



SERVOPRO NANO Trace DF-750/750 Ultra Analyzer Installation and Operator Manual

Part Number: **225485**
Revision: **081922**
Language: **US English**



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.

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This handbook is accurate at the date of printing, but will be superseded and should be disregarded if specifications or appearance are changed.

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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 NANO Trace DF-750/750 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 DF-750 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 NanoTrace DF-750 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 NanoTrace DF-750 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 NanoTrace Analyzer 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 NanoTrace 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, Startup and Shut Down**.

Unlike much UHP analytical equipment, the NanoTrace Analyzer does not require periodic maintenance for its moisture cell or other electronic components. Refer to **8.3 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 power cord ground wire is properly installed in 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 your facility supply.

DANGER



Potentially hazardous AC voltages are present within this instrument. Leave all servicing to qualified personnel. Disconnect the AC power source when installing or removing external connections, the sensor, or electronic 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 a 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-750 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-750 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-750/750 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-750 is shown in **Figure 1**, **Figure 2**, and **Figure 3**.

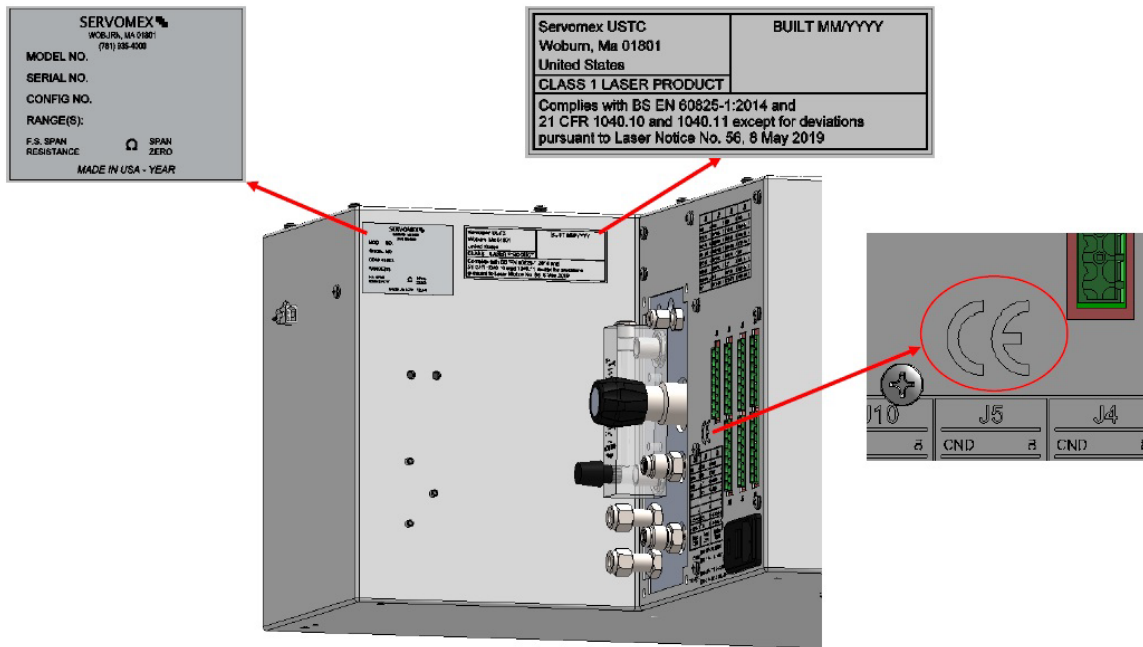


Figure 1: Analyzer Markings Shown in Rear Area View

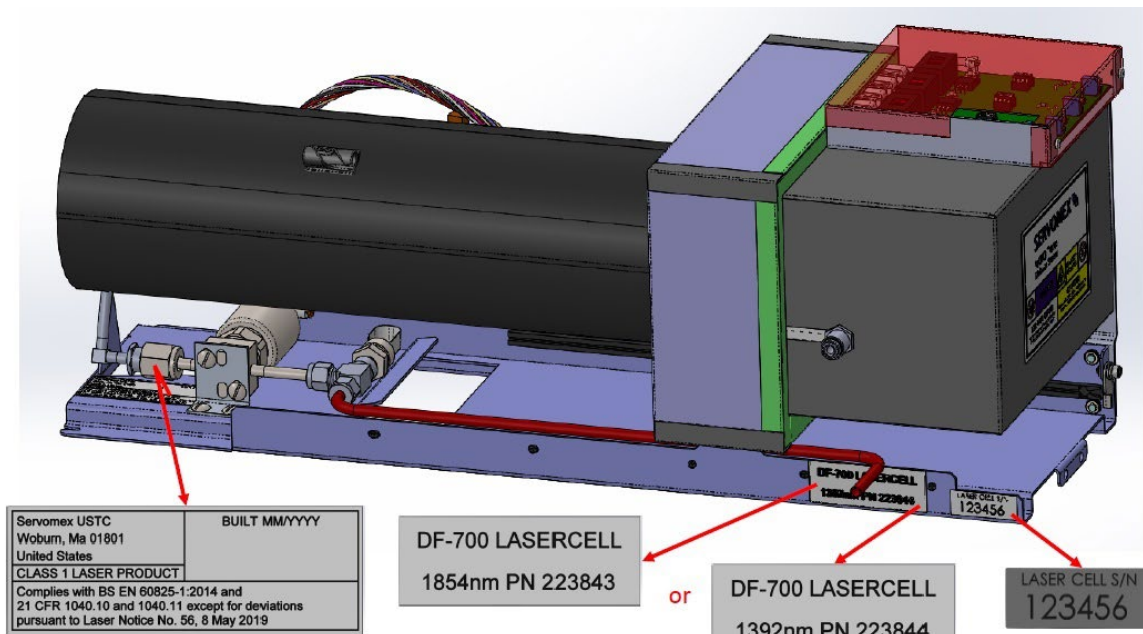


Figure 2: Sensor Markings – Side

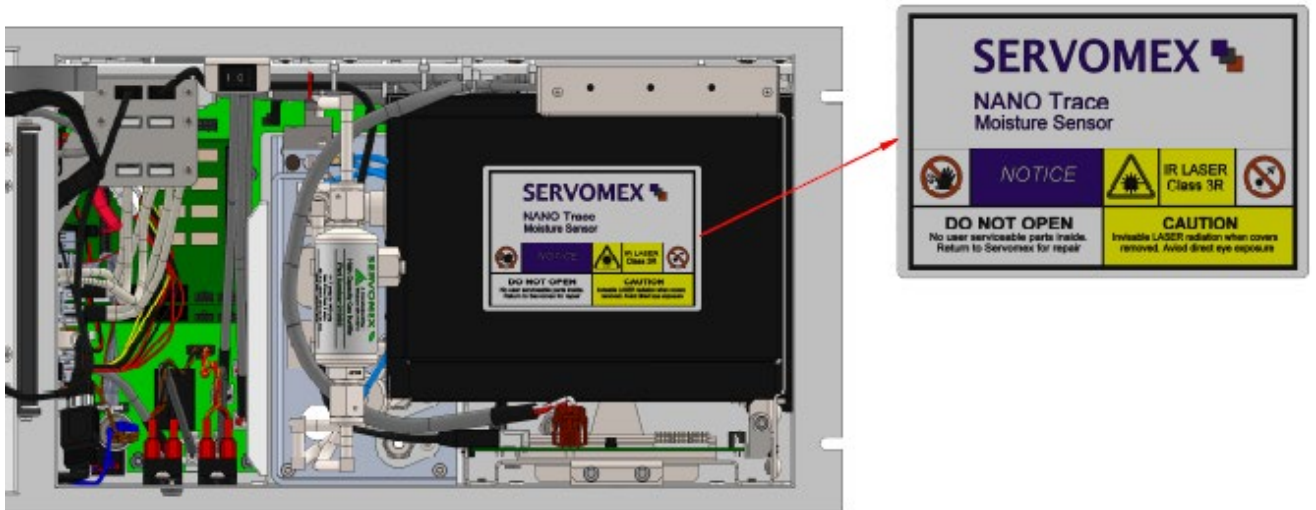


Figure 3: Sensor Marking – Front

2. Introduction

2.1 Product Description

The NanoTrace DF-750 and DF-750 Ultra moisture analyzers are designed for continuous UHP (Ultra High Purity) analysis of moisture 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, gas purifier, valves and plumbing for routing of gasses, 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. A description of the analytical methods used for determining moisture content is provided in **Chapter 9 Theory of Operation**.

The DF-750 and DF 750 Ultra are similar in design, layout, and operation, however, the DF 750 Ultra is capable of greater resolution. 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-750 Analyzer.

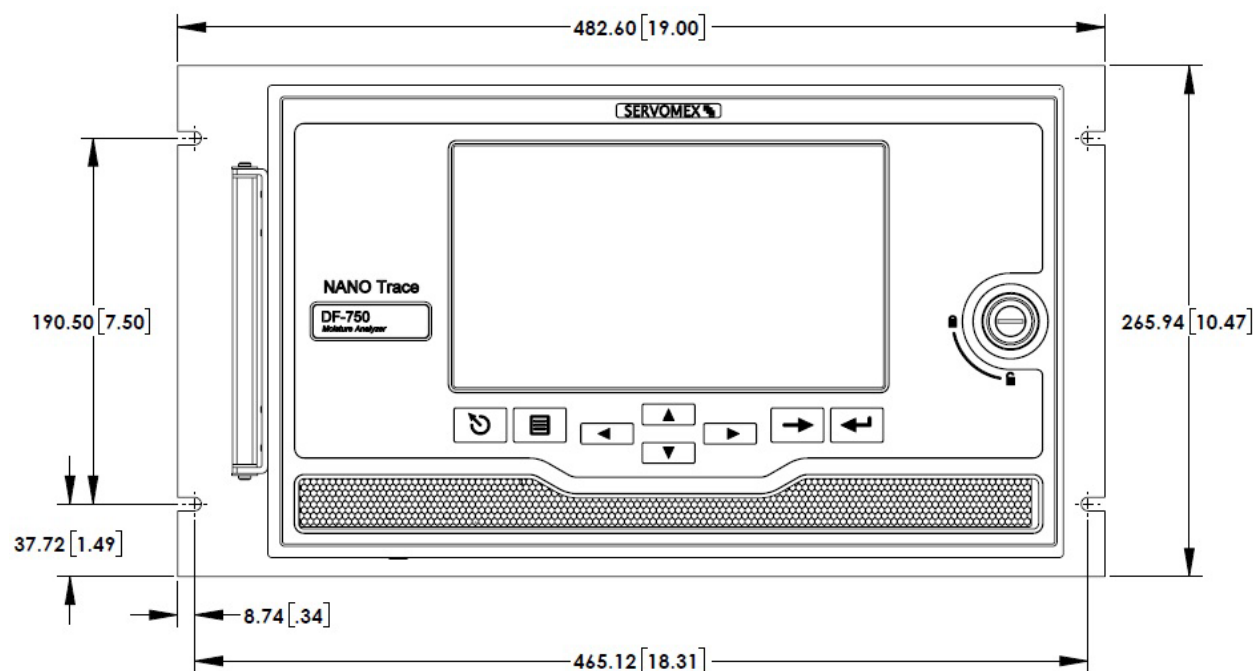


Figure 4: DF-750 Analyzer (front)



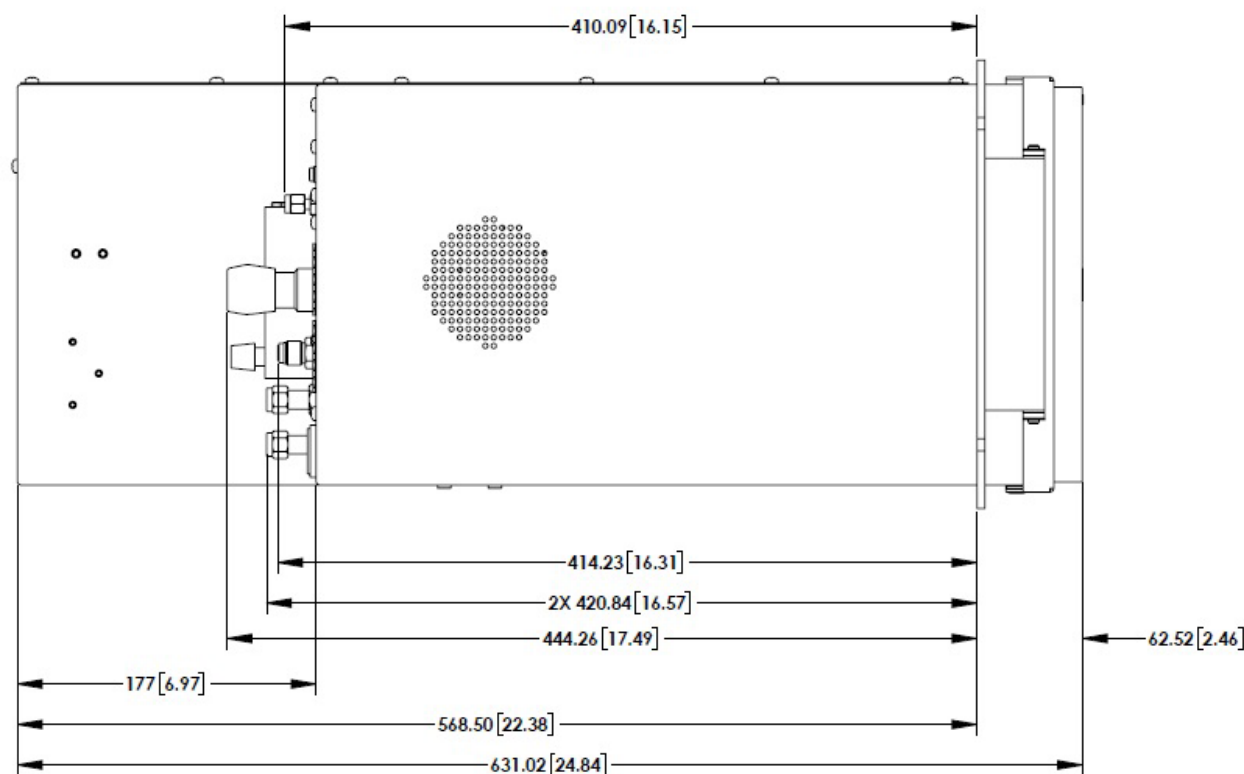


Figure 6: DF-750 Analyzer (left)

2.1.2 Internal Components

The DF-750 Analyzer's major internal components are depicted in **Figure 7**.

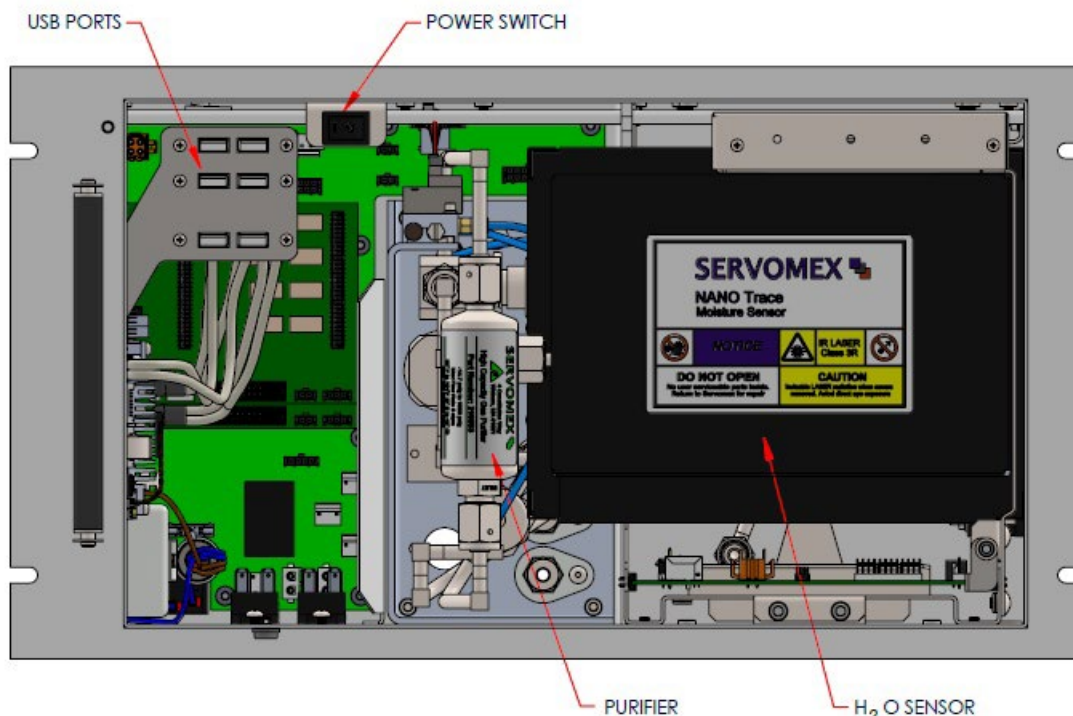


Figure 7: Major Internal Components

2.2 Specifications Summary

A summary of DF-750 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-750: 100 ppt @ Constant Conditions (except with CO₂ background: 250 ppt)

Lowest Detection Level: (LDL) DF-750 Ultra: 55 ppt @ Constant Conditions (except with CO₂ background: 250 ppt)

Resolution: Analytical (Smallest Detectable Change): 100 ppt

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

Background Gas Compatibility: N₂, H₂, He, Ar, O₂, and CO₂

2.2.2 Electrical Requirements

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

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

2.2.3 Laser Specifications

Max Power: 50mW/30mW

Beam Divergence: 436 mrad

Pulse Pattern: CW

Classification: The DF-750/750Ultra analyzer is a Class 1 laser product (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).

2.2.4 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-750 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-750 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
Gasket, VCR	210431
² Aspirator	210566
² Pump (optional)	210972, 120VAC 210973, 220/VAC
Instruction Manual (Provided digitally on USB, Clip Flash Drive p/n 220562)	225486
Quick Start Guide (In digital format and stored on USB, Clip Flash Drive P/N 220562)	NANOTRACE700Q
Notes: ¹ Customer may select US, UK, or EU style power cable when ordering. If other 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.	

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 and, optionally, the vacuum pump.
2. Connecting the N2/Air supply to the aspirator if required.
3. Connecting an exhaust tube to the aspirator or vacuum outlet.
4. Connecting the pneumatic pressure service to the pneumatic inlet fitting.
5. Connecting the sample gas line to the analyzer inlet fitting.
6. Wiring connections to data and relay outputs.
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.

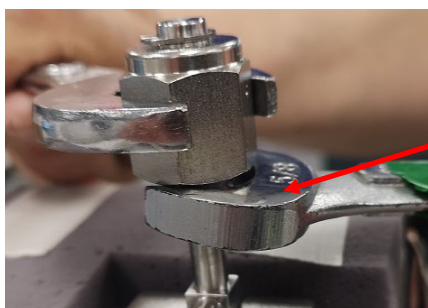


The DF-750 is for indoor use only. It should not be in an area where it will be subjected to particulate, condensed moisture, caustic atmosphere, temperature extremes, or operation outside of any limits listed in **Chapter 10 Specifications**.

1. Position or mount the analyzer in working location (in instrument rack or on shop table) within 8 feet of gas sources.



Use backup wrenches when removing or installing VCR connectors, otherwise torque may be applied to analyzer plumbing and cause damage. Refer to **Figure 8**.



Backup
Wrench

Figure 8: Backup Wrench Use

2. If the analyzer is equipped with the optional Hydrogen Safety System (HSS), install the shut-off valve for the Hydrogen Safety System on the analyzer process gas inlet fitting. Use VCR gasket (see **Figure 9**) at connection point. Refer to **Figure 10** for analyzer gas connection locations.



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



Figure 9: VCR Gasket (with supplied mounting bracket)

3. On HSS-equipped system, connect the stainless-steel sample gas feed to the open end of shutoff valve (not supplied) using VCR gasket. Please note that shutoff valve requires pneumatic pressure to open and allow gas to flow through it.

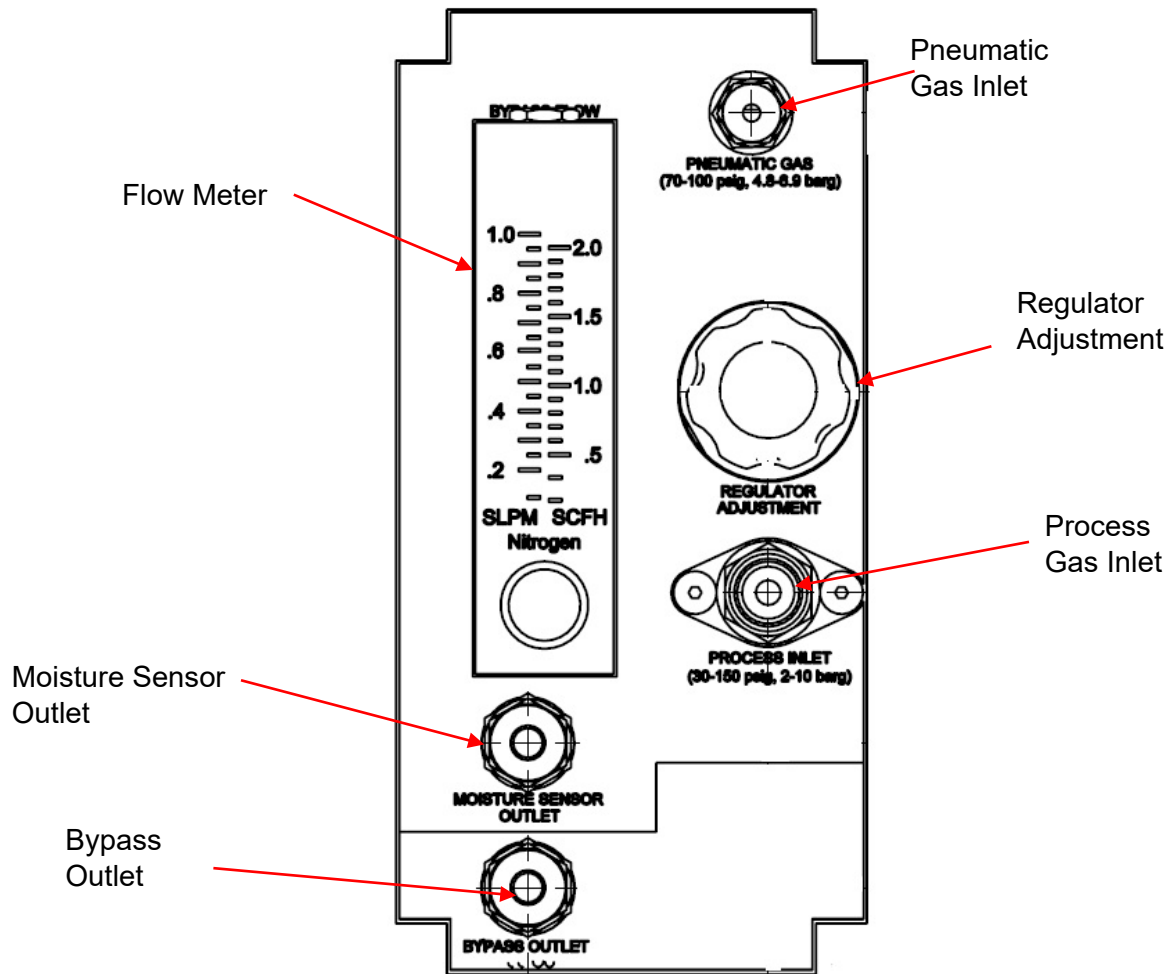


Figure 10: DF-750 Analyzer Gas Panel

4. If the analyzer is not equipped with the optional HSS, connect the stainless-steel sample gas feed to the process gas inlet fitting using VCR gasket.
5. Connect the pneumatic supply to the 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. Refer to **Figure 11**.

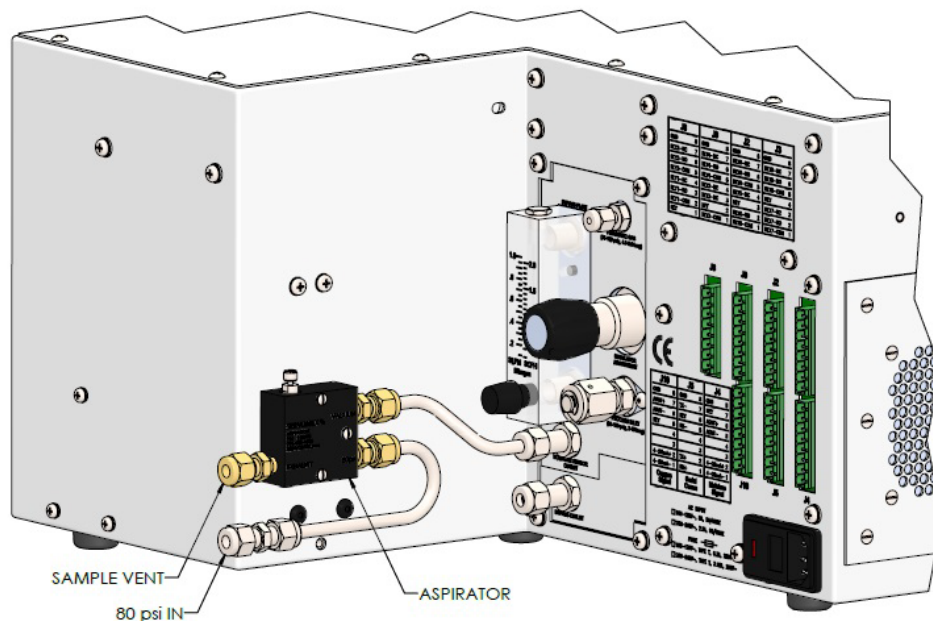


Figure 11: Aspirator Installation

7. 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.



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

8. Connect sample vent line from vacuum pump or aspirator outlet to facility vent.
9. Connect by-pass outlet to facility vent. If system has HSS, by-pass outlet must be stainless-steel.
10. If analyzer has vacuum pump, connect a line from the moisture sample outlet to the pump vacuum control valve (see **Figure 12**). For systems that do not have the HSS, use the provided polyethylene line. For systems with the HSS, use ¼ in stainless-steel line.

11.

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 your facility supply.

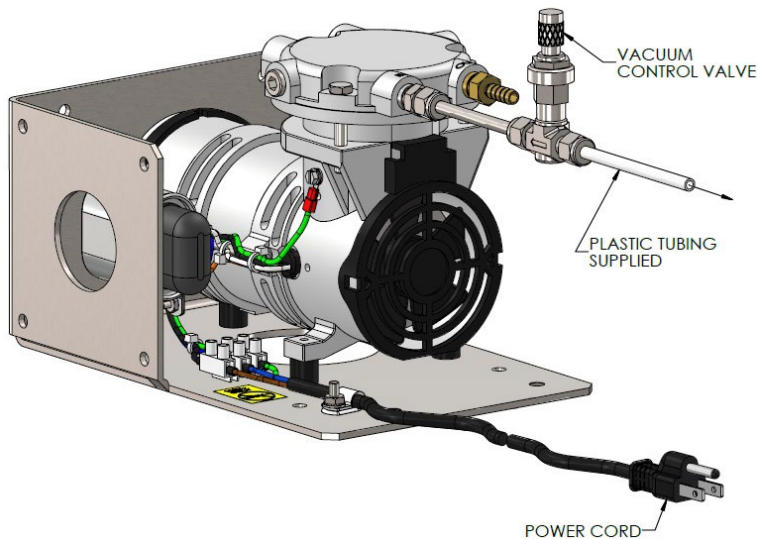


Figure 12: Vacuum Pump Assembly

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 the correct voltage for your facility.



Power cord is supplied for locations using US, UK, or EU style plugs for facility power. For locations using other connectors cord must be 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.

12. Turn on analyzer. Refer to **3.4 Analyzer Startup**.
13. Verify that sample gas is flowing through the bypass flow meter. Inlet pressure of 18_psig (nominal) is required.
14. Allow the sample inlet to purge for at least 10 minutes.
15. After warm-up and purge are complete, establish sample gas flow by pressing the menu key and selecting **Restore Sample Gas Flow** as shown in **Figure 13**.

16. Proceed to **3.4.2 Gas Flow and Pressure Settings** to set gas flow and moisture cell pressure.

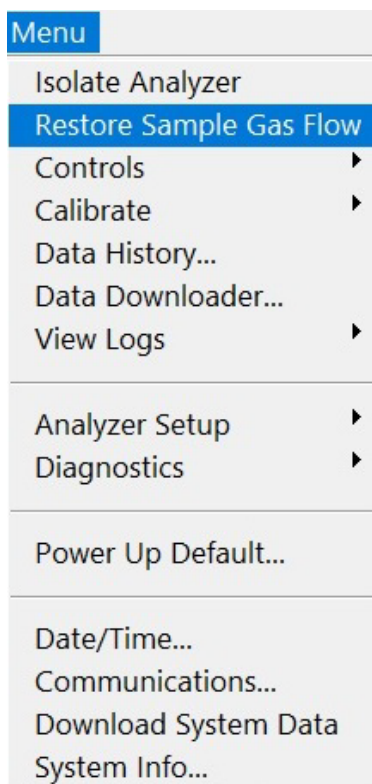


Figure 13: Starting Gas Flow

17. Set sample gas flow and pressure. **Refer to 3.4.2 Gas Flow and Pressure Settings.**

3.4 Analyzer Startup

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 (refer to **Figure 14**.) 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. Refer to **6.3.17 Power Up Default** for setting user selectable preferences at the time of power up.

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.

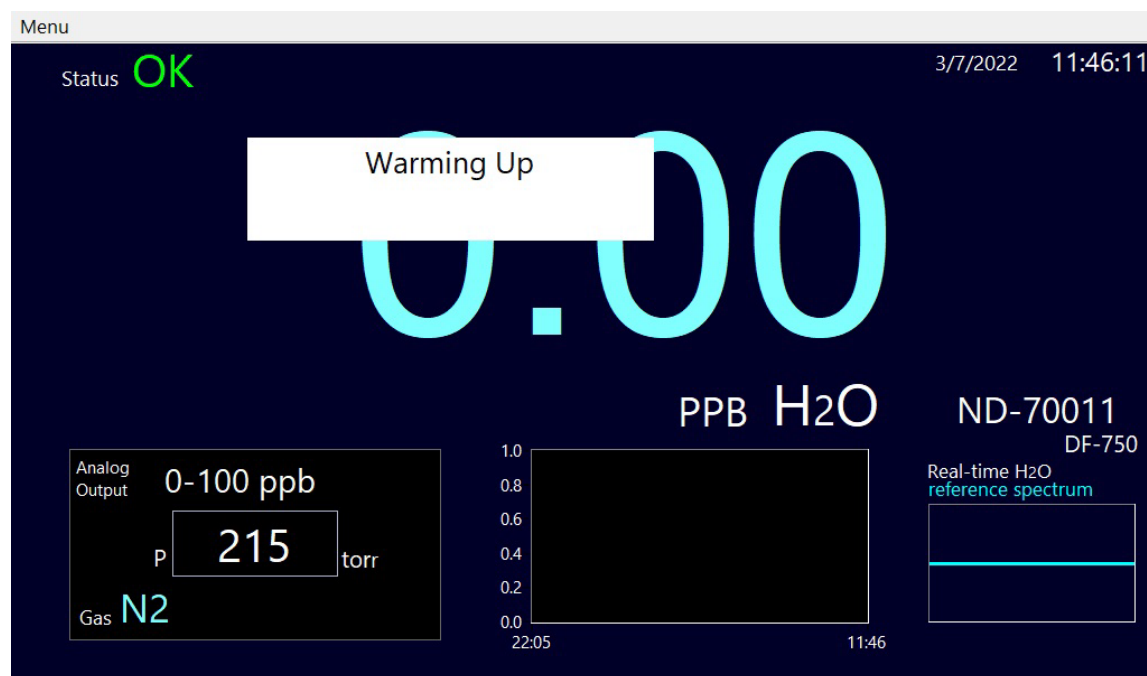


Figure 14: Data Display Screen During Warmup

3.4.1 Gas Flow and Pressure Regulation

The gas delivery system is designed to deliver a gas flow rate of 1 liter per minute to the moisture sensor while maintaining the highest standards of gas purity and delivery for ultra-trace analysis. Proper sample pressure varies with the type of background gas being analyzed. Acceptable ranges for DF-750 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
CO2	130 - 230 Torr	ON

*Vacuum source is removed for Helium.

Table 1: Recommended Sample Outlet Vacuum Pressure

3.4.2 Gas Flow and Pressure 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 disconnected.

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 flowmeter bypass valve to 0.5 SLPM.
4. Purge for 15 minutes before opening 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 **6.3.17 Power Up Default**. If the sensor is in isolation, establish process gas flow by selecting **Restore Sample Gas Flow** on the main menu as shown in **Figure 13**
6. Once flow has been established through the moisture cell, 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.

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

On initial start-up, after the 6-minute warm-up process is complete, the moisture analyzer will take a few hours to equilibrate, and the concentration of moisture is automatically shown in parts per million (ppm) or parts per billion (ppb) on the display.

If, after initial start-up, the power is briefly turned off, the analyzer will take approximately 6 minutes to re-equilibrate.

See **3.4.1 Gas Flow and Pressure Regulation** for important information on setting proper pressures and flow rates.

See 6.3.17 Power Up Default for setting user-selectable preferences at the time of power up.

3.5 Analyzer Shut Down or Disconnection

To shut down analyzer, turn power switch behind the front door to the **OFF** position. This action initiates the standard isolation process and computer shutdown, which takes approximately 40 seconds. **Figure 15** provides a block diagram of the gas flow path.

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.

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

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

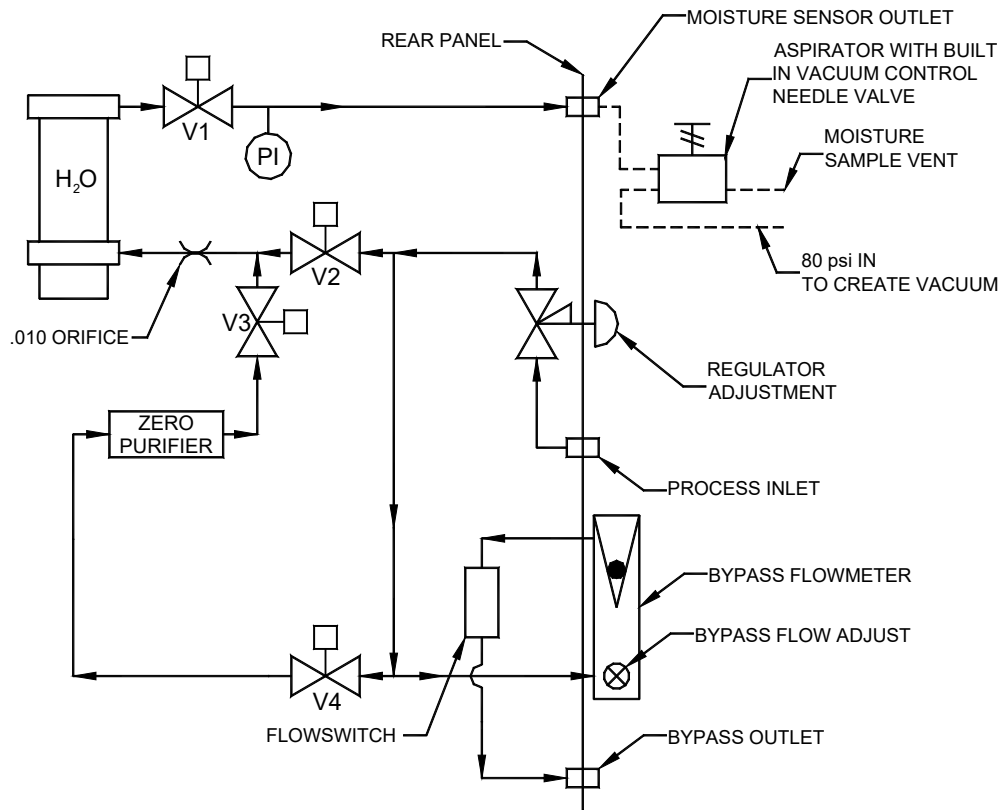


Figure 15: Block Diagram of Gas Flow Path

4. Options

The following options to the DF-750 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.

4.3 Serial Communications

The analyzer can be set to communicate through either RS-232 or RS-485 protocols.

The serial communications option is not adjustable 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.

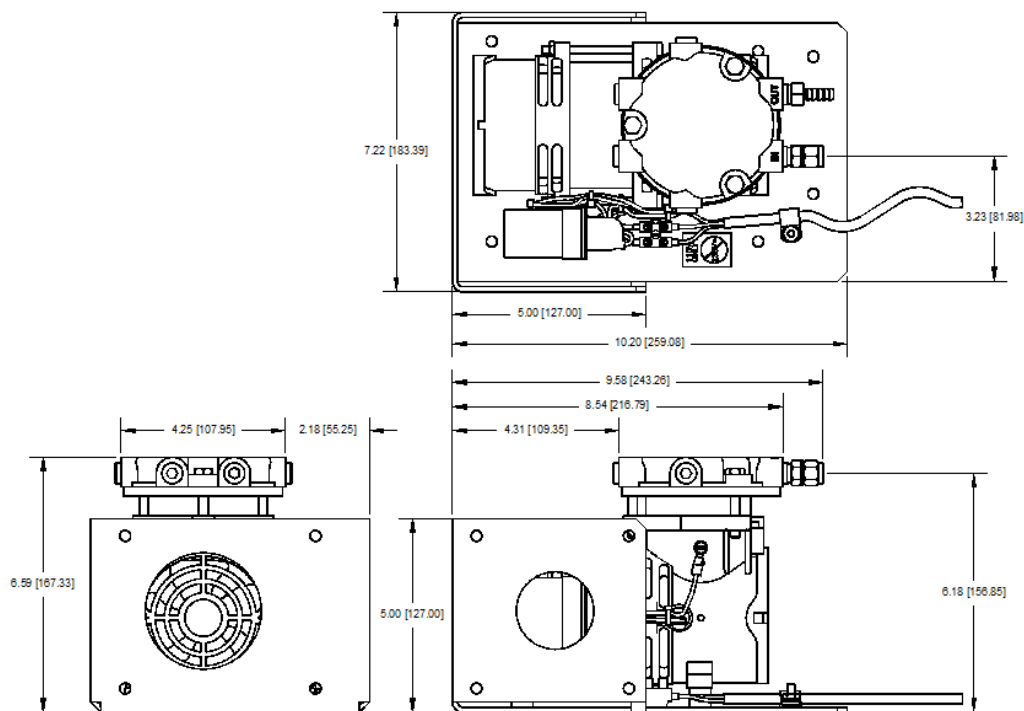
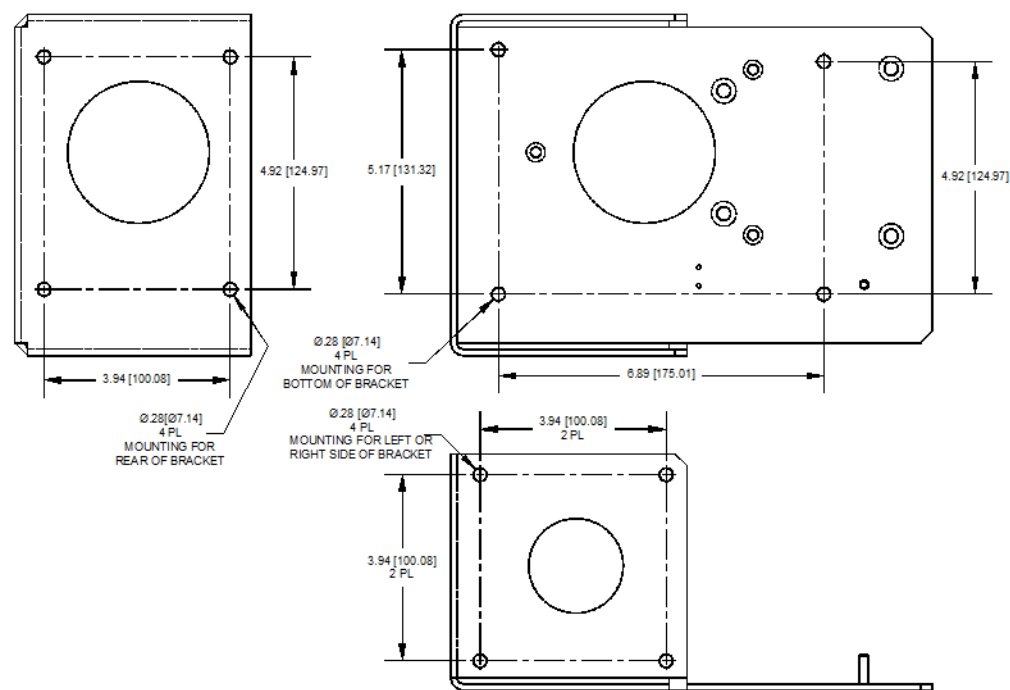
The maximum analog voltage output is not adjustable in the field.

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 16** and **Figure 17** below for 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, and current outputs, and serial communications are supported. All outputs, analog or digital, are fully isolated from earth ground.

NOTE:



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

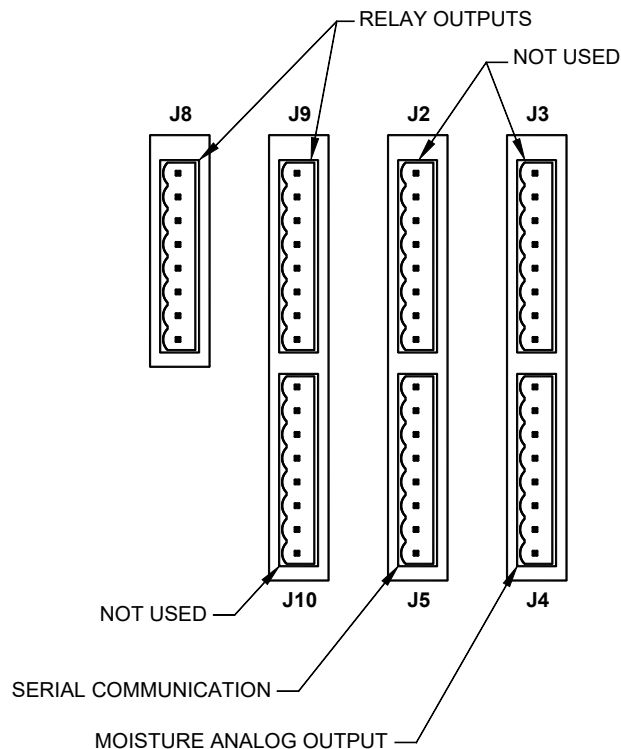


Figure 18: Rear Panel Electrical Connectors

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** on page 34 for wiring information.

See the chapter on Communications on page 97 for additional information on setting unit ID's 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-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

The analog voltage output correlating to the front panel display reading is provided on the rear of the analyzer through connector J4. The full-scale voltage is set at the factory at the time of order to: 0 to 1 VDC, 0 to 5 VDC, or 0 to 10 VDC. The output is electrically isolated from all other analyzer outputs and from chassis (Earth) ground. See page 76 for additional information on setting the Analog Output. The output may be tested with the use of the analog voltage test routine found on page 84.

5.3 4-20 mA Outputs – J4

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

The 4-20 mA analog output correlating to the front panel display reading is provided on the rear of the analyzer through connector J4. This output is 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.

5.4 Relay Ports – J8, J9

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

The relay contacts can be programmed through the user interface for up to four moisture levels, temperature, moisture cell diagnostics, zero calibration in progress, analyzer off line, and 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.

The relay wiring can be tested with the Relay test routine found on page 83.

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 5 Pin Out of Relay Ports J8 and J9

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 19** below.



Figure 19: Data Display Screen

The display provides information from the moisture analyzer:

- Alarm status indicator – ‘1, etc.’ denotes an alarm condition (if enabled), ‘OK’ denotes no alarm conditions (if enabled).
- The Data Line reading of the most recent concentration measurement. This box will also provide indication of abnormal operating conditions for the moisture 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

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 20** below.

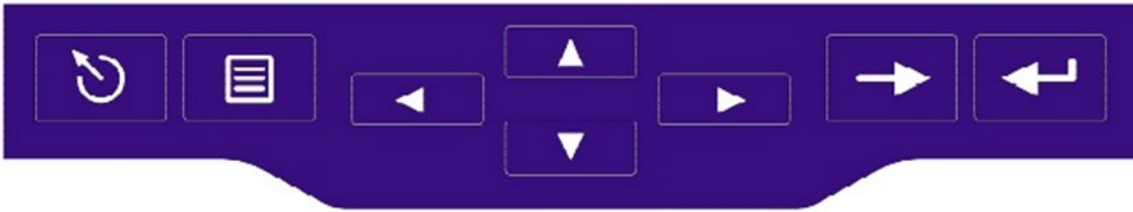


Figure 20: Keypad

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 figure that follow.

6.3.1 Main Menu

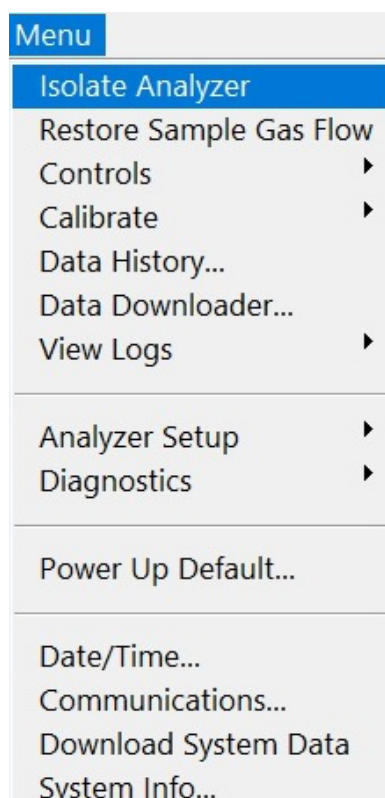


Figure 21: Main Menu

The Main Menu (**Figure 21**) 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.

6.3.2 Isolate Analyzer

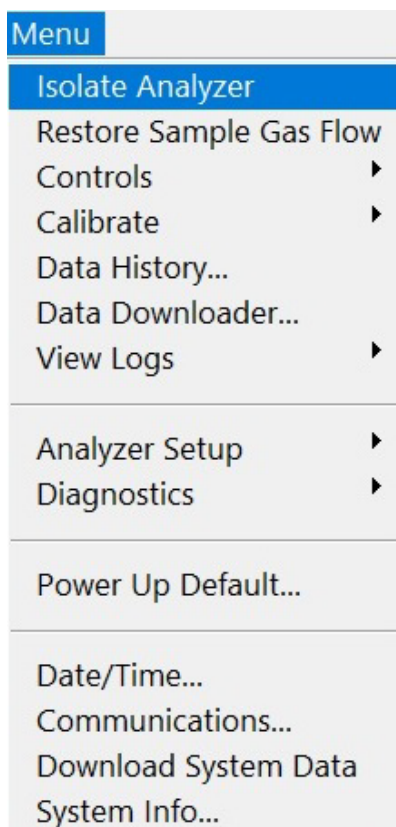


Figure 22: Isolate Analyzer Selection from Main Menu

The **Isolate Analyzer** selection (Figure 22) causes the internal gas lines and the moisture sensing cell volume to be isolated in anticipation of a break in the external delivery lines. It is also considered the first step in the shut-down procedure. Highlight this selection and press the **Enter** key to initiate the isolation process. The warning shown in Figure 23 will appear for 40 seconds.

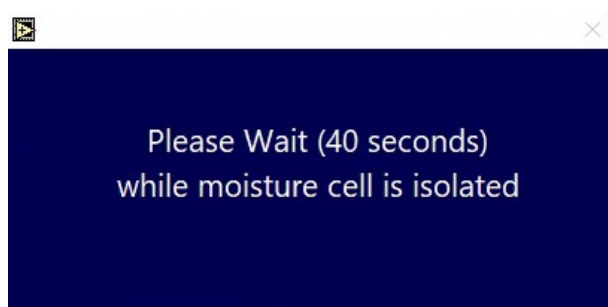


Figure 23: Isolate Warning

While the moisture cell is isolated from gas flow, a warning will appear at the bottom of the main display indicating “**Isolated.**”



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.

6.3.3 Restore Sample Gas Flow

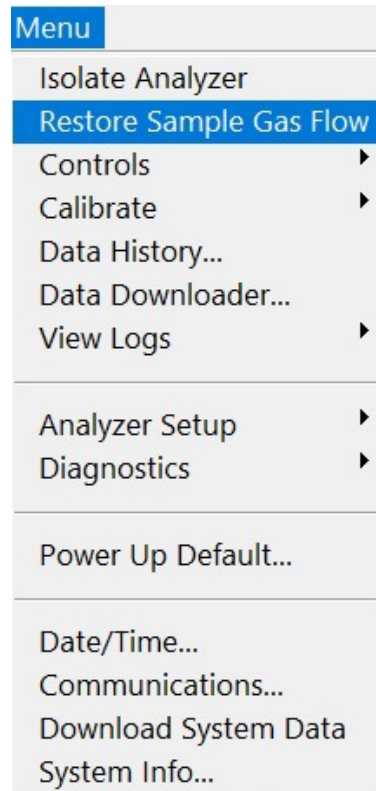


Figure 24: Restore Sample Gas Flow Selection from Main Menu

The **Restore Sample Gas Flow** main menu selection (Figure 24) returns the analyzer gas flow to normal after isolation.

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.

6.3.4 Controls Menu

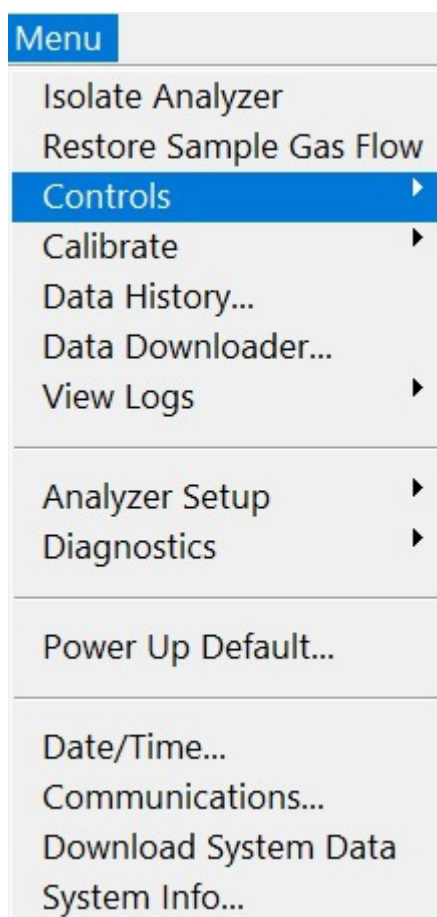


Figure 25: Controls Selection from Main Menu

The **Controls** menu selection (Figure 25) provides access to the gas control dialog box, which is used to control gas flow through the moisture cell.

6.3.4.1 Gas Valves Control

The gas valves control dialog box, as shown in Figure 27, 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 select **Enter** again to apply your choice. The gas valves 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. When **Isolate Sensor** is selected, the isolation valves are closed, and a message is displayed (see Figure 26) advising the user to wait 40 seconds for the moisture cell to be fully isolated.

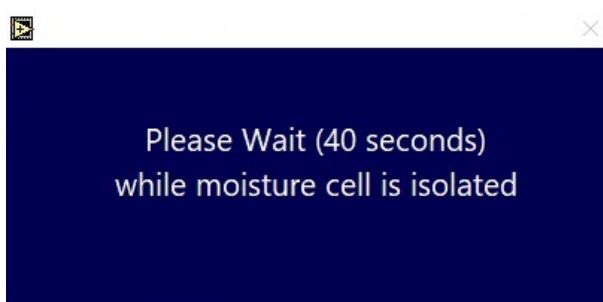


Figure 26: Isolate Warning

When the moisture cell is isolated from gas flow, an indication will appear at the bottom of the main display indicating **Isolated**.



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.

- **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 purity level of the incoming gas.

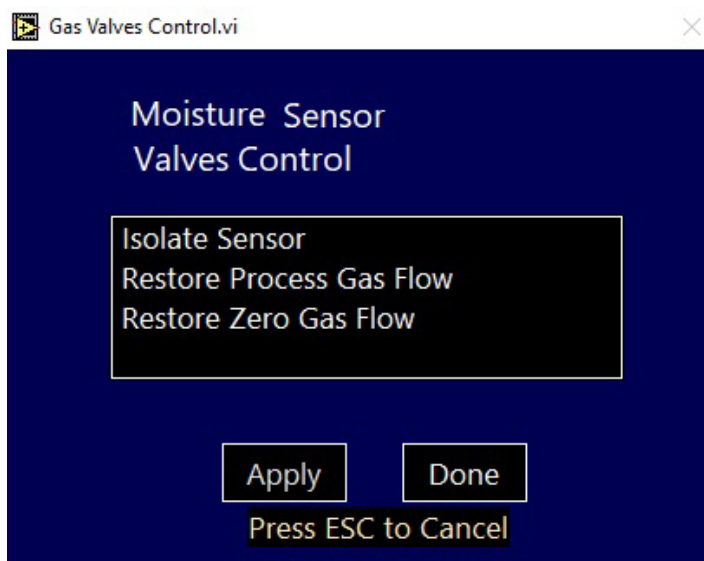


Figure 27: Gas Valves Control Dialog Box

6.3.4.2 Back Flow Prevention System

The Back Flow Prevention System mitigates the possibility of contamination of the plumbing system when gas flow is lost or accidentally shut off. Under these conditions, 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 .1 lpm. When bypass flow is reduced, the switch will remove power to the solenoids controlling the gas panel valves. When the system detects a zero-pressure reading, a message will be displayed which states that backflow prevention is engaged and to check sample and bypass flow (see **Figure 28**). The analyzer will remain in isolation and the user will not have control of any valves at this point.

CAUTION



While the Back Flow Prevention System is engaged, the moisture reading is *not* valid.

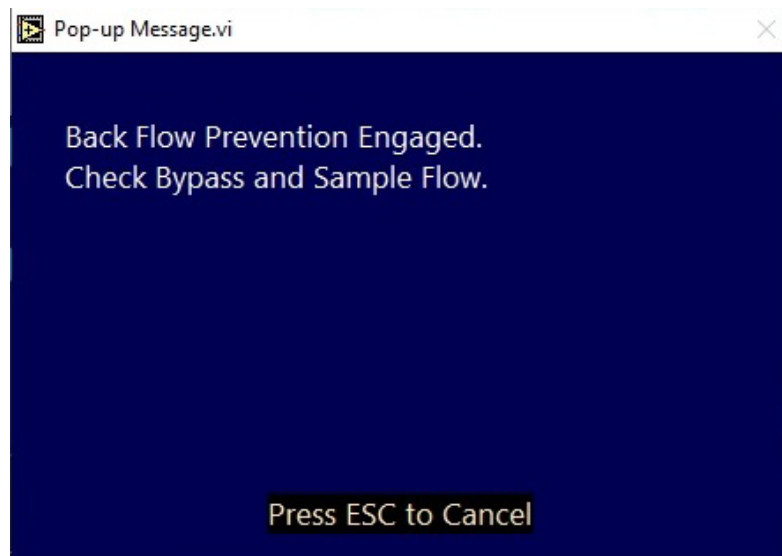


Figure 28: Back Flow Prevention Warning

The user must determine the cause of the loss of gas flow and remedy the situation. When 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 and to wait five minutes to restore internal sample flow to the sensors (see **Figure 29**).

A five-minute timeline is displayed, and the user will still not have valve control until the five minutes are up. During this time, the **Esc** key may be hit to cancel the five-minute delay and return control to the user. Once the Esc key is hit, or the five-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. See page 42 for additional information on restoring gas flow.

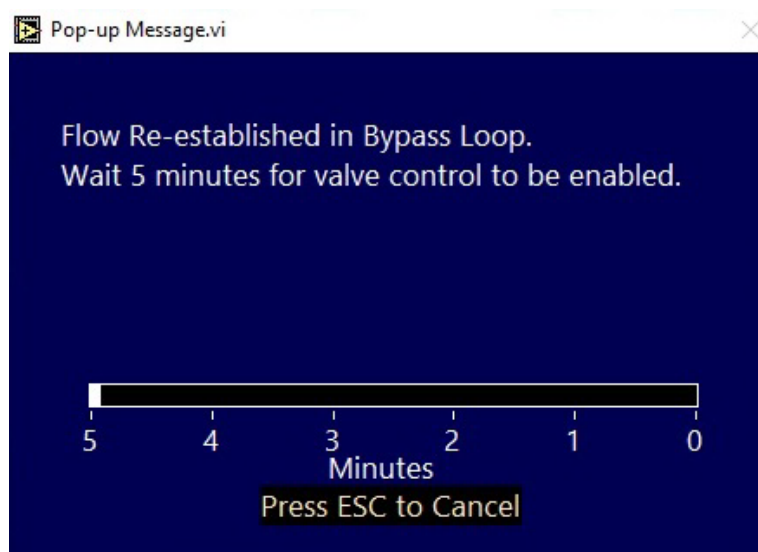


Figure 29: Re-established flow delay

Activation of Backflow Prevention triggers a system alarm (192) for the moisture cell. See **6.3.8.2 System Error Codes** for additional information on system alarms.

6.3.5 Calibrate Menu

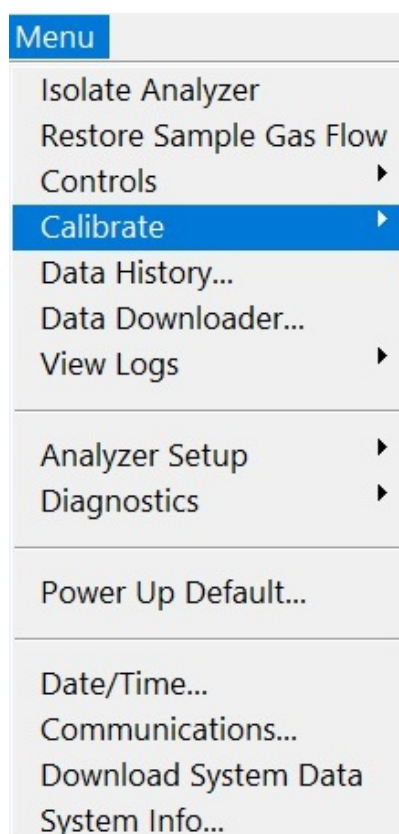


Figure 30: Calibrate Menu

The **Calibrate** menu selection (**Figure 30**) is used to compensate analyzer measurements for the effect of small amounts of moisture in the analyzer plumbing or sample gas supply line.

Sample line contributions to moisture, especially at the sub-ppb level, are difficult to remove even in a correctly operating system. 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, however, 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.

Any zero action whether completed or aborted is recorded in the **Zero Cal Log** as shown in **Figure 50**.

NOTE:

Instrumental drift has minimal effect on the quantitative moisture content result. Once operating parameters are in place from the factory, no other SPAN calibration is necessary.

6.3.5.1 Check/Adjust Zero

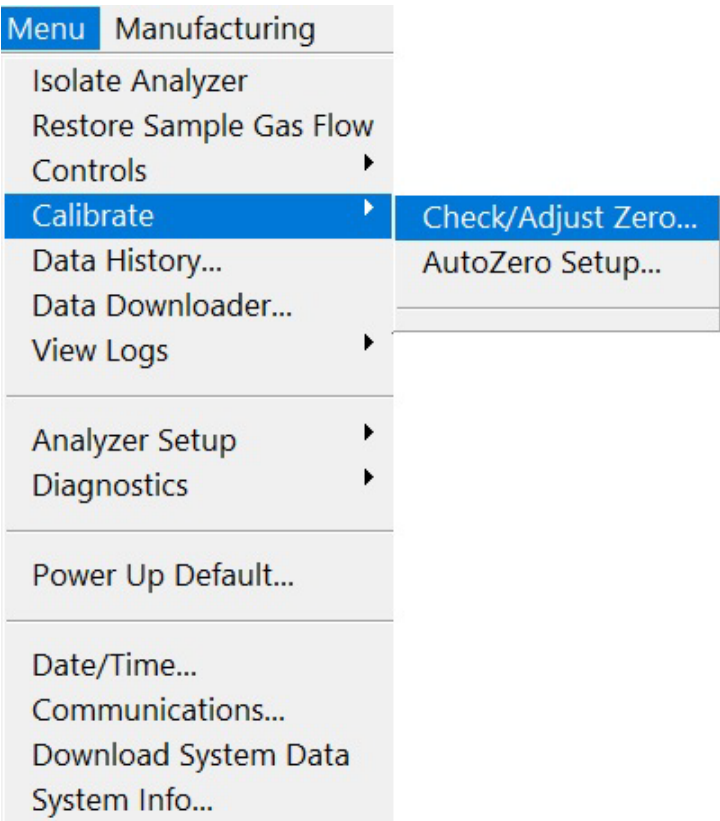


Figure 31: Check/Adjust Zero Menu

The Check/Adjust Zero submenu selection (**Figure 31**) accesses the **Check/Adjust Zero** screen (**Figure 32**). This 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.

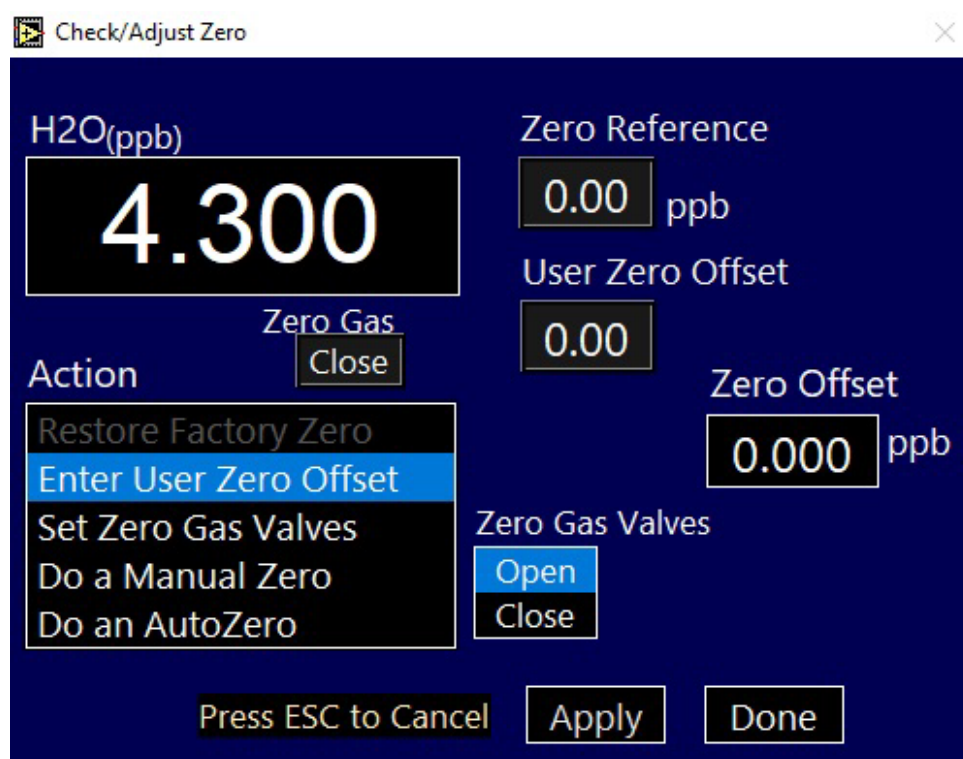


Figure 32: Check/Adjust Zero Screen

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 or auto zero is performed, this value may change slightly.

If the moisture cell has been previously calibrated by the user, **Restore Factory Zero** will be enabled on this screen. Enacting this will erase any user zero and restore the factory set point.

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. See page 80 for additional information on the Active Zero feature.

A relay is available on the **Analog Output Setup** screen (see page 77) 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.

6.3.5.2 User Zero Offset

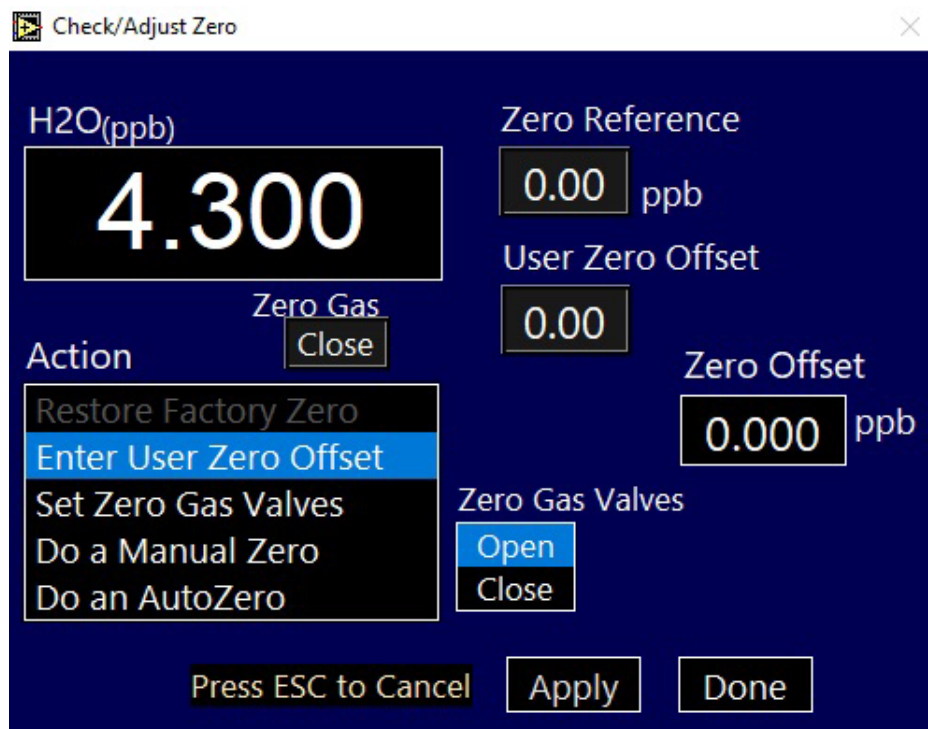


Figure 33: Enter User Zero Offset

The **User Zero Offset** selection (Figure 33) enables the user to add a given moisture ppb value to the displayed concentration. This can be useful in preventing inaccurate readings to be 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 this condition, the moisture reading would be 1.0 ppb.

Use the arrow keys (▲ and ▼) to highlight **Enter User Zero Offset** in the Check/Adjust Zero screen, Figure 32. Select the **Enter** key on the front panel, and the zero offset box will appear on the screen as shown in Figure 33. 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. When done hit the **Enter** key which will move the highlighted area to the **Apply** button and hit **Enter** to set the value. Use the **Next** key to go back and change the value or move to the **Done** button, followed by hitting the **Enter** key to leave the screen. Using the **ESC** key at any time will exit the screen making no changes and return to the main display.

6.3.5.3 Set Zero Gas Valves

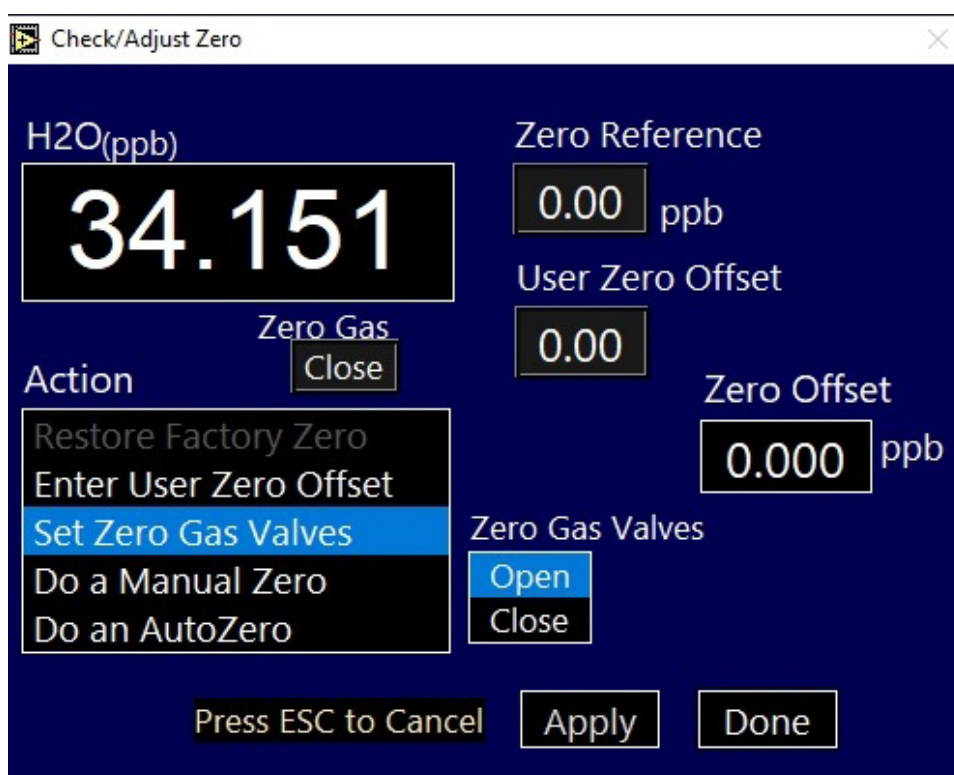


Figure 34 Set Zero Gas Valves Screen

The state of the Zero Gas Control Valves can be toggled on or off from this screen. Use the arrow keys (▲ and ▼) to highlight **Set Zero Gas Valves** on the Check/Adjust Zero screen (Figure 32), select the **Enter** key on the front panel, and the Zero Gas Valves box will appear on the screen as shown in Figure 34. Use the arrow keys (▲ and ▼) to highlight **Open** or **Close** and hit **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 to the **Done** button followed by **Enter** to leave the screen. Using the **ESC** key at any time will exit the screen without applying changes and return to the main display.

6.3.5.4 Do A Manual Zero

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. See **6.3.5.3.Set Zero Gas Valves** above. When switching to a gas that is moisture-free, it is important to wait long enough to allow the reading to re-stabilize.

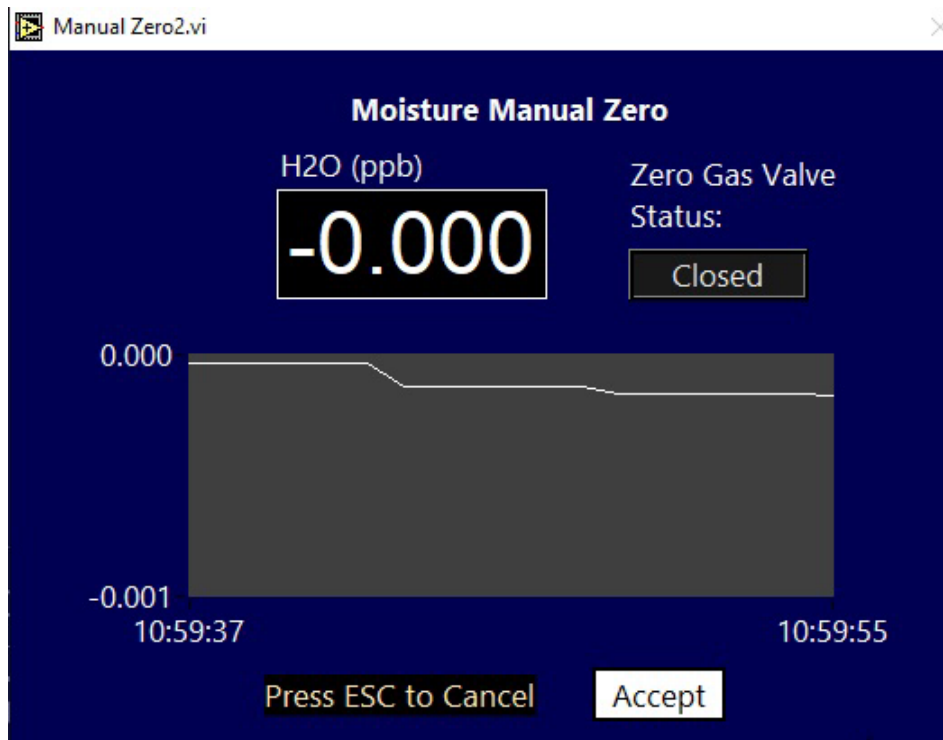


Figure 35: Manual Zero Screen

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 35**). Observe the trace until the reading is stable and then select **Accept**. 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.

A relay is available on the Analog Output Setup Screen (see page 77) 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.

6.3.5.5 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 on page 52.

The process measurement mode can be restored at any time during the calibration process by pressing **ESC**. 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 38**. See page 53 for additional information.

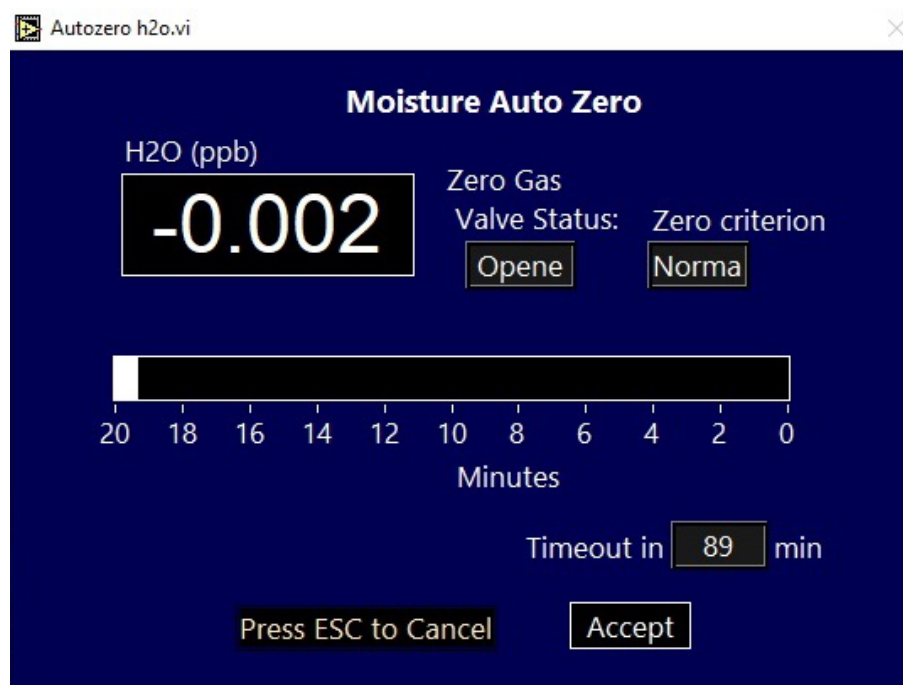


Figure 36: AutoZero Progress Screen

After selecting **Do an AutoZero** from the action dialog box shown in **Figure 32**, a screen like **Figure 36** 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 twenty-minute autozero cycle begins. During this twenty-minute cycle, the analyzer applies stability criteria. If, after twenty 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 the section on 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 Analog Output Setup Screen (see page 77) 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.

6.3.5.6 AutoZero Setup

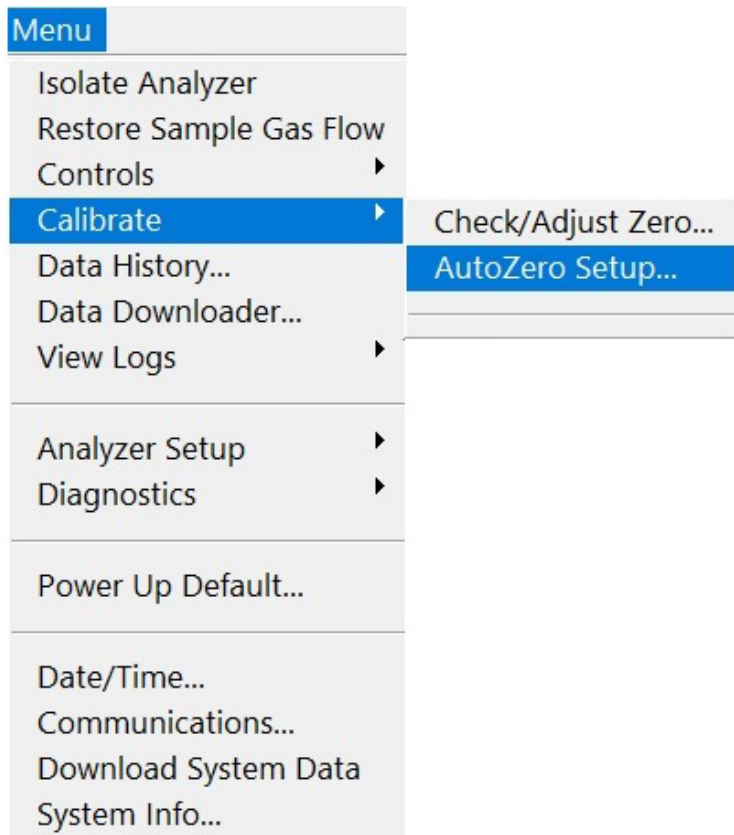


Figure 37: AutoZero Setup Menu Selection from Main Menu

The **AutoZero Setup** submenu selection (Figure 37) accesses the **Moisture Auto Zero Setup** screen (Figure 38).

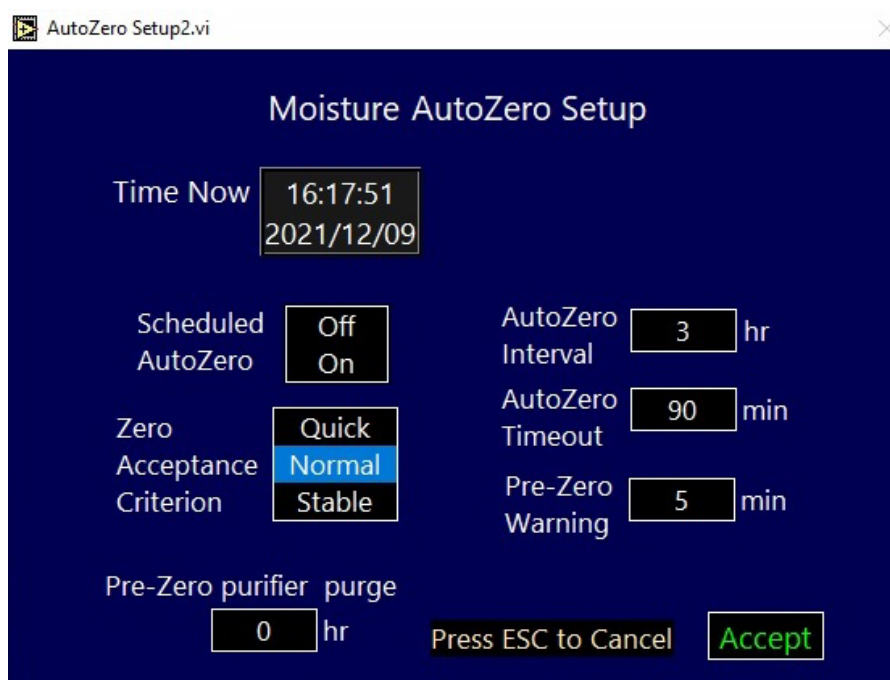


Figure 38: AutoZero Setup Screen

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

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** 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 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-hand 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** setting the user can adjust 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.

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

The **Pre-Zero purifier purge** enables the user to set an amount of time during which the system will be purged with zero gas before the AutoZero process begins.

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. The Normal selection is between the other two selections (34-minute delay).

A relay is available on the Analog Output Setup Screen (see page 77) 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.

6.3.6 Data History Routine

The Data History Screen (**Figure 40**) 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 1 point per minute (fixed) and the y-axis is auto-scaling.

The **Next** button can be used to toggle the X axis from 1 day (default), to 1 hour, to 1 week and then to 3 weeks.

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

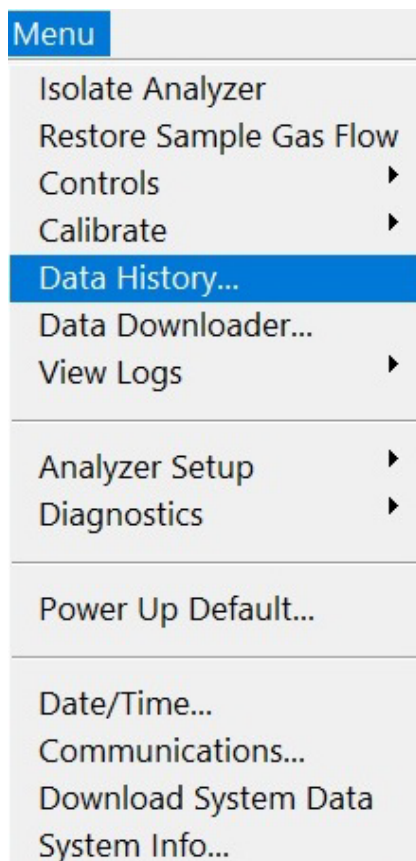


Figure 39: Data History Menu

The Data History menu selection (**Figure 39**) accesses the **Data History Screen (Figure 40)** Using this screen, Data history may be downloaded to a USB memory stick by using the **Next** key to move to the **Download** box and hitting **ENTER**. A screen like **Figure 41** will appear, requesting that a memory stick can be placed in the external USB socket. The socket is located behind the front door on the left side of the chassis.

The downloaded file will be in tab delimited form and will be all moisture 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 is returned to the operator. See **Figure 42** for an example of a portion of a download taken between the dates of May 1 and May 22. The complete file covers three full weeks.

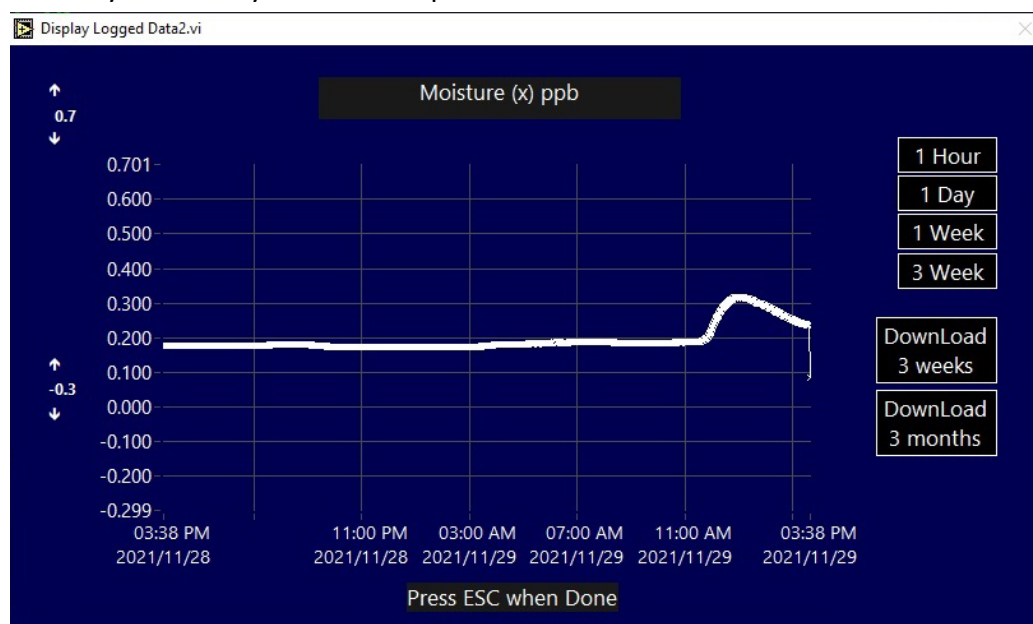


Figure 40: Data History Screen

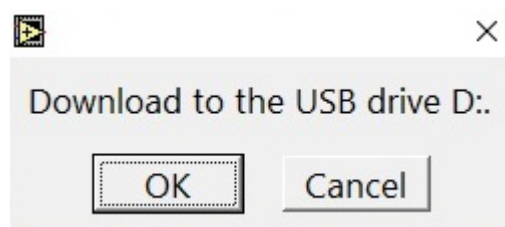


Figure 41: Install Media

```

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 42: Example of Data Download

6.3.7 Data Downloader Routine

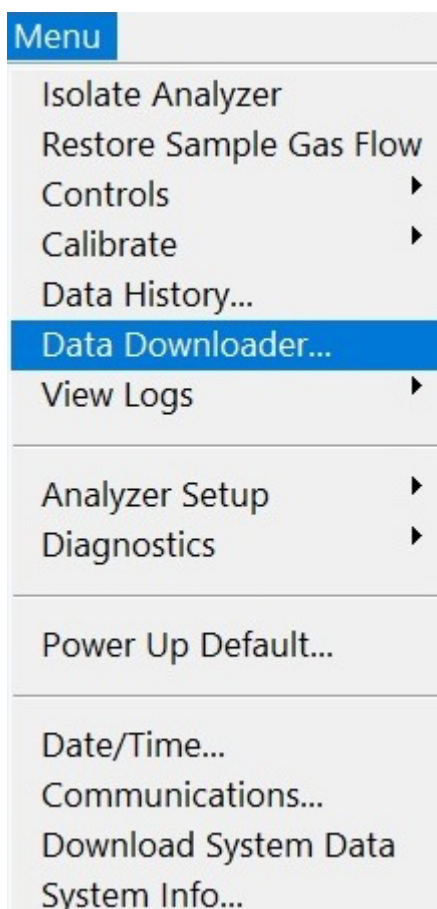


Figure 43: Data Downloader Menu Selection

The Data Downloader Data Selection (**Figure 43**), access the Data Downloader screen (**Figure 44**). This screen enables the user to label data with unique location names as well as to view and download specified data.

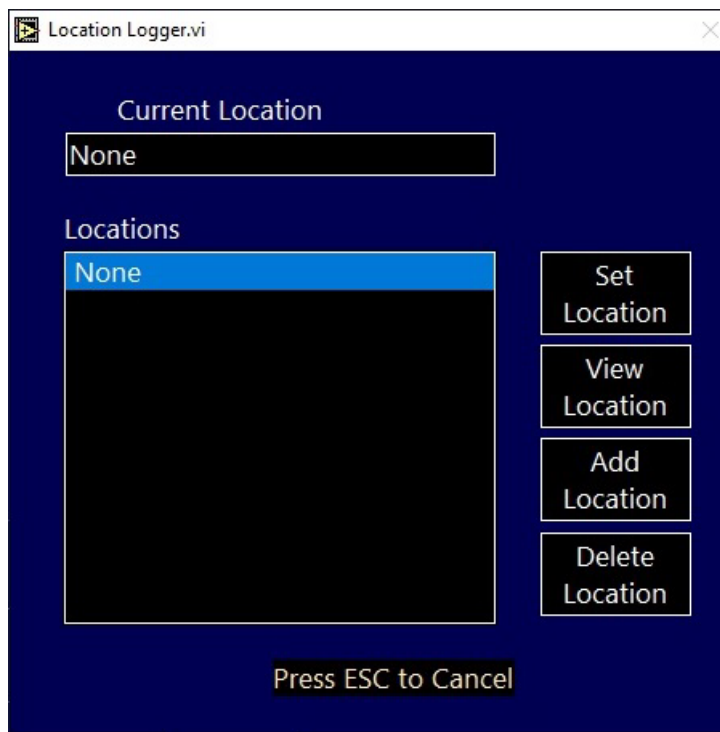


Figure 44: Data Downloader Screen

6.3.7.1 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 59). On the Data Downloader screen (**Figure 44**), 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.

6.3.7.2 View Location

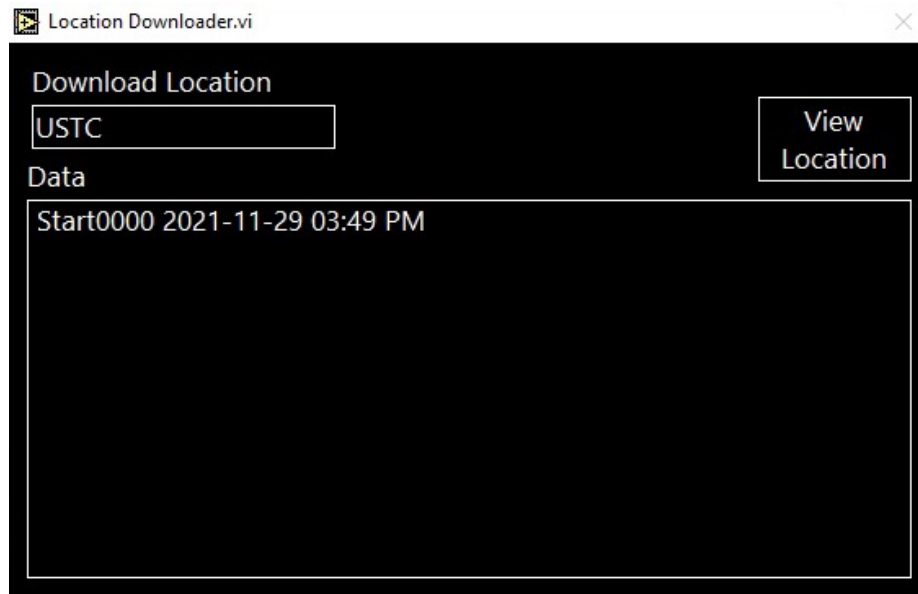


Figure 45: View Location Screen

The view location function is used to view data previously stored in the system sorted by location. On the Data Downloader screen (Figure 44), 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 be displayed as in Figure 45.

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 40. From the data history screen, the data may also be downloaded to a USB Memory Stick.

6.3.7.3 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 46 that is used to enter the name of the new location.

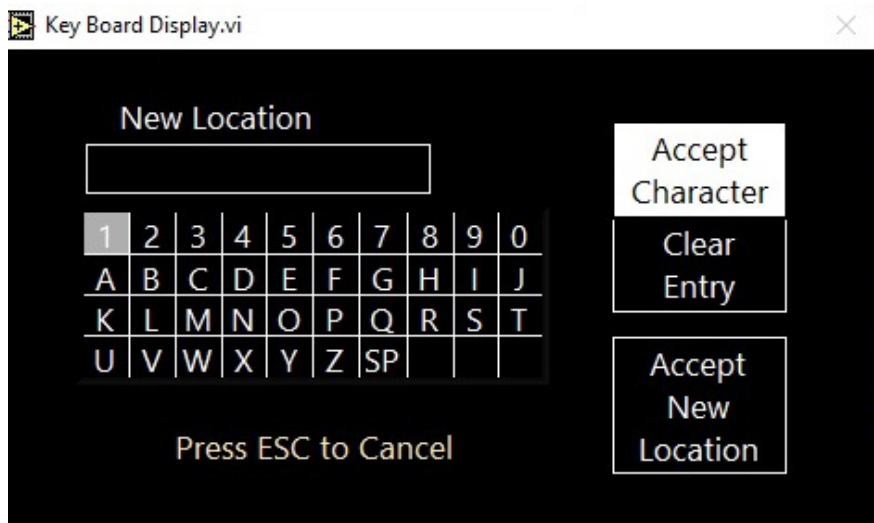


Figure 46: Keyboard Display

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.

6.3.7.4 Delete Location

The delete location function is used to remove a location from the list of available names. On the Data Downloader screen (Figure 44), 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 47) 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.

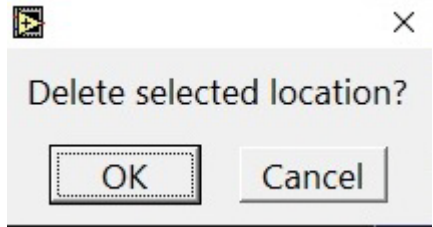


Figure 47: Delete Selection

6.3.8 View Logs Menu

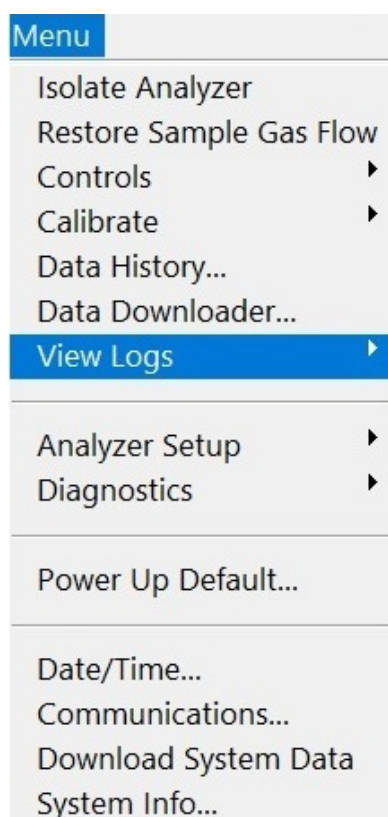


Figure 48: View Logs Menu Selection

View Logs allows the user to easily access 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. Pressing **ESC** will return to the main display.

6.3.8.1 Zero Log

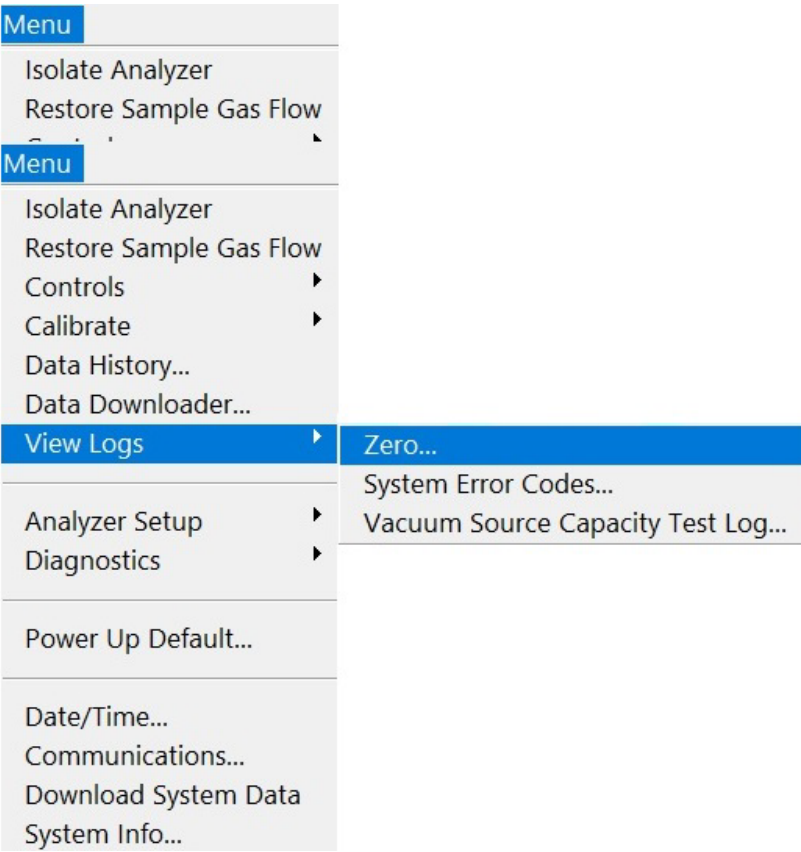


Figure 49: View Zero Log Menu

The View Logs Zero Log menu selection (**Figure 49**) accesses a history of adjustments made to the moisture cell zero setting (**Figure 50**). 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 scheduled. The time to perform the zero and the resulting zero reference also appear.

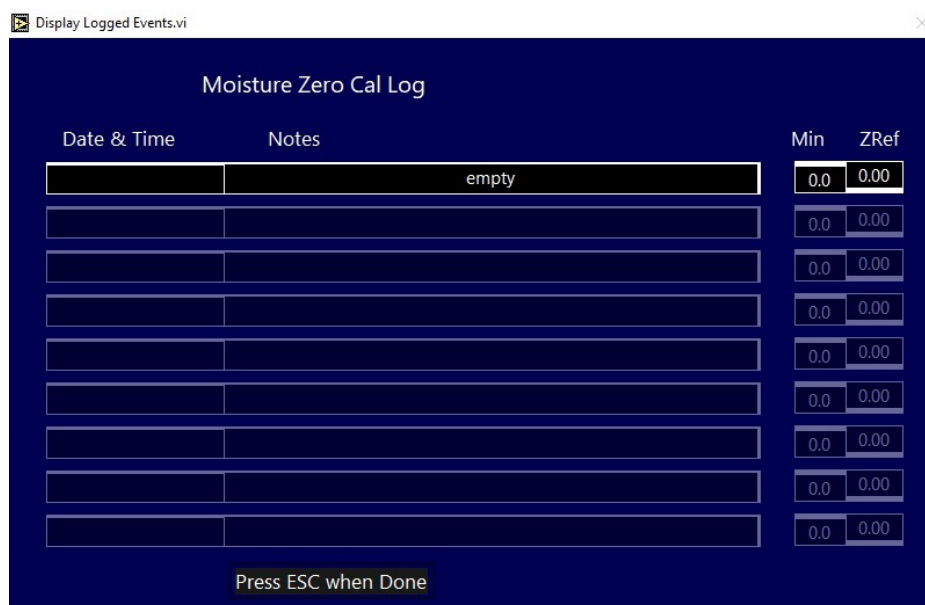


Figure 50: Zero Log Screen

6.3.8.2 System Error Codes

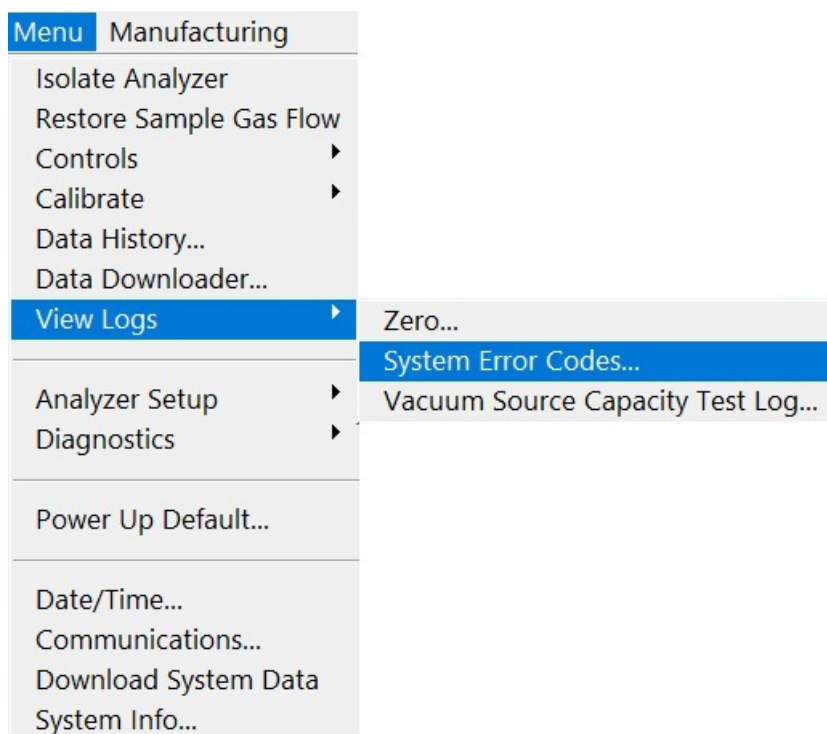


Figure 51: View System Error Code Log Menu

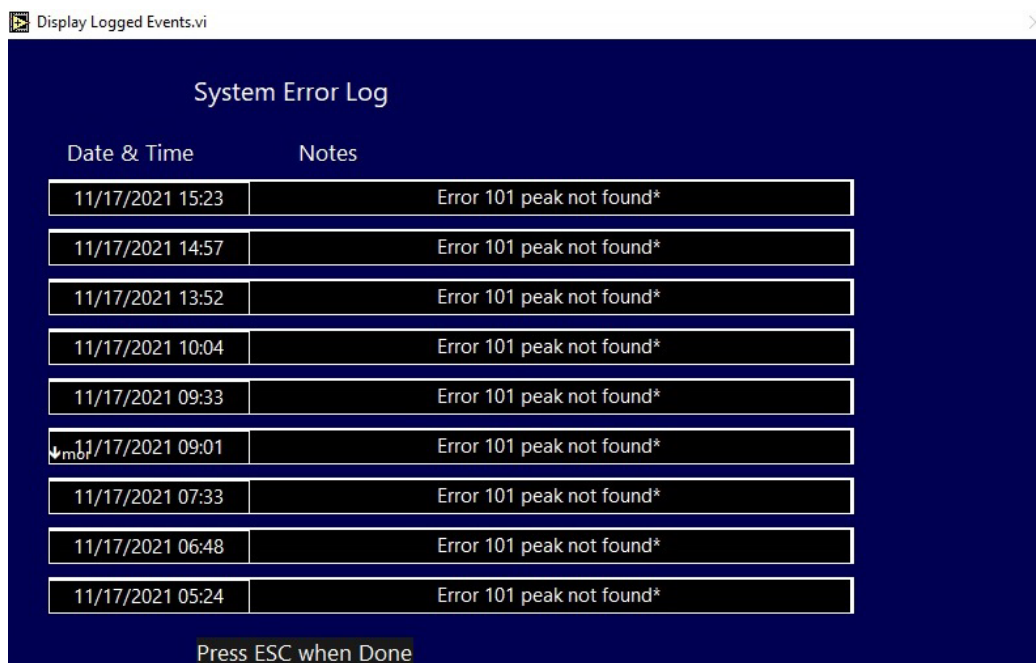


Figure 52: System Error Log Screen

The **System Error Codes** menu selection (Figure 51) accesses the **System Error Log** (Figure 52) showing functional error history in the system. If the error persists for more than 30 minutes, the code is displayed. In addition, a system alarm will trip if configured to do so. See page 86 for additional information on setting System Alarms. **NOTE:** The 30-minute clock is delayed for 60 minutes on a “cold” system startup. **Table 6** provides common error codes that may be reported on the System Error Log.

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 6: 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.

6.3.8.3 Vacuum Source Capacity Test Log

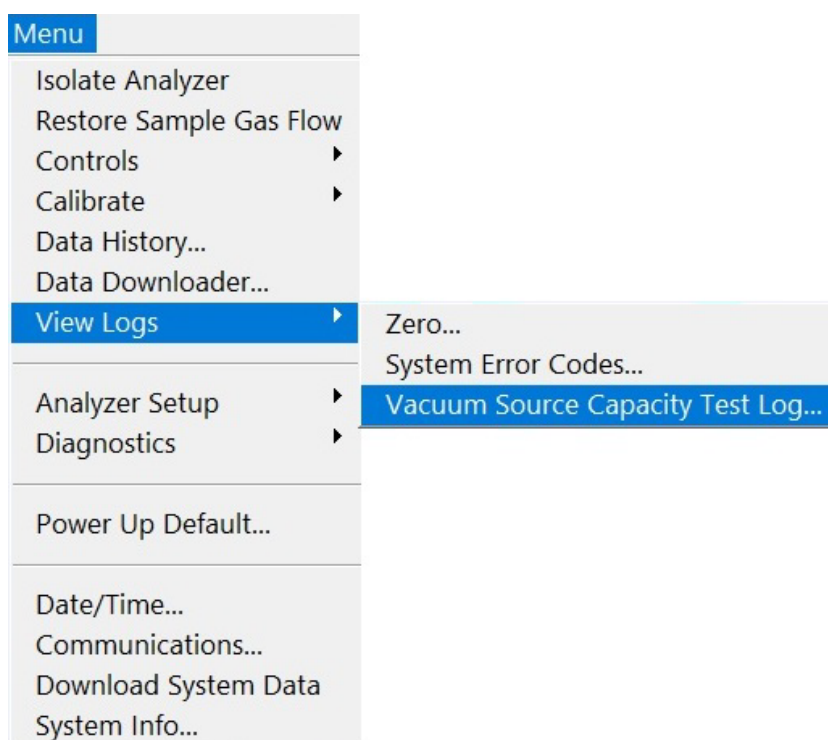


Figure 53: Vacuum Source Capacity Test Log Menu Selection

The **Vacuum Source Capacity Test Log** menu selection (Figure 53) accesses the Vacuum Source Capacity Test Log screen (Figure 54). The vacuum source capacity test is used to determine the vacuum that the aspirator or pump can pull in the absence of flow. This 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 **6.3.14 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.

Display Logged Events.vi

Vacuum Source Test Log

Date & Time	Notes	h2o	torr
11/17/2021 15:19	pump capacity test	0.1	21.00
11/17/2021 15:19	pump capacity test	0.1	21.00
		0.0	0.00
		0.0	0.00
		0.0	0.00
		0.0	0.00
		0.0	0.00
		0.0	0.00
		0.0	0.00

Press ESC when Done

Figure 54: Vacuum Source Test Log

6.3.9 Analyzer Setup

Menu
Isolate Analyzer
Restore Sample Gas Flow
Controls ▶
Calibrate ▶
Data History...
Data Downloader...
View Logs ▶
Analyzer Setup ▶
Diagnostics ▶
Power Up Default...
Date/Time...
Communications...
Download System Data
System Info...

Figure 55: Analyzer Setup Menu Selection

The **Analyzer Setup** menu selection (Figure 55 above) accesses five submenus for analyzer setup.

6.3.9.1 Sample GSF

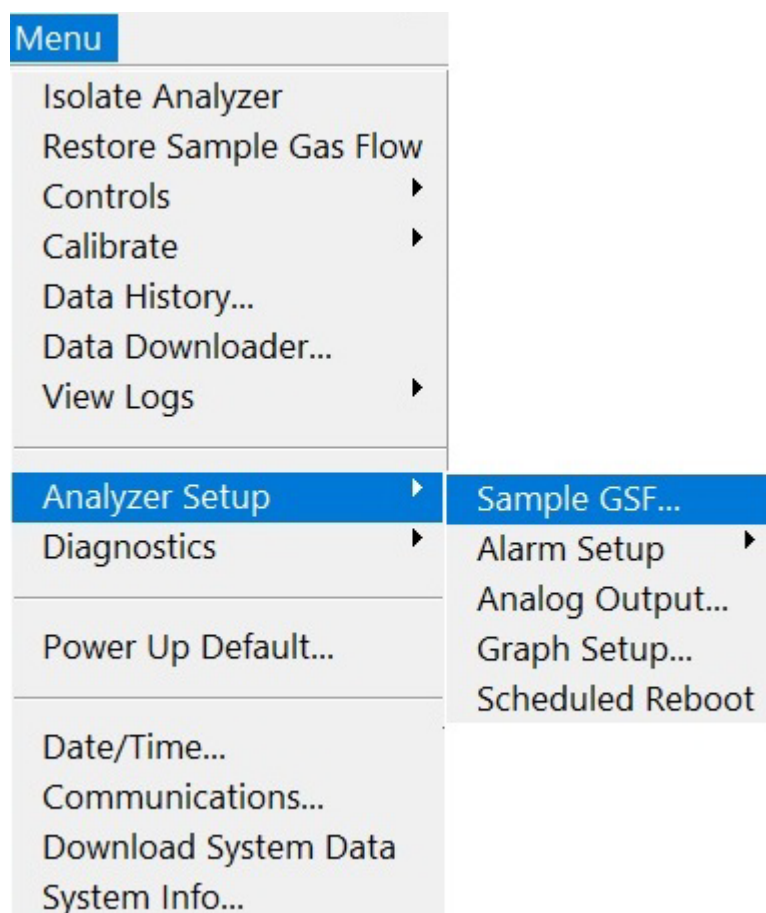


Figure 56: Sample GSF Menu Selection

The Sample GSF submenu selection (**Figure 56**) accesses the GSF Setup screen (**Figure 57**). GSF (Gas Scale Factor) setup is critical for obtaining quantitatively correct results. It accounts for the fact that moisture molecules have different absorption features in different background gases.

The GSF should be applied when the user has any knowledge of a change in the background gas or change in the percentages of component gases in background gas mixtures. The default setting from the factory is 100% N₂, yielding a GSF of 1.00.

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. Using the **ESC** at any time will exit the screen without applying changes and return to the main display.

The screenshot shows a window titled "GSF Setup" with a dark blue background. The title bar includes a small icon and a close button (X). The main heading is "Sample Gas Mixture". Below this, there is a list of gases with their respective percentages in input fields:

N2:	100	%
O2:	0	%
Ar:	0	%
H2:	0	%
He:	0	%
CO2:	0	%

To the right of the gas list, the text "H2O Gas Pressure Range" is displayed above two input fields containing "150" and "250", followed by the unit "torr". At the bottom of the window, there are two buttons: "Press ESC to Cancel" and "Accept".

Figure 57: Sample GSF Setup Screen

After the percentages of all background gas 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 as in **Figure 58** and the limits are set on the Pressure Alarm Screen. See page 73 for additional information on setting the Pressure Alarm.

The screenshot shows a standard Windows-style message box with a light gray background. It has a title bar with a small icon and a close button (X). The text inside the box reads: "Make sure H2O sample gas pressure is set between 150 and 250 torr." At the bottom center of the box is an "OK" button.

Figure 58: GSF Pressure Setting Message

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

6.3.9.2 Fan Failure

The analyzer constantly monitors the condition of the cabinet exhaust fans. If hydrogen is entered as a gas in the GSF Setup and the analyzer is configured with the Hydrogen Safety System, the analyzer will automatically isolate when the system detects a failure in the exhaust fan circuitry.

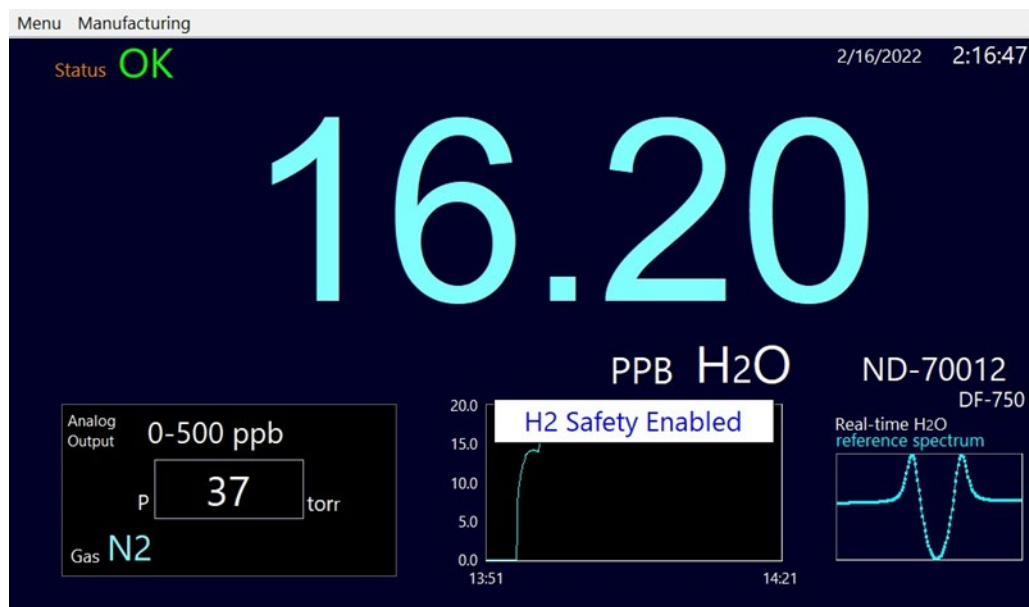


Figure 59: Fan Failure Alarm

A message of **H2 Safety Enabled** as shown in **Figure 59** will flash over the moisture data graph on the main display and the user will be unable to restore any flow until the fan problem has been fixed.

6.3.9.3 Alarm Setup

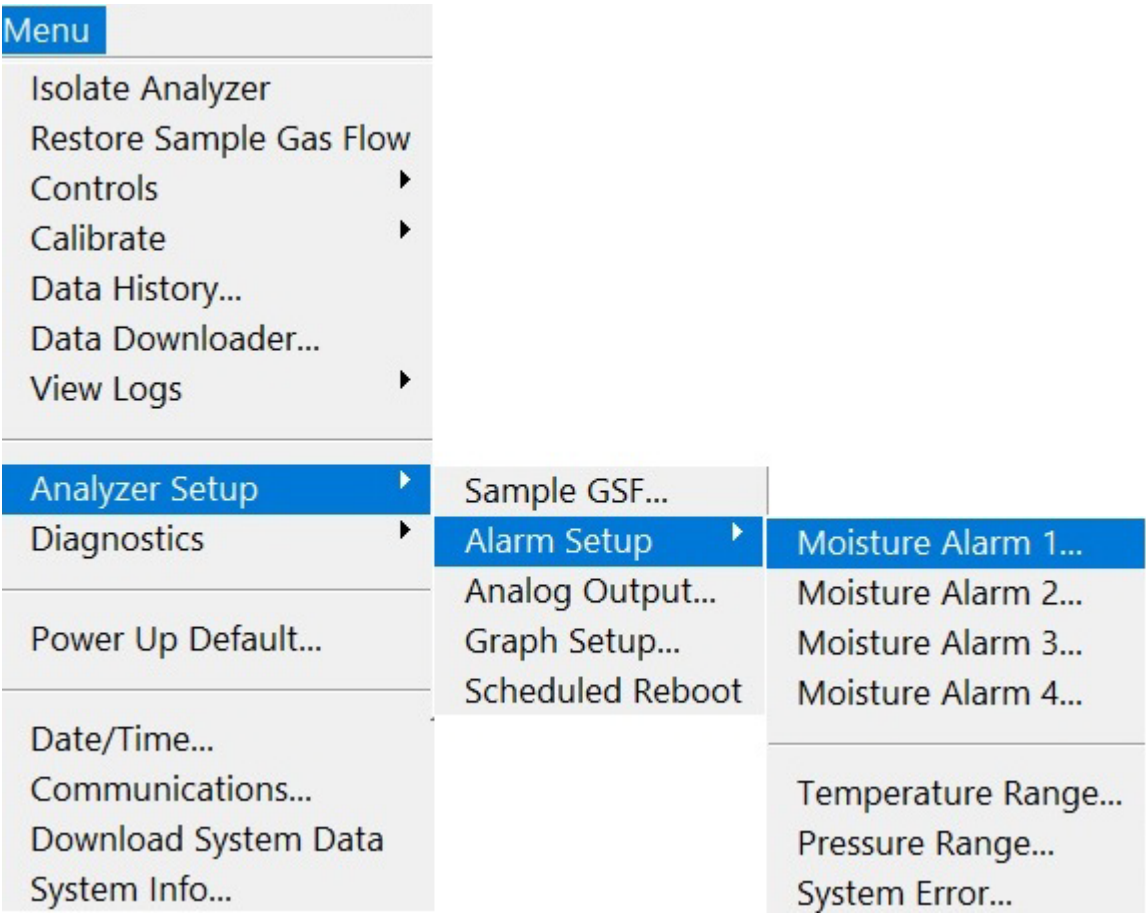


Figure 60: Alarm Setup Menu

The Alarm Setup menu selection (**Figure 60**) is used to access seven alarm setup submenus. The analyzer alarms include four moisture concentration alarms and three system alarms as listed in **Table 7**. Moisture 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 Moisture Alarm Setup Screen is shown in **Figure 61**.

Alarm Number	Function
1	Moisture Level 1
2	Moisture Level 2
3	Moisture Level 3
4	Moisture Level 4
T	Temperature
P	Pressure
S	System

Table 7: Alarm Codes

The temperature alarm indicates an out of specification ambient temperature condition in the analyzer cabinet. The Temperature Alarm Setup screen is shown in **Figure 62**.

The pressure range alarm is related to the pressure in the gas path. The Pressure Range Alarm Setup screen is shown in **Figure 63**.

Finally, system errors are monitored, and under certain conditions will trip alarms if enabled. The System Alarm Setup screen is shown in **Figure 64**.

NOTE: When any hydrogen is included in the background gas matrix (see discussion regarding GSF on page 67 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 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 is repaired. See Fan Failure on page 69.

An alarm warning will overwrite the moisture level readout if an alarm condition exists. To acknowledge the alarm simply hit the **Enter** button and its number or letter will appear in the Alarm Status line above the display. This action will not clear the alarm. Only restoration of the condition that existed prior to the alarm will clear the alarm.

6.3.9.4 Moisture Alarm Setup

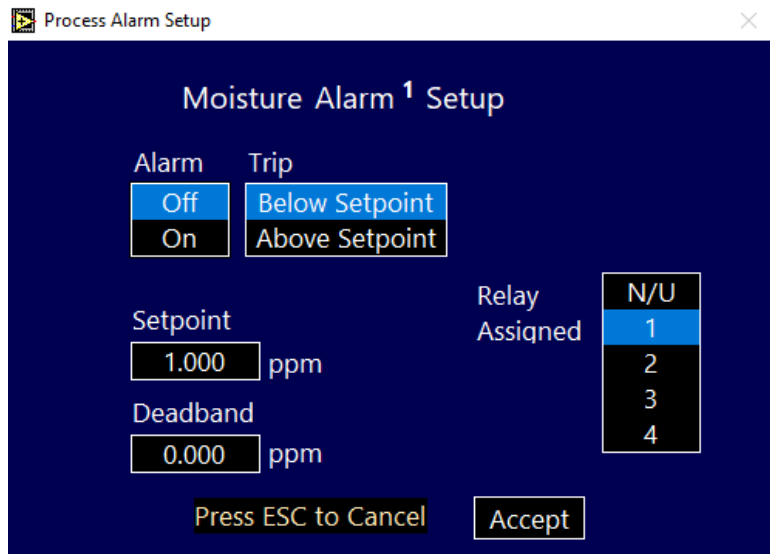


Figure 61: Alarm Setup Screen

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 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. Using the **ESC** key at any time will exit the screen making no changes and return to the main display.

6.3.9.5 Temperature Range Alarm Setup

The screenshot shows a 'Temperature Alarm Setup' window with a dark blue background. At the top, it says 'Moisture Sensor Temperature Alarm Setup'. There are four main input areas: 'Alarm' with 'Off' selected, 'Deadband' set to '0.0', 'High Trip' set to '21.0', and 'Low Trip' set to '5.0'. On the right, a 'Relay Assigned' list shows options 'N/U', '1', '2', '3', and '4', with '1' selected. Below this, 'Temperature inside Cabinet' is displayed as '30.0 °C'. At the bottom, there are two buttons: 'Press ESC to Cancel' and 'Accept'.

Figure 62: 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.

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. Using the **ESC** key at any time will exit the screen making no changes and return to the main display.

6.3.9.6 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 preset limits. The user may assign the pressure alarm to one of four relays.

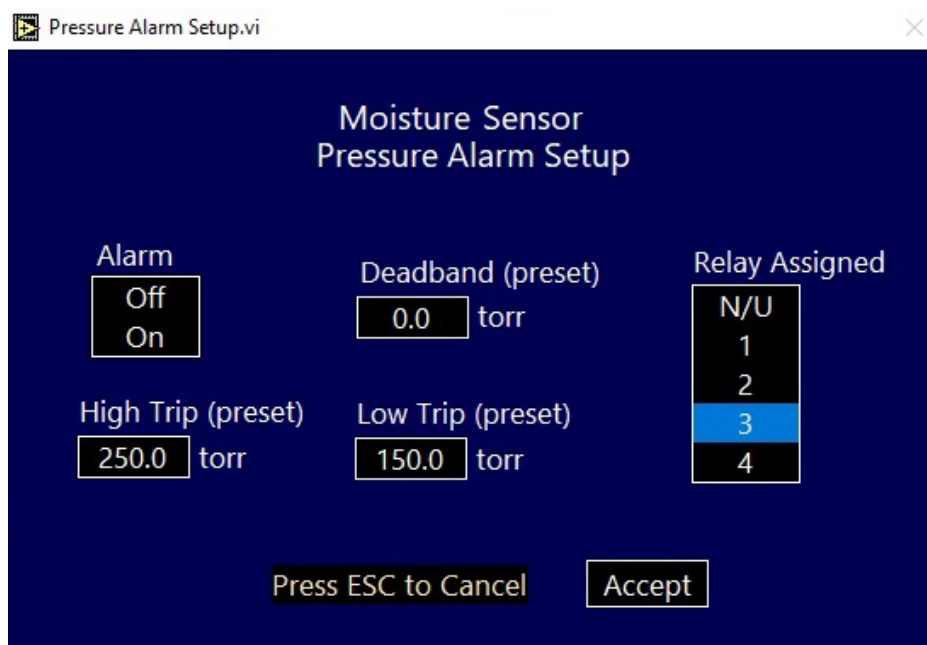


Figure 63: Pressure Range Alarm Setup

The limits are not user adjustable but are set automatically based on the background gases entered in the GSF screen. See page 67 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. Using the **ESC** key at any time will exit the screen making no changes and return to the main display.

6.3.9.7 System Alarm Setup



Figure 64: 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. Using the **ESC** key at any time will exit the screen making no changes and return to the main display.

6.3.10 Analog Output Setup

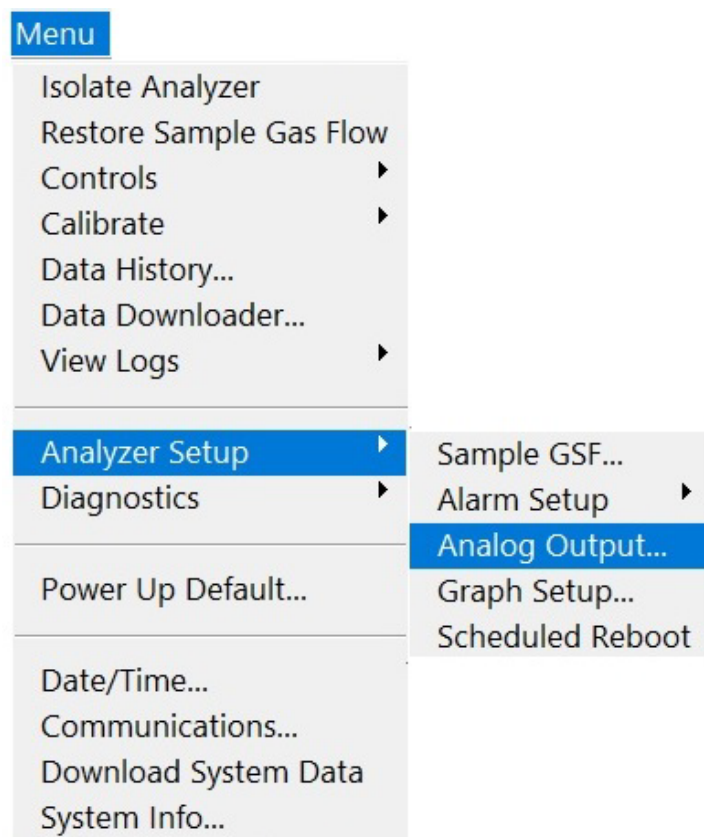
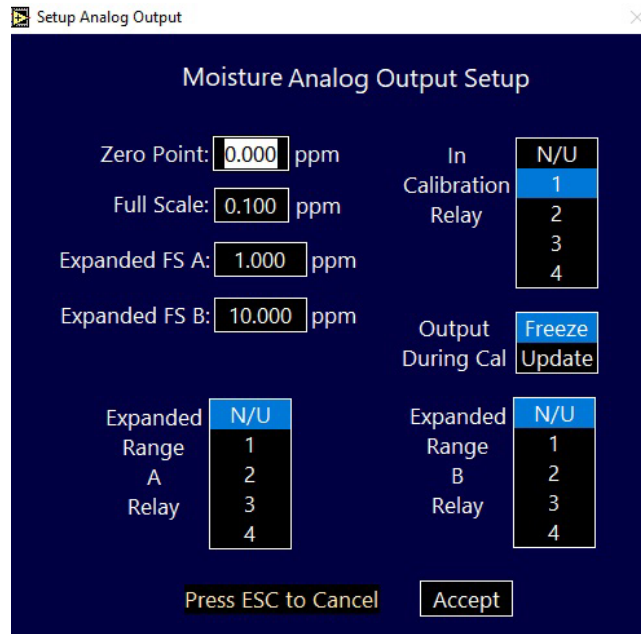


Figure 65: Analog Output Setup Menu Selection

The Analog Output Setup menu selection is shown in Figure 65. This menu accesses the Moisture Analog Setup screen shown in Figure 66.

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 in 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.



Setup Analog Output

Moisture Analog Output Setup

Zero Point: ppm

Full Scale: ppm

Expanded FS A: ppm

Expanded FS B: ppm

Expanded Range A:

In Calibration Relay:

Output During Cal:

Expanded Range B:

Press ESC to Cancel

Figure 66: Analog Output Setup Screen

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.

6.3.11 Graph Setup

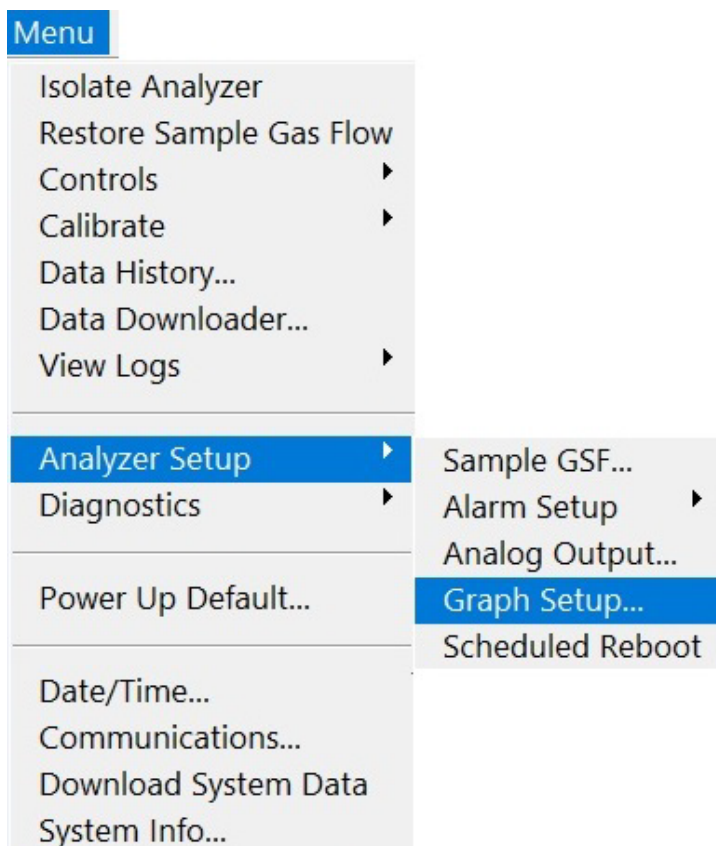


Figure 67: Graph Setup Menu

The Graph Setup menu selection is shown in Figure 67. This menu accesses the Graph Setup screen shown in Figure 68.

This screen 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 display 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.

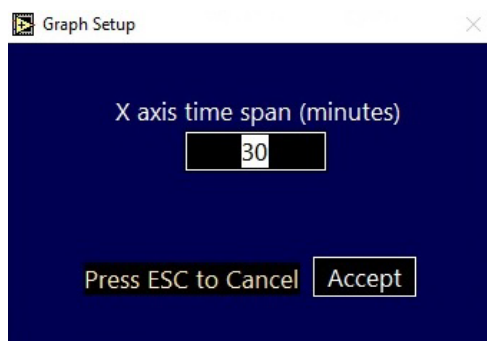


Figure 68: Graph Setup Screen

6.3.12 Scheduled Reboot

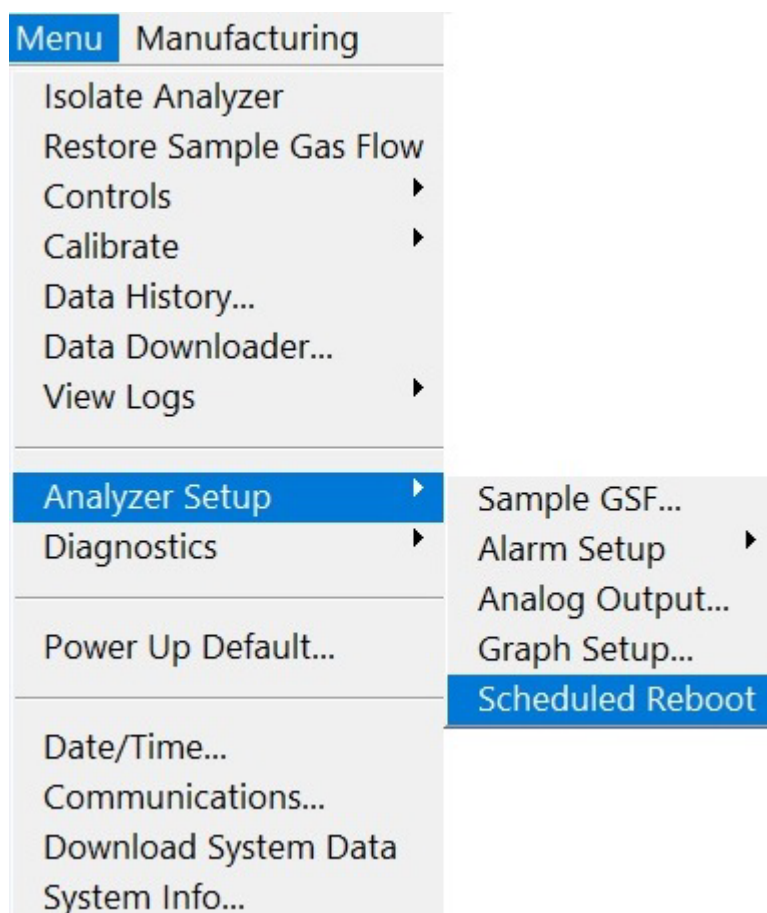


Figure 69: Scheduled Reboot Menu Selection

The Scheduled Reboot menu selection is shown in Figure 69. This menu accesses the Graph Setup screen shown in **Figure 68**.

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 70**.

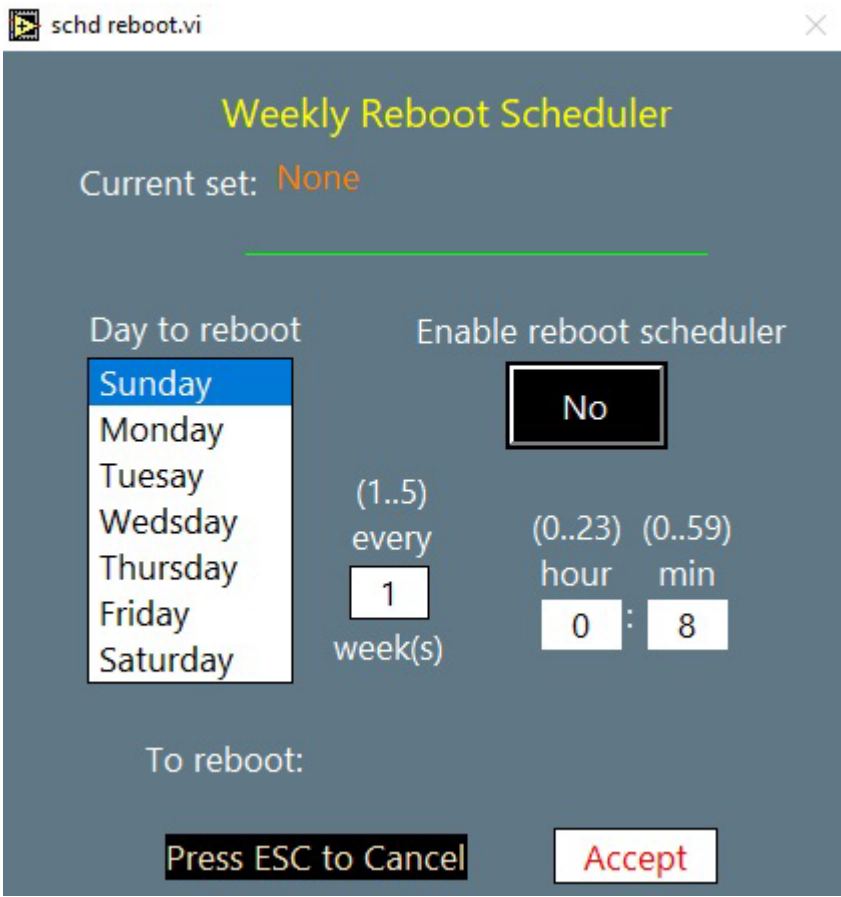


Figure 70: Next Scheduled Reboot

6.3.13 Diagnostics Menu

The **Diagnostics** menu selection from the Main Menu access eight diagnostic submenus –as can be seen in **Figure 71**.

6.3.13.1 Active Zero On/Off

The Active Zero On/Off menu selection is shown in Figure 71. This menu accesses the Active Zero Setup screen shown in Figure 72.

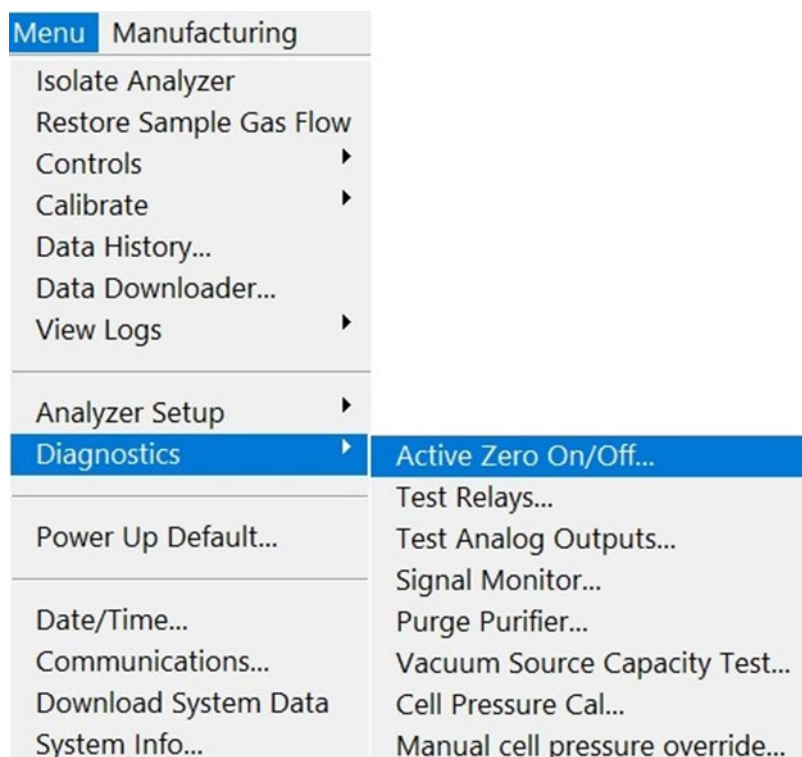


Figure 71 Active Zero On/Off Menu

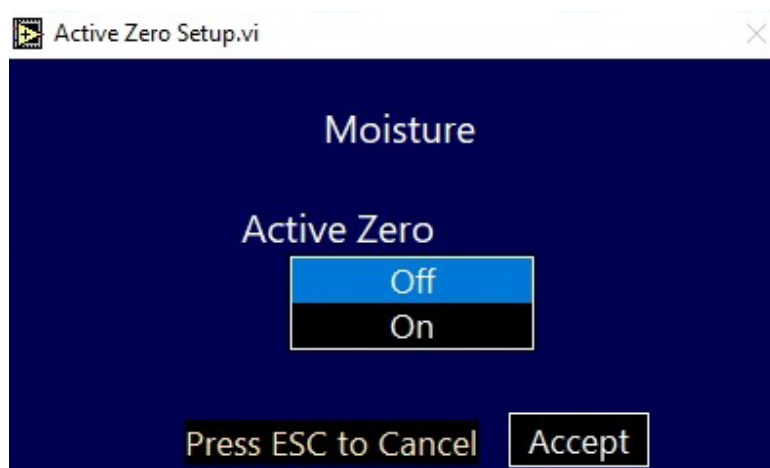


Figure 72: Active Zero Setup Screen

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 startup or after prolonged or abnormally high moisture exposure. This feature ensures that accurate low ppb H₂O readings can be made as soon as possible after initial startup, or after a high H₂O upset event. It is like the **User Zero Offset** feature in that a small positive offset is added to the analyzer H₂O 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 predictable behavior 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 as shown in **Figure 32**. 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 H₂O readings may be decreasing too rapidly for the Active Zero Offset feature to operate properly and inaccurate H₂O readings may result.

If the Active Zero Offset value reaches 5 ppb, the CAL ZERO warning message will flash in the system status block on the display. This is an indication to the operator 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) will result in inaccurate readings until the next user calibration is performed to reset 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.

6.3.13.2 Test Relays

The Test Relays menu selection is shown in Figure 73. This menu accesses the Test Alarm Relays screen shown in Figure 74.

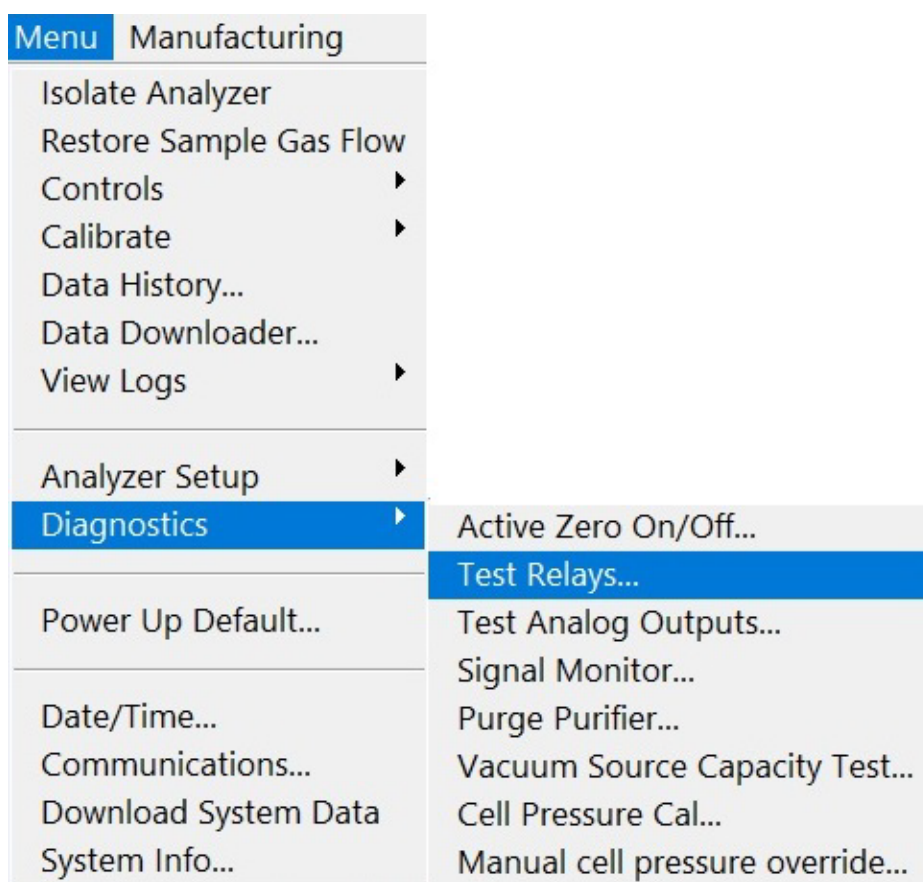


Figure 73: Test Relays Menu Selection

The Test Alarm Relays screen, shown in **Figure 74**, is used to assure that the relay outputs are functioning properly. When the Test Alarm Relays screen is accessed, 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. Then, the **Enter** key is pressed 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 35 for additional information.

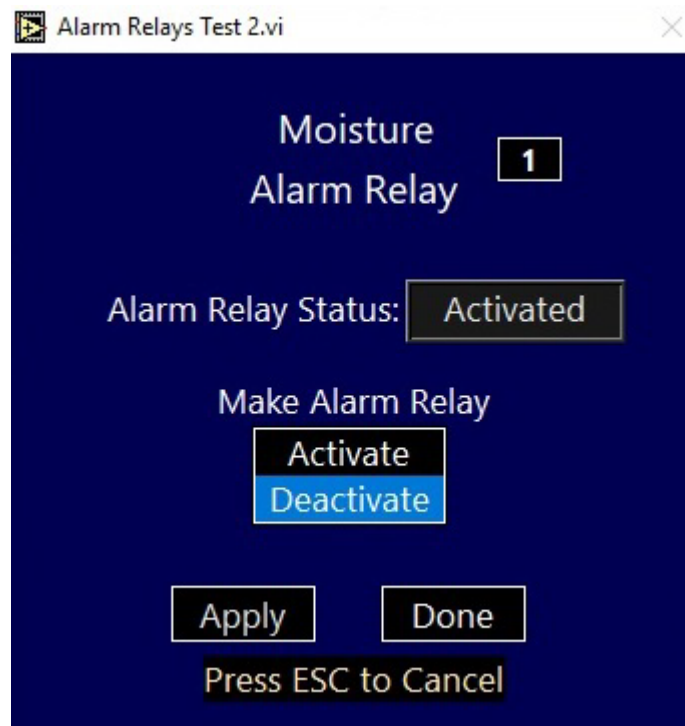


Figure 74: Test Alarm Relays Screen

6.3.13.3 Test Analog Voltage Output

The **Test Analog Voltage Output** menu selection is shown in **Figure 75**. This menu accesses the Test Analog Voltage Output screen shown in **Figure 76**.

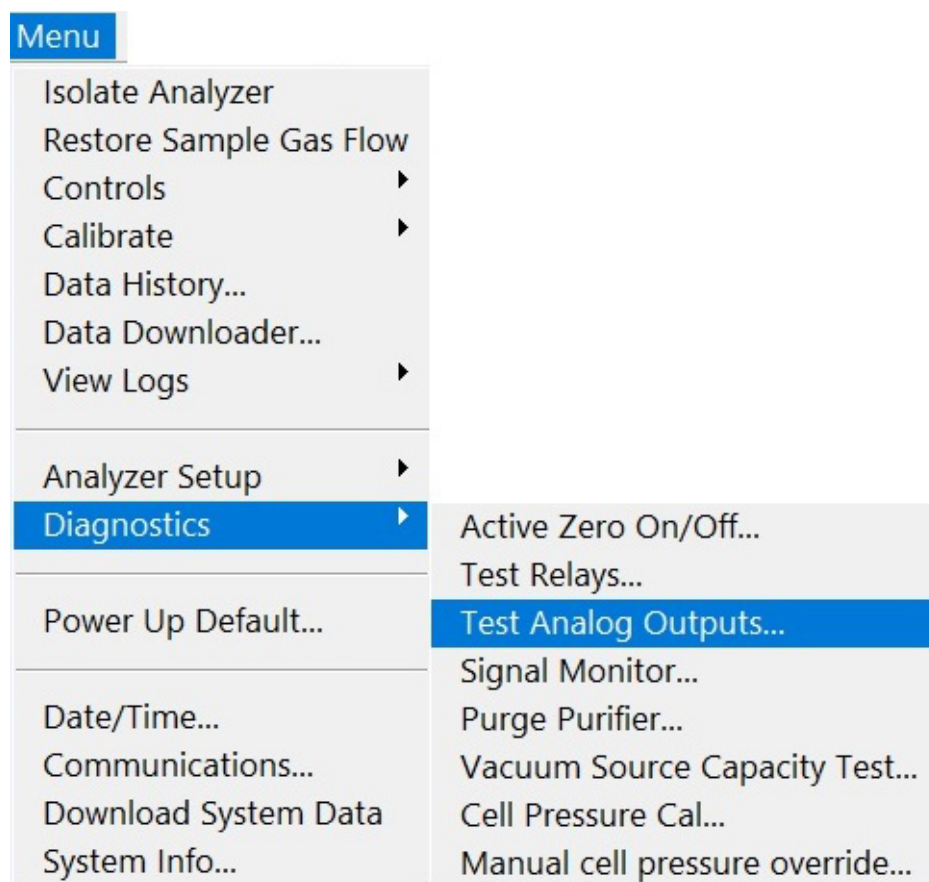


Figure 75: Test Analog Outputs Menu Selection

The Test Analog Outputs screen, as shown in **Figure 76**, is used to calibrate the analog recorder output. When the Test Analog Outputs 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 the section on analog outputs found on page 34 for additional information.

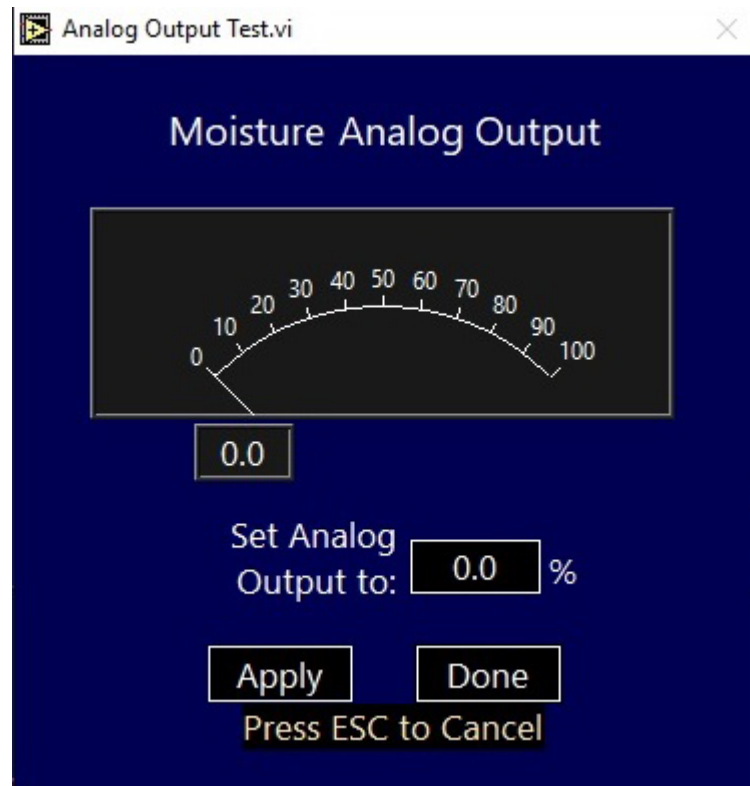


Figure 76: Test Analog Voltage Outputs Screen

6.3.13.4 Signal Monitor

The **Signal Monitor** menu selection is shown in **Figure 77**. This menu accesses the Test Signal Monitor screen shown in **Figure 78**.

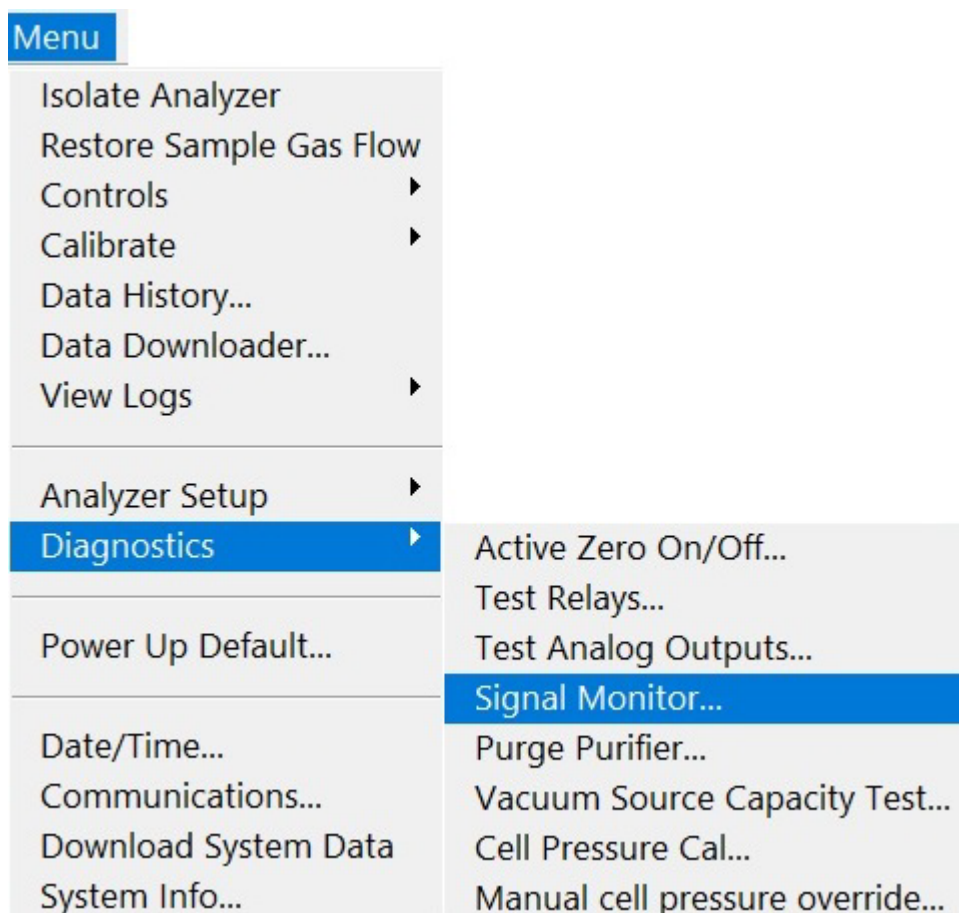


Figure 77: Signal Monitor Menu Selection

The Signal Monitor screen depicts 18 system parameters. Values for parameters are unique to each system. In the event of a system error, the parameters can be used for diagnostic purposes. Contact Servomex for assistance in using signal parameter data as a diagnostic tool for maintaining system performance.

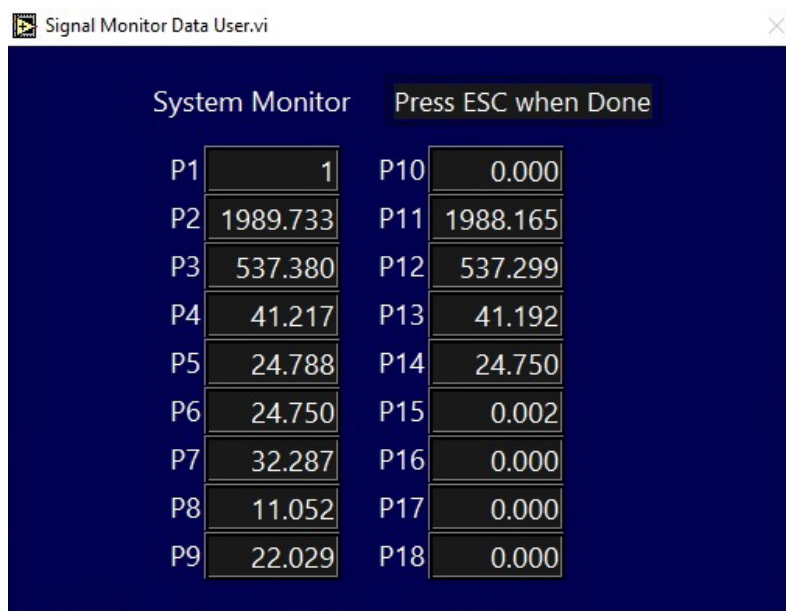


Figure 78: Signal Monitor Screen

6.3.13.5 Purge Purifier

Installation of the purifier, no matter how quickly performed, will allow ambient air to enter the plumbing. When gas flow is restored, the air will be sent into the system resulting in an increase in the moisture reading. For this reason, it is mandatory that the purifier plumbing be cycle purged before use after replacing the purifier.

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

Top purge purifier, select **Purge Purifier** from the **Diagnostics** menu (Figure 79) and the **Start Purge** dialog box shown in Figure 80 will be displayed. Use the **Next** key to toggle to **OK**, and when ready press **Enter** and Figure 81 will be displayed.

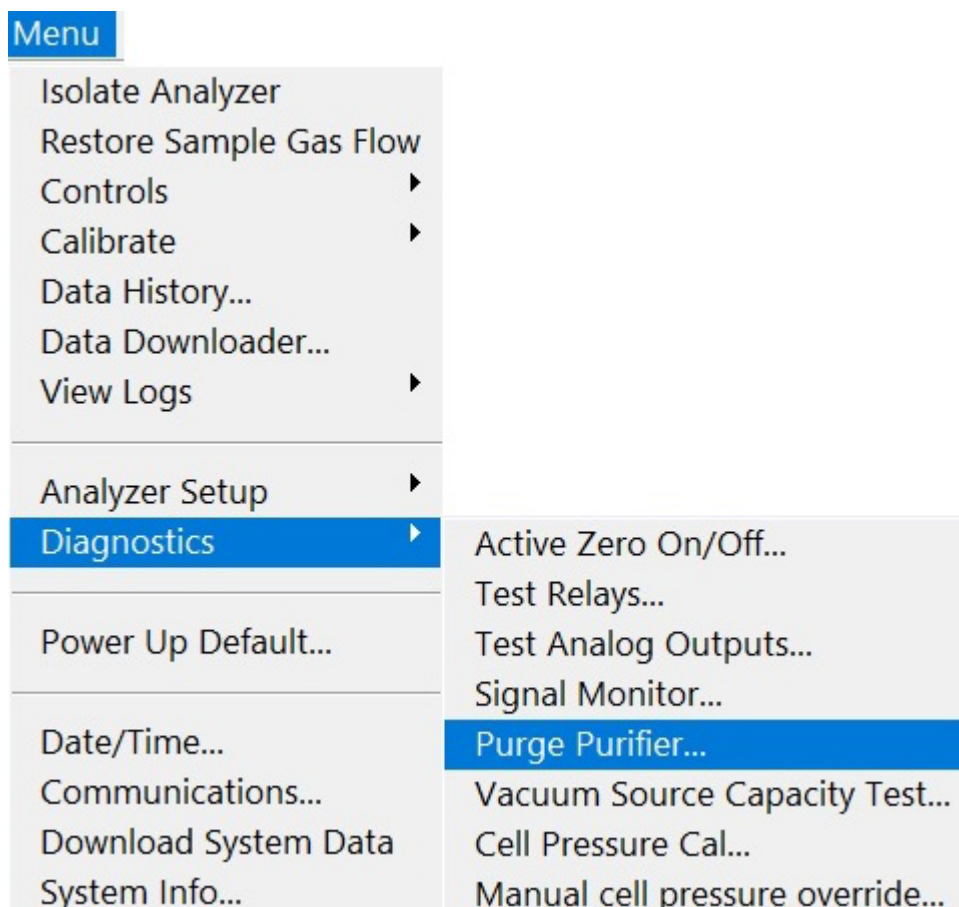


Figure 79: Purge Purifier Menu

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.

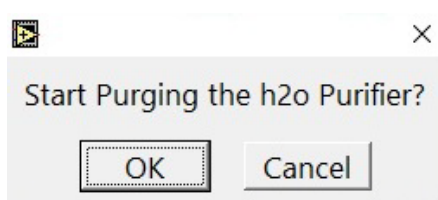


Figure 80: Purge Start

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 82**. 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 with very low moisture.

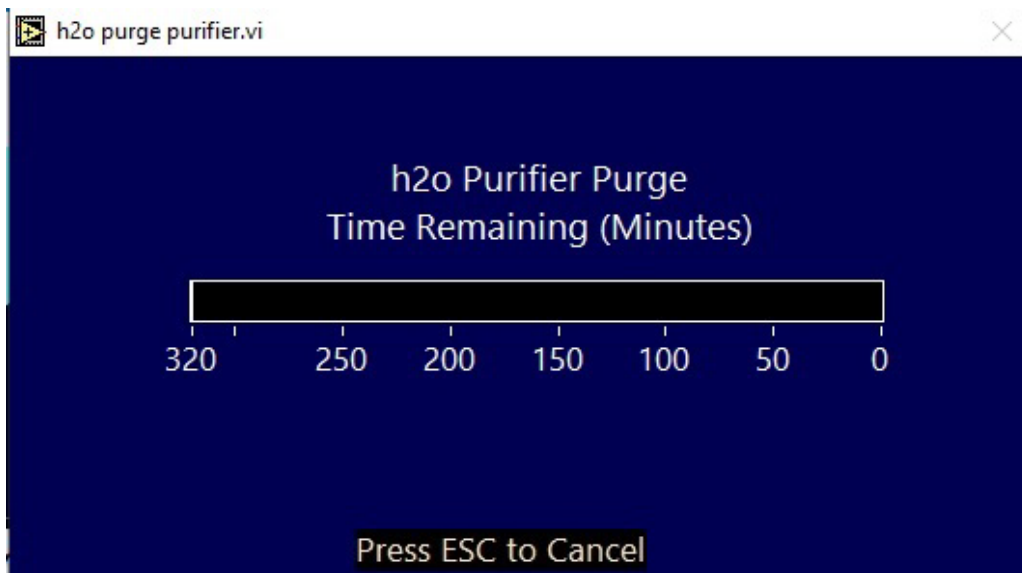


Figure 81: Purifier Purge Timeline

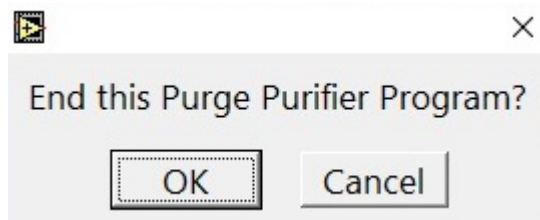


Figure 82: Purge Cancel

6.3.14 Vacuum Source Capacity Test

The Vacuum Source Capacity Test submenu is shown in Figure 83. This menu selection accesses the Vacuum source Capacity Test screen shown in Figure 84

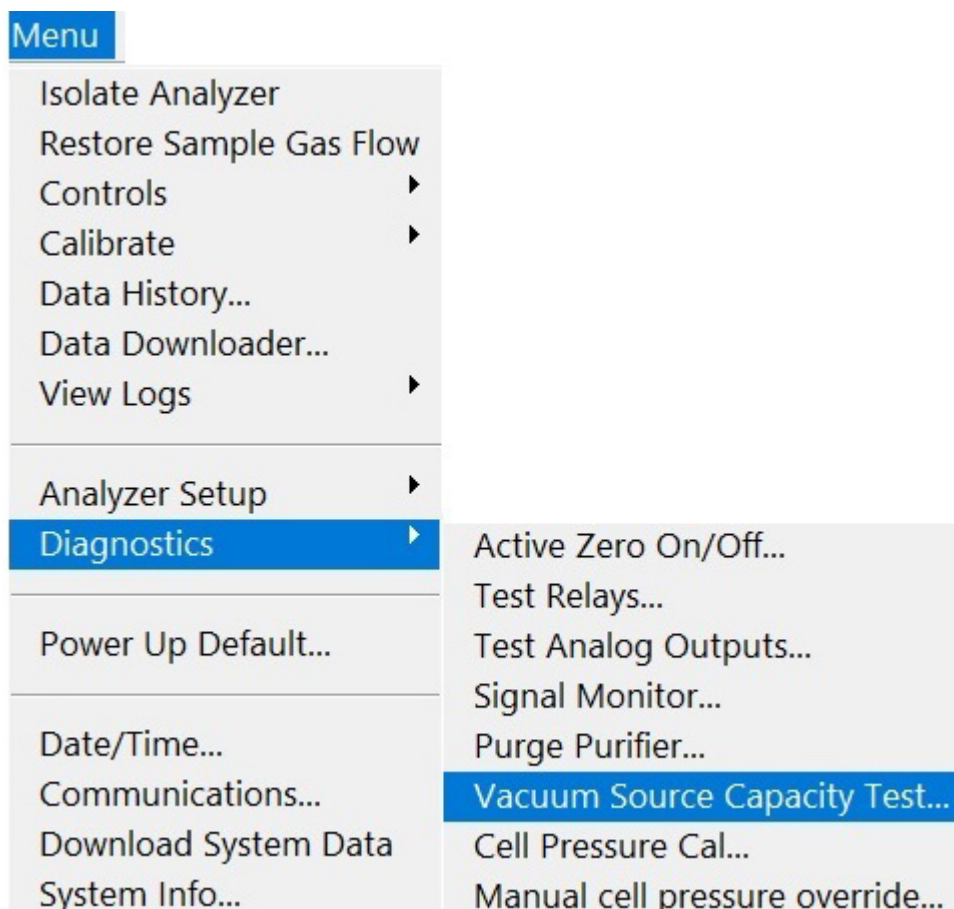


Figure 83: Vacuum Source Capacity Test Menu

The vacuum source capacity test is used to determine the strength of vacuum that the aspirator or pump can create. When the test is started, the analyzer isolates the moisture cell by closing the upstream and downstream valves. Vacuum is then monitored and displayed on the screen for 20 seconds. Pressure lower than 115 Torr is considered passing. If the aspirator or pump is unable to pull 115 Torr, a failure is indicated by the message shown in **Figure 85**. After completing the test, the user selects Escape to return to the main display. After the pump test is complete, an entry is automatically put in the pump capacity test log as shown in **Figure 54**. See page 65 for additional information on the pump test log.

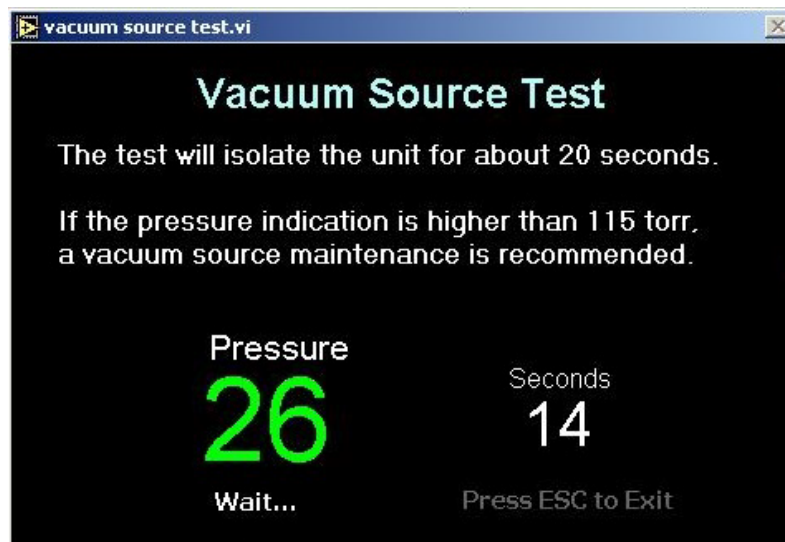


Figure 84: Vacuum Source Capacity Test

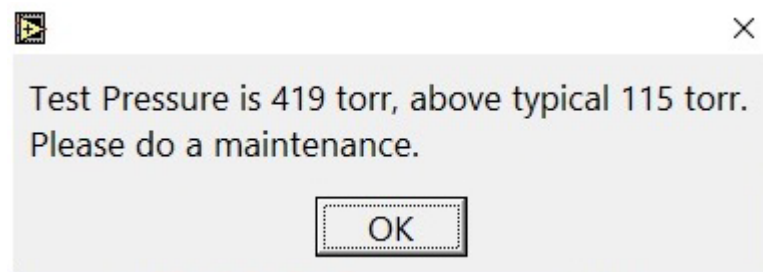


Figure 85: Pump Pressure Failure

6.3.15 Cell Pressure Calibration

The Cell Pressure Calibration Menu Selection is shown in **Figure 86**. This menu selection accesses the Cell Pressure Calibration Screen in **Figure 87**.

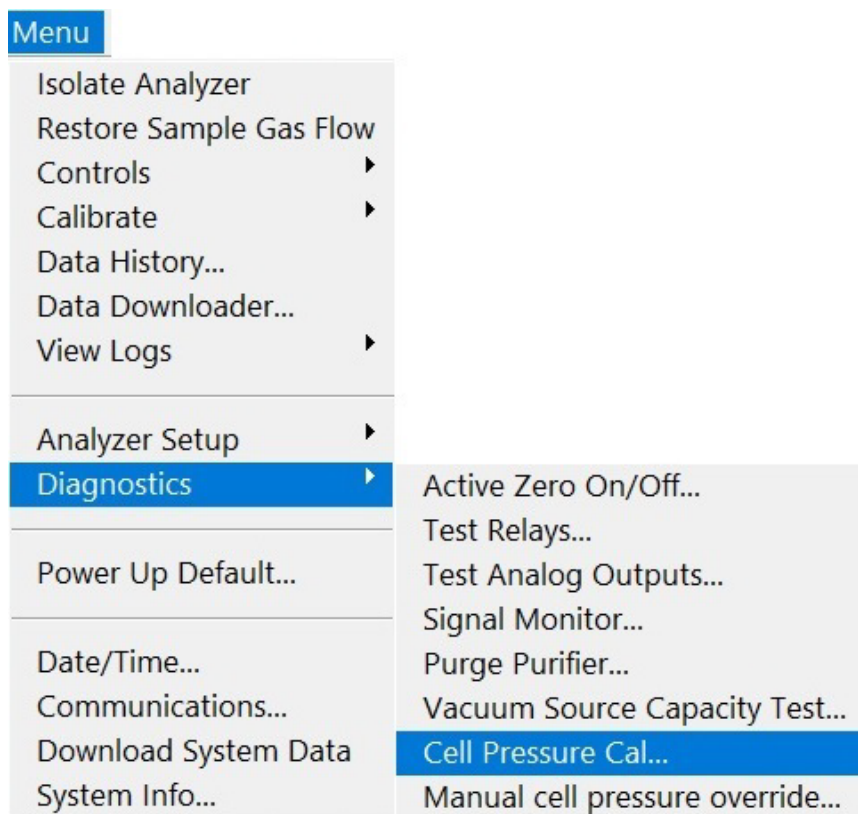


Figure 86: Cell Pressure Calibration

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 relatively 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 generally for testing purposes and should not be used during routine calibrations.

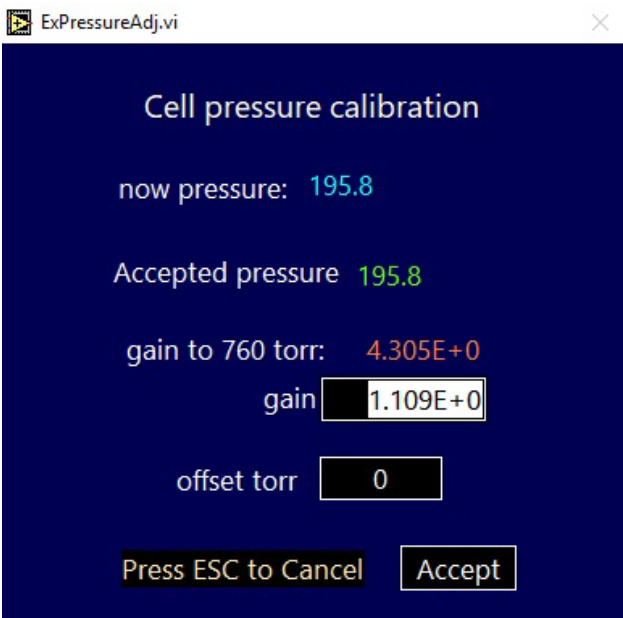


Figure 87: Cell Pressure Calibration Screen

6.3.16 Manual Cell Pressure Override

The **Manual Cell Pressure Override** menu selection is shown in **Figure 88**. This menu selection accesses the **Manual Cell Pressure Override** screen in **Figure 89**.

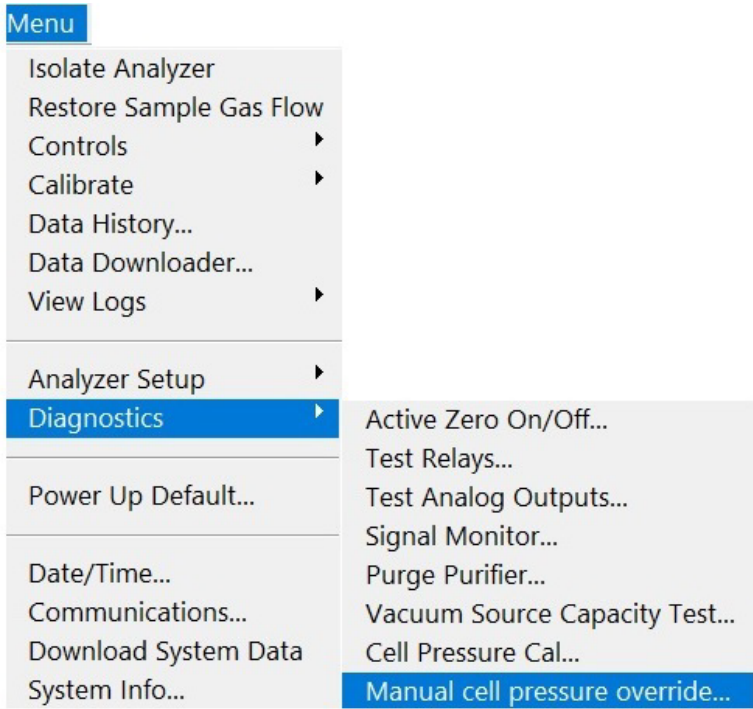


Figure 88: Manual Cell Pressure Override

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.

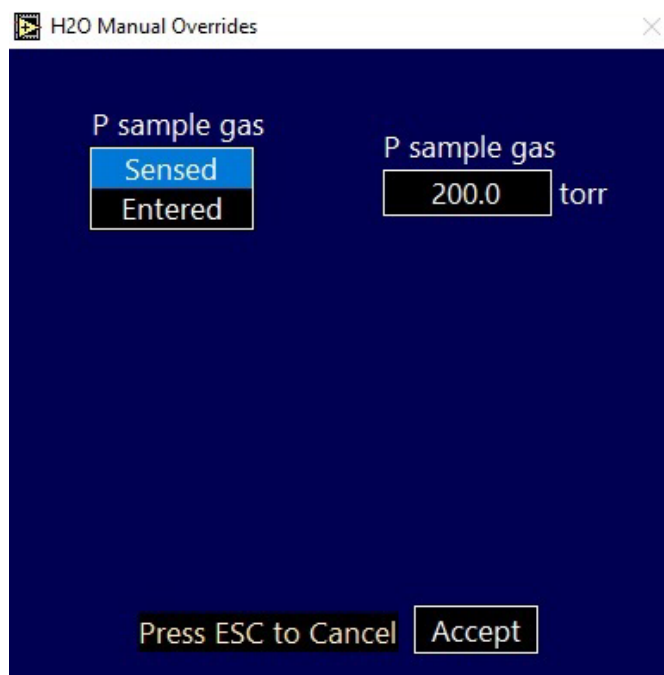


Figure 89: Manual Cell Pressure Override

6.3.17 Power Up Default

The **Power Up Default** menu selection is shown in Figure 90. This menu selection accesses the **Power Up Default** screen in Figure 91.

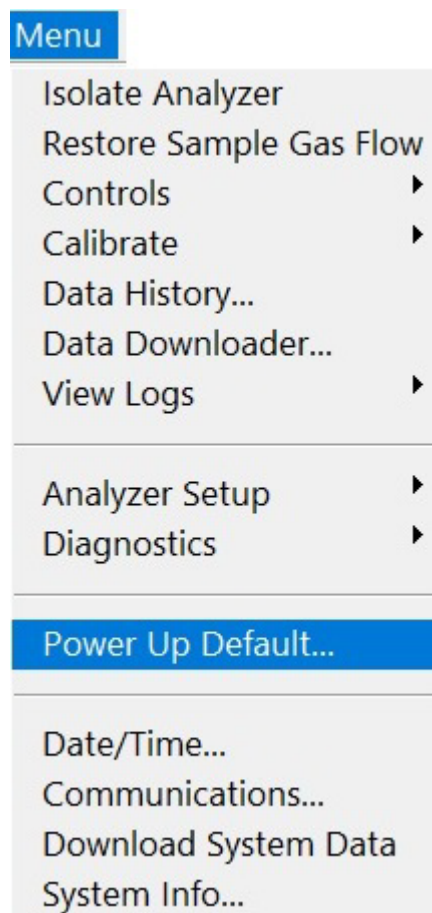


Figure 90: Power Up Default Menu

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 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.

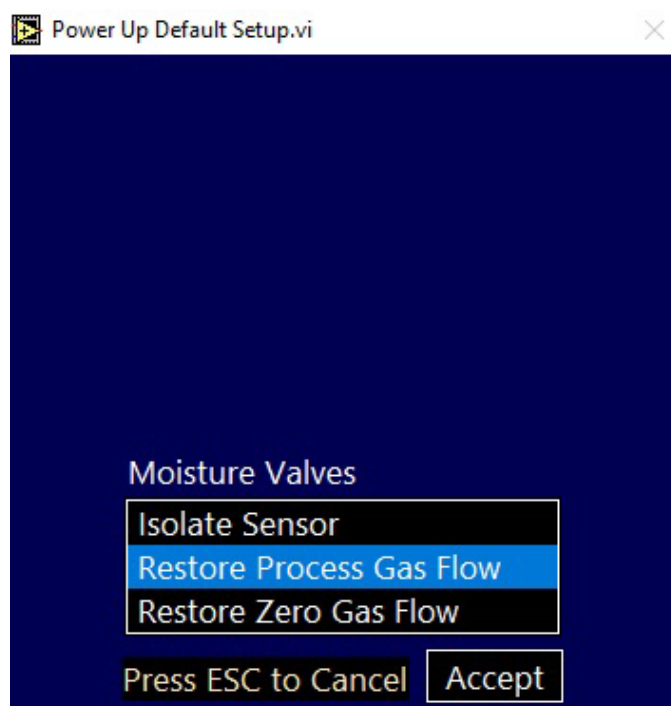


Figure 91: Power Up Default Screen

6.3.18 Communications

The **Communication** menu selection is shown in **Figure 92**. This menu selection accesses the **Communications Setup** screen in **Figure 93**.

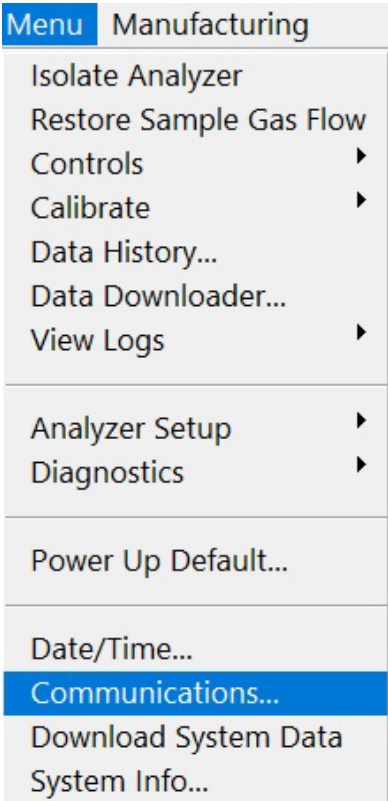


Figure 92: Communications Menu

The Communications screen is used to set parameters related to serial PC 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 the **Next** key is used to move to the **Accept** field and the **Enter** key is hit. See page 33 for additional information.

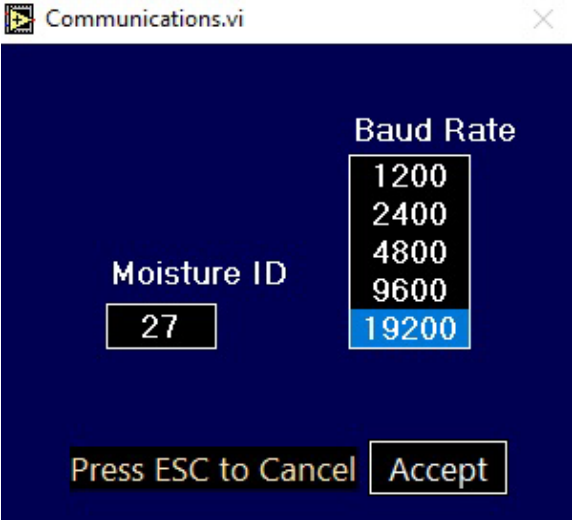


Figure 93: Communications Setup Screen

6.3.19 Date/Time

The **Date/Time** menu selection is shown in **Figure 94**. This menu selection accesses the **Manual Date/Time Setup** screen in **Figure 95**.

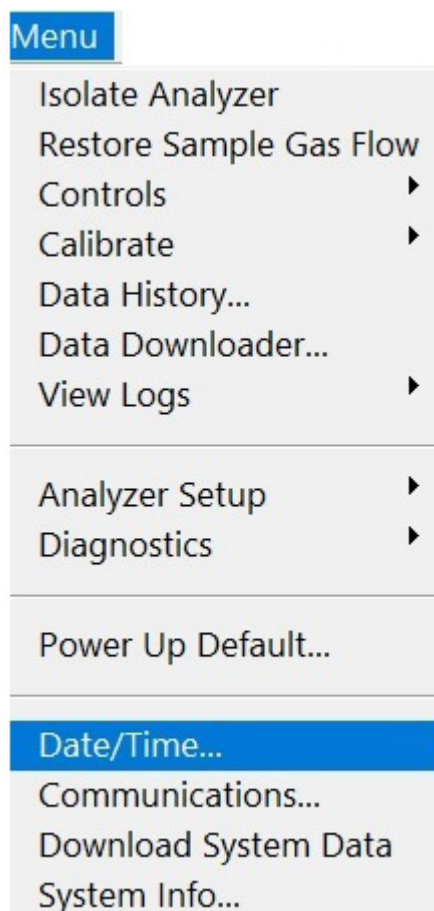


Figure 94: Date/Time Menu

The **Date/Time Setup** screen (**Figure 95**) 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 96**). 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.

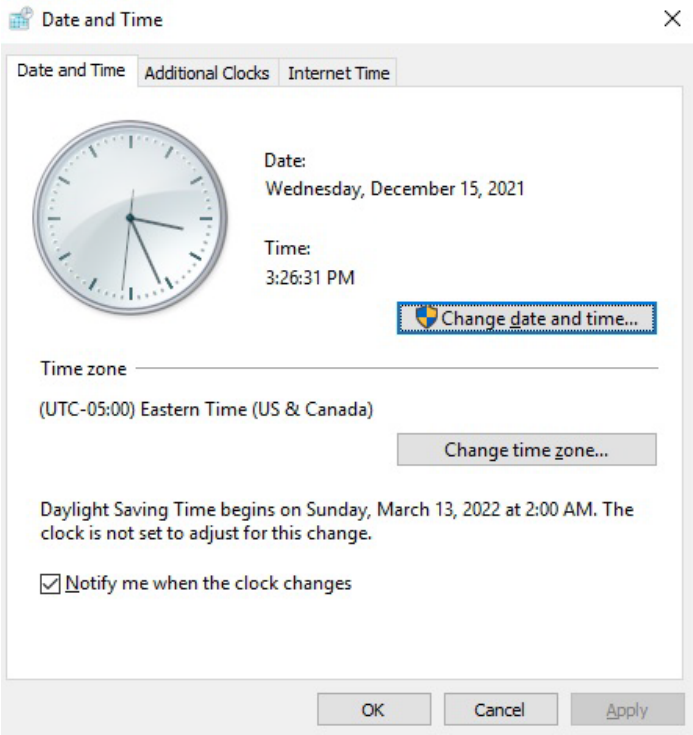


Figure 95: Date/Time Setup Screen

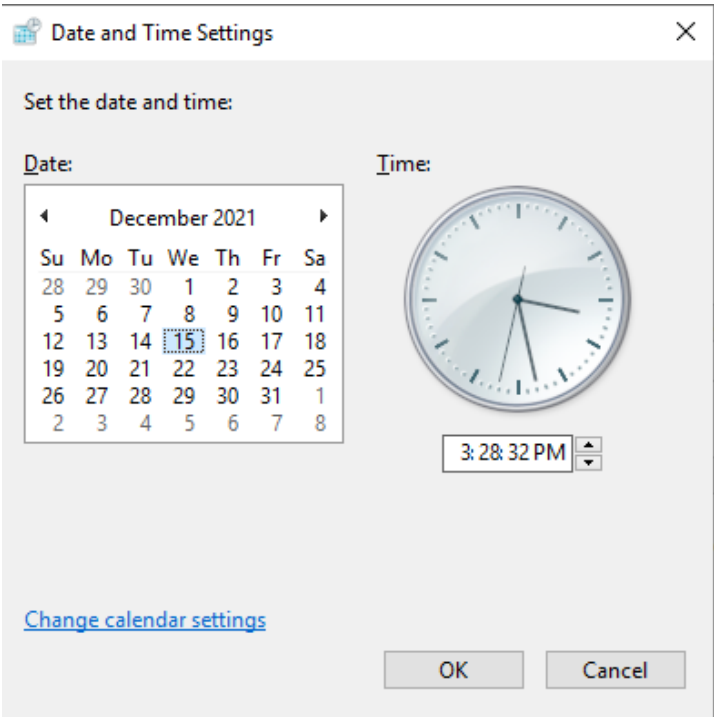


Figure 96: Date and Time Edit Screen

6.3.20 Download System Data

The **Download System Data** menu selection is shown in **Figure 97**. This menu selection accesses the **Insert Media** screen in **Figure 89**.

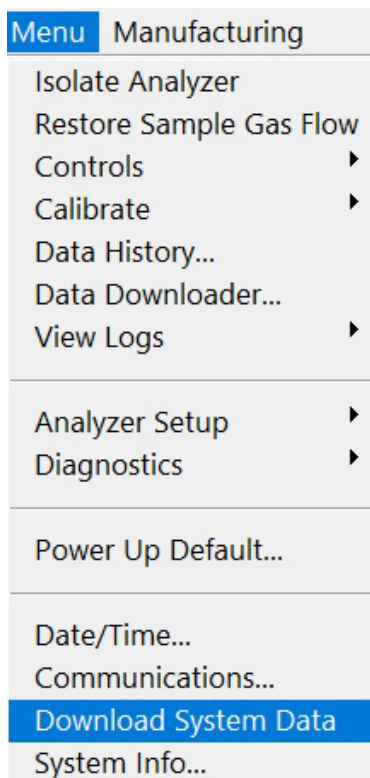


Figure 97 Download System Data Menu

If problems develop with the analyzer, the contents of the internal system data files can easily be downloaded to a USB memory stick, and the files can either be mailed or e-mailed to Servomex for evaluation. Install a memory stick into the external USB socket located behind the front door and on the left side of the analyzer. After hitting **Enter** from the Download System Data menu, **Figure 98** will appear.

The system downloads data for ten days ending with the date set on the screen as shown in **Figure 98**. The current date is set automatically but can be changed to capture activity at a specific time other than the last 10 days. To change the date, use the **Next** key to move between fields and use the arrow keys (and ▼ change the date.

Hit **Enter** and the download process will begin, and a time bar will appear as in **Figure 100**. The process should only take a minute or two and when complete control will be returned to the user.

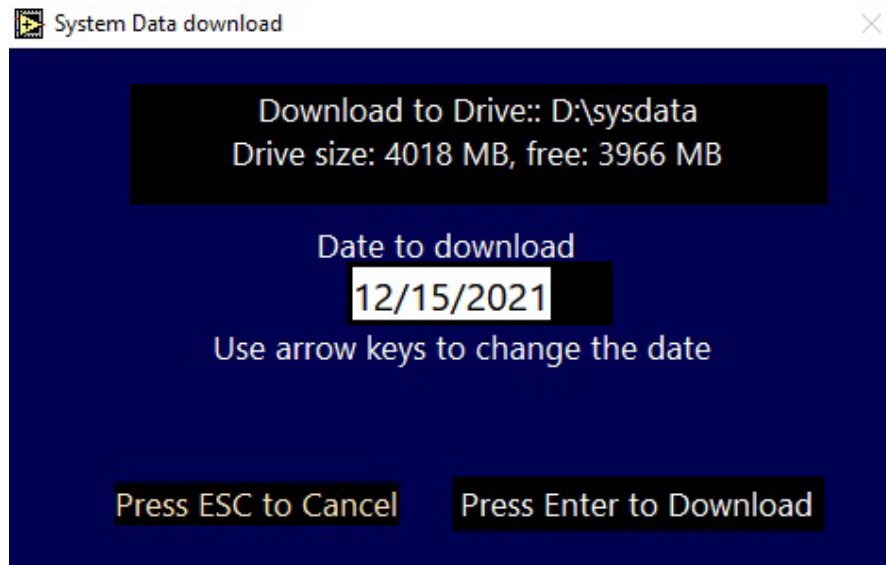


Figure 98: Insert Media

If there is insufficient space available on the media a warning will appear as in **Figure 99**.

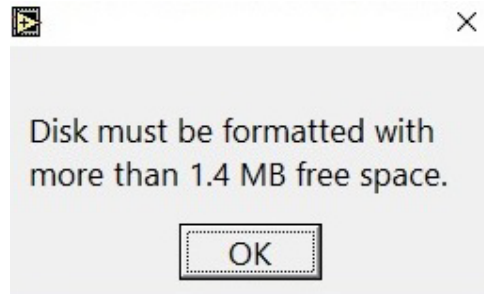


Figure 99: Disk Space Warning

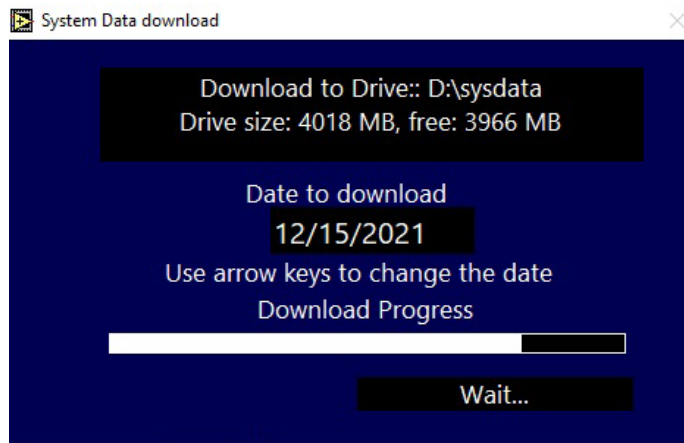


Figure 100: Download Timeline

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 memory stick, which can then be used to forward the information to Servomex for evaluation.

6.3.21 System Info

The **System Info** menu selection is shown in **Figure 101**. This menu selection accesses the **System Info** screen in **Figure 102**.

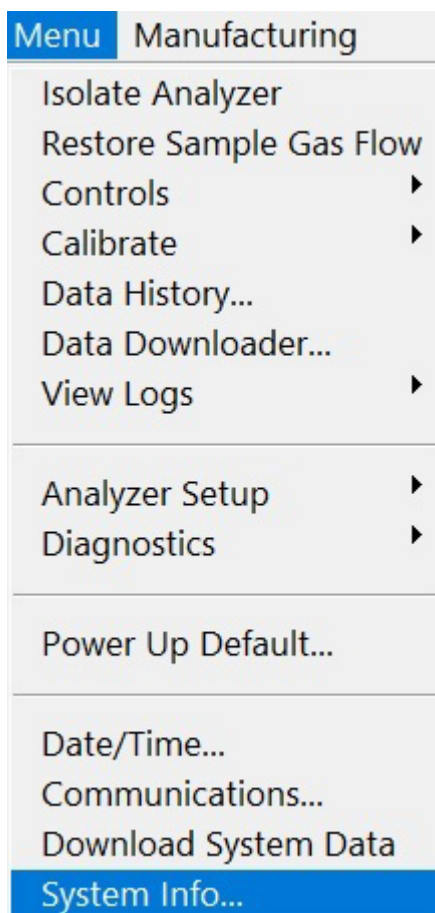


Figure 101: System Info Menu

The System Info screen gives 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 102: System Info Screen

6.3.22 Firmware Upgrade

While the **Firmware Upgrade** box is highlighted, hitting the **Next** key will bring up the Firmware Upgrade dialog box as in **Figure 103** below.

Place the memory stick with appropriate files in the USB port located behind the front door. When ready, select the **Yes, Proceed** key and follow the instructions. At the conclusion of the upgrade the analyzer will automatically reboot.

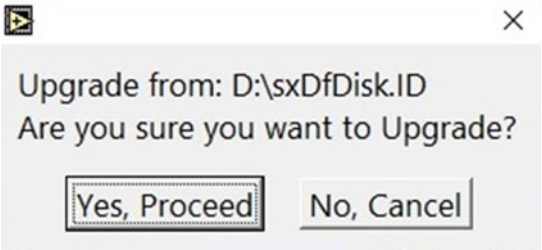


Figure 103: Firmware Upgrade

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 9**). 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
CO2	180 +/- 50 Torr

Table 8: 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 reasonably correct readings. The exceptions are light gases such as Helium and Hydrogen, whose flow rates should be set to approximately one-third that of Nitrogen.

7.5 Flammable Sample Gas

The only flammable gas that the DF 750 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 Maintenance

8.3.1 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 50° C (122° F). Storage in direct sunlight can cause temperatures to exceed the recommended limits even though ambient temperatures may be below the maximum temperature.

8.3.2 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 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.

8.3.3 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.

8.3.4 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.

8.3.5 Gas Purifier Maintenance

8.3.5.1 Gas Purifier provides a low moisture calibration gas (Zero Gas)

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 greatly 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.

8.3.5.2 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) flows through the zero purifier and the moisture reading does not reduce, then the purifier is expended and needs to be replaced.

8.3.5.3 Preparation for Gas Purifier Removal and Installation

NOTE



Read the installation instruction 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

8.3.6 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 page 42) 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, refer to the purifier purge routine found in the diagnostics menu (see **6.3.13.5 Purge Purifier**.)

8.3.7 Power Cord Replacement

CAUTION: POWER CORD SAFETY



The power cord provides the 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.

8.4 Troubleshooting Guide for the NanoTrace Analyzer

The DF-700 series moisture analyzer constantly monitors of the analyzer 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 **6.3.8.2 System Error 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 as shown in **Table 6** on page 71. In addition, it may be helpful to download system data and provide the downloaded file to Servomex (refer to **6.3.20 Download System Data**).

8.5 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 1.5Analyzer 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.).
4. Mark each for reattachment later.
5. Ensure that all internal components are adequately 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 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

8.6 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.**)*

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

The label shown in Figure 104 is fitted to the analyzer.



Figure 104 The WEE label

The label identifies that:

- The analyzer is within the scope of the 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 the requirements 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

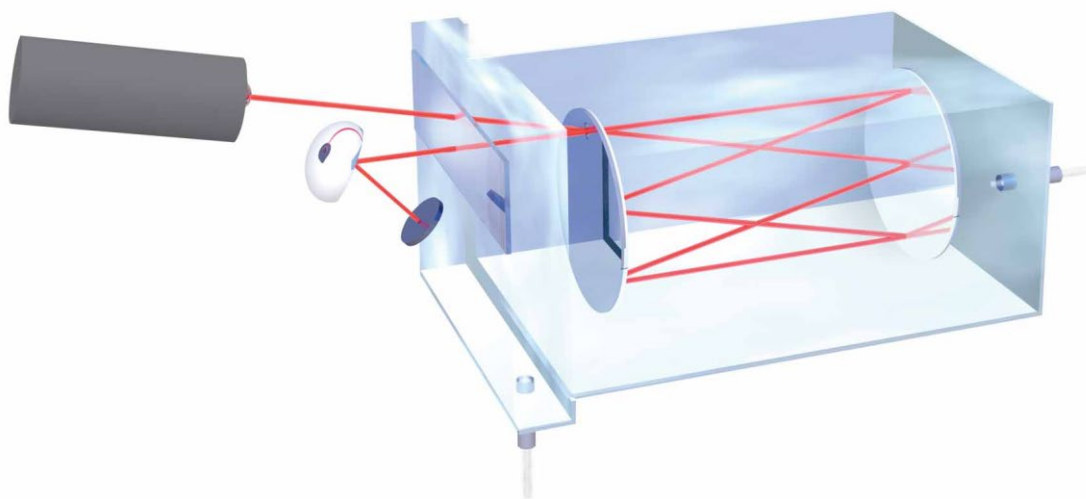


Figure 105: Herriott Cell Conceptual Drawing

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 105**. 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-750 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

Theory of Operation

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_{λ} $\equiv$ Absorbance at wavelength λ

T $\equiv$ Transmittance

I_0 $\equiv$ Reference Intensity of Light

I $\equiv$ Measured Intensity of Light after Absorption

ε_{λ} $\equiv$ 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:

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

σ_{λ} $\equiv$ Molecular Cross Section (cm²/molecule) at wavelength λ

N $\equiv$ Molecular Density (molecules/cm³)

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 (ppbv).

10. Specifications

10.1 Moisture Detection

Lowest Detection Level (LDL) DF-750: 100 ppt @ Constant Conditions with all background gases except CO₂. LDL with CO₂: 250ppt

Lowest Detection Level (LDL) DF-750 Ultra: 55 ppt @ Constant Conditions with all background gases except CO₂. LDL with CO₂: 250ppt

Accuracy: Greater of $\pm 3\%$ 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: N₂, H₂, He, Ar, O₂, and CO₂

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

10.2 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)

10.3 Gas Routing

Gas Inlet, Sample:

Flow Rate: 1.3 slpm total (moisture cell: 1 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

10.4 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.

10.5 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)

10.6 Power

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

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

10.7 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

10.8 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 Data Safety Sheets



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Section 1. Identification

Country of Origin: : Made in USA.

Section 2. Hazards identification

OSHA/HCS status : While this material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200), this SDS contains valuable information critical to the safe handling and proper use of the product. This SDS should be retained and available for employees and other users of this product.

Classification of the substance or mixture : Not classified.

GHS label elements

Signal word : No signal word.

Hazard statements : No known significant effects or critical hazards.

Precautionary statements

General : Read Product Installation Instructions before use. Keep out of reach of children. If medical advice is needed, have product label and this document at hand.

Prevention : Not applicable.

Response : Not applicable.

Storage : Not applicable.

Disposal : Not applicable.

Hazards not otherwise classified : None known.

Section 3. Composition/information on ingredients

Substance/mixture : Mixture (Article)

Other means of identification : Not available.

CAS number/other identifiers

CAS number : Not applicable.

Product code : Part numbers containing 'OXF' and 'CLXP'

Ingredient name	%	CAS number
Stainless Steel 316	70 - 100	
Zeolites	0 - 30	1318-02-1

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

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.

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Section 4. First aid measures

Description of necessary first aid measures

- | | |
|---------------------|--|
| Eye contact | : Unlikely route of exposure if used under recommended conditions. Wash with water, continuing for 10 minutes. Remove contact lenses and raise eyelid first. Seek medical attention if adverse symptoms are experienced. |
| Inhalation | : Unlikely route of exposure if used under recommended conditions. If dust resulting from damage to the unit is inhaled, remove casualty to fresh air. Seek medical attention if adverse symptoms experienced. |
| Skin contact | : Unlikely route of exposure if used under recommended conditions. If experiencing irritation, wash with soap and water. Seek medical attention if irritation or other symptoms are experienced. |
| Ingestion | : Unlikely route of exposure if used under recommended conditions. Rinse mouth with water and give plenty of water to drink. Do not induce vomiting unless instructed to do so by medical personnel. |

Most important symptoms/effects, acute and delayed

Potential acute health effects

- | | |
|---------------------|---|
| Eye contact | : No known significant effects or critical hazards. |
| Inhalation | : No known significant effects or critical hazards. |
| Skin contact | : No known significant effects or critical hazards. |
| Ingestion | : No known significant effects or critical hazards. |

Over-exposure signs/symptoms

- | | |
|---------------------|---|
| Eye contact | : No known significant effects or critical hazards. |
| Inhalation | : No known significant effects or critical hazards. |
| Skin contact | : No known significant effects or critical hazards. |
| Ingestion | : No known significant effects or critical hazards. |

Indication of immediate medical attention and special treatment needed, if necessary

- | | |
|-----------------------------------|---|
| Notes to physician | : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled. |
| Specific treatments | : No specific treatment. |
| Protection of first-aiders | : No action shall be taken involving any personal risk or without suitable training. |

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

- | | |
|---------------------------------------|---|
| Suitable extinguishing media | : Use an extinguishing agent suitable for the surrounding fire. |
| Unsuitable extinguishing media | : None known. |

Specific hazards arising from the chemical : No specific fire or explosion hazard.

Hazardous thermal decomposition products : No specific data.

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Section 5. Fire-fighting measures

- Special protective actions for fire-fighters** : AresKleen OXP Purification Material is sold contained within a sealed assemblies and no fire hazard is present under ordinary conditions. The material it self is not combustible and poses no fire hazard if released from the assembly. In the event of damage to the unit, a small quantity of water reactive material that can generate heat can be exposed.
- Special protective equipment for fire-fighters** : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

- For non-emergency personnel** : No action shall be taken involving any personal risk or without suitable training. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Put on appropriate personal protective equipment.
- For emergency responders** : If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

- Environmental precautions** : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Please note the assembly contains a reactive solid material. Contact of that AresKleen OXP purification material with water and/or air will generate heat. Contact of the material with skin or eyes will cause burns and/or severe irritation

Serious harm from accidental release during handling of the undamaged, unused article is unlikely due to the form of the product and the quantity of hazardous material present. Dust resulting from damage to the unit is potentially water-reactive and must be disposed of as hazardous waste.

Eliminate sources of ignition and other combustible materials. Wear protective clothing as indicated in Section 8. Place in a dry container. Use care in handling container as product and container may become sufficiently hot to burn the skin. Place container in a well ventilated area. Stir material occasionally to ensure complete reaction (if the AresKleen OXP purification material has been exposed to moisture, heat may be generated). Material is spent when no further increase in temperature occurs following stirring. Handling must take into account any contaminants on the Gaskleen Purifier Assembly as the result of use.

Methods and materials for containment and cleaning up

- Small spill** : Move containers from spill area. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor.
- Large spill** : Move containers from spill area. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Wear gloves while handling and all PPE appropriate for any of the contaminants/materials used in contact with the article, as the result of use. Ensure any areas are clear of gases. Remove purifier assembly and contain in a labeled box. Dispose of via a licensed waste disposal contractor.

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Section 7. Handling and storage

Precautions for safe handling

- Protective measures** : Put on appropriate personal protective equipment (see Section 8).
- Advice on general occupational hygiene** : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. See also Section 8 for additional information on hygiene measures.

- Conditions for safe storage, including any incompatibilities** : Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

The filter in its supplied state contains zeolite chemically enclosed with no risk from dust.

Take precautions to avoid mechanical damage to the filter.

If damaged there is a risk of exposure to zeolite dust.

Follow instructions with regard to installation, purging, and operation.

When not in use and before installation, store the Gaskleen purifier assembly in a cool, clean, dry, and well ventilated place in the unopened packaging as supplied.

Take precautions to maintain the integrity of the protective argon covering.

Keep product in packaging as supplied until ready for use.

Keep container tightly closed. Do not expose purification material to the atmosphere.

Keep dry.

Store assemblies at ambient temperatures

Do not puncture container.

The AresKleen OXP purification material in the assembly will react with strong oxidizing agents. Avoid contact with these types of compounds except as per intended use as outlined in the product literature.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

None.

- Appropriate engineering controls** : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.
- Environmental exposure controls** : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation.

Individual protection measures

- Hygiene measures** : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Ensure that eyewash stations and safety showers are close to the workstation location.
- Eye/face protection** : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

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Section 8. Exposure controls/personal protection

- Hand protection** : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.
- Body protection** : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Other skin protection** : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Respiratory protection** : Use a properly fitted, particulate filter respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

- Physical state** : Solid. [Stainless Steel Gas Purifier.] Article contains AresKleen OXP purification material - small, round, tan beads which are not visible unless the unit is damaged, as when supplied, the beads are fully encased in a welded stainless steel assembly.
- Color** : Outer assembly metallic
- Odor** : Not available.
- Odor threshold** : Not available.
- pH** : Not available.
- Melting point** : AresKleen OXP purification material will combust or decompose before melting. Melting point of stainless-steel 1400°C.
- Boiling point** : Not available.
- Flash point** : Not applicable.
- Evaporation rate** : Not applicable.
- Flammability (solid, gas)** : Not available.
- Lower and upper explosive (flammable) limits** : Not available.
- Vapor pressure** : Not available.
- Vapor density** : Not available.
- Relative density** : Not available.
- Solubility** : Insoluble in the following materials: cold water and hot water.
- Partition coefficient: n-octanol/water** : Not available.
- Auto-ignition temperature** : Not available.
- Decomposition temperature** : Not applicable.
- Viscosity** : Not available.

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Section 10. Stability and reactivity

Reactivity	: The product is non-reactive under recommended conditions of use and storage. AresKleen OXP Purification Material is slightly water reactive.
Chemical stability	: The product is stable.
Possibility of hazardous reactions	: Under normal conditions of storage and use, hazardous reactions will not occur.
Conditions to avoid	: No specific data.
Incompatible materials	: Water.
Hazardous decomposition products	: Silica.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

There is no data available.

Irritation/Corrosion

There is no data available.

Sensitization

There is no data available.

Carcinogenicity

There is no data available.

Specific target organ toxicity (single exposure)

There is no data available.

Specific target organ toxicity (repeated exposure)

There is no data available.

Aspiration hazard

There is no data available.

Information on the likely routes of exposure : Dermal contact.

Potential acute health effects

Eye contact	: No known significant effects or critical hazards.
Inhalation	: No known significant effects or critical hazards.
Skin contact	: No known significant effects or critical hazards.
Ingestion	: No known significant effects or critical hazards.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact	: No known significant effects or critical hazards.
Inhalation	: No known significant effects or critical hazards.

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Section 11. Toxicological information

Skin contact : No known significant effects or critical hazards.

Ingestion : No known significant effects or critical hazards.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : No known significant effects or critical hazards.

Potential delayed effects : No known significant effects or critical hazards.

Long term exposure

Potential immediate effects : No known significant effects or critical hazards.

Potential delayed effects : No known significant effects or critical hazards.

Potential chronic health effects

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

There is no data available.

Section 12. Ecological information

Toxicity

There is no data available.

Persistence and degradability

There is no data available.

Bioaccumulative potential

There is no data available.

Mobility in soil

Soil/water partition coefficient (K_{oc}) : There is no data available.

Other adverse effects : No known significant effects or critical hazards.

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Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 14. Transport information

	DOT Classification	IMDG	IATA
UN number	Not regulated.	Not regulated.	Not regulated.
UN proper shipping name	-	-	-
Transport hazard class(es)	-	-	-
Packing group	-	-	-
Environmental hazards	No.	No.	No.
Additional information	-	-	-

AERG : Not applicable

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption:** Not determined
United States inventory (TSCA 8b): Not determined.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

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SAFETY DATA SHEET

Gaskleen® Purifier Assemblies employing AresKleen™ OXP and CLXP Purification Materials

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Section 15. Regulatory information

Clean Air Act Section 602 : Not listed

Class II Substances

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304**Composition/information on ingredients**

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Not applicable.

Composition/information on ingredients

No products were found.

State regulations

Massachusetts : None of the components are listed.

New York : None of the components are listed.

New Jersey : None of the components are listed.

Pennsylvania : None of the components are listed.

California Prop. 65

No products were found.

Section 16. Other information

History

Date of issue mm/dd/yyyy : 06/30/2014

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Prepared by : KMK Regulatory Services Inc.

Key to abbreviations : ATE = Acute Toxicity Estimate
 BCF = Bioconcentration Factor
 GHS = Globally Harmonized System of Classification and Labelling of Chemicals
 IATA = International Air Transport Association
 IBC = Intermediate Bulk Container
 IMDG = International Maritime Dangerous Goods
 LogPow = logarithm of the octanol/water partition coefficient
 MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
 UN = United Nations

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Section 16. Other information

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Appendix A – Hydrogen Safety System

The **Hydrogen Safety System** is designed to safeguard the DF-750 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 Service 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 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 107** on page 136.

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 107** on page 136.
- The sample gas inlet connection is made to an interlock valve mounted at the sample gas inlet on the rear of the analyzer. NOTE: 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 and 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 28**) 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 rotameter 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 assure 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 most likely 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-750 only: Relay 8 has been permanently designated for this safety system and is not available to the end user for assignment to alarms.

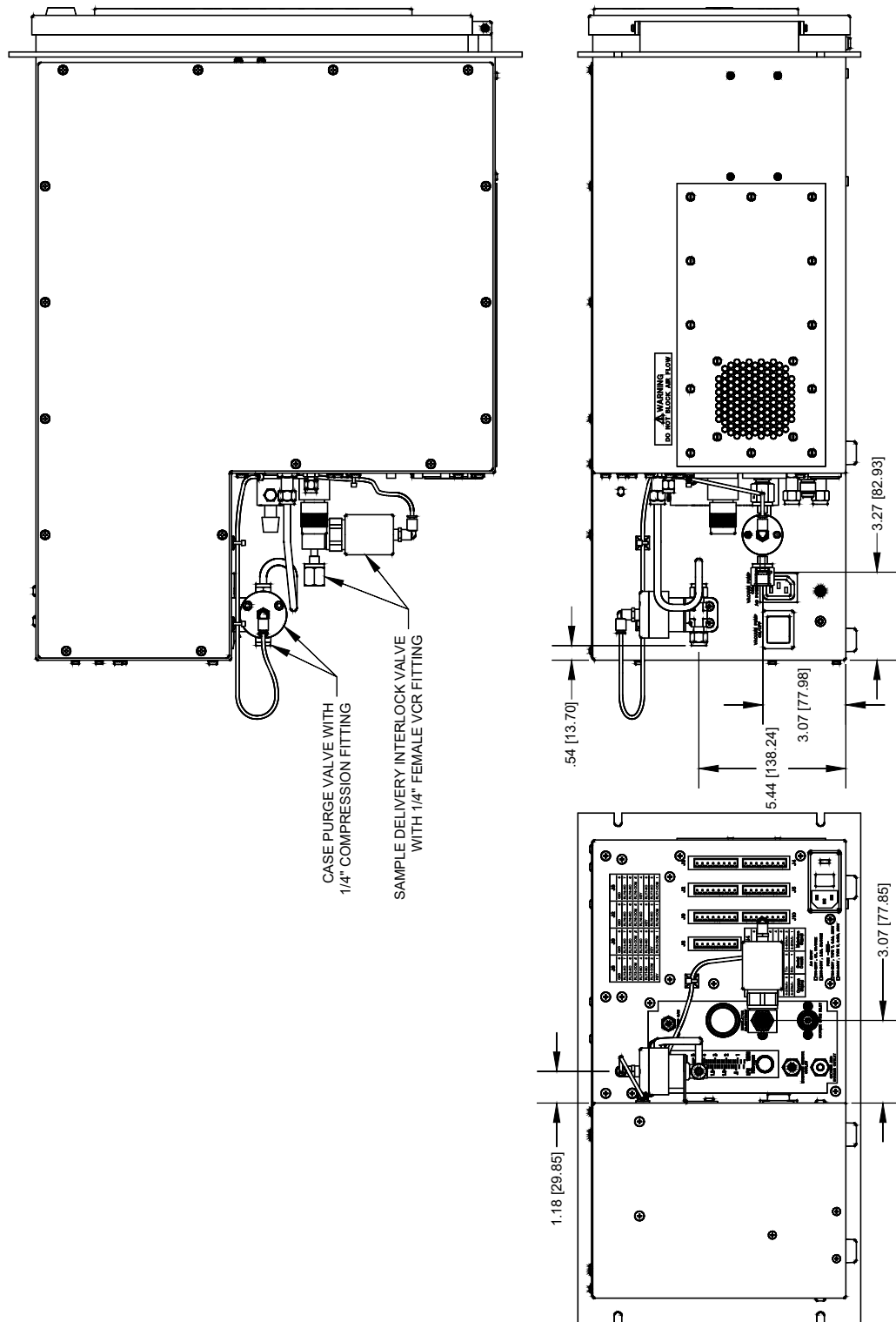


Figure 106: Hydrogen Safety System



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**
- 1. Protocol**
- 2. Table of Commands**
- 3. RS-232/RS-485 Wiring**
- 4. Timing**
- 5. Command Description and Examples**

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, can't 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 as long as the commands share the same syntax.

1. Protocol

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

11 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

12 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 has to 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+01

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

<u>Command</u>	<u>Cmd#</u>	<u>Bytes</u>	<u>Reply</u>	<u>Description</u>
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

<u>Command</u>	<u>Cmd#</u>	<u>Bytes</u>	<u>Reply</u>	<u>Description</u>
Get ppb in Text	24	0	10	get ppb reading in ASCII text

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

Command 32: Analog Output Range

<u>Command</u>	<u>Cmd#</u>	<u>Bytes</u>	<u>Reply</u>	<u>Description</u>
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 3.000000

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 °C for T

HighThreshold: in ppm for O; in °C for T

Deadband: in ppm for O; in °C 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
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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

<u>Command</u>	<u>Cmd#</u>	<u>Bytes</u>	<u>Re p l y</u>	<u>Description</u>
Send a Control	67	0	4 (fl)	Read watchdog timer delay

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

<u>Command</u>	<u>Cmd#</u>	<u>Bytes</u>	<u>Re p l y</u>	<u>DF-760</u>	<u>Description</u>
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	V	P	download 128 bytes from the prepared log file
			starting at	Offset	

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 AnalyzerModel 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

<u>Command</u>	<u>Cmd#</u>	<u>Bytes</u>	<u>Reply</u>	<u>DF-760</u>	<u>Description</u>
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

<u>Command</u>	<u>Cmd#</u>	<u>Bytes</u>	<u>Reply</u>	<u>Description</u>
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

<u>Command</u>	<u>Cmd#</u>	<u>Bytes</u>	<u>Reply</u>	<u>Description</u>
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

<u>Command</u>	<u>Cmd#</u>	<u>Bytes</u>	<u>Reply</u>	<u>Description</u>
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".