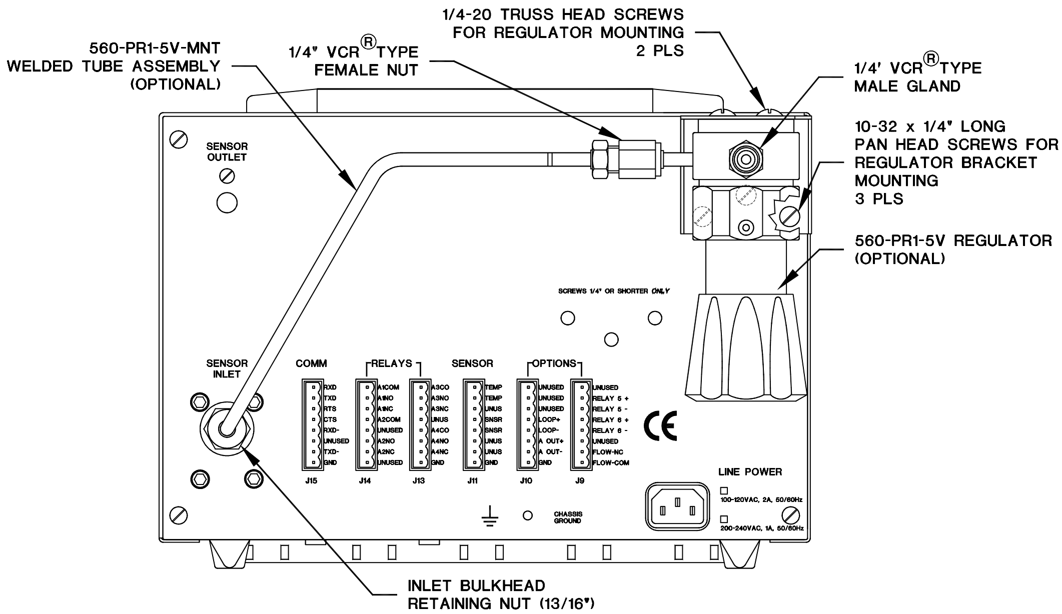


Figure 10: Regulator Installation

CAUTION

It is very important to use the supplied screws (or their equivalent - steel pan head 10-32 by ¼-inch long) to mount the bracket. Longer screws 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.

4.9 Gas Regulator Purge

Regulators used on bottled calibration standards are typically equipped with 2 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 measurement delay time and offer opportunities for leaks.

4.9.1 Regulator Purge Procedure

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

1. 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.
2. Adjust the flow control valve to allow a modest flow rate (hissing sound).
3. Close the cylinder valve until the cylinder pressure falls to approximately 200 psig.
4. Open the cylinder valve to restore full delivery pressure.
5. On the regulator, turn the delivery pressure down to approximately 2 psig.
6. On the regulator, increase the delivery pressure to the maximum level.
7. Repeat steps 3 through 6 five to 10 times to thoroughly purge the regulator and gauges.
8. Close the flow control valve.
9. Set the delivery pressure to 5 psig.

The above procedure insures that any ambient air trapped in the pressure gauges and cavities of the regulator is 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 two to four hours is recommended when the regulator is first connected before using the new setup for calibration

4.10 Flow Control (Shutoff) Valve

The optional Ultra High Purity (UHP) flow control valve can be used as a flow control valve and an upstream isolation valve. This option 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, to completely isolate the sensor.

4.11 Downstream Isolation Valve

For analyzers used in portable applications, an optional downstream outlet valve can be fitted to the sensor. When used with the optional Regulator or upstream UHP Shutoff, the sensor can be completely isolated from ambient air when transporting the analyzer to other test locations. An isolated sensor is rapidly returned to zero after reconnection.

CAUTION

To avoid over-pressurizing the analyzer, always be certain to shut off the external upstream valve or regulator ***before*** *closing the internal downstream isolation valve. Always open the internal downstream valve completely* ***before*** *restoring flow to the analyzer.*

4.12 Nitrogen Case Purge System

The NanoTrace Analyzer can be equipped with an inert gas (nitrogen) purge system. The purge system provides improved protection against an explosion hazard by purging the enclosure to a concentration level below the lower explosive limit.

With a 20 scfh flow, the nitrogen purge system provides a minimum of thirty volume changes per hour of the atmosphere inside the analyzer's enclosure. A low-flow switch controls the failsafe feature. AC power is connected to the analyzer through the purge control as long as the low-flow switch contacts are closed. In the event of a partial or full loss of purge gas flow, the low-flow switch opens causing a hermetically sealed relay to disconnect power to the analyzer.

The electrical and purge gas connections are at the rear of the analyzer. The purge system has a maximum supply pressure rating of 100 psig and is connected via a 1/8-inch compression fitting. Dry nitrogen is recommended. AC power is connected by the user at the three-terminal connector block next to the purge gas inlet.

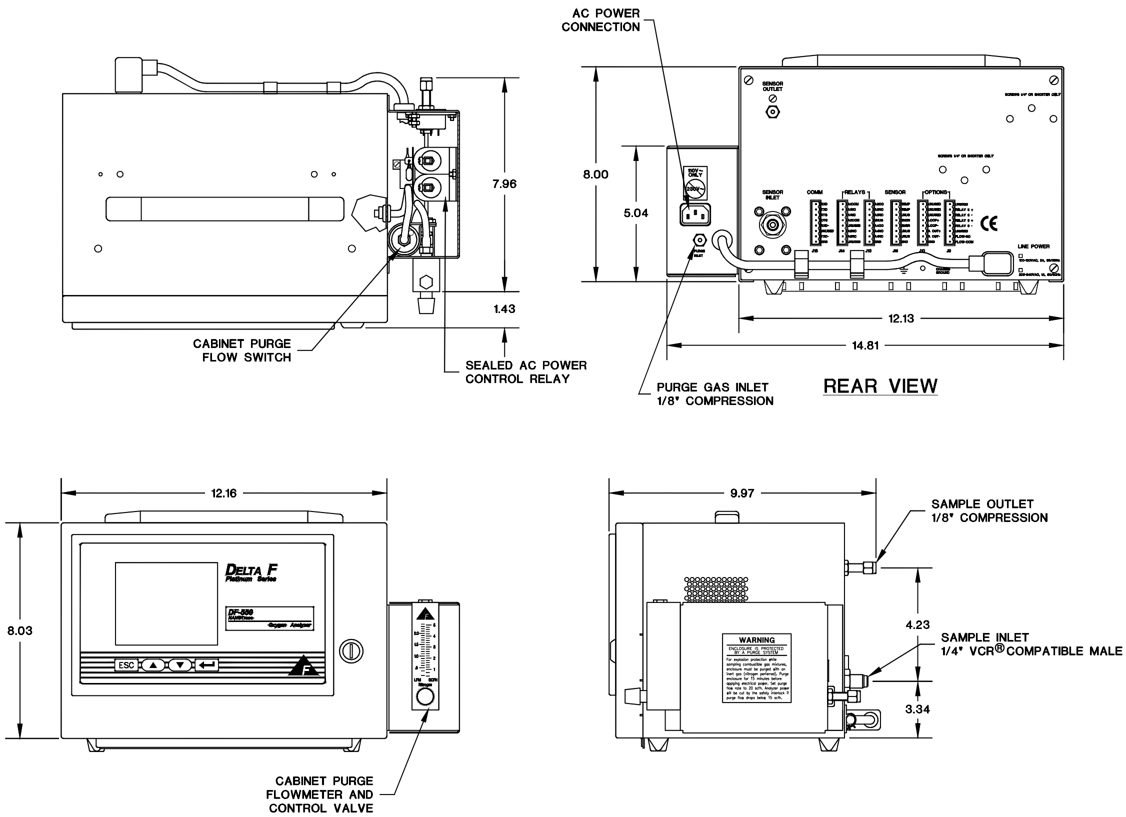


Figure 11: Case Purge System

CAUTION

In the event that the NiCad Battery Option is installed in an analyzer that also has the Case Purge Option, the NiCad Battery system ***must*** *be disabled. This will enable the analyzer to shut down properly in case the purge gas flow is reduced or lost.*

4.13 Portable Operation Procedure

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:

NOTE

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 that is mounted inside the enclosure.*

1. If equipped with a pressure regulator or a flow control valve, close it.

2. If equipped with a calibration system, close all three diaphragm valves in the calibration system.
3. Immediately close the downstream isolation valve in the enclosure, if available, by turning the toggle off. Closing the valve as quickly as possible after completing step 1 minimizes back diffusion of ambient air prior to achieving sensor isolation.
4. With the sensor isolated by valves on each side, the oxygen concentration likely increases. A non-zero reading with no flow can be attributable to oxygen leaks past the valve seats and packing in the downstream valve. The oxygen reading should remain below 150 ppb between relocations when the sensor is isolated for best performance.

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.

5. Disconnect the sample gas line from the analyzer. Discard the VCR-type gasket.
6. Disconnect the power cord.

4.13.1 Reconnection Procedure

To reconnect the analyzer to another sample tap, follow this procedure:

1. Reconnect the power cord.
2. Connect the sample gas line to the calibration system *just finger tight*. Use a new VCR®-type gasket.
3. 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 purges 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.
4. Open the downstream isolation valve in the enclosure by flipping the toggle valve open.
5. Open both purifier valves so that gas initially flows through the purifier.
6. 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.
7. After 5 to 10 minutes of purging through the purifier, open the sample valve, and then close both purifier valves.

NOTE

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.

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

Be sure to use the appropriate gas scale factor (GSF) when measuring in different background gases. See "Gas Scale Factor (GSF)" under Background Gas Effects in Calibration Gas Considerations in the User Interface Section for information on selecting background GSF.

Avoid any exposure that drives the analyzer over10 ppm. This minimizes the time required to reach low ppb levels.

5 Options

5.1 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. You need a 3/16-inch wrench for the inlet nut; a ½-inch 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.

5.2 NiCad Battery Pack

Analyzers equipped with a battery pack can be operated on battery power for three to six hours, depending upon configuration (see Table 2). 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 *Sensor Power* in *the User Interface* section under *Controls Menu*.

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 Alarm Status in the analyzer's display (**Figure** 15: Data Display Screen) indicates low battery power, "**[BAT LOW]**". When the BAT LOW signal comes on, approximately 10 minutes of operating time remain. The unit gradually ceases to function as the voltage declines.

To conserve battery power, if the unit has the Isolated Outputs option, jumper JP11 may be removed. However, removing this jumper disables the analog recorder output and the 4-20 mA output. Turning off the backlighting also conserves battery power.

In the event that the NiCad Battery Option is installed in an analyzer that also has the Case Purge Option, the NiCad Battery system ***must*** *be disabled. This will enable the analyzer to shut down properly in case the purge gas flow is reduced or lost.*

Analyzer State	Length of Time the Battery will Hold Power
Basic Analyzer (Outputs off, Backlight off)	9 hours
Backlight on, outputs off	6 hours
Isolated Outputs on, Backlight off	6 hours
Backlight on, Isolated Outputs on	3.5 hours

Table 2: Battery Operation Time

NOTE

Use only Delta F P/N 16315700 when replacing the NICAD battery pack.

5.3 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 does not prevent adjustments from the front panel. Password Protection, described in the *User Interface* section under *Setup Analyzer Menu*, must be used to lockout front panel control changes.

5.4 4-20 mA Output

The analyzer can be equipped with an optional 4-20 mA, 1000Ω maximum loop resistance, fully-isolated output including internal 28 VDC compliance voltage. This output is completely isolated from the communications outputs and earth ground but not from the Analog Voltage output. NOTE - This option is not in addition to the standard 4-20 mA output.

Connections are made at pins J10-4 (LOOP+) and J10-5 (LOOP-) at the back of the instrument.

5.5 Relays

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 30 VDC @ 5A under a resistive load. Connection to the relays is made through the J13 and J14 connectors on the rear of the analyzer.

5.6 Panel/Rack Mount

A panel mount and a 19-inch rack mount are available for the analyzer. The panel mount requires a cut-out for installation. Figure 12: Rack Mount Configuration shows the rack and panel mounts; the cutout for mounting the panel is shown in Figure 14: Cutout Dimensions for Panel Mount.

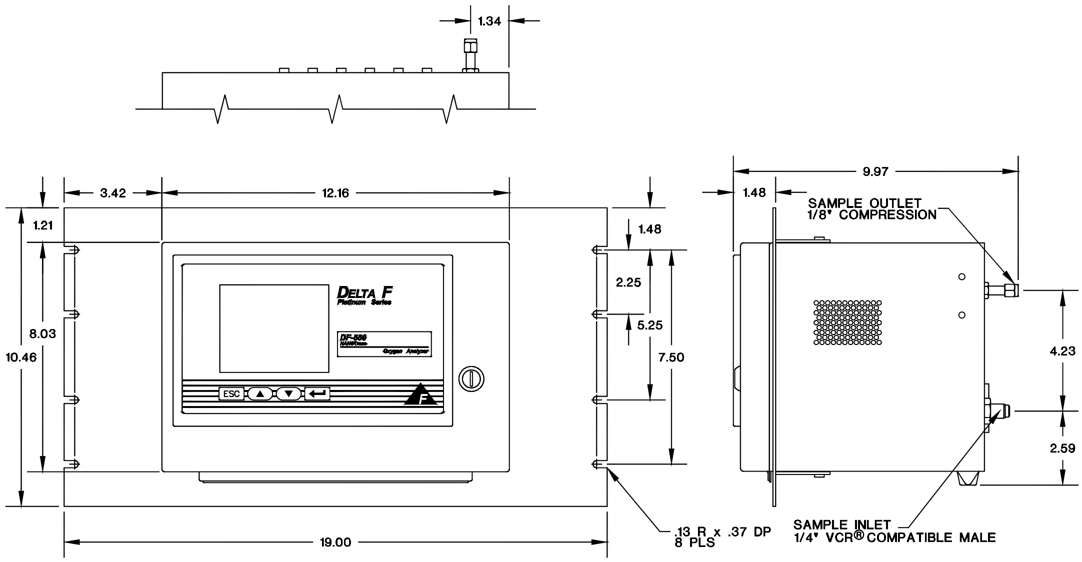


Figure 12: Rack Mount Configuration

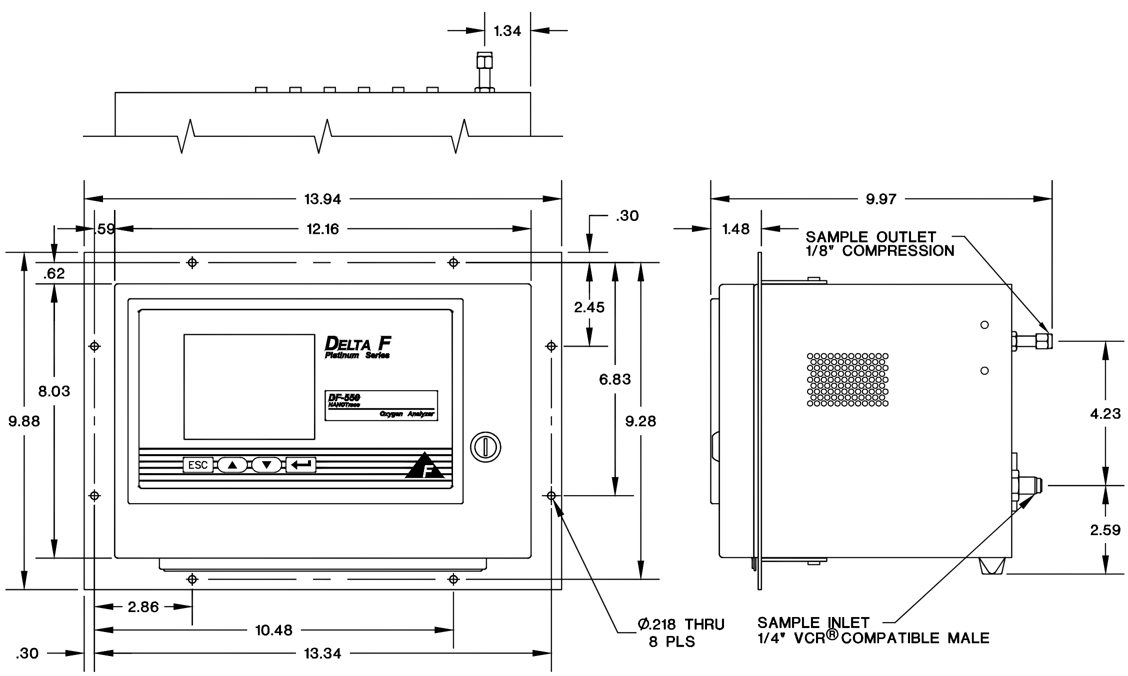


Figure 13: Panel Mount Configuration

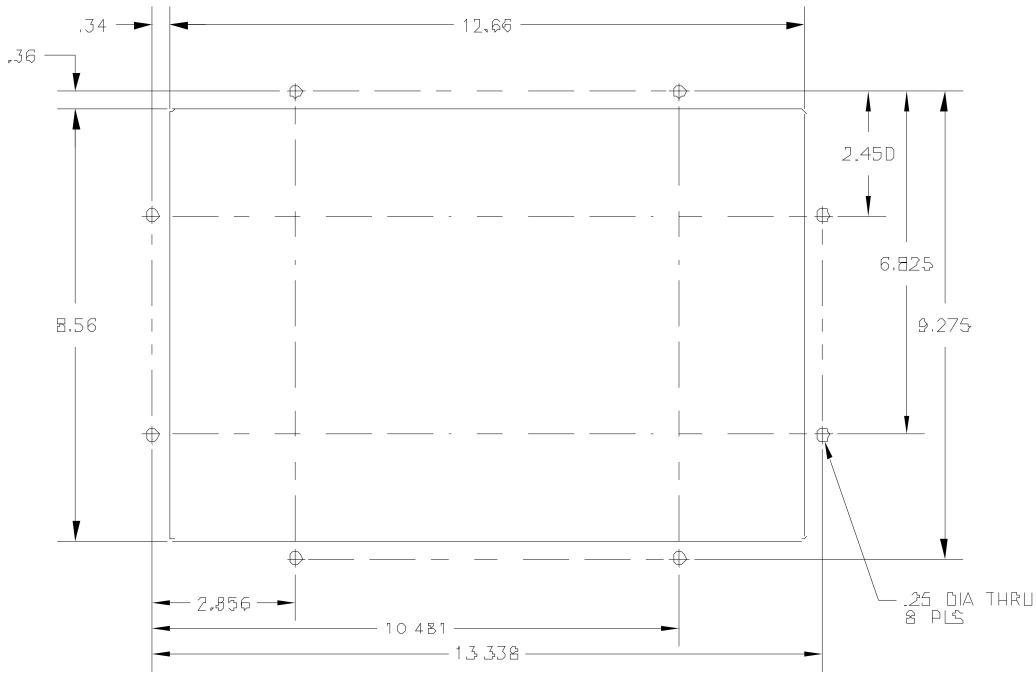


Figure 14: Cutout Dimensions for Panel Mount

5.7 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. A “C” language software library package is available for customized development of communication software.

NOTE

The Fully-Isolated Outputs Option is recommended with the COMM Ports option to prevent ground loop problems.

5.8 Fully-Isolated Analog Outputs

The standard analog output (0 to 10 VDC, or optional 0 to 1 VDC or 0-2 VDC or 0-5 VDC) and 4-20 mA output are isolated from Earth Ground, but share the same ground as the communication port. In applications where the voltage or current output are used, in addition to the communication port, it is possible to create a ground loop. The Fully-Isolated Outputs option isolates the analog output and 4-20 mA output ground from the communication port ground.

6 Sample Gas Preparation and Delivery

6.1 The STAB-EL Acid Gas System

The optional STAB-EL system consists of a special electrode, which reduces the sensitivity to low levels of acids in the sample gas. Limitations on the amount of acid the STAB-EL system can handle are given in the table below.

CO_2* %	SO_2 ppm	H_2S ppm	NO_x ppm	Cl_2 ppm	HCl ppm
0.05	50	50	50	25	25

Table 3: Maximum Allowable Acid Gas Limits for the STAB-EL Sensor

*Concentrations of CO_2 are in percent. One percent is equivalent to 10,000 ppm.

6.2 Sample GSF

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 span calibration gas. The Sample GSF menu can be entered through the Setup Analyzer Menu, Figure 19.

In many applications, the sample GSF does not need to be altered from the default value of 1.00. However, if the sample gas has a significantly different diffusivity compared with 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
Nitrogen	N_2	1.00
Argon	Ar	1.03
Hydrogen	H_2	0.61
Helium	He	0.69
Carbon Monoxide	CO	1.01
Ammonia	NH_3	0.90
Nitrous Oxide	N_2O	1.25
Sulfur Hexafluoride	SF_6	1.84
Trifluoro-methane	CHF_3	1.69
Tetrafluoro-methane	CF_4	1.61

Hexafluoroethane	C_2F_6	2.20
Octafluoropropane	C_3F_8	2.58
Methane	CH_4	0.94
Ethylene	C_2H_4	1.10
Ethane	C_2H_6	1.15
Propylene	C_3H_6	1.28
Butane	C_4H_{10}	1.48
Hexane	C_6H_{14}	1.75

Table 4: Gas Scale Factors

Call the Delta F Service Line at (781) 935-5808 to contact the factory for assistance with gases not listed above.

See page 60 for additional information on the Gas Scale Factor.

6.2.1.1 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 85-90% accurate. In addition, there is further error introduced when correcting for a "multi" component background gas. This may result in an additional 3-5% 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 Calibration standard that has been prepared in a background gas that models the average process sample. 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 (781) 935-5808.

6.3 Sample Flow Rate and Pressure

The analyzer is factory calibrated at a flow rate of 2.0 scfh, in N_2, and should be operated at that level for optimal accuracy. However, the Delta F Sensor is relatively unaffected by gas sample flow rate, within limits. Sample flow rate should be maintained within the recommended range of 1.0 to 3.0 scfh. The analyzer can be operated at flow rates outside that range, but it should be recalibrated at that different flow rate to maintain optimal accuracy.

The analyzer has a small pressure drop (0.2 to 0.5 psi), so relatively small changes in inlet or outlet pressure causes dramatic changes in flow rate. Consequently, it is preferable to vent the outlet to atmosphere so that outlet pressure remains constant, leaving inlet pressure as the only variable to control.

6.3.1 Flow Rate Effects on Sensor Performance

Assuming a leak-tight system, higher flow rates may cause O_2 readings to increase by a few percent of reading above the level that would be displayed if flow was within the recommended 1.0 to 3.0 scfh range. Lower flow rates similarly cause O_2 readings to decrease by a few percent of reading. Very low flow rates (below 0.2 scfh) should be avoided as the sample inside of the sensor is no longer representative of the actual sample.

The insensitivity to flow rate changes is the basis for the sample system leak detection procedure described below. The sensor output should be virtually constant for readings between 0.5 and 4.0 scfh. Therefore, if O_2 readings become higher at lower flows, then ambient O_2 is leaking into the sample system, or venting from a dead space (closed pocket with trapped higher O_2 level gas) in the sample system. A higher flow rate dilutes the O_2 entering the sample system decreasing the reading. O_2 readings in a leak free sample system should not go up or down significantly with flow changes between 0.5 and 4.0 scfh.

6.3.2 Checking for Plumbing Leaks using Flow Rate Effects

Significant measurement error can be caused by leaks in the plumbing system. A simple test can be performed to identify oxygen leaks.

Observe the analyzer readout at two flow levels: 0.5 and 3.0 scfh. Only a slight decrease (1ppb), if any, in readout will occur in a tight system as the flow is increased. If leakage in the plumbing system exists, then the increased flow results in a substantial decrease in oxygen readout -- typically dropping by 25 to 50 percent.

When flow sensitivity is observed, check the external plumbing for leaks.

6.3.3 Background Gas Effects on Indicated Flow Rate

If the molecular weight of the background gas is much different from N_2, the flowmeter reading is not accurate. The Rotometer type flowmeter used in the NanoTrace is calibrated for use in air (or N_2). Most other gases have molecular weights within ± 25 percent of air. Since the required flow rate is not extremely critical most gases produces reasonably correct readings. The exceptions are light gases such as Helium and Hydrogen whose flow rates should be set to approximately one-third that of Nitrogen or .6 scfh.

6.3.4 Regulator requirements

If the sample gas is at constant pressure between 0.2 psig and 10.0 psig, the flow control valve at the sensor inlet can be used to adjust flow rate.

If the pressure in the sample line varies, but does not drop below 2.0 psig, use a regulator to drop the pressure to approximately 1.0 psig. Set final flow rate with the sensor flow control valve.

If a regulator is not used, the flow rate changes when the pressure at the inlet of the flow control valve changes. As long as this pressure variation does not bring the flow rate out of the recommended flow range (1.0 - 3.0 scfh) no regulator is required. A flow change of ±1.0 scfh may result in a small change to the oxygen reading.

If a pressure change causes the flow rate to move outside the recommended range, an adjustment of the flow control valve must be made. If the adjustment is not made, and the flow rate remains outside the recommended range, the analyzer may not be operating within its stated accuracy.

6.3.5 Pressure Effects on Sensor Performance

If the analyzer is not vented to atmosphere, the sensor pressure is influenced by the conditions downstream of the analyzer. A recalibration under your operating conditions 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.

NOTE

It is not recommended that gauges be installed upstream of the analyzer. The presence of a gauge increases response times and introduces potential leaks to ambient.

Sample gas line lengths, fittings and bends should be kept to a minimum to maintain low pressure drops. Larger diameter tubing and fittings reduce pressure drop and also lengthen response time. In general, 1/8-inch tubing should be limited to 15-foot runs; longer runs should be made with 1/4-inch tubing.

6.3.6 Sample Outlet Backpressure Effects

It is always recommended to vent the analyzer to atmospheric pressure. However, if a sample vent or return line is used, attention must be given to maintain a low and consistent backpressure so as not to affect the flow rate.

The allowable backpressure on the sensor is ±1 psig. If variations in the vent line pressure are expected, a sub-atmospheric backpressure regulator should be installed on the vent line to maintain an even backpressure on the analyzer. Consider the regulator’s pressure drop (typically 1 psi) when designing the sample vent system in order to stay within the ±1 psig pressure limits at the sensor.

When not venting the analyzer to atmosphere, it is also suggested to install a fairly high resolution pressure gauge immediately at the analyzer outlet.

NOTE

If a regulator or gauge is installed on the analyzer outlet, the Stainless Steel Downstream Plumbing option should be installed.

6.4 Sample Gas Compatibility

There are a wide range of considerations in determining the gas sample compatibility of the NanoTrace. Delta F attempts to identify all pertinent application details prior to quoting and order processing. All non-typical applications concerning gas sample compatibility must be reviewed by our in-house Application Engineers. It is impossible to accurately predict all of the chemical tolerances under the variety of process gases and process conditions that exist.

6.4.1 Condensation

The analyzer should be installed and operated with a sample gas that is preconditioned (if necessary) to avoid condensation in the gas lines. Several methods are available to minimize the possibility of condensation. If the sample gas is a hydrocarbon, maintain the gas temperature 20° F to 40° F above its dew point. In some applications, it may be necessary to chill the sample gas before it enters the analyzer so that the hydrocarbons can be condensed, collected, and removed. It is good practice to pitch the sample gas lines to allow condensables to drain away from the analyzer. Gas sample delivery lines that contain sample gases with high moisture content must not be exposed to temperatures below the dew point.

6.4.2 Gas Solubility in Aqueous KOH Solution

Some sample gas constituents are soluble in the sensor's potassium hydroxide (KOH) electrolyte. Gases that are rated as "Soluble" to "Infinitely-Soluble" may pose a threat to the sensor.

The sensor should have limited exposure (less than 1% by volume on a continuous basis) to highly water soluble alcohols, such as methanol, and/or be supplemented with periodic electrolyte changes to limit buildup within the electrolyte.

Many gas species with infinite solubility in aqueous KOH (such as nitrous oxide (N_2O), however, do not affect the electrode or sealing materials, or interfere with the O_2 reduction/oxidation reactions. Call the Delta F Service Line at (781) 935-5808 for recommendations on a specific application.

6.4.3 Reactivity with KOH Electrolyte

Many process sample streams contain various concentrations of acid gases. Acid gases are gases that react with the basic KOH electrolyte solution to form a neutralized solution. The sensor does not operate properly when the electrolyte solution is neutralized.

Besides a neutralization of the electrolyte, a base reactive sample gas may have other negative effects, such as a base-catalyzed polymerization reaction. The O_2 electrode reaction sites may become blocked by the polymerized byproduct residue at the interface where the gas sample meets the electrolyte.

6.4.4 Flammable Sample Gas

There is nothing within the analyzer sample system that can ignite a flammable sample gas. However, it is critical to ensure that the sample gas does not escape from the sample system into the analyzer enclosure, or the room, where ignition is possible. Stainless steel plumbing should be used throughout the entire sample system if the sample gas is flammable.

Also, the analyzer enclosure can be purged with nitrogen, or the entire Analyzer can be mounted in a purged enclosure, so that any sample gas that escapes the plumbing is diluted.

6.4.5 Trace acids in the sample gas

With the STAB-EL Acid Gas system, oxygen measurements in sample gases containing certain levels of acids are possible. Trace acids are common byproducts of gas distribution system assembly and its accessories. Trace acids can compromise the accuracy of the sensor and its construction if they are not managed properly. See the section *STABE-L Acid Gas Option* for more detail.

Contact the Delta F Customer Support Services Department at (781) 935-5808 for recommendations on using the STAB-EL sensor on acid gases other than those listed above.

6.4.6 Sample Gas Temperature

Gas temperature should not exceed 50 °C (122° F), nor should it fall below 0° C (32° F). Gas temperature can be controlled by passing the gas through 5 to 10 feet of metal tubing that is within the recommended sample temperature. Because of its low thermal mass, the gas sample quickly reaches the gas sample line temperature.

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.

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 49*. This temperature value is updated at intervals of 15 to 45 seconds.*

6.4.7 Protecting the Analyzer from Process Upsets

The analyzer should be protected from extended exposure to high concentrations of oxygen or hostile gases. Automatically solenoid controlled valves should be installed to switch the analyzer over to an N_2 purge when the process reaches some identifiable condition.

Gas line maintenance operations must also be examined for their effect on the analyzer. For example, in many pipeline process or normal gas applications the plumbing system is cleaned with either a liquid solvent or detergent solution. Since either causes damage to the sensor, switch the analyzer over to a N_2 bypass purge, or shut off sample flow and power to the analyzer prior to initiating the potentially hazardous process.

6.5 Calibration Gas Considerations

Calibrations performed from a bottled, calibrated sample gas, may introduce additional issues that could adversely affect the analyzer calibration.

6.5.1 Calibration Standards

Certified calibration standards are available from gas manufacturers. These standards are available in steel and aluminum cylinders. Steel cylinders are less expensive but do not dependably maintain a stable oxygen concentration for long periods of time.

Calibration standards in aluminum cylinders are recommended. Delta F has found that calibration standards in aluminum cylinders are very stable for long periods of time (between 6 and 24 months) where steel cylinders should be recalibrated every three months.

6.5.2 Calibration Cylinder Regulators

Regulators used on bottled calibration standards are typically 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. Install a flow control valve after the regulator to adjust the flow.

6.5.3 Purge Procedure

Before the calibration gas is connected to the analyzer follow the procedure listed below to purge ambient air from the regulator which prevents contamination of the gas in the cylinder rendering it useless:

1. After securely attaching the regulator to the cylinder, fully adjust the regulator (clockwise) to its maximum outlet pressure capability. Slightly open the regulator flow control valve. Open the cylinder valve.
2. Adjust the flow control valve to allow a modest flow rate (hissing sound).
3. Close the cylinder valve until the cylinder pressure falls to nearly 0.0 psig on the secondary pressure gauge, or until flow almost stops.
4. Immediately open the cylinder valve to restore full delivery pressure.
5. Close the cylinder valve to again drop the outlet pressure and flow to near zero.
6. Repeat steps 4 and 5 at least 10 times to thoroughly purge the regulator and gauges. This pressure cycling action acts to flush out all the air trapped in the dead space and cavities inside the regulator.
7. Adjust the regulator to set the delivery pressure at about 5 - 10 psig.
8. Close the flow control valve.

Once the regulator is mounted and purged, do not remove it from the cylinder until a fresh cylinder is required.

6.5.4 Sample Gas Delivery and Vent Pressure during Calibration

The most accurate calibration is obtained when the analyzer is plumbed into the gas sample system so that the analyzer is under actual process operating conditions. But when the process sample is being delivered to the analyzer under Vacuum conditions, or being returned from the sample outlet under either positive pressure or Vacuum conditions the operating pressure at the sensor is likely to be quite different than under factory calibration conditions.

For systems where the gas sample is not vented to atmosphere, the analyzer outlet should remain connected in the same manner during calibration, if possible. This ensures that downstream pressure effects on the sensor are the same during calibration and process monitoring.

Use the flow control valve on the regulator to meter the calibration gas to the analyzer at the suggested 2.0 scfh flow. By leaving the analyzer's flow controls untouched from when the analyzer is used on process, the calibration pressure duplicates the process sampling pressure.

6.5.5 Background Gas Effects on Calibration

6.5.5.1 Flow rate

Ideally, the calibration gas and the sample gas have the same gas composition, and as a result, the indicated flow rate during calibration and process sampling are identical. However, if the composition of the calibration and sample gases are not the same, the flow rate indicated on the rotometer may need to be adjusted. Light gases, such as H_2 and He, have a higher flow rate than is indicated on the flowmeter. As a result, the flow rate of the light gas should be set to one third of the flow specifications found in this manual. For example: The recommended flow rate for N_2 is 1.0 to 3.0 scfh. In H_2 or He service, the recommended flow rate (***as indicated on the analyzer***) should be 0.3 to 1.0 scfh.

6.5.5.2 Gas Scale Factor (GSF)

If possible, the background of the calibration gas should be the same as the process sample gas. If not, a gas scale factor may have to be applied to the calibration gas oxygen readings because of the difference between the diffusion rate of oxygen in nitrogen (factory calibration gas) versus the diffusion rate in the user's calibration gas. *The Sample Gas Preparation and Delivery* section discusses the proper setting of the gas scale factor option during calibration as well as during process gas measurement.

7 Connecting to External Devices

The analyzer can be interfaced to a variety of external devices via the ports on the rear panel. Alarm contacts, voltage, and current outputs, and serial communications are supported.

NOTE

It is important to note that the shield of all connecting cables should be attached only to the stud on the rear of the PNT analyzer and left open (ungrounded) at the other end.

7.1 The Comm Port

The optional Comm port is used for communication via RS-232C or 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 menu on the display.

A library of interface functions, written in C, is available to allow programmers to create custom interface program for accessing the communication port. The *Interface C Library Reference Manual* comes with a disk containing Microsoft and Borland versions of the object code.

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 – Connect to ground stud on rear of cabinet

Table 5: Comm Port (J15) Connector Pinout

NOTE

To avoid ground-loop conflicts when using RS-232C or RS-485 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 Ground.

When connecting the NanoTrace Analyzer to a computer via an RS-232 or RS-485 communication cable, a Ferrite Sleeve may be required around the cable in a single-turn configuration. It is recommended that the proper Delta F cable be used for this purpose.

NOTE

Use of the Fully-Isolated Comm Ports Option (which isolates the grounds of the 0-10v and 4-20mA outputs from the communication port) avoids any ground-loop conflict.

NOTE

In order to prevent spikes from appearing in the oxygen output reading while using the communications option, it is critical to connect pin 8 of connector J15 (GND) to the ground stud on the rear of the cabinet.

7.2 Relay Ports

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

Table 6: Relay Port Connectors (J13, J14) Pin Out

Four optional form C (SPDT) relays (contact closures) are provided on the analyzer. These are used in conjunction with up to seven alarms. The contacts are rated at 30 VDC, 5A resistive load. Not to be used for switching AC power.

The relay contacts can be programmed for up to four Oxygen Alarms, plus Temperature, Low Flow, and Electrolyte Condition. A relay can be assigned to any alarm through the display menu.

The Normally Open (No alarm) contact connects to common when an alarm occurs or when power to the instrument is lost.

7.3 Option Ports

Two option port connectors, J10 and J9, are provided. Connector J10 is the interface for an analog recorder (0 to 1 VDC, 0-2 , 0 to 5 VDC, or 0 to 10 VDC, selectable) and the 4 to 20 MA loop. Connector J9 interfaces with the optional automated calibration systems.

J10-1	ILOOP+	Unused
J10-2	UNUSED	Key
J10-3	ILOOP-	Unused
J10-4	LOOP+	4-20 mA output (+)
J10-5	LOOP-	4-20 mA output (-)
J10-6	AOUT+	Voltage Output +(per customer order, see Section 7.3.1)
J10-7	AOUT-	Voltage Output - (per customer order, see Section 7.3.1)
J10-8	GND	Ground

Table 7: Analog Output Connector (J10) Pin Out

J9-1	UNUSED	Key
J9-2	RELAY 5+	Sample/Calibration Relay 5 +
J9-3	RELAY 5-	Sample/Calibration Relay 5 -
J9-4	RELAY 6+	Zero/Span Relay 6 +
J9-5	RELAY 6-	Zero/Span Relay 6 -
J9-6	Not Used	Not Used
J9-7	FLOW-NC	Flow Switch (Opens on Low Flow)
J9-8	FLOW-COM	Flow Switch Common

Table 8: AutoCal System Control Connector (J9) Pin Out

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 6 VDC at .25A to control the sample/calibrate mode. J9-4 and J9-5 provide 6 VDC at .25A to control the zero/span mode.

7.3.1 Procedure to change the Analog Output voltage

The analyzer is shipped from the factory with 0-10 VDC range. However, you can field-adjust the analog output to one of the following: 0 to 1 VDC, 0 to 2 VDC, 0 to 5 VDC, or 0 to 10 VDC. To change the voltage output, you need a small, straightedge screwdriver or tweaking tool, and a digital voltmeter, Fluke Model 8060 or equivalent. To make analog voltage output changes, proceed as follows:

1. Turn off the main power switch. Above the power switch is a card cage with three narrow slots and one wide slot. Locate and remove the Signal Processing and Control PCB that is located in the wide slot.
2. Insert a single jumper to select the desired voltage output (see table below).
3. Remove any other jumpers in these locations.

Jumper	Voltage Range	Max. Low Output (Volts)	Max. High Output (Volts)
None	10 Volts	0	10.000
JP15	5 Volts	0	5.000
JP14	2 Volts	0	2.000
JP 1	1 Volt	0	1.000

Table 9: Analog Output Jumper Settings

4. Reinstall the board.
5. Connect the digital voltmeter to J10-6 (A OUT+) and J10-7 (A OUT-).
6. Locate the calibration adjustment potentiometers, RV4 and RV2 that are at the front edge of the Analog Output PCB.
7. Turn on the analyzer.
8. When the oxygen display comes up, press ↵ to reach the Main Menu. Select **Maintenance**, **Diagnostics** and then select **Test Analog Output**. Set the desired output level to 0.00 percent.
9. Observe your Digital Voltmeter. Using a slotted screwdriver, adjust RV4 until the meter reads 0.000 volts.
10. Return to Test Analog Output. Enter 100.0 percent. Adjust RV2 until the output matches the Maximum high output voltage given in Table 9.

The Analog Output is now calibrated for the new range.

8 User Interface

8.1 The Data Display Screen

When powered up, the Platinum Series *NanoTrace* Oxygen Analyzer goes through a series of internal diagnostic tests that take about 1.5 minutes.

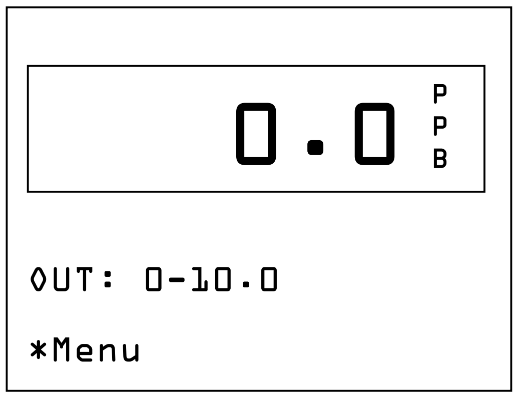


Figure 15: Data Display Screen

8.1.1 Numerical Information

The numerical information displayed on the Data Display Screen is representative and is described as follows:

- **Alarm Status –** Located above the data line, the alarm status provides alarm information which is displayed if the condition remains after the audible signal or overwrite message is canceled.
- **Data Line** - Indicates the measured oxygen concentration (for instance, 12.34 ppb). If the analyzer is in an abnormal state, the data line alternately shows the measured oxygen and a message about the state.

8.1.2 Messages

The following messages may be displayed on the Data Display Screen:

- **Oxygen- over-range** - The measured oxygen is higher than the range of the analyzer (for example,>100 ppm).
- **Oxygen-under-range** - The measured oxygen is lower than the range of the analyzer (for example, <-50 ppb).
- **Temperature-over range** - The temperature is outside of the range of 5° C to 45° C.
- **Sensor OFF!** - The sensor is turned OFF.

- **Zero delay** - The sensor is in calibration mode.
- **O2 alarm (1, 2, 3 or 4)** - Any unacknowledged alarms are also displayed here.
- To acknowledge an alarm, press the ESC key. To clear the alarm, restore it to it's prior existing condition. Once an alarm has been acknowledged, a number or letter is continuously displayed as the Alarm Status.

8.1.3 Analog Output Range

The Analog Output Range indicates which of the two possible oxygen ranges are currently used by the analog output.

8.1.4 System Flags and Messages

System Flags - Alert the user to potential maintenance conditions.

The following messages may be displayed:

- **Add Water** - Indicates that the add water interval has expired.
- **Low Bat** - Indicates that the optional backup battery should be recharged.
- **Uncal** - Warns the user that the analyzer is not calibrated.
- **Fail Zero** - Warns that an AutoZero calibration was unsuccessful.
- **Fail Span** - Warns that an Auto Span check or recalibration was unsuccessful.
- **SPAN in xx** - Indicates the number of minutes (xx) until the calibration relays enter Auto Span mode. Relay 5 (Terminals J9-2 and J9-3) and Relay 6 (Terminals J9-4 and J9-5) are energized.
- **ZERO in xx** - Indicates the number of minutes (xx) until the calibration relays enter AutoZero mode. Relay 5 (Terminals J9-2 and J9-3) are energized. Relay 6 (Terminals J9-4 and J9-5) is not energized. If any alarm has been acknowledged, shows as the Alarm Status
- **GSF Tag** - Indicates the value of the current Gas Scale Factor. If a GSF value is entered or calculated by the analyzer, GSF: X.XX is displayed in the Data Display screen. If the GSF is not shown in the Data Display screen, the analyzer is using the default value of 1.00 that represents Nitrogen.
- **Data Logging Status** - Shows whether the system is currently logging data in the short-term mode.
- **CAL ZERO –** Warns the user that a zero calibration should be performed.

8.2 Keypad

The four pressure-sensitive keys displayed below the Data Display Screen are described as follows:

- 

 - 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 keypad allows you to move through the menu tree and to change values at various points.

The ↵ key - accepts the current entry or and advances to the next item or screen.

- Pressing the↵ key while in the Oxygen display brings up the Main Menu display (Figure 16: Main Menu).
- Use the ▲ or ▼ keys to move the asterisk up and down through the items. An asterisk (*) is displayed in many screens to indicate a selected item.
- Press ↵ to activate a choice.
- Press ESCto cancel a choice
- Use the ↵ key to edit a numerical value. Highlight (reverse video) the digit to be changed. Continue pressing the ↵ key to highlight additional digits to the right. Press the ▲ key to increase the rightmost highlighted digit (the ▼ decreases the digit). When one digit is highlighted, the display increments from 0 to 9 before returning to 0 or incrementing to 10 by adding another digit (depending upon the acceptable value). Once the correct value is reached, press the ↵ key until the number no longer appears in reverse video. (The ESC key moves the highlighting to the left and cancels any adjustment.) **Note**: It may be easier to add and change a digit-editable digit by stepping down through zero.
- Press the ESC key to return to the previous screen without changing parameters. If any parameters have been edited and ESC is pressed, the display presents the message: Abandon **Changes?** ↵ **For yes**. All parameter changes are **lost** if the ↵ key is pressed.
- Press the ↵ key if the **Update and Quit** message is displayed. Changes are saved and you are automatically returned to the previous menu.

8.3 Main Menu

The analyzer menu tree is large but simple to navigate. To help you quickly locate a particular screen from this manual, the steps required are located above each menu (see Figure 16).

To reach the Main Menu from the Data Display (because the asterisk is always in front of "Main Menu") press ↵. Alarm status and abnormal state information, if any, is displayed over the Main Menu.

From the Main Menu, all other menus are accessed by moving the asterisk with the ▲ and ▼ keys and pressing ↵.

If a password is required, enter it by selecting **Password Level** and entering the correct password. For additional information, refer to the *Analyzer Setup* section.

If the password is required, the **Password Level** line is not displayed on the Main Screen.

Data Display ➪ Main Menu

```
      NT Ver 1.00

*Controls...
 Setup...
 Password Level...
 Diagnostics...
```

Figure 16: Main Menu

8.4 Controls Menu

The Controls Menu allows the user to set up default conditions and to activate optional features. See Figure 17: Controls Menu.

Data Display ➪ Main Menu ➪ Controls

```
        CONTROLS

*Averaging Filter Reset
 Zero Relay <OFF>
 Span Relay <OFF>
 Sensor <ON>
 ESC to Quit
```

Figure 17: Controls Menu

8.4.1 Averaging Filter Reset

Selecting **AvgFilter Reset** instantaneously resets data in the signal filter used to average the oxygen display. It displays **Filter OFF** on the Data Display for 10 seconds as shown in Figure 18. At the end of this time the current oxygen measurements are used to fill the filter registers. This feature is useful to reduce time lags resulting from heavy filtering, or if the data in the filter is corrupted by a momentary spike. After the Averaging Filter has been reset, the display automatically returns to the Data Display Screen.

Data Display ⇨ Main Menu ⇨ Controls ⇨ Averaging Filter Reset

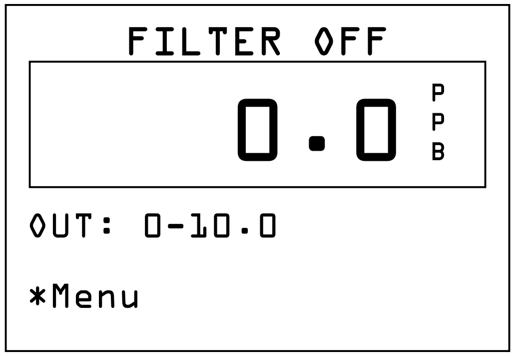


Figure 18: Averaging Filter Off Delay

8.4.2 Zero Relay

This optional relay is used to control external valves for zero calibrations. When the option is not available, this choice reads NA. Manually turn the valves ON and OFF by using the ▲ or ▼ key to move the asterisk to **Zero Relay**. Press ↵ to toggle the zero gas relay OPEN or CLOSED. When the Zero Relay is OPEN, 6 VDC is switched to the relay terminals J9-2 and J9-3, (relay 5) only.

NOTE

Switching the Zero Relay to ON automatically toggles the Span Relay to OFF.

The instrument does not store the zero relay state (OPEN or CLOSED). If AC power is lost, and then restored, the zero relay defaults to CLOSED. Battery equipped instruments are not affected by the loss of AC power.

8.4.3 Span Relay

This optional relay is used to manually control a valve for span calibrations. When the option is not available this choice reads N/A. Manually turn the valves on and off by using the ▲ or ▼ key to move the asterisk to the **Span Relay** position. Press the ↵ to toggle the Span Relay OPEN or CLOSED. When the Span Relay is OPEN, 6 VDC 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 the Section on *Option Ports* for relay terminal pin-outs.

NOTE

Switching the Span Relay to ON automatically toggles the Zero Relay to OFF.

The instrument does not store the span Relay State (OPEN or CLOSED). If AC power is lost and then restored, the span and zero relays default to CLOSED. Battery equipped instruments are not affected by the loss of AC power.

8.4.4 Sensor

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

The analyzer is programmed to protect the oxygen 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 is set to the default (ON) position.

8.4.5 (ESC)ape to Quit

Pressing the Esc key at any time takes the user back one level, in this case to the Main Menu.

8.5 Setup Analyzer Menu

Data Display ⇨ Main Menu ⇨Setup

```
         SETUP MENU

*Alarms...
 Output...
 Comm Port...
 GSF...
 Oxygen Calibration...
 Backlight...
```

Figure 19: Setup Analyzer Menu

The Setup Analyzer Menu is used to set a variety of Analyzer parameters. Some of these parameters are set when initially configuring the analyzer. When this selection is made (and the appropriate password is entered if required), Figure 19 is displayed.

Each entry in Figure 19 leads to a submenu. Select the desired submenu, by placing the asterisk next to it and then press ↵. A new display is shown as indicated below.

8.5.1 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 setpoints as well as deadbands are user-set.

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

Data Display ⇨ Main Menu ⇨ Setup ⇨ Alarms

```
       ALARM SETUP

*4 O2 Alm 1 Used
 1 Temp Alm Used
 1 Flow Alm Used
 1 Elec Alm Used
 Update and Quit
```

Figure 20: Alarm Setup Screen

The electrolyte alarm indicates a fault condition of the electrolyte. The alarm sounds if the electrolyte level is low, or if the electrolyte is contaminated.

The Alarms screen is used to set or determine the status of alarms. **NU** (not used) indicates that an alarm is not currently assigned. When the Alarms entry is selected Figure 20 is displayed.

To select an alarm for editing, use the ▲ and ▼ keys to move the asterisk and press ↵.

If NA appears next to Flow Alm (optional) then it is not available.

8.5.1.1 Oxygen Alarms

If one of the O_2 alarms has been selected, the display is show in Figure 21.

After selecting an alarm and pressing ↵ then the following Alarm setup screen appears.

Data Display ⇨ Main Menu ⇨ Setup ⇨ Alarms ⇨ 4 Oxygen Alarms

```
        O2 Alarms

*Alarm 1 <Used>
 Alarm 2 <NA>
 Alarm 3 <NA>
 Alarm 4 <NA>
```

Figure 21: O2 Alarms

Data Display ⇨ Main Menu ⇨ Setup ⇨ Alarms ⇨ 4 Oxygen Alarms ⇨ Alarm 1

```
*Alarm 1: ON
 Audible <OFF>
 Hi Setpoint:90.000PPM
 Lo Setpoint: 0.100PPM
 Deadband: 0.050PPM
 Relay NU
 Update and Quit
```

Figure 22: Settings for Oxygen Alarms

To indicate that the alarm is to be used, move the asterisk to **Oxygen Alarm 1 (2, 3 or 4):** and press ↵. The display toggles between ON and OFF.

Audible is used to toggle the audible feature on and off, it does not clear the alarm.

The **Hi Setpoint** and **Lo Setpoint** refer to the limits above and below which the alarm will be triggered.

Deadband refers to the value from the nominal set point that an output value must exceed before an alarm is reset. For example, for a Hi Setpoint value of 0.050 ppm, a Lo Setpoint value of 0.030ppm and the deadband set at 0.005 ppm, the alarm is triggerd at 0.050 ppm. The alarm continues to report until the oxygen concentration falls below 0.045 ppm. At 0.045 ppm, the Hi alarm is reset.

The Low 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 Lo alarm would reset.

Relay Assignment 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 trips the relay, and the relay remains tripped until ALL alarms assigned to it are cleared.

NOTE

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

8.5.1.2 Temperature Range Alarm

The temperature alarm is used to indicate an out of range temperature condition for the sensor. From Figure 20 selecting the **Temperature Range Alarm** will bring the display shown in Figure 23.

Data Display ⇨ Main Menu ⇨ Setup ⇨ Alarms ⇨ Temperature Range Alarm

```
*Alarm T: OFF
 Audible <OFF>
 Hi Setpoint: 40.0 C
 Lo Setpoint: 5.0 C
 Deadband: 0.25 C
 Relay NU
 Update and Quit
```

Figure 23: Temperature Range Alarm Screen

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 the high trigger value.

8.5.1.3 Low Flow Alarm (Optional)

If equipped, the low flow alarm is used to indicate a low sample gas flow condition. The flow alarm is provided with a low flow switch that trips if the flow rate drops below the value listed in Table 10.

From the Alarm Setup Screen Figure 20 selecting the **Low Flow Alarm** brings up the display shown in Figure 24. This alarm can be assigned to any optional relay(s).

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

Table 10: Flow Switch Trip Points

Data Display ⇨ Main Menu ⇨ Setup ⇨ Alarms ⇨ Low Flow Alarm

```
*Alarm F: Flow
 Audible <OFF>
 Hi Setpoint: NA
 Lo Setpoint: NA
 Deadband: NA
 Relay NU
 Update and Quit
```

Figure 24: Low Flow Alarm Screen

8.5.1.4 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 the Section on *Sensor Maintenance*. From the Alarm Setup Screen Figure 20 selecting the **Electrolyte Cond. Alarm** brings the display shown in Figure 25. This alarm can be assigned to any optional relay(s).

Data Display ➪ Main Menu ➪ Setup ➪ Alarms ➪ Electrolyte Condition Alarm

```
*Alarm E: Elec
 Audible <OFF>
 Hi Setpoint: NA
 Lo Setpoint: NA
 Deadband: NA
 Relay NU
 Update and Quit
```

Figure 25: Electrolyte Condition Alarm Screen

8.5.2 Analog Output

The **Outputs** entry in the Setup Analyzer Menu, Figure 19, is used to scale the full range of analog output (voltage and current) over a partial or full range of oxygen concentration. NOTE: The unit of oxygen measurement is PPM.

The Analog Outputs Screen is shown in Figure 26.

Data Display ➪ Main Menu ➪ Setup ➪ Output

```
         OUTPUT
*Zero: 0.000 PPM
   FS: 10.000 PPM
 Expand FS: 10.00 PPM
 Expand Range Relay NU
 CAL FREEZE <ON>
 IN-CAL RELAY NU
 Update and Quit
```

Figure 26: Analog Outputs Screen

8.5.2.1 Zero Point

The **Zero Point** input corresponds to the lowest voltage or current output (0 VDC, 4 mA) that is sent to a recorder, while the **FS** (Full Scale) input corresponds up to the maximum voltage or current output (1/2/5/10 VDC and 20 mA) is sent. The full scale point is set in the range from 0.000 ppm to 9.999 ppm.

NOTE

The voltage or current output accurately tracks up to -5% of the full scale range selected. For example: F.S.=0.100 ppm, Zero=0.0 ppm, Analyzer output tracks down as low as -5 ppb.

8.5.2.2 Output Ranges

Often in pure gas monitoring applications, the 0-10 VDC and/or 4-20 mA analog outputs are set to scale over a low range (normal scale) of concentrations for example 0.0 – 0.02 ppm. As a result small changes can easily be detected on a chart recorder or external data acquisition system. On the other hand, a process upset would quickly exceed full scale. As a result, by use of the Expanded Range Scale, the upset can still be monitored as the analyzer automatically switches to the higher scale. And conversely, when the oxygen reading has dropped back to 95% of the normal scale the analyzer will switch back down.

Both analog output ranges can be selected from Figure 26. The range of the Primary Full Scale (FS) must be less than that of the Expanded Full Scale (Expand FS). Both output ranges are available through pins A Out + and A Out – on the J10 connector on the rear of the analyzer. The analyzer auto-ranges between the two outputs depending on the current analyzer reading.

A window as narrow as 10 percent of the analyzer's decades (0 to 10 ppm, 0 to 1 ppm, 0 to 100 ppb) can be set for the full-scale analog output. Analyzers are shipped with a factory setting of 0 to .100 ppm on the primary scale, 0-1 ppm on FSA, and 0-10 ppm on FSB. This range changes if a new Zero Point or Full Scale is entered. The analog output range is displayed under the oxygen reading on the Data Display Screen. The units are always expressed in ppm.

8.5.2.3 Expanded Range Relay

Any installed relay can be assigned to the Expanded Range function. When the analyzer’s reading causes a change to the analog output scale, the assigned relay trips indicating that the analyzer has auto-ranged to a different analog output scale.

8.5.2.4 Cal Freeze

When **CAL FREEZE** is ON, the system holds the oxygen analog output at the last reading prior to entering a calibration sequence. When this option is OFF, the oxygen analog output follows the calibration measurement. Using ↵ toggles 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.

CAL FREEZE only activates when entering a calibration sequence. Selecting **CAL FREEZE** ON does not freeze the output in real time.

8.5.2.5 IN CAL Relay Assign

IN CAL RELAY ASSIGN is used to assign one of four optional relays to signal an external device that the analyzer is in the calibration mode. Sequentially pressing ↲ toggles among **NU**, **1**, **2**, **3** and **4**.

The assigned relay trips when the analyzer is performing a zero or span calibration. Following a successful completion of either a Manual or Automatic calibration process, the relay releases after about a two minute delay which allows the electronics to stabilize.

After entering the CHECK/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):

If the oxygen reading is above the Lowest Active High Alarm Set Point (minus its deadband), the instrument releases 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.

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 releases the in-Cal Relay upon the completion of an AutoSpan/AutoZero or entering Update and Quit after a manual span or zero.

The user can control the length of time following a span calibration that the analyzer is given before reporting data, to ensure the reliability of the 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.

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. This alarm can be configured as just a visual alarm. No audible annunciation or relay action is needed for this alarm.

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 is informed not to use oxygen data until the oxygen readings are safely below the alarm level.

Choose the highest level that is safely below the maximum contamination level to minimize the amount of time that the analyzer is signaling 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 1to 3 hours to be safely below 10 ppb. The lower the Lowest Active High Alarm Set Point (minus deadband) is set, the longer it takes 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 judgment criteria to release the relay is met within 12 hours, the relay is released.

8.5.3 Communications Port

Select Communications Port from the Setup Analyzer Menu (Figure 19). This COMM SETUP Screen (Figure 48) is used to edit information about the external communications port.

Data Display ⇨ Main Menu ⇨ Setup ⇨ Comm Port

```
      COMM SETUP
*Port (RS232)
 Device ID: 1
 Baud: (9600)
 Update and Quit
```

Figure 27: COMM SETUP Screen

Port - Used to indicate if the data is in the format of RS-232C **(232)**, the RS-485 **(485)** 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 is sent. The device number can be edited. **ID:** must be set even if the RS-232 mode is used. Pressing ↵ to enter thye field and use the arrow keys to change the number. Press ↵ to leave the field.

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.

8.5.4 Sample GSF

The 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 span calibration gas. Enter the Sample GSF Menu through the Setup Analyzer Menu (Figure 19).

In many applications, the sample GSF does not need to be altered from the default value of 1.00. However, if the sample gas has a significantly different diffusivity compared with 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
Nitrogen	N_2	1.00
Argon	Ar	1.03
Hydrogen	H_2	0.61
Helium	He	0.69
Carbon Monoxide	CO	1.01
Ammonia	NH_3	0.90
Nitrous Oxide	N_2O	1.11
Sulfur Hexafluoride	SF_6	1.84
Trifluoro-methane	CHF_3	1.24
Tetrafluoro-methane	CF_4	1.61
Hexafluoroethane	C_2F_6	1.97
Octafluoropropane	C_3F_8	2.30
Methane	CH_4	0.94
Ethylene	C_2H_4	1.10
Ethane	C_2H_6	1.15
Propylene	C_3H_6	1.22
Butane	C_4H_{10}	1.48
Hexane	C_6H_{14}	1.75

Table 11: Gas Scale Factors

Select **Sample GSF** to see the first, second and third pages of the Sample GSF Menu (Figures 40, 41, and 42).

Data Display ⇨ ***Main Menu*** ⇨ ***Setup*** ⇨ ***GSF***

```
GAS FACTOR (%)
N2:          0.00%
Ar:          0.00%
H2:          0.00%
He:          0.00%
CO:          0.00%
NH3:         0.00%
N2O:         0.00%
SF6:         0.00%
```

Figure 28: First Page of Sample GSF Menu

The Sample Gas Scale Factor allows the user to enter the composition of the sample gas, from which the correct GSF is calculated. Entries for additional gases can be accessed by using the ▲ or ▼ key to scroll through the list. The entries spread across three screens. Selecting **More Gases** gives access to the additional choices, shown in Figure 29. 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. Entries to the second page of the Sample Gas Scale Factor Menu are added to entries on the first page to calculate the correct GSF.

```
GAS FACTOR (%)
CHF3: 0.00%
CF4:  0.00%
C2F6: 0.00%
C3F8: 0.00%
CH4:  0.00%
C2H4: 0.00%
C2H6: 0.00%
C3H6  0.00%
```

Figure 29: Second Page of Sample GSF Menu

NOTE

An error message appears if the sum of gases does not equal ***100*** *percent. If that occurs, adjust one (or more) value(s) and press* ↵ *again.*

```
GAS FACTOR (%)
C4H10:      0.00%
C6H14:      0.00%
GSF: 1.000
Update and Quit
```

Figure 30: Third Page of Sample GSF Menu

Entries to the third page of the Sample Gas Scale Factor Menu are added to entries on the first and second pages to calculate the correct GSF. When the composition of the gas has been entered, move the asterisk to **Update and Quit** and press ↵. The GSF is 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 percent, just manually enter a GSF of 1.00. Using the ▲, ▼ and ↵ keys to enter the value.

Call Delta F at (781) 935-5808 for assistance with gases not listed above.

8.5.4.1 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 85-90% accurate. In addition, there is further error introduced when correcting for a "multi" component background gas. This may result in an additional 3-5% 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 Calibration standard that 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 percent hydrogen and 50 percent nitrogen, and a safer gas mixture can be used for calibrating such as 45 percent helium and 55 percent 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 by calling the Service Line at (781) 935-5808.

8.5.5 Oxygen Calibration Menu

The Oxygen Calibration Menu is entered from the Setup Menu, as show in Figure 19, when the user wants to check the calibration or recalibrate the analyzer. The Oxygen Calibration Menu is shown in Figure 31.

Calibrating the Analyzer

The analyzer can be calibrated by selecting **Oxygen Calibration** from the Setup Menu, Figure 19. This menu leads to other menus that provide options for automated (with optional equipment) and manual calibration. A zero or span calibration can be independently performed in either the automated or the manual mode.

Data Display ⇨ Main Menu ⇨ Setup ⇨ Oxygen Calibration

```
       OXYGEN CAL

*GSF: 1.00 (N2)
 Check/Adjust Zero...
 Check Adjust Span...
 New Sensor...
 Averaging Filter...
```

Figure 31: Oxygen Calibration Menu

If the analyzer has failed either a zero or a span calibration, a flag is added to the Calibration Menu: **Reset Fail AutoZero flag** or **Reset Fail AutoSpan flag**. To reset the flags, use the ▼ key to scroll to the entry. Use the ↵ key to reset the flag.

The following information should be noted on the calibration log at each zero or span calibration:

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

NOTE

*Over-pressurizing the sensor can result in permanent damage. 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 1.0 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.*

8.5.5.1 GSF (Gas Scale Factor)

See page 60 for information on the Gas Scale Factor function.

8.5.5.2 Check/Adjust 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.

From the **Setup Menu,** select **Oxygen Calibration** and then **Check/Adjust Zero**. The Check/Adj Zero Screen shown in Figure 32 is displayed.

Data Display ⇨ Main Menu ⇨ Setup ⇨ Oxygen Calibration ⇨Check/Adjust Zero

```
      ZERO CHECK
 O2:       0.0 PPB
 ZERO REF: 0.0

*CAL Offset: 0.0
 ZERO GAS (OFF)
 AUTO ZERO
 MANUAL ZERO
 Update and Quit
```

Figure 32: Check/Adjust Zero Screen.

O2: Displays the current oxygen measurement.

If the system has been previously re-calibrated by the user, an additional line is added to the Check/Adj Zero Screen, that states **Remove Zero Adjust** as shown in Figure 33.

The **Zero Reference** value is a reflection of the deviation of the zero current from the original factory calibration. Instruments are shipped from the factory with the zero reference set to 0.00. After a manual or autozero is performed, the zero reference may change slightly. If for example, the analyzer is reading 3.0ppb, and the zero is set by the user to read 0.00ppb, the zero reference will then equal 3.0ppb.

NOTE: The Zero Reference should not fall outside the range of –10 to +75. If the value is outside these limits contact Delta F.

Selecting **Remove Zero Adjust** restores the factory calibration data and resets the Zero Ref to 0.0.

```
       ZERO CHECK
 O2:      0.0 PPB
 ZERO REF: 0.0
 Remove Zero Adjust
*CAL Offset: 0.0
 ZERO GAS (OFF)
 AUTO ZERO
 MANUAL ZERO
 Update and Quit
```

Figure 33: Restore Zero Adjust

8.5.5.2.1 CAL Offset

Upon initial startup of the analyzer, and whenever the electrolyte is changed, the electrolyte itself causes a higher current to flow than normal. As the electrolyte ages (for a period of about 3 weeks) the zero current gradually decreases. To prevent this decrease from causing a display of negative oxygen concentration, the **CAL Offset** can be used. A value from 0 to 9.99 ppb can be set. The value does not effect zero calibration; it is simply added to the calibrated zero.

For example, an offset of 1.0 ppb could be put into an analyzer reading 0.0ppb to allow a chart recorder attached to the output to read slightly above zero. Under these conditions the analyzer will read 1.0 ppb.

8.5.5.2.2 Zero Gas

The Zero Gas Valves selection toggles RELAY 5 **ON (Open)** or **OFF (Closed)**. The relay terminals are located at the back of the instrument on connector J-9, labeled RELAY 5+ and RELAY 5 -. This function is used to manually control the zero gas valve when the instrument is equipped with Delta F's optional Automated Calibration System or with the External/User Calibration Components option.

NOTE

The gas purifier supplied by Delta F Corporation has a finite life that 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.

8.5.5.2.3 AutoZero

When an optional Automated Calibration System or Automated Control of External/User-Supplied Components is supplied, Auto Zero initiates a sequence to automatically perform a calibration between the electronic zero and the sensor, accept the new calibration data, and then automatically return the analyzer to the process measurement mode. Selecting this entry first brings up a warning regarding the importance of purging the analyzer well as shown in Figure 35 and then brings up Figure 34: Auto Zero Screen.

NOTE

This selection should be made only after the analyzer has been operating on zero gas with a stable output. Use a chart recorder to determine whether the output is stable.

To prevent erroneous data logging or alarming by an upstream data acquisition systems, the oxygen analog output can be automatically frozen in the state just prior to calibration. The output resumes normally once the calibration is completed. To activate this option, set **CAL FREEZE** to **ON** (see Analog Outputs Screen, Figure 26).

Data Display ⇨ Setup ⇨ Oxygen Calibration

⇨Check/Adjust Zero ⇨ AutoZero

```
      ZERO CHECK

ZERO:    1.0 PPB
ZERO GAS (ON)
     AUTO ZERO ON

 20   15   10   5   0
        Minutes
```

Figure 34: Auto Zero Screen.

Selecting **AutoZero** from the Check/Adjust Zero Menu begins the process of verifying or recalibrating zero. The Process Mode can be restored manually by pressing **ESC**, or it is automatically restored at the completion of the AutoZero cycle.

ZERO: Displays the current oxygen measurement.

ZERO GAS – Notification of gas valve states. No user action is available.

AUTOZERO CYCLE CLOCK - Displays a graphical timer that begins counting down from 20 minutes. The first 15 minutes is allowing for equilibrium to take place and during the last 5 minutes of the cycle, the analyzer applies stability criteria. If the oxygen reading has acceptable stability the analyzer automatically accepts the reading, updates the **ZERO Reference**, and returns to the Data Display Screen. If the reading is not stable, the analyzer continues the stability monitoring until the criteria has been met.

After the analyzer completes the AutoZero cycle, the display returns to the Data Display Screen . (see Figure 15). The automated calibration system control relays

(relays 5 and 6) de-energize returning the analyzer to operation on process gas. The Data Display screen indicates **ZERO DELAY** for the next 2 minutes during the electronics zero adjustment before real-time oxygen readings resume. The **CAL FREEZE** and **IN-CAL RELAYS** are released.

NOTE

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

8.5.5.2.4 Manual Zero

The Manual Zero function initiates the zero process. A warning will result, as shown in Figure 35, regarding the need to purge the sensor before a zero calibration is performed.

After a key is pressed to acknowledge the warning, the Manual Zero screen is displayed as in Figure 36 and the zero process begins. At the end of the countdown, the new zero is logged, and the display is returned to Figure 32.

NOTE

This selection should be made only after the analyzer has been operating on zero gas with a stable output. Use a chart recorder to determine whether the output is stable..

If the signal is not stable, such as in the case of a rapidly falling zero baseline after an initial startup, the clock cycle resets to 5 minutes and repeats the procedure. This process continues indefinitely until a stable signal terminates the process. To accept the zero value from the Manual Zero Adjust Screen, press ↵. (The message "↵ to accept present value" is displayed for several seconds, then "ESC to Abort" is displayed.

Data Display ⇨ Setup ⇨ Oxygen Calibration ⇨ Check/Adjust Zero ⇨ Zero Ref

```
        ZERO CAL

The sensor must be fully
purged before setting
Zero. See Manual.

To Continue...
Press any key
```

Figure 35: Purge Warning

Data Display ⇨ Main Menu ⇨ Setup ⇨
Oxygen Calibration ⇨ Check/Adjust Zero ⇨ Zero Ref

```
         MANUAL ZERO

ZERO:    1.0 PPB

       MANUAL ZERO ON
__________________
5          2.5          0
         Minutes
```

Figure 36: Do a Manual Zero Screen

The Zero Reference value changes to reflect the deviation from the original factory calibration. A line is added to Figure 32 below the O2: reading that says Restore Factory Zero. At this point, the user can choose to keep the zero calibration by selecting Update and Quit, return to the previously used Zero Reference value by selecting ESC, or return to the factory calibration by moving the asterisk (*) to Restore Factory Zero and pressing ↵.

The Data Display screen indicates **ZERO DELAY** for the next 2 minutes during the electronics zero adjustment before real-time oxygen readings resume. The **CAL FREEZE** and **IN-CAL RELAYS** are released.

NOTE

*The live **O2** reading as well as the Data Display Screen and every other location where oxygen is displayed indicates **Zero 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 Zero Offset.*

8.5.5.3 Check/Adjust Span

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.

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.*

Selecting **Check/Adjust Span** from the Calibration Menu displays the Check/Adj Span Screen, Figure 37.

Data Display ⇨ Main Menu ⇨ Setup ⇨
Oxygen Calibration ⇨ Check/Adjust Span

```
       SPAN CHECK
 O2:  0.0 PPB
 SPAN REF: 1000

*GSF: 1.00 (N2)
 SPAN GAS (OFF)
 AUTO SPAN
 MANUAL SPAN
 Update and Quit
```

Figure 37: Check/Adj Span Menu

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. Be sure to set the GSF before performing a calibration, if necessary.

It is advantageous to use a span gas with the same background gas as the process gas to minimize stabilization time and reduce the probability of measurement error.

O2 - Displays the current oxygen measurement.

GSF - See page 60 for information on the Gas Scale Factor function.

If an auto calibration system is installed, the **Span Gas** entry toggles *both* RELAYS 5 AND 6 **ON (Open)** and **OFF(Closed)**. The relay terminals are located at the back of the instrument on connector J-9 RELAY 5+, RELAY 5-, RELAY 6+, and RELAY 6-. This function is used to manually control the span gas control valve when the instrument is equipped with an optional automated calibration system.

The **Span Reference** value is a reflection of the deviation from the current user span calibration to the original factory calibration. Instruments are shipped from the factory with the Span Reference set to 1000. After a manual or auto-span is performed this value may change.

NOTE: The Span Reference value should not fall outside the range of 500 to 1500. If the value is outside this range contact Delta F.

If the system has been previously recalibrated by the user, when the **Check/Adjust Span** selection is made, an additional line is added to the Span Check Menu, Figure 38: **Remove Span Adjust**. Selecting **Remove Span Adjust** restores the factory calibration data and resets the Span Ref to 1000.

```
       SPAN CHECK
 O2:  0.0 PPB
 SPAN REF: 1000
 Remove Span Adjust
*GSF: 1.00 (N2)
 SPAN GAS (OFF)
 AUTO SPAN
 MANUAL SPAN
 Update and Quit
```

Figure 38: Remove Span Adjust

NOTE

Protection against false high alarms after a span calibration is provided by the firmware. Following a successful or aborted Span Calibration, the analyzer delays 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.

8.5.5.3.1 Auto Span

If the optional Automatic Calibration System is installed, **Auto Span** initiates an automated calibration using the gas connected to the span port. For best results, make sure the analyzer operates on a low ppb gas for several hours and Zero has been calibrated before performing a span check. All calibrations should be done after the analyzer has operated for over 24 hours and with the door closed.

Hitting Auto Span enables the entry of the **SPAN GAS** value in ppm as shown in Figure 39. The span gas must not exceed 10 ppm and it should have approximately the same composition as the sample gas. Only values less than 10 ppm are accepted.

```
       SPAN CHECK
 O2:  0.0 PPB
 SPAN REF: 1000

*GSF: 1.00 (N2)
 SPAN GAS (OFF)
 SPAN GAS:  1.000
 MANUAL SPAN
 Update and Quit
```

Figure 39: Enter Span Gas Value

After entering the span gas value with the arrow keys, the display automatically turns on the flow of the span gas and shows the Auto Span Screen shown in Figure 40.

Data Display ⇨ Main Menu ⇨ Setup ⇨ Oxygen Calibration ⇨ Check/Adjust Span ⇨Auto Span

```
       SPAN CHECK

O2: 0.0 PPB
SPAN GAS (ON)
      AUTO SPAN ON

20   15   10   5    0
        Seconds
```

Figure 40: Auto Span Screen

O2 - Displays the current oxygen measurement.

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

AUTOSPAN CYCLE CLOCK - Displays a graphical timer that begins counting down from 20 minutes. The first 15 minutes is allowing for equilibrium to take place and during the last 5 minutes of the cycle, the analyzer applies stability criteria. If the oxygen reading has acceptable stability the analyzer automatically accepts the reading, updates the **ZERO Reference**, and returns to the Data Display Screen. If the reading is not stable, the analyzer continues the stability monitoring until the criteria has been met.

If the **CAL FREEZE** selection is **ON**, the analyzer output is frozen at the value prior to entering the calibration.

If the **IN-CAL RELAY** 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 changes state upon entering the CALIBRATION screen.

After the analyzer completes the automated span calibration, the display returns to the Data Display Screen and the automated calibration control (relays 5 and 6) returns the analyzer to measuring process gas. However, if the alarms are set, the **CAL FREEZE** and **IN-CAL RELAY** is not 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).

8.5.5.3.2 Manual Span

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 results in a zero baseline that drops slightly over time. The preferred technique is to set the zero baseline prior to the ppm span exposure.

Data Display ⇨ Main Menu ⇨ Setup ⇨ Oxygen Calibration ⇨ Check/Adjust Span ⇨ MANUAL SPAN

```
          SPAN CHECK

O2:  0.0 PPB

        MANUAL SPAN ON
______________________
60    45    30    15    0
           Minutes
```

Figure 41: Manual Span RECAL Screen

A manual calibration can be performed after the span gas is connected and the analyzer is stable. After initiating a manual calibration, it may take up to five minutes before convergence occurs and the 60 second time bar begins to move. 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:

1. Make sure the gas connections are leak free. See the section on *Checking for Plumbing Leaks Using Flow Rate Effects on page 35*.

2. Make sure the sensor has had sufficient time to attain a stable reading on the calibration gas by installing a chart recorder and monitoring the signal over a period of time.
3. Check the electrical connections to the sensor.

NOTE

The IN-CAL Relay and CAL FREEZE function is released in the same manner as that for Auto Span.

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

8.5.5.4 New Sensor

The New Sensor Data Screen displays the calibration values that were established when the sensor and analyzer were calibrated at the factory. If a new sensor is required, the replacement sensor is factory calibrated and arrives with installation instructions that include a new set of Sensor Data values.

NOTE

These values should not be changed unless the sensor is changed.

Data Display ➪ Main Menu ➪ Setup ➪ Oxygen Calibration ➪ New Sensor

```
This option is only to
install a new sensor.
Info supplied by Delta
F is required.

To continue...
Press ↵
```

Figure 42: New Sensor Warning

After continuing, the following screen is displayed.

```
Enter the five 10 digit
numbers shipped with
the sensor.

To continue...
Press ↵
```

Figure 43: New Sensor Instructions

NOTE

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

```
       NEW SENSOR
*(1) 0000000000
 (2) 0000000000
 (3) 0000000000
 (4) 0000000000
 (5) 0000000000
 Update and Quit
```

Figure 44: New Sensor Data

8.5.5.5 Averaging Filter

The *NanoTrace* Oxygen Analyzer is equipped with electronic digital filtering that conditions the output signal to smooth out noise and spikes**.**

The AVERAGING FILTER menu is shown in Figure 45. This menu displays the offset between the displayed reading **O2 AVG:** and the real-time reading **O2 RAW:**. The difference between the two readings illustrates the time lag and noise reduction effects of the filter while in use. Observing the relative changes to these readings can help the user to establish optimum filter settings for a specific process or application. See the tables at the end of this section for a comparison of the various modes and the benefits of each.

Data Display ⇨ Main Menu ⇨ Setup ⇨ Oxygen Calibration ⇨ Averaging Filter

```
     AVG FILTER
AVG: 1.0 PPB
RAW: 1.0 PPB
*Threshold: 0.01
 Filter Weight: 100
 RESP: FAST
 Update and Quit
```

Figure 45: Averaging Filter Menu

8.5.5.5.1 Filter Mode: Weight and Threshold Average

The signal output from the oxygen sensor can be filtered for noise by a Weighted Moving Average Filter. The filter weight is user adjustable for optimum measuring conditions in a particular application. As the weight value is increased, noise is reduced and response time is lengthened. Clearly, the weight should not be set higher than that which yields acceptable peak to peak noise based on the required analytical resolution.

In addition, a second signal conditioning filter can be added to the weighted moving average filter to provide enhanced noise suppression by setting the **Response** parameter to **Low Noise**. The **Low Noise** feature is a rate-of-change filter that retards a rapid rise or fall event which is generally due to electronic noise. As a result, this **Low Noise** filter can be used with lower WEIGHT settings, and is more effective in displaying gradual reading changes which are generally due to real oxygen changes in the process.

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 quickly display a large oxygen intrusion. Experience with a particular application determines optimum settings for Weight, Response, and Threshold settings.

8.5.5.5.2 Using Weight and Threshold Filtering

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

Filter Weight - 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 percent of a step change. (See examples that follow.)

Response Type - The user may choose **FAST** or **LOW NOISE**. The LOW NOISE setting applies additional filtering (typically a factor of two) to the signal.

Threshold - The Filter Threshold setting is in ppm units. Filtering is active for oxygen concentrations changes below the user set value. When the concentration change exceeds the threshold value, the filtering functions are deactivated. While the filtering is deactivated, a real-time rate of change to the measured value is displayed. This feature allows the user to apply heavy signal noise reduction, while maintaining real-time, high-speed response for larger oxygen changes.

EXAMPLE: With settings of **Weight: 100**, and **Response Type: FAST**, the time to reach 99.9 percent of a step change is ~200 seconds (2 x 100); with a setting of **Response Type: LOW NOISE,** the time to reach 99.9 percent of a step change would be ~400 seconds.

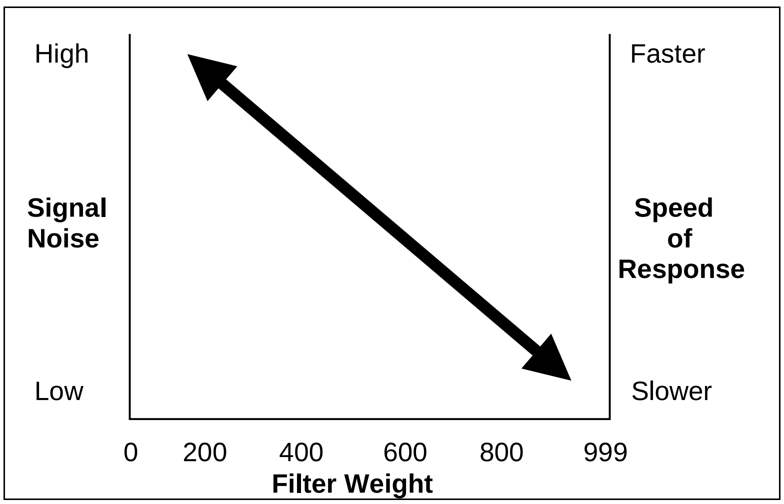


Figure 46: Effects of Filtering

This example assumes that the oxygen change is less than the setting of **Threshold**. As such, the filtering is not interrupted to permit quicker response. If **Threshold** is set to 0.01 (10 ppb), then filtering is deactivated when a change in the raw signal is more than 10 ppb different from the averaged signal. Filtering is 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. As a result, low **Threshold** settings can dramatically increase the analyzers speed of response.

8.5.5.5.3 Summary of Signal Filter Modes

>1.0 ppb	w/Low Noise
Initial startup or upset recovery	w/Fast Response

Table 12: Signal Filter Mode

	Weight	Threshold	Response
< 2 ppb	> 500	> 0.02	Low Noise
< 10 ppb	> 100	> 0.01	Low Noise or Fast
> 10 ppb	< 100	.01	Fast
Upset Recovery	0-100	.01	Fast

Table 13: Typical Weight and Threshold Filter Settings by O2 Level

The following table provides nominal filtering values for a variety of applications. These recommendations should be used as a starting point for setting the Averaging Filter. Experience with the specific application leads to optimum settings.

Weight	Response Type	Peak to Peak Noise
999	Low Noise	<0.10 ppb
500	Low Noise	0.15 ppb
200	Low Noise	0.20 ppb
200	Fast	0.30 ppb
100	Fast	0.35 ppb
50	Fast	0.40 ppb

Table 14: Typical Peak to Peak Noise by Filter Setting

NOTE

*Use **Reset Averaging Filter** in the Controls Menu to restore operation after a spike.*

NOTE

The following settings are preset from the factory: Weight = .01 ppm, Threshold = 100 and Response = FAST.

8.5.5.6 Backlight

A light behind the display allows for easier viewing. To minimize power consumption, this light can be turned off or set to automatically light when the keypad is used, and turn off after a preset time. Use the ▲ or ▼ keys to toggle the backlight to ON, 5 Min Timeout (automatically turns off after 5 minutes idle), 15 Min Timeout (automatically turns off after 15 minutes idle) or OFF.

Note: The Backlight option activates immediately. Scrolling to “Update and Quit” is not required for input to take affect.

Data Display ⇨ Main Menu ⇨Setup ⇨Backlight

```
        BACKLIGHT

*MODE: ON
 Timeout: NA
 Update and Quit
```

<u>Figure 47: Backlight Screen</u>

8.6 Password Protection

The Platinum Series NanoTrace Oxygen Analyzer includes password protection that can be used to limit access to the menus.

The password operates on two levels, a Master Password for a higher level control of the system, and a Operator Password to allow partial access to the system. If the selected level requires a password, the display presents a password prompt.

The Password Menu is displayed in Figure 48.

NOTE

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

Data Display ⇨ Main Menu ⇨ Password Menu

```
       PASSWORD
*Operator Password
 Master Password
 Controls
 Setup
 Diagnostics
 Update and Quit
```

Figure 48: Password Menu Screen

The **Master Password** is required for all levels marked M under **Setup** (see below).

The **Operator Password** is required for all levels marked O under **Setup**.

When **Password Required** is set **OFF**, no passwords are required. When it is set **ON**, Password protection is activated.

Setup allows access to all the NanoTrace menus. Pressing ↵ at any editable point toggles the option through M (Master password required for access), O (Master or Operator password required for access) and * (no password required for access).

NOTE

When an Analyzer is shipped from the factory, no password is installed.

To set an Operator Password or Master Password, select the desired level. A password consists of a series of one to eight keystrokes using the ESC, ▲, and ▼ keys. Any combination of these keystrokes is acceptable. A typical password is ▲, ESC, ▼, ▼. After the eighth key is pressed for setting the Operator Password, the display automatically skips to the next menu line. If fewer than eight keys are used to set the Operator Password, ↵ must be pressed to enter the password.

After the Password options have been set, select Update and Quit to save the information and return to Figure 19.

NOTE

Once the Master password has been entered on this screen, the system enters into password protection mode, as if that password had been entered after the "Main Menu" selection. Password access remains at the master level until the Main menu is re-selected and a new password is entered.

NOTE

The master password should be recorded in a secure location. If the master password is misplaced, call Delta F at (781) 935-5808.

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

NOTE

A Master Password must be set before an Operator Password is recognized by the analyzer.

8.7 Diagnostics Menu

The Diagnostics Menu is used to test different functions of the analyzer. When this Menu is selected, Figure 49 is displayed.

8.7.1 Sensor Temperature

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

8.7.2 Temperature Compensation

If the analyzer appears to be drifting unacceptably, and with the aid of a recorder it is determined that the drift correlates to ambient temperature changes, the T Comp feature is useful to correct the drifting. The factory setting is indicated by an inverted arrow and the present setting is indicated by a solid line. Use the arrow keys (▲ and ▼) to move the line to different settings corresponding to different amounts of compensation. If the analyzer reading increases with increased temperature (under-compensation), then increase the set point to the right. If the analyzer reading decreases with increased temperature (over-compensation), decrease the set point by moving it to the left.

Data Display ⇨ Main Menu ⇨ Diagnostics Menu

```
      DIAGNOSTICS
Temp: 0.00 C
 TComp....!....
 Test Output
 Test Relays
 Memory Test
 Screen Test
```

Figure 49: Diagnostics Menu

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.

Once the desired compensation has been entered, select Update and Quit. Observe the readings over an extended period (24-to-72 hours) during which temperature changes occur. Refine the compensation adjustment as necessary.

NOTE

Temp. Comp *is designed to correct temperature drift at oxygen levels close to zero (<10 ppb). At higher levels, changing* ***Temp. Comp*** *is not very effective. A* ***Temp. Comp*** *set point is best selected while the analyzer is on zero gas.*

8.7.3 Test Analog Outputs

The Test Output entry is used to calibrate the recorder output. When the Test Output option is selected Figure 50 appears. Use the ↵ and the ▲ and ▼ keys to set the desired output level in percent of full scale. After setting the percent full scale level, press ↵. The analog output response should match the value that was entered. For example, if 80 percent is entered for the percent full scale level, and the analog output is set for 0 to 10 VDC, the analog output is 8.000 VDC.

Data Display ⇨ Main Menu ⇨ Diagnostics Menu ⇨ Test Output

```
Press ↵ to set
DAC to desired
%FS level

*Output: 0.00%

ESC to Quit
```

Figure 50: Test Output

8.7.4 Test Relays

The **Test Relays** selection Figure 51 is used to assure that the relay outputs are functioning. When the Test Relays option is selected, the user is prompted to select the relay number to be tested, using the ▲ and ▼ keys.

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.

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

Data Display ⇨ Main Menu ⇨ Diagnostics Menu ⇨ Test Relays

```
         RELAYS
*RELAY 1 (ON)
 RELAY 2 (OFF)
 RELAY 3 (OFF)
 RELAY 4 (OFF)

 ESC to Quit
```

Figure 51: Test Relays

8.7.5 Memory Test

The Memory Test Screen is used to test the internal memory of the analyzer. When the Memory test option is selected from the Diagnostics Menu, Figure 52 is displayed. Testing takes place automatically.

Data Display ⇨ Main Menu ⇨ Diagnostics Menu ⇨ Memory Test

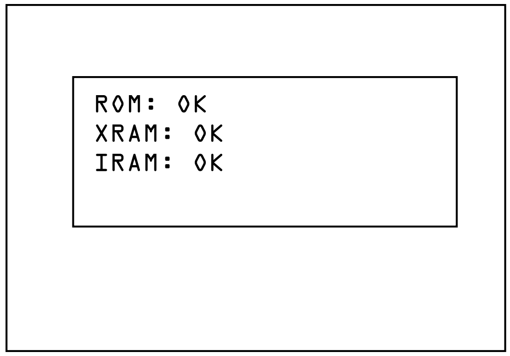


Figure 52: Memory Test Screen

After the test is complete, the display should indicate **ROM:OK**, **IRAM:OK**, and **XRAM: OK**.

If any memory test fails, repeat the test. If a failure repeats, contact the Delta F Service Line at (781) 935-5808.

8.7.6 Screen Test

When the screen test option is selected from Figure 49, 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 49.

If an error message appears or a pixel is inactive, contact the Delta F Service Line at (781) 935-5808.

9 Service

9.1 Return Material Authorization number

If an analyzer has to be returned to the factory, the shipper will have to obtain a Return Material Authorization number from Delta F by calling the Service Line at (781) 935-5808 or sending a written request via their Service Fax Line at (781) 932-0053. See the *Shipping* section for more details.

9.2 Maintenance

9.2.1 Calibration

All 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 12 months using a gas with a known level of oxygen. Span checks can be performed with gases in the range of 0 to 10 ppm. However, reliable standard gas mixtures are readily available in the 4-7 ppm range. Refer to page 39 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 are 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 requires 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	**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

Table 15: Zero Check Frequency

Experience with a particular application determines 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 after exposure to high oxygen concentrations. 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 Active Zero Offset feature is in use, and the "Cal Zero" message appears on the display, it is mandatory to do a zero calibration.

NOTE

If the analyzer is used in a portable mode, the optional isolation valves should be used during transport to preserve the stability of the zero calibration.

9.2.2 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 50° C (122° F). 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.

9.2.3 Sensor Maintenance

The analyzer does not require routine maintenance other than water addition. Exposure to dry gas for an extended time gradually extracts water from the sensor. The water needs 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 is 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 minimum and maximum 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 the *Alarms* section.

9.2.4 Procedure for Adding Water to the Sensor

The procedure to add water to the sensor is as follows:

1. Open the front door.
2. Unscrew the gray sensor cover. Remember, the electrolyte is caustic; be careful of drips of electrolyte from the cover.
3. Slide the cover to one side. It will not fall off, nor can it be removed while the sensor is in the enclosure.
4. Add distilled or deionized water to the DF-EO7 electrolyte solution 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**.
5. Replace the cover securely.
6. Close the front door.

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.

9.2.5 Gas Purifier Maintenance

9.2.5.1 Optional Gas Purifier provides a low oxygen calibration gas (Zero Gas)

The Gas Purifier removes oxygen from typical trace level sample gas stream to provide sub-ppb oxygen concentrations for use as a zero reference gas during Analyzer calibration. Calibration systems are supplied from the Delta F with a

100 ppm-hr installed standard or an optional 3000 ppm-hr purifier can be selected. Replacement purifiers can be ordered from the Delta F Corporation.

NOTE

The gas purifier supplied by Delta F Corporation has a finite life that 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..

9.2.5.2 Determining When to Change the Purifier

In time the active component in the purifier becomes depleted and oxygen breakthrough occurs.

There are two observable signs of breakthrough:

1. 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.)
2. When the zero reference value increases after each successive zero calibration, see the *Troubleshooting* section in this manual.

The following verification test lets you know if breakthrough is occurring, and that the purifier needs to be replaced:

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

9.2.5.3 Preparation for Gas Purifier Removal and Installation

NOTE

*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 -inch open end wrench
- 3/4 -inch open end wrench
- Two VCR-type gaskets and retainers Delta F P/N 60300241 or Cajon P/N SS-4-VCR-2-GR

9.2.5.4 Gas Purifier Change in the Manual and Automated Calibration Systems

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

9.2.6 Gas Purifier Removal/Installation Procedure

The procedure to remove the gas purifier is as follows:

1. The analyzer must be in the process measurement mode by placing the valve handles in the positions as shown in Figure 53: Valve Handle Positions When Changing the Gas Purifier
2. Using the 7/8-inch wrench to backup the fittings, loosen both VCR-type end fittings on the expended purifier with the ¾-inch wrench.
3. Fully unscrew both VCR-type fittings. If necessary, spring the tubing slightly to remove the purifier.
4. Remove the gaskets with their retainers.

9.2.6.1.1 The procedure to install the gas purifier is as follows::

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

NOTE

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.

1. After the expended purifier has been removed, install new gaskets and retainers on the calibration system plumbing.
2. Open the sealed packing bag containing the new purifier.
3. Write the installation date on the gas purifier label.
4. Quickly remove both VCR-type cap nuts from the new purifier.

NOTE

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.

5. Install the purifier with the flow direction arrow as shown in Figure 53. It may be necessary to slightly spring the calibration system plumbing to insert the gas purifier.
6. Screw the fitting nuts at both ends finger-tight.

7. Using a backup wrench at each end of the purifier. Tighten the gas nut 1/4 turn beyond finger-tight.

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.

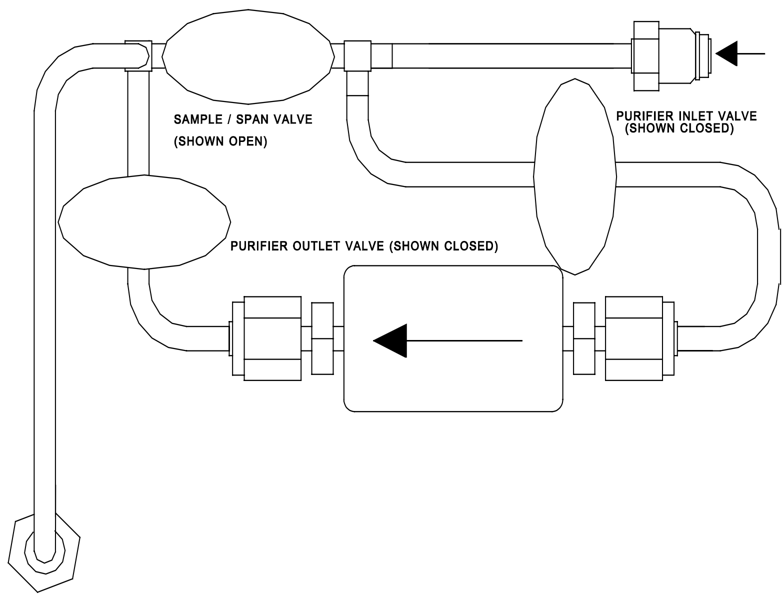


Figure 53: Valve Handle Positions When Changing the Gas Purifier

9.3 Replaceable Spare Parts List

When ordering spare parts, please be certain to supply the model number and serial number of your analyzer.

PART NO.	PART DESCRIPTION
	Printed Circuit Boards
10421920	PCB, Main
10421770	PCB, Display
10322380	PCB, Power Supply
16422640	PCB, Backplane
10315210	PCB, NICAD Battery (Optional)
10421980	PCB, Auxiliary Electrodes Power
16222950	Assembly, LCD Display
	Cable Harnesses And Connectors
13219700	Cable, Sensor Harness (with clips)
13321800	Cable, Display to Backplane, 26 pin ribbon
13215720	Cable, Battery PCB to Backplane (Optional)
13222650	Cable, Auxiliary Power Module to Sensor & Backplane
13320080	Cable, RS232 and RS485 to 9 Pin D-Sub Serial Port Adapter
59017300	Power Cord, 110 VAC
59036140	Power Cord, 220 VAC
50980707	Terminal Block, Plug-In I/O, 8 Pin
50980708	Terminal Block, Connector Key
	Optional Electrical / Electronic Assemblies
44001180	Module, RS-232 Interface
44912314	Module, RS-485 Interface
48100000	Relay, Alarm (SPDT, 5 Amp)
16315700	Battery Pack, NICAD, Spare
14207770	Probe, Temperature Sensor
	Hardware Items
SNT0010	Sensor Cell
16217340	Orifice
60300241	Gasket, VCR
60300268	Gasket, VCR w/filter
83950001	Feet, Rubber
51300017	Switch, Low Flow (Optional)
11220841	Rotometer Without Valve
62000032	Valve, Downstream Sensor Isolation (Optional)
16016910	Cap, Sensor Tank
60002222	Fitting, Outlet Bulkhead, (1/8" Comp)
12415980	Assembly, Welded 1/4" VCR Male Inlet

18422000	Bracket, Sensor Mounting
65001000	Assembly, Handle (Portable Units Only)
	Optional Automated or Manual Calibration System
64102701	Regulator, Pressure
18317330	Bracket, Pressure Regulator
16217280	Purifier, Zero Gas, 1/4" VCR Male
16233870	Purifier, Zero Gas, High Capacity, 1/4" VCR Male
73200040	Fitting, Elbow, Pneumatic, 1/8" NPT X 1/8" Barb
73200000	Fitting, Tee, Pneumatic, 1/8" Barb
73000020	Tubing, Pneumatic, 1/8" OD (4 foot length)
	Miscellaneous / Service Aids
DF-E07	Electrolyte Solution, (100 mL Bottle)
45002301	Fuse, 250 mA (5 X 20 mm) (Main & Cal)
45002361	Fuse, 500 mA (5 X 20 mm) (Main)
45002241	Fuse, 125 mA (5 X 20 mm) (Cal)
99000042	Operations Manual
15024960	B-Size PCB Schematics Package
10315290	Single Width Extender Board
10315280	Double Width Extender Board

Table 16: Spare Parts List

9.4 Troubleshooting

The following *Troubleshooting Guide* helps 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 NanoTrace Analyzer

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

9.4.1.1 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:
	Sensor Electrodes (wht/yel* and wht/red/blk) 1.300 ± 0.005 VDC (NOTE - May be reduced on initial startup by up to 25% due to high O2 levels in electrolyte and resulting higher current)
	Secondary Electrodes (wht/blue* and wht/red) 2.1 ± 0.3 VDC (NOTE - May be reduced on initial startup by up to 25% due to high O2 levels in electrolyte and resulting higher current)
	Stablex Electrodes (white* and blue) 1.55 ± 0.005 VDC (NOTE - May be reduced on initial startup by up to 25% due to high O2 levels in electrolyte and resulting higher current)
	* refers to the common lead of the voltmeter.
D	Measure the DC currents on electrode pairs: Secondary Electrodes 2.0 ± 0.2 mADC (disconnect wht/red wire at reservoir terminal, and insert ammeter between wht/red wire and reservoir terminal) 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 1-3° C higher than current ambient temperature when the door is closed.
F	Reduce the flow of process gas, in particular on light gases such as H2 and He.
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. See page 35.
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 # (781) 935-5808 Fax # (781) 932-0053
J	Adjust Filter Settings to Ultra Low LDL. Transient Rejection ON.
K	Check the span reference, if it is outside the standard limits of 500 to 1500, restore the factory span calibration.
L	Adjust Filter Settings to Weight ≥ 50, Threshold ≥ 0.1, RESP: Faster. See page 75.
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.
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.
S	Make sure the span background gas is properly accounted for using SPAN GSF in the menu.
T	Check the accuracy and age of the calibration reference cylinder.
U	If serial communications are being used, connect a jumper between the Serial Comms connector (J15) pin labeled "GND" with the ground stud on the rear panel of the analyzer.
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.
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).
AA	Remove any devices downstream of the analyzer which may cause backpressure.
AB	Make sure the fan is operating and proper ventilation exists.
AC	Engage the zero purifier if equipped, or install purifier upstream of analyzer

9.5 Shipping

If it comes necessary to return the analyzer to the factory or ship it to another location, please follow the packaging and shipping procedure below in order to prevent damage to the analyzer during shipment.

CAUTION

Do not ship the analyzer with electrolyte - thoroughly drain and rinse sensor before shipping

9.5.1 Shipment Procedure

Note: If you are shipping the analyzer to another location, follow the procedure below. If you are returning the analyzer to the factory, first call Delta F to obtain **a Return Material Authorization number** (see complete details below), then proceed as follows:

1. Turn off the power switch. Disconnect any source of AC power from the analyzer.
2. Disconnect all external electrical connections (for instance, alarms, data output, and so forth).
3. Mark each for reattachment later.
4. Remove the sensor as described in the Adding Electrolyte Procedure on page 10. Be sure to protect the inlet fitting sealing surface by using the supplied green cap or a gasket retainer assembly.
5. Drain the electrolyte into a receptacle suitable for proper disposal.
6. Rinse the sensor with distilled or de-ionized water at least three times. Drain the water into the receptacle.
7. Securely hand tighten the cover.
8. Reinstall the sensor using the two sensor mounting screws.
9. Install the bulkhead lock nut. Cap the inlet fitting to prevent debris from entering.

Put the analyzer in its <u>original</u> container. Ensure that all internal components are adequately secured. It is recommended that bubble packing or similar protective material be added inside the container for added protection.

If you are returning the analyzer to the factory, call the Delta F Service Line at (781) 935-5808 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.

10 Theory of Operation

10.1 The Sensor

The sensor in the NanoTrace Analyzer operates on a Coulometric principle. Oxygen in the sample gas is reduced in an electrochemical reaction that results in a measurable current flow. The use of this technique is widely recognized for its ability to provide a precise oxygen measurement. A schematic of the sensor configuration is shown in Figure 54.

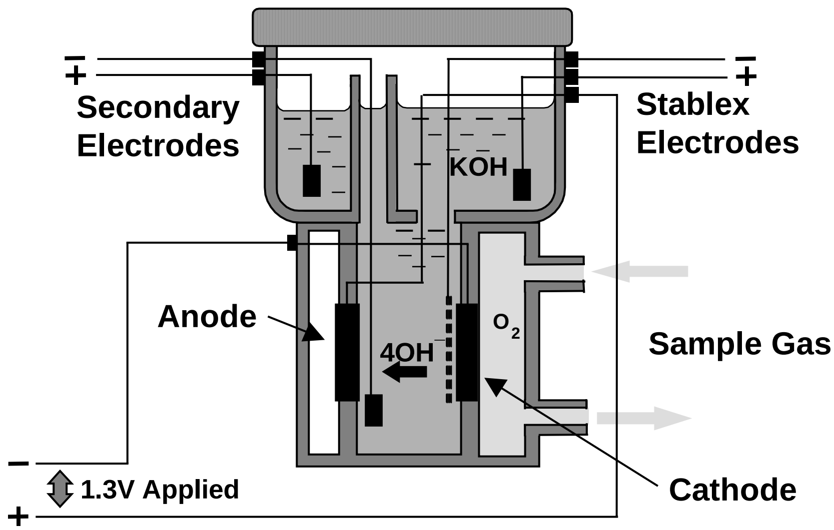


Figure 54: Schematic of NanoTrace II Oxygen Sensor

The sample gas is in direct contact with the sensor cathode. Oxygen in the sample gas is reduced electrochemically at the cathode to hydroxyl ions (OH^-). The electrolyte solution contains potassium hydroxide (KOH) which assists in the migration of hydroxyl ions (OH^-) to the anode where they are oxidized to complete the reaction. A voltage of approximately 1.3 VDC, applied to the sensor electrodes, drives the reduction and oxidation reactions. The current flow resulting from the reaction is proportional to the oxygen content in the sample gas. The processed signal is then displayed on the front panel in ppm or ppb units of oxygen.

10.2 The Electrolyte Conditioning System

The NanoTrace Analyzer is equipped with Delta F's patented electrolyte conditioning system and is composed of two specialized electrode pairs.

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

The Stablex electrode pair effectively isolates the sensor cathode from the 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 and removes the need to sparge the electrolyte. (Sparging involves bubbling pure nitrogen through the electrolyte and it causes significant levels of electrochemical interference to the oxygen measurement process)

11 Safety

11.1 Symbols and Explanations

Following is a list of the various symbols used throughout this manual and their definitions.

This symbol alerts the user to the presence of physically hazardous conditions that may be dangerous to individuals or equipment.

This symbol alerts the user to the presence of important operations and/or maintenance information.

This symbol alerts the user to the presence of caustic liquid. Refer to the MSDS at the back of the manual for handling instructions.

11.2 Terms and 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 setup or operate the Oxygen Analyzer without a complete understanding of the instructions in this manual. Do not connect this Analyzer to a power source until all signal and plumbing connections are made.

CAUTION

This analyzer must be operated in a manner consistent with its intended use and as specified in this manual.

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.

DANGER

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

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

CAUTION

Over-pressurizing the sensor can result in permanent damage to the sensor. Limit the backpressure to the analyzer to ±1 psig.

Be sure the downstream isolation valve (if so equipped) is toggled open ***before*** *gas flow is started.*

CAUTION

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

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:

- Reorient the receiving antenna.
- Move the instrument with respect to the receiver.
- Place the analyzer and receiver on different AC circuits.

11.3 Material Safety Data Sheet (MSDS) for Electrolyte Solution

MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION OF THE SUBSTANCE

Trade Name	Electrolyte Solution, DF-E05, DF-E06, DF-E07, DF-E09
Manufacturer	Delta F Corp., 4 Constitution Way, Woburn, MA 01801-1087, USA, Tel + 1-781-935-4600
Emergency Contact	USA: 1-800-424-9300 International: 1-813-979-0626 (collect)
Supplier and contact in UK (for use in the UK only)	

2. COMPOSITION

CAS #	Component	EC Code/class	Concentration	Risk Phrase	Risk Description
1310-58-3	Potassium Hydroxide in aqueous solution	215-181-3 C	0.77N: 4.3%w/w	R35	Causes severe burns

3. HAZARDS IDENTIFICATION

Main Hazard Corrosive. Causes severe burns on contact with skin, eyes and mucous membrane

CERCLA Ratings (scale 0-3)	Health = 3	Fire = 0	Reactivity = 1	Persistence = 0
NFPA Ratings (scale 0-4)	Health = 3	Fire = 0	Reactivity = 1	

Potential Health Effects:

Eye Contact Causes severe eye burns. May cause irreversible eye injury. Contact may cause ulceration of the conjunctiva and cornea. Eye damage may be delayed.

Skin Contact Causes skin burns. May cause deep, penetrating ulcers of the skin.

Ingestion May cause circulatory system failure. May cause perforation of the digestive tract. Causes severe digestive tract burns with abdominal pain, vomiting, and possible death.

Inhalation Inhalation under normal use would not be expected as this product is supplied as an aqueous solution and no hazardous vapors are emitted. Effects of inhalation are irritation that may lead to chemical pneumonitis and pulmonary edema. Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma.

Chronic Prolonged or repeated skin contact may cause dermatitis. Prolonged or repeated eye contact may cause conjunctivitis.

4. FIRST-AID MEASURES

Skin Contact	In case of skin contact, remove contaminated clothing and shoes immediately. Wash affected area with soap or mild detergent and large amounts of water for at least 15 minutes. Obtain medical attention immediately.
Eye Contact	If the substance has entered the eyes, wash out with plenty of water for at least 15 - 20 minutes, occasionally lifting the upper and lower lids. Obtain medical attention immediately.
Ingestion	If the chemical has been confined to the mouth, give large quantities of water as a mouthwash. Ensure the mouthwash has not been swallowed. If the chemical has been swallowed, do NOT induce vomiting. Give 470 - 950ml (2 - 4 cups) of water or milk. Never give anything by mouth to an unconscious person. Obtain medical attention immediately.
Inhalation	Inhalation under normal use would not be expected as this product is supplied as an aqueous solution and no hazardous vapors are emitted; however, if inhalation should somehow occur, remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Seek medical aid immediately.

5. FIRE FIGHTING MEASURES

Special Exposure Hazard	Not applicable
Extinguishing Media	Not Combustible. Select extinguishing media appropriate to the surrounding fire conditions.
Protective Equipment	Wear appropriate protective clothing to prevent contact with skin and eyes. Wear a self-contained breathing apparatus (SCBA) to prevent contact with thermal decomposition products.

6. ACCIDENTAL RELEASE MEASURES

Personal Protection	Use proper personal protective equipment as indicated in Section 8.
Leaks and Spills	Absorb spill with inert material (e.g., dry sand or earth), then place into a chemical waste container. Neutralize spill with a weak acid such as vinegar or acetic acid.
Clean-up Procedures	Wash the spillage site with large amounts of water.

7. HANDLING AND STORAGE

Handling Precautions	Complete eye and face protection, protective clothing, and appropriate gloves must be used. Do not get in eyes, on skin, or on clothing. Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Do not ingest or inhale.
Storage Precautions	Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Keep away from strong acids.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Personal Protection

Eyes	Wear appropriate protective chemical safety goggles and face shield as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin	Wear appropriate gloves to prevent skin exposure.

Clothing	Wear appropriate protective clothing to prevent skin exposure.
Respirators	Not Applicable. Inhalation under normal use would not be expected as this product is supplied as an aqueous solution and no hazardous vapors are emitted.
Airborne Exposure	This material is supplied as an aqueous solution and will not be present in the atmosphere in normal use.
Exposure Limits	Potassium Hydroxide UK EH40, OEL (8hr TWA) 2mg/m^3 NIOSH, (8hr TWA) 2mg/m^3 ACGIH, Ceiling 2mg/m^3 OSHA, not listed

9. Physical & Chemical Properties

Molecular Formula	KOH Mixture
Physical State	.77N aqueous solution. Colorless, odorless
pH	Alkaline
Solubility	Completely soluble in water
Boiling Point	104.5^{0}C
Melting Point	-3.5^{0}C
Flash Point	Not applicable
Flammability	Not flammable
Explosion Limits	Not applicable
Specific Gravity	1.15
Vapor Pressure	16.1 mm Hg @ 20^{0}C

10. Stability & Reactivity

Chemical Stability	Stable
Conditions/Materials to Avoid	Incompatible materials, acids and metals
Incompatibilities with other Materials	Reacts with chlorine dioxide, nitrobenzene, nitromethane, nitrogen trichloride, peroxidized tetrahydrofuran, 2,4,6-trinitrotoluene, bromoform+ crown ethers, acids alcohols, sugars, germanium cyclopentadiene, maleic dicarbide. Corrosive to metals such as aluminum, tin, and zinc to cause formation of flammable hydrogen gas.
Hazardous Decomposition Products	Oxides of potassium
Hazardous Polymerization	Has not been reported

11. Toxological Information

Toxicity (Potassium Hydroxide)	CAS# 1310-58-3: Oral, rat: LD50 = 273 mg/kg
Carcinogen Status	Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA

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

12. Ecological Information

Mobility	Completely soluble in water
Degradability	Will degrade by reaction with carbon dioxide from the atmosphere to produce a non-hazardous product.

Accumulation	No
Ecotoxicity	Information not available. No long-term effects expected due to degradation. The preparation is already in dilute solution and adverse aquatic effects are not expected due to further dilution. The preparation is corrosive, and direct contact with fauna will cause burns.

13. Disposal Considerations

Waste Disposal	Dispose of in a manner consistent with federal, state, and local regulations.

14. Transportation Information

	Shipping Name	Hazard Class	UN Number	Packaging Group
US DOT	Potassium Hydroxide Solution	8	UN1814	II
IATA	Potassium Hydroxide Solution	8	UN1814	II
ADR/RID	Potassium Hydroxide Solution	8	UN1814	II
IMDG Code	Potassium Hydroxide Solution	8	UN1814	II
Canadian TDG	Potassium Hydroxide Solution	8(9.2)	UN1814	Not Available

15. Regulatory Information

European/International Regulations
European Labeling in Accordance with EC Directives

Classification	Corrosive	
Hazard Symbol	C	
EC Number	215-181-3	
Risk Phrases	R35	Causes severe burns.
Safety Phrases	S1/2	Keep locked up and out of reach of children.
	S26	In case of contact with the eyes, rinse immediately with plenty of water and seek medical advice.
	S36	Wear suitable protective clothing.
	S37/39	Wear suitable gloves and eye/face protection.
	S45	In case of accident or if you feel unwell, seek medical advice immediately (show label where possible).

16. Other Information

MSDS Creation Date: 09/30/94 MSDS Revised: March 4, 2004

The information above 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. Liability is expressly disclaimed for loss or injury arising out of use of this information or the use of any materials designated. Users should make their own investigation to determine the suitability of the information for their particular purpose.

11.4 Material Safety Data Sheet (MSDS) for Gas Purifier

AERONEX
The Source for Gas Purification

AERONEX, INC. • 6975 Flanders Drive • San Diego, CA 92121 TEL 858 452 0124 • FAX 858 452 0229

1.1.1.1 MATERIAL SAFETY DATA SHEET

Hydrogen (H) Gas Purifier Media

Delta F Part Number: 16233870
Patent: U.S. 6,059,859

SECTION 1 - PRODUCT IDENTIFICATION

Trade name and Synonyms: Hydrogen (H) Gas Purifier media
Chemical name: Titanium Dioxide and Nickel
Formula: TiO_2, Ni, NiO
Product CAS No.: Chemical mixture
Product use: Hydrogen Purifier, removes oxygen, moisture and other molecular impurities from H_2 gas and Hydrogen-Inert gas mixtures.

SECTION 2 – COMPOSITION / INFORMATION ON INGREDIENTS

Hazardous components in the solid mixture inside the purifier body

COMPONENT	CAS No.	%	Shipping Hazard
Titanium Dioxide	13463-67-7	20-50	No
Sodium Oxide	1313-59-3	1-3	No
Graphite, Synthetic	7782-42-5	1-3	No
Nickel	7440-02-0	10-30	Yes
Nickel Oxide	1313-99-1	10-30	Yes
Silica, Amorphous	7631-86-9	10-20	No
Magnesium Oxide	1309-48-4	10-20	No

Note: See Section 8 for Exposure Limits and Section 11 for Toxicological Information

SECTION 3 – HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

Black extrusions and Gray Pellets

Odorless

Flash Point: Not Determined

Suspected Cancer Hazard: Risk of cancer depends on route, duration and level of exposure.

Causes eye, skin and respiratory tract irritation. May cause allergic skin and respiratory reaction. Harmful if swallowed. May cause gastrointestinal irritation, headache, nausea, vomiting and diarrhea.

This product will remain stable when housed in the purifier body. When nickel is exposed air at temperatures below 175ºF (79ºC) will remain stable. At temperature above 175ºF (79ºC), oxidation will occur. Nickel when exposed to excess air and moisture, the oxidation process may generate temperatures high enough to cause combustion. Exposing this product to atmospheres containing hydrogen and temperatures above 300ºF (150ºC) will render this product pyrophoric. Exposure of the pyrophoric product to air at room temperature will cause ignition.

Routes of Entry:

Eyes? YES Skin? YES Inhalation? YES Ingestion? YES

Potential Heath Effects:

EYE CONTACT causes irritation.

SKIN CONTACT causes irritation and may cause sensitization or allergic reactions which may be accentuated by heat and humidity. The symptoms of this NICKEL dermatitis, referred to as "nickel itch," may include an itching or burning sensation followed by the eruption of sores.

INHALATION causes upper respiratory irritation. Individuals hypersensitive to NICKEL may develop asthma, bronchitis, shortness of breath or wheezing. Prolonged or repeated overexposure to TITANIUM may cause lung damage.

INGESTION is harmful. May cause nausea, abdominal discomfort, vomiting and diarrhea.

Carcinogenicity: Nickel

NTP? YES IARC? YES OSHA? NO

NICKEL has been classified by both the International Agency for Research on Cancer (IARC) and the National Toxicology Program (NTP) as having sufficient evidence of carcinogenicity in experimental animals. In addition, IARC has determined that there is inadequate evidence of carcinogenicity in humans (Class 2B). The American Conference of Governmental Industrial Hygienists (ACGIH) has categorized nickel as A5 (not suspected as a human carcinogen). In evaluating NICKEL COMPOUNDS, the International Agency for Research on Cancer (IARC) has determined that there is sufficient evidence of carcinogenicity to humans (Group 1). The National Toxicology Program (NTP) lists only certain nickel compounds as substances which may reasonably be anticipated to be carcinogenic. This product contains one of those nickel compounds specifically identified by NTP.

Carcinogenicity: Titanium Dioxide

NTP? NO IARC? NO OSHA? NO

Chronic Health Hazards:

Refer to Potential Health Effects and Carcinogenicity.

Medical Conditions Generally Aggravated by Exposure:

May aggravate existing medical conditions such as allergies, dermatitis, asthma, bronchitis or any other respiratory ailment.

NOTE: See Section 8 for Exposure Limits, Section 11 for Toxicological Information and Section 12 for Ecological Information.

SECTION 4 – FIRST AID MEASURES

In the unlikely event that the purifier media is liberated from the purifier body these health hazards may arise from inhalation, ingestion, and or/contact with the skin and/or eyes

Eye Contact: Immediately flush eyes with plenty of water for at least 15min. Call a physician.

Skin Contact: Immediately wash skin with soap and plenty of water. If irritation persists, call a physician.

Inhalation: Remove to fresh air. If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician.

Ingestion: Get medical attention! If vomiting occurs, keep head lower than hips to prevent aspiration.

SECTION 5 – FIRE-FIGHTING MEASURES

Flash Point: Not Determined
Auto-Ignition: Not Applicable
LEL: Not Applicable
UEL: Not Applicable

NFPA Hazard Classification: Nickel

Health: 1 Flammable: 2 Reactivity: 0

HMIS Hazard Classification: Nickel

Health: 2* Flammable: 2 Reactivity: 0

* Indicates the possibility of chronic health effects. See Chronic Health Hazards in Section 3 for more information.

NFPA Hazard Classification: Titanium Dioxide

Health: 0 Flammable: 0 Reactivity: 0

HMIS Hazard Classification: Titanium Dioxide

Health: 1* Flammable: 0 Reactivity: 0

* Indicates the possibility of chronic health effects. See Chronic Health Hazards in Section 3 for more information

Extinguishing Media: Use water, carbon dioxide or foam.

Special Fire-Fighting Procedures: Wear NIOSH/MSHA approved positive-pressure self-contained breathing apparatus and protective clothing as specified in 29 CFR 1910.156.

Unusual Fire and Explosion Hazards: This product will remain stable when housed in the purifier body. When nickel is exposed air at temperatures below 175ºF (79ºC) will remain stable. At temperature above 175ºF (79ºC), oxidation will occur. Nickel when exposed to excess air and moisture, the oxidation process may generate temperatures high enough to cause combustion. Exposing this product to atmospheres containing hydrogen and temperatures above 300ºF (150ºC) will render this product pyrophoric. Exposure of the pyrophoric product to air at room temperature will cause ignition.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Allow media to cool before taking any action.

Contain spillage and scoop up or vacuum. Avoid dusting. Notification of the National Response Center (800-424-8802) may be required. Refer to EPA, DOT and applicable state and local regulations for current response information.

It is recommended that each user establish a spill prevention, control and countermeasure plan (SPCC). Such plan should include procedures applicable to proper storage, control and clean up of spills, including reuse or disposal as appropriate (see Section 13: Disposal Consideration).

****Note**** In the unlikely event that the purifier media is liberated from the purifier body the above procedures should be followed. Additionally, proper exposure controls and personal protection equipment should be used (see Section 8: Exposure Control/Personal Protection), and disposal of the material should be in accordance with Section 13: Disposal Considerations.

SECTION 7 - HANDLING AND STORAGE

Note In the unlikely event that the purifier media is liberated from the purifier body the following procedures should be observed.

Notify Safety personnel. **Allow media to cool before taking any action**. Wash thoroughly after handling media. Keep container closed. Avoid breathing dust. Keep away from sunlight, heat or fire. Store in cool, dry location away from incompatible materials

SECTION 8 – EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Limits Ingredients:	PEL-OSHA	TLV-ACGIH
Titanium Dioxide CAS NO.: 13463-67-7	10mg/m^3 (Total Dust) 5mg/m^3 (Respirable Dust)	10mg/m^3 (Total Dust)
Sodium Oxide CAS NO.: 1313-59-3	Not Established	Not Established
Graphite, Synthetic CAS NO.: 7782-42-5	2.5mg/m^3 (Respirable Dust)	2mg/m^3 (Respirable Dust)
Nickel CAS NO.: 7440-02-0	1 mg/m^3	1. 5 mg/m^3 (Inhalable Fraction)
Nickel Oxide CAS NO.: 1313-99-1	1 mg/m^3 (as Ni, insoluble compounds)	0.2 mg/m^3 (as Ni, Inhalable fraction)
Silica, Amorphous CAS NO.: 7631-86-9	6mg/m^3	10mg/m^3
Magnesium Oxide CAS NO.: 1309-48-4	10mg/m^3 (Fume, total dust) 5mg/m^3 (Fume respirable fraction)	10mg/m^3 (Fume)

Unless otherwise noted, all values are reported as 8-hour Time-Weighted Averages (TWAs) and total dust (particulates only). All ACGIH TLVs refer to the 1998 Standards. All OSHA PELs refer to 29 CFR Part 1910 Air Contaminants: Final Rule. January 19, 1989.

Respiratory Protection: A NISOSH/MSHA-approved respirator recommended for dust if media is liberated from purifier body.

Ventilation: General; local exhaust ventilation as necessary to control any air contaminants to within their PELs or TEVs during exposure to media

Protective Equipment: Chemical goggles as needed to prevent irritation. Rubber or neoprene gloves. Body protection as necessary to prevent skin contact.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Black extrusions and Grey Pellets

Odor: Odorless

Specific Gravity (H_2O=1): 0.9 g/cc (Bulk Density)

Melting Point: Not Determined

Vapor Pressure (mm Hg): Not Applicable

Vapor Density (Air=1): Not Applicable

Evaporation Rate: Not Applicable

% Solubility in Water: Insoluble

pH: Not Determined

SECTION 10 – STABILITY AND REACTIVITY

Stability: Generally considered stable housed inside purifier body or when properly installed in Inert Gas Systems. Purifier may heat up if used with oxygen or corrosive gases.

Avoid: Heat and humidity.

Incompatibility (Materials to Avoid): Air, strong acids, strong oxidizing agents and mineral acids.

Hazardous Decomposition or By-Products: Toxic emissions may be released in a fire situation. Mineral acids will react with the nickel content to liberate flammable hydrogen gas. Thermal decomposition may produce oxides of Titanium.

Polymerization: Polymerization is not expected to occur.

SECTION 11- TOXICOLOGICAL INFORMATION

Chemical Name	%Wt.	LD50	LC50
Titanium Dioxide CAS NO.: 13463-67-7	20-50	5000mg/kg Rat, Oral	Not Available
Sodium Oxide CAS NO.: 1313-59-3	1-3	Not Available	Not Available
Graphite, Synthetic CAS NO.: 7782-42-5	1-3	Not Available	Not Available
Nickel CAS NO.: 7440-02-0	10-30	Not Available	Not Available
Nickel Oxide CAS NO.: 1313-99-1	10-30	50mg/kg Mouse, subcutaneous	Not Available
Silica, Amorphous CAS NO.: 7631-86-9	10-20	3160mg/kg Rat, Oral	Not Available
Magnesium Oxide CAS NO.: 1309-48-4	10-20	Not Available	Not Available

NOTE: See Section 3, 8 and 12 for additional information.

SECTION 12 – ECOLOGICAL INFORMATION

Ecotoxicity: No data available.

Environmental Fate: No data available.

SECTION 13 – DISPOSAL CONSIDERATIONS

US EPA Waste Number: Not Regulated

Federal, State, and Local disposal laws and regulations will determine the proper waste disposal/recycling/reclamation procedure. All waste materials should be reviewed to determine the applicable hazards (testing may be necessary). Disposal requirements are dependent on the hazard classification and will vary by location and the type of disposal selected.

NOTE Chemical additions, processing or otherwise altering this material may make the waste management information presented above incomplete, inaccurate or otherwise inappropriate.

As local regulations may vary; all waste must be disposed/recycled/reclaimed in accordance with Federal, State, and Local environmental control regulations.

SECTION 14 – TRANSPORT INFORMATION

INTERNATIONAL

UN Number: UN3190

UNITED STATES

EPA Waste Number: Not Regulated
DOT Classification: 4.2 Spontaneously combustible material
DOT Proper Shipping Name: Self Heating Solid, Inorganic, N.O.S. (Nickel mixture)

Packing Group: II

CANADA

PIN Number: UN3190
TDG Class: 4.2 Spontaneously combustible material

EC DGL: Spontaneously combustible substance

SECTION 15 – REGULATORY INFORMATION

US FEDERAL REGULATIONS

TSCA: IN TSCA

SARA 311 and 312 Hazard Categories

Immediate (Acute) Health Hazard: Yes
Delayed (Chronic) Health Hazard: Yes
Fire Hazard: Yes
Reactivity Hazard: No
Sudden Release of Pressure: No

SARA Section 313 Notification:

This product contains a toxic chemical (or chemicals) subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

CHEMICAL NAME	CAS Number	%Wt.
Nickel	7440-02-0	10-30
Nickel Oxide	1313-99-1	10-30

OZONE DEPLETING SUBSTANCES (ODS): This product neither contains nor is manufactured with an ozone depleting substance subject to the labeling requirements of the Clean Air Act Amendments 1990 and 40 CFR Part 82.

VOLATILE ORGANIC COMPOUNDS (VOC): None

US STATE REGULATIONS

CALIFORNIA: The State of California has a regulation (Proposition 65) which identifies specific chemicals known to the State of California to cause cancer or birth defects. Proposition 65 requires a disclosure for products sold within the State of California containing an identified chemical. The following information is required by the State of California for this product:

***WARNING: This product contains chemicals known to the State of California to cause cancer.**

Components: Nickel and Nickel Oxide

VOLATILE ORGANIC COMPOUND (CARB): Not determined

CANADIAN REGULATIONS

DSL/NDSL: DSL
WHMIS Classification: Class B Division 6
Class D Division 2 Subdivision A
Class D Division 2 Subdivision B

EUROPEAN REGULATIONS

EINECS: Yes

OTHER REGULATIONS

MITI (Japan): Yes

AICS (AUSTRALIA): Yes

SECTION 16 – OTHER INFORMATION

Prepared by: Aeronex Inc., Research and Development Department
Phone Number: See Header

All information within this document is believed to be accurate and current. Aeronex does not guarantee the information to be all-inclusive and shall not be held accountable for any damage caused from this product.

12 Warranty

Delta F Corporation 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 Sensor Warranty offers extended protection such that, if any Sensor of a Delta F Oxygen Analyzer fails under normal use within five years from the date of purchase, 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 no additional cost. The original warranty expiration date is not extended by this action.

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.

13 Index

T

U

W

Z