SERVOMEX
ANALYZERS
HIGH-PERFORMANCE GAS ANALYSIS

NanoTrace Dual DF-760ε/760ε Ultra

Installation and Operator Manual

Part Number: **225484**
Revision: **022823**
Language: **US English**

SERVOMEX
a spectris company

IMPORTANT INFORMATION

Continued safe and reliable operation of this equipment is conditional on all installation, operation and maintenance procedures being carried out in accordance with the appropriate manuals, by personnel having appropriate qualifications, experience, and training.

Failure to observe the requirements of the manual may result in the user being held responsible for the consequences and may invalidate any warranty.

Servomex will accept no liability for unauthorized modifications to Servomex supplied equipment.

Servomex has paid particular attention to Health and Safety throughout this manual. Where special precautions need to be taken due to the nature of the equipment or product, an appropriate safety icon and warning message is shown. Special attention should be made to the Safety Chapter if available, where all such messages are summarized.

The user is solely responsible for implementing appropriate environmental monitoring, ventilation, and gas safety controls for flammable and/or toxic gas installations to meet all relevant safety standards including but not limited to those imposed by legal, governmental, statutory, industrial, regulatory and/or corporate requirements.

Servomex 700 Series gas analyzers are not intended for use in applications to which a flammable gas is blended with an enriched oxygen background gas.

In line with our continuous policy of research and development, we reserve the right to amend models and specifications without prior notice.

This handbook is accurate at the date of printing, but will be superseded and should be disregarded if specifications or appearance are changed.

Table of Contents

Table of Figures

About this manual

Safety information

The following icons are used throughout this manual to identify any potential hazards that could cause serious injury to people or damage to the equipment:

This symbol warns of specific hazards which, if not considered, may result in personal injury or death.

This symbol warns of specific hazards from laser radiation.

This symbol alerts the user to the presence of AC voltage that is dangerous to individuals.

Other information provided by the manual

This symbol highlights where you must take special care to ensure the analyzer or other equipment, or property is not damaged.

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

Scope of the manual

This manual is the Installation and Operation Manual for the NanoTrace DF-760E/760E Ultra analyzers. These products are also supported by the DF-700 Series Quick Start Guide, p/n NANOTRACE700Q.

.

Getting Started

Thank you for selecting the NanoTrace Dual DF-760E/760E Ultra Analyzer. Servomex designs, manufactures, exhaustively tests, and supports every analyzer under the tightest quality controls. You can expect every Servomex analyzer to arrive in perfect condition and provide years of trouble-free service if maintained properly. Please call your nearest Servomex Business Center if you need assistance.

Quality

The DF-760E/760E Ultra analyzer has been designed and manufactured under ISO-9001 controls, thus helping to ensure the highest possible standards of quality. Every analyzer that Servomex manufactures is tested to ensure that it functions properly when you receive it.

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

For more information, or if you have questions, please do not hesitate to go to our website at Servomex.com, or contact your local Servomex Business Center as found on the back cover of this manual.

Usage

The DF-760E/760E Ultra analyzer is designed to measure the moisture content of a sample gas. This manual is written with the assumption that the user will be using the analyzer in this fashion. It is assumed that 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.

For a fast and successful start-up, read this manual carefully. The manual contains important cautions, instructions, and guidelines that ensure the successful operation of your analyzer.

Installation and Maintenance

The 760/760E analyzer will provide 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 **Chapter 3, Installation, Start-up, and Shutdown**.

Unlike much UHP analytical equipment, the NanoTrace Analyzer does not require periodic maintenance for its moisture cell and associated electronic components. The analyzer automatically monitors the condition of the Electrolyte in the oxygen cell and notifies the user when replenishment is required. Refer to 8.4 Maintenance for information relating to maintenance requirements for the optional vacuum pump.

1. Safety Summary

1.1 General Warnings and Cautions

WARNING: HAZARDOUS AC

Hazardous AC voltages are present within this instrument. Do not remove the top or left side covers — no user-serviceable parts are located under the covers. Do not connect this analyzer to AC power until all signal cables and plumbing have been connected. Disconnect the analyzer from AC power before installing or removing external connections, or performing service of any kind. Disconnect the analyzer from AC power before moving the analyzer.

WARNING: AC POWER GROUND REQUIRED

Ensure that the power cord ground wire is properly installed in the connector and that connector is plugged into to a grounded outlet. Failure to provide AC power ground is a hazard that may result in electrical shock or death.

WARNING: CHECK AC OPERATING VOLTAGE

The analyzer has been factory set to operate on either 110 or 220 VAC. Check the voltage setting marked near the AC inlet. The analyzer may be damaged if operated on a different voltage than marked. Contact Servomex if you have received an analyzer that is set to operate on a different voltage from your facility supply.

WARNING: HAZARDOUS AC

Hazardous AC voltages are present within this instrument. Do not remove the top or left side covers — no user-serviceable parts are located under the covers. Do not connect this analyzer to AC power until all signal cables and plumbing have been connected. Disconnect the analyzer from AC power before installing or removing external connections, or performing service of any kind. Disconnect the analyzer from AC power before moving the analyzer.

WARNING: Electrolyte is a Caustic Solution

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

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

WARNING: Electrolyte is a Caustic Solution

Do not spill electrolyte on analyzer internal components!!! Permanent damage to analyzer may result if electrolyte is spilled on analyzer components.

CAUTION

Do not set up or operate the 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.

WARNING: ENSURE PROPER CARRYING, LIFTING AND MOUNTING

The weight of this analyzer is greater than 30 kg. Proper methods of lifting and carrying can help to protect against injury. Two individuals should lift and carry the instrument. Make sure to center your balance and properly space your feet shoulder-width apart when lifting the instrument. Bend at the knees and make sure your back is straight. Grip the instrument with your fingers and palms and do not lift unless your back is straight. Lift up with your legs, not your back. Carry the instrument close to your body. Lower the instrument by bending your knees and keep your back straight.

The DF-760E is designed to be rack mounted. Ensure that the rack slides, or support rails, are rated to support a 30 kg analyzer. Use screws in all four front panel rack mount locations.

`

CAUTION: FOR INDOOR USE ONLY

The DF-760E/760E Ultra is designed for indoor use only. It should not be located in an area where it will be subjected to particulate, condensed moisture, caustic atmosphere, temperature extremes, or operation outside of any limits listed in **Chapter 10 Specifications**.

1.2 Laser Safety

The DF-760E/760E Ultra analyzer is a Class 1 laser device (per BS EN 60825-1:2014 and 21CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 56, 5 May 2019).

It contains a laser emitter inside the moisture sensor, which is sealed and not user serviceable. Do not disassemble or modify the moisture sensor. Exposure to laser emissions may result in injury, including damage to the eyes.

1.3 Safety Labelling and General Marking

Location of Informational product marking and safety labelling on the DF-760E is shown in **Figure 1**, **Figure 2**, and **Figure 3**.

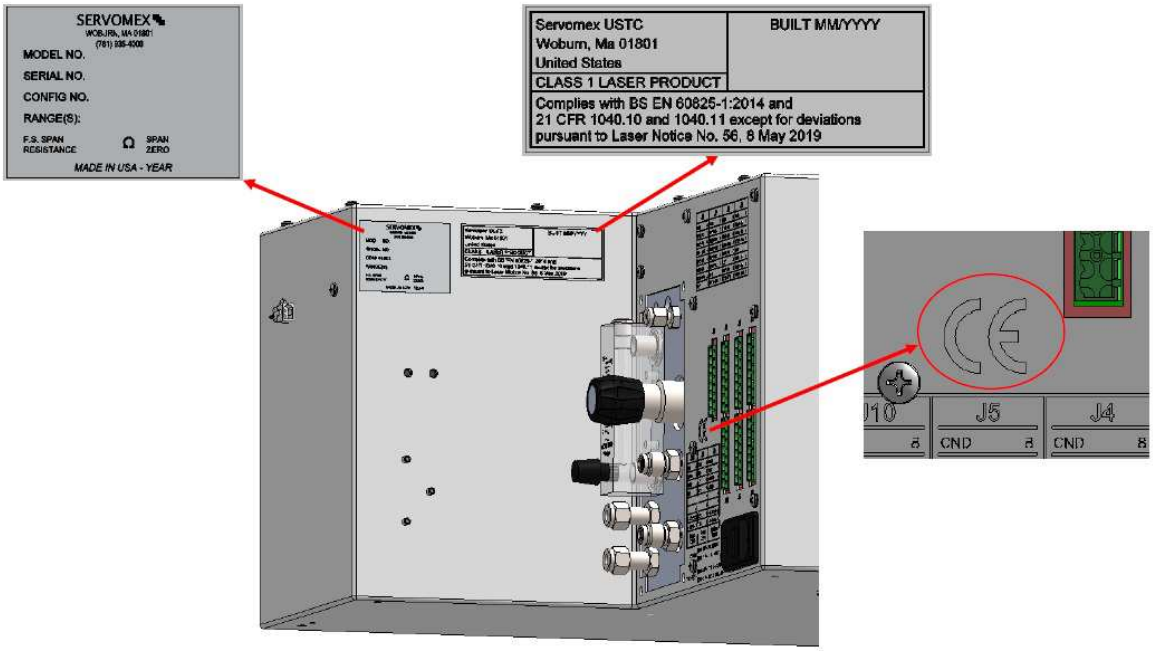


Figure 1: Analyzer Markings Shown in Rear Area View

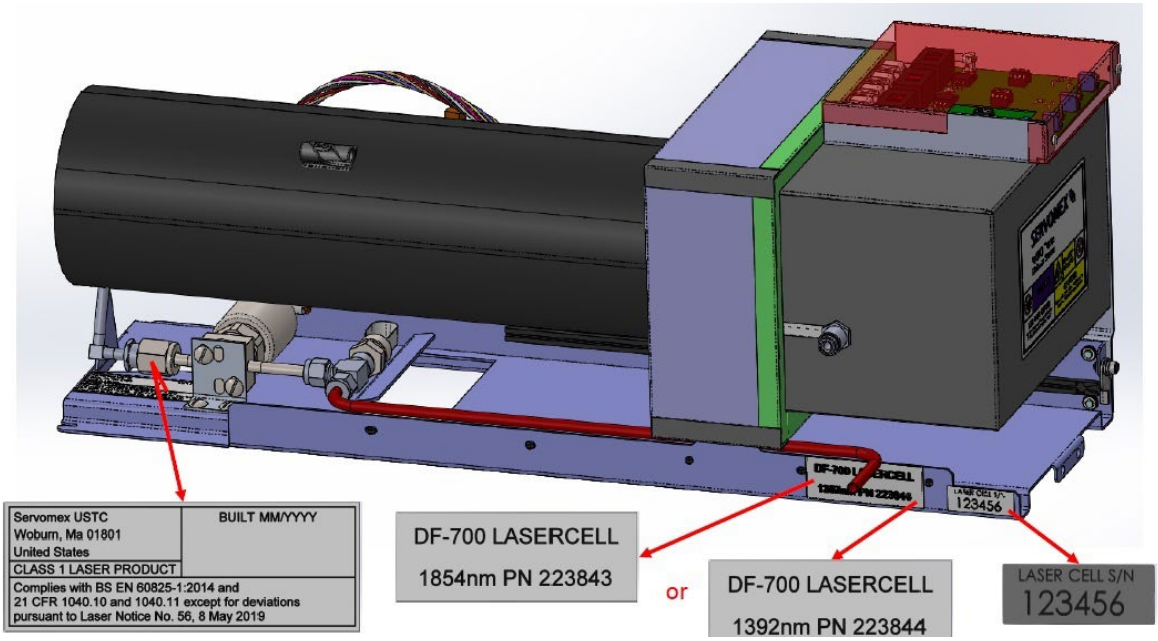


Figure 2: Sensor Markings – Side

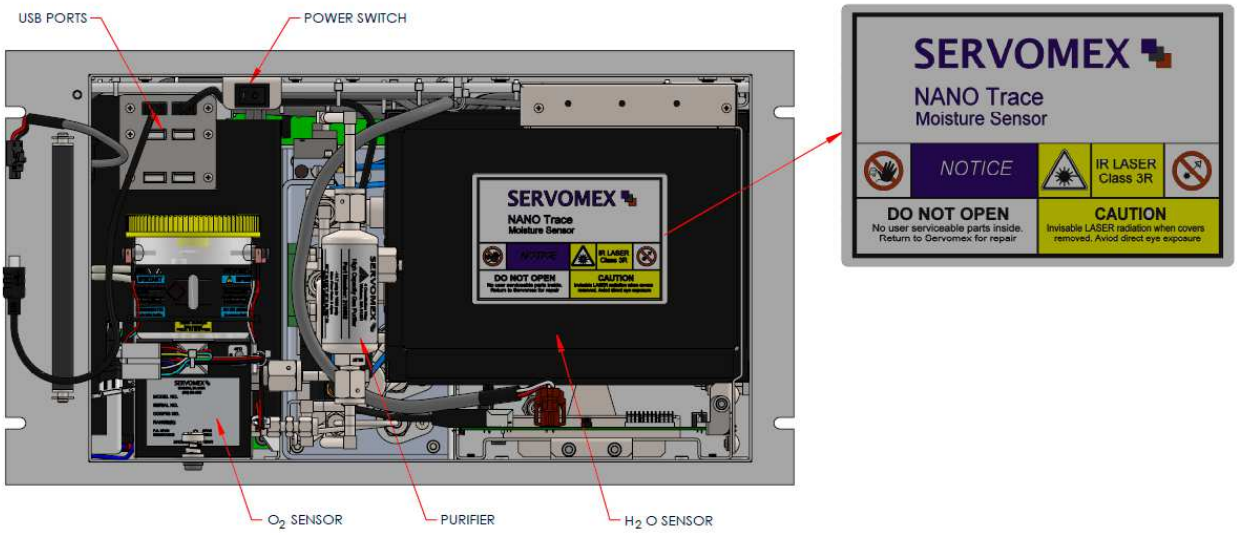


Figure 3: Sensor Marking – Front

2. Introduction

2.1 Product Description

The NanoTrace Dual DF-760E and DF-760E Ultra analyzers are designed for continuous UHP (Ultra High Purity) analysis of moisture and oxygen content in process gases. These instruments have a similar design that includes the following external features: steel chassis enclosure for rack mounting, 6 x 9-inch LCD screen, push-button keys for user-interface, gas panel containing ports for input and output of gasses (process and pneumatic), flowmeter, connectors for digital and analog data output, and an IEC 60320 C-13 receptacle for connection to electrical power. Internal components include a moisture cell, an oxygen cell, gas purifier, valves and plumbing for routing of gases, and electrical and electronic components. The moisture cell, which is a sealed, non-serviceable unit, contains a Class 3 laser for performing moisture analysis using absorption spectrometry. The oxygen cell utilizes the coulometric method for oxygen analysis and includes a reservoir of Electrolyte fluid. A description of the analytical methods used for determining moisture content and oxygen content is provided in **Chapter 9 Theory of Operation.** The DF-760E and DF 760E Ultra are similar in design, layout, and operation, however, the DF 760E Ultra has a lower detection limit for moisture. Refer to **2.2 Specifications Summary** and **Chapter 10 Specifications.**

2.1.1 Product Dimensions

The figures below (Figure 4, Figure 5, Figure 6) provide dimensioned front, rear and left side views of the DF-760E Analyzer.

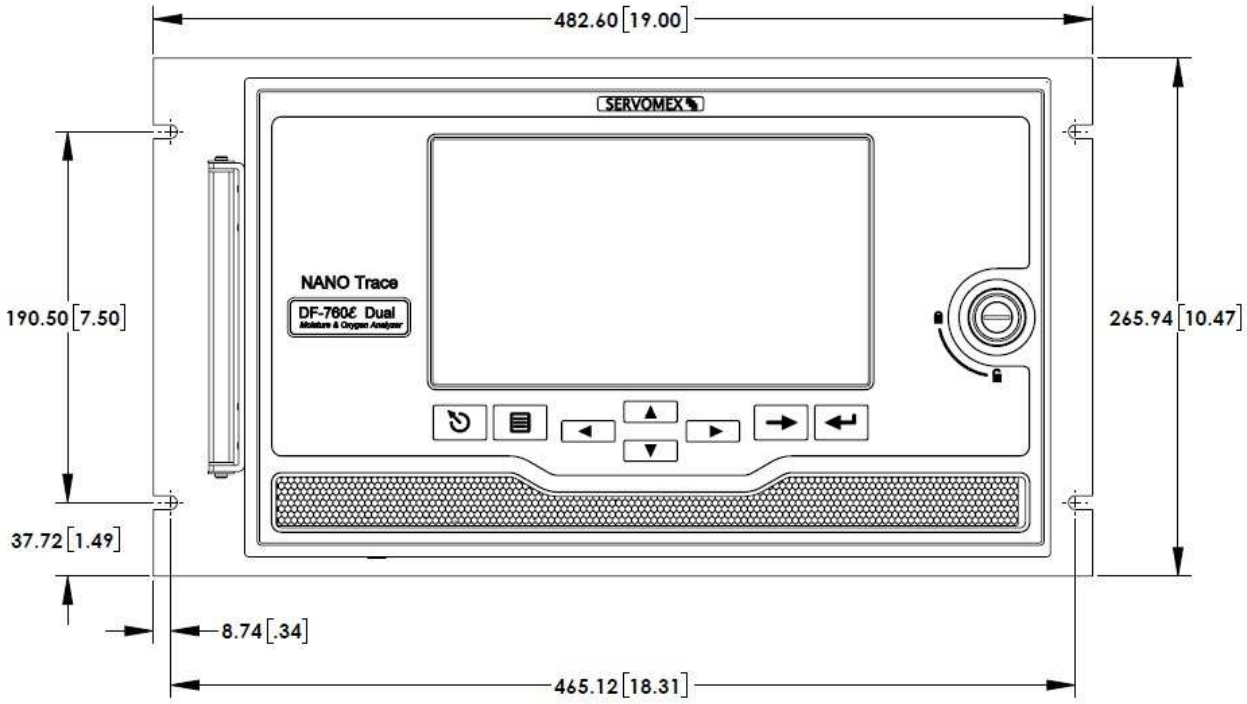


Figure 4: DF-760E Analyzer (front)

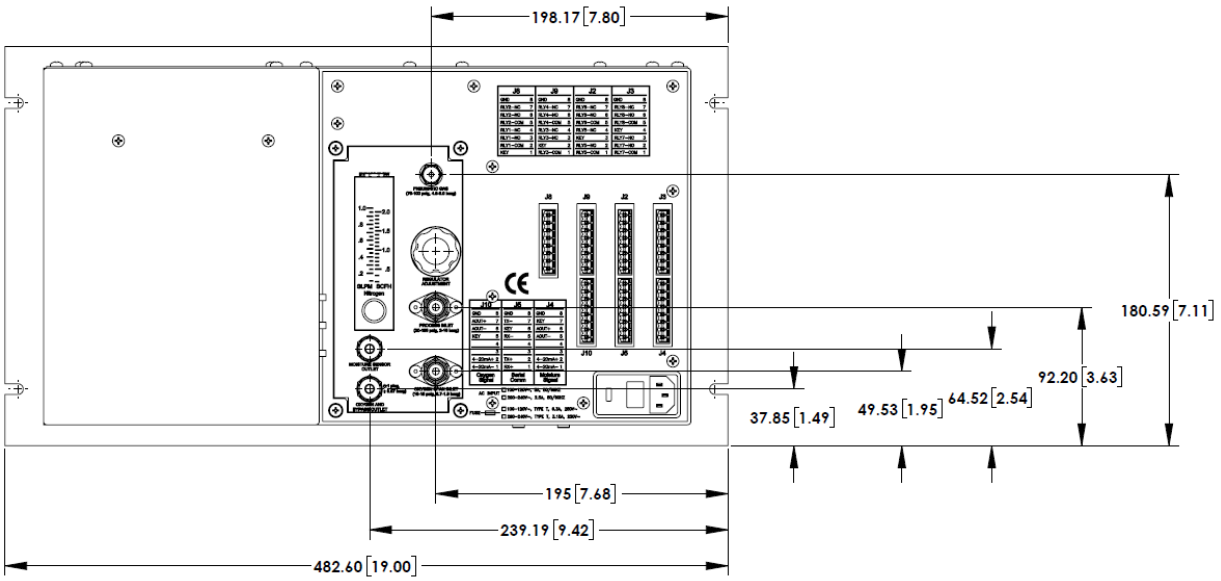


Figure 5: DF-760E Analyzer (rear)

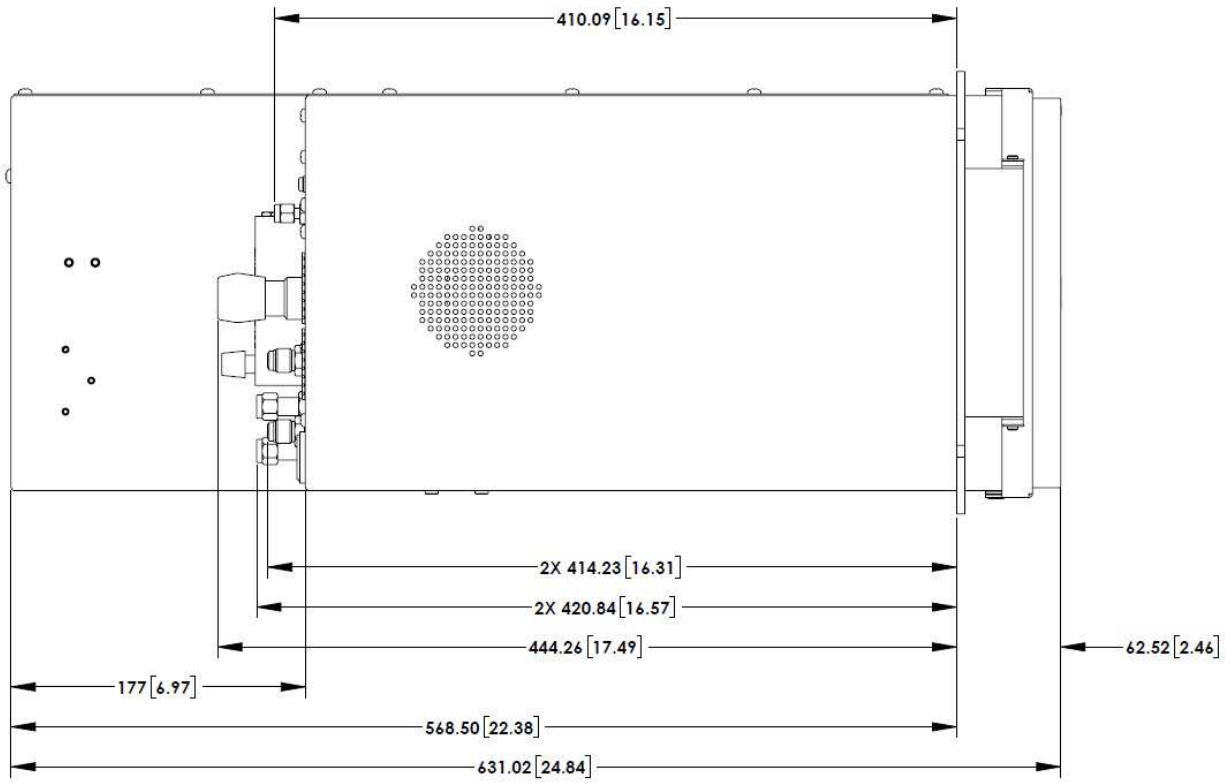


Figure 6: DF-760E Analyzer (left)

2.1.2 Internal Components

Figure 7 depicts the DF-760E/760jE Ultra Analyzer's major internal components.

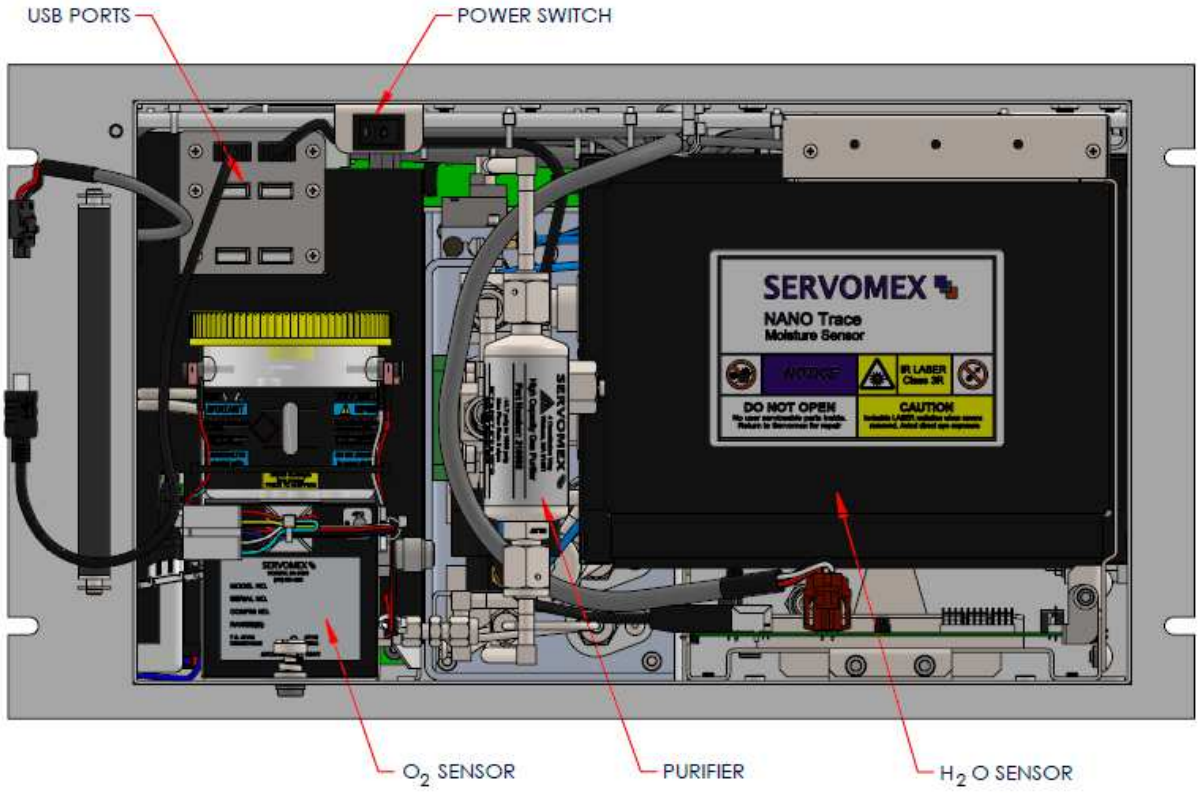


Figure 7: Major Internal Components

2.2 Specifications Summary

A summary of DF-760E/760E Ultra characteristics is provided in the paragraphs below. Complete specifications are provided in **Chapter 10 Specifications.**

2.2.1 Moisture Detection

Lowest Detection Level (LDL) DF-760E: 100 ppt @ Constant Conditions

Lowest Detection Level: (LDL) DF-760E Ultra: 55 ppt @ Constant Conditions

Resolution: Analytical (Smallest Detectable Change): 100 ppt

Accuracy: Greater of ±3% of reading or ±0.2 ppb @ Constant Conditions

Background Gas Compatibility: N_2, H_2, He, Ar, O_2,

2.2.2 Oxygen Detection

Lowest Detection Level (LDL): 45 ppt @ Constant Conditions

Resolution: Analytical (Smallest Detectable Change): 50 ppt

Accuracy: Greater of ±3% of reading or ±0.1 ppb @ Constant Conditions

Background Gas Compatibility: N_2, H_2, He, and Ar

2.2.3 Electrical Requirements

Standard: 100 to 120 VAC, 50/60 Hz, 5 Amps

Optional: 200 to 240 VAC, 50/60 Hz, 2.5 Amps

2.2.4 Laser Specifications

Max Power: 50mW/30mW

Beam Divergence: 436 mrad

Pulse Pattern: CW

Classification**:** The DF-760E/760EUltra analyzers are Class 1 laser products (per BS EN 60825-1:2014 and 21CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 56, 5 May 2019).

2.2.5 Environmental Operating Conditions

General: Indoor use in a clean, dry, non-hazardous area of pollution degree 2, as defined in EN 60664-1

Altitude: 2000 meters (6500 feet), max

Ambient Operating Temperature: 10° C to 40° C (50° F to 105° F)

Humidity: 95% relative humidity, non-condensing

3. Installation, Start-up, and Shutdown

3.1 Unpacking Procedure

Follow the procedure below to unpack your DF-760E/760E Ultra NanoTrace Analyzer:

1. Examine the condition of the packaging and its contents. If any damage is apparent, immediately notify the carrier and Servomex. 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 Servomex immediately.
3. DF-760E/760E Ultra NanoTrace analyzers are shipped with the following:

Item	Part Number
[1]Power cord	2527-0314, 115 VAC Connector (US) 2527-0321, 220 VAC Connector (UK) 2527-0338, 220 VAC Connector (EU)
USB, Clip Flash Drive	220562
VCR Filter Gasket	210432
[2]Aspirator	210566
[2]Pump (optional)	210972, 120VAC 210973, 220/VAC
Instruction Manual (Provided digitally on USB, Clip Flash Drive p/n 220562)	2xxxx
Quick Start Guide (In digital format and stored on USB, Clip Flash Drive P/N 220562)	NANOTRACE700Q
One bottle of Electrolyte[3]	E-Lectrolyte Gold
One bottle of Replenishment Solution[3]	RSA
Zero Gas Purifier[3]	210592
Notes: [1]Customer may select US, UK, or EU style power cable when ordering. If another type is required, cable is customer supplied. [2]If vacuum pump option is selected, aspirator is not supplied, and vacuum pump is provided in separate packaging. [3] Packaged separately	

4. Open the analyzer door, remove any shipping materials, and verify that nothing has come loose during transit.

CAUTION: CHECK AC OPERATING VOLTAGE

The analyzer has been factory set to operate on either 110 or 220 VAC. Check the voltage setting marked near the AC inlet. The analyzer may be damaged if operated on a different voltage than marked. Changing the operating voltage requires the analyzer to be returned to the factory.

5. Examine the voltage indicator on the rear panel to verify that the voltage is set as ordered.
6. Save the original container in the event you may need to ship the analyzer to another location or back to the factory (see Chapter 8 Service).

3.2 Analyzer Installation Overview

Installation of the analyzer requires the following general steps be followed:

1. Mounting the analyzer.
2. Adding Electrolyte to the oxygen sensor.
3. Connecting the N2/Air supply to the aspirator.
4. Connecting an exhaust tube to the aspirator outlet, if needed.
5. Connecting the pneumatic pressure service to the pneumatic inlet fitting.
6. Connecting the sample gas lines to the analyzer inlet fitting.
7. Making the power connection to the analyzer.

3.3 Analyzer Installation

The following steps describe the procedure for installation and initial startup of the analyzer. Installation may be performed only by qualified personnel.

The DF-760E is for indoor use only. It should not be in an area where it will be subjected to particulate, condensed moisture, caustic atmosphere, temperature extremes, or operation outside of any limits listed in **Chapter 10 Specifications**.

1. Position or mount the analyzer in a working location (in instrument rack or on shop table) within 8 feet of gas sources.
2. Open front door of analyzer and locate the oxygen sensor reservoir (see **Figure 8**). Remove the gold cap from the top.

Electrolyte is a caustic solution. Review the Material Safety Data Sheet (MSDS) for electrolytes located in 9.2 Material Safety Data Sheet (MSDS) for Electrolyte Solution before handling the electrolyte solution.

Do not spill electrolyte on analyzer internal components!!! Permanent damage to analyzer may result if electrolyte is spilled on analyzer components.

3. Carefully pour one full bottle (100 ml) of Servomex E-Lectrolyte Gold into the sensor. Reservoir. Replace cap.

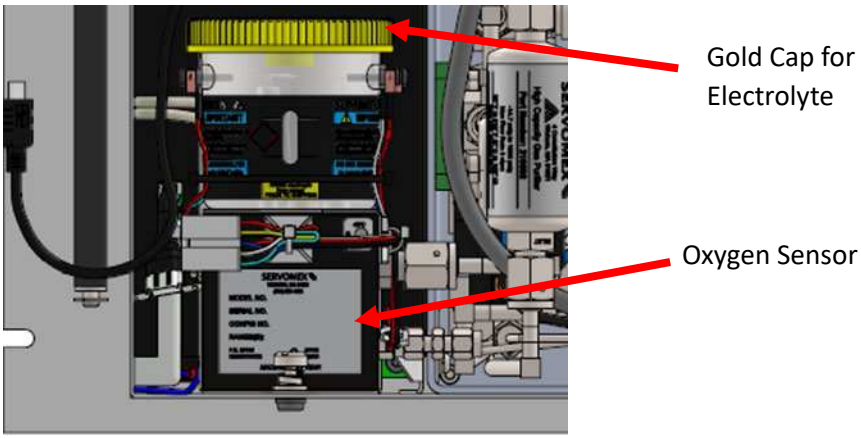


Figure 8: DF-760E Oxygen Sensor

NOTE

Use backup wrenches when removing or installing VCR connectors, otherwise torque may be applied to analyzer plumbing and cause damage.

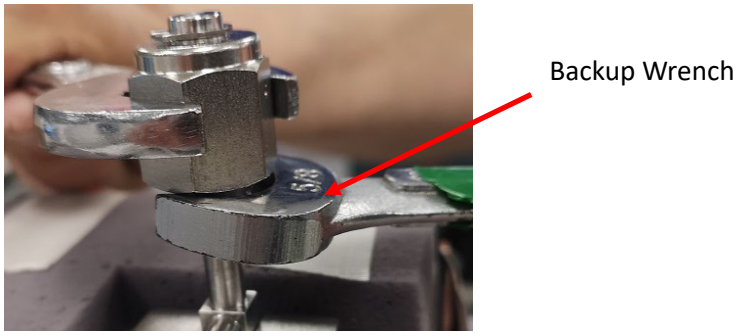


Figure 9: Backup Wrench Use

4. If the analyzer is equipped with the optional Hydrogen Safety System (HSS) install a shut-off valve on the analyzer process gas inlet fitting. Use supplied VCR gaskets when making valve connections. Refer to Figure 10 and Figure 11.

NOTE

VCR gaskets are one-time use only. Replace every time plumbing components are separated. Be sure gasket is clean and free of debris.

Figure 10: VCR Gasket (with supplied mounting bracket)

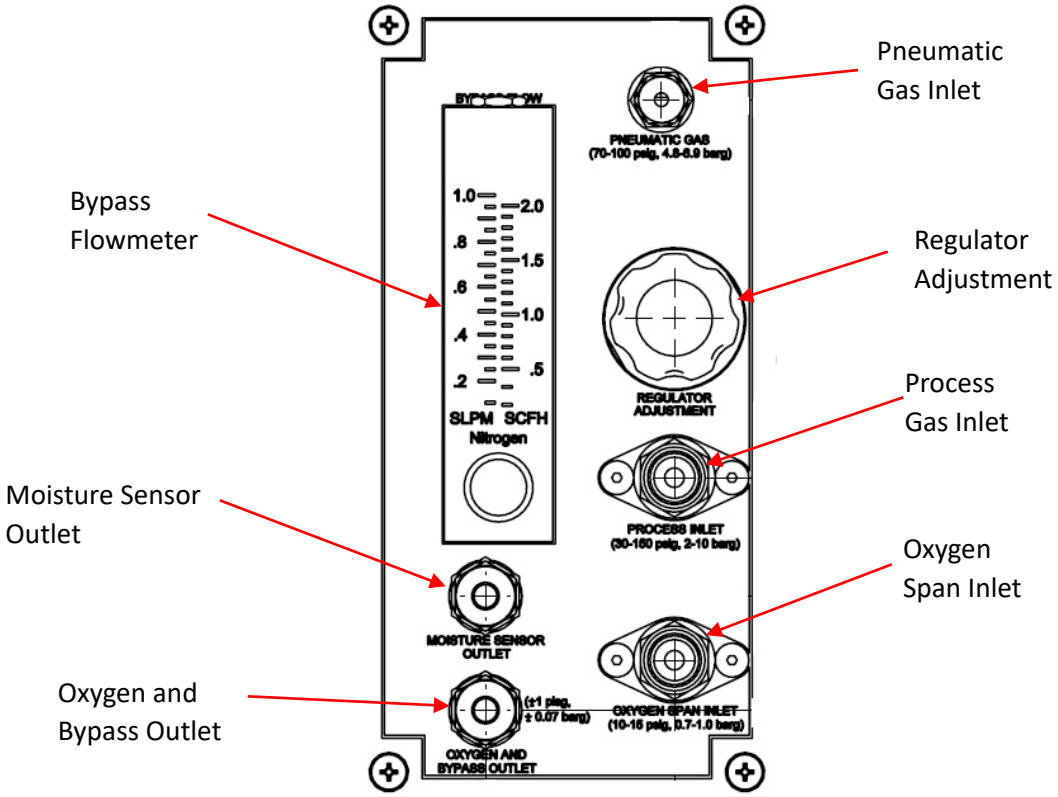


Figure 11: DF-760E Analyzer Gas Panel

NOTE:

The connections at the rear of the gas delivery system include a pneumatic gas connection (1/8" compression), a ¼" VCR swivel connection for the process inlet, a ¼" VCR swivel connection for oxygen span gas, a ¼" compression outlet for the moisture cell, and a ¼" compression outlet for the oxygen sensor and bypass loop. Also on the rear of the gas delivery system is a sample gas regulator to adjust the internal sample pressure and a bypass flow meter.

The moisture sensor outlet must be connected to the supplied aspirator or to the vacuum pump, if equipped. The oxygen and bypass outlet should not be connected to a vent that causes back-pressure greater than 1psig on the oxygen sensor.

5. Connect the pneumatic supply to analyzer Pneumatic Gas Inlet.
6. If the analyzer is configured with an aspirator, connect the 80psi gas feed line to it. The aspirator requires 15 LPM at 80 PSI for optimum operation.
7. Using VCR gaskets at all connections points, connect Oxygen Span and Process Gas feed lines to analyzer. (For HSS-equipped systems, Process Gas connection is to shut-off valve input.)

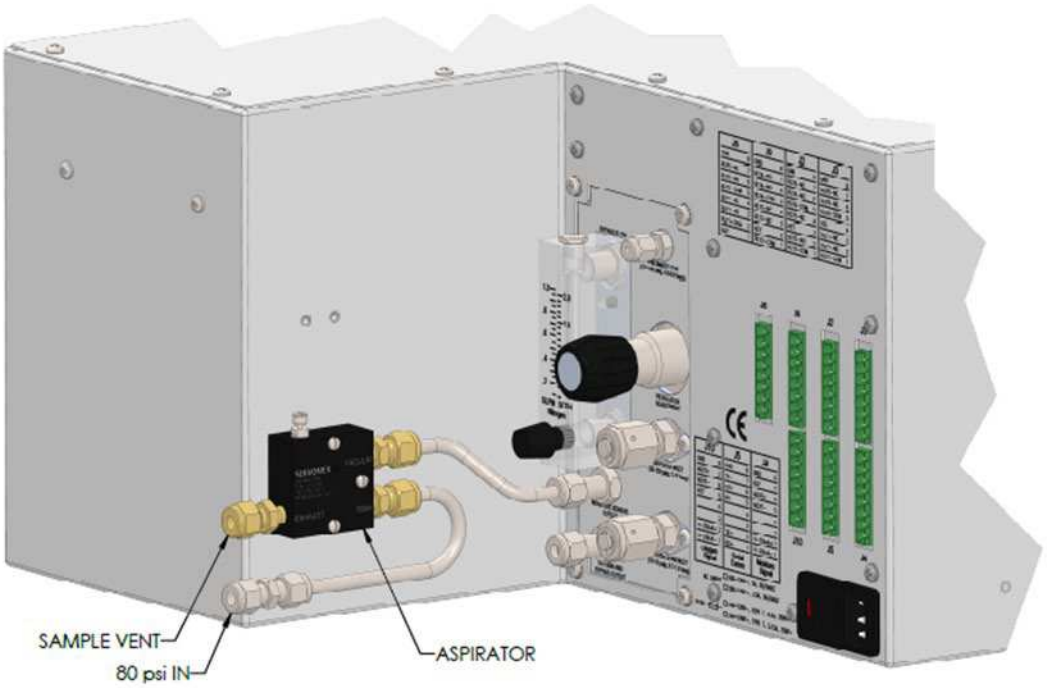


Figure 12: Aspirator Installation

8. If the analyzer has a vacuum pump, install vacuum pump within 8 feet of the analyzer by securing mounting bracket to appropriate surface with screws.

NOTE

If the Hydrogen Service Safety System (HSS) is installed, the sample outlet line must be made of stainless steel. See **Appendix A – Hydrogen Safety System** for more information.

9. Connect sample vent line from vacuum pump or aspirator outlet to facility vent.
10. Connect by-pass outlet to facility vent. If the system has HSS, the bypass outlet must be stainless-steel.
11. If analyzer has vacuum pump, connect a line from the moisture sample outlet to the pump vacuum control valve (see Figure 13). For systems that do not have the HSS, use the provided polyethylene line. For systems with the HSS, use ¼ in stainless-steel line.

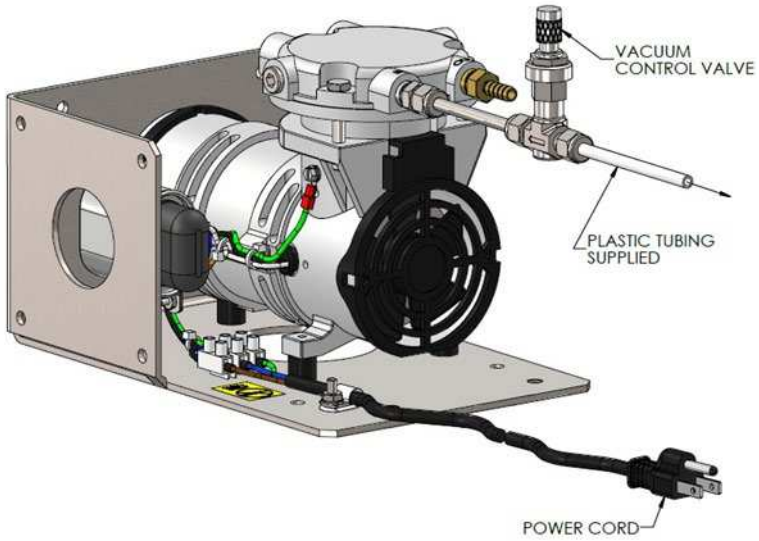


Figure 13: Vacuum Pump Assembly

12. Connect analyzer and optional pump (if applicable) to electrical power. Be sure to verify that you are connecting to the correct voltage (110VAC or 220VAC) for your analyzer and pump. Contact Servomex if you received an analyzer or pump that is not compatible with your facility power.

NOTE

Power cord is supplied for 110VAC installations. For 220VAC installations, power cord is customer-supplied. Customer-supplied cord must be rated for 250 VAC, 10 A with appropriate plug for location and an IEC 60320 C-13 receptacle for connection to the analyzer.

13. Turn on analyzer. After booting up, the analyzer goes into warm-up. During warm-up, analyzer is isolated and O2 sensor is off.
14. Verify that sample gas is flowing through the bypass flow meter. Inlet pressure of 30 – 150 psi is required.
15. Allow the sample inlet to purge for at least 10 minutes.
16. After warm-up and purge are complete, establish sample gas flow by pressing the menu key and selecting System > Restore Sample Gas Flow as shown in Figure 14. Verify that the main screen indicates flow for both moisture and oxygen.

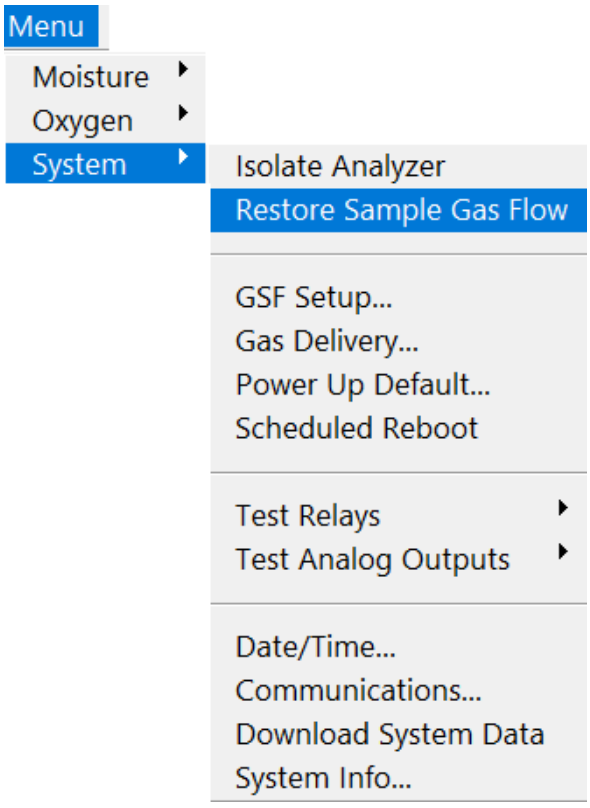


Figure 14: Starting Gas Flow

17. Install the purifier. This needs to be done quickly and carefully. Use the following procedure.
    a. Remove the plugs from the analyzer plumbing.
    b. Press the menu button, then select Oxygen > Controls > Gas Valves.

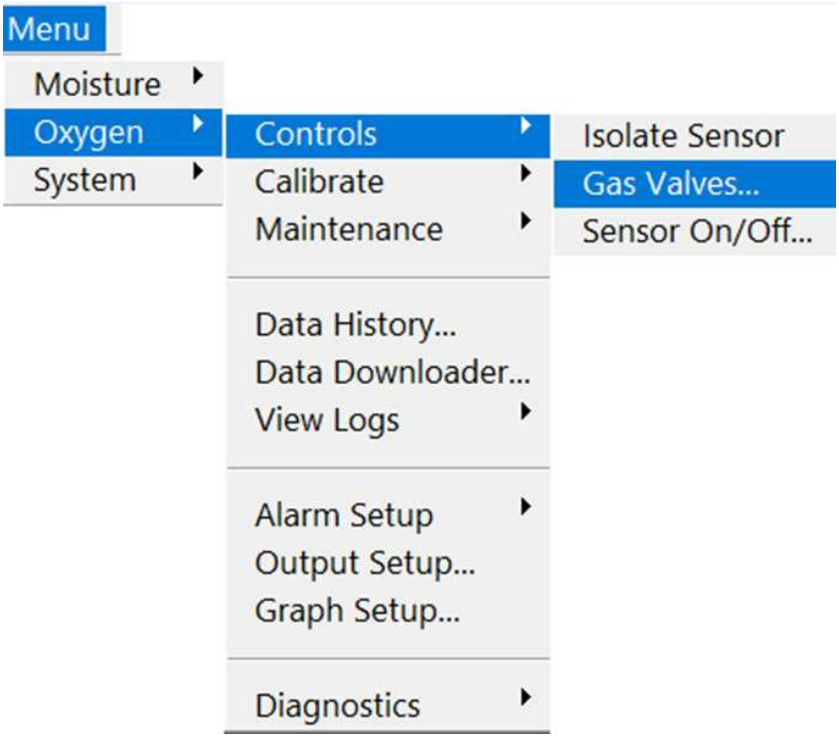


Figure 15: Oxygen Gas Valves Control Menu

c. On the Oxygen Sensor Valves Control dialog box (Figure 16), select Restore Zero Gas Flow, then select Apply and Done.

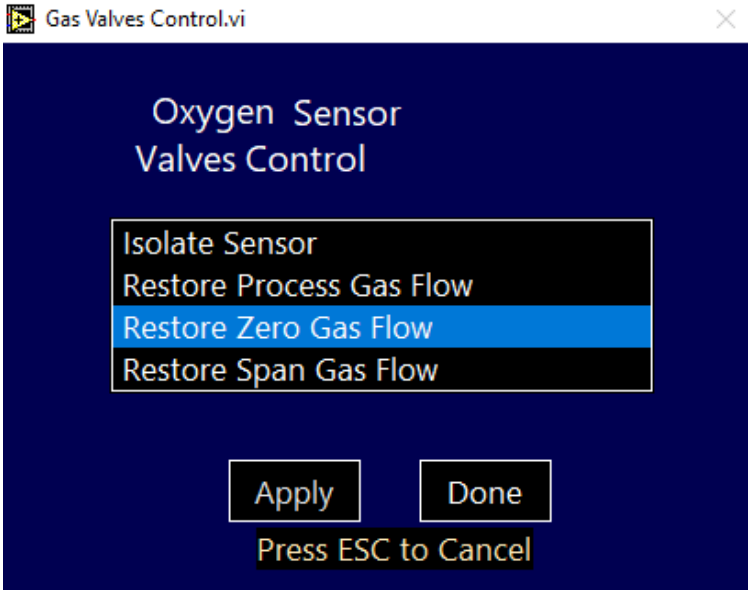


Figure 16: Oxygen Sensor Valves Dialog Box

d. Verify that gas is flowing out from the lower port in the analyzer.

e. Remove the caps from the purifier and put a fresh VCR gasket on each end of the purifier.

CAUTION:

Take care when loosening and tightening the fittings on the purifier. Avoid contacting the delicate electrical connections on the side of the oxygen sensor with the wrenches.

f. Install the purifier in the analyzer with the direction of flow arrow pointing up. Tighten the bottom fitting first (see **Figure 17**).

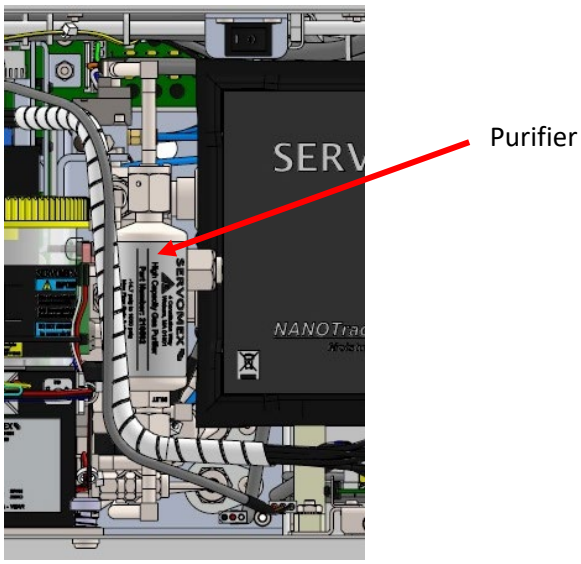


Figure 17: Purifier Installation

g. Allow the zero gas to flow through the O_2 cell for 1/2 hour to help purge any moisture from the plumbing downstream from the purifier.

h. Restore process gas through the O_2 sensor. To do this, press **Menu**, then select **Oxygen > Controls >Restore Process gas flow (Figure 18)**. Allow the analyzer to clean up and dry down.

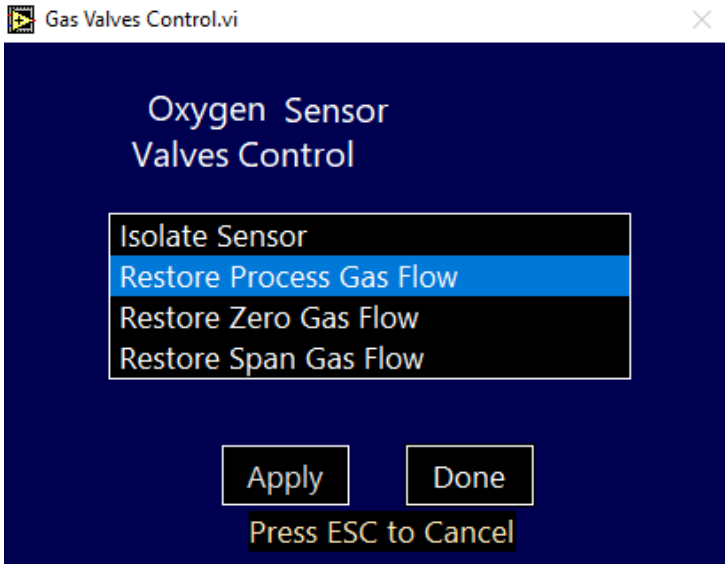


Figure 18: Restore Process Gas Flow Screen

3.4 Analyzer Start Up

It is important to note that the moisture and oxygen sensors are isolated from gas flow while the analyzer is off power.

Open the door and turn on the power using the main power switch inside the analyzer (see **Figure 7**). If equipped with optional pump, plug pump power cord connector into grounded electrical outlet. The pump, if equipped, should turn on. The analyzer will undergo a series of Diagnostic Procedures while the various start-up screens are displayed. Next, the Servomex logo is briefly displayed and then the data displays appear with the “Warming Up” screens flashing. The warm-up process takes approximately 6 to 15 minutes. After warm-up is complete, the display is like Figure 19 (values will vary). The analyzer may take up to 90 minutes to completely warm up depending on environmental conditions.

See 6.6.6 Power Up Default, for setting user selectable preferences at the time of power up.

During warm-up, gas valves can be opened, gas flow started, and flow rates and pressures set. See **3.4.2 Gas Pressure and Flow Settings**, for important information on the gas delivery system and setting proper pressures and flow rates.

NOTE:

During the warm-up period all analog and digital outputs are held to an artificial 0.011 ppb reading to avoid the reporting of false readings.

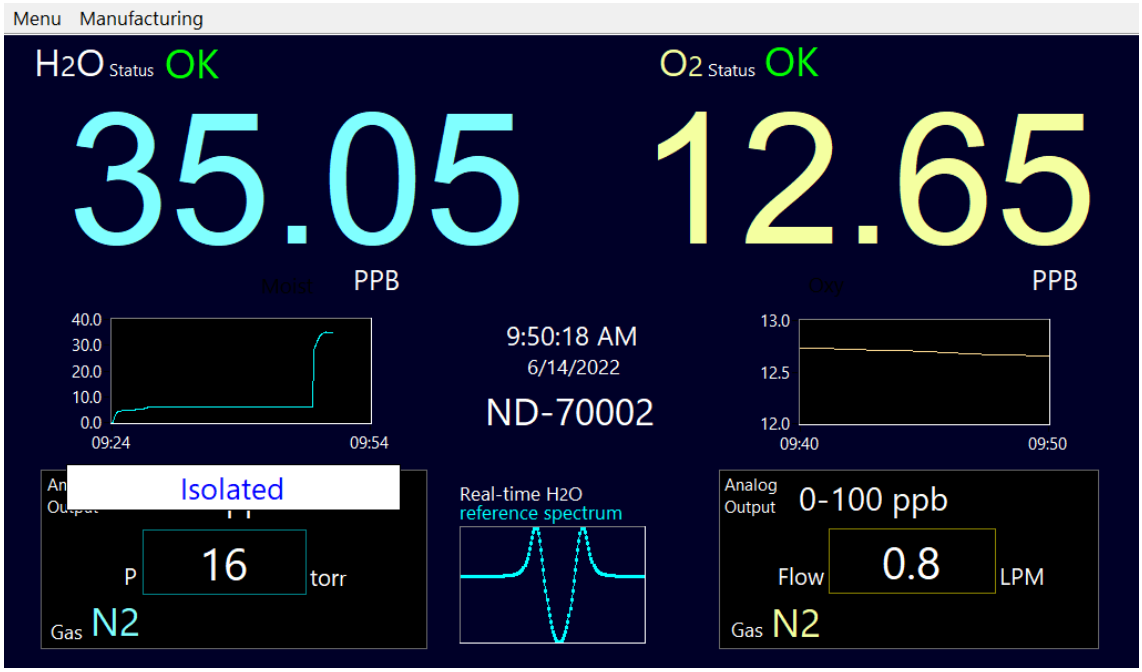


Figure 19: Data Display Screen

3.4.1 Gas Flow and Pressure Regulation

The gas delivery system is designed to deliver gas flow to both the moisture and oxygen sensors while maintaining gas purity for ultra-trace analysis. The design features include a single inlet line for the gas sample and a bypass loop to maintain constant purging and delivery. The gas delivery system allows the user to perform zero calibration adjustments for both the oxygen and moisture cells as well as a span calibration for the oxygen sensor (if span gas is connected). Proper sample pressure varies with the type of background gas being analyzed. Acceptable ranges for DF-760E background gases are provided in **Table 1.**

Background Gas	Pressure	Vacuum Source
N2	150 - 250 Torr	ON
Ar	280 - 380 Torr	ON
He	740 - 780 Torr	OFF*
H2	300 - 400 Torr	ON
O2	300 - 400 Torr	ON

***Vacuum source is removed for Helium.**

Table 1: Recommended Sample Outlet Vacuum Pressure

NOTE: After properly setting the flow rates, isolation of either sensor will not affect the flow rate through the other.

3.4.2 Gas Pressure and Flow Settings

Attention to the setting of gas pressure and flow is critical to proper operation of the analyzer. If steps 1-7 are followed carefully at the time of start-up, subsequent changes to flow or background gas will be made easier. The following procedure assumes all electrical and plumbing connections have been made according to instructions in this guide.

1. Power up the unit if not already powered up (3.4 **Analyzer Startup**).
2. Ensure that the needle valve on the aspirator is fully open and that the feed (pneumatic) gas to the aspirator is shut off. If analyzer has a vacuum pump, remove power to the vacuum pump.

NOTE: If the analyzer is going to be used with helium as the background gas, the aspirator should be removed.

3. Open the bypass flowmeter valve on the rear of the analyzer. Flow in the bypass loop will be indicated on the flowmeter. Adjust the bypass flowmeter valve to 0.5 SLPM.
4. Purge for 15 minutes before opening the gas valves.
5. The state of the gas control valves for the moisture sensor is indicated on the main display. The default state of a factory-shipped instrument is isolation of the sensor. This can be adjusted as described in 6.6.6 **Power Up Default**
6. Once flow has been established through the moisture and oxygen sensors, verify that the adjustment screw on the aspirator is fully open, and attach a flowmeter to the exhaust port. If your analyzer is configured with a pump, attach the flowmeter directly to the sample outlet port on the analyzer. Adjust the analyzer's pressure regulator to achieve a flow rate of 1 SLPM.
7. Remove the flowmeter from the analyzer setup and return system to previous configuration.
8. Activate the vacuum source and monitor the pressure indicator on the main display. Referencing **Table 1**, adjust the screw on the aspirator or the valve on the pump to achieve the appropriate pressure for the background gas being monitored. (No adjustment is required in the case of He, as analyzer operates at ambient pressure.)

NOTE: The proper pressure ranges listed in **Table 1** will automatically appear on the display when the background GSF is selected.

3.4.3 Moisture

Start the gas flow through the Moisture cell by going to the Moisture Controls Menu as shown in 6.4.1 Moisture Controls Menu and select Gas Valves. On the Gas Valves screen Figure 31, highlight Restore Process Gas Flow and select Apply, and then select Done.

On initial start-up the moisture analyzer takes a few hours to equilibrate after the 6-minute warm-up process is complete. Moisture readings display after the 6-minute warm-up period is complete, however, they will not be accurate until the unit reaches full equilibrium.

If analyzer power is briefly interrupted after reaching full equilibrium, the moisture sensor takes approximately 6 minutes to re-equilibrate.

3.4.4 Oxygen

Start the gas flow through the oxygen sensor by going to the Oxygen Controls menu as shown in **6.5.1.2 Gas Valves** and select **Gas Valves**. On the **Gas Valves** screen, select **Restore Process Gas Flow**, select **Apply**, and then select **Done**.

See 3.4.2 Gas Pressure and Flow Settings for important information on setting proper pressures and flow rates.

Allow the oxygen sensor to purge for 10 minutes before proceeding.

On initial start-up from the factory, the display will show **Sensor Off** indicating that the oxygen sensor polarizing voltage is automatically turned off and must be manually turned on. See **6.5.1.3 Oxygen Sensor On/Off**. Also, see **6.6.6 Power Up Default** for further information on changing this function on future power ups. After turning the oxygen sensor polarization voltage on, it should take less than 5 minutes for the analyzer to come on scale (< 20ppm). The concentration of oxygen is automatically shown in parts per million (ppm), parts per billion (ppb), or parts per trillion (ppt) on the display.

NOTE

If oxygen is included in the background gas scale factor calculation, the oxygen sensor is automatically isolated. In addition, no zero adjustments will be possible using the internal purifier on either the oxygen or moisture cells.

NOTE

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

3.4.5 Back Flow Prevention System

The Back Flow Prevention System reduces the possibility of contamination of the plumbing system when gas flow is lost or accidentally shut off. Under this condition ambient air may be drawn into the system through the bypass exhaust by means of the aspirator or vacuum pump.

During normal operation, the gas flow is constantly monitored by a flow switch mounted in the bypass loop that is set to trip when the flow drops below 0.1 lpm. When this occurs, the switch will automatically activate the gas panel isolation valves. In addition, the pressure reading will artificially read zero. When the system detects pressure reading of 0, a message will be displayed which states that backflow prevention is engaged and to check sample and bypass flow (see **Figure 20**). The analyzer will remain in isolation and the user will not have control of any valves at this point.

NOTE: When the Back Flow Prevention System is engaged, the moisture reading is not valid.

The user must determine the cause of the loss of gas flow and remedy the situation. When the flow has been restored to the analyzer, the pressure reading will go to a non-zero value and a message will then appear stating that sample flow has been restored. The user must wait 5 minutes to restore internal sample flow to the sensors. See **Figure 20.**

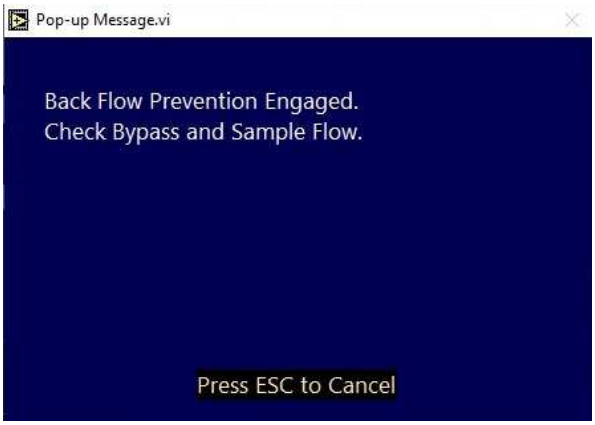


Figure 20: Back Flow Prevention Warning

A 5-minute timeline is displayed. Valve control will not be available until the 5 minutes are up. During this time, the **ESC** key may be hit to cancel the 5-minute delay and return control to the user. Once the **ESC** key is hit, or the 5-minute waiting period has expired, all remaining messages are cleared from the screen and the system will remain in isolation until the user restores flow.

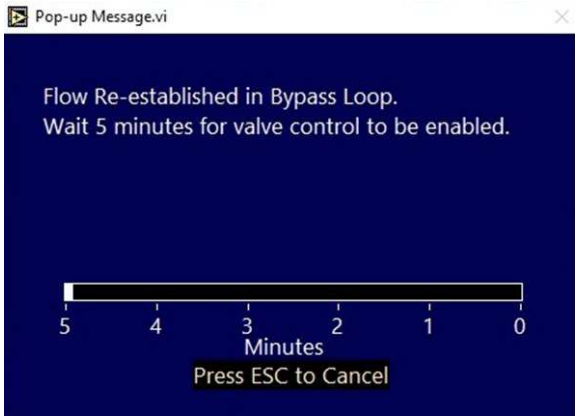


Figure 21: Re-established Flow Delay

Engagement of the backflow prevention system will trigger a system alarm (192) for the moisture cell. See page 63 for additional information on system alarms.

3.4.6 Purifier Installation

Shipping regulations require that the zero-gas purifier be packaged separately from the analyzer. As a result, the purifier must be installed by the user after the analyzer is operational. See **3.3 Analyzer Installation**.

3.4.7 Download System Data

The final step of the installation, after a couple days of dry down, is to download the diagnostics (see **6.6.16 Download System Data**) (which may optionally be sent by e-mail to Servomex) for review. This will allow the factory to confirm that the analyzer is working properly by comparison with data stored at the time of shipment, and in addition will set a baseline for comparison with future downloads, if any.

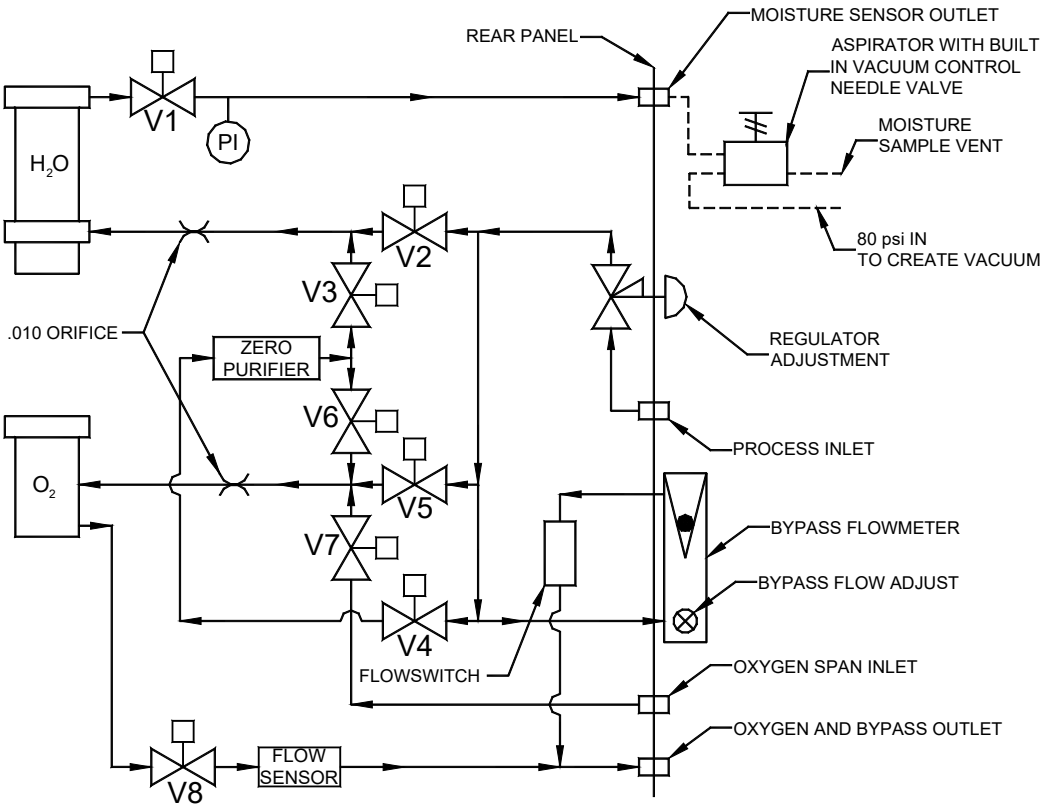
3.5 Analyzer Shut Down or Disconnection

To shut down the analyzer, turn the power switch behind the front door to the off position. This action initiates the standard isolation process and computer shut down which takes approximately 40 seconds.

Additional long-term isolation security can be achieved by closing the valve on the rotameter on the rear of the instrument as well as completely closing the sample inlet regulator. Refer to **+Figure 22** for a block diagram that shows gas valves and routing within the analyzer.

If the analyzer is disconnected from gas, be sure to tightly cap all gas connections.

Before disconnecting and moving the analyzer, the power cord should be disconnected from the AC receptacle.



+Figure 22: Block Diagram of Gas Flow Path

4. Options

The following options to the DF-760E are available at the time of order:

4.1 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.

The key lock only prevents access to the internals of the analyzer. It does not prevent adjustments through the interface on the front panel.

4.2 Operating Voltage

The analyzer can be ordered for operation at either 100-120 Volts AC or 200-240 Volts AC. Customers may select a UK, US, or EU style power cable. If another type of power cable is required, the customer must provide it.

4.3 Serial Communications

The analyzer can be set to communicate through either RS-232 or RS-485 protocols. The serial communications option cannot be changed in the field. See Chapter 5 Connecting to External Devices for more information.

4.4 Analog Voltage Output

The maximum analog voltage output can be set at the factory to 0-1, 0-5-, or 0-10-volts DC. The maximum analog voltage output is not adjustable in the field.

4.5 Hydrogen Safety System

This option enables the analyzer to be safely used in a hydrogen background application. See **Appendix A – Hydrogen Safety System** for additional information.

4.6 Vacuum Pump

An optional pump can be purchased to replace the aspirator in cases where there is insufficient gas flow for the aspirator or when the analyzer is installed in a portable cart and connection to an air supply is inconvenient. Refer to **Figure 23** and **Figure 24** below for vacuum pump dimensions.

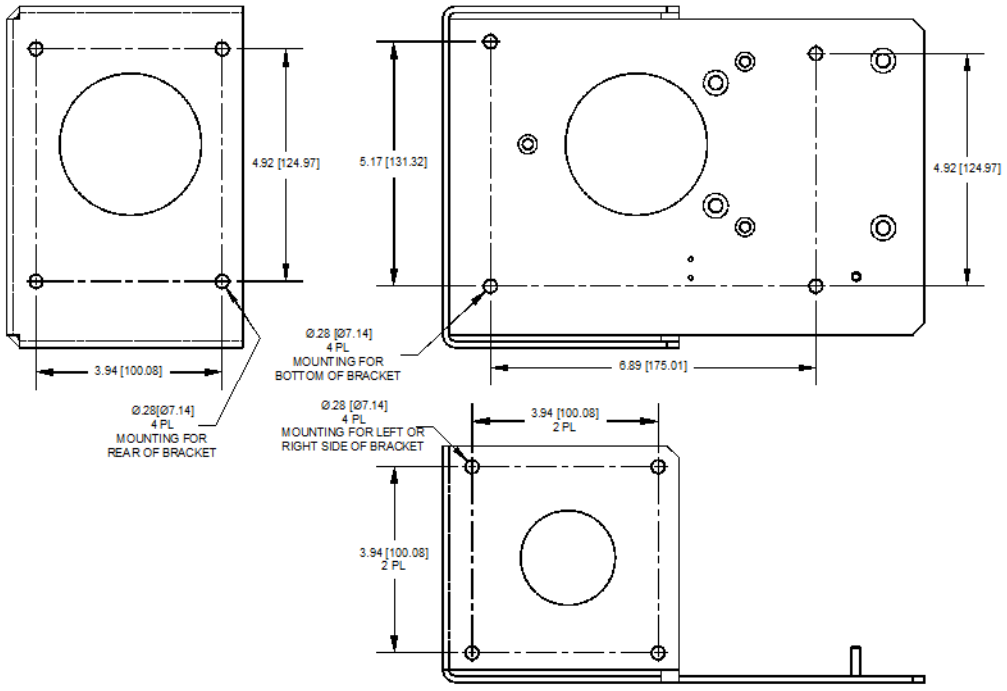


Figure 23: Vacuum Pump Mounting Dimensions

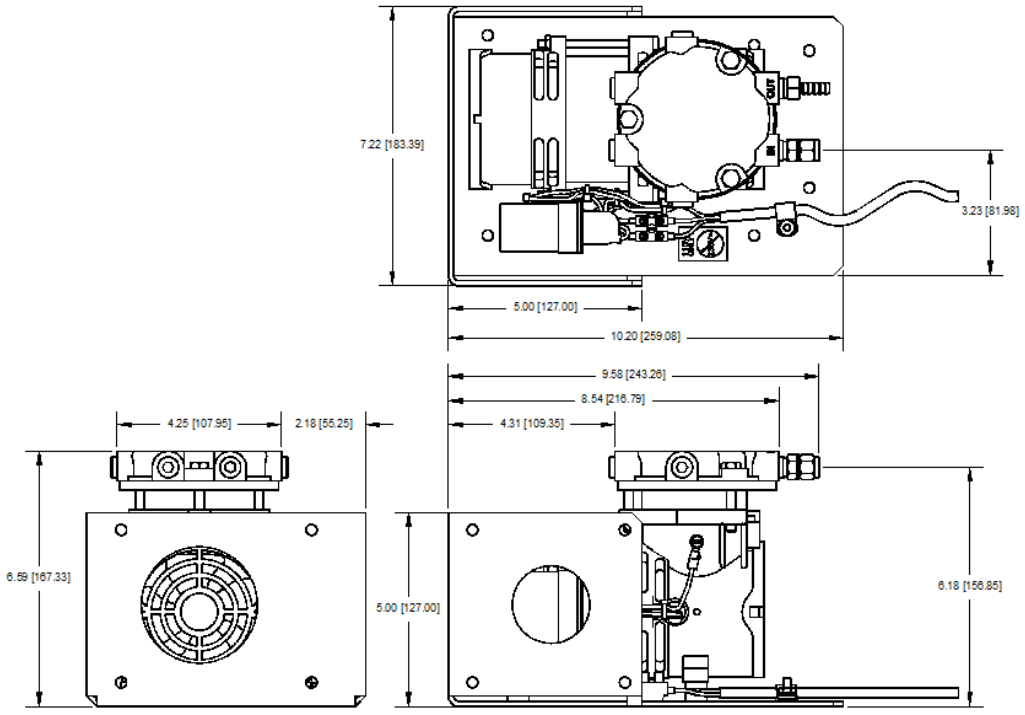


Figure 24: Vacuum Pump Dimensions

5. 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, current outputs, and serial communications are supported. All outputs, analog or digital, are fully isolated from earth ground.

NOTE

During the 6-minute warm-up period at start-up, all analog and digital outputs are held to an artificial 0.011ppb reading to avoid the reporting of false readings.

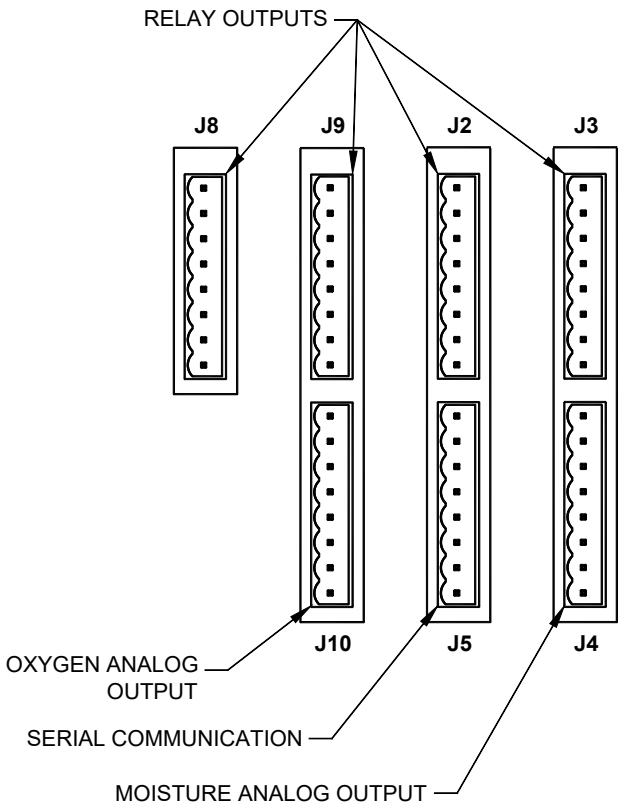


Figure 25: Rear Panel Electrical Connectors

5.1 Serial Communication Port – J5

Either of two serial communication ports are available at the time of order: RS232C or RS485 which enable interface between the analyzer and other operating systems.

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.

See Table 2 and Table 3 for wiring information.

See 6.6.15 Communications, for additional information on setting unit IDs and baud rates.

A program to facilitate serial communications is available from Servomex. Please contact us the applicable email for your region: service_americas@servomex.com (North and South America), service_europe@servomex.com (Europe), or service_asia@servomex.com (Asia).

Pin #	Signal	Description
J5-8	GND	Ground
J5-7	TX-	4 wired 485 paired with TX+
J5-6	Key	Unused
J5-5	RX-	4 wire 485 paired with RX+
J5-4		Unused
J5-3		Unused
J5-2	TX+	Data transmitted by the analyzer via RS-232 or RS-485
J5-1	RX+	Data received by the analyzer via RS-232 or RS-485

Table 2: Pin-out of Serial Comm Connector J5

Pin Assignments			
DF-760/750 Connector J5	**PC-DB9/RS-232**	**PC-DB25/RS-232**	**PC/RS-485 Converter**
1: RX+	3: TD	2: TD	TX+
2: TX+	2: RD	3: RD	RX+
8: Gnd	5: Gnd	7: Gnd	
5: RX-			TX-
7: TX-			RX-

Table 3: Serial Communications Connections

5.2 Analog Signal Outputs – J4, J10

Two sets of analog voltage outputs correlating to the front panel display readings are provided on the rear of the analyzer. The analog voltage output for the oxygen signal is provided through connector J10. The analog voltage output for the moisture signal is provided through connector J4. The full-scale voltage for each is set at the factory at the time of order to: 0 to 1 VDC, 0 to 5 VDC, or 0 to 10 VDC. These outputs are electrically isolated from all other analyzer outputs, and from chassis (Earth) ground. See **6.4.26 Moisture Analog Output Setup Routine** and **6.5.8 Oxygen Analog Output Setup** for additional information on setting the Moisture and Oxygen Analog Outputs. These outputs may be tested with the use of the analog voltage test routine found in **6.6.11 Test Analog Outputs**.

5.3 4-20 mA Outputs – J4, J10

Two sets of 4-20 mA analog outputs correlating to the front panel display readings are provided on the rear of the analyzer. The 4-20 mA output for the oxygen signal is provided through connector J10. The 4-20 mA output for moisture is provided through connector J4. These outputs are electrically isolated from all other analyzer outputs, and from chassis (Earth) ground.

The maximum load resistance for each is 1K Ohms and the analyzer provides a compliance voltage of approximately 28 VDC for each.

J4 Pin #	Moisture Signal	Description
J4-8	GND	Ground
J4-7	Key	
J4-6	A Out +	Analog Voltage Output (+)
J4-5	A Out -	Analog Voltage Output (-)
J4-4		Unused
J4-3		Unused
J4-2	4-20 mA +	4-20 mA Output (+)
J4-1	4-20 mA -	4-20 mA Output (-)

Table 4: Pin-Out of Moisture Signal Output Connector J4

J4 Pin #	Oxygen Signal	Description
J10-8	GND	Ground
J10-7	A OUT +	Analog Voltage Output (+)
J10-6	A OUT -	Analog Voltage Output (-)
J10-5	Key	
J10-4		Unused
J10-3		Unused
J10-2	4-20 mA +	4-20 mA Output (+)
J10-1	4-20 mA -	4-20 mA Output (-)

Table 5: Pin-Out of Oxygen Signal Output Connector J10

5.4 Relay Ports – J2, J3, J8, J9

Eight form C (SPDT) relays (contact closures) are provided to assign to the various alarms. The contacts are rated at 30 VDC, 1A resistive load. They are not designed to switch AC power.

The relay contacts can be programmed through the user interface for up to four oxygen and four moisture levels, temperature, electrolyte level/condition, moisture cell diagnostics, loss of gas flow, zero calibration in progress, moisture analyzer off-line, freeze of analog outputs during calibration.

The relays are wired for Fail Safe operation such that a Normally Open (No alarm) contact connects to common when an alarm occurs or when power to the instrument is lost.

Relays 1, 2, 3, and 4 are assignable to moisture signals and relays 5, 6, 7, and 8 are assignable to oxygen signals. The relay wiring can be tested with the Relay test routine found in **6.6.8 Test Relays**.

Pin #	Moisture Relay	Description
J8-8	GND	Ground
J8-7	RLY2-NC	Relay 2 Normally Closed
J8-6	RLY2-NO	Relay 2 Normally Open
J8-5	RLY2-COM	Relay 2 Common
J8-4	RLY1-NC	Relay 1 Normally Closed
J8-3	RLY1-NO	Relay 1 Normally Open

J8-2	RLY1-COM	Relay 1 Common
J8-1	KEY	Unused
J9-8	GND	Ground
J9-7	RLY4-NC	Relay 4 Normally Closed
J9-6	RLY4-NO	Relay 4 Normally Open
J9-5	RLY4- COM	Relay 4 Common
J9-4	RLY3-NC	Relay 3 Normally Closed
J9-3	RLY3-NO	Relay 3 Normally Open
J9-2	Key	Unused
J9-1	RLY3-COM	Relay 3 Common

Table 6: Pin-Out of Moisture Relay Connectors J8 and J9

Pin #	Oxygen Relay	Description
J2-8	GND	Ground
J2-7	RLY6-NC	Relay 6 Normally Closed
J2-6	RLY6-NO	Relay 6 Normally Open
J2-5	RLY6-COM	Relay 6 Common
J2-4	RLY5-NC	Relay 5 Normally Closed
J2-3	KEY	Unused
J2-2	RLY5-NO	Relay 5 Normally Open
J2-1	RLY5-COM	Relay 5 Common
J3-8	GND	Ground
J3-7	RLY8-NC	Relay 8 Normally Closed
J3-6	RLY8-NO	Relay 8 Normally Open
J3-5	RLY8- COM	Relay 8 Common
J3-4	Key	Unused
J3-3	RLY7-NC	Relay 7 Normally Closed
J3-2	RLY7-NO	Relay 7 Normally Open
J3-1	RLY7-COM	Relay 7 Common

Table 7: Pin-Out of Oxygen Relay Connectors J2 and J3

6. User Interface

6.1 Data Display Screen

The front panel display consists of the Graphical User Interface (GUI), as displayed on the view screen in **Figure 26** below.

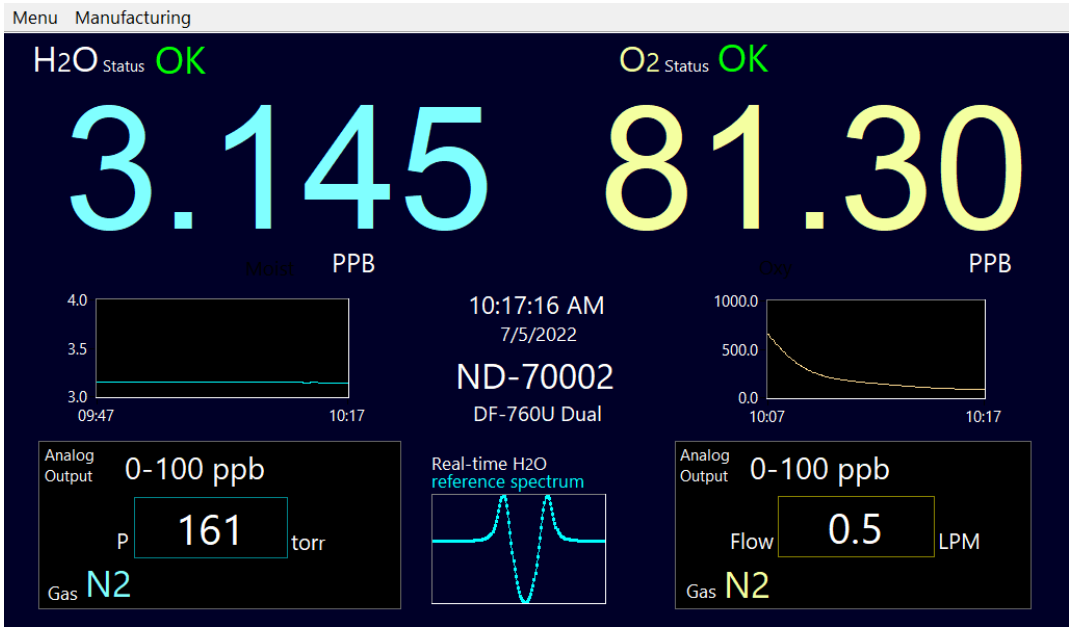


Figure 26: Data Display Screen

The display provides information for both oxygen and moisture analysis:

- Alarm status indicator –Blank if there is an alarm condition. Displays **OK** denotes if no alarm conditions.
- The Data Line reading of the most recent concentration measurement. This box will also provide indication of abnormal operating conditions for each sensor.
- A strip chart history of concentration measurements.
- A concentration output range, for the analog outputs, as designated by the user.
- Background gas as set by user.
- Gas pressure within the moisture sensor
- Gas Flow to the oxygen sensor

The digital readout of the moisture concentration will be overwritten with a warning if any of the level or system alarms are tripped.

6.2 Keypad

The keypad allows the user to control all the features of the analyzer. The layout of the keypad on the front panel is represented in **Figure 27** below.

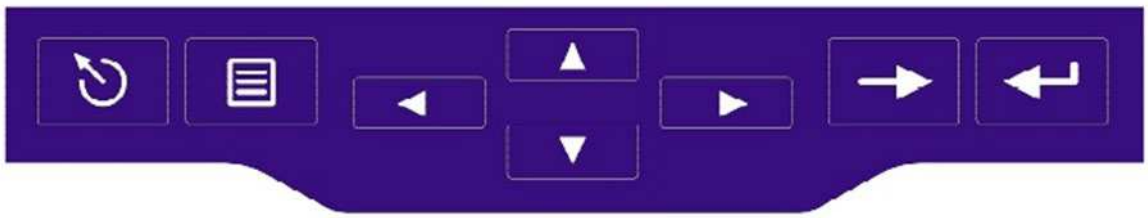


Figure 27: Keypad

The **Menu** key activates the menu structure along the top of the GUI interface on the view screen.

Once in the menu, the arrow keys (and) highlight the various menu features. When the desired selection is highlighted, the right arrow will access the submenu if available (denoted by a right arrow next to the menu text). The '**Next**' key and the '**Enter**' key will do this as well. The arrows also enable the entry of numerical parameters as will be described below.

The **Enter** key will call up dialogue boxes from the menu (denoted by the sequence … next to the menu text). It will also enter numerical values within dialogue boxes.

The **Next** key allows the user to change between active inputs within a dialogue box.

The **ESC** key allows the user to exit numerical entry boxes within dialogue boxes without any user changes, dialogue boxes without any user changes, and the menu bar.

6.3 Menu Structure

The NanoTrace Moisture Analyzer menu tree consists of main menus, sub-menus and screens as depicted in the descriptions and figures that follow.

6.3.1 Main Menu

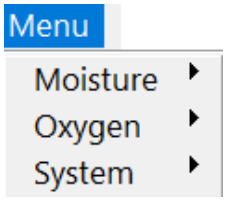


Figure 28: Main Menu

The Main Menu (**Figure 28**) is accessed by pressing the Menu key on the front panel. Use the arrow keys (and) to navigate up and down through the list. Select the highlighted item with the **Enter** key on the front panel. The main menu provides access to the **Moisture**, **Oxygen**, and **System** submenus.

6.4 Moisture Menu

6.4.1 Moisture Controls Menu

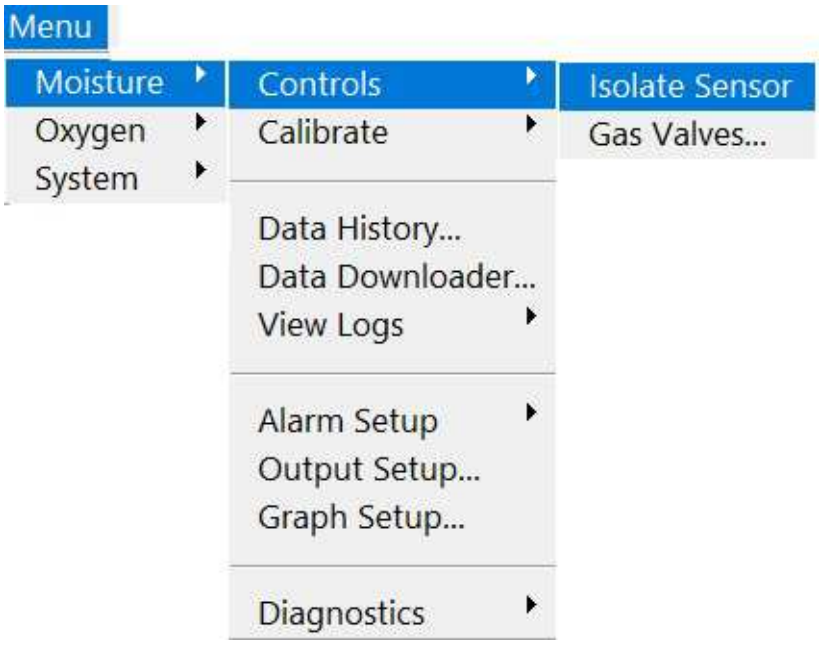


Figure 29: Moisture Controls Submenu

The Moisture Controls menu provides control of functions related to gas flowing through the moisture cell.

6.4.2 Isolate Sensor

The **Isolate Sensor** selection **(Figure 29)** isolates the internal gas lines and the moisture sensing cell volume in the case of an impending break in the external delivery lines. Highlight this item and hit the **Enter** key to begin the isolation process. The **Isolate Sensor Warning** (**Figure 30**) will appear for 40 seconds.

Figure 30: Isolate Sensor Warning

While the moisture cell is isolated from gas flow, a warning will appear in the lower left corner of the main display indicating **Isolated**. Under this condition, the pressure alarm is disabled.

CAUTION

When in isolation mode, the moisture cell's pressure transducer will yield an incorrect reading of the actual cell pressure. Because the displayed moisture reading is dependent upon a proper pressure reading, moisture readings should be ignored while the cell is under isolation.

NOTE: Under these conditions, the pressure alarm is disabled.

6.4.3 Gas Valves Control

The moisture **Gas Valves** Control menu selection accesses the **Gas Valves Control** screen (**Figure 31**), which is used to control the flow of gas through the moisture cell.

Three options exist for gas valve control. Use the arrow keys (and) to move between the selections. After highlighting your choice, use the **Enter** key to move to the **Apply** button and hit **Enter** again to apply your choice. The **Gas Valves Control** screen will stay visible, allowing other changes until the **Next** key is used to highlight the **Done** button, and the **Enter** key is hit to return to the main display.

- **Isolate Sensor** closes the upstream and downstream valves for the moisture cell. This is done to prevent moisture contamination of the cell when in transport or for changing process lines.
- **Restore Process Gas Flow** opens the upstream and downstream valves of the moisture cell to allow for gas flow from the sample inlet for normal operation.
- **Restore Zero Gas Flow** diverts the sample inlet flow through the gas purifier and then through the moisture cell. Flowing the sample through the purifier is necessary for performing zero calibrations or for assessing the relative purity level of the incoming gas.

See 3.4.5 Back Flow Prevention System for additional information on gas valves and their control.

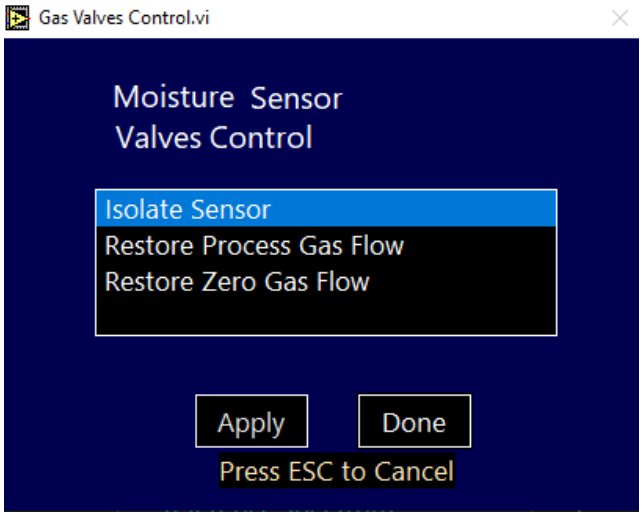


Figure 31: Moisture Gas Valves Control Screen

6.4.4 Moisture Calibrate Menu

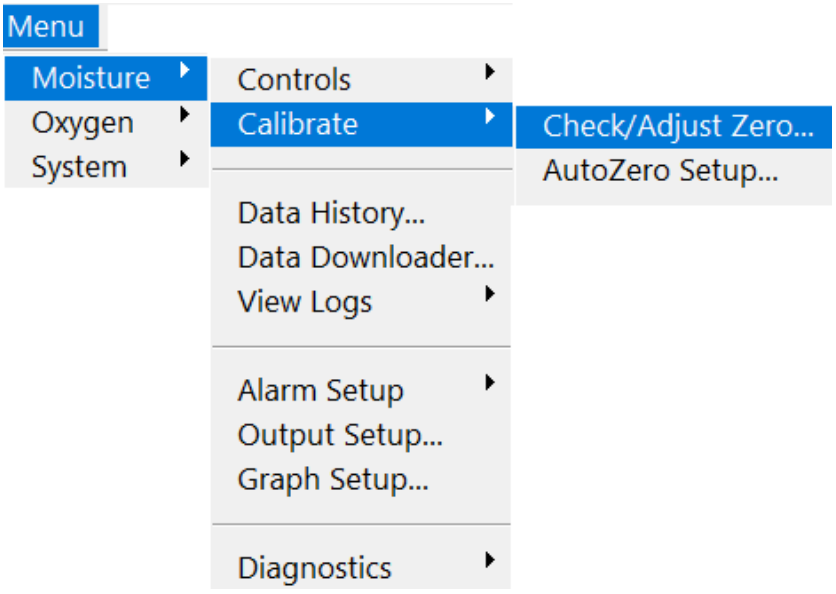


Figure 32: Moisture Calibrate Submenu

The Check/Adjust Zero menu selection from the Moisture Calibrate submenu is shown in **Figure 32,** above. This menus selection accesses the Moisture Check/Adjust Zero screen **(Figure 33**.)

Because of the nature of absorption spectroscopy measurements using the wavelength modulation technique, instrumental drift has minimal effect on the quantitative moisture content result. Once operating parameters are in place from the factory, no other SPAN calibration of the moisture sensor is necessary.

However, sample line contributions to moisture offsets in measurements, especially at the sub-ppb level, are difficult to remove even with a system that is operating correctly. The dry-down process of the analyzer and/or gas supply system can take many months. The moisture analyzer has an array of zeroing features that enable the user to establish *temporary* performance near 0.0 ppb during the dry down process. Monitoring the zero-reference number during that time, or repeated restoration of the factory zero, will give the user a sense of the offset being induced by the user zero actions.

6.4.5 Check/Adjust Zero

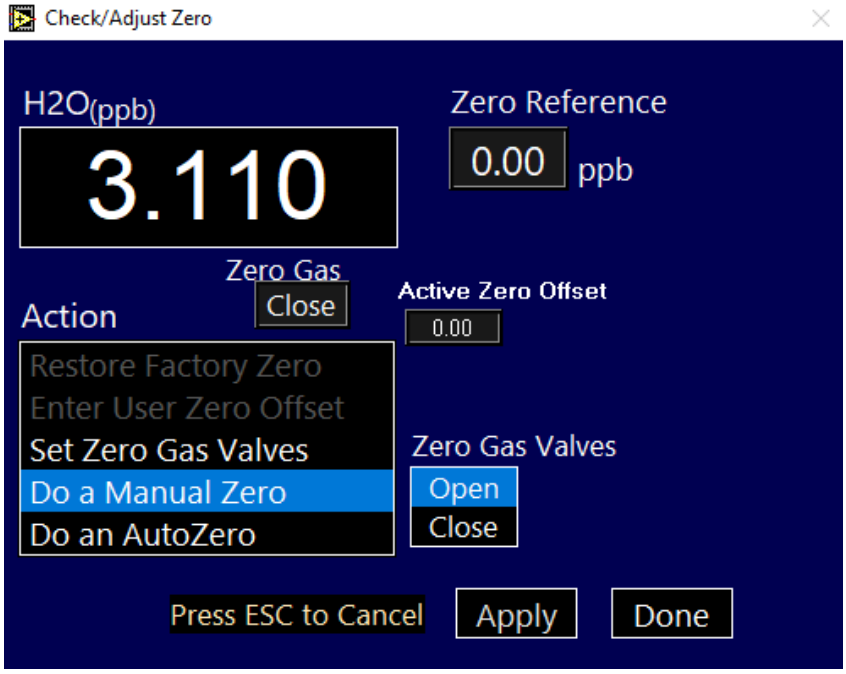


Figure 33: Moisture Check/Adjust Zero Screen

The moisture **Check/Adjust Zero** screen displays many pieces of information including a live reading of moisture in ppb (or ppm) and the state of the zero gas control valves. Also depicted are zero reference and zero offset values.

The **Zero Reference** value reflects the deviation of the instrument's baseline from what was set at the factory. The zero reference of an instrument from the factory will be 0.00. After a manual zero or AutoZero is performed, this value may change slightly.

The **Active Zero Offset** is another offset feature. When this feature is turned on, the **User Zero Offset** display is inactive and Active Zero Offset will be displayed instead.

A relay is available on the **Moisture Analog Output Setup** screen (see **Figure 59**) to signal that a zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

The following actions are available from the Check/Adjust Zero Screen: **Restore Factory Zero**, **Enter User Zero Offset**, **Set Zero Gas Valves**, **Do a Manual Zero**, and **Do an AutoZero**. These actions are described in the subparagraphs that follow.

6.4.6 Restore Factory Zero

If the moisture cell has been previously calibrated by the user, **Restore Factory Zero** is enabled. This action will erase any user zero and restore the factory set point.

6.4.7 User Zero Offset

The **User Zero Offset** function enables the user to add a given moisture ppb value to the displayed concentration. This function is only available when **Active Zero** is off. **User Zero Offset** is useful in preventing negative readings from being displayed should the baseline drift below the calibrated zero point. The value does not affect zero calibration, it is simply added to the calibrated zero. For example, an offset of 1.0 ppb could be put into a system reading 0.0 ppb to allow a chart recorder attached to the output to read slightly above zero. Under these conditions, the moisture reading would be 1.0 ppb. Select **Enter User Zero Offset** in the **Check/Adjust Zero** screen, **Figure 33**, and press the **Enter** key on the front panel. The zero offset box will appear on the screen as shown in **Figure 34.** With the left and right arrow keys move the cursor to the right of the digit you want to change. With the up and down arrow keys set the number to the desired value.

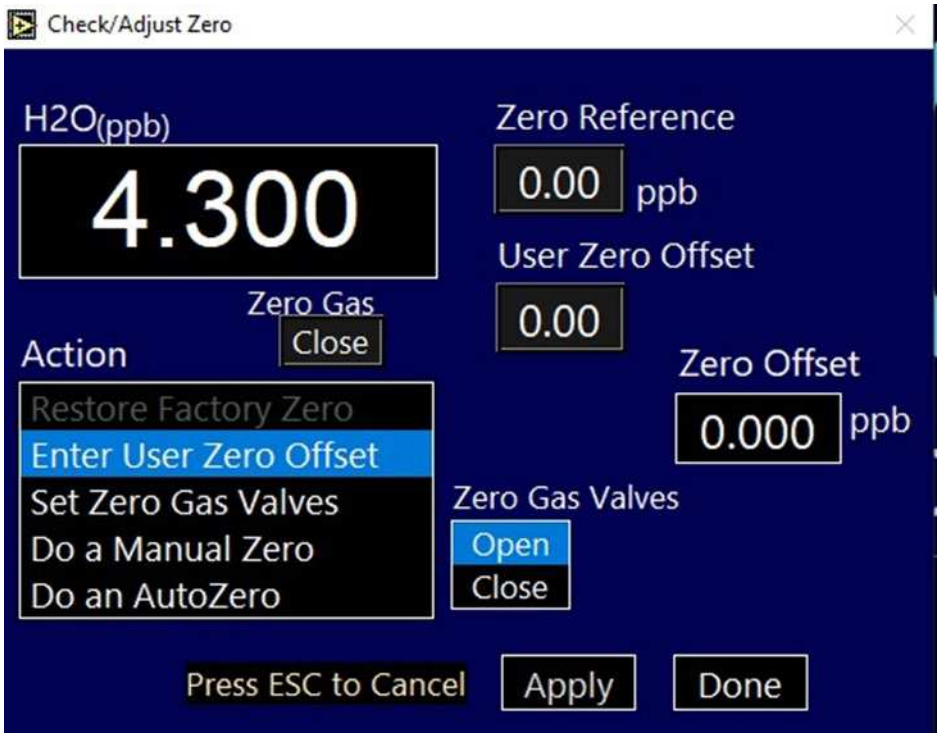


Figure 34: Moisture User Zero Offset Selection

When done, press the **Enter** key which will move the highlighted area to the **Apply** button and press **Enter** to set the value. Use the **Next** key to go back and change the value or move to the **Done** button and press the **Enter** key to leave the screen. Pressing the **ESC** key at any time will exit the screen without making changes and return to the main display.

6.4.8 Set Zero Gas Valves

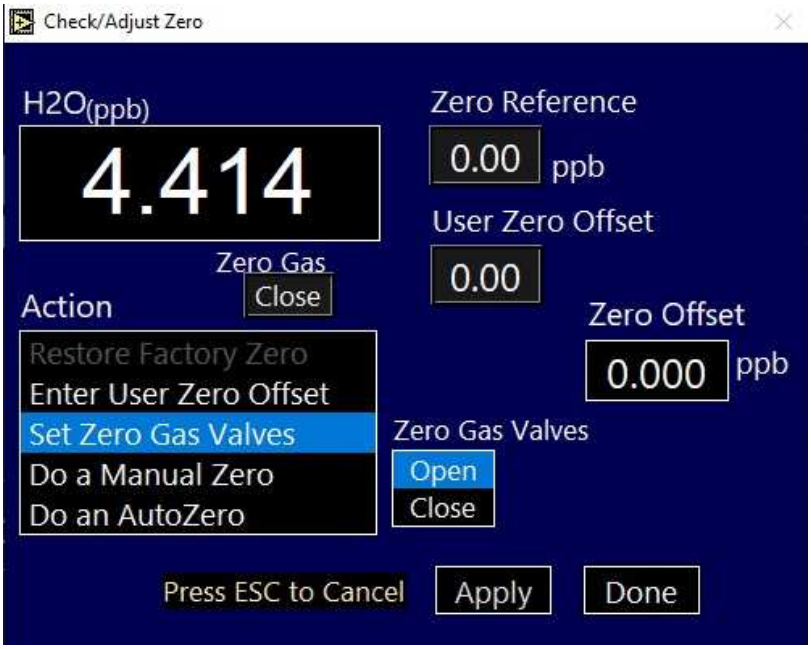


Figure 35: Moisture Set Zero Gas Valves Screen

The state of the Zero Gas Control Valves can be toggled on or off from this screen. Select **Set Zero Gas Valves** on the **Check/Adjust Zero** screen **Figure 35**), and press the **Enter** key on the front panel. The **Zero Gas Valves** box will appear on the screen as shown. Then select **Open** or **Close** and press **Enter** which will move the highlighted area to the **Apply** button. Hit **Enter** again to change the valve state. Use the **Next** key to move back to the control box or the **Done** button followed by **Enter** to leave the screen. Pressing the **ESC** key at any time will exit the screen without making changes and return to the main display.

6.4.9 Do A Manual Zero

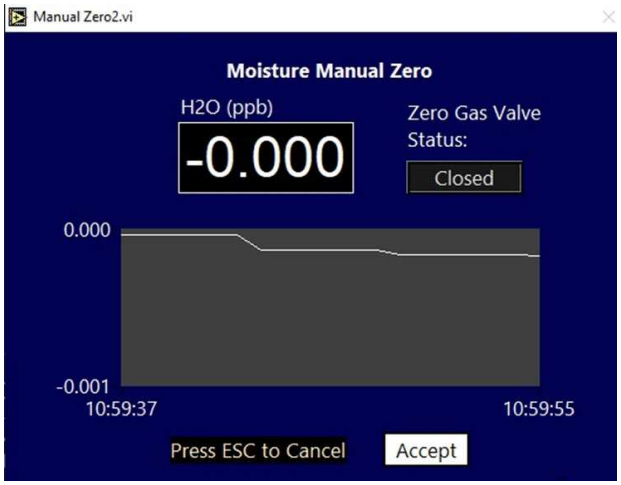


Figure 36: Moisture Manual Zero Screen

The Manual Zero command enables the user to zero the moisture cell in an interactive manner.

For this purpose, it is necessary to ensure that moisture free gas is entering the sensor. This can be accomplished by opening the zero gas valves for the moisture cell. Refer to **Figure 35**. When switching to a gas that is moisture free, it is important to wait long enough to allow the reading to re-stabilize.

NOTE

If oxygen is included in the background gas calculation (see 6.5.2.3 **Span GSF**), the on-board zero gas purifier is automatically prevented from being used. As a result, an adjustment of the moisture zero must be done manually and the zero gas must be supplied from the outside through the sample inlet. This prevents unsafe concentrations of oxygen from entering the purifier.

After opening the zero-gas valve and selecting **Do a Manual Zero**, a screen will appear which displays a trace of the recent moisture reading. See **Figure 36**. Observe the trace until the reading is stable and then press **Enter**. This action will accept the present value as the new zero setting for the moisture cell and the **Zero Reference** field will be updated. After this action, the user will be brought back to the main display.

Pressing **ESC** during the calibration process will abort the action and return the user to the main display. Pressing Accept will complete the zero process, update the zero log, and return the user to the main display.

Once complete, the gas valves must be returned to the original state with process gas going directly through the sensor (see **Figure 31**).

A relay is available on the Moisture Analog Output Setup Screen (see **Figure 59**) to signal that a zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

6.4.10 Do an AutoZero

The AutoZero command enables the user to zero the moisture cell in an automated manner. In addition, the AutoZero procedure can be scheduled to run automatically by using the AutoZero Setup procedure described in **4.5.2** Moisture Calibrate Menu.

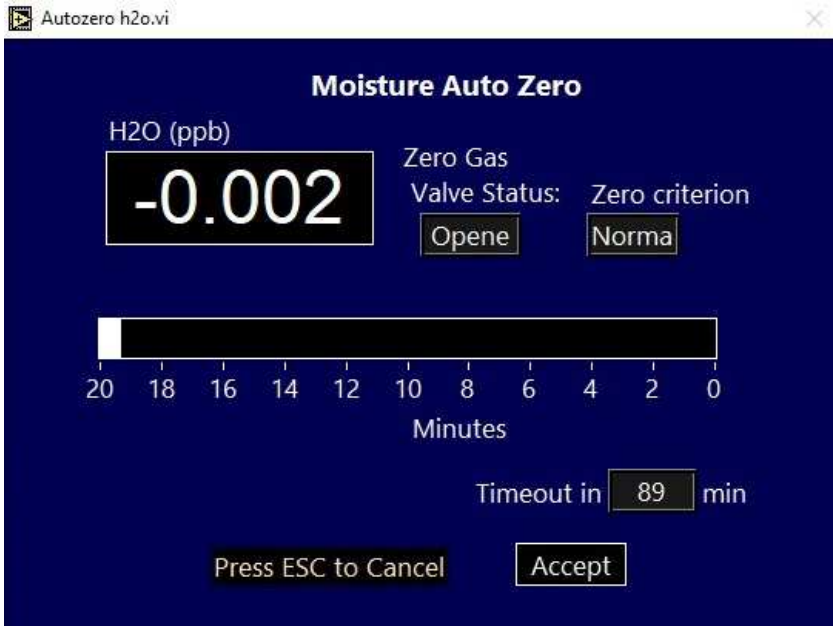


Figure 37: AutoZero Progress Screen

NOTE: If oxygen is included in the background gas calculation (see **6.5.2.3 Span GSF**), the on-board zero gas purifier is automatically prevented from being used. As a result, an adjustment of the moisture zero, must be done manually and the zero gas must be supplied from the outside through the sample inlet.

NOTE

If oxygen is included in the background gas calculation (see 6.5.2.3 **Span GSF**), the on-board zero gas purifier is automatically prevented from being used. As a result, an adjustment of the moisture zero must be done manually and the zero gas must be supplied from the outside through the sample inlet. This prevents unsafe concentrations of oxygen from entering the purifier.

The process measurement mode can be restored at any time during the calibration process by pressing **ESC** or it will be automatically restored at the end of the AutoZero process.

Before the AutoZero process can be started, various criteria must be set using the AutoZero Setup screen in Figure 34. See **6.5.2.2** AutoZero Setup for additional information.

After selecting **Do an AutoZero** from **Figure 33**, a screen similar to **Figure 37** will appear. Throughout the zero process the screen displays the current moisture reading as well as the valve status and selected zero criteria. If a Pre-Zero purge time has been set in the AutoZero Setup screen, then the zero purifier will be valved in, and the gas will flow through the purifier to purge the plumbing for that amount of time. Once the pre-purge is complete, the 20-minute AutoZero cycle begins. During this 20-minute cycle, the analyzer applies stability criteria. If after 20 minutes the moisture 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 stability monitoring until the criteria has been met or until the cycle timer expires. In the latter case, the analyzer returns to operation on sample gas with no adjustment to the zero calibration and reports a failed zero calibration. See **6.4.11**

AutoZero Setup below for a description of the **Cycle Timeout** function. The **Zero Ref** in the **Check/Adjust Zero** screen may change because of this process. Pressing **ESC** during the calibration process will abort the action. The user may also restore the factory calibration from the **Check/Adjust Zero** screen.

A relay is available on the **Moisture Analog Output Setup** screen (see **Figure 59**) to signal that a zero calibration is taking place. Also, the analog output signal can either be frozen or allowed to update during the calibration process.

6.4.11 AutoZero Setup

Moisture AutoZero Setup allows for unattended, automatic zeroing of the moisture analyzer at preset times, preceded automatically by a purge of zero gas if desired. The **AutoZero Setup** menu selection is shown in **Figure 38,** below. This menu selection accesses the AutoZero Setup screen (**Figure 39**), which is used to configure the **Moisture AutoZero Setup** function.

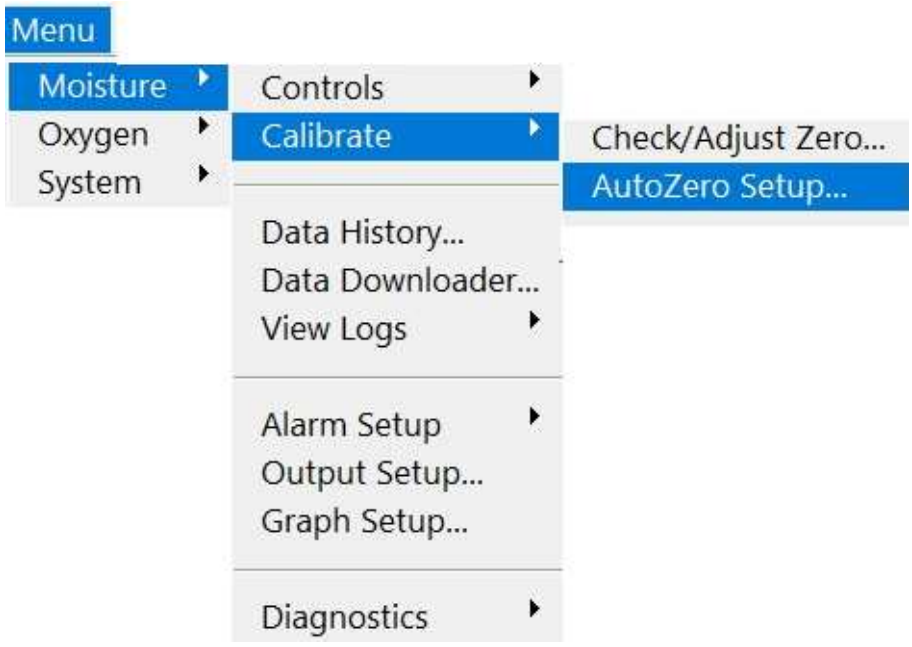


Figure 38 AutoZero Setup Menu Selection

Figure 39: Moisture AutoZero Setup Screen

If when this screen is entered the **Scheduled AutoZero** is turned off, the box in the upper right corner will not be displayed. When the **Scheduled AutoZero** is switched from off to on, the box will appear and the time of the **Next AutoZero** will be set to the current time and date. If no other changes are made when this screen is accepted, the AutoZero process will start immediately. Use the **ESC** key to escape from the screen without starting an AutoZero process.

Setting a time and date for the **Next AutoZero** is accomplished by accepting the current time and date or using the **Nex**t key to move to the **Next AutoZero** box. With the left and right arrow keys, move the cursor to the right of the digit you want to change and use the up and down arrow keys to set it to the desired value. When done, use the Enter key to move to the next box.

NOTE: If the **Scheduled AutoZero** is then turned off, the AutoZero process is stopped and returning to this screen will not show the **Next AutoZero** box in the upper right corner.

The **AutoZero Interval** can be used to set the frequency of zeroing the moisture cell starting with the setting in the box labeled Next AutoZero. The date and time of the next scheduled AutoZero is automatically calculated based on the current AutoZero Interval setting.

With the **AutoZero Timeout** the user can set the allowed time for stabilization (after completion of any pre-zero purge). If the required stable period is not achieved during this time, the AutoZero is automatically aborted, and the Fail Zero flag is set in the Zero Cal Log as shown in **Figure 50.**

The system provides warning of a scheduled AutoZero (preceded by a pre-zero purge if any) before the calibration takes place, according to the time set in the **Pre-Zero Warning**.

The **Pre-Zero purifier purge** enables the user to set an amount of time from 1 to 200 hours during which the system will be purged with zero gas before the AutoZero process begins. This is useful for gases such as oxygen that take a long time to equilibrate. When a non-zero number is entered in this field, a

separate purge count down is added to the AutoZero screen and this time is also automatically added to the timeout.

The **Zero Acceptance Criterion** allows the user to select the stability criteria required before the zero value is accepted. The Stable selection (recommended) ensures the most accurate zero calibration but takes the longest time to execute (68-minute delay before the zero process begins). The Quick selection takes the least time (17-minute delay) and as a result is the least precise. Normal selection applies a mid-range delay of 34-minutes.

A relay is available on the Moisture Analog Output Setup Screen (see **Figure 59**) to signal that a zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

6.4.12 Moisture Data History Routine

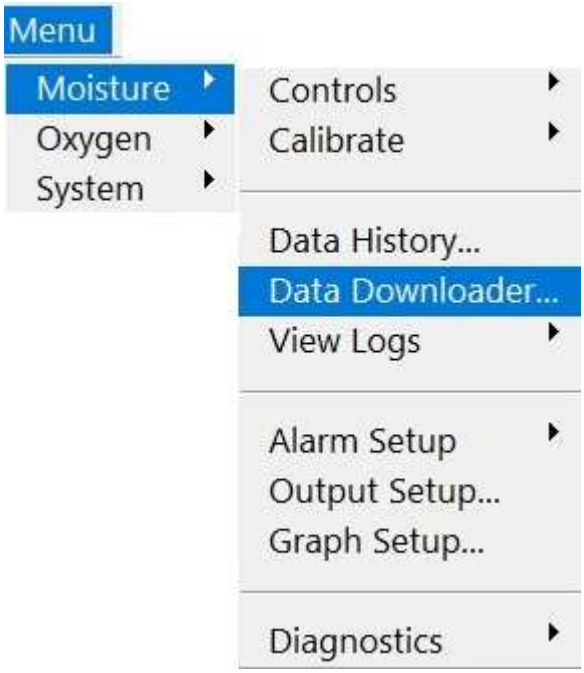


Figure 40: Moisture Data History Selection

The Data History Screen (Figure 41) enables the user to see the data history displayed in strip chart form on the front display. By default, the data history screen displays data for the most recent 24-hour period sampled at a rate of 1 point per minute and the y-axis is auto-scaling. Data History Screen can also be accessed from the Data Downloader screen (**Figure 45**).

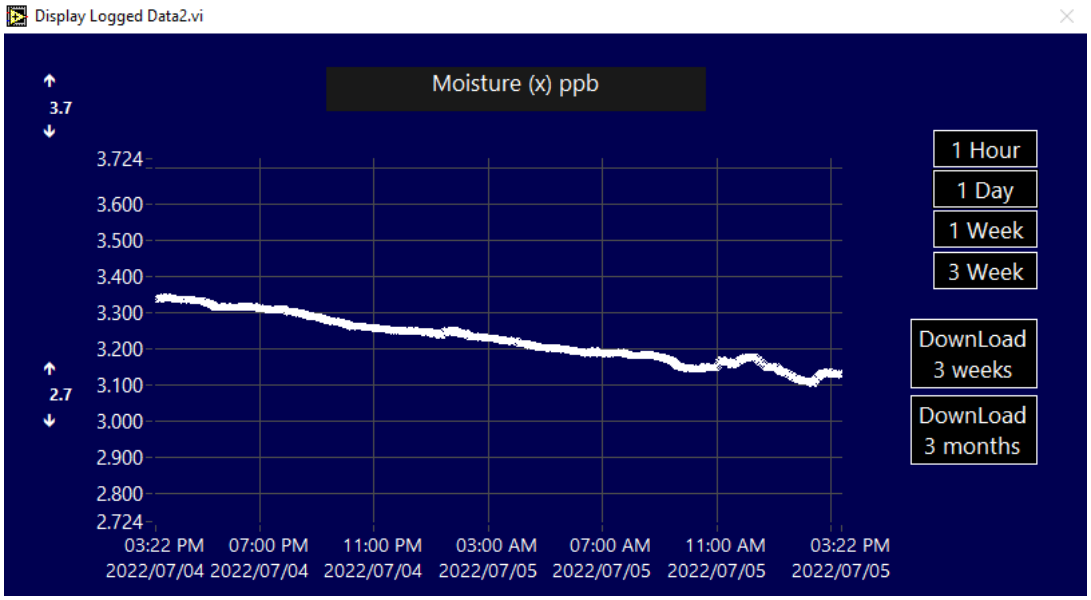
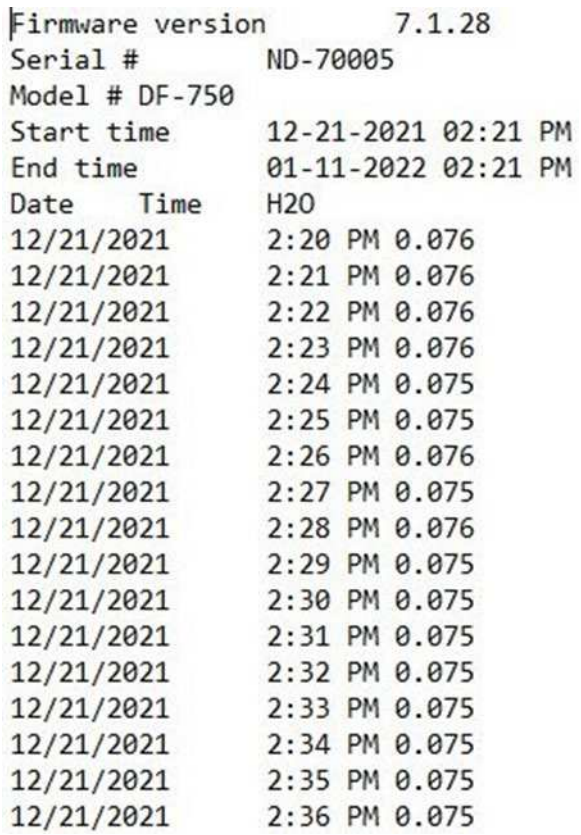


Figure 41: Moisture Data History Screen

The **Next** button can be used to toggle the X-axis scale between 1 day (default), 1 hour, 1 week, and 3 weeks. The **Next** button can also toggle the cursor to the max and min values on the Y axis. The arrow keys ( ) up ▼ ▲ wn can be used to adjust the values, and the display will actively update.

The data history may be downloaded to a USB memory stick (flash drive) by using the **Next** key to move to the **Download** box and hitting **Enter.** A screen will appear (see **Figure 42**) requesting that a memory stick be placed in the USB socket located behind the front door on the left side of the chassis.

Figure 42: Install Media



```
Firmware version        7.1.28
Serial #        ND-70005
Model # DF-750
Start time      12-21-2021 02:21 PM
End time        01-11-2022 02:21 PM
Date    Time    H2O
12/21/2021      2:20 PM 0.076
12/21/2021      2:21 PM 0.076
12/21/2021      2:22 PM 0.076
12/21/2021      2:23 PM 0.076
12/21/2021      2:24 PM 0.075
12/21/2021      2:25 PM 0.075
12/21/2021      2:26 PM 0.076
12/21/2021      2:27 PM 0.075
12/21/2021      2:28 PM 0.076
12/21/2021      2:29 PM 0.075
12/21/2021      2:30 PM 0.075
12/21/2021      2:31 PM 0.075
12/21/2021      2:32 PM 0.075
12/21/2021      2:33 PM 0.075
12/21/2021      2:34 PM 0.075
12/21/2021      2:35 PM 0.075
12/21/2021      2:36 PM 0.075
```

Figure 43: Example of Data Download

The downloaded file will be in tab delimited form and will include all moisture and oxygen data in the system up to 3 weeks old if available. The download process will take up to 15 seconds and the display will indicate downloading is in progress. Once the download is complete, control of the analyzer will be returned to the operator. See **Figure 43** for an example of a portion of a download taken between the dates of May 1 and May 22. The complete file covers 3 full weeks.

6.4.13 Moisture Data Downloader Routine

The Moisture Data Downloader menu selection is shown in Figure 44 This menu selection accesses the Moisture Data Downloader screen (Figure 45) , which enables the user to label data with unique location names as well as to view and download specified data.

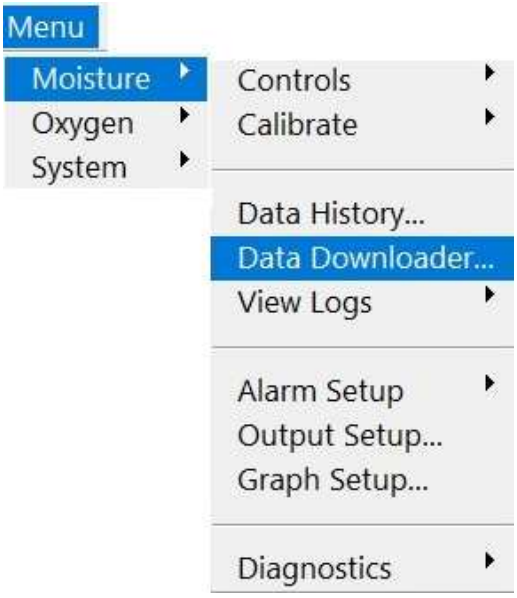


Figure 44: Moisture Data Downloader Menu Selection

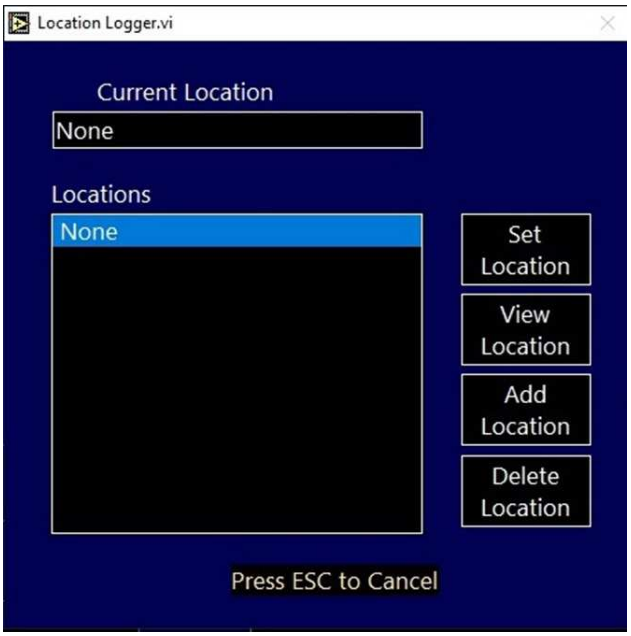


Figure 45: Moisture Data Downloader Screen

6.4.14 Set Location

The set location function is used to choose a location from a list of existing locations previously entered into the system (see **6.4.16 Add Location**). On the Moisture Data Downloader screen (Figure 1), use the **Next** key to move to the list of existing names and then use the arrow keys (and) to select the location desired. Then, use the **Next** key to move to **Set Location** and press **Enter** to accept the new location.

The action of setting a location starts the logging process and creates a new file. Changing to a new location will, in turn, end the previous file and start a new one.

6.4.15 View Location

The view location function is used to view data previously stored in the system sorted by location. On the **Moisture Data Downloader** screen, **Figure 45**, use the **Next** key to move to the list of existing names and then use the arrow keys (and) to select the location desired. Then use the **Next** key to move to **View Location** and press **Enter.** The View Location screen will appear as in **Figure 41**.

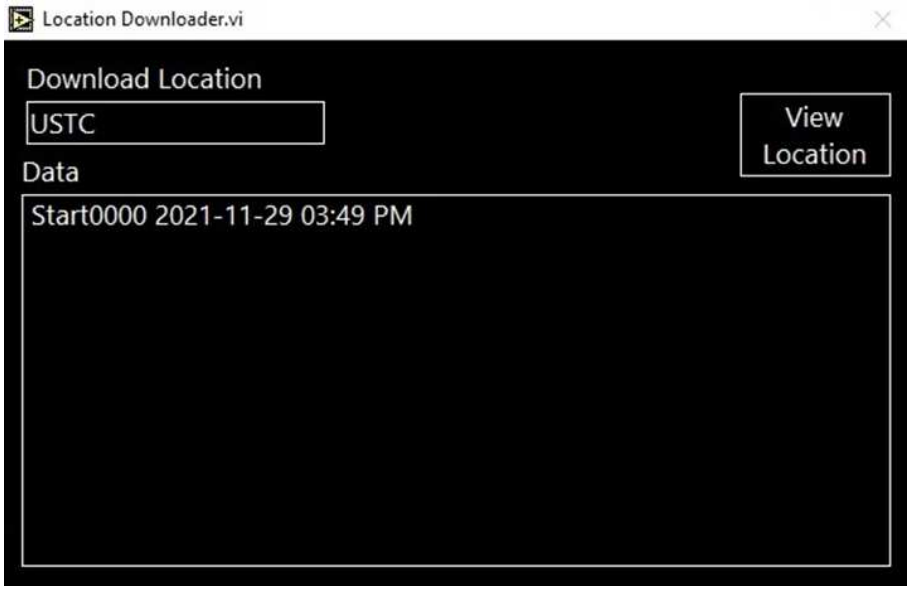


Figure 46: View Location Screen

Use the arrow keys (and) to select the data block desired and use the **Next** key to move to **View Location** and press **Enter.** The data history screen will appear as shown in **Figure 41**. From the data history screen, the data may also be downloaded to a USB memory stick by way of the USB port found behind the front door.

6.4.16 Add Location

The user can create a new location stamp by moving the cursor to the **Add Location** button and hitting enter. This brings up the keyboard shown in **Figure 47** that is used to enter the name of the new location.

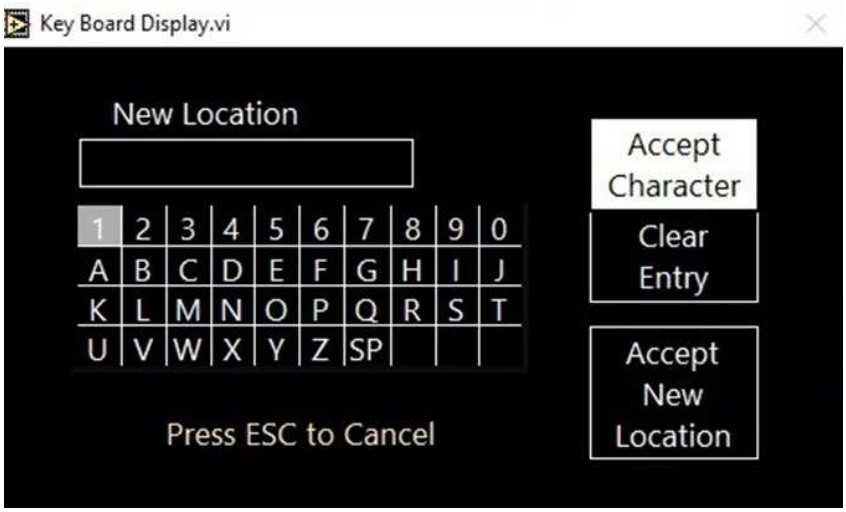


Figure 47: Keyboard Display

Use the arrow keys (and) to navigate the keyboard and use the **Enter** key to accept each character. If an error is made, use the **Next** key to move to the **Clear Entry** key and hit enter. When the location name is complete, use the **Next** key to move the highlight to **Accept New Location** and hit **Enter. (Hint:** You can also use **Ctr+Enter** to post locations.) The display will return to the Downloader Screen and the new location name will appear in the list of available locations.

6.4.17 Delete Location

The delete location function is used to remove a location from the list of available names. On the Moisture Data Downloader screen, **Figure 45** use the **Next** key to move to the list of existing names and then use the arrow keys (and) to select the location desired. Then use the **Next** key to move to **Delete Location** and press **Enter.** A confirmation box will then appear (see **Figure 48**) and the user can either accept the deleted selection with the **Enter** key or can hit **ESC** to cancel the action. If accepted, the selected name will be removed from the list of available locations.

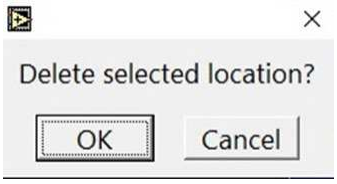


Figure 48: Delete Selection

6.4.18 View Moisture Logs Menu

View Logs allows the user to easily access a log of past events that may relate to past operational changes (e.g., zero) or instrument upsets. Use the arrow keys (and) to scroll up and down through the list. If additional pages exist, an arrow will appear at either the top or bottom of the page. Pressing **ESC** will return to the main display.

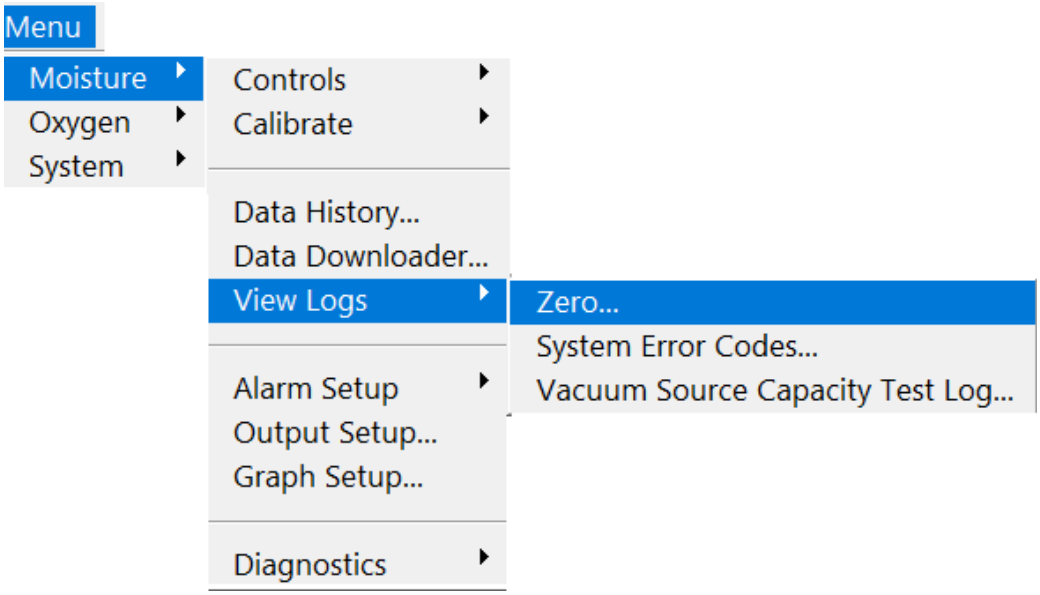


Figure 49: Moisture View Logs Submenu

6.4.19 Moisture Zero Log

The Moisture Zero Log reports on adjustments made to the moisture cell zero setting. The date and time of the zero calibration is noted. The zero is listed in the notes section as either Manual or Automatic. The letters Q, N, and S in the notes section indicate the type of acceptance criteria selected (Quick/Normal/Stable). The notes section also indicates if the zero was aborted, failed due to timeout, or in the event of an Automatic Zero if it were scheduled. The time to perform the zero and the resulting zero reference also appear.

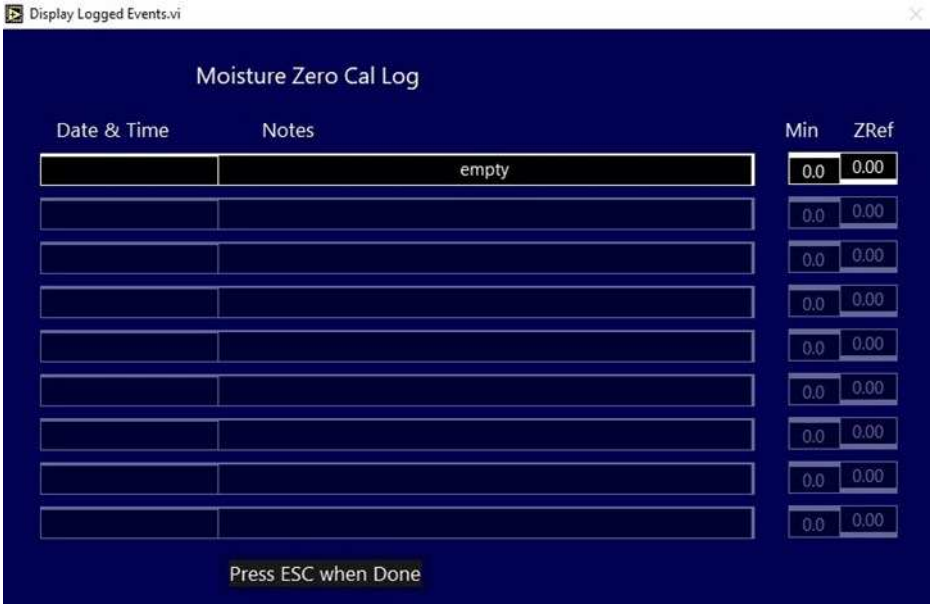


Figure 50: Moisture Zero Log Screen

6.4.20 System Error/Event Codes

The **System Error Log** reports functional errors and events related to the system. If the error persists for more than 30 minutes, the corresponding code is displayed.

In addition, a system alarm will trip if configured to do so. See 6.4.25 Moisture System Alarm Setup for additional information on setting System Alarms.

NOTE: The 30-minute clock is delayed for 60 minutes on a “cold” system start-up.

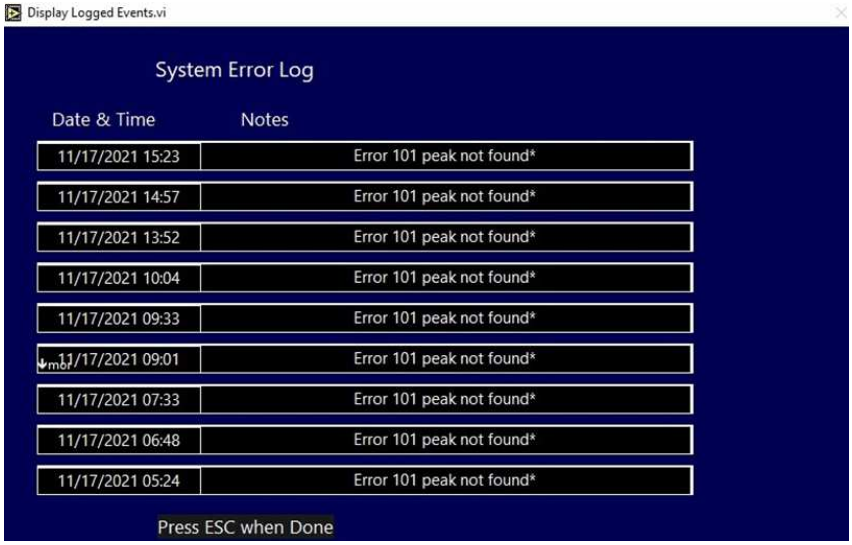


Figure 51: System Error Log Screen

See Table 8 below for a list of some common error codes and their descriptions:

Error Number	Description
101	Moisture Peak Not Found
121	Low Sample DC
161	Laser Temperature too far from Setpoint
191	Fan condition
192	Backflow Prevention – ensure adequate flow through the analyzer

Table 8: Common Error Codes

If these or any other error codes appear on the display of the unit, contact Servomex for assistance. For an expedited turnaround, make sure that a System Data File is downloaded and attached if contact is made through email.

6.4.21 Vacuum Source Capacity Test Log

The vacuum source capacity test can be used to determine the vacuum that the aspirator or pump can pull in the absence of flow. This is process is used to remove potential variability in the test. Proper flow through the analyzer is a direct result of the proper balance between the

pressure on the analyzer inlet and the vacuum at the analyzer outlet. If either is incorrect, the readings given by the analyzer may not accurately reflect the condition of the process gas. See **6.4.32 Vacuum Source Capacity Test** for additional information on the vacuum source test. As the last step of the test, the system automatically puts an entry in the vacuum source capacity test log for future reference. Review of this information can be useful in detecting a trend in the vacuum source condition which can indicate a need to rebuild the pump or troubleshoot the aspirator.

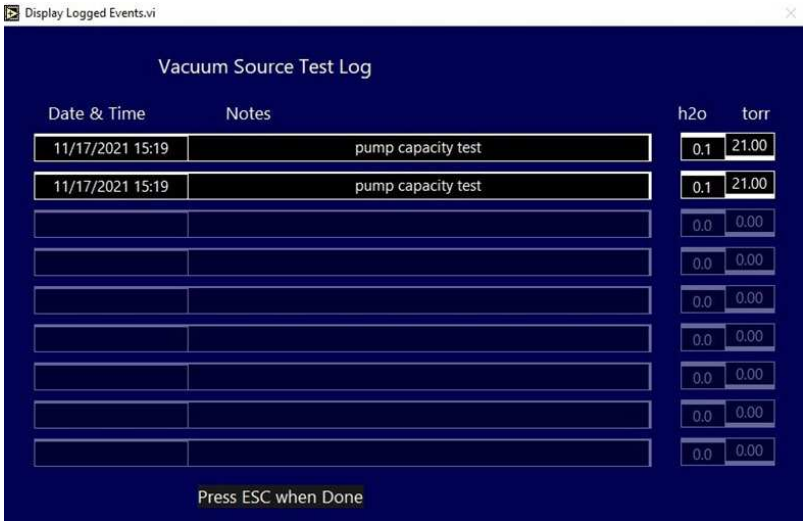


Figure 52: Vacuum Source Capacity Test Log

6.4.22 Moisture Alarm Setup Menu

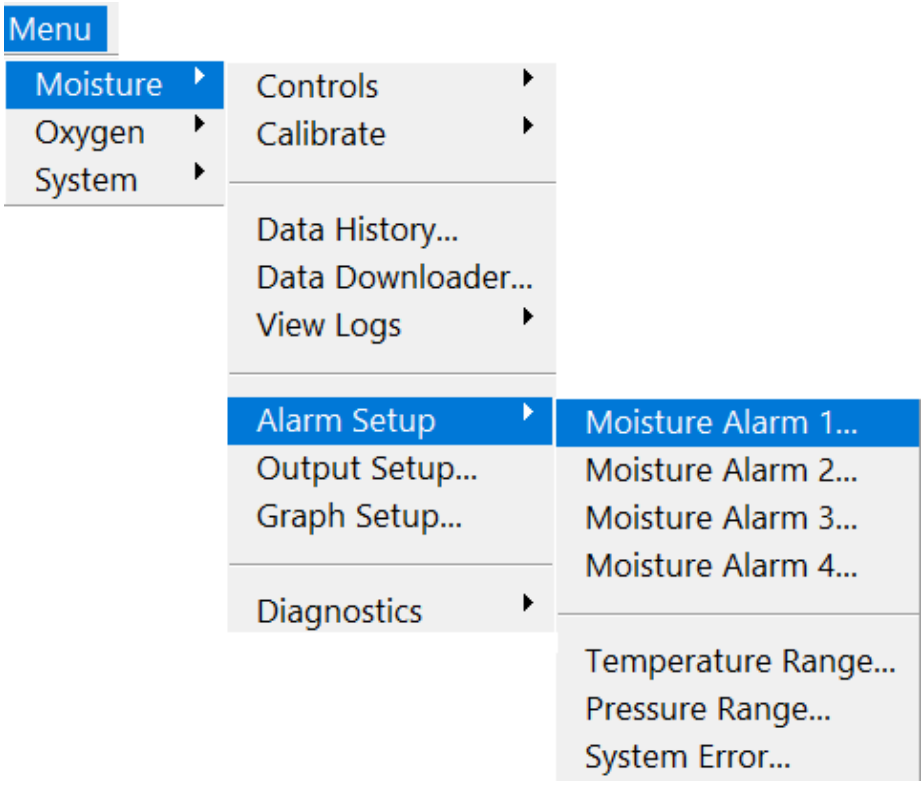


Figure 53: Moisture Alarm Setup Submenu

the **Moisture Alarm Setup screen is shown in Figure 54**. The moisture analyzer includes a total of seven alarms. The four moisture concentration alarms can be used to activate up to four optional relays. High and low setpoints as well as dead bands are user-set.

The temperature alarm indicates an out of specification ambient temperature condition in the analyzer cabinet.

The pressure range alarm alerts the user that the pressure on the outlet of the analyzer is outside of operating range.

Finally, system errors are monitored, and under certain conditions will trip alarms if enabled.

NOTE: When any hydrogen is included in the background gas matrix, an additional alarm is enabled to monitor the cabinet exhaust fan status (see discussion regarding GSF on page 115 for additional information). If the system detects a failure in the operation of the cabinet exhaust fan while operating in a hydrogen background, the system immediately isolates the moisture cell until the fan is repaired. A warning describing this condition will appear over the main display and the user will be unable to restore gas flow until the fan failure is remedied. See **Fan Alarm** on page 118.

An alarm warning will overwrite the moisture level readout if an alarm condition exists. Only fixing the problem that caused the alarm will clear the alarm.
Table 8 provides a list of alarm code abbreviations that can appear in the Status Line:

Alarm Number	Function
1	Moisture Level 1
2	Moisture Level 2
3	Moisture Level 3
4	Moisture Level 4
5	Oxygen Level 1
6	Oxygen Level 2
7	Oxygen Level 3
8	Oxygen Level 4
T	Temperature
P	Pressure
S	System

Table 9: Alarm Codes

6.4.23 Moisture Alarm Setup

Figure 54: Moisture Alarm Setup depicts the Moisture Alarm Setup Screen. The Setpoint value refers to the limit above or below which the alarm is triggered. The Trip command sets the above/below parameter. The dead band refers to the value from the nominal setpoint that the output value must change before an alarm is reset. The Relay Assignment indicates to which relay the alarm is assigned.

Use the **Next** key to move from between fields and use the arrow keys (▼ and ▲) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Pressing the **ESC** key at any time will exit the screen without making changes and return to the main display.

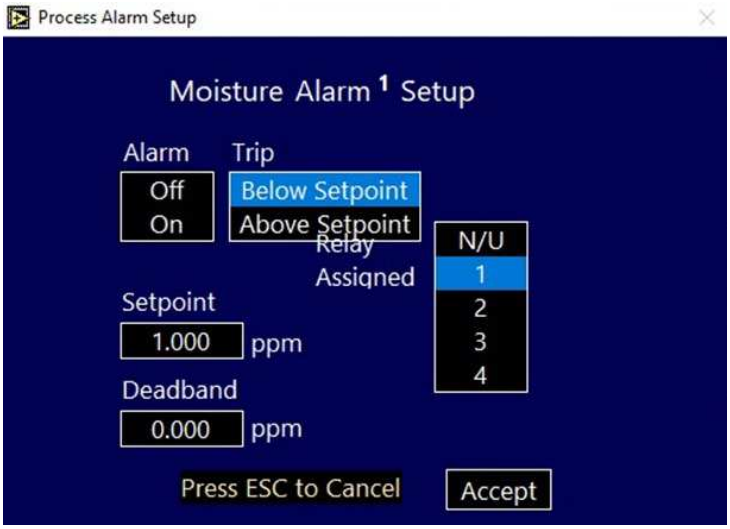


Figure 54: Moisture Alarm Setup

6.4.24 Moisture Temperature Range Alarm Setup

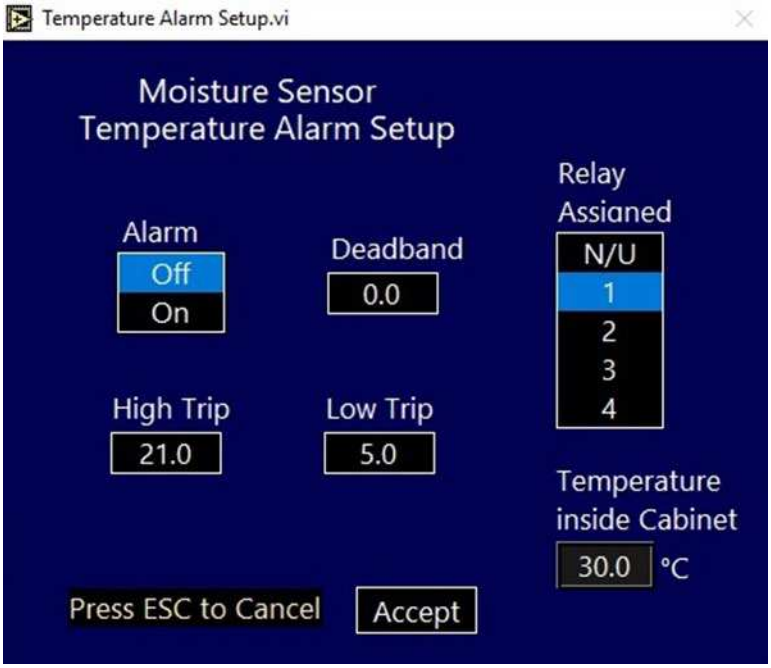


Figure 55: Moisture Temperature Alarm Setup

The system is constantly monitoring the ambient temperature in the analyzer cabinet. If enabled on the Temperature Alarm Setup Screen, an alarm can be assigned to trip if the ambient temperature exceeds preset limits. The user may assign the temperature alarm to one of four relays. **Figure 54** depicts the **Moisture Temperature Alarm Setup** screen.

Use the **Next** key to move from between fields and use the arrow keys (▲ and ▼) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Pressing the ESC key at any time will exit the screen without making changes and return to the main display. Moisture Pressure Range Alarm Setup

The system is constantly monitoring the pressure in the gas path and the result is displayed on the front panel. If enabled on the **Pressure Alarm Setup** screen, an alarm can be assigned to trip if the pressure is outside the preset limits. The user may assign the pressure alarm to one of four relays. **Figure 56** depicts the **Moisture Pressure Range Alarm Setup** screen.

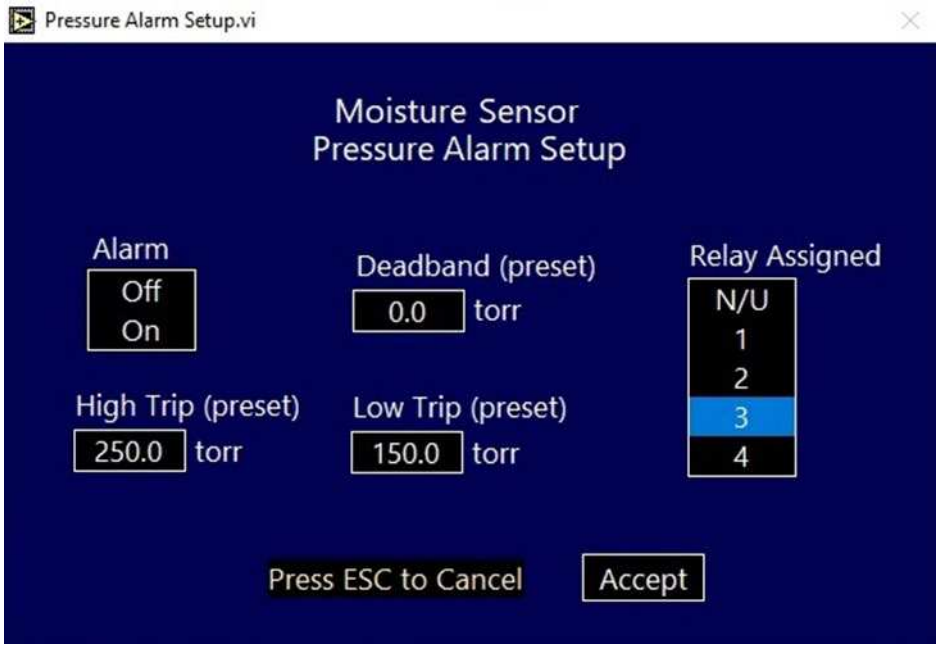


Figure 56: Moisture Pressure Range Alarm Setup

The limits are not user adjustable but are set automatically based on the background gases entered in the GSF screen. See1Safety Summary for additional information on setting the background gases.

Use the **Next** key to move from between fields and use the arrow keys (and) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Pressing the **ESC** key at any time will exit the screen without making changes and return to the main display. **Figure 57** depicts the **Moisture System Alarm Setup** screen.

6.4.25 Moisture System Alarm Setup

Figure 57: Moisture System Alarm Setup

If an error is present for more than 30 minutes, a System Error Code will trip a System Alarm if configured to do so. See page 63 for additional information on **System Error Codes**.

NOTE: The 30-minute clock is delayed for 60 minutes on a “cold” system startup.

Use the **Next** key to move from between fields and use the arrow keys (and) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Pressing the **ESC** key at any time will exit the screen without making changes and return to the main display.

6.4.26 Moisture Analog Output Setup Routine

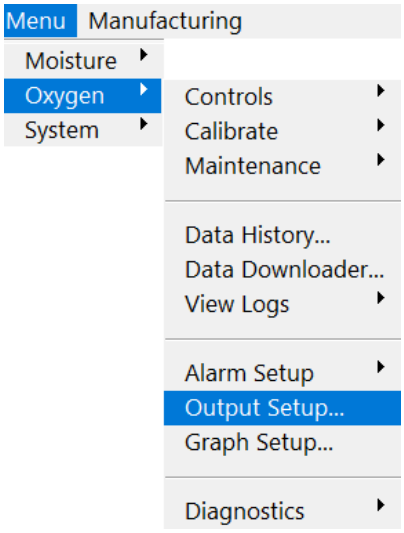


Figure 58: Moisture Analog Output Setup Submenu

The Moisture Analog Output Setup submenu is shown in Figure 58. This menu accesses the Moisture Analog Output Setup screen shown in Figure 59.

The Zero Point corresponds to the lowest voltage or current output (0 VDC, 4 mA) that is sent to a recorder, while the Full Scale corresponds to the maximum voltage or current output (1/2/5/10 VDC or 20mA) that is sent. The Full-Scale set point (FS) is set from 0.002 ppm to 20.00 ppm.

Three ranges can be entered on this screen. The range of the Primary Full Scale (FS) must be less than that of the Expanded Full Scale “A” (FS A) which must be less than that of the Expanded Full Scale “B” (FS B). The analyzer auto-ranges between the three outputs depending on the current analyzer reading. Relay contacts can then be assigned to signal a change in range. If only one expanded range is required, rather than two, then the value of FS B should be set to equal the FS A value.

The **In-Calibration Relay** can be enabled to signal that a zero calibration is in process. In addition, the user has the option to freeze the analog output or enable the analog output to update as the calibration progresses.

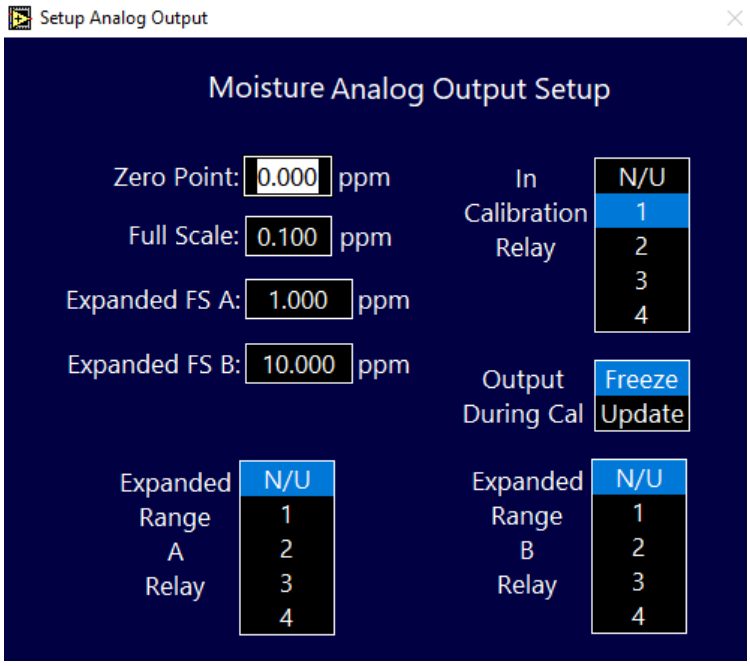


Figure 59: Moisture Analog Output Setup Screen

6.4.27 Moisture Graph Setup

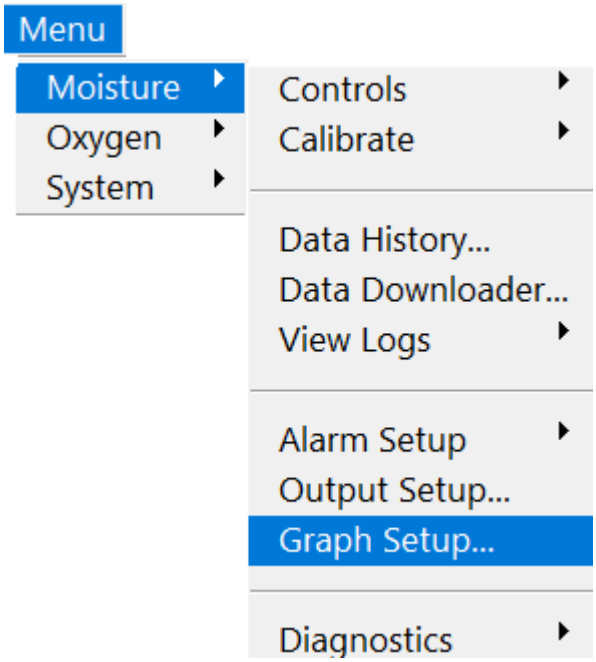


Figure 60: Moisture Graph Setup Submenu

The graph setup is used to adjust the time scale on the main data display of the analyzer. A specific time interval in minutes can be chosen for the X-axis on that display. The minimum acceptable time is 3 minutes. The information on the graph represents current data and will show a history of moisture

concentration based on the given time span to the present. The Y-axis of the main data display is auto-ranging.

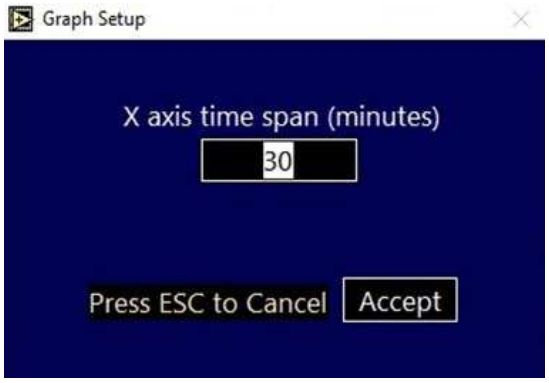


Figure 61: Moisture Graph Setup Screen

6.4.28 Moisture Diagnostics Menu

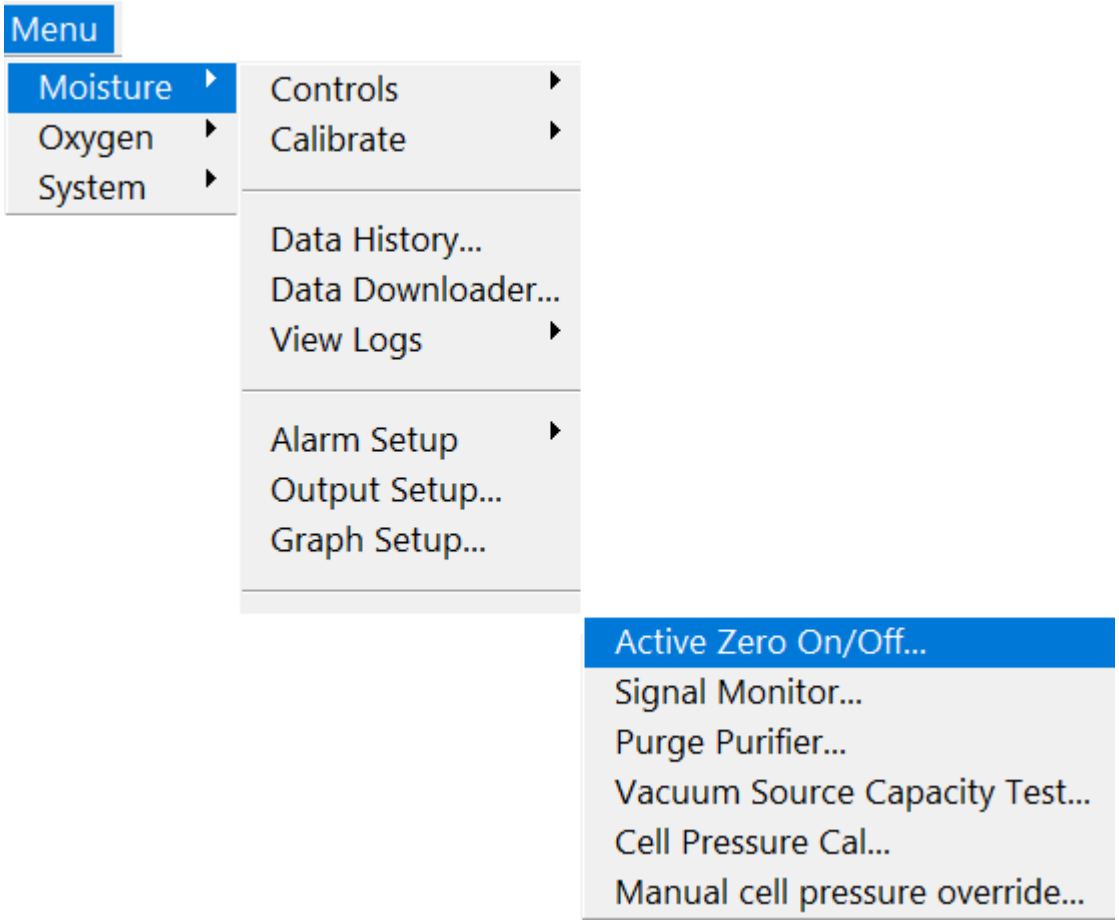


Figure 62: Moisture Diagnostics Submenu

6.4.29 Active Zero On/Off

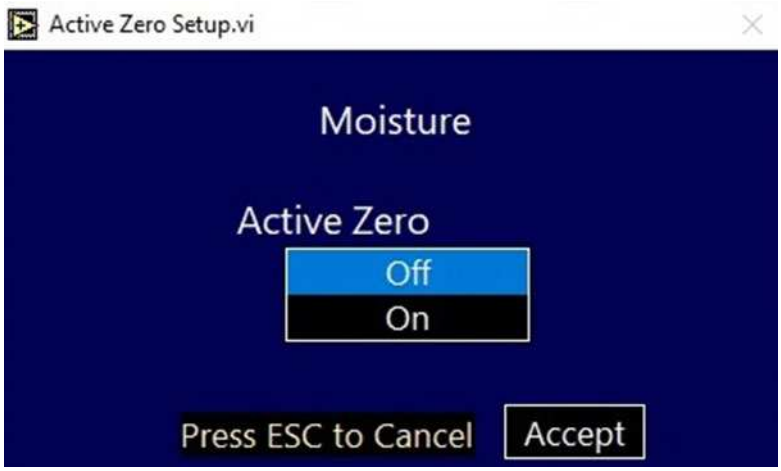


Figure 63: Moisture Active Zero Setup Screen

The Active Zero Offset feature compensates for long-term drying of process lines and analyzer plumbing. When connected to a very dry stream, the reading of the analyzer will tend to trend downward over time periods of months or years. This trend reflects the real moisture content of the stream continuing to drop as a new balance of absorption and desorption occurs in the plumbing upstream of the moisture cell due to the transport properties of moisture. This behavior is very predictable, so it can be detected and automatically offset to ensure accurate readings both shortly after installation and years after startup. When Active Zero Offset is enabled through the Diagnostics Menu, the User Zero Offset feature is disabled and vice versa. While the User Zero Offset feature requires the user to enter a fixed positive offset value to accommodate the baseline cleanup, the Active Zero Offset does so automatically, and only when necessary.

The current Active Zero Offset value is shown in the **Check/Adjust Zero** screen as shown in **Figure 33**. It starts at a value of 0.00 ppb when the analyzer is first turned on, and then increments automatically as the analyzer applies offset to the readings. After each User Zero Calibration, the Active Zero Offset value is reset to 0.00 ppb and then automatically increments again as needed.

The Active Zero Offset is designed to operate when the zero baseline is falling at a rate less than 0.1 ppb/hr. as would be the case after 1-2 weeks of initial operation. If user calibrations are performed sooner, the H_2O readings may decrease too rapidly for the Active Zero Offset feature to operate properly and negative H_2O readings may result.

If the Active Zero Offset value reaches 5 ppb a warning message CAL ZERO will flash in the system status block on the display instructing the user that a zero calibration should be performed. The maximum amount of offset that can be applied by this feature is 5 ppb. Any further downward trend (baseline cleanup) exceeding –0.3 ppb will result in negative readings until the next user calibration is performed resetting the Active Zero Offset value to zero.

If the Active Zero Offset feature is turned off, the User Zero Offset value will appear in its place in the CHECK/ADJUST ZERO menu. The previous user Zero Offset value (if any) will reappear and immediately be applied to the live display readings. Likewise, if the Active Zero Offset feature is on, then its value (if any) will appear and immediately be applied to the live readings.

6.4.30 Signal Monitor

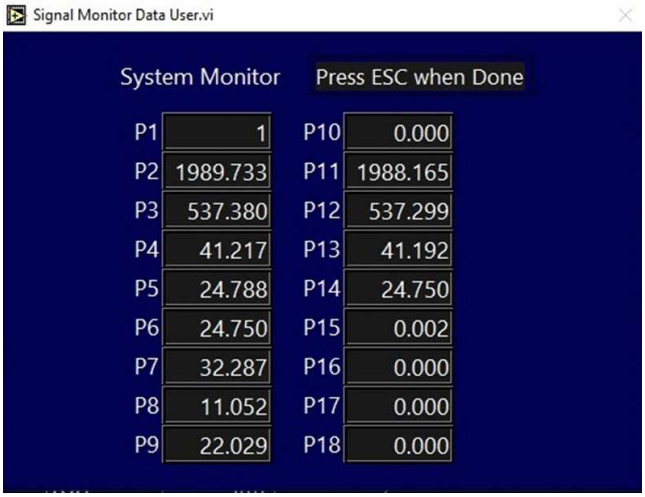


Figure 64: Signal Monitor

The Signal Monitor depicts 18 system parameters in numerical order. Each parameter is unique for each system. In the event of a system error, these parameters can be used as a diagnostic tool. See page 63 for additional information on system errors.

6.4.31 Purge Purifier

When installing or replacing a purifier, the plumbing is inevitably exposed to ambient air. The key is to install the purifier quickly to minimize the duration of the exposure and therefore reduce the amount of time it takes the analyzer to release moisture from the wetted surfaces.

NOTE: When the analyzer is shipped from the factory, the plumbing is purged, filled with N2, and the purifier fittings are capped.

Installation of the purifier, no matter how quick, will allow ambient air to enter the plumbing and when gas flow is restored, the air will be sent into the system resulting in an increase in the moisture reading. As such, it is mandatory that the purifier plumbing be cycle purged before use.

The analyzer includes a system to automate the purge process by alternately flowing gas through and around the purifier. The process is repeated numerous times to eliminate all effects of wetted surfaces due to exposure to ambient air.

Select Purge Purifier from the Diagnostics screen and **Figure 60** will display. Use the Next key to select OK, and when ready press Enter and Figure 66 will display.

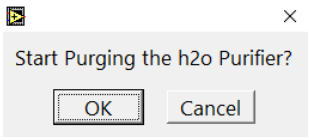


Figure 65: Purge Start

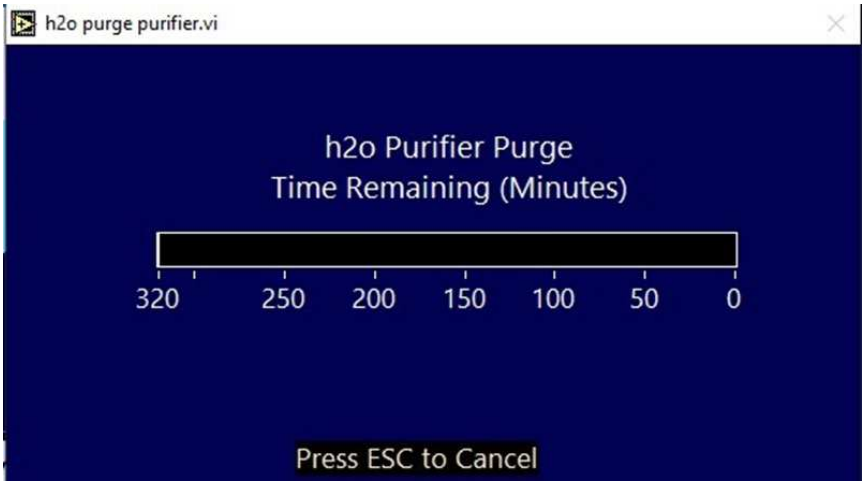


Figure 66: Purifier Purge Timeline

As the timeline progresses, the analyzer is going through a preset sequence of cycles which alternately flow the process gas through the zero and process legs of the gas panel. During this time, the analyzer should not be used for process measurements. The purge cycle can be terminated at any time by hitting the **ESC** key which will bring up **Figure 67**. Use the **Next** key to toggle between the options and use the **Enter** key to either end the process or, by canceling, allow it to continue. When the process is complete, control of the analyzer will be returned to the user.

NOTE: When purging a purifier, it is important to use clean process gas that has a very low moisture and oxygen concentration.

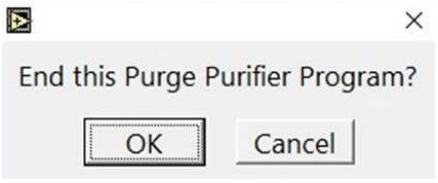


Figure 67: Purge Cancel

6.4.32 Vacuum Source Capacity Test

The vacuum source capacity test (**Figure 68**) can be used to determine the maximum vacuum that the aspirator or pump can create. Proper flow through the analyzer is a direct result of the proper balance between the pressure on the analyzer inlet and the vacuum at the analyzer outlet. If either is incorrect, the flow will suffer, and the moisture readings will not accurately reflect the condition of the process gas.

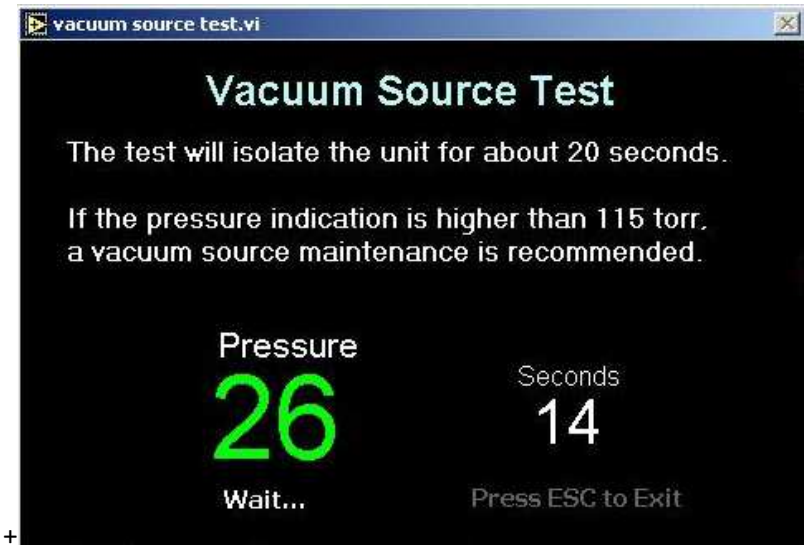


Figure 68: Vacuum Source Capacity Test

The test is automatic in nature in that the analyzer isolates the moisture cell by closing the upstream and downstream valves and vacuum pressure is displayed for 20 seconds. Any pressure lower than 115 Torr is considered acceptable. If the aspirator or pump is unable to reach 115 Torr, the message in **Figure 69** displays with the recommendation to rebuild the pump or check for leaks. At the end of the 20-second test, the user must hit **Escape** to return to the main display (regardless of whether the result is pass or fail).

After the pump test is complete, an entry is automatically put in the pump capacity test log as shown in **Figure 70**. See page 63 for additional information on the pump test log.

Figure 69: Pump Pressure Failure

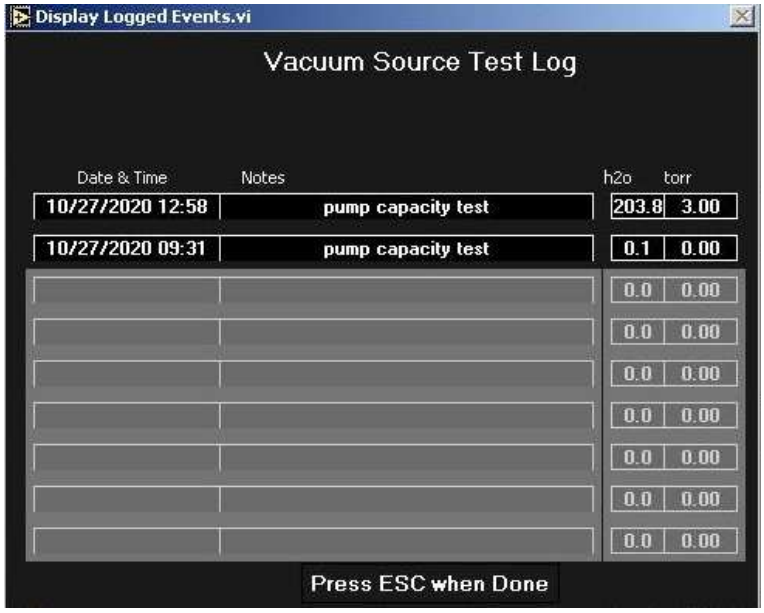


Figure 70: Pump Capacity Test Log

6.4.33 Cell Pressure Calibration

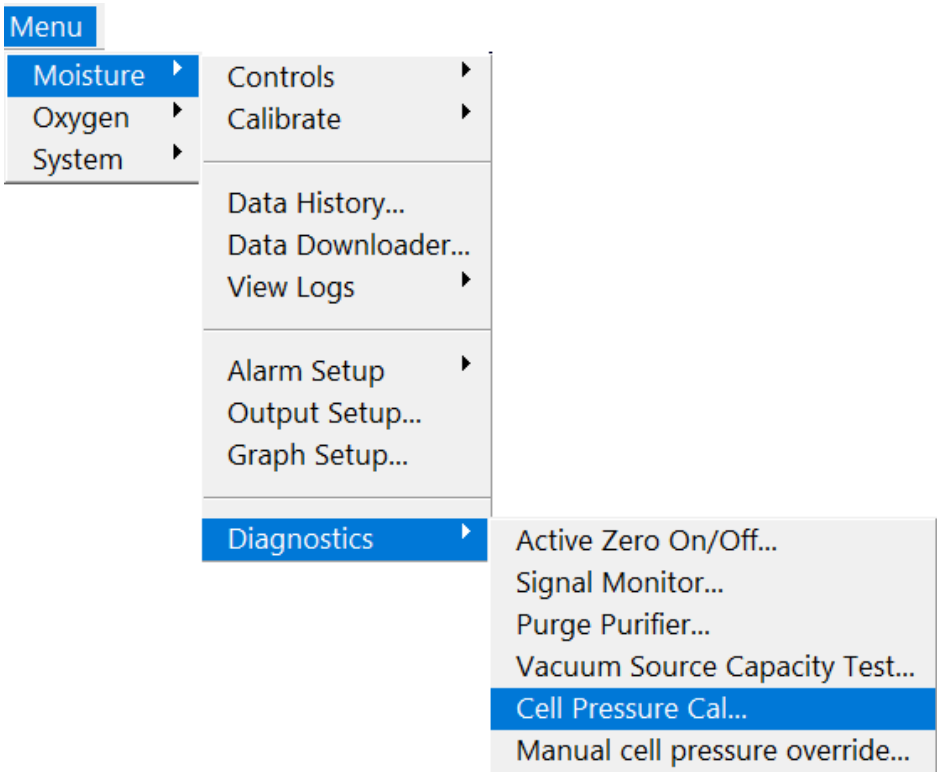


Figure 71: Cell Pressure Calibration Menu Selection

Cell pressure calibration allows calibration of the cell pressure transducer. Although the transducer is calibrated at the factory, if the analyzer is located at a high altitude or has had the transducer replaced, a calibration check should be performed. The default target is 760 Torr (nominal seal level pressure), however, as atmospheric pressure varies with elevation and weather conditions, it is recommended that the nearest weather station be used to determine the current ambient pressure. The vacuum source (pump or aspirator) should be disconnected, and gas flow stopped when performing calibration. To navigate, press the “Next” button to highlight the gain adjustment box. Move the cursor with the left and right arrows as needed. Change the selected digits using the up and down arrows. This screen also allows a manual offset to be applied to the displayed pressure. This feature is for testing purposes and should not be used during routine calibrations.

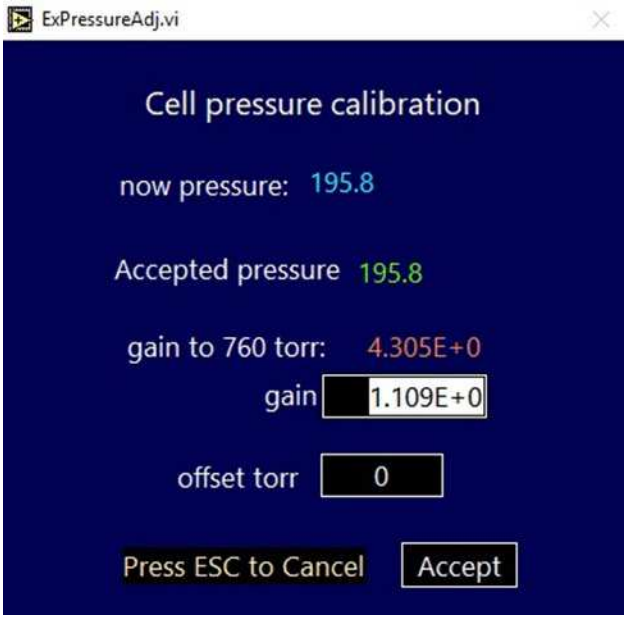


Figure 72: Cell Pressure Calibration Screen

6.4.34 Manual Cell Pressure Override

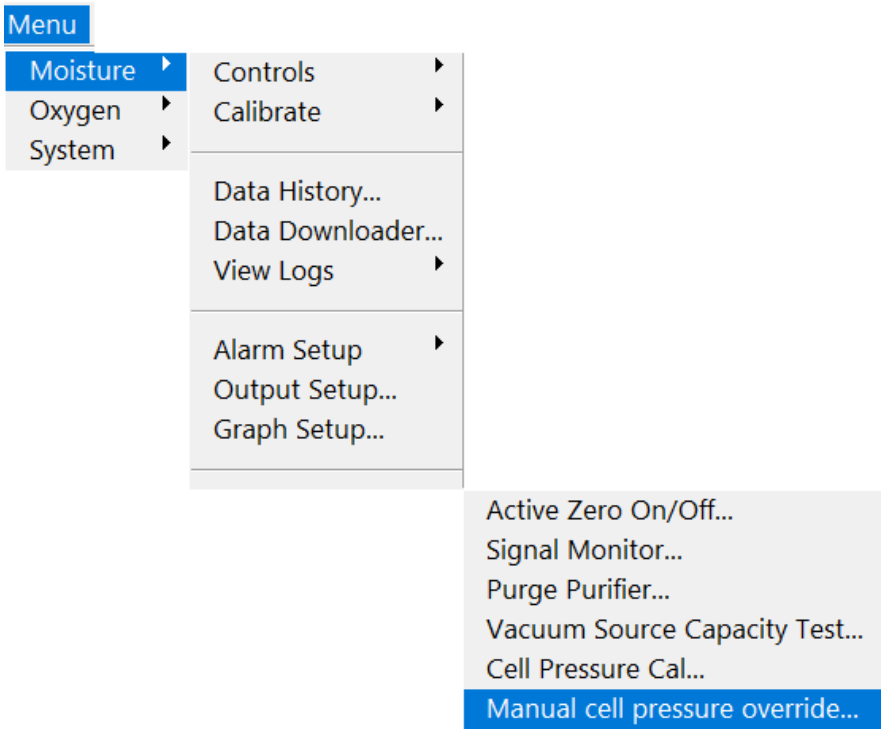


Figure 73: Manual Cell Pressure Override Menu Selection

Manual cell pressure override allows the use of either the pressure reading provided by the transducer or a manually entered pressure to determine moisture concentration. Navigation is performed using the **Next** and arrow buttons. The default setting is **Sensed**, meaning the analyzer is using the value provided by the pressure transducer. Selecting **Entered** enables the user to manually enter the pressure to be used by the analyzer. Care should be taken when doing this. A large error in moisture readings will occur if the entered reading is not close to the actual pressure.

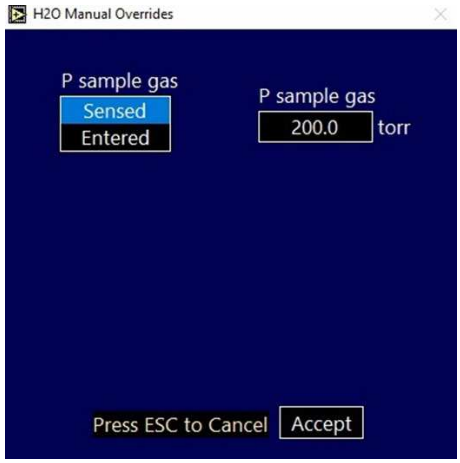


Figure 74: Manual Cell Pressure OverRide

6.5 Oxygen Menu

The Oxygen Submenu (**Figure 75**) relates to the operation of the oxygen sensor without affecting moisture cell operation. Use the arrow keys (and) to navigate up and down through the list. Select the highlighted item with the **Enter** key on the front panel.

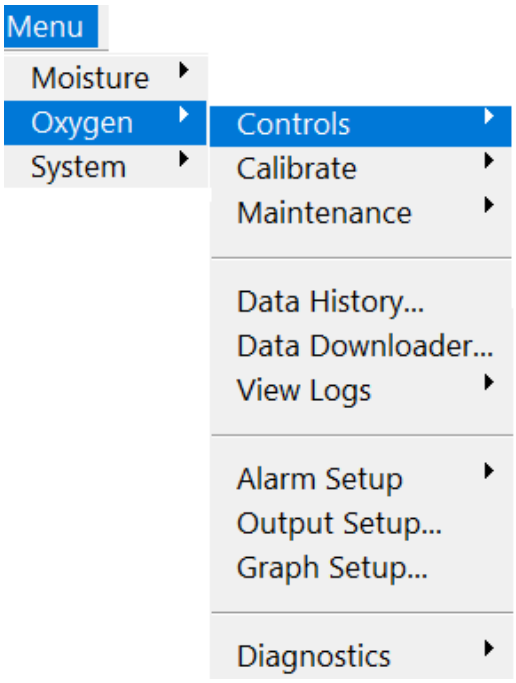


Figure 75: Oxygen Submenu

6.5.1 Oxygen Controls Menu

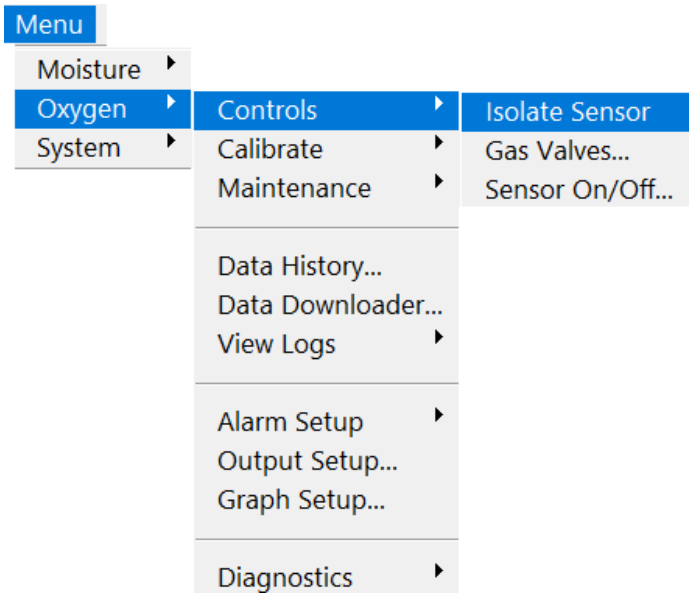


Figure 76: Oxygen Controls Menu

6.5.1.1 Isolate Sensor

This menu selection closes the oxygen sensor isolation valves, thereby isolating the oxygen cell. (Moisture cell isolation valves are not affected.)

6.5.1.2 Gas Valves

The Oxygen Sensor Valves Control dialogue screen (**Figure 77**) provides four options for gas valve control.

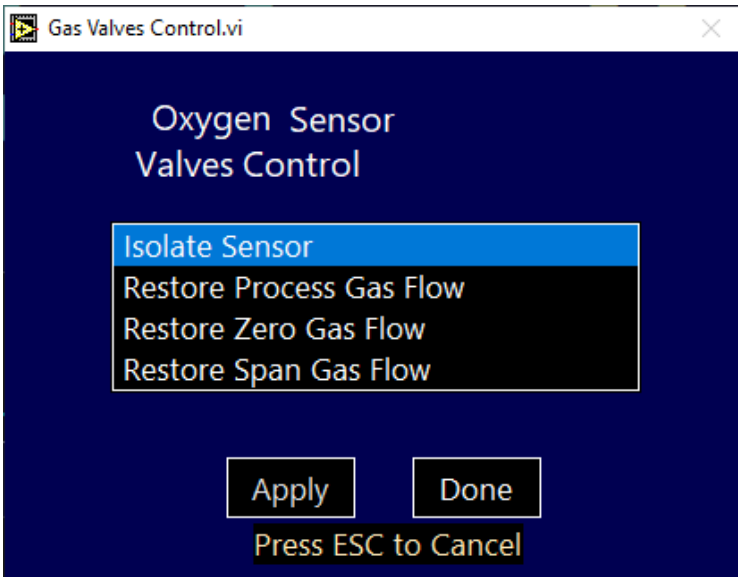


Figure 77: Oxygen Valves Control Screen

- The **Isolate Sensor** selection closes the upstream and downstream valves for the oxygen sensor. This is done to prevent contamination of the sensor when in transport or for changing process lines.
- **Restore Process Flow** opens the upstream and downstream valves of the oxygen sensor to allow for gas flow from the sample inlet for normal operation.
- **Restore Zero Gas Flow** diverts the sample inlet flow through the gas purifier and then through the oxygen sensor. Flowing the sample through the purifier is necessary for performing zero calibrations or for assessing the purity level of the incoming gas.
- **Restore Span Gas Flow** controls valves for span calibrations on the oxygen sensor.

See **Figure 131** on page 119 for additional information on valves and gas valves control.

6.5.1.3 Oxygen Sensor On/Off

The oxygen sensor power can be toggled **ON** or **OFF** by selecting **Sensor On/Off** from the Oxygen Valves Controls menu **(**Figure 77**)**, and selecting **Activate Sensor** or **Deactivate Sensor** from the Oxygen On/Off Control screen **(Figure 78**). The analyzer is programmed to protect the oxygen sensor from extended

operation at high oxygen concentrations and will shut the sensor off automatically after 20 minutes at a level greater than 20 ppm.

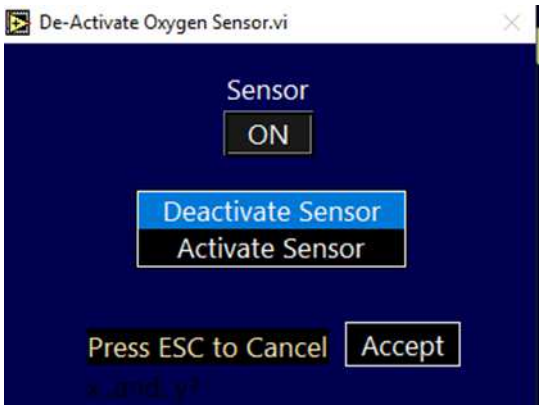


Figure 78: Oxygen Sensor On/Off Control Screen

NOTE

After the high oxygen level condition has been ended, the system will not automatically turn the sensor back on. The user must access this screen and manually turn the sensor back on after the oxygen concentration is back within range. Similarly, if maintenance is expected to bring about a high concentration of oxygen into the sensor lines, it is advised to turn the oxygen sensor **OFF** before proceeding.

NOTE

If there is a non-zero entry in the GSF setup screen for O_2, then the polarization voltage to the O_2 sensor is automatically turned off and the O_2 sensor is automatically isolated from gas flow.

An alarm/relay combination may be assigned to the sensor on/off signal to indicate the status. See page 107 for additional information.

The state of the sensor-polarizing voltage at the time of analyzer power up is determined by parameters set on the Power-up defaults screen. See page 46 for additional information on Power-up default settings.

NOTE

The oxygen sensor is automatically turned off on initial analyzer power-up from the factory. The user may change this setting with the power-up defaults screen.

6.5.2 Oxygen Calibrate Menu

Sample line contributions to oxygen offsets, especially at the sub-ppb level, are difficult to remove even in a system that is operating correctly. The dry-down process of the analyzer and/or gas supply system

can take many months. During dry-down, however, the analyzer has an array of zeroing features that enable the user to establish *temporary* performance near 0.0 ppb. Monitoring the zero-reference number during that time will give the user a sense of the offset being induced by the user zero actions. The Oxygen Calibrate Menu is shown in **Figure 79**, below.

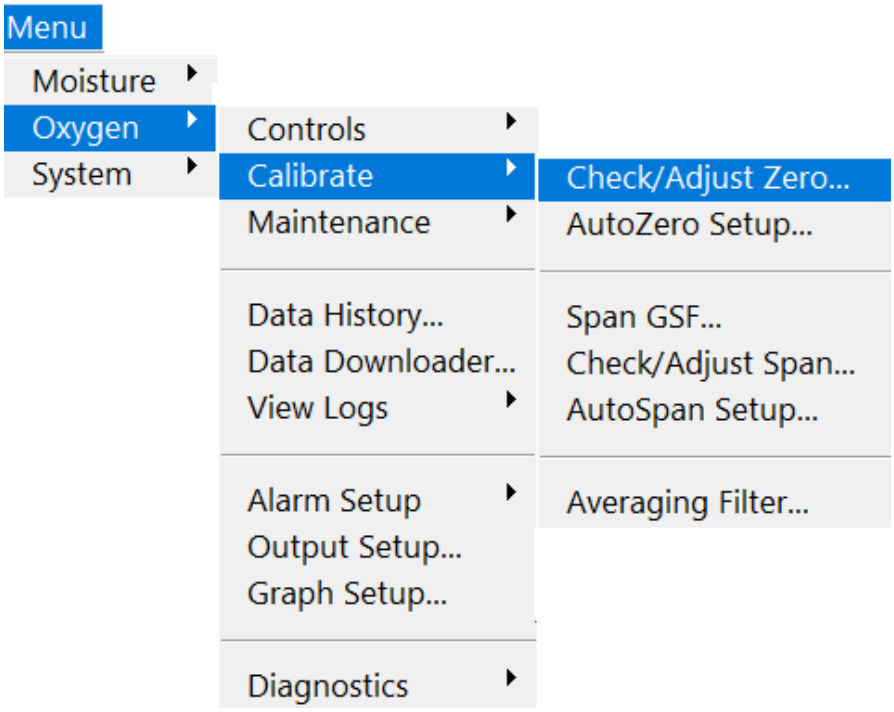


Figure 79: Oxygen Calibrate Menu

6.5.2.1 Check/Adjust Zero

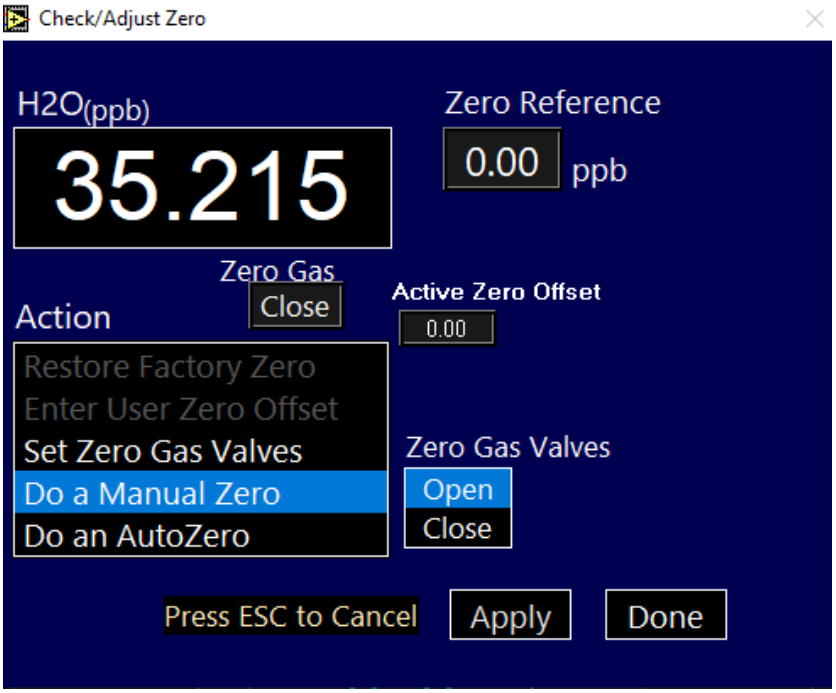


Figure 80: Check/Adjust Zero Screen

The Check/Adjust Zero screen shown in **Figure 80** enables the user to pick from numerous zero calibration-related functions.

The **Zero Reference** value in the upper right corner reflects the deviation of the oxygen sensor's present zero current from the original factory calibration based on any user zero actions. 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.

User **Zero Offset**: Upon initial start-up of the analyzer, and whenever the electrolyte is changed, the electrolyte itself causes a higher current to flow than normal. As the electrolyte ages (~ 3 weeks) the zero current gradually decreases. To prevent this decrease from causing a display of negative oxygen concentration, the **User Zero Offset** can be used. This value does not affect zero calibration; it is simply added to the calibrated zero.

Zero Gas Valves: Can be toggled OPEN or CLOSED. This function allows manual control of the zero gas valves.

Do a Manual Zero: This option enables the user to perform a re-zero of the oxygen sensor's output. See page 83.

Do an AutoZero: This option 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. See page 84.

A relay is available on the Oxygen Output Setup Screen (see page 108) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

6.5.2.1.1 Do A Manual Zero

After selecting Do a Manual Zero from the Check/Adjust Zero Screen (Figure **80**), the **Oxygen Manual Zero** screen (**Figure 81**) is displayed**.**

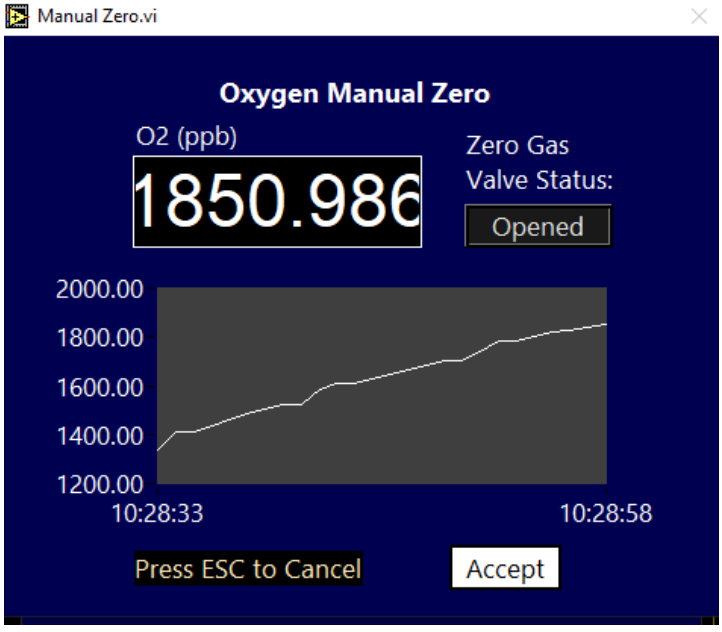


Figure 81: Oxygen Manual Zero

For a manual zero operation, it is necessary to ensure that oxygen-free gas is entering the sensor. This can be accomplished by opening the zero gas valves for the oxygen sensor. See **Figure 80** above. When switching to a gas that is oxygen-free, it is important to wait for a period necessary to allow the reading to re-stabilize.

Use the arrows to highlight **Set Zero Gas Valves** and press **Enter**. A box will appear at the right and the arrows can be used to select either **Open** or **Close valves.** Highlight **Open** and hit **Enter. Zero Gas Flowing** will appear at the bottom of the main display.

After selecting "**Do a Manual Zero**", a screen will appear which displays a trace of the recent oxygen reading (see **Figure 81)**. Observe the trace until the reading is stable and then press **Enter**. This action will accept the present value as the new zero setting for the oxygen sensor and the **Zero Reference** field will be updated. After this action, the user will be returned to the main display and the Oxygen Cal Log is updated as shown in **Figure 103**.

Once complete, the gas valves must be returned to the original state with process gas going directly through the sensor. Use the arrows to highlight **Set Zero Gas Valves** and press **Enter**. A box will appear at the right and the arrows can then be used to select either **Open** or **Close valves.** Highlight **Close** and hit **Enter. Zero Gas Flowing** will then disappear from the bottom of the main display.

Pressing **ESC** during the calibration process will abort the action. Whether the calibration is complete or aborted, pressing Done from the previous screen will allow the user to return to the main display and the **Oxygen Cal Log** is updated as shown in **Figure 103**.

A relay is available on the Oxygen Output Setup Screen (see page 108) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

6.5.2.1.2 Do An AutoZero

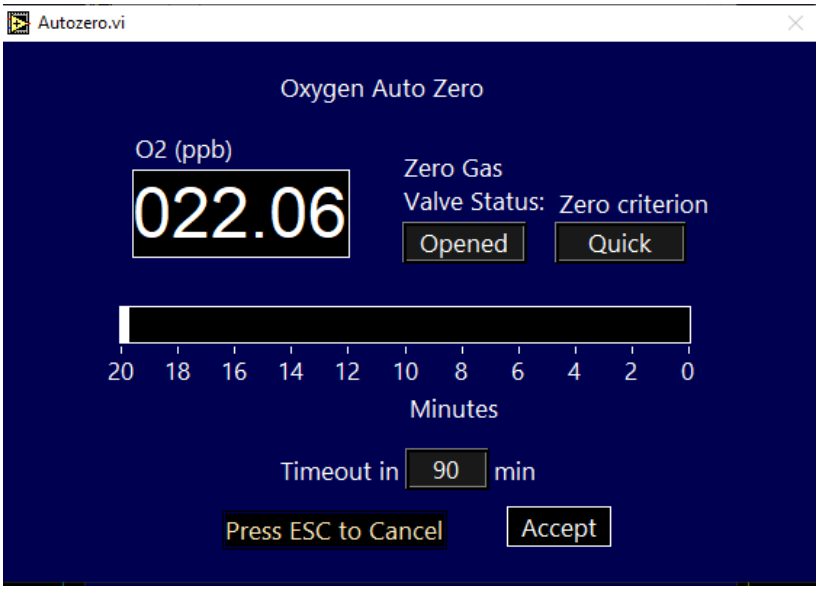


Figure 82: Oxygen AutoZero Screen

The **Do an AutoZero** selection (see **Figure 80)** enables the user to zero the oxygen sensor in an automated manner. In addition, the AutoZero procedure can be scheduled to run automatically by using the AutoZero Setup procedure described on page 85.

The process measurement mode can be restored at any time during the calibration process by pressing **ESC** or it will be automatically restored at the end of the AutoZero process.

Before the AutoZero process can be started, various criteria must be set using the **AutoZero Setup** screen shown in **Figure 84**. See page **85** for additional information.

After selecting "**Do an AutoZero**" from **Figure 80**, a screen similar to **Figure 82** will appear. Throughout the zero process, the screen displays the current moisture reading as well as the valve status and selected zero criteria. A graphical timer begins counting down from 20 minutes. During the 20-minute cycle, the analyzer applies stability criteria. If after 20 minutes the moisture 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 to monitor stability until the criteria has been met or until the cycle timer expires. In the latter case, the analyzer returns to operation on sample gas with no adjustment to the zero calibration and reports a failed zero calibration. See 6.5.2.2 AutoZero Setup below for a description of the **Cycle Timeout** function. The **Zero Ref** in the Check/Adjust Zero screen may change because of this process. Pressing **ESC** during the calibration process will abort the action. The user may also restore the factory calibration from the Check/Adjust Zero screen.

A relay is available on the **Oxygen Analog Output Setup** screen **(Figure 115**) to signal that a zero calibration is taking place. Also, the analog output signal can either be frozen or allowed to update during the calibration process.

6.5.2.2 AutoZero Setup

The **AutoZero Setup** menu selection (Figure 83) accesses the **Oxygen AutoZero Setup** screen (**Figure 84**).

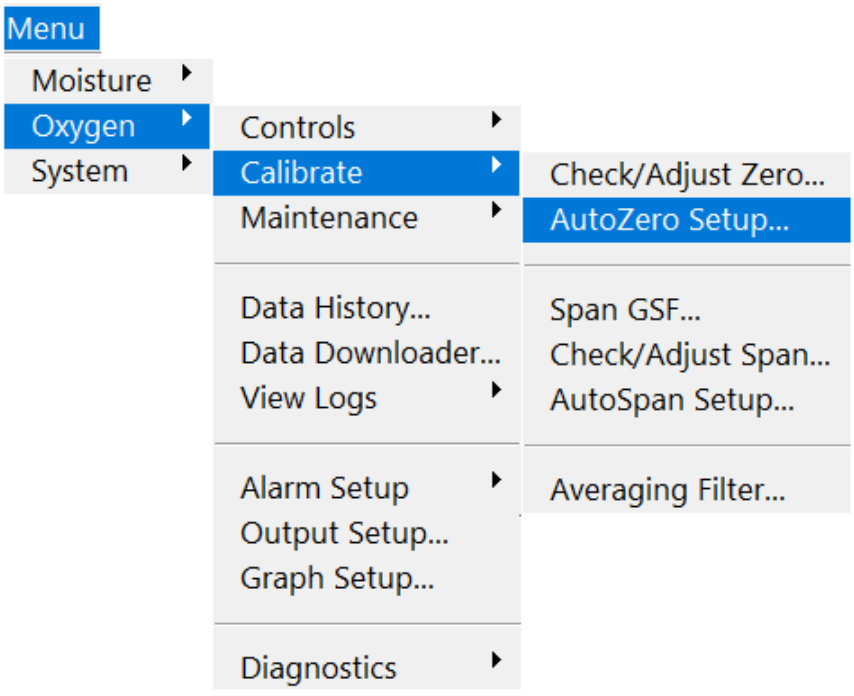


Figure 83 Oxygen AutoZero Setup Menu Selection

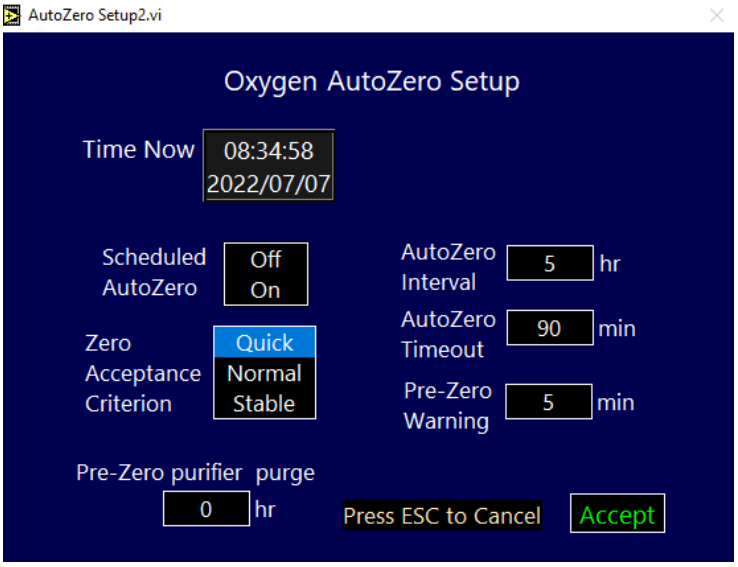


Figure 84: Oxygen AutoZero Setup Screen

Oxygen AutoZero Setup allows for unattended, automatic zeroing of the moisture analyzer at preset times.

Use the **Next** key to move from between fields and use the arrow keys (and) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Pressing the **ESC** key at any time will exit the screen without making changes and return to the main display.

If, when this screen is entered **Scheduled AutoZero** is turned off, the **Next Scheduled AutoZero** box in the upper right corner will not be displayed. When the **Scheduled AutoZero** is switched from off to on, the box will appear and the time of the **Next** scheduled **AutoZero** will be set to the current time and date. If no other changes are made, when this screen is accepted the AutoZero process will start immediately. Use the **ESC** key to escape from the screen without starting an AutoZero process.

Setting a time and date for the next AutoZero is accomplished by accepting the current time and date or using the **Next** key to move to the **Next AutoZero** box. With the left and right arrow keys, move the cursor to the right of the digit you want to change and use the up and down arrow keys to set it to the desired value. When done, use the **Enter** key to move to the next box.

NOTE: If the **Scheduled AutoZero** is then turned off, the AutoZero process is stopped and returning to this screen will not show the **Next AutoZero** box in the upper right corner.

The **AutoZero Interval** can be used to set the frequency of zeroing the oxygen cell starting with the setting in the box labeled Next AutoZero. The date and time of the next scheduled AutoZero is automatically calculated based on the current AutoZero Interval setting.

With the **AutoZero Timeout** the user can set the allowed time for stabilization. If the required stable period is not achieved during this time, the AutoZero is automatically aborted, and the Fail Zero flag is set in the Zero Cal Log as shown in **Figure 103**.

The system provides warning of a scheduled AutoZero before the calibration takes place, per the time set in the **Pre-Zero Warning**.

The **Zero Acceptance Criterion** allows the user to select the stability criteria required before the zero value is accepted. The Stable selection ensures the most accurate zero calibration but takes the longest time to execute (68-minute delay before the zero process begins). The Quick selection takes the least time (17-minute delay) and as a result is the least precise. The Normal selection (recommended) applies an average of the two (34-minute delay).

A relay is available on the Oxygen Analog Output Setup Screen (see page 109) to signal that a zero calibration is taking place Also, the analog output signal can either be frozen or allowed to update during the calibration process.

6.5.2.3 Span GSF

As with moisture, GSF (gas scale factor) allows correction of reported ppb for different background gases. In the case of the oxygen sensor, it 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 GSF in oxygen measurements is far less critical than for moisture measurements. 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 (e.g., helium and hydrogen), GSF should be applied.

The O_2 GSF may be calculated or entered directly. It is recommended that the entry be calculated for any gas listed on the screen.

Figure 85 depicts the Oxygen GSF screen.

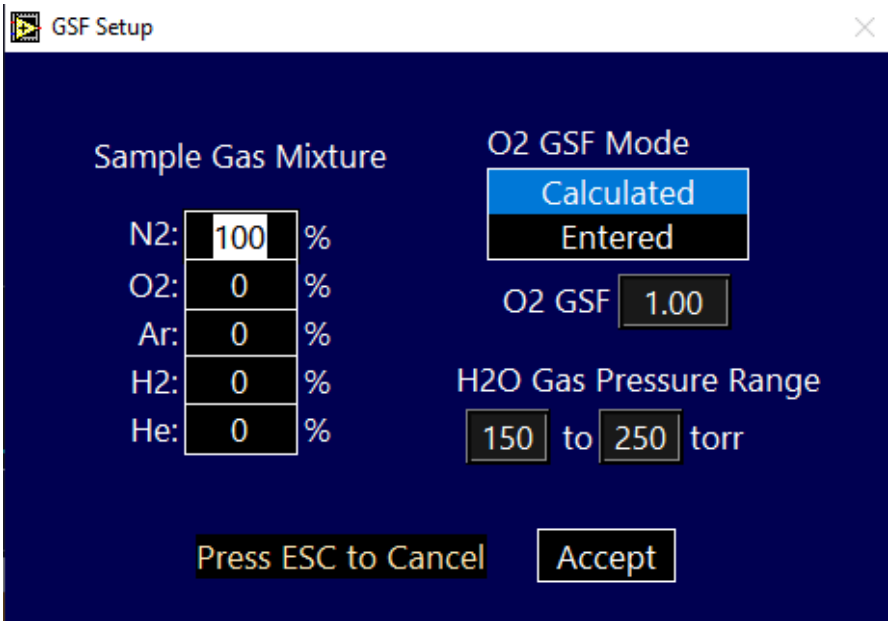


Figure 85: Oxygen GSF Screen

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.

A relay is available on the Oxygen Output Setup Screen (see page 108) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

6.5.2.4 Check/Adjust Span

The Span Reference value reflects the deviation from 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 Servomex.

Attach a span cylinder to the oxygen span inlet fitting on the rear of the analyzer and supply 10 - 15 psig (0.7 – 1.0 barg).

Use the **NEXT** key to toggle through the various user fields.

The value of the calibration gas can be entered directly in the **Span Gas** box after using the arrows to highlight **Enter Span Gas Value** and hitting **NEXT**. Only values less than 10 ppm are accepted.

To turn the span valves on, use the arrows and move to **Set Span Valves** and hit **Apply.**

Then move to **Do a Manual Span** and hit **Apply**.

If **Do an AutoSpan Check** is highlighted and the **APPLY** button is hit, an additional box appears which allows input of a **Check Limit**. This field is used in the Auto Span Check process as described on page 90.

A relay is available on the Oxygen Output Setup Screen (see page 108) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

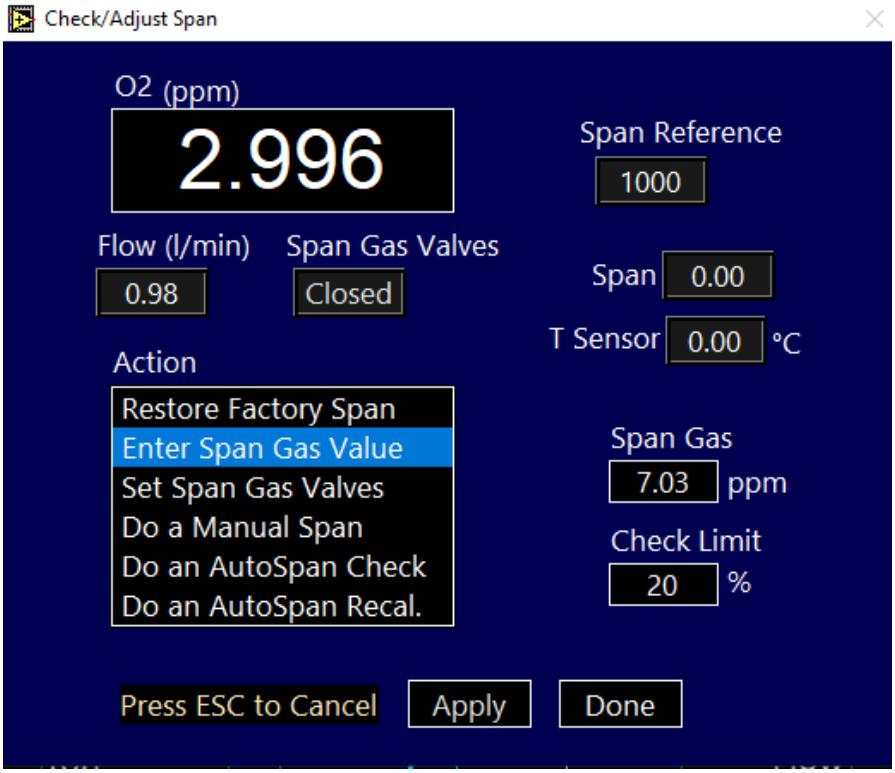


Figure 86: Check Adjust Oxygen Span Screen

6.5.2.4.1 Do A Manual Span

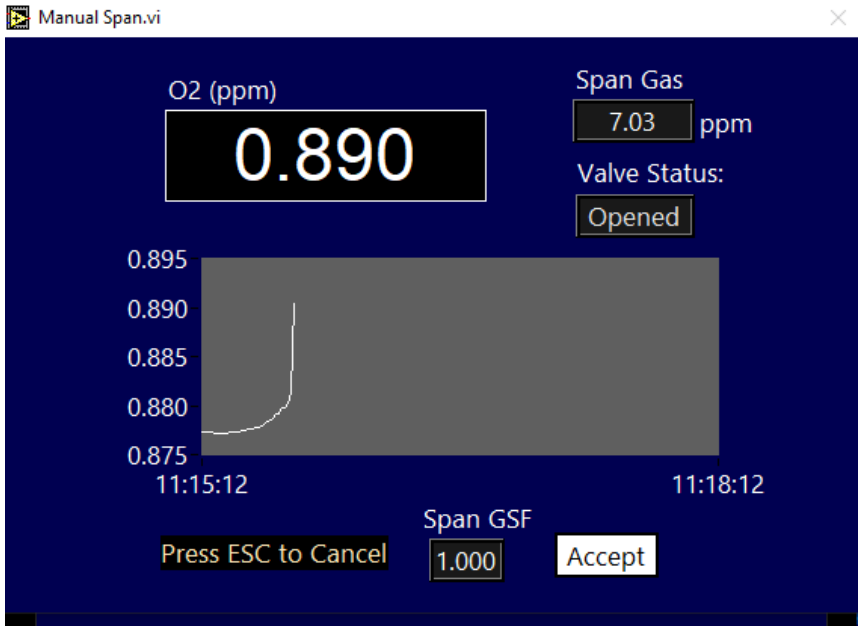


Figure 87: Oxygen Manual Span

A manual calibration can be performed after the span gas is connected to the oxygen span inlet and the analyzer is stable. The pressure of the span gas should be 15 PSI. The O_2 flow rate for span should be set

to match that of process gas. This is 0.2 – 0.3 LPM. After initiating a manual calibration, it may take up to 5 minutes before convergence occurs and the 60 second time bar begins to move. During convergence, the analyzer verifies the stability of the reading before accepting the data. If the convergence does not occur within 5-10 minutes, check the following:

- Make sure the gas connections are leak free.
- Make sure the sensor has had sufficient time to attain a stable reading on the calibration gas via a separate chart recorder.
- Check the electrical connections to the sensor.

To automate this process, see the following section on Auto Span checks and recalibrations.

A relay is available on the Oxygen Output Setup screen (**Figure 115**) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

6.5.2.4.2 Do An Auto Span Check

Figure 88: Oxygen Auto Span Check

As opposed to the Manual Span mode, in the Auto Span mode, whether Check or Recal, the analyzer takes complete control of the process. In the Span Check mode, a complete re-calibration does not take place. The final span reading is simply compared to the previous reading to see if the two values are within the user specified percentage set on the Check/Adjust Span Screen in the **Check Limit** field. See page 88 for additional information.

After the span gas bottle is attached to the oxygen span inlet on the rear of the analyzer, the gas value is entered in the Check/Adj Span screen as shown on page 88.

Similarly, the **Span GSF** value is entered in the Span GSF screen as described on page 87, if needed.

TimeOut is set in the **Auto Span Setup** screen as described on page 92.

A relay is available on the **Oxygen Output Setup** screen (see page 108) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

6.5.2.4.3 Do An AutoSpan Recal

Like the Auto Span Check process, the Auto Span Recal process is also fully automated. After the span gas bottle is attached to the oxygen span inlet on the rear of the analyzer, the **Span Gas** value is entered in the **Check/Adj Spa**n screen as shown on page 88.

Similarly, the Span GSF value is entered in the Span GSF screen as described on page 87, if needed.

The **Timeout** is set in the Auto Span Setup screen as described on page 92.

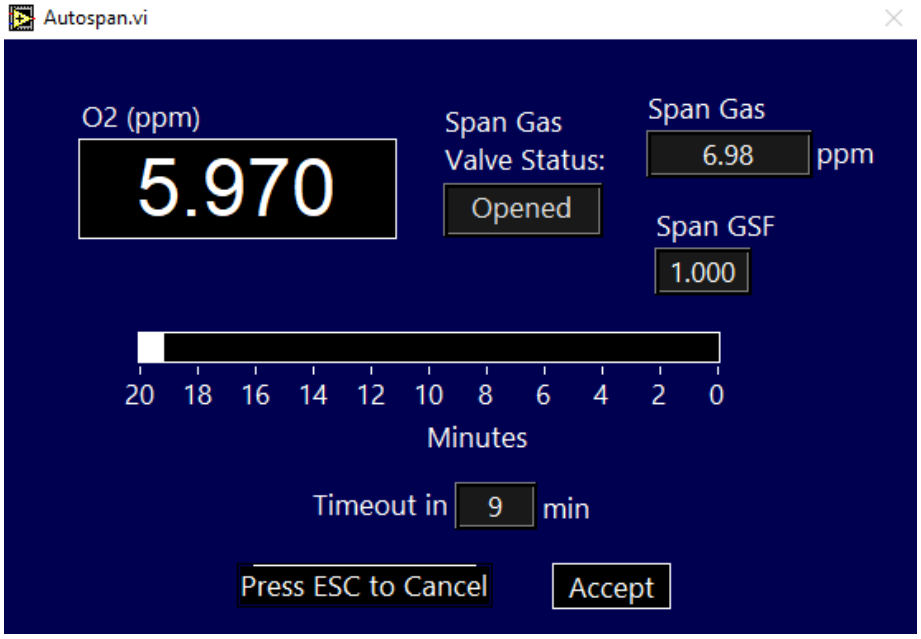


Figure 89: Oxygen Auto Span Recal

6.5.2.5 Auto Span Setup

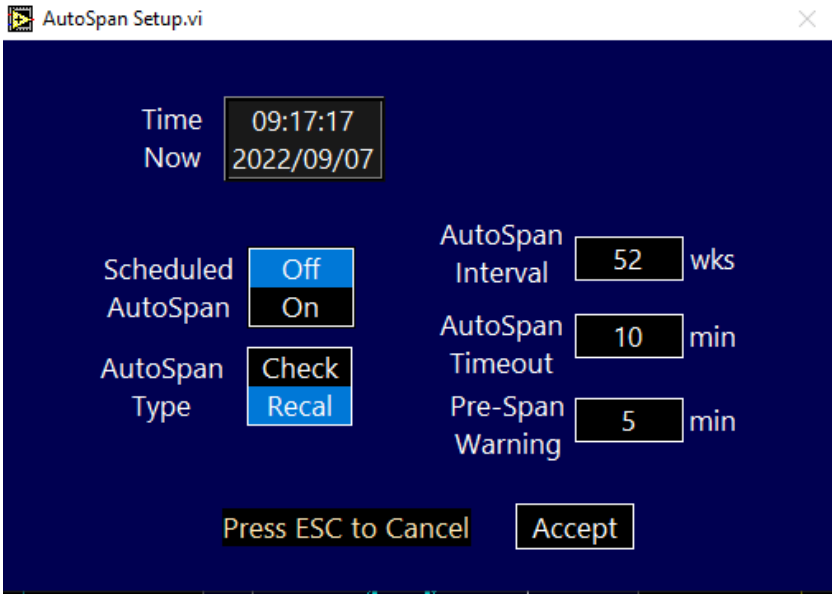


Figure 90: Oxygen Auto Span Setup Screen

The **Auto Span Setup** screen allows for automatic span calibration or span checks of the oxygen sensor at preset times. An optional warning period allows the user to disable the Auto Span function at critical measurement periods.

The **Auto Span Interval** can be set for the frequency of spanning the oxygen sensor. The date and time of the next scheduled Auto Span is automatically calculated based on the current **Auto Span Interval** setting.

Auto Span Timeout/Warning: The timeout allows time for stabilization. If the required stable period is not achieved, the Auto Span is automatically aborted. The Pre-Span warning is set to provide an advance warning of an Auto Span, based on the minutes entered.

Auto Span Type: Allows the user to re-calibrate the oxygen sensor with each span or merely to check if the span is within user specified limits.

A relay is available on the Oxygen Output Setup Screen (see page 108) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

6.5.2.6 Averaging Filter

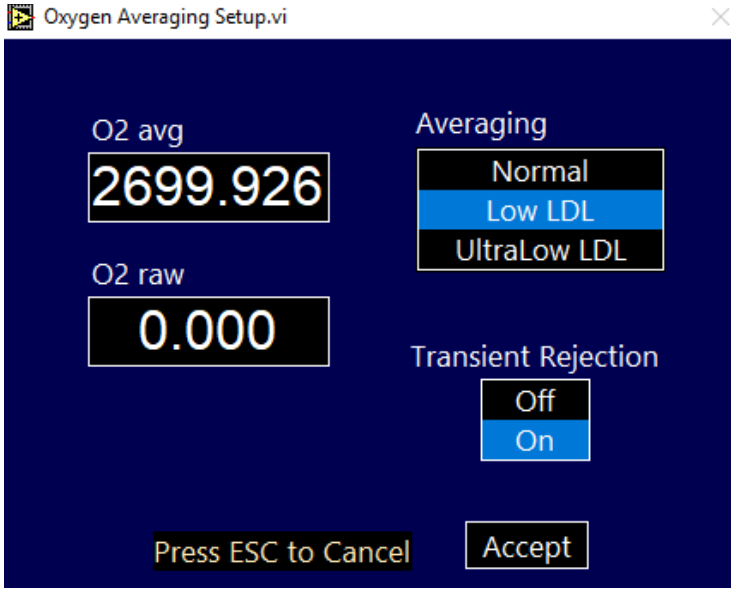


Figure 91: Oxygen Signal Filter Control Screen

This screen displays the offset between the displayed reading O_2 AVG and the real-time reading O_2 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.

Three types of electronic digital filtering are available which are used to condition the output signal to smooth out noise and spikes.

- Normal
- Low LDL
- Ultralow LDL

The use of one technique over another will depend upon the noise level or speed of response required for the application. Selecting **Ultralow LDL** will provide for the least noise in the signal but the slowest response time. Selecting **Normal** will yield a faster response but a noisier signal. Units are shipped from the factory with the setting at **Ultralow LDL.**

The user also can enable an additional **Transient Rejection** algorithm if spikes are observed on the signal. If a spike occurs, the algorithm will delay any additional data from entering the buffer for a given time interval. During this interval, the system determines if the spike represents a true change to the baseline or is just a transient. If merely a transient, the data is not transferred to the buffer. This method of transient rejection is useful for eliminating artifacts, but will result in delays of up to 1 minute reporting the actual data when a real oxygen intrusion occurs.

6.5.3 Oxygen Maintenance Menu

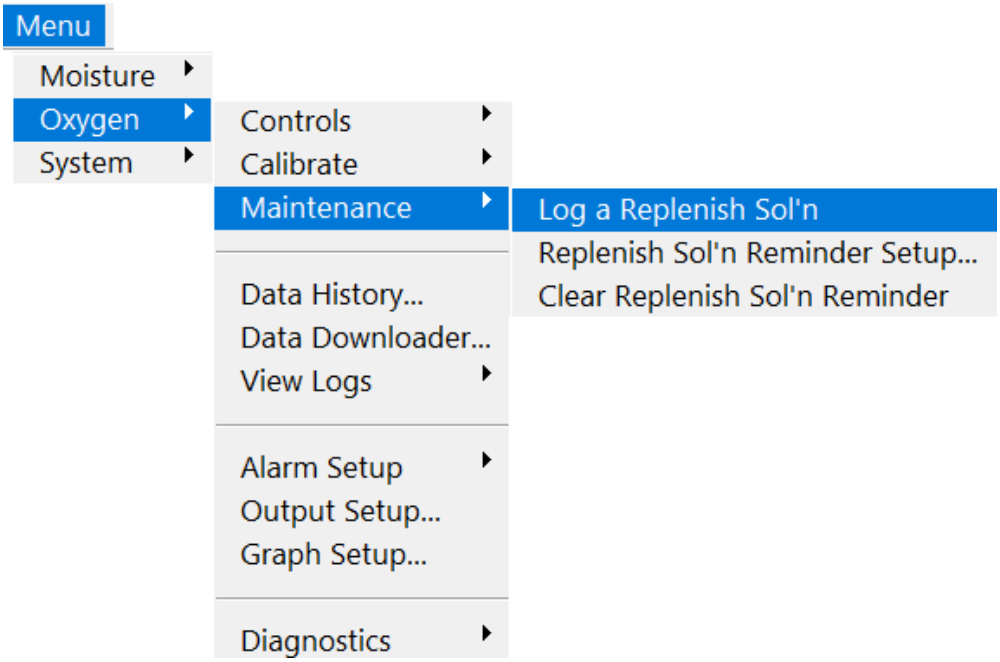


Figure 92: Oxygen Maintenance Menu

6.5.3.1 Log a Replenishment Solution Addition

This command allows the user to acknowledge that replenishment solution has been added to the oxygen sensor. If the **Replenish Sol'n** reminder flag is active on the display, it will be cleared after the user acknowledges that replenishment has been added. Solution additions are tracked in the Replenish Sol'n Log as shown on page 101. The current date is then used to automatically calculate the date for the next solution addition reminder based on the criteria set on the Replenish Sol'n Reminder Setup screen below.

6.5.3.2 Replenish Sol'n Reminder Setup

The Add Replenishment Solution reminder can be turned on or off and a time (in weeks) can be set for solution addition reminders.

If the electrolyte level is low in the oxygen sensor, only Servomex Replenishment Solution should be added to the sensor. **Do not add electrolyte solution to restore the electrolyte level.** Do not overfill.

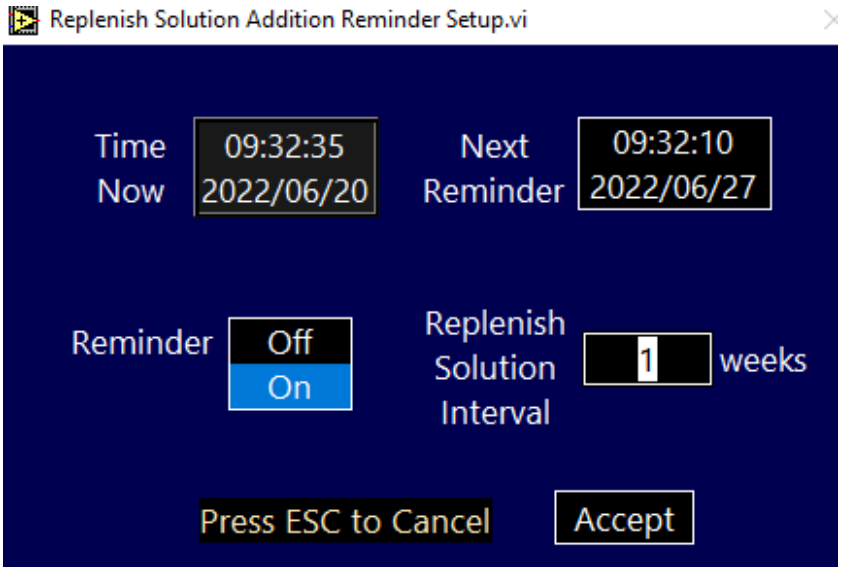


Figure 93: Replenish Sol'n Reminder Setup Screen

6.5.3.3 Clear Replenish Sol'n Reminder

The Replenish Sol'n Reminder flag can be cleared from the main data display without indicating in the Replenish Sol'n Addition log that solution has been added to the oxygen sensor.

6.5.4 View Oxygen Data History

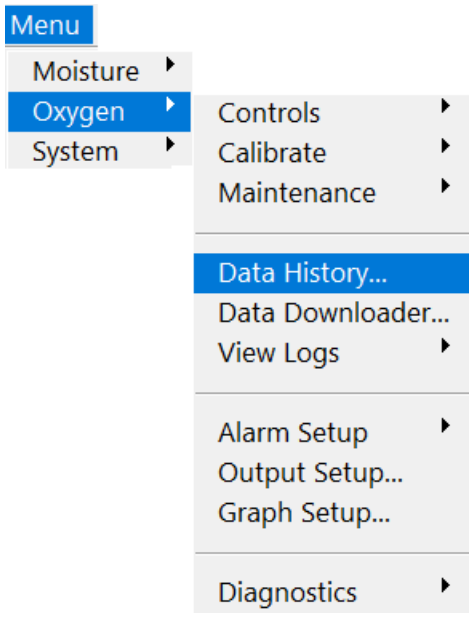


Figure 94: Oxygen Data History Menu

The **Oxygen Data History** screen enables the user to see the data history displayed in strip chart form on the front display. By default, the data history screen displays data for the most recent 24-hour period sampled at a rate of 1 point per minute and the y-axis is auto-scaling. The Data History Screen is also

accessed from the Location Logger screen (**Figure 98**). The **Next** button can be used to toggle the X axis scale from 1 day (default), to 1 hour, to 1 week, or to 3 weeks.

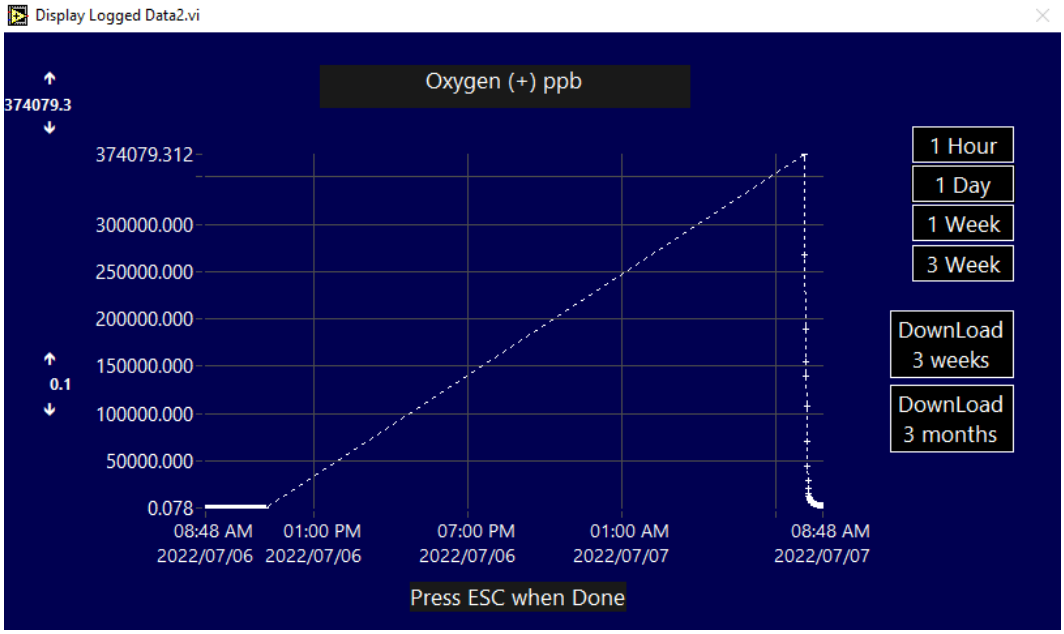


Figure 95: Oxygen Data History Screen

The **Next** button can also toggle the cursor to the max and min values on the Y axis. The arrow keys (and) can then be used to adjust the values, and the display will actively update.

The data history may be downloaded to a USB memory stick (Flash Drive) by using the **Next** key to move to the **Download** box and hitting **Enter.** A screen will appear requesting that a memory stick be placed in the external USB socket located behind the front door on the left side of the chassis.

The downloaded file will be in tab delimited form and will include all moisture and oxygen data in the system up to 3 weeks old if available. The download process will take up to 15 seconds and the display will indicate downloading is in progress. Once the download is complete, control of the analyzer will be returned to the operator. See **Figure 43** for an example of a portion of a download taken between the dates of May 1 and May 22. The complete file covers 3 full weeks.

Figure 96: Install Media

6.5.5 Oxygen Data Download Routine

The Oxygen Data Downloader screen (**Figure 98**) enables the user to label data with unique location names as well as to view and download specified data. The **Next** key is used to toggle through the various options on the screen and the arrow keys (and) move up and down through the location list.

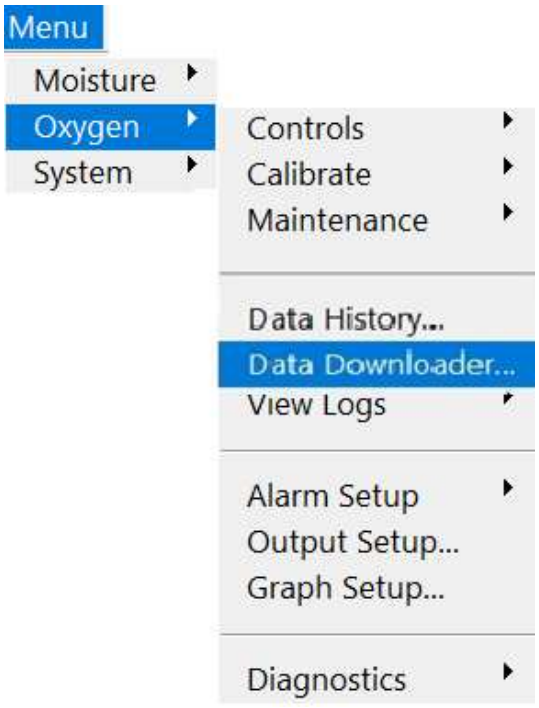


Figure 97: Oxygen Data Downloader Menu

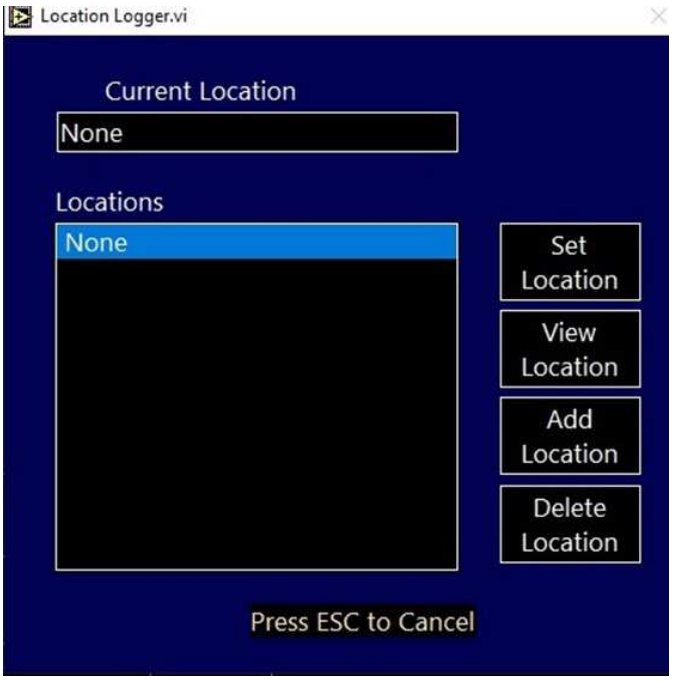


Figure 98: Oxygen Data Location Logger Screen

6.5.5.1 Set Location

The set location function is used to choose a location from a list of existing locations previously entered in the system (see Add Location on page 99). On the Oxygen Data Downloader screen in **Figure 98**, use the **Next** key to move to the list of existing names and then use the arrow keys (and) to select the location desired. Then use the **Next** key to move to **Set Location** and press **Enter** to accept the new location.

The action of setting a location starts the logging process and creates a new file. Changing to a new location will, in turn, end the previous file and start a new one.

6.5.5.2 View Location

The view location function is used to view data previously stored in the system sorted by location. On the Location Logger screen **Figure 98**, use the **Next** key to move to the list of existing names and then use the arrow keys (and) to select the location desired. Then use the **Next** key to move to **View Location** and press **Enter.** The **View Location** screen will appear as shown in **Figure 99**

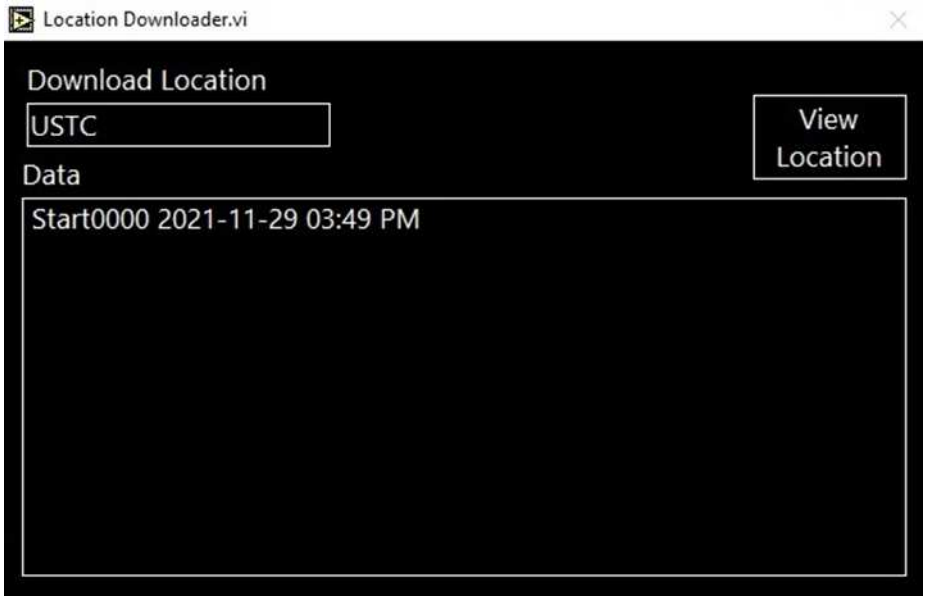


Figure 99: View Location Screen

Use the arrow keys (and) to select the data block desired and use the **Next** key to move to **View Location** and press **Enter.** The data history screen will appear as shown in **Figure 95**. From the data history screen, the data may also be downloaded to USB memory stick by way of the USB port located behind the front door.

6.5.5.3 Add Location

The user can create a new location stamp by moving the cursor to the **Add Location** button and hitting enter. This brings up the keyboard shown in **Figure 100** that is used to enter the name of the new location.

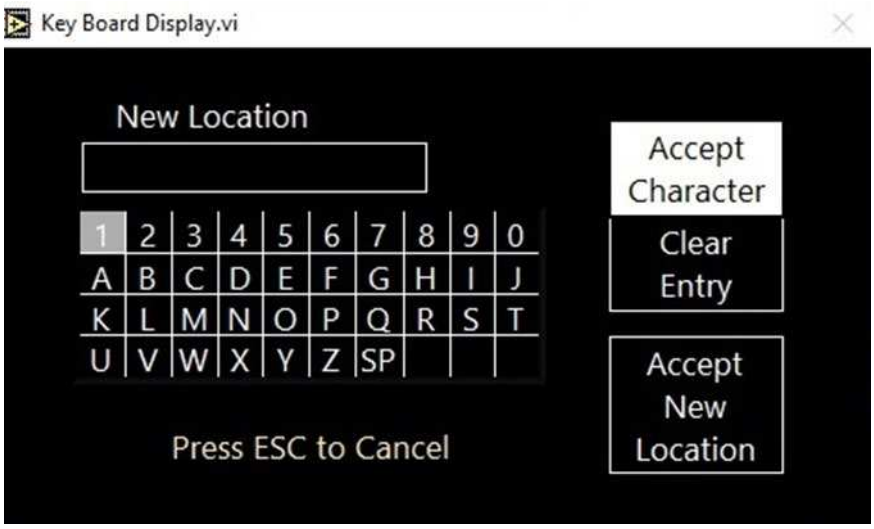


Figure 100: Keyboard Display

Use the arrow keys (▲ and ▼) to navigate the keyboard and use the **Enter** key to accept each character. If an error is made use the **Next** key to move to the **Clear Entry** key and hit enter. When the location name is complete, use the **Next** key to move the highlight to **Accept New Location** and hit **Enter.** The display will return to the Downloader Screen and the name will appear in the list of available locations.

6.5.5.4 Delete Location

The delete location function is used to remove a location from the list of available names. On the Location Logger screen **Figure 98**, use the **Next** key to move to the list of existing names and then use the arrow keys (▲ and ▼) to select the location desired. Then use the **Next** key to move to **Delete Location** and press **Enter.** A confirmation box will then appear (see **Figure 101**) and the user can either accept the deleted selection with the **Enter** key or can hit **ESC** to cancel the action. If accepted, the name will be removed from the list of available locations.

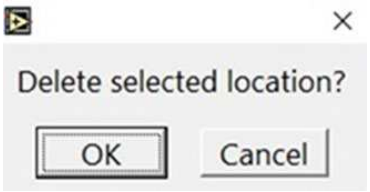


Figure 101: Delete Selected Location

6.5.6 View Oxygen Logs

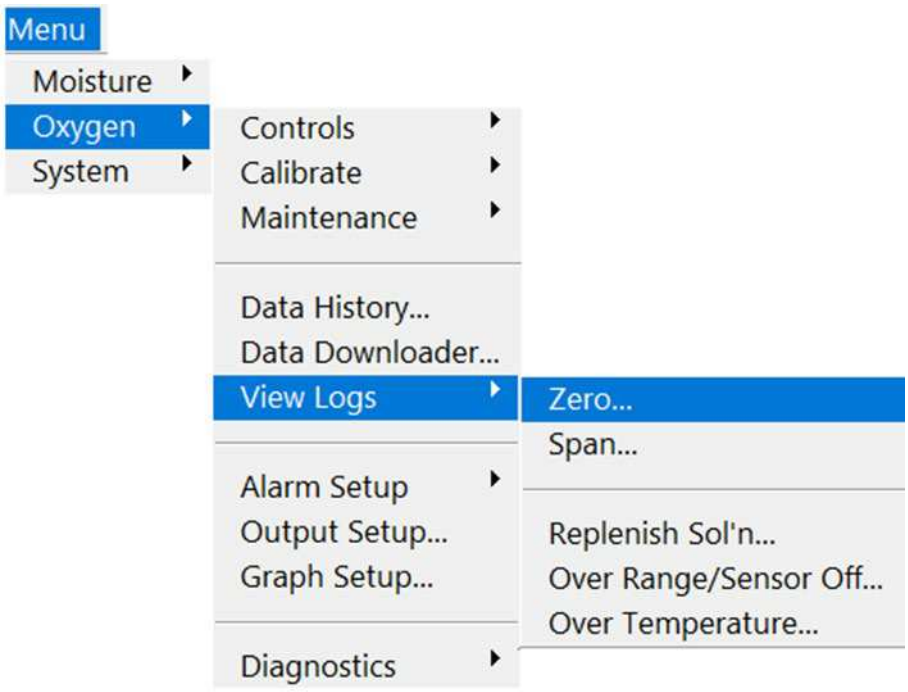


Figure 102: View Oxygen Logs Menu

These options allow the user to review logged activities or alarm events selectively in the five areas shown.

6.5.6.1 View Oxygen Zero Log

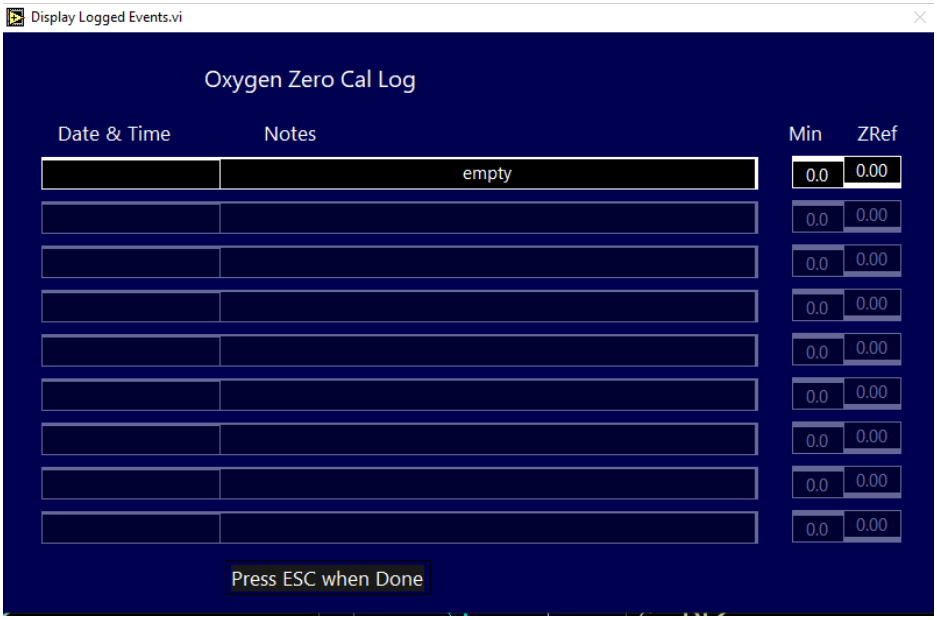


Figure 103: Oxygen Zero Log

The Oxygen Zero Log reports on adjustments made to the oxygen sensor zero setting. The date and time of the zero calibration is noted. The zero is listed in the notes section as either Manual or Automatic. The letters Q, N and S in the notes section indicate the type of acceptance criteria selected (Quick/Normal/Stable). The notes section also indicates if the zero was aborted, failed due to timeout, or in the event of an Automatic Zero if it were scheduled. The time to perform the zero and the resulting zero reference also appear.

6.5.6.2 View Oxygen Span Log

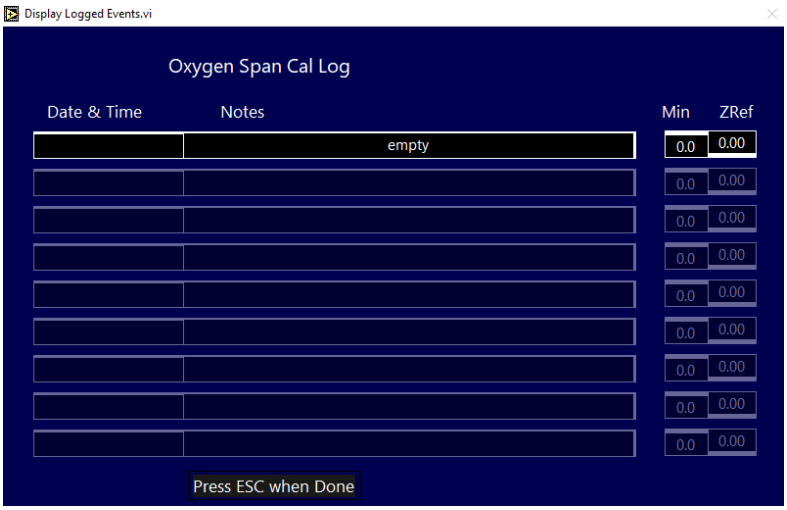


Figure 104: Oxygen Span Log

6.5.6.3 View Oxygen Replenishment Sol'n Addition Log

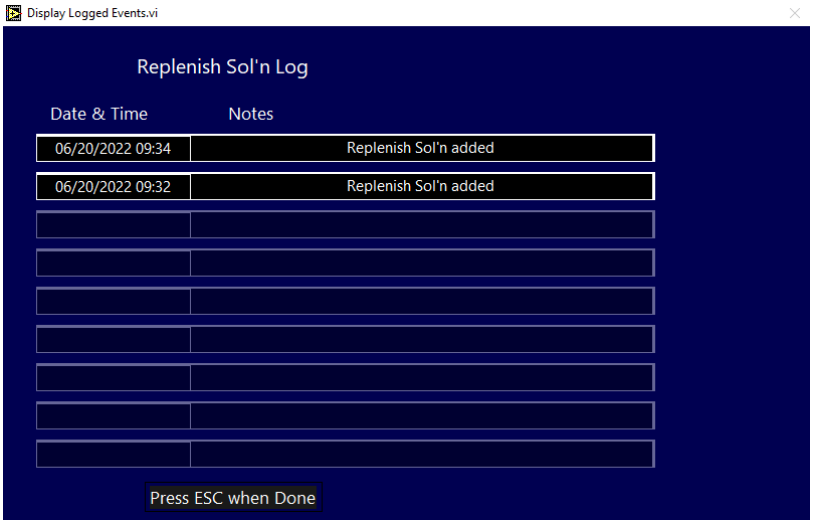


Figure 105: Oxygen Replenishment Sol'n Addition Log

6.5.6.4 View Oxygen Over Range/Sensor Off Log

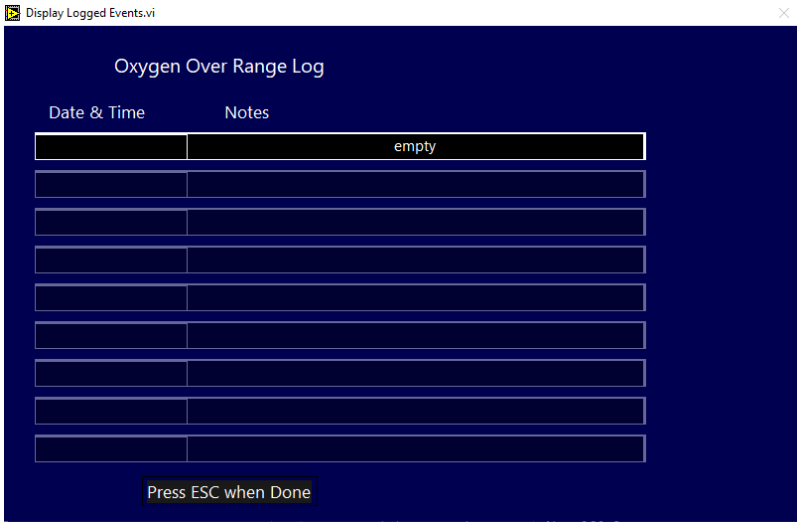


Figure 106: Oxygen overranges Log

6.5.6.5 View Oxygen Over Temperature Log

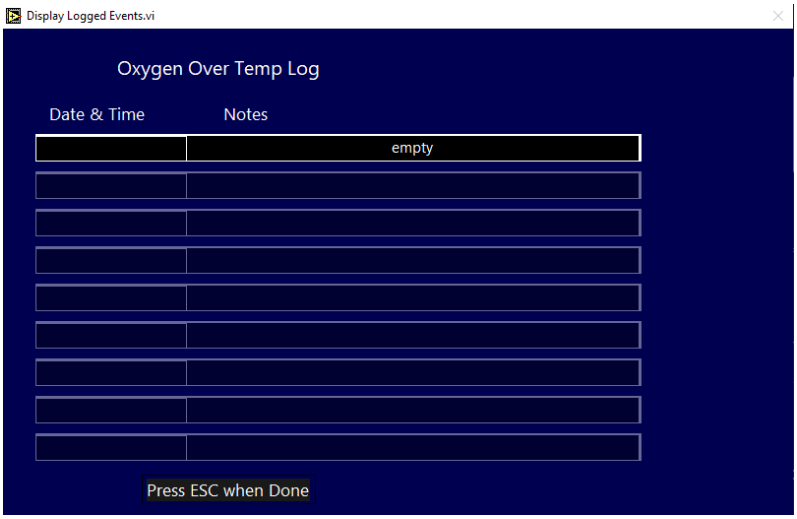


Figure 107: Oxygen Over Temperature Log

6.5.7 Oxygen Alarm Setup

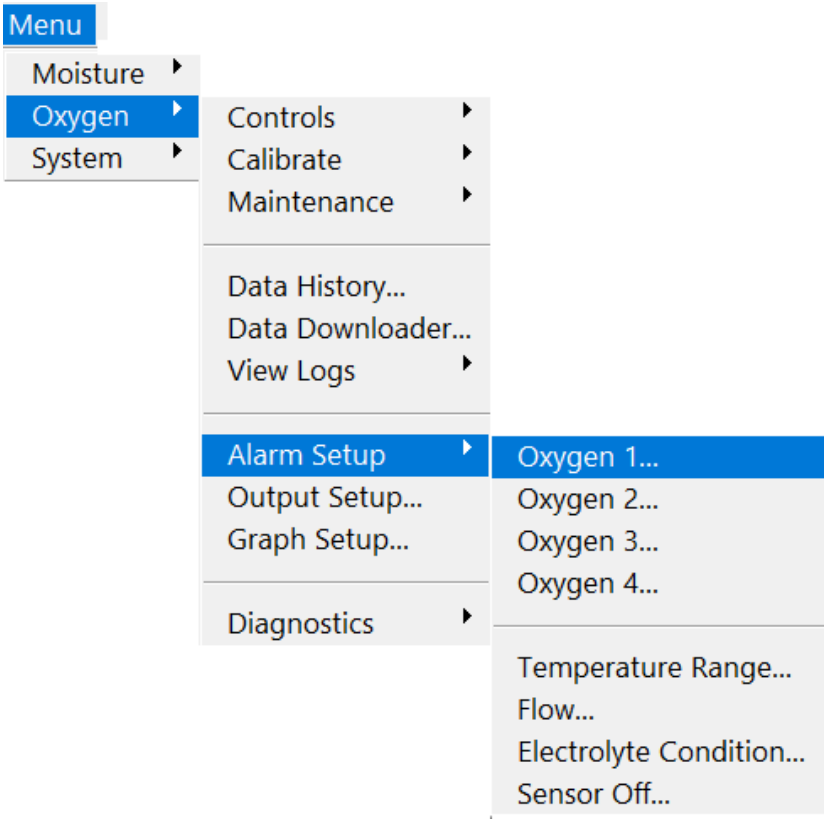


Figure 108: Oxygen Alarm Setup Menu

The oxygen analyzer includes a total of eight alarms. The four oxygen concentration alarms can be user controlled to activate up to four optional relays. High and low setpoints as well as dead bands are user-set.

The Temperature, Low Flow, and Electrolyte Condition alarms all relate to the operation of the oxygen sensor.

In addition, an alarm can be programmed to indicate whether the oxygen sensor has been turned off, either manually or automatically.

NOTE: When any hydrogen is included in the background gas matrix (see discussion regarding GSF on page 115 for additional information), an additional alarm is enabled to monitor the cabinet exhaust fan status. If the system detects a failure in the operation of the cabinet exhaust fans while operating in a hydrogen background, the system immediately isolates the oxygen and moisture cells until the fan is repaired. A warning describing this condition will appear over the main display and the user will be unable to restore gas flow until the fan is repaired. See Fan Alarm on page 118.

An alarm warning will overwrite the oxygen level readout if an alarm condition exists.. Only restoration of the condition that existed prior to the alarm will clear the alarm. Following is a list of alarm code abbreviations that can appear in the Status Line:

ALARM NUMBER	FUNCTION

1	Moisture Level 1
2	Moisture Level 2
3	Moisture Level 3
4	Moisture Level 4
5	Oxygen Level 1
6	Oxygen Level 2
7	Oxygen Level 3
8	Oxygen Level 4
T	Temperature
P	Pressure
S	System

Table 10: Alarm Codes

6.5.7.1 Oxygen Alarm Setup

The Setpoint value refers to the limit above or below which the alarm is triggered. The Trip command sets the above/below parameter. The dead band refers to the value from the nominal setpoint that the output value must exceed before an alarm is reset. The Relay Assignment indicates to which relay the alarm is assigned.

Use the **Next** key to move from between fields and use the arrow keys (and) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Pressing the **ESC** key at any time will exit the screen without making changes and return to the main display.

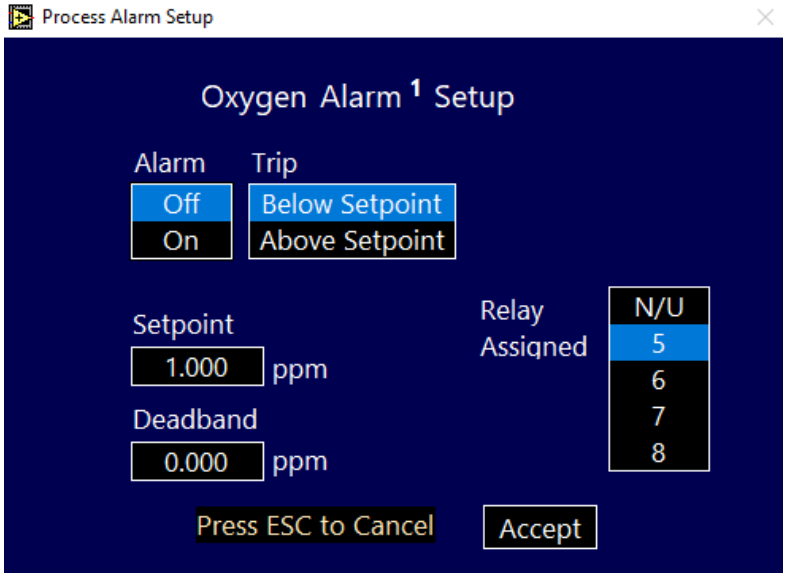


Figure 109:Oxygen Alarm Setup Screen

6.5.7.2 Oxygen Temperature Alarm Setup

The system is constantly monitoring the ambient temperature of the oxygen sensor. If enabled on the Temperature Alarm Setup screen, an alarm can be assigned to trip if the sensor temperature exceeds preset limits. The user may assign the temperature alarm to one of four relays.

Use the **Next** key to move from between fields and use the arrow keys (and) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Pressing the **ESC** key at any time will exit the screen without making changes and return to the main display.

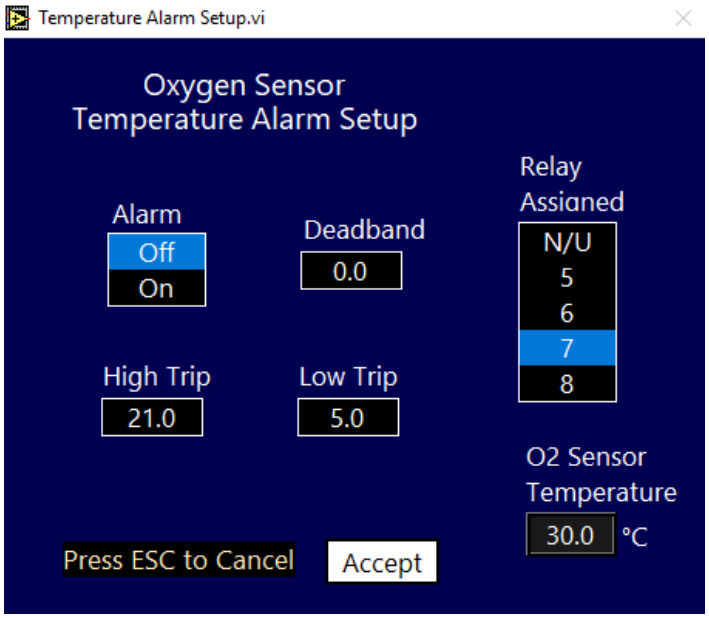


Figure 110: Oxygen Temperature Alarm Setup Screen

6.5.7.3 Oxygen Flow Alarm Setup

The system is constantly monitoring the flow rate in the oxygen sensor and the result is displayed on the front panel. If enabled on the Flow Alarm Setup screen, an alarm can be assigned to trip if the flow exceeds preset limits. The user may assign the pressure alarm to one of four relays.

Use the **Next** key to move from between fields and use the arrow keys (and) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Pressing the **ESC** key at any time will exit the screen without making changes and return to the main display.

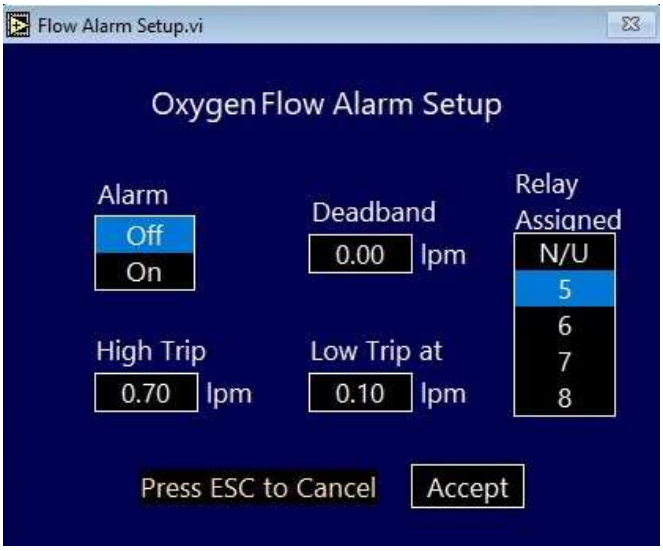


Figure 111: Oxygen Flow Alarm Setup Screen

6.5.7.4 Oxygen Electrolyte Alarm Setup

The **Electrolyte Condition** alarm alerts the user to those fault conditions that may impact the quality of the oxygen measurement. Fault conditions include low electrolyte level (add Servomex Replenishment Solution) and electrolyte contamination. The user may assign the electrolyte condition alarm to one of four relays.

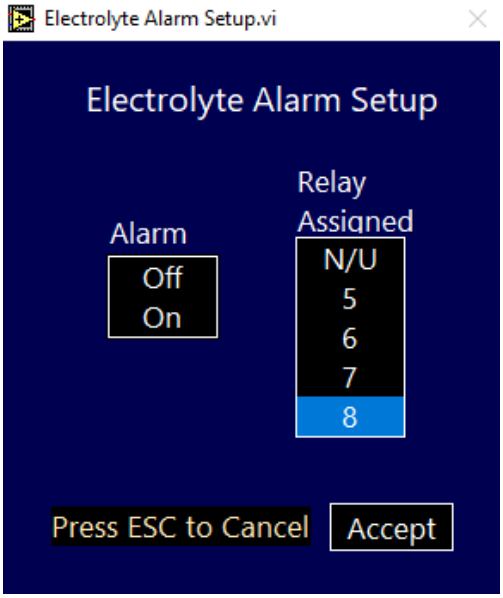


Figure 112: Oxygen Electrolyte Alarm Setup Screen

Use the **Next** key to move from between fields and use the arrow keys (and) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Pressing the **ESC** key at any time will exit the screen without making changes and return to the main display.

6.5.7.5 Oxygen Sensor Off Alarm Setup

If the oxygen sensor polarization voltage has been manually or automatically turned off, an alarm can be enabled to indicate the current sensor status. For additional information on control of the oxygen sensor, see **6.5.1 Oxygen Controls Menu**. The user may assign the sensor off alarm to one of four relays.

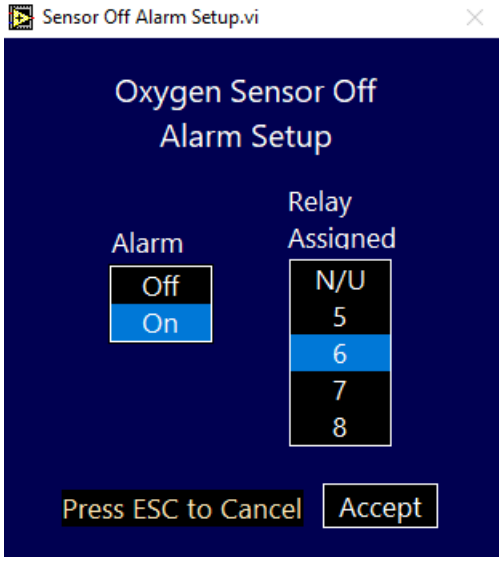


Figure 113: Oxygen Sensor-Off Alarm Setup Screen

Use the **Next** key to move from between fields and use the arrow keys (and) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Pressing the **ESC** key at any time will exit the screen without making changes and return to the main display.

6.5.8 Oxygen Analog Output Setup

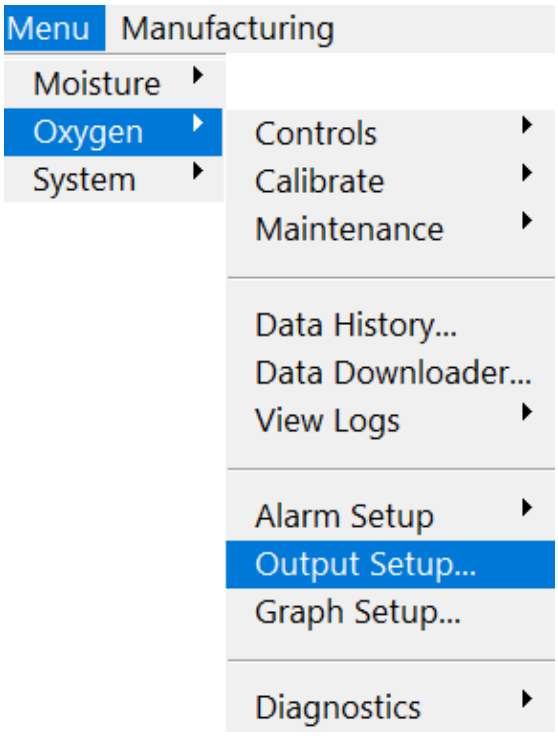


Figure 114: Oxygen Analog Output Setup Menu

The **Output Setup** selection access the **Oxygen Output Setup** screen. This screen is used to set the voltage levels that correspond to the **Zero Point** and **Full Scale** for the three ranges used by the analyzer: Primary, Expanded, and Expanded B.

The **Zero Point** corresponds to the lowest voltage or current output (0 VDC, 4 mA) that is sent to a recorder, while the **Full Scale** corresponds to the maximum voltage or current output (1/5/10 VDC or 20mA) that is sent. The **Full-Scale** set point (FS) is set from 0.002 ppm to 20.00 ppm.

Three ranges can be entered on this screen. The range of the primary Full Scale (FS) must be less than that of the Expanded Full Scale “A” (FS A) which must be less than that of the Expanded Full Scale “B” (FS B). The analyzer auto-ranges between the three outputs depending on the current analyzer reading. Relay contacts can then be assigned to signal a change in range. If only one expanded range is required, rather than two, then the value of FS B should be set to equal the FS A value. A window as narrow as 2 ppb. can be set for the Full-Scale analog output.

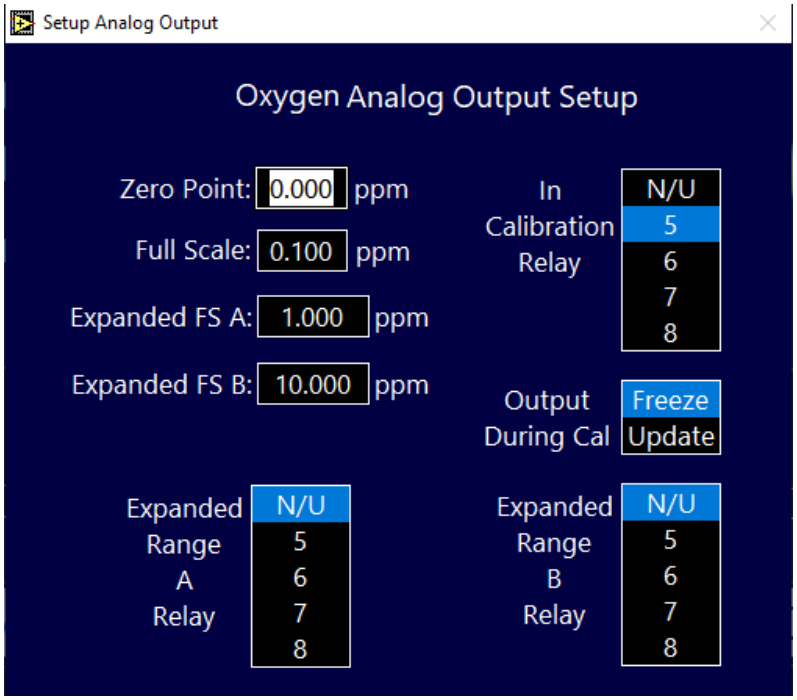


Figure 115: Oxygen Output Setup Screen

The **In Calibration Relay** can be enabled to signal that a zero or span calibration is in process. In addition, the user has the option to freeze the analog output or enable the analog output to update as the calibration progresses.

6.5.9 Oxygen Graph Setup Screen

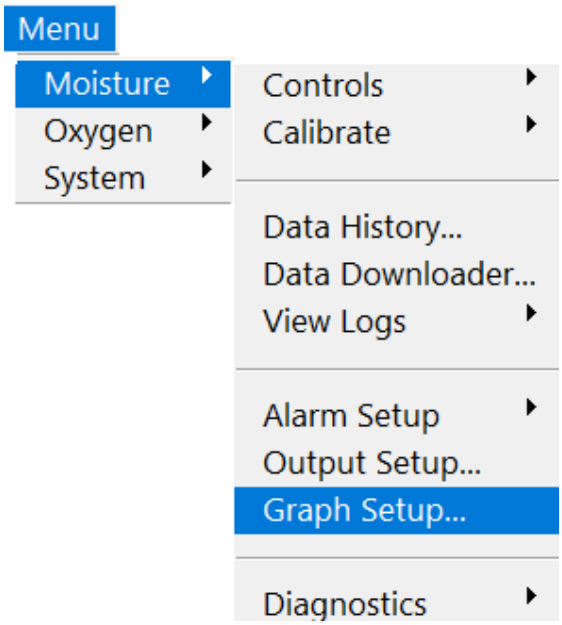


Figure 116: Oxygen Graph Setup Menu

Graph **Setup** is used to adjust the time scale on the front display of the analyzer. A specific time interval in minutes can be chosen for that display. The information on the display represents current data and will show a history of concentration from the given time span to the present. The Y-axis of the main data display is auto-ranging.

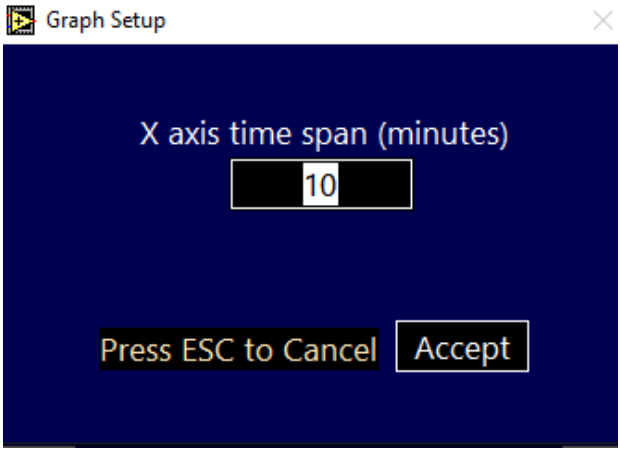


Figure 117: Oxygen Graph Setup Screen

6.5.10 Oxygen Diagnostics Menu

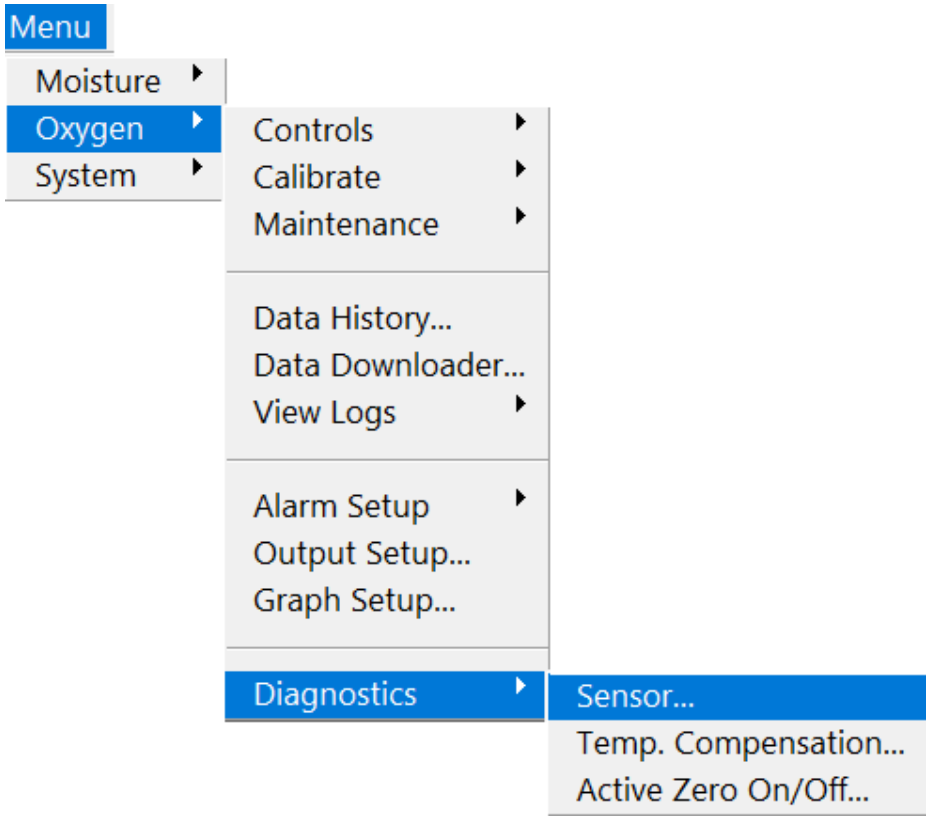


Figure 118: Oxygen Diagnostics Menu

6.5.10.1 Oxygen Sensor Diagnostics

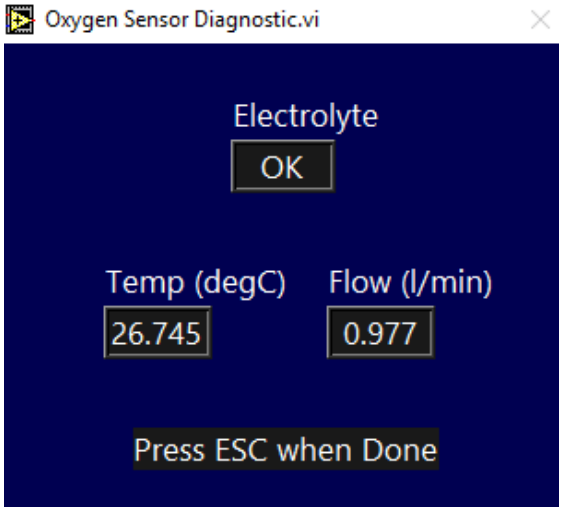


Figure 119: Oxygen Sensor Diagnostics Screen

This subroutine contains read-only parameters. It assists the user in allowing determination of the three parameters: electrolyte level, oxygen cell temperature, and gas flow. These values require no user action. If out of specification, any of these parameters may alert the system if enabled. See page 103 for additional information.

6.5.10.2 Oxygen Sensor Temperature Compensation Screen

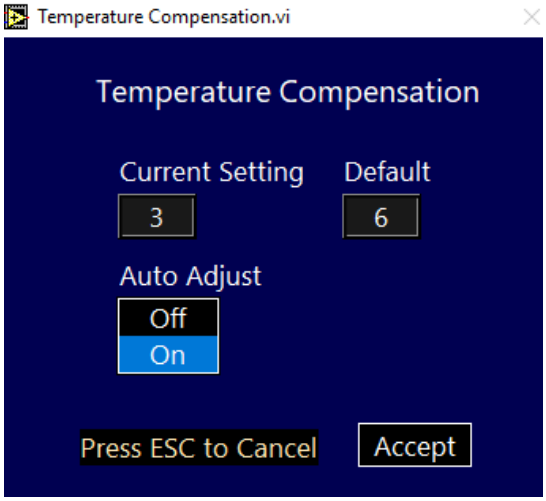


Figure 120: Oxygen Sensor Temperature Compensation Screen

One can automatically compensate for temperature changes by using the Automatic Adjust setting. Under this setting, the analyzer determines the optimum temperature compensation. However, if the analyzer output is drifting unacceptably, and this drift correlates with ambient temperature change, the Temperature Compensation feature is useful to manually correct for the temperature-related drifts.

The factory (default) setting and current setting are shown above in **Figure 120**. First change the Automatic Adjust to OFF. Then use the arrow up and down keys to adjust the 'New Setting' for different

compensation, between 0 and 19. If the analyzer reading increases with temperature (under compensation), then increase the set point (closer to 19). If the analyzer reading decreases with increased temperature (over-compensation), decrease the set point.

NOTE: Factory default is set at factory and varies from unit to unit based on sensor characteristics.

It is important to judge if the analyzer's response is temperature dependent only while the sample is in an oxygen-free zero gas.

6.5.10.3 Active Zero On/Off

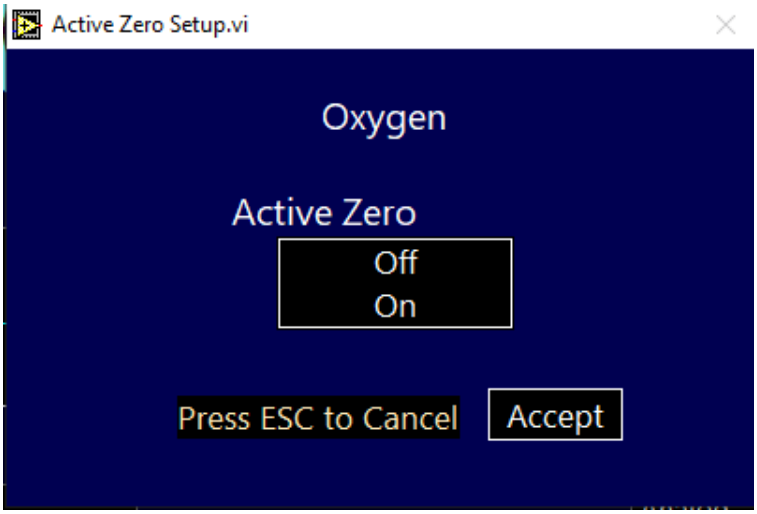


Figure 121: Active Zero Setup Screen

The **Active Zero** Offset feature is designed to automatically compensate for the analyzer's gradual zero baseline cleanup. This gradual cleanup is natural and occurs after a fresh start-up or after a prolonged or abnormally high oxygen exposure. This feature ensures that accurate low ppb O_2 readings can be made as soon as possible after initial start-up, or after a high O_2 upset event. It is like the User Zero Offset feature in that a small positive offset is added to the analyzer O_2 readings (display and output) to compensate for the long-term downward trending in the readings during cleanup. The Active Zero Offset provides an automatic addition of offset that occurs in miniscule steps, and within set guidelines, corresponding to the predictable behavior of a typical system during cleanup.

When Active Zero Offset is enabled through the Diagnostics Menu, the User Zero Offset feature is disabled and vice versa. While the User Zero Offset feature requires the user to enter a fixed positive offset value to accommodate the baseline cleanup, the Active Zero Offset does so automatically, and only when necessary.

The current Active Zero Offset value is shown in the **Check/Adjust Zero** screen. It starts at a value of 0.00 ppb when the analyzer is first turned on, and then increments automatically as the analyzer applies offset to the readings. After each User Zero Calibration, the Active Zero Offset value is reset to 0.00 ppb and then automatically increments again as needed.

The Active Zero Offset is designed to operate when the zero baseline is falling at a rate less than 0.1 ppb/hr. as would be the case after 1-2 weeks of initial operation. If user calibrations are performed

sooner, the O_2 readings may decrease too rapidly for the Active Zero Offset feature to operate properly and negative O_2 readings may result.

If the Active Zero Offset value reaches 3 ppb a warning message **CAL ZERO** will flash in the system status block on the display instructing the user that a zero calibration should be performed. The maximum amount of offset that can be applied by this feature is 3 ppb. Any further downward trend (baseline cleanup) exceeding –0.3ppb will result in negative readings until the next user calibration is performed resetting the Active Zero Offset value to zero.

If the Active Zero Offset feature is turned off, the User Zero Offset value will appear in its place in the **Check/Adjust Zero** screen. The previous user Zero Offset value (if any) will reappear and immediately be applied to the live display readings. Likewise, if the Active Zero Offset feature is on, then its value (if any) will appear and immediately be applied to the live readings.

6.6 System Menu

The System menu controls operation of systems outside of the specific sensors and allows higher level user options to be implemented.

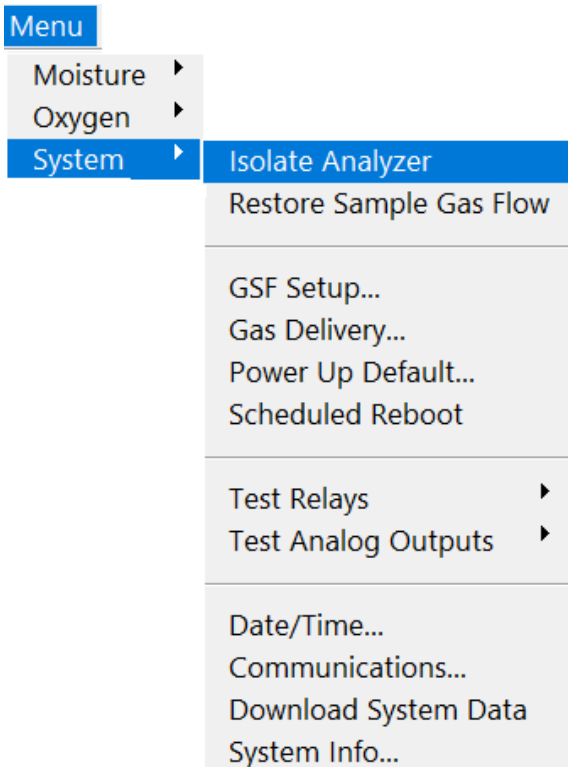


Figure 122: System Menu

6.6.1 Isolate Analyzer

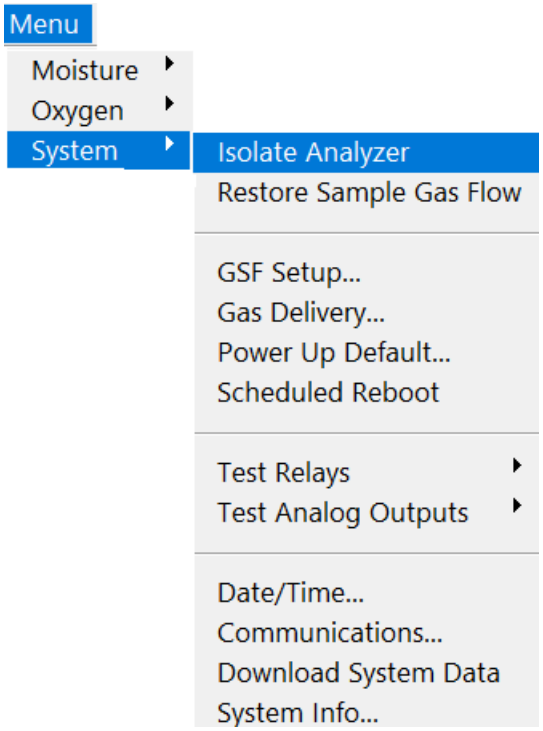


Figure 123: Isolate Analyzer

The Isolate Analyzer command allows both the oxygen and moisture cells to be isolated, for instance, prior to shipping or movement. It acts in the same fashion as the isolate sensor functions in the Moisture and Oxygen Submenus. After selecting this command, the isolation process takes 40 seconds to complete and the warning in **Figure 124** appears on the screen. When complete, the warning automatically disappears. The Restore Sample Gas Flow command below returns the analyzer to normal operation.

NOTE: While the moisture and oxygen sensors are isolated, sample gas will still flow through the bypass loop.

Figure 124: Isolate Analyzer Warning

6.6.2 Restore Sample Gas Flow

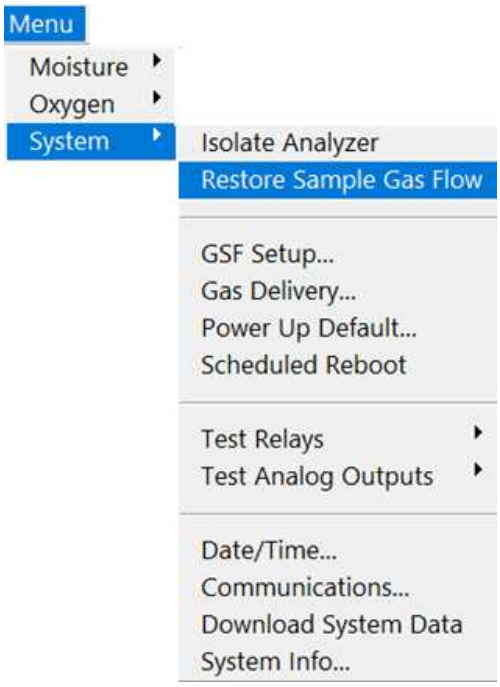


Figure 125: Restore Sample Gas Flow

This command allows the user to return the analyzer gas flow back to normal after isolation. If the analyzer is set to isolate on startup, this option must but used to restore flow after the analyzer boots.

CAUTION

Before restoring flow to an isolated moisture cell, be sure the pressure at the outlet is at or below the cell pressure at the time of isolation to avoid back diffusion of ambient air from the outlet into the cell.

6.6.3 GSF Setup

The GSF setup (Gas Scale Factor) is critical for obtaining quantitatively correct results. It accounts for the fact that moisture and oxygen molecules have different absorption and diffusion characteristics in different background gases.

The GSF should be applied when the user has any knowledge of a change in the composition or ratios of the background gas. The default setting from the factory is 100% N_2, yielding a GSF of 1.00.

The user selects **O2 GSF Mode** of either **Calculated** or **Entered**. If **Calculated** is selected, the system calculates the GSF based on the ratios entered by the user in the **Sample Gas Mixture** section. This is the recommended mode for most applications. If **Entered** is selected, the user directly enters the GSF in the **O2 GSF** field. This mode may be used if the background gas mixture includes a gas not listed in the **Sample Gas Mixture** section.

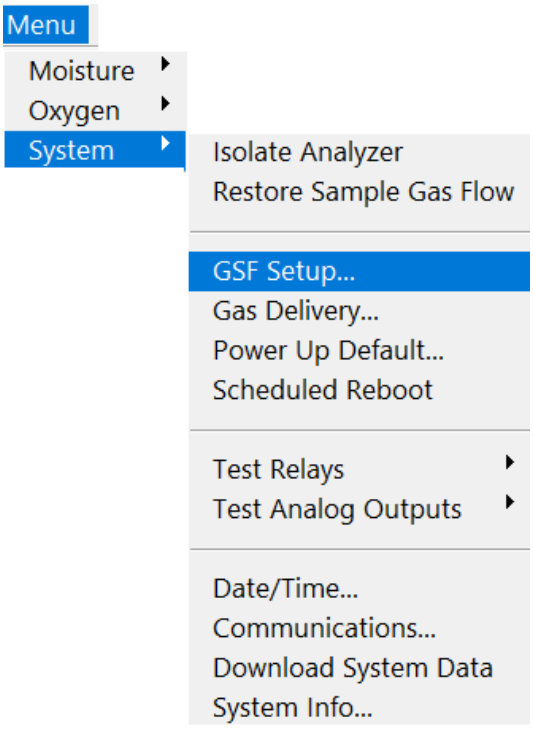


Figure 126: GSF Setup

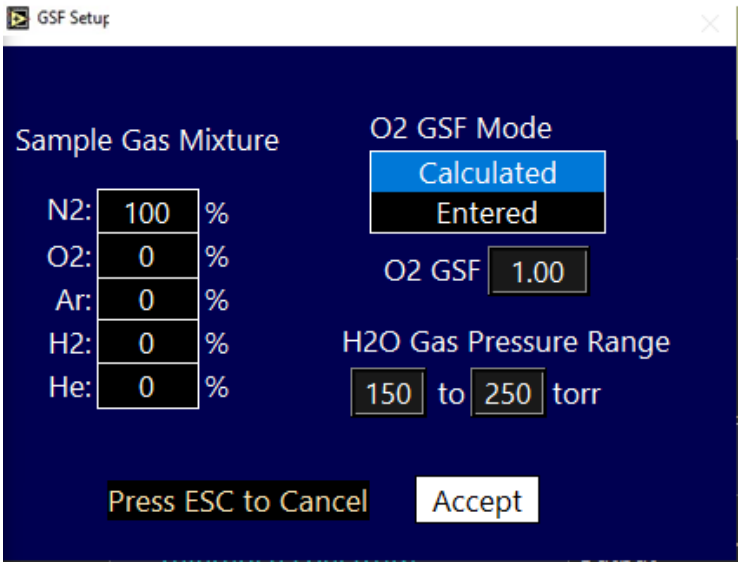


Figure 127: GSF Setup Screen

After the percentages of all background gases are entered, the Accept button is hit and the system confirms that the total is 100%. Next, if appropriate, the system indicates the proper pressure setting and the limits are set on the Pressure Alarm Screen.

See page 67 for additional information on setting the Pressure Alarm. The O_2 GSF may be calculated or entered directly.

NOTE: If oxygen is included in the background gas calculation, the Oxygen sensor is automatically isolated, and the polarization voltage is turned off. In addition, if a non-zero number is entered in the Oxygen field in the GSF setup screen, the Purifier Warning screen automatically appears and requires the user to indicate which type of purifier is installed in the analyzer before proceeding. See **Figure 128.**

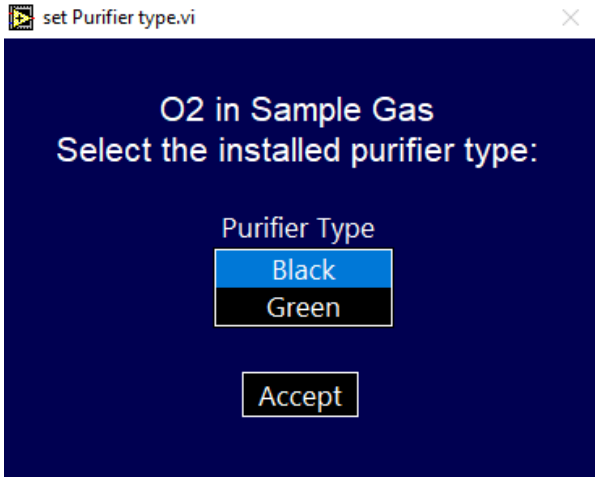


Figure 128: Purifier Warning

If a black purifier is installed in the analyzer, then no Zero adjustments will be possible using the internal purifier on either the Oxygen or Moisture cells until the Oxygen value in the GSF screen is set to zero.

NOTE: An entry of any percentage of Hydrogen in the GSF calculation will automatically engage the Hydrogen Safety Service System option if equipped. See page 174 for additional information.

6.6.4 Fan Failure

If hydrogen is entered as a gas in the GSF Setup, and the system detects a failure in the exhaust fan circuitry, the entire analyzer will automatically isolate. A message of **H2 Safety Enabled** as shown in **Figure 129** will flash over the moisture reading on the main display and the user will be unable to restore any flow until the fan problem has been fixed. This is a safety measure to prevent unsafe levels of hydrogen from accumulating inside the analyzer cabinet if there is a leak in the system.

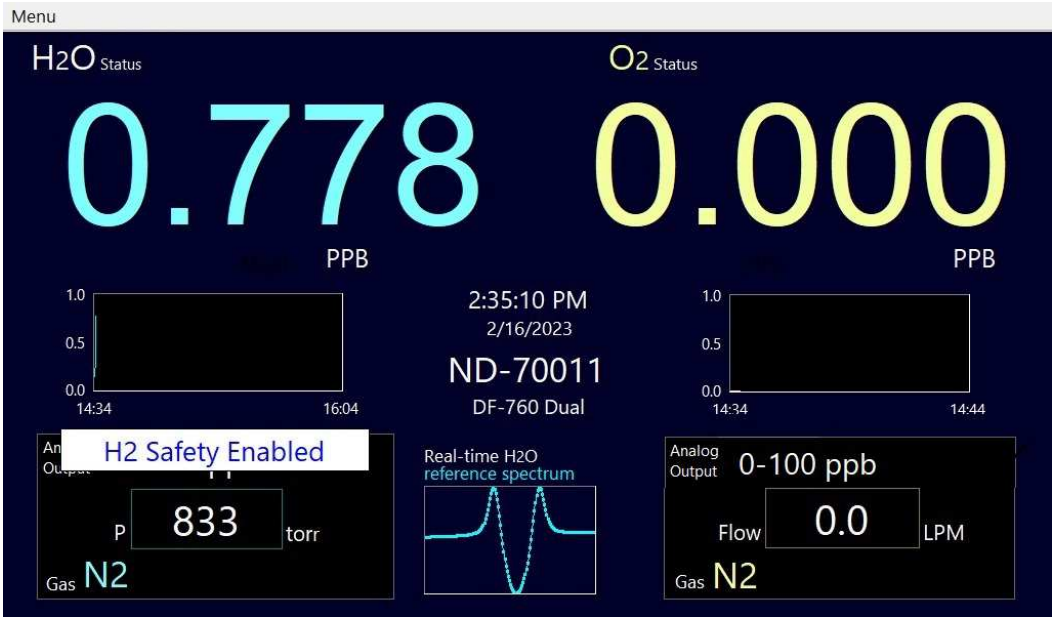


Figure 129: Fan Failure Alarm

6.6.5 Gas Delivery

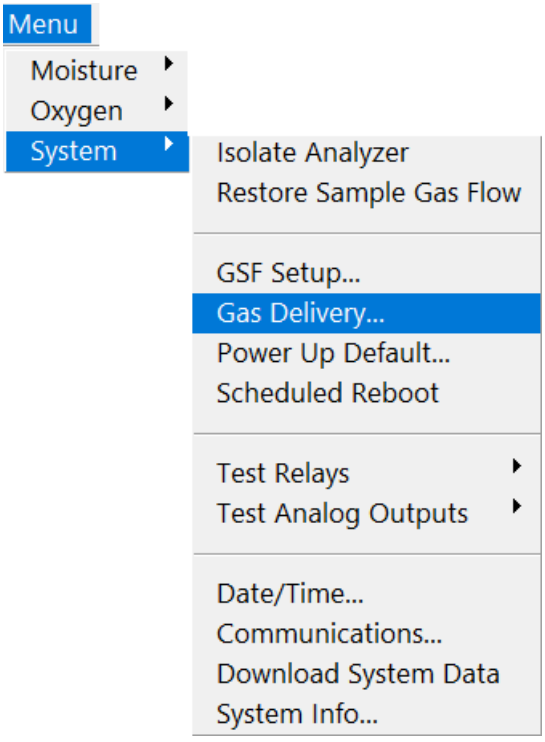


Figure 130: Gas Delivery Menu Selection

The Gas Delivery Status screen allows for monitoring of the gas delivery system valves. An 'X' indicates that the valve is closed. This screen is for display purposes only and allows no user interaction.

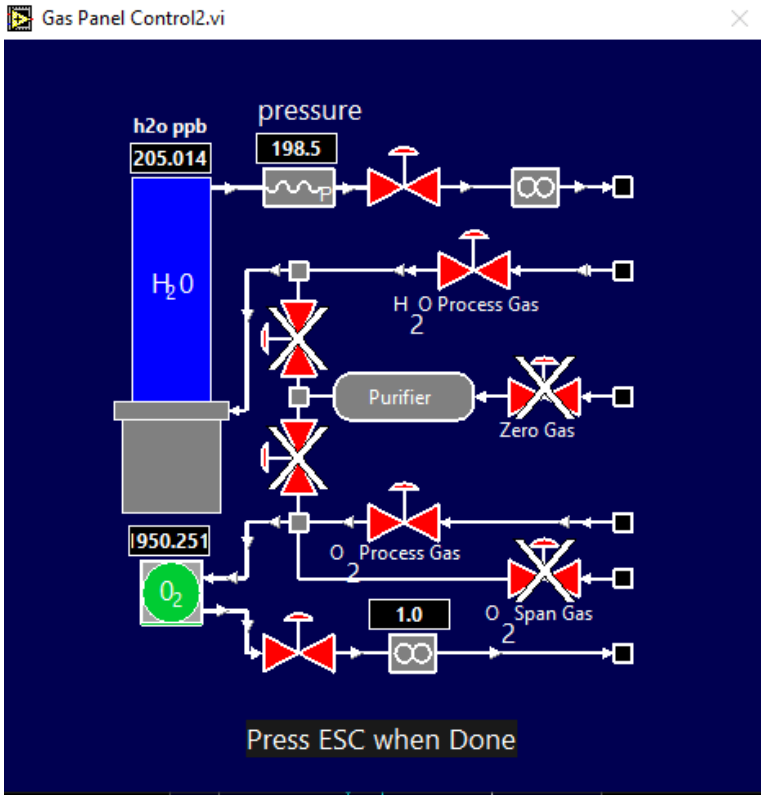


Figure 131: Gas Delivery System Status

6.6.6 Power Up Default

The **Power Up Default** menu selection is shown in Figure 132. This menu selection accesses the **Power Up Default** screen in **Figure 133**.

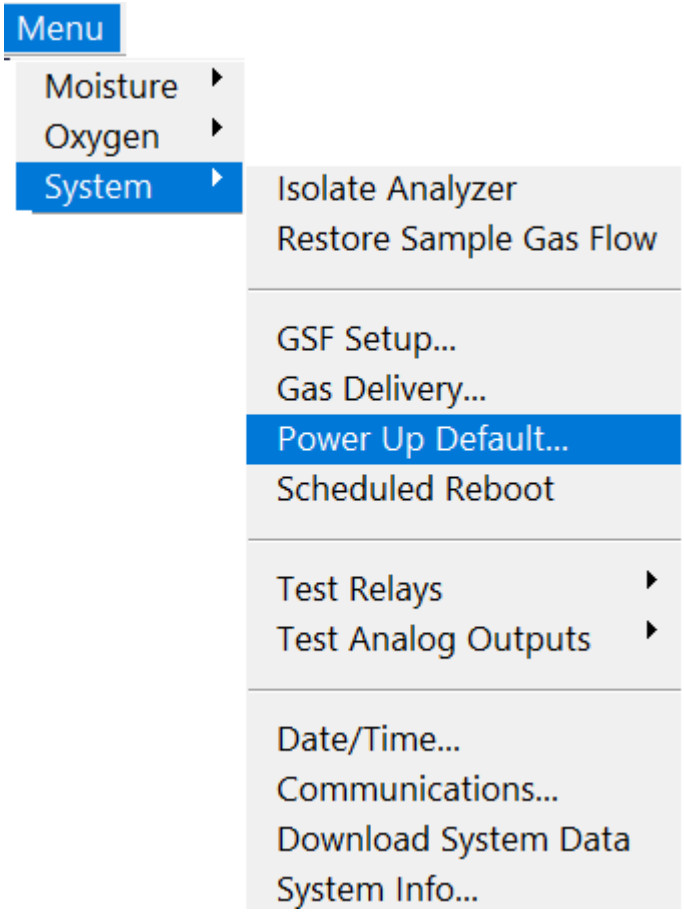


Figure 132: Power Up Default Menu

The Power Up Default Subroutine allows the user to determine the various default states during analyzer power up. The power up states are useful because they determine whether, for instance, the sensor is protected from ambient air contamination or whether it is configured in the best way for rapid station to station transfer and measurement.

Use the **NEXT** key to move from field to field. Use the up and down arrows (and) to move between the selections within the field. When done, use the **NEXT** key to move to the **Accept** field and hit the **Enter** key. Pressing the **ESC** at any time will make no changes and will return to the main data display.

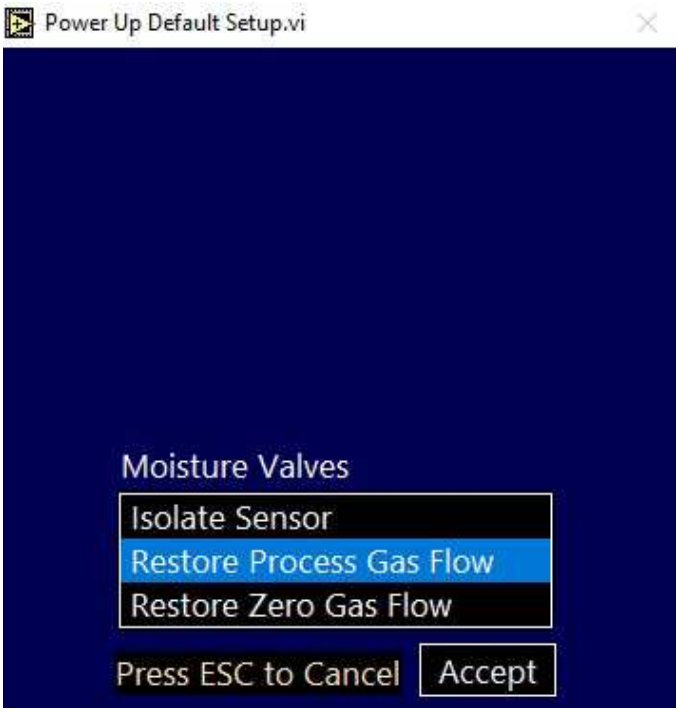


Figure 133: Power Up Default Screen

6.6.7 Scheduled Reboot

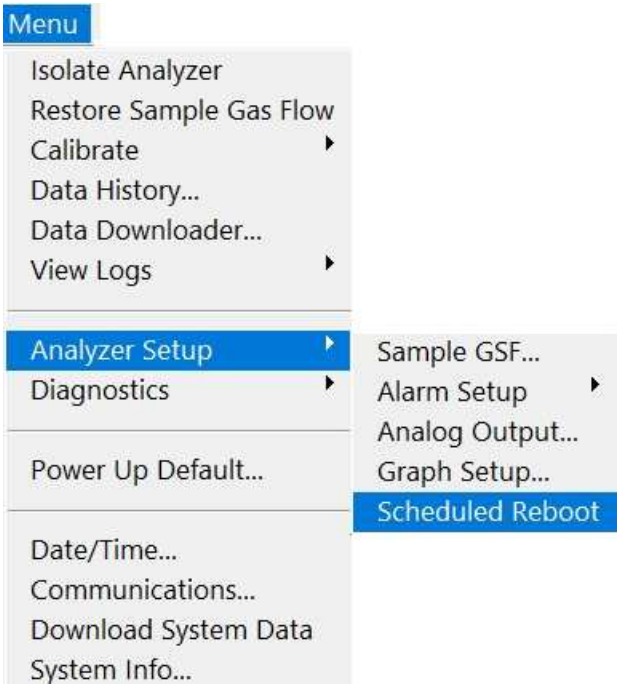


Figure 134:Scheduled Reboot Menu Selection

Scheduled reboot allows scheduling of a periodic automatic reboot of the analyzer. The time interval is settable to between 1 and 5 weeks. Time is settable to any time using 24-hour clock notation. Navigation

is accomplished using the **Next** and arrow buttons. The next scheduled reboot is displayed near the bottom of the screen as shown in **Figure 135.**

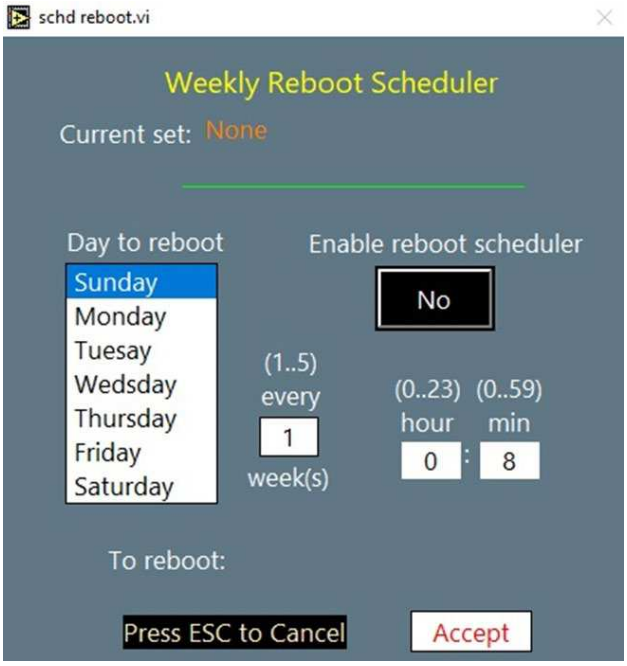


Figure 135: Next Scheduled Reboot

6.6.8 Test Relays

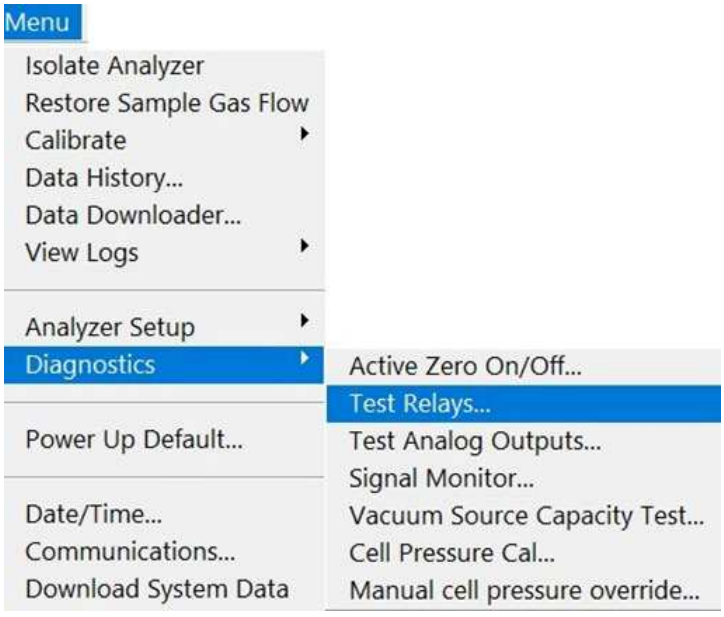


Figure 136: Test Relays Menu

6.6.9 Test Moisture Relays

The **Test Relays** screen, as shown in **Figure 137**, is used to assure that the moisture relays numbered 1 – 4 are functioning properly. When the Test Relays screen is selected, the **NEXT** key is used to move to the number field where the arrow keys (and) are used to choose the appropriate relay number. The **NEXT** key is then used to move to the **Activate/Deactivate** field where the arrow keys (and) are used to toggle between the two options. The **NEXT** key is then used to move to the **Apply** field where the **Enter** key is hit to change the relay state. This process can be repeated as often as needed. When done, the **NEXT** key is used to move to the **Done** field and the **Enter** key is hit to leave the screen. The condition of the relays before the test is restored when the test is concluded. See **5.4 Relay Ports – J2, J3, J8, J9** for additional information.

Figure 137: Test Moisture Relays

6.6.10 Test Oxygen Relays

The **Test Oxygen Relays** screen, as shown in **Figure 138**, is used to assure that the oxygen relays numbered 5- 8 are functioning properly. When the Test Relays screen is selected, the **NEXT** key is used to move to the number field where the arrow keys (and) are used to choose the appropriate relay number. The **NEXT** key is then used to move to the **Activate/Deactivate** field where the arrow keys (and) are used to toggle between the two options. The **NEXT** key is then used to move to the **Apply** field where the **Enter** key is hit to change the relay state. This process can be repeated as often as needed. When done, the **NEXT** key is used to move to the **Done** field and the **Enter** key is hit to leave the screen. The condition of the relays before the test is restored when the test is concluded. See the section on relay ports found on page 41 for additional information.

Figure 138: Test Oxygen Relay

6.6.11 Test Analog Outputs

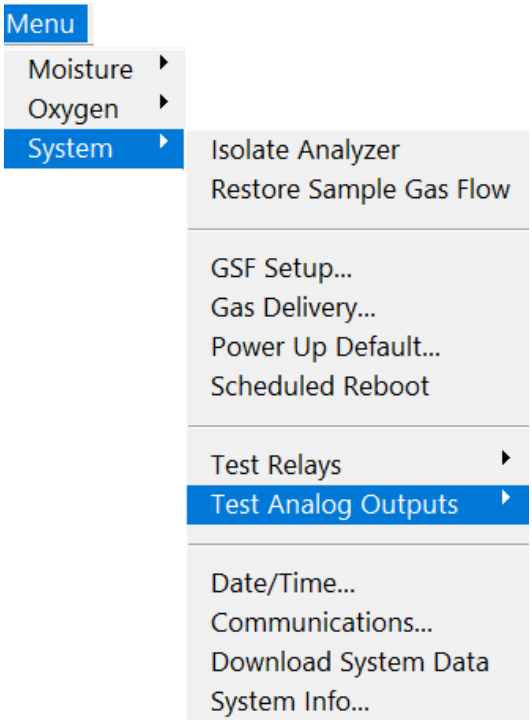


Figure 139: Test Analog Outputs Menu

6.6.12 Test Moisture Analog Output

The Test Moisture Analog Output screen, as shown in Figure 140 is used to calibrate the moisture analog recorder output. When the Test Output screen is selected, the **NEXT** key is used to move to the percentage field where the arrow keys (▲ and ▼) are used to choose the appropriate setting. The **NEXT** key is then used to move to the **Apply** field where the **Enter** key is hit to set the analog output to the selected value. 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. This process can be repeated as often as needed. When done, the **NEXT** key is used to move to the **Done** field and the **Enter** key is hit to leave the screen. The condition of the analog output before the test is restored when the test is concluded. See **5.2 Analog Signal Outputs – J4, J10** for additional information.

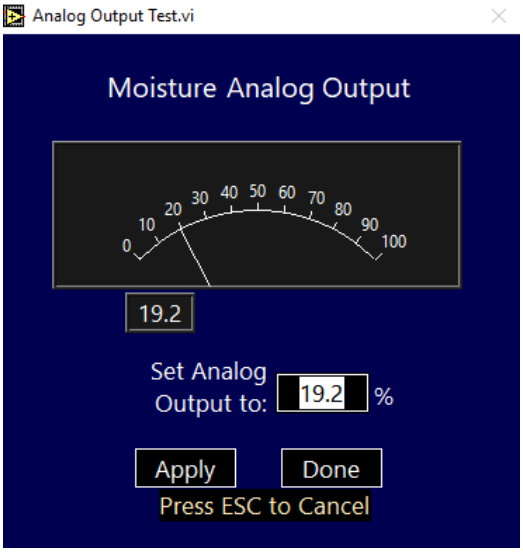


Figure 140: Test Moisture Analog Output

6.6.13 Test Oxygen Analog Output

The Test Oxygen Analog Output screen, as shown in **Figure 141** is used to calibrate the oxygen analog recorder output. When the Test Output screen is selected, the NEXT key is used to move to the percentage field where the arrow keys (▲ and ▼) are used to choose the appropriate setting. The NEXT key is then used to move to the Apply field where the Enter key is hit to set the analog output to the selected value. 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. This process can be repeated as often as needed. When done, the NEXT key is used to move to the Done field and the **Enter** key is hit to leave the screen. The condition of the analog output before the test is restored when the test is concluded. See **5.2 Analog Signal Outputs – J4, J10** for additional information.

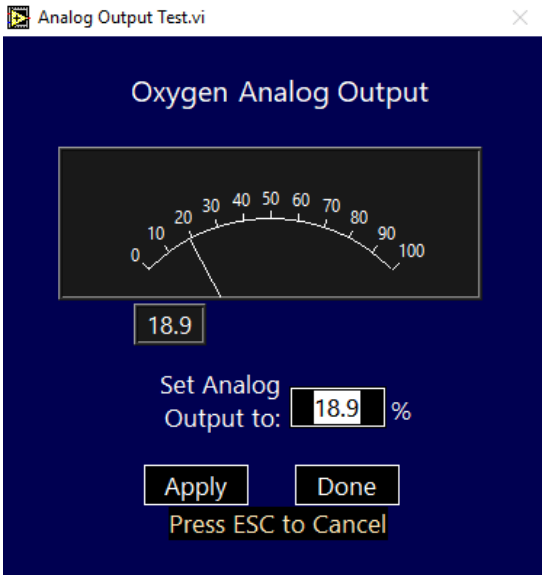


Figure 141: Test Oxygen Analog Output

6.6.14 Date/Time

The **Date/Time** menu selection is shown in **Figure 142** . This menu selection accesses the **Manual Date/Time Setup** screen in **Figure 143.**

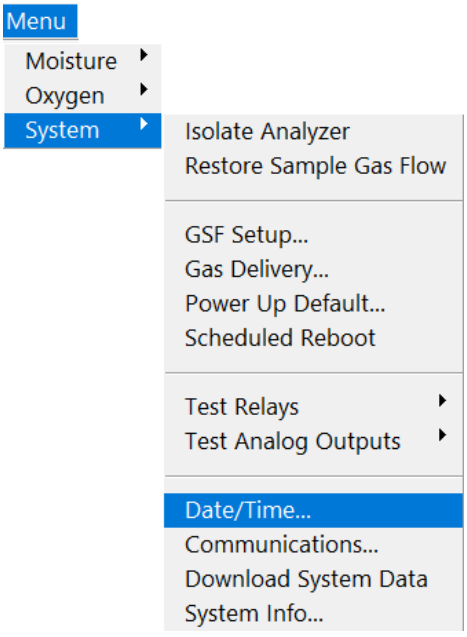


Figure 142: Date/Time Menu

The **Date/Time Setup** screen **(Figure 143**) is used to set various calendar and clock related parameters. Selecting **Change Time Zone** allows the user to select the appropriate time zone.

Selecting Change **Date and Time** accesses the **Date/Time Edit** screen (**Figure 144**)**.** Use this screen to change the date and time. When done, use the **Next** key to move to the **Accept** field and press the **Enter** key to confirm.

Hitting the **Esc** key at any time will exit the screen with no changes and return the user to the main data display.

NOTE: The time is not automatically adjusted for daylight savings and must be changed manually.

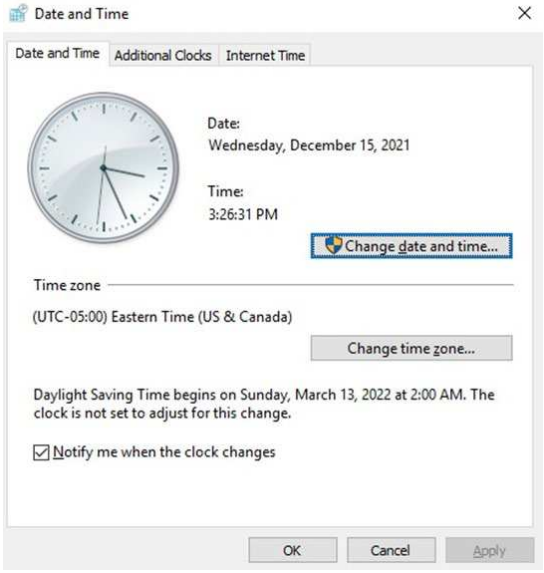


Figure 143: Date/Time Setup Screen

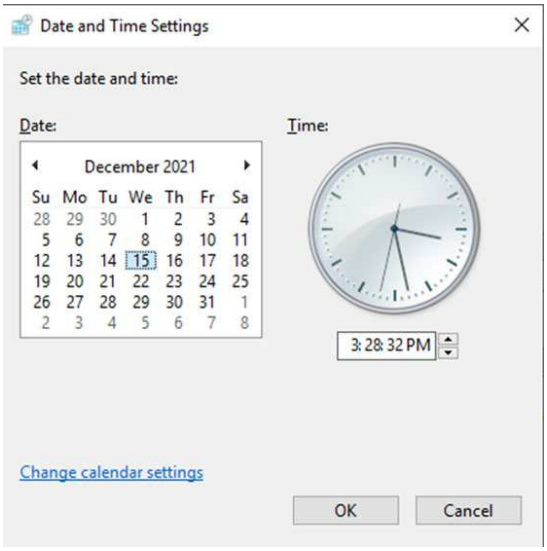


Figure 144: Date/Time Edit Screen

Access the Date/Time Screen (from the **System** menu) to set various calendar and clock-related parameters.

Use the **Next** key to move from field to field, and the arrow keys (and) to change the various numerical digits and units.

When in the Time Zone field, use the left and right arrow keys toggle through the various options. When done, use the **Next** key to move to the **OK** field and press the **Enter** key.

Hitting the **ESC** key at any time will exit the screen with no changes and return to the main data display.

NOTE

The time is not automatically adjusted for daylight savings and must be changed manually.

6.6.15 Communications

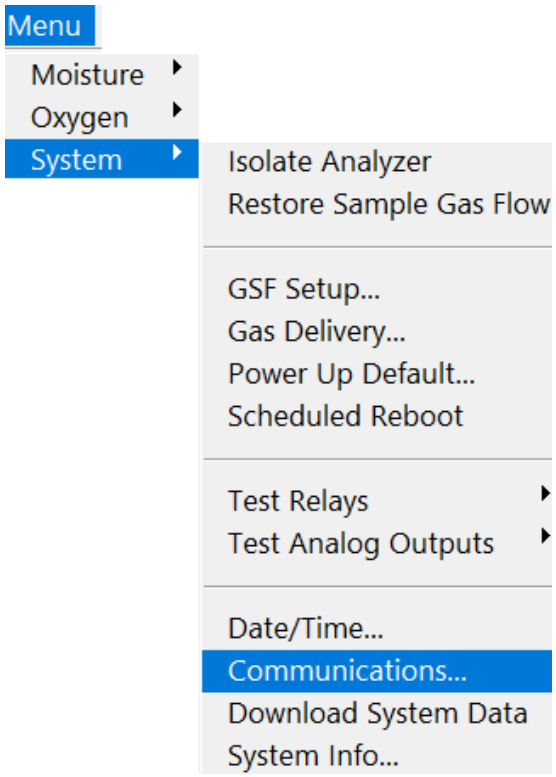


Figure 145: Communications Menu

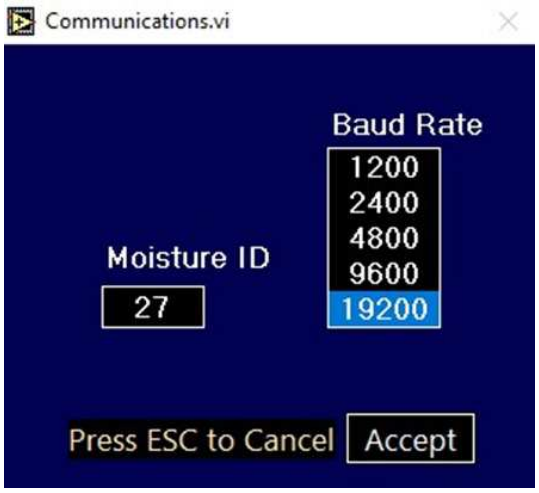


Figure 146: Communications Setup Screen

The **Communications Setup** screen is used to set parameters related to serial communications. The **Next** key is used to move from field to field, and the arrow keys (▲ and ▼) are used to change the numerical digits as well as to select the baud rate. When done, use the **Next** key to highlight the **Accept** field, and use the **Enter** key to confirm. See page 39 for additional information.

6.6.16 Download System Data

If problems develop with the analyzer, the contents of the internal system data files can easily be downloaded to a USB memory stick (Flash Drive) and the files can be e-mailed to Servomex for evaluation. Install a memory stick into the USB port located behind the front door on the left side of the analyzer. After selecting **Download System Data**, press **Enter,** and the **Insert Media** screen shown in **Figure 148** will be displayed.

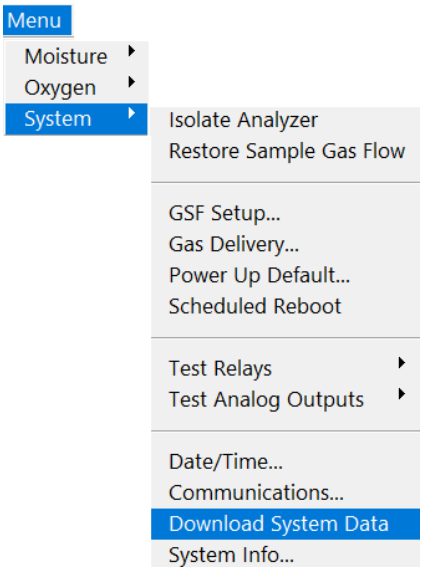


Figure 147: Download System Data

Figure 148: Insert Media

The system downloads data for 10 days ending with the date set on the screen as shown in **Figure 148**. The current date is set automatically but can be changed to capture activity at a specific time other than the last 10 days. Use the **Next** key to move between fields and the arrow keys (and) to select a date.

Hit **Enter** and the download process will begin, indicated by a loading bar as shown in **Figure 151**. The process should only take a minute or two, and when complete, control will be returned to the user.

If there is insufficient space available on the media, a warning will appear as in **Figure 149.**

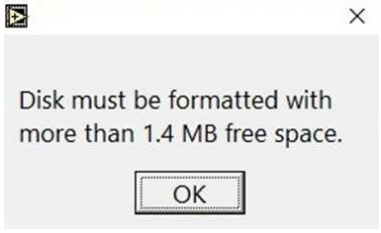


Figure 149: Media Warning

If Drive D is not ready, a message will appear as in **Figure 150** below.

If not ready message appears, select **OK**, wait a minute, and try again.

Figure 150: Not ready Drive d:

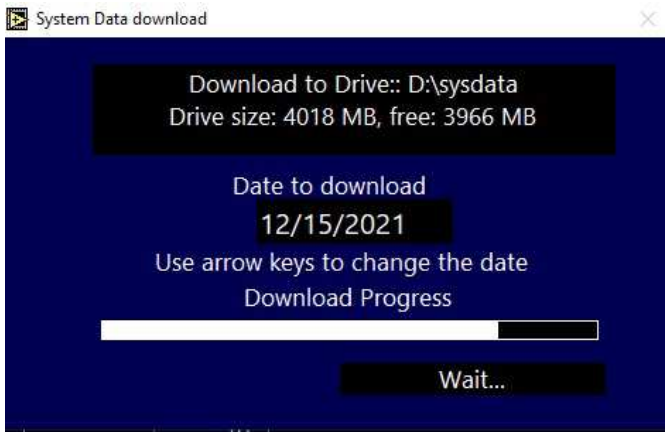


Figure 151: Download Timeline

The file name is automatically created and includes the date and time that the data was recorded as well as the serial number of the analyzer. All files are then automatically compressed and loaded as one file on the flash drive, which can then be used to forward the information to Servomex for evaluation.

6.6.17 System Info

The System Info Menu selection (**Figure 152**) accesses the **System Information** screen (**Figure 153**), which provides the user information regarding the configuration of the analyzer as well as the version of firmware currently installed. The Service Menu is password protected. Do not use this function unless instructed by Servomex.

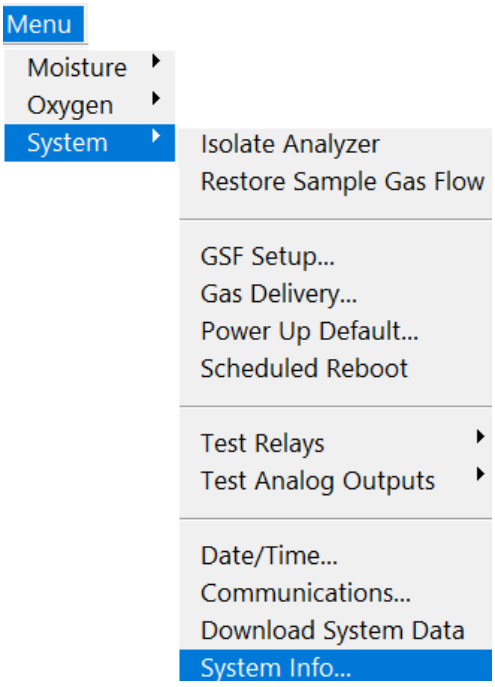


Figure 152: System Info Menu Selection

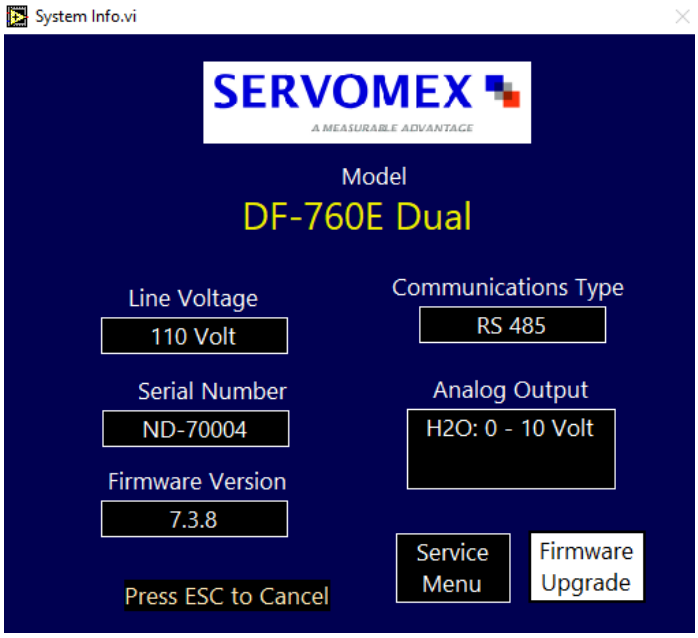


Figure 153: System Info Screen

6.6.18 Firmware Upgrade

When the **Firmware Upgrade** box is highlighted, hitting the **Enter** key will cause the Firmware Upgrade dialog box to appear as in **Figure 154** below.

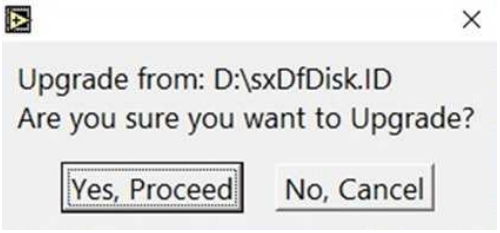


Figure 154: Firmware Upgrade

Place the memory stick (Flash Drive) with appropriate files in the external USB port located behind the front door next to the oxygen sensor. When ready, hit the **Yes, Proceed** key and follow the instructions. At the conclusion of the upgrade the analyzer will automatically reboot.

Once the analyzer has rebooted and resumed operation, it is safe to remove the flash drive.

7. Sample Gas Preparation and Delivery

7.1 Introduction

It is important to monitor sample pressure to ensure it does not vary from the specified range for the background gas being supplied to the moisture analyzer. Pressure and background gas composition significantly affect system performance. Flow rate also affects analyzer performance, but is less critical.

7.2 Sample Pressure

Proper moisture analyzer operation is dependent upon the pressure of the sample gas. For each sample gas, there is a specified range that the analyzer must operate in (refer to **Table 11**.) The pressure can be adjusted by balancing the inlet regulator setting with the throttling valve in the aspirator or, if equipped, with the needle valve in the vacuum pump assembly. When using a mixture of background gases, the required pressure range may be different than either gas individually. A message on the screen will indicate the required pressure in this case.

Background Gas	Pressure
N2	200 +/- 50 Torr
Ar	330 +/- 50 Torr
He	780 +/- 50 Torr
H2	350 +/- 50 Torr
O2	350 +/- 50 Torr

Table 11: Required Sample Outlet Pressure Ranges

7.3 Flow Rate Effects on Sensor Performance

Assuming a leak-free system, flow rate changes will have minimal effects on the performance of the moisture cell.

7.4 Background Gas Effects on Indicated Flow Rate

If the molecular weight of the background gas is much different from N2, the flowmeter reading is not accurate. The bypass loop flowmeter mounted on the rear of the DF-700 series Moisture Analyzer is calibrated for use in air (or N2). Most other gases have molecular weights within ± 25 percent of air. Since the required flow rate is not extremely critical, most gases produce 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.

7.5 Flammable Sample Gas

The only flammable gas that the DF 760E can be used with is Hydrogen. If used with Hydrogen, the optional Hydrogen Safety System should be installed, or the analyzer must be installed in a purged environment.

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.

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.

8. Service

8.1 Return Material Authorization Number

If the analyzer is being returned to the factory, call the Servomex Business office 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:

Servomex Corporation
4 Constitution Way
Woburn, MA 01801-1087

8.2 Cautions Related to Maintenance

CAUTION: HAZARDS AFFECTING SERVICE PERSONNEL

Service personnel perform activities that expose them to hazards, such as disconnecting pressurized sample and vent lines, replacing power cords, and replacing fuses. Read the **Safety Summary** at the beginning of this manual before performing any maintenance on this analyzer. Also, read the cautions and manual instructions that are included in the section that covers the specific maintenance operation.

CAUTION: RETURNING THE ANALYZER TO SERVICE

Following maintenance, ensure that the analyzer is in a safe state. Close the AC inlet fuse door. Fasten the top or left side analyzer covers, using all screws. Ensure that the internal and external fittings are connected properly and tightened adequately. Ensure that inlet and outlet valves are in the appropriate position for normal operation and the power cord is properly plugged into a grounded outlet. Ensure that the AC power cord and plumbing are routed to avoid a tripping hazard.

8.3 Spares

Refer to **Appendix C — Spares** for part numbers for replaceable parts and consumables and for ordering information.

8.4 Maintenance

8.4.1 Storage

Refit any protective plastic covers and place the analyzer and any associated equipment in its original packaging before storage. Alternatively, seal it inside a waterproof plastic bag, sack, or storage box. Store the analyzer and any associated equipment in a clean, dry area. Do not subject it to excessively hot, cold, or humid conditions.

If the analyzer is to be stored for extended periods of time, be sure that the temperature of storage location does not exceed 45° C (113° F). Storage in direct sunlight can cause temperatures to exceed the recommended limits even though ambient temperatures may be below the maximum temperature.

8.4.2 Coulometric Cell Storage

The DF Coulometric O_2 sensor is designed to be put into service immediately upon receipt. It performs best when in continuous service and will require minimal maintenance over its lifetime. If circumstances are such that the analyzer/sensor cannot be put into service right away or needs to be taken from service and put into storage, precautions should be taken to ensure performance is not degraded. These precautions include the following:

- The electrolyte should be drained, and the sensor rinsed with distilled or DI water. If it is not drained, the water in the electrolyte will evaporate over time. Eventually the electrolyte will crystalize, which will destroy the sensor.
- Storage conditions should approximate the normal operating conditions. Temperatures above 45 C will damage the sensor.

Storage for more than 6 months may result in degraded sensor performance. If the above precautions are taken, however, the 5-year warranty is not affected. If your sensor exhibits degraded performance after storage, contact your regional Servomex Service Center for a warranty replacement to be sent to you

8.4.3 Coulometric Cell Removal

To drain the electrolyte, it is necessary to remove the coulometric cell module from the analyzer:

1. Turn off oxygen sensor. (Refer to **6.5.1.3 Oxygen Sensor On/Off**.)
2. Disconnect three electrical connectors (one white, two black). Refer to **Figure 155**.
3. Disconnect the gas lines from input and output ports using open end wrenches (7/16 (two), 3/4 and 5/8 in. required.)

NOTE

Use backup wrenches when removing or installing gas line connectors, otherwise torque may be applied to analyzer plumbing and cause damage.

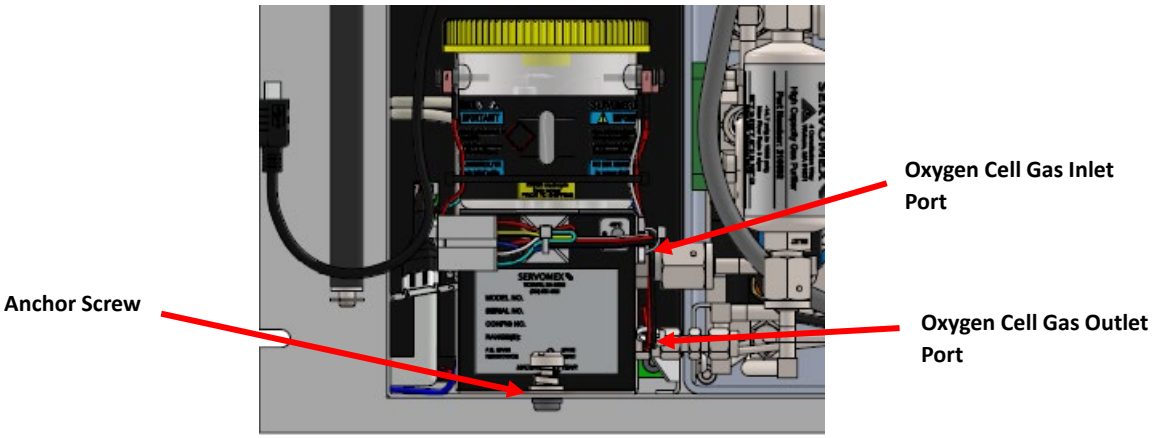


Figure 155 Oxygen Cell Removal

4. Loosen anchor screw.
5. Pull oxygen cell module forward and out of analyzer and place on work table.

8.4.4 Draining Coulometric Cell

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

Do not spill electrolyte on analyzer internal components!!! Permanent damage to analyzer may result if electrolyte is spilled on analyzer components.

After removing coulometric cell (see **8.4.3 Coulometric Cell Removal**), drain as follows:

1. Remove the gold cap.
2. Lift cell module and pour electrolyte into container (with leak-proof cap) made from inert material (container that Electrolyte was shipped in is recommended.) Avoid spilling. Use of a funnel is recommended.
3. Carefully rinse the reservoir and inside of gold cap with DI water.
4. Replace gold cap on reservoir.
5. Tightly cap container of used electrolyte. Dispose of electrolyte in accordance with local laws and regulations.

NOTE

Electrolyte cannot be re-used and should be discarded after draining.

8.4.5 Coulometric Cell Installation

Reverse procedure in **8.4.3 Coulometric Cell Removal** to install coulometric cell. Use a new VCR gasket when making VCR connection to oxygen cell input.

8.4.6 Putting Analyzer Back in Service After Storage

Use procedures in **3.3 Analyzer Installation** and **3.4 Analyzer Start Up** to put analyzer back into service after storage.

8.4.7 Fuse Replacement

CAUTION: HAZARDOUS AC

Before replacing fuses, turn off the analyzer power switch and allow the analyzer to shut down normally. Disconnect the analyzer power cord from the AC inlet.

Main fuses are in the AC inlet module. Facing the AC inlet there is a tab, on the left side of the inlet, which is pried to open the fuse cover. Gently pry the tab with a straight blade screwdriver, being careful not to damage the tab. The cover will flip open to expose a red fuse carrier. Use the screwdriver to pry the fuse carrier out of the AC inlet. Both sides of the AC line are fused. Note the position of the two fuses. This fuse carrier can accommodate different length fuses, and it is important to install the new fuses in the same position as the original fuses.
Replacement fuses may be purchased from Servomex (see replacement parts list, section 9.4) or purchase the following:

- For 110 VAC operation -- 250 VAC, 6.3A, 5X20 mm, IEC 60127-2 Sheet 3, such as Littelfuse 021806.3HXP.
- For 220 VAC operation -- 250 VAC, 3.15, 5X20 mm, IEC 60127-2 Sheet 3, such as Littelfuse 02183.15HXP.

8.4.8 Moisture Cell Maintenance

The moisture cell does not require any periodic maintenance or inspection. If you observe that moisture cell is not performing correctly, or if moisture-cell related error codes are displayed that are not clearable, contact Servomex.

8.4.9 Vacuum Pump Maintenance

If equipped, the vacuum pump requires periodic maintenance every 6 – 12 months to maintain proper pressure. The interval will vary depending on characteristics of the installation. A good working pump will pull down to approximately 115 torr or less when the moisture cell is isolated. When pump performance degrades to the point that proper pressure cannot be attained, a significant improvement in performance can often be achieved by cleaning of the cylinder and piston assembly. A rebuild kit is available from Servomex to return the pump to original specifications. See the list on page 140 for cleaning fluid and rebuild kit part numbers.

8.4.10 Gas Purifier Maintenance

The Gas Purifier removes moisture from typical trace level sample gas stream to provide sub-ppb moisture concentrations for use as a zero-reference gas during Analyzer calibration. Calibration systems are supplied with a 3000 ppm-hr. purifier. Replacement purifiers can be ordered from Servomex.

The gas purifier supplied by Servomex has a finite life that is affected by the source gas moisture 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.

8.4.11 Determining When to Change the Purifier

With use the active component in the purifier becomes depleted and moisture breakthrough occurs. If the process gas (containing low levels of moisture) is flowed through the zero purifier and the moisture reading does not reduce, then the purifier is expended and needs to be replaced.Preparation for Gas Purifier Removal and Installation

NOTE

Read the installation instructions and prepare all tools and parts for a **quick** installation. 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 require the following tools and parts:

- 1 3/8 -inch open end wrench (for purifier body)
- 3/4 -inch open end wrench (for VCR fitting on calibration panel)
- Two VCR-type gaskets and retainers Servomex P/N 210431 or Cajon P/N SS-4-VCR-2-GR

8.4.12 Gas Purifier Removal/Installation Procedure

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. Shut off the vacuum source and wait 5 minutes for the pressure to equalize. *This step is critical to minimize ambient intrusion.*
2. Using the moisture gas valve control screen (see **6.4.1 Moisture Controls Menu**) start the gas flow through the zero purifier.
3. Write the installation date on the gas purifier label.
4. Install new gaskets and retainers on the purifier. Gently replace the cap nuts on the purifier to minimize exposure to ambient air.
5. Open the door and locate the purifier position. See **Figure 7**.
6. If installing a new purifier at initial startup, remove the VCR plugs installed in the plumbing system allowing gas to escape from the lower plug.
7. If replacing a spent purifier, remove the purifier allowing gas to escape from the lower fitting.

8. Remove both VCR-type cap nuts from the new purifier and quickly install the purifier **with the arrow pointing up**. It may be necessary to slightly spring the calibration system plumbing to insert the gas purifier. Be sure not to scratch the gasket surfaces.
9. Screw the fitting nuts at both ends finger-tight allowing gas to escape for two minutes.
10. Using a backup wrench tighten the nut at the bottom of the purifier 1/4 turn beyond finger-tight and allow the gas to escape from only the top fitting for an additional two minutes. Then tighten the top fitting 1/4 turn beyond finger tight.
11. Turn the vacuum source on and continue to allow the gas to flow through the purifier for 24 hours or until the original analyzer reading is achieved.
12. After installation is complete, low ppb process gas must be allowed to flow through the gas purifier to purge ambient gas from the gas lines and valves. Effective purging of the system can be accomplished by repeatedly opening and closing the valves in the process and zero legs to start and stop the flow of gas. To automate this purge process, see the purifier purge routine found in the diagnostics menu (see **6.4.31 Purge Purifier.**)

8.4.13 Power Cord Replacement

CAUTION: POWER CORD SAFETY

The power cord provides a protective earth connection. Do not use a power cord without a protective earth wire. Do not use a power cord with inadequate ratings (less than 120 VAC, 10 Amps for 110 VAC, or less than 240 VAC, 10 Amps for 220 VAC).

CAUTION: HAZARDOUS AC

Before replacing the power cord, turn off the analyzer power switch and allow the analyzer to shut down normally. Disconnect the analyzer power cord from the AC inlet.

For 110 VAC operation, the power cord is a Volex 17251 10 B1. Any equivalent three-wire power cord may be used provided it has a protective ground wire and conforms to the following specifications: 120 VAC, 10 A, 18 AWG, SVT jacket, with a NEMA 5-15P plug and an IEC 60320 C-13 receptacle for connection to the analyzer. Make sure that the cord has the necessary agency approvals required for your country.

For 220 VAC operation, any three-wire power cord may be used provided it has a protective ground wire and conforms to the following specifications: 250 VAC, 10 A, with a plug appropriate for country and an IEC 60320 C-13 receptacle for connection to the analyzer. Make sure that the cord and plug have the necessary agency approvals required for your country.

8.5 Troubleshooting

The DF-700 series moisture analyzer constantly monitors the analyzer's performance. In the event of a failure, a system alarm will be displayed on the front panel. In addition, the failure will be logged in the System Error Log (see**6.4.20 System Error/Event Codes**). In the event of a system alarm, contact Servomex with information as displayed in the log as well as on the **Signal Monitor** screen (Figure 64.) In addition, it may be helpful to download system data and provide the downloaded file to Servomex (refer to **6.6.16 Download System Data**.

8.6 Shipping

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

1. Isolate the analyzer gas path properly by following the steps in 3.5 Analyzer Shut Down or Disconnection.
2. Turn off the power switch. Disconnect any source of AC power from the analyzer.
3. Disconnect all external electrical connections (alarms, data output, communications etc.) Mark each for reattachment later.
4. Drain Electrolyte. Refer to 8.4.4 Draining Coulometric Cell
5. Remove purifier and quickly cap off gas lines. Refer to 8.4.12 Gas Purifier Removal/Installation Procedure.
6. Ensure that all internal components are secured and put the analyzer in its original container.

If the analyzer is to be returned to the factory, call the nearest Servomex Business office to obtain a **Return Material Authorization Number** and a form to certify that the analyzer has been properly decontaminated. Clearly mark the **Return Material Authorization Number** on the outside of the shipping container and on the packing list. Include the properly completed **Decontamination Certificate** with the shipment.

The analyzer should be returned (freight prepaid) to:

Servomex Corporation
4 Constitution Way
Woburn, MA 01801-1087

8.7 Disposal

Dispose of the analyzer and any associated equipment safely, and in accordance with your local and national safety and environmental requirements.

Hint: *If you send the analyzer to Servomex or your local Servomex agent for disposal, it must be accompanied by a correctly completed decontamination certificate and a Return Authorization Number (RAN) (refer to* ***8.1*** **Return Material Authorization Number***.)*

8.7.1 Disposal in accordance with the Waste Electrical and Electronic Equipment (WEEE) Directive

The label shown in **Figure 156** is fitted to the analyzer.

Figure 156 The WEE label

The label identifies that:

- The analyzer is within the scope ofthe Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU.
- The analyzer is not intended for disposal in a municipal waste stream, but shall be submitted for material recovery and recycling in accordance with the local regulations implementing the WEEE Directive.

For additional information on the disposal of this product in accordance with therequirements of the WEEE Directive, contact Servomex:

Servomex Group Limited,Jarvis Brook,
Crowborough, East Sussex, TN6 3FB,
England
Tel: + 44 (0)1892 652181
Fax: +44 (0)1892 662253
Email: Europe_sales@servomex.com

9. Theory of Operation

9.1 The Moisture Measurement

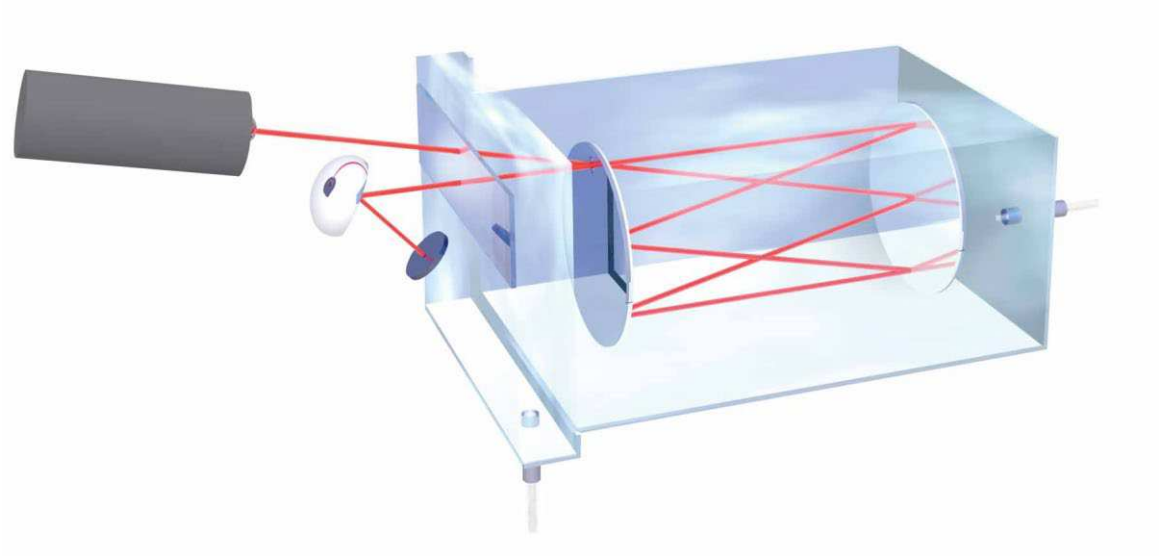


Figure 157: Herriott Cell Conceptual Drawing

9.1.1 Moisture and the IR Spectrum

The NanoTrace Moisture Analyzer uses infrared (IR) absorption as its detection method. IR absorption is a subset of the overall field of spectroscopy, which concerns analytical methods based on the interaction of light and matter. A conceptual drawing of the type of moisture cell used in the analyzer (called a Herriott cell for physicist Donald R Herriott) is shown in **Figure 157**. The cell includes a laser light source, an enclosed cavity through which the sample gas passes, a system of mirrors and a light sensor.

Absorption spectroscopy is based on the absorption of energy that occurs when electromagnetic waves collide with matter. In the infrared spectral region, the wavelengths of light overlap with absorptions created by molecular vibrations. IR absorption is often used in diagnosing molecular composition based on “fingerprints” of these absorptions over a wide wavelength range. But also, if the strength of a single vibrational absorbance is known, a single wavelength is often used to determine the amount of a particular substance. It should be noted that there are factors other than changing moisture concentration that can affect the amount of light that reaches the sensor. The DF-760E moisture cell mitigates this problem by scanning across a narrow wavelength range and continuously comparing the intensity of light at the interfering frequency with a non-interfering frequency. This is how we measure moisture.

9.1.2 Absorption Spectroscopy

The relationship that defines absorption spectroscopy is known as Beer's Law. Beer's Law equates, in rigorous terms, the concentration of any absorbing molecule based on absorbed light intensity at a particular wavelength, given knowledge of the molecule's absorption strength and the "path length" of the sample medium.

Many are familiar with Beer's Law as it is conventionally used in analytical laboratories:

$$A_\lambda = \log(1/T)_\lambda = \log(I_0/I)_\lambda = 2.303 \times \varepsilon_\lambda \times b \times C$$

Definitions:

$A_\lambda \equiv$ Absorbance at wavelength λ

$T \equiv$ Transmittance

$I_0 \equiv$ Reference Intensity of Light

$I \equiv$ Measured Intensity of Light after Absorption

$\varepsilon_\lambda \equiv$ Molar Absorptivity at wavelength λ

$b \equiv$ Path length

$C \equiv$ Molar concentration

In this embodiment, a solution with a broad absorbance band is dialed to a wavelength within the band, where a substance's molar absorptivity is known, and the concentration of that substance is determined. The substance is usually a liquid solution, placed in a 1 cm cuvette, and the concentration is expressed in moles/liter.

This same Law can have units reassigned to determine absolute numbers of molecules per cubic centimeter, useful in gaseous measurements:

$$A_\lambda = \ln(I_0/I)_\lambda = \sigma_\lambda \times b \times N$$

$\sigma_\lambda \equiv$ Molecular Cross Section (cm^2/molecule) at wavelength λ

$N \equiv$ Molecular Density (molecules/cm^3)

The values σ and ε are related primarily by Avogadro's Number. If the molecular density of an absorbing substance in gas, such as moisture, is known, it can be compared to the number of molecules in an ideal gas, resulting in a report of parts per billion (ppb). Since the measurement is calculated per unit volume instead of per molecule count, this concentration is more specifically called parts per billion in volume (ppb).

10. Specifications

10.1 Moisture Detection

Lowest Detection Level (LDL) DF-760E: 100 ppt @ Constant Conditions

Lowest Detection Level (LDL) DF-760E Ultra: 55 ppt @ Constant Conditions

Accuracy: Greater of ±3% of reading or ±0.2 ppb @ Constant Conditions

Speed of Response: Less than 3 minutes to reach 90 percent of an upward step change

Upset Recovery Time: Less than 5 minutes from a high ppb upset to within 10 ppb of the previously stable reading.

Range: 0-20 ppm

Background Gas Compatibility: N_2, H_2, He, Ar, O_2,

Cell Pressure: Variable from 180 – 760 Torr (0.23-1.01 bar, 24-101.3 Kpa) based on background gas.

10.2 Oxygen Detection

Lowest Detection Level (LDL): 45 ppt @ Constant Conditions

Resolution: Analytical (Smallest Detectable Change): 50 ppt

Accuracy: Greater of ±3% of reading or ±0.1 ppb @ Constant Conditions

Speed of Response: Less than 20 seconds to reach 90 percent of a step change in either direction.

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

Range: 0-20 ppm

Background Gas Compatibility: N_2, H_2, He, and Ar

Return Pressure: ±1.0 psig (±0.07 barg), atmospheric vent recommended.

10.3 General

Construction: NEMA 1 (IP10), 19-inch rack mount

Dimensions: 19 inch (48.3cm) wide x 10.5 inch (26.7 cm) high x 22.5 inch (57.2 cm) deep

Display: 10.1-inch LCD Color 1024X600)

Weight: 73 pounds (33.11 kg)

Sample Conditions: oil free, non-corrosive, non-condensing, filtered for particulates to 2µm.

10.4 Environmental:

Altitude: 2000 meters (6500 feet) max

Ambient Operating Temperature: 10° C to 40° C (50° F to 105° F)

Humidity: 95% relative humidity non-condensing

General: Indoor use only in a clean and dry, non-hazardous area of pollution degree 2, as defined in EN 60664-1.

Storage Temperature: Max 50° C (122° F)

10.5 Gas Routing

Gas Inlet, Sample:

Flow Rate**:** 1.8 slpm total (moisture cell: 1 slpm, oxygen cell: .5 slpm, bypass outlet: .3 slpm)

Inlet Pressure**:** 30 to 150 psig (2 to 10 barg, 206.8 to 1034.2 kpag)

Gas Inlet, Pneumatic:

Gas: N2 or air

Inlet Pressure: 70 to 100 psig (4.8 to 6.9 barg, 482.6 to 689.4 kpag)

Gas Inlet, Aspirator:

Flow Rate: 15 slpm

Gas: N2 or air

Inlet Pressure: 80 psig (5.5 barg, 551.6 kpag)

Span Gas: Not required.

Zero Gas: From Purifier

Gas Path Construction Materials: 316 Stainless Steel, 304 Stainless Steel, Indium, Passivated Steel, Hastelloy C22, Gold, Invar, Acrylic, Buna-N, Sapphire, PCTFE, Polypropylene, Brass, Aluminum

10.6 Output Signals & Status Indicators

Alarm Relays: Four non-latching, independently assignable to moisture alarms. SPDT contacts rated at 1 Amp @ 30 VDC resistive load. Fail safe action upon loss of power to alarm condition. Not designed to switch AC power.

Analog Output: 0-1, 0-5, or 0-10 VDC (minimum load resistance: 1K), User Scalable 0-2 ppb to 0-20 ppm Moisture.

Isolated 4-20 mA DC: 1K ohm loop resistance max, (28V Compliance voltage provided).

Visual Alarm Status Indicators: Four Moisture levels, Temperature, System Error, Loss of Flow, Pressure Range, Zero Verification or Calibration in Process, Fan Failure.

Dual Scale Range: Two user selectable secondary analog output ranges for rescaling the output to display screen once the primary range is exceeded

Digital Communications: Two-way RS-232 or RS-485 set at the time of order.

10.7 Laser

Max Power: 50mW/30mW

Beam Divergence: 436 mrad

Pulse Pattern: Continuous Wave
Analyzer Product Classification: Class 1 (per BS EN 60825-1:2014 and 21CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 56, 5 May 2019)

10.8 Power

Standard: 100 to 120 VAC, 50/60 Hz, 5 Amps

Optional: 200 to 240 VAC, 50/60 Hz (optional), 2.5 Amps

10.9 Compliance

EMC: (EMC) Directive 2014/30/EU

Electrical Safety: EU Low Voltage Directive; IEC 610110-1 Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use

11. Material Safety Data Sheets

11.1 Material Safety Data Sheet (MSDS) for Electrolyte Solution

1. IDENTIFICATION OF THE SUBSTANCE

Trade Name	Electrolyte Solution, *ℰ-lectrolyte Gold*, *ℰ-lectrolyte Blue, ℰ-lectrolyte Black*, DF-E05, DF-E06, DF-E07, DF-E09
Manufacturer	Servomex 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
7732-18-5	Water	231-791-2			
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 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 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 **Chapter 6 Service**.

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	104.5^0C
Melting Point	-3.5^0C
Flash Point	Not applicable
Flammability	Not flammable
Explosion Limits	Not applicable
Specific Gravity	1.15
Vapor Pressure	16.1 mm Hg @ 20^0C

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. Toxicological Information

RTECS#	CAS# 7732-18-5	ZC0110000
	CAS# 1310-58-3	TT2100000
LD50/ LC50	CAS# 7732-18-5	Oral, ret: LD50 = >90 ml/kg
	CAS# 1310-58-3	Draize test, rabbit, skin: 50 mg/24H Severe Oral, rat: LD50 = 273 mg/kg
Carcinogen Status	CAS# 7732-18-5	Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA
	CAS# 1310-58-3	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

US FEDERAL

TSCA	CAS# 7732-18-5	**Listed on TSCA Inventory**
	CAS# 1310-58-3	**Listed on TSCA Inventory**
Health & Safety Reporting List		None of the chemicals on Health & Safety Reporting List
Chemical Test Rules		None of the chemicals are under Chemical Test Rule
Section 12b		None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule		None of the chemicals have a SNUR under TSCA
CERCLA Hazardous Substances and	CAS# 1310-58-3	1000 lb final RQ; 454kg final RQ

corresponding RQ's		
SARA Section 302 Extremely Hazardous Substances		None of the chemicals have a TQP
SARA Codes	CAS# 1310-58-3	Immediate, Reactive
Section 313		No chemicals are reportable under Section 313
Clean Air Act		Does not contain any hazardous air pollutants Does not contain any Class 1 Ozone depletors Does not contain any Class 2 Ozone depletors
Clean Water Act	CAS# 1310-58-3	Listed as a Hazardous Substance under the CWA
		None of the chemicals are listed as Priority Pollutants under the CWA
		None of the chemicals are listed as Toxic Pollutants under the CWA
OSHA		None of the chemicals are considered highly hazardous by OSHA
STATE	CAS# 7732-18-5	Not present on state lists from CA, PA, MN, MA, or NJ.
	CAS# 1310-58-3	Can be found on the following state right to know lists; CA, NJ, PA, MN, MA.
California Prop 65		California No Significant Risk Level: None of the chemicals are listed.

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.
	R22	Harmful if swallowed
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).
WGK (Water Danger/Protection)	CAS# 7732-18-5	No information available
	CAS# 1310-58-3	1
Canada – DSL/ NDSL	CAS# 7732-18-5	Listed on Canada's DSL List
	CAS# 1310-58-3	Listed on Canada's DSL List
Canada - WHMIS	Classification E, D1B	Classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by those regulations.
Canadian Ingredient Disclosure List	CAS# 1310-58-3	Listed on the Canadian Ingredient Disclosure List

16. Other Information

MSDS Creation Date: 09/30/94 MSDS Revised: May 1, 2007

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.

11.2 Material Safety Data Sheet (MSDS) for Replenishment Solution

1. IDENTIFICATION OF THE SUBSTANCE

Trade Name	Replenishment Solution, RS-A
Manufacturer	Servomex 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
7732-18-5	Water (Contains trace salts)	215-181-3 C	100%		

3. HAZARDS IDENTIFICATION

Main Hazard	None			
CERCLA Ratings (scale 0-3)	Health = 0	Fire = 0	Reactivity = 1	Persistence = 0
NFPA Ratings (scale 0-4)	Health = 0	Fire = 0	Reactivity = 1	

Potential Health Effects:

Eye Contact	Not applicable.
Skin Contact	Not applicable.
Ingestion	Not applicable.
Inhalation	Not applicable.
Chronic	Not applicable.

4. FIRST-AID MEASURES

Skin Contact	Not applicable.
Eye Contact	Not applicable.
Ingestion	Not applicable.

Inhalation	Not applicable.

5. FIRE FIGHTING MEASURES

Special Exposure Hazard	Not applicable.
Extinguishing Media	Not combustible. Select extinguishing media appropriate to the surrounding fire conditions.
Protective Equipment	In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. ACCIDENTAL RELEASE MEASURES

Non-hazardous material. Clean up of spills requires no special equipment or procedures.

7. HANDLING AND STORAGE

Keep container tightly closed. Suitable for any general chemical storage area. Protect from freezing. May react vigorously with some specific materials. Avoid contact with all materials until investigation shows substance is compatible.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Personal Protection

Eyes	None required.
Skin	None required.
Clothing	Not applicable.
Respirators	Not applicable.
Airborne Exposure	Not applicable.
	Not applicable.

Exposure Limits

9. Physical & Chemical Properties

Molecular Formula	H2O containing trace salts
Physical State	Colorless, odorless liquid
pH	6.0-8.0
Solubility	Complete (100%)
Boiling Point	100^0C
Melting Point	0^0C
Flash Point	Not applicable

Flammability	Not flammable
Explosion Limits	Not applicable
Specific Gravity	1.00
Vapor Pressure	17.5 mm Hg @ 20^0C

10. Stability & Reactivity

Chemical Stability	Stable
Conditions/Materials to Avoid	Strong reducing agents, acid chlorides, phosphorus trichloride, phosphorus pentachloride, phosphorus oxychloride.
Hazardous Decomposition Products	Not applicable.
Hazardous Polymerization	Has not been reported

11. Toxicological Information

Toxicity (water)	CAS# 7732-18-5: Oral, rat: LD50 >90 mL/kg
Carcinogen Status	Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA

12. Ecological Information

Mobility	Completely soluble in water.
Degradability	Not applicable.
Accumulation	Not applicable.
Ecotoxicity	Applicable.

13. Disposal Considerations

Waste Disposal	Whatever cannot be saved can be flushed to sewer. If material becomes contaminated during use, dispose of accordingly. Dispose of container and unused contents in accordance with federal, state, and local requirements.

14. Transportation Information

Not regulated.

15. Regulatory Information

16. Other Information

NFPA Ratings: Health: 0 Flammability: 0 Reactivity: 0

MSDS Creation Date: 09/30/94 MSDS Revised: December 7, 2006

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.

11.3 Material Safety Data Sheet (MSDS) for Purifier

Entegris

Safety Data Sheet

Material Name: Inert and Hydrogen (HX) Gas Purifier Media **SDS ID: 0047P**

* * *Section 1 - IDENTIFICATION* * *

Product Identifier: Inert and Hydrogen (HX) Gas Purifier Media

Product Description

The media contained in this product, when used as designed, under normal operating conditions, and installed and maintained according to product literature, is not expected to be hazardous. Classifications and hazards represented on this Safety Data Sheet are only applicable in the unlikely event that the purifier media is liberated from the purifier housing. The purifier has sieves internal to the housing to prevent the media from escaping during intended use. Caution: Some units are provided with a fill port, which is factory sealed with a VCR® fitting and plug, covered with red shrink wrap. This port must never be opened by the end user, since it will potentially result in a release of the media.

Recommended Use

Hydrogen Gas Purifier removes oxygen, moisture and other molecular impurities from H2 gas and Hydrogen/Inert gas mixtures

Restrictions on Use

Use only with gases listed in Recommended Use.

Entegris, Inc.
129 Concord Road
Building 2
Billerica, MA 01821
USA

Telephone Number: +1-952-556-4181
Telephone Number: +1-800-394-4083 (toll free within North America)

Emergency Telephone Number:
CHEMTREC - U.S. - 1-800-424-9300
CHEMTREC - Intl. - 1-703-527-3887

Email of Competent Person

Product.stewardship@entegris.com

SDS Part Number(s)

8008648

* * *Section 2 - HAZARDS IDENTIFICATION* * *

Classification in accordance with 29 CFR 1910.1200

Combustible dust
Skin Corrosion / Irritation, Category 2

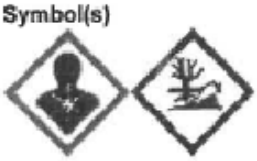
Safety Data Sheet

Material Name: Inert and Hydrogen (HX) Gas Purifier Media **SDS ID: 0047P**

Eye Damage / Irritation, Category 2A
Respiratory sensitizer, Category 1
Skin sensitizer, Category 1
Carcinogenicity, Category 1A
Specific Target Organ Toxicity - Single Exposure, Category 1 (kidneys and respiratory system)
Specific Target Organ Toxicity - Repeated Exposure, Category 1 (respiratory system)
Hazardous to the Aquatic Environment - Acute Hazard, Category 1 (50 % unknown)
Hazardous to the Aquatic Environment - Chronic Hazard, Category 2 (70 % unknown)

GHS LABEL ELEMENTS

Symbol(s)



Signal Word

DANGER

Hazard Statement(s)

May form combustible dust concentrations in air
Causes skin irritation
Causes serious eye irritation
May cause allergy or asthma symptoms or breathing difficulties if inhaled
May cause an allergic skin reaction
May cause cancer
Causes damage to kidneys and respiratory system.
Causes damage to respiratory system through prolonged or repeated exposure.
Very toxic to aquatic life
Toxic to aquatic life with long lasting effects

Precautionary Statement(s)

Prevention

Do not breathe dust. Wash thoroughly after handling. Wear protective gloves/clothing and eye/face protection. Wear respiratory protection. Contaminated work clothing should not be allowed out of the workplace. Do not eat, drink, or smoke when using this product. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Avoid release to the environment.

Response

IF exposed or concerned: Get medical advice/attention. IF INHALED: If breathing is difficult, remove person to fresh air and keep at rest in a position comfortable for breathing. If experiencing respiratory symptoms: Call a POISON CENTER or doctor/physician. IF ON SKIN: Wash with plenty of soap and water. If skin irritation or rash occurs: Get medical advice/attention. Take off contaminated clothing and wash it before reuse. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention. Collect spillage.

Storage

Store locked up.

Disposal

Dispose in accordance with all applicable regulations.

Safety Data Sheet

Material Name: Inert and Hydrogen (HX) Gas Purifier Media **SDS ID:** 0047P

Hazard(s) Not Otherwise Classified

In normal use, as installed and maintained according to product literature, this material in its final form is not expected to be hazardous.

* * *Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS* * *

CAS	Component	Percent
Proprietary	Proprietary	30-40
7440-02-0	Nickel	10-30
1313-99-1	Nickel oxide	20-30
7631-86-9	Silicon dioxide	10-20
1309-48-4	Magnesium oxide	5-10

Component Related Regulatory Information

This product may be regulated, have exposure limits or other information identified as the following: Nickel compounds, Nickel inorganic compounds, Magnesium inorganic compounds.
There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.
Occupational exposure limits, if available, are listed in Section 8.
The chemical identity and/or percentage of composition is being withheld as a trade secret.

* * *Section 4 - FIRST AID MEASURES* * *

Description of Necessary Measures

Inhalation

First aid is not expected to be necessary if material is used under ordinary conditions and as recommended. If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. Get immediate medical attention.

Skin

First aid is not expected to be necessary if material is used under ordinary conditions and as recommended. Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.

Eyes

First aid is not expected to be necessary if material is used under ordinary conditions and as recommended. Flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Then get immediate medical attention.

Ingestion

First aid is not expected to be necessary if material is used under ordinary conditions and as recommended. If swallowed, get medical attention.

Most Important Symptoms/Effects

Acute

respiratory tract irritation, skin irritation, eye irritation, allergic reactions, kidney damage, respiratory system damage

Delayed

allergic reactions, cancer, respiratory system damage

Indication of Immediate Medical Attention and Special Treatment

Treat symptomatically and supportively.

Safety Data Sheet

Material Name: Inert and Hydrogen (HX) Gas Purifier Media **SDS ID: 0047P**

* * *Section 5 - FIRE FIGHTING MEASURES* * *

Suitable Extinguishing Media

Use extinguishing agents appropriate for surrounding fire.

Unsuitable Extinguishing Media

None known.

Specific Hazards Arising from the Chemical

Negligible fire hazard. Avoid generating dust; fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.

Fire Fighting Measures

The media within the housing will remain stable when exposed to ambient temperatures below 79 C (175 F). At temperatures above 79 C (175 F), oxidation will occur. When exposed to excess air and moisture, the oxidation process may generate temperatures high enough to cause combustion. Exposure to atmospheres containing hydrogen and temperatures above 150 C (300 F) will render media pyrophoric. Exposure of the pyrophoric product to air at room temperature will cause ignition.

Special Protective Equipment and Precautions for Firefighters

Wear full protective fire fighting gear including self contained breathing apparatus (SCBA) for protection against possible exposure.

* * *Section 6 - ACCIDENTAL RELEASE MEASURES* * *

Personal Precautions, Protective Equipment and Emergency Procedures

Wear personal protective clothing and equipment. In normal use, as installed and maintained according to product literature, this material in its final form is not expected to be hazardous. Classifications and hazards represented on this Safety Data Sheet are only applicable in the unlikely event that the purifier media is liberated from the purifier housing. The purifier has sieves internal to the housing to prevent the media from escaping during intended use. Avoid release to the environment.

Methods and Materials for Containment and Cleaning Up

Keep unnecessary people away, isolate hazard area and deny entry. Collect spill using a vacuum cleaner with a HEPA filter or wet and scoop up dry spills. Avoid accumulation of airborne dusts. Avoid sweeping spilled dry material. If sweeping of a contaminated area is necessary, use a dust suppressant agent. Eliminate ignition sources including sources of electrical, static or frictional sparks.

* * *Section 7 - HANDLING AND STORAGE* * *

Precautions for Safe Handling

Do not breathe dust. Avoid contact with skin and eyes. Wash thoroughly after handling. Wear protective gloves/clothing and eye/face protection. Wear respiratory protection. Contaminated work clothing should not be allowed out of the workplace. Do not eat, drink, or smoke when using this product. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Avoid significant deposits of material, especially on horizontal surfaces, which may become airborne and form combustible dust clouds and may contribute to secondary explosions.

Conditions for Safe Storage, including any Incompatibilities

Store and handle in accordance with all current regulations and standards. Store locked up. Keep container tightly closed. Store in a well-ventilated place. Store in a cool, dry place. Keep separated from incompatible substances.

Incompatibilities: acids, oxidizing materials

* * *Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION* * *

The following constituents are the only constituents of the product which have a PEL, TLV or other recommended exposure limit. At this time, the other constituents have no known exposure limits.

Safety Data Sheet

Material Name: Inert and Hydrogen (HX) Gas Purifier Media **SDS ID: 0047P**

Component Exposure Limits

Nickel oxide (1313-99-1)

NIOSH: 0.015 mg/m3 TWA (except Nickel carbonyl, as Ni, related to Nickel compounds)

Nickel (7440-02-0)

OSHA (final): 1 mg/m3 TWA
OSHA (vacated): 1 mg/m3 TWA
ACGIH: 1.5 mg/m3 TWA (inhalable fraction)
NIOSH: 0.015 mg/m3 TWA

Silicon dioxide (7631-86-9)

OSHA (final): 20 mppcf TWA; (80)/(% SiO2) mg/m3 TWA
OSHA (vacated): 6 mg/m3 TWA (<1% Crystalline silica)
NIOSH: 6 mg/m3 TWA

Magnesium oxide (1309-48-4)

OSHA (final): 15 mg/m3 TWA (fume, total particulate)
OSHA (vacated): 10 mg/m3 TWA (fume and total particulate)
ACGIH: 10 mg/m3 TWA (inhalable fraction)

Component Biological Limit Values

There are no biological limit values for any of this product's components.

Appropriate Engineering Controls

Provide local exhaust or process enclosure ventilation system. Ensure that dust-handling systems (such as exhaust ducts, dust collectors, vessels, and processing equipment) are designed in a manner to prevent the escape of dust into the work area (i.e., there is no leakage from the equipment). Ensure compliance with applicable exposure limits.

Individual Protection Measures, such as Personal Protective Equipment

Eyes/Face Protection

Wear safety glasses. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

Skin Protection

Wear appropriate chemical resistant clothing.

Glove Recommendations

Wear appropriate chemical resistant gloves.

Respiratory Protection

SCBA with full face piece should be available in case of emergency.

* * *Section 9 - PHYSICAL AND CHEMICAL PROPERTIES* * *

Physical State:	Solid	**Appearance:**	black / tan solid
Color:	black / tan	**Physical Form:**	solid
Odor:	odorless	**Odor Threshold:**	Not available
pH:	Not available	**Melting/Freezing Point:**	Not available
Boiling Point:	Not applicable	**Flash Point:**	Not flammable
Decomposition Temp.:	Not available	**Evaporation Rate:**	Not available
LEL:	Not available	**UEL:**	Not available
Vapor Pressure:	Not applicable	**Vapor Density (air = 1):**	Not applicable
Density:	Not available	**Water Solubility:**	Not available
Log Kow:	Not available	**Auto Ignition Temp.:**	Not available
Viscosity:	Not available	**Volatility:**	Not available
Coefficient of Water/Oil Dist:	Not available	**Flammability (solid, gas):**	Not flammable

Safety Data Sheet

Material Name: Inert and Hydrogen (HX) Gas Purifier Media **SDS ID: 0047P**

Other Property Information

No additional information is available.

* * *Section 10 - STABILITY AND REACTIVITY* * *

Reactivity

No dangerous reaction known under conditions of normal use. Media is generally considered stable when housed inside purifier body or when properly installed in Entegris Gas Systems. Media will react with air and high concentrations of oxygen to produce heat.

Chemical Stability

Stable at normal temperatures and pressure.

Possibility of Hazardous Reactions

Will not polymerize.

Conditions to Avoid

Avoid accumulation of airborne dusts. Avoid heat and humidity. Avoid contact with incompatible materials.

Incompatible Materials

acids, oxidizing materials

Decomposition Products

miscellaneous decomposition products

* * *Section 11 - TOXICOLOGICAL INFORMATION* * *

Acute and Chronic Toxicity

In normal use, as installed and maintained according to product literature, this material in its final form is not expected to be hazardous.

Component Analysis - LD50/LC50

The components of this material have been reviewed in various sources and the following selected endpoints are published:

Nickel oxide (1313-99-1)

Oral LD50 Rat >5000 mg/kg

Nickel (7440-02-0)

Oral LD50 Rat >9000 mg/kg

Silicon dioxide (7631-86-9)

Dermal LD50 Rabbit >2000 mg/kg; Inhalation LC50 Rat >2.2 mg/L 1 h; Oral LD50 Rat >5000 mg/kg

RTECS Acute Toxicity (selected)

The components of this material have been reviewed and RTECS publishes no data as of the date on this document.

Information on Likely Routes of Exposure

Inhalation

irritation, allergic reactions, respiratory system damage, cancer

Ingestion

gastrointestinal irritation

Skin Contact

irritation, allergic reactions

Eye Contact

irritation

Immediate Effects

respiratory tract irritation, skin irritation, eye irritation, allergic reactions, kidney damage, respiratory system damage

Safety Data Sheet

Material Name: Inert and Hydrogen (HX) Gas Purifier Media **SDS ID: 0047P**

UN/NA #: UN3190 **Hazard Class:** 4.2 **Packing Group:** II
Required Label(s): 4.2

Component Marine Pollutants (DOT)

This material does not contain any chemicals listed on the Hazardous Materials Table required by US DOT to be identified as a marine pollutant.

IATA Information

Shipping Name: Self-heating solid, inorganic, n.o.s. (Contains: Nickel mixture)
UN #: UN3190 **Hazard Class:** 4.2 **Packing Group:** II
Required Label(s): 4.2

IMDG Information

Shipping Name: Self-heating solid, inorganic, n.o.s. (Contains: Nickel mixture)
UN #: UN3190 **Hazard Class:** 4.2 **Packing Group:** II
Required Label(s): 4.2

Component Marine Pollutants (IMDG)

This material does not contain any chemicals listed in Chapter 3.2 - Dangerous Good List - required by IMDG to be identified as a marine pollutant.

Marine Pollutant(s) based on 2.9.3 of the UN Model Regulations

NICKEL, NICKEL OXIDE

* * *Section 15 - REGULATORY INFORMATION* * *

Component Analysis

U.S. Federal Regulations

This material contains one or more of the following chemicals required to be identified under SARA Sections 302/304 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65), CERCLA (40 CFR 302.4), TSCA 12(b), and/or require an OSHA process safety plan.

Nickel oxide (1313-99-1)

SARA 313: 0.1 % de minimis concentration (related to Nickel compounds)

Nickel (7440-02-0)

SARA 313: 0.1 % de minimis concentration
CERCLA: 100 lb final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm); 45.4 kg final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm)

SARA 311/312 Hazardous Categories

Acute Health: Yes **Chronic Health:** Yes **Fire:** No **Pressure:** No **Reactive:** No

U.S. State Regulations

The following components appear on one or more of the following state hazardous substances lists:

Component	CAS	CA	MA	MN	NJ	PA
Nickel oxide (*related to: Nickel compounds)	1313-99-1	Yes*	Yes	No	Yes	Yes
Nickel	7440-02-0	Yes	Yes	Yes	Yes	Yes
Silicon dioxide	7631-86-9	Yes	Yes	Yes	Yes	Yes
Magnesium oxide	1309-48-4	Yes	Yes	Yes	Yes	Yes

The following statement(s) are provided under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65):

Safety Data Sheet

Material Name: Inert and Hydrogen (HX) Gas Purifier Media **SDS ID: 0047P**

WARNING! This product contains a chemical known to the state of California to cause cancer.

U.S. Inventory (TSCA)

All the components of this substance are listed on or are exempt from the TSCA inventory listing.

Component Analysis - Inventory

Component	CAS	US
Proprietary	Proprietary	No
Nickel oxide	1313-99-1	Yes
Nickel	7440-02-0	Yes
Silicon dioxide	7631-86-9	Yes
Magnesium oxide	1309-48-4	Yes

EU - REACH (1907/2006) - Article 59(1) Candidate List of Substances for Eventual Inclusion in Annex XIV

No component(s) of this material are listed.

EU - REACH (1907/2006) - Annex XIV List of Substances Subject to Authorisation

No component(s) of this material are listed.

EU - REACH (1907/2006) - Annex XVII Restrictions of Certain Dangerous Substances, Mixtures and Articles

Nickel oxide (1313-99-1)

Use restricted. See item 28.

Nickel (7440-02-0)

Use restricted. See item 27.

* * *Section 16 - OTHER INFORMATION* * *

NFPA Ratings: Health: 2 **Fire:** 0 **Reactivity:** 0

Hazard Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

New SDS: 5/11/2015

Key / Legend

ACGIH - American Conference of Governmental Industrial Hygienists; ADR - European Road Transport; BOD - Biochemical Oxygen Demand; C - Celsius; CAS - Chemical Abstracts Service; CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act; DFG - Deutsche Forschungsgemeinschaft; DOT - Department of Transportation; EEC - European Economic Community; EINECS - European Inventory of Existing Commercial Chemical Substances; EPA - Environmental Protection Agency; EU - European Union; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; ICAO - International Civil Aviation Organization; IMDG - International Maritime Dangerous Goods; Kow - Octanol/water partition coefficient; LEL - Lower Explosive Limit; LOLI - List Of Lists™ - ChemADVISOR's Regulatory Database; MAK - Maximum Concentration Value in the Workplace; MEL - Maximum Exposure Limits; NFPA - National Fire Protection Agency; NIOSH - National Institute for Occupational Safety and Health; NJTSR - New Jersey Trade Secret Registry; NTP - National Toxicology Program; OSHA - Occupational Safety and Health Administration; RCRA - Resource Conservation and Recovery Act; RID - European Rail Transport; RTECS - Registry of Toxic Effects of Chemical Substances®; SARA - Superfund Amendments and Reauthorization Act; STEL - Short-term Exposure Limit; TSCA - Toxic Substances Control Act; TWA - Time Weighted Average; UEL - Upper Explosive Limit; US - United States

Other Information

VCR is a registered trademark of Swagelok Company.

Safety Data Sheet

Material Name: Inert and Hydrogen (HX) Gas Purifier Media **SDS ID: 0047P**

Disclaimer

The information in this (Material) Safety Data Sheet ("(M)SDS") is believed to be current and accurate as of the time of shipment of the product by Entegris. Entegris makes no warranties, express or implied, with respect to such information, including, without limitation, the implied warranties of merchantability and fitness for a particular purpose. Entegris assumes no liability for any loss or injury which may result from the use of the information contained in this (M)SDS. The chemical, physical and toxicological properties of the Entegris product described in this (M)SDS have not been thoroughly investigated. Users are responsible for exercising due care in using the Entegris product, and for conducting their own investigation to determine whether the product is fit for their particular purpose and suitable for their method of use or application. It is the user's responsibility to ensure that its activities comply with all applicable laws and regulations. Entegris is a registered trademark of Entegris Inc. or an affiliated company.

End of Sheet 0047P

10 Warranty

Servomex warrants each instrument it manufactures 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 (1) year from delivery to the carrier and found, to the Seller's satisfaction, to have been so defective.

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.

Index

Appendix A – Hydrogen Safety System

The **Hydrogen Safety System** is designed to safeguard the DF-760E from explosion hazards when operating on hydrogen sample gas under normal pressure and flow conditions as described in this manual. The instrument chassis and the remote pump, if equipped, are both protected by maintaining a safe condition within their respective enclosures.

If equipped with this option at the time of shipment from the factory, the analyzer will be set for Hydrogen operation through the GSF screen, and the Hydrogen Safety System will automatically be enabled.

Instrument

- **Air circulation fans** pull air in through the front door (and vent through the rear) of the chassis. The fans are rated at 50 cfm (130 cfm max) which will maintain the internal chassis space below the lower explosive limit (LEL)[1].
- **Sample delivery interlock valve** blocks the flow of sample gas from entering the instrument chassis under various conditions as described below. It consists of a normally closed pneumatically actuated UHP springless diaphragm valve positioned on the sample inlet bulkhead.
- **Analyzer case purge valve** introduces nitrogen purge flow into the chassis upon closure of the sample delivery interlock valve. It consists of a normally open pneumatically actuated valve which feeds a customer supplied and regulated source of nitrogen purge gas through a bulkhead on the rear of the cabinet. [2]
- **Instrument controls and logic**[3] default, manage and actuate the above-mentioned components to maintain safe operating conditions.

Vacuum Pump

- If equipped with a vacuum pump, an enclosure equipped with a nitrogen case purge is provided to maintain a safe condition. In addition, an interlock is provided to detect and react to loss of Nitrogen purge flow. See **Figure 159** on page 178.

Installation

If equipped with this safety system, the analyzer installation procedure is modified as follows:

- If the analyzer has the optional vacuum pump, the pump enclosure must be mounted to a nearby wall or inside the rack shared by the analyzer. See **Figure 159** on page 178.
- The sample gas inlet connection is made to an interlock valve mounted at the sample gas inlet on the rear of the analyzer. The installation of this option changes the sample inlet connection to female VCR, from male.
- The sample gas outlet is connected by a ¼ inch metal tube from the analyzer sample outlet to the aspirator. If the analyzer has the optional vacuum pump, the sample gas outlet is connected by a ¼ inch metal tube from the analyzer sample outlet to the needle control valve (supplied loose), and then to the sample inlet on the pump enclosure.
- A customer supplied and regulated source of nitrogen purge gas is connected to both the ¼ inch compression fitting on the case purge valve mounted on the rear of the analyzer, and, if

equipped with the vacuum pump, to the 1/8-inch compression purge inlet fitting on the vacuum pump enclosure. Using the customer supplied regulator, adjust the flow into both enclosures to approx. 30 scfh as indicated on a rotameter.

- If required, the pump enclosure sample outlet and/or analyzer sample outlets need to be connected by ¼ inch metal tube and compression fittings to an appropriate exhaust system.
- The pump power cord is connected from the rear of the analyzer to the rear of the pump enclosure.

Operation

- Before power is applied to the analyzer, the moisture cell is isolated as the internal inlet and outlet valves are closed. In addition, the external sample interlock valve is closed, and the case purge valve is opened, allowing customer supplied and regulated Nitrogen gas to purge the analyzer cabinet.

  When power is applied, and only after the system has verified proper exhaust fan operation, the system automatically opens the external sample interlock valve to enable gas flow and the case purge valve is closed.

  NOTE: The backflow prevention screen (**Figure 20)** will be displayed and the user must hit **ESC** to acknowledge the screen and remove it.

  After approx. 5 minutes, the Warming Up indication will disappear, and the user is then free to open the internal inlet and outlet valves to the moisture cell.

- On analyzer shutdown, or in the event of a power failure or fan failure, the moisture cell is automatically isolated with internal valves, the external sample interlock valve closes to block sample flow from entering, and the purge valve opens to allow Nitrogen purge into the analyzer enclosure.

- The pump case purge system continuously feeds a customer-regulated supply of nitrogen into the pump enclosure to: (1) maintain the hydrogen level well below the maximum safe level (4% for hydrogen) if the pump diaphragm fails and leaks sample gas into the enclosure; and (2) maintain appropriate flow for adequate pump cooling. The purge flow rate is set to 30 scfh as indicated on a rotometer mounted on the side of the pump enclosure. An in-line flow switch will trip at a flow rate of less than 26 scfh assuring adequate flow. Loss of purge flow breaks the contacts in the flow switch, which in turn trips a mercury relay that removes electrical power to the pump.

CAUTION

The purge flow out of the pump enclosure may contain sample gas and should be appropriately vented.

CAUTION

After passing through the moisture cell and orifice, the sample is under vacuum and any leak in the system would result in ingress of ambient rather than release of sample gas to ambient. Accordingly, the sample outlet should be vented appropriately to assure adequate dilution.

CAUTION

The Hydrogen Safety System is designed to be safe as provided by the factory when operating as described in the Operating Instruction Manual. DO NOT make additional penetrations in the enclosure. If there is a need to do so, please contact the factory. Additional penetrations made in the enclosure (or failure to properly fasten the enclosure door) will allow additional influx of ambient oxygen and may defeat the case purge safety mechanism. A pressure relief valve is installed to prevent over-pressurization of the enclosure.

CAUTION

Do not open the pump enclosure door unless AC power is shut off.

CAUTION

The operator is obligated to ensure proper operation of the analyzer air flow system as designed. Do not impede air flow at the inlet in the front door or at the exhaust fan outlets on either side of the cabinet in the rear.

NOTES

[1] For hydrogen, which has a lower explosive limit (LEL) of 4%, the maximum allowable influx in event of an internal leak would be 120 scfh, whereas the normal flow as defined in the Operating Instruction Manual is about 1/10th that at approximately 14 scfh.

[2] Use of the analyzer case purge is at the customer's discretion. It is not necessary since in the event of sample delivery interlock, the sample feed is blocked from entering the chassis and the only open flow path through the system is dissipation of remaining sample in the bypass, which would be vented externally, or in the event of an internal leak, would be volumetrically insignificant.

[3] The pneumatic control for the sample interlock and case purge valves is provided by an internal 12 VDC solenoid.

NOTE: On the DF-760E only, Relay 8 has been permanently designated for this safety system and is not available to the end user for assignment to alarms.

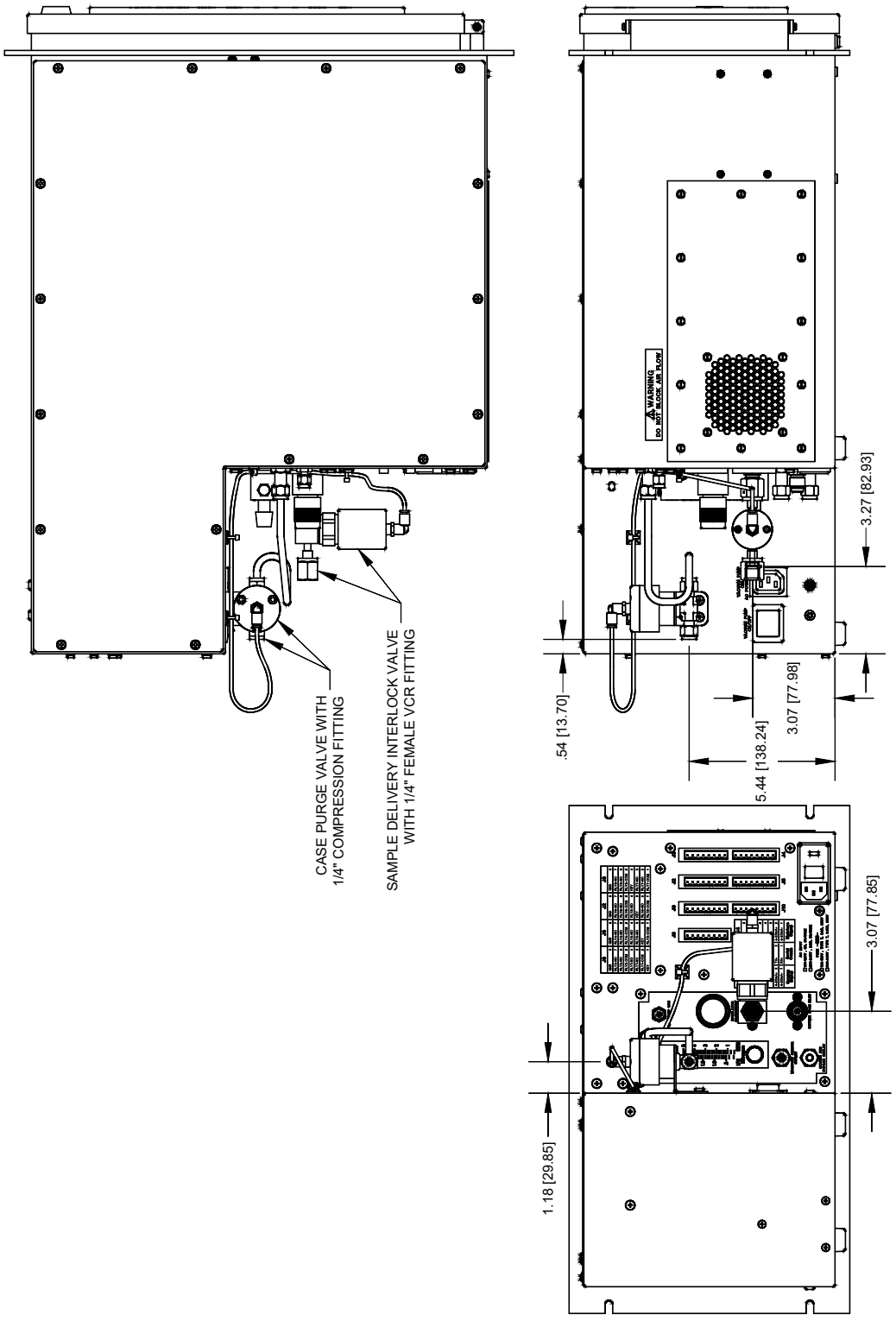


Figure 158: Hydrogen Safety System

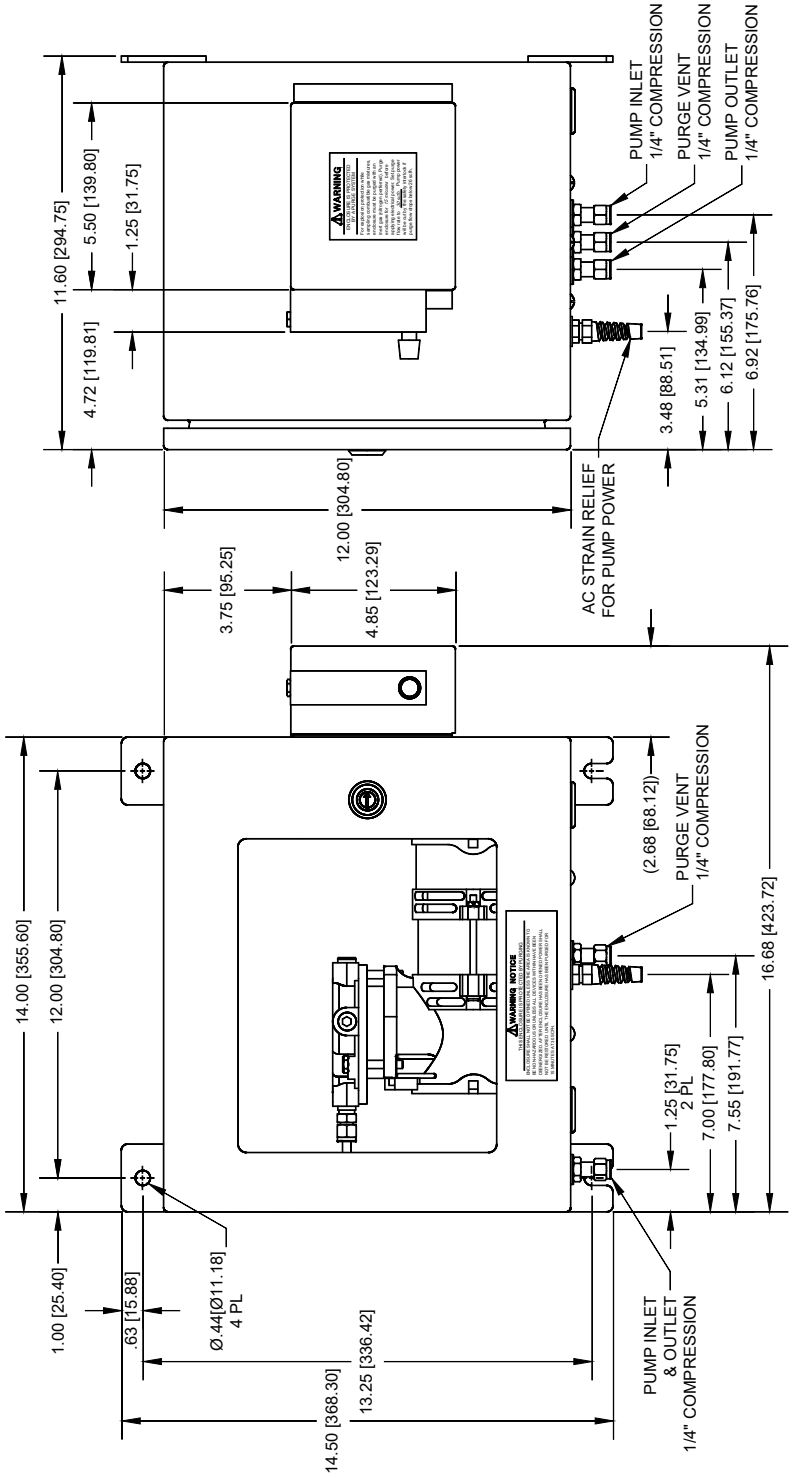


Figure 159: Pump Purge Option

Appendix B – NanoTrace DF-700 Series Moisture Analyzers Serial Digital Communication Protocol Programming Guide

***NOTE**: For questions about the information in this guide, contact Servomex Customer Service.*

This guide assumes a user has a basic understanding of binary/hexadecimal system and a programming background. You cannot use the Hyper Terminal program in Microsoft Windows to talk to our analyzers. There is a diagnostic utility ("NTCommD.exe") available upon request to facilitate troubleshooting and to assist in programming.

Table of Contents:

0. Introduction

Servomex DF digital communication protocol messages are mainly in binary format, unless stated otherwise. The main reasons for using binary format, instead of ASCII text format are:

1) to ensure data integrity,
2) to improve communication efficiency and
3) to support multi-drop communication in a RS-485 loop

The disadvantage is that a terminal program, like the Hyper Terminal that comes with Microsoft Windows operating system, cannot communicate with a DF analyzer in a comprehensible way.

Data integrity is important particularly in a multi-drop RS-485 loop. A host computer communicates with multiple analyzers via a serially connected loop. Without a mechanism to ensure its data integrity, a host message may not reach an intended unit, may reach beyond an intended unit, may be corrupted, a reply may or may not be from an intended unit or a reply is from an intended unit but for a different command. For DF communication protocol, data integrity is ensured by using an embedded Checksum with every message, and an echoed ID and command numbers in every reply message. Checking them serves as an indicator whether a command is successful.

A NanoTrace Dual DF-760E consists of a moisture and an oxygen sensor. Each sensor must be configured with a unique 485 ID.

Some commands are backward compatible to our oxygen-only analyzers if the commands share the same syntax.

1. Protocol

All numbers are in binary format, unless stated otherwise. For convenience, binary is represented in hexadecimal.

1 Computer (Host) command format:

<01><ID#><Cmd><Bytes><Data>...<Data><MsCheckSum><LsCheckSum><CR>

where:
< > - represents one byte
01 = 01, constant preamble to identify a computer command
ID# = ID number of intended analyzer (1-255)
Cmd = Command Number
Bytes = Number of data byte (128 max)
Data...Data = Data bytes; either in binary or ASCII text format
MsCheckSum = Most significant byte of message checksum (checksum includes ID# through last Data byte)
LsCheckSum = Least significant byte of message checksum
CR = Carriage return - constant synchronization terminator

2 Analyzer (Slave) response format:

<02><ID#><Cmd><Bytes><Data>...<Data><MsCheckSum><LsCheckSum><CR>

where:
< > - represents one byte
02 = 02, constant preamble to identify an analyzer reply
ID# = ID number of analyzer (echoed from a computer command) **Cmd**
= Command number (echoed from a computer command) **Bytes** =
Number of data byte (128 max)
Data...Data = Data bytes
MsCheckSum = Most significant byte of message checksum (checksum includes ID# through last Data byte)
LsCheckSum = Least significant byte of message checksum
CR = Carriage return - constant synchronization terminator

2. Table of Commands

Notation:

fl.: IEEE floating point format.
*: additional description available. V: variable length

Command name	Cmd #	Bytes	Reply	700 only	Description
Status Request*	0	0	3		get status
Get ppb*	1	0	4 (fl)		get averaged ppb reading
Get FS	2	0	4 (fl)		get device full scale in ppm
Get Temp	3	0	4 (fl)		get averaged temp; O2: sensor, H2O: cell
Get version	7	0	4 (fl)		get firmware version
Get model*	13	0	13		get analyzer model
Get serial No	15	0	16		get unit serial number string
Get ppb in text*	24	0	10		get ppb reading in ASCII text
Aout Range*	32	V	0		get/set analog output range
Alarms*	33	V	0		get/set alarm
GSF*	34	V	0		get/set the Gas Scale Factor
Do user Cal*	40	V	0		do a user calibration
Abort cal	41	0	0		abort command 40 in progress
Accept a Cal	42	0	0		accept a manual calibration data
Watchdog Status	67	0	4 (fl)	y	get watchdog delay timer in mS = 0002 BF20 = 180000
Prepare Log*	100	V	0	y	compile a history log
Download Log*	101	V	V	y	download a history log
Get H2O Data*	102	0	15	y	get H2O data: Status/ppb/Pcell/RmTemp
System Controls*	103	4	0	y	send a system control
Write Info*	126	V	0	y	select a background gas; send a reboot request
Read Info*	127	0	V	y	get the current background gas

3. RS-232/RS485 Wiring

Parameters are 8N1, (8 bits, no parity, one stop bit).

For using the RS-232C option, connect the unit directly to an RS-232C port at the PC. The RS-485 option requires that the PC have either an internal RS-422/485 interface board or an external RS-232C to RS-485 converter.

Only three wires are required for the RS-232C interface. The RTS and CTS lines are not used.

RS-232

Analyzer COMM Connector J15 on analyzer	to Personal Computer	
pin	Female DB9 connector	Female DB25 connector
1 RXD	**3**	**2**
2 TXD	**2**	**3**
3 RTS (not used)		
4 CTS (not used)		
5 RXD- (not used)		
6 (not used)		
7 TXD- (not used)		
8 GND	**5**	**7**

It is recommended that the wire length not exceed 30 feet. Wire size can be anything larger than #26 AWG.

RS-485

For RS-485, the analyzer has been configured for a four-wire, full duplex interface. A recommended wire for RS-485 communications is #20 AWG twisted pair. Do not exceed 4000 feet. Connect the RS- 485 wiring as follows:

Analyzer COMM Connector J15 on analyzer	to RS-485 interface
1 RXD	**TXD+**
2 TXD	**RXD+**
3 RTS (not used)	
4 CTS (not used)	
5 RXD-	**TXD-**
6 (not used)	
7 TXD-	**RXD-**
8 GND	

4. Serial Digital Communication Timing

Readings (i.e., ppb, temperature, ...) in either a dual or a moisture only model, are updated about every two seconds. A PC can generally expect a reply to a command in less than one second. A two- second timeout is recommended for receiving a reply. The delay interval between consecutive commands is recommended at minimum 300 ms. If a command syntax is correct, but an analyzer is unable to perform the command either because it is invalid or an analyzer is busy, it will set the MS bit of the CMD byte (command number) in its return string. If the command syntax is incorrect (wrong Bytes, ID, Checksum etc.) an analyzer will not reply.

If a PC sends out a command at 1 Hz rate, the actual perceived communication rate to any unit in a 485 multi-unit loop is 1 Hz, independent of the number of units. This is the nature of a multi-drop 485 serial communication. A unit in a multi-drop loop must check all the traffic (commands/replies) to know the destination of messages. That is the significance of the "**constant preamble**" and "**ID**". The preamble tells if a message originates from a PC host or an analyzer slave. The ID tells the destination.

5. Command Description and Examples

Command 0 : Status Request Command 1 : Get ppb Command 13 : Get Model
Command 32 : Analog Output Range Command 33 : Alarms
Command 34 : GSF
Command 40 : User Calibration

Command 67 : Watchdog Timer Delay

Command 100: Prepare Log Command 101: Download Log Command 102: Get H2O Data Command 103: Send a System Control

Remote Sample selection **Command 126: Write Info Command 127: Read Info**

Command 0: Status Request

Command	Cmd#	Bytes	Reply	Description
Status Request	**0**	**0**	**3**	**get status**

Byte 2 bit assignment:	Byte 1 bit assignment:	Byte 0 bit assignment:
0 Unit isolated	0 NU	0 Over Range
1 Unreasonable Room Temp	1 NU	1 NU
2 Warm up	2 NU	2 Invalid Data
3 H2O error/O2 sensor off	3 Command Error	3 NU
4 Pres. not in range/No O2 sensor	4 Temperature alarm	4 alarm 1 on
5 In Calibration	5 O2 electrolyte/H2O pres. alarm	5 alarm 2 on
6 NU	6 O2 Flow Alarm/H2O sys. alarm	6 alarm 3 on
7 NU	7 O2 sensor off/H2O NU alarm	7 alarm 4 on

A set (=1) bit is True.
In Calibration: an Auto/Manual Span/Zero is in progress.
When the **Invalid Data** bit is set (=1), the ppb reading is considered not reliable. The **Invalid Data** bit is set when any of bit 0-4 in Byte 2 is set.
The alarms 1-4 are concentration alarms.
Command Error: the last command is invalid. To clear the bit, resend a valid command.

Ex. code in hexadecimal:
Get Status from the ID5 analyzer: 0105 0000 0005 0D
where
01: host (PC) identification, indicating the message from a PC
05: analyzer ID number

00: command number, 0: Get status
00: number of data bytes in the message = 0

0005: Checksum = the byte sum of 05 0000 = 05+00+00
0D: carriage return, marking the end of message

Reply: 0205 0003 0002 0100 0B0D
where
02: slave (analyzer) identification, indicating the message from an analyzer
05: analyzer ID number
00: echoed command number from the host message
03: number of data bytes in message = 3
0002 01: 3 data bytes, indicating that bit 1 in byte 2 and bit 0 in byte 3 are set. The sensor is in isolation and in calibration.
00 0B: CheckSum = the byte sum of 05 0003 0002 01 = 05+00+03+00+02+0l
0D : carriage return, marking the end of message

The ID and Command number are identical to the original host message, and Checksum passes error checking. The success and integrity of the host command and reply messages are confirmed.

Command 1: Get ppb

Command	Cmd#	Bytes	Reply	Description
Get ppb	**1**	**0**	**4 (fl)**	**get ppb reading**

Ex. code in hexadecimal
Get ppb from the ID2 analyzer: 0102 0100 0003 0D
where
01: host (PC) identification, indicating the message from a PC
69: analyzer ID number
01: command number, 1: Get ppb
00: number of data bytes in the message = 0
0003: Checksum = the byte sum of 02 0100 = 02+01+00
0D: carriage return, marking the end of message

Reply: 0202 0104 3CC1 1C2B 014B 0D
where
02: slave (analyzer) identification, indicating the message from an analyzer
02: analyzer ID number
01: echoed command number from the host message
04: number of data byte in message = 4
3CC1 1C2B: 4 data bytes, = 0.024 ppb
014B: Checksum = the byte sum of **02 0104 3CC1 1C2B** = 02+01+04+3C+C1+1C+2B
0D : carriage return, marking the end of message

The ID and Command number are identical to the original host message, and the Checksum passes error checking. The success and integrity of the host command and reply messages are confirmed.

The **3CC1 1C2B** is the representation of ppb reading in single precision IEEE floating point format.

Most programming languages have a built-in function or a type-cast for the conversion. To do it yourself:

IEEE Standard: For 32-bit system (single precision) 1-
bit sign (most significant)
8-bit exponent
23-bit mantissa (least significant)
The value of an IEEE floating point is given as

value = $(-1)^{\textbf{sign}} * 2^{\textbf{(exponent-127)}} * (1.\text{fraction})$ where

fraction = mantissa / 2^{23}

3CC1 1C2B gives sign=0, exponent = 121, mantissa = 4267051

$(-1)^{0} * 2^{(121-127)} * (1+4267051/2^{23}) = 1 * 0.015625 * 1.508672 = 0.024$

Command 13: Get Model Number

Command	Cmd#	Bytes	Reply	Description
Get Model	**13**	**0**	**10**	**get Model**

Byte assignment

0 NU
1 NU
2 Space (Hex 20)
3 Space (Hex 20)
4 Space (Hex 20)
5-8 model string, UTOA (oxygen) and UTHA (moisture)
9 Null (Hex 0)

Command 24: Get ppb in Text

Command	Cmd#	Bytes	Reply	Description
Get ppb in Text	**24**	**0**	**10**	**get ppb reading in ASCII text**

Returned data bytes: 10 bytes fix length Format:
scientific notation "**±1.XXXE±YY**" in ppb
ex. +1.234E+01

Command 32: Analog Output Range

Command	Cmd#	Bytes	Reply	Description
AOut Range	**32**	**V**	**V**	**Set/Read analog (0-10V and 4-20mA) output range**

Data Bytes in ASCII text:
"**AnalyzerModel Mode zero FullScale InCalRelay CalFreeze ExpRangeARelay ExpRangeAFS**

ExpRangeBRelay ExpRangeBFS NULL"
where
AnalyzerModel: **NTOA**: oxygen, **NTHA**: moisture
Mode: S: set; **R**: read settings;
for the read ('**R**') case the remaining parameters in the command are returned
zero: in ppm, the minimum output scale
FullScale: in ppm, the maximum output scale
InCalRelay: 0-4, 0 for no assigned relay, relay for calibration
CalFreeze: 0:Off; 1:On, when on, no analog output update
ExpRangeARelay: 0-4, 0 for no assigned relay **ExpRangeAFS**:
expanded range A full scale in ppm **ExpRangeBRelay**: 0-4, 0 for
no assigned relay **ExpRangeBFS**: expanded range B full scale in
ppm
NULL: string terminator, NUL character

All values must be valid, or the Command Error bit is set in the Status byte. Note that for the analog outputs the **ExpRangeAFS** value must be either 0 or greater than the FS value, **ExpRangeBFS** value must be 0 or greater than **FullScale** and **ExpRangeAFS**. If **ExpRangeAFS** is zero the **ExpA** function is disabled. **ExpB** works the same way. If the ID and AnalyzerModel are inconsistent, the MS bit of the CMD byte in the reply is set.

Ex. Code:

Get **AOut Range** from an oxygen analyzer with a 485 ID 1:
Command:
Hex: 0101 2033 4E54 4841 2052 2030 2E30 3030 3030 3020 302E 3030 3030 3030 2030 2030 2030
2030 2E30 3030 3030 3020 3020 302E 3030 3030 3030 0009 A90D
ASCII: 3NTHA R 0.000000 0.000000 0 0 0 0.000000 0 0.000000
*Note: the characters after the "R" are ignored and do not have to be present.
: non-printable ASCII
Reply:
Hex: 0201 202B 302E 3030 3030 3030 2031 2E30 3030 3030 3020 3020 3020 3020 322E 3030 3030
3030 2030 2033 2E30 3030 3030 3007 EA0D
ASCII: +0.000000 1.000000 0 0 0 2.000000 0 3.000000ê

The reply indicates
zero: 0.0 ppm
FullScale: 1.00 ppm
InCalRelay: 0
CalFreeze: 0
ExpRangeARelay: 0
ExpRangeAFS: 2.00 ppm
ExpRangeBRelay: 0
ExpRangeBFS: 3.00 ppm

Set **AOut Range** from an oxygen analyzer with a 485 ID 1 to:
zero: 0.0 ppm

FullScale: 1.0 ppm
InCalRelay: 2
CalFreeze: 0
ExpRangeARelay: 3
ExpRangeAFS: 0.30 ppm
ExpRangeBRelay: 0
ExpRangeBFS: 10.0 ppm
Command:
Hex: 0101 2033 4E54 4841 2053 2030 2E30 3030 3030 3020 312E 3230 3030 3030 2030 2030 2032
2032 2E35 3030 3030 3020 3020 352E 3030 3030 3030 0009 BB0D
ASCII: 3NTHA S 0.000000 1.200000 0 0 2 2.500000 0 5.000000
Reply:
Hex: 0201 2000 0021 0D

Command 33: Alarms

Command	Cmd#	Bytes	Reply	Description
Set Alarms	**33**	**V**	**0**	**Set/Read alarm thresholds**

Set Data bytes format in ASCII text:
"**AnalyzerModel S AlarmID Alarm# On/Off Relay# Audible** [**LowThreshold HighThreshold Deadband**] **NULL**"
Set Reply: no data bytes
Set Note: for 'O' alarms if the high threshold is larger than low threshold the high value is used for setpoint, and the "trip" is set to "above." If low is larger than high the low value is used for setpoint, and "trip" is set to "below." If the ID and AnalyzerModel are inconsistent, the MS bit of the CMD byte in the reply is set.

Read Data bytes in ASCII text: "**NTOA**
R AlarmID Alarm# NULL"
Read Reply Data bytes:
"**On/Off Relay# Audible** [**LowThreshold HighThreshold Deadband**] **NULL** "
Read Note: the remaining parameters (after 'O' , 'T, 'E' or 'F' and the alarm #) are returned.

Where
AnalyzerModel: **NTOA**: oxygen, **NTHA**: moisture
S: set; **R**: read settings
AlarmID: 1 byte; either O, T, E or F;
O/H: concentration, 4 available alarms; O: O2, H:H2O T:
temperature, 1 available alarm
E: electrolyte for O2, Pressure for H2O, 1 available alarm F: flow for
O2, System Error for H2O, 1 available alarm
Alarm#: 1 byte; 1-4 for O, and 1 for T, E and F
On/Off: 1 byte; 0 for Off, 1 for On alarm
Relay#: 1 byte; 0-4; 0 for no assigned relay; 1..4 corresponds relay 1..4 for H2O; 5..8 for O2

Audible: 1 byte; 0 for Off, 1 for On for
AlarmID= O or T
LowThreshold: in ppm for O; in ºC for T
HighThreshold: in ppm for O; in ºC for T
Deadband: in ppm for O; in ºC for T **NULL**:
string terminator, NUL character
For AlarmID = O, If **HighThreshold** > **LowThreshold**, the **HighThreshold** is the setpoint and the "Trip" is set to "Above". If **LowThreshold** > **HighThreshold**, the **LowThreshold** is the setpoint and the "Trip" is set to "Below".

Refer to **Command 32** for example codes

Command 34: GSF

Command	Cmd#	Bytes	Reply	Description
Set GSF	**34**	**V**	**0**	**Set/Read gas scale factor**

To oxygen Analyzer: Write format Data bytes in ASCII text: "**NTOA S SampleGSF SpanGSF**" Write reply: no data bytes Read format in ASCII text: "**NTOA R**" Read reply: "**SampleGSF SpanGSF** " If the ID and AnalyzerModel are inconsistent, the MS bit of the CMD byte in the reply is set.	To moisture Analyzer: Write format Data bytes in ASCII text: "**NTHA S SampleGSF SpanGSF**" Write reply: no data bytes Read format: "**NTHA R**" Read reply: "**SampleGSF SpanGSF**" If the ID and AnalyzerModel are inconsistent, the MS bit of the CMD byte in the reply is set.

Command 40: User Calibration

Command	Cmd#	Bytes	Reply	Description
User Cal	**40**	**V**	**0**	**activate user calibration**

Data Bytes:
<**Type**><**Mode**><**ppm Span value in ASCII**> **Type**:
0: Span, 1: Zero
Mode: 0: Manual, 1: Auto

Ex1. Auto Span at 7.05 ppm
Data Bytes in hex: **0001 372E 3035**

Ex2. Manual zero

Data Bytes in hex: **0100 30**

Command 67: Read Watchdog Timer Delay

Command	Cmd#	Bytes	Reply	Description
Send a Control	**67**	**0**	**4 (fl) timer delay**	**Read watchdog**

Data byte is an unsigned (4-byte) long integer binary format, the LSB first. The delay is hard coded to 3 minutes.
thus reply data byte = 0002 BF20 = 180000 ms.

Command 100: Prepare Log

Command	Cmd#	Bytes	Reply	DF-760	Description
Prepare Log	**100**	**V**	**V**	**P**	**1. Set: prepare history log for download** **2. Read: status of log file preparation**

Set Data bytes format in ASCII text:
"**AnalyzerModel S MM/DD/YY HH:MM:SS MM/DD/YY HH:MM:SS Sec NULL**"

If the ID and AnalyzerModel are inconsistent, the MS bit of the CMD byte in the reply is set. To

moisture analyzer at ID 1:
Start Date: 06/24/01
Start Hour: 15:0:0 End
Date: 06/25/01 End
hour: 15:0:0 Data
interval: 60 sec
Hex: 0101 642B 4E54 4841 2053 2030 362F 3234 2F30 3120 3135 3A30 3A30 2030 362F 3235 2F30 3120 3135 3A30 3A30 2036 3020 0008 DF0D
ASCII: d+NTHA S 06/24/01 15:0:0 06/25/01 15:0:0 60
Set reply:
no data bytes

Read format:
"**AnalyzerModel R**"
Hex: 0101 642B 4E54 4841 2052 2030 362F 3234 2F30 3120 3135 3A30 3A30 2030 362F 3235 2F30 3120 3135 3A30 3A30 2036 3020 0008 DE0D
ASCII: d+NTHA R 06/24/01 15:0:0 06/25/01 15:0:0 60
*Note: the characters after the "R" are ignored and do not have to be present.
Read reply:
" **MM/DD/YY HH:MM:SS MM/DD/YY HH:MM:SS Sec Msg NULL**"

Hex: 0201 6437 3036 2F32 342F 3031 2031 353A 3030 3A30 3020 3036 2F32 352F 3031 2031 353A 3030 3A30 3020 3630 2036 3031 3620 4259 5445 5320 5245 4144 590B F60D
ASCII: d706/24/01 15:00:00 06/25/01 15:00:00 60 6016 BYTES READY ö

Where
AnalyzerModel: **NTOA** for oxygen, **NTHA** for moisture
MM/DD/YY: log start/end date
HH:MM:SS: log start/end time
Sec: data point interval in seconds, valid value: multiple of 60 seconds
Msg: either "BUSY", "NO FILE" or "XXXX BYTES READY"
BUSY: preparing log
NO FILE: no log file for download
XXXX BYTES READY: log is ready for download
NULL: string terminator, NUL character = ASCII 0

Command 101: Download Log

Command	Cmd#	Bytes	Reply	DF-760	Description
Download Log	**101**	**V starting at Offset**	**V**	**P**	**download 128 bytes from the prepared log file**

Data bytes format in binary: [**4ByteOffset**]
Reply Data bytes:
[**size number of data bytes**]

The command to download the last segment of log file:
0101 6504 0017 0000 0081 0D
The offset is = 0017 0000 in hex = 5888 in decimal. To convert the hex to decimal using a calculator, the hex offset bytes need to be reversed to 0000 1700.

Get history log data (concentration in ppm) from the start of the log file plus the 4-byte offset (msb first). Offset must be less than files size Reported by command 100. The log file starts with a 128-byte header, followed by continuous data points without a delimiter between points. A data point is presented in 4-byte IEEE floating point format. The header details data information, such as origin, timing, etc.

If the ID and Analyzer Model are inconsistent, the MS bit of the CMD byte in the reply is set.

The sample header and first two data points in ASCII:
s/n: ND-00002, type: H2O, start: 6/24/01 3:00 PM, end: 6/25/01 3:00 PM, min/pt: 1, Npts: 1441, Nblks (incl hdr): 47
06/24/2001 15:00:00 1.375E+1
06/24/2001 15:01:00 1.399E+1
The number after date/time stamp is in ppb.

Command 102: Get H2O Data

Command	Cmd#	Bytes	Reply	DF-760	Description
Get H2O Data	**102**	**0**	**15**	**P**	H2O Data: Status_Bytes, ppb, Pcell and Room_Temperature

Reply Data bytes:
[Status_Bytes (3 bytes), ppb (4 bytes), Pcell (4 bytes) and Room_Temperature (4 bytes)]

Data:
Status_Bytes: same as the Command 1 "Status Request"
ppb: same as the Command 1 "get ppb"
Room_Temperature: the temperature in Celsius inside the chassis
Pcell: cell pressure in torr

Command 103: Send a System Control

Command	Cmd#	Bytes	Reply	Description
Send a Control	**103**	**4**	**0**	**Send a control**

Data byte is an unsigned (4-byte) long integer binary format, the LSB first.

Data byte number assignment in decimal (hexadecimal):
65 (0x41): Isolate a sensors (ID dependant)
66 (0x42): Restore sensors Process gas Flow (ID dependant)
67 (0x43): Isolate System (ID independent)
68 (0x44): Restore System Process Gas Flow (ID independent)
70 (0x46): Turn off Oxygen sensor (ID independent)
71 (0x47): Turn On oxygen sensor (ID independent)

Ex. code in hexadecimal
Isolate System: 0102 6704 4300 0000 00B0 0D
where
01: host (PC) identification, indicating the message from a PC
02: analyzer ID number
67: command number, 103: Send a control **04**:
number of data bytes in the message = 0 **4300**
0000: 4 data bytes LSB first
00B0: Checksum = the byte sum of 02 6704 4300 0000 = 02+67+04+43
0D: carriage return, marking the end of message
The example code isolates both H2O and O2 sensors, if so equipped.

Command 126: Write Info

Command	Cmd#	Bytes	Reply	Description
Send a Control	**126**	**V**	**0**	**Write Info**

Functionality: depending on the data byte parameter.

Timing
A new sample name selected via Command 126 will be displayed on the front screen in about 3 seconds. Similarly in about 3 seconds, the new name is available for Command 127 reply.

------ 2017-10-23 background sample gas selection------
Command 126 (HS): Select background sample gas
write info, data bytes are case sensitive for all models, except
745sgMax. To select a background sample gas or a template:
"HS gas_name" or " HS #template".
where HS: function identifier, following H2O background sample name, #: prefix for a template name
Usage: ex. "HS Ar" or "HS
#AIR" Return data byte: 0
Only 745sgMax supports sample mixing via a template. A user-generated template must already exist in the analyzer.
For non-745sgMax, the command is case sensitive, and a gas name must be exact such as He, O2, H2, He, CO2, Ar, HCl, or NH3.

"Remote Sample Selection": write selection (see Cmd 127 to read)

------ as of firmware v6.3.7, 2019-04-22 ------
Command 126 (RB 101): Select background sample gas

write Remote reboot command with: "**RB 101**"
reply Data bytes: if command ok, various with arbitrary data

Command 127: Read Info

Command	Cmd#	Bytes	Reply	Description
Send a Control	**127**	**0**	**v**	**Read Info**

Functionality: depending on the data byte parameter.

"Remote Sample Selection": read selection (see Cmd 126 to write)

Timing
A new sample name selected via Command 126 will be displayed on the front screen in about 3 seconds. Similarly in about 3 seconds, the new name is available for Command 127 reply.

Command 127: read info
To read back the current sample or template name:
"HS": data bytes optional
Usage: "HS" or ""
Return data bytes: various either "gas or template_name" or if previously erroneous Cmd 126, "NOK, gas/template name".

Appendix C – Spares

Replacement part and consumable part numbers for DF 700 series analyzers are provided below. Additional spares are available that are not on this list. Contact your local Servomex representative to order spares. Refer to **Servomex Offices Worldwide** for contact information.

SPARES BASE PACK

This starter pack is recommended with your initial analyzer purchase

Part Number	Description	Qty
DF700_BK_110v	Fuse, 6.3A, SB, 5X20 Littelfuse Main Pwr	2
	Fuse, 1 Amp, Main Internal Pwr Supply	1
	Fuse, 100 mA, H2O Output PCB	2
	Flash Drive, USB, 16 GB, Kingston	1
	Front Door Filter Replacement	1

Part Number	Description	Qty
DF700_BK_220v	Fuse, 3.15A, SB, 5X20 Littelfuse Main Pwr	2
	Fuse, 500 mA, Main Internal Pwr Supply	1
	Fuse, 100 mA, H2O Output PCB	2
	Flash Drive, USB, 16 GB, Kingston	1
	Front Door Filter Replacement	1

Part Number	Description	Qty
DF760_BK_110v	Replenishment Solution 1L	1
	Cap, Sensor Tank, Gold (E Sensors)	1
	Electrolyte Gold	1
	Fuse, 6.3A, SB, 5X20 Littelfuse Main Pwr	2
	Fuse, 1 Amp, Main Internal Pwr Supply	1
	Fuse, 100 mA, H2O Output PCB	2
	Fuse, 100 mA, O2 Output PCB	2
	Flash Drive, USB, 16 GB, Kingston	1
	Front Door Filter Replacement	1

Part Number	Description	Qty
DF760_BK_220v	Replenishment Solution 1L	1
	Cap, Sensor Tank, Gold (E Sensors)	1
	Electrolyte Gold	1
	Fuse, 3.15A, SB, 5X20 Littelfuse Main Pwr	2
	Fuse, 500 mA, Main Internal Pwr Supply	1
	Fuse, 100 mA, H2O Output PCB	2
	Fuse, 100 mA, O2 Output PCB	2
	Flash Drive, USB, 16 GB, Kingston	1
	Front Door Filter Replacement	1

RECOMMENDED SPARES OPTIONS

To maximize uptime over the life of your analyzer

Optional spares compatibility dependent on analyzer configuration – consult your Servomex representative

Part Number	Description
210622	Spec., Universal Keypad DF 700 Series
210588	K767 Rebuild Kit, Ohleiser Corp.
210592	Assembly, Oxygen, Black Gas Purifier
210593	Assembly, Moisture Only, Green Gas Purifier
210595	Hard Drv 80GB Western Digital WD800AAJB
210614	Flowmeter, Dwyer #196085-00
210852	Flowmeter W/VLV, Dwyer #196086-00
210959	Assembly, Pressure Transducer DF700
211278	Pump, Gast Model #LOA-101-HB (120V)
211280	Pump, KNF Neuberger UN726.3ATI 115V/60Hz
211281	Pmp, KNF Mpu1550-N726.0-9.03 230V/50-60Hz
211276	Pump Repair Kit, K726-1ATA, #071817, KNF
211156	Pwr Supply, UTMA,XI125-8 Rev. S,N2 Power
211229	Display, LCD, Sharp#LM64K104

We strongly recommend the use of the Servomex Service manual when installing optional spares to ensure correct repair and maintenance procedures are followed.

Servomex Offices Worldwide

REGIONAL BUSINESS CENTRES

AMERICAS BUSINESS CENTER

Tel: +1 281 295 5800
Fax: +1 281 295 5899
Email: americas_sales@servomex.com

EUROPEAN BUSINESS CENTRE

Tel: +44 1892 603 330
Fax: +44 1892 662 253
Email: europe_sales@servomex.com

ASIA PACIFIC BUSINESS CENTRE

Tel: +86 (0)21 6489 7570
Fax: +86 (0)21 6442 6498
Email: asia_sales@servomex.com

INDIA BUSINESS CENTRE

Tel: +91 22 3934 2700
Fax: +91 22 3934 2701
Email: MEI_sales@servomex.com

MIDDLE EAST BUSINESS CENTRE

Tel: +971 6552 8073
Fax: +971 6552 8074
Email: MEI_sales@servomex.com

GLOBAL TECHNICAL CENTRES

AMERICAS TECHNICAL CENTER

Tel: +1 781 935 4600
USA Toll Free: +1 800 433 2552
Fax: +1 781 938 0531
Email: americas_sales@servomex.com

UK TECHNICAL CENTRE

Tel: +44 1892 652 181
Fax: +44 1892 662 253
Email: europe_sales@servomex.com