



SERVOPRO NANO Trace DF-740 Analyzer Installation and Operator Manual

Part Number: **225488**
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Language: **US English**



SERVOMEX.COM

IMPORTANT INFORMATION



Continued safe and reliable operation of this equipment is conditional on all installation, operation and maintenance procedures being conducted 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This handbook is accurate at the date of printing but will be superseded and should be disregarded if specifications or appearance are changed.

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Table of Contents

1. Safety Summary	1
1.1 General Warnings and Cautions.....	1
1.2 Laser Safety	3
1.3 Safety Labelling and General Marking	4
2. Introduction.....	6
2.1 Product Description.....	6
2.1.1 Product Dimensions	6
2.1.3 Internal Components.....	10
2.2 Specifications Summary	10
2.2.1 Moisture Detection	10
2.2.2 Electrical Requirements.....	10
2.2.3 Laser	11
2.2.4 Environmental Operating Conditions.....	11
3. Installation, Start-up, and Shutdown	12
3.1 Unpacking Procedure	12
3.2 Analyzer Installation Overview.....	13
3.3 Analyzer Installation	13
3.4 Analyzer Start-up	18
3.4.1 Gas Flow and Pressure Regulation	18
3.4.2 Gas Pressure and Flow Settings.....	19
3.4.3 Download System Data	19
3.5 Analyzer Shut Down	20
4. Options.....	21
4.1 Key Lock.....	21
4.2 Operating Voltage	21
4.3 Serial Communications.....	21
4.4 Analog Voltage Output.....	21
5. Connecting to External Devices	22
5.1 Serial Communication Port – J5	22
5.2 Analog Signal Outputs – J4	23
5.3 4-20 mA Outputs – J4	24
5.4 Relay Ports – J8, J9.....	25
6. User Interface	26
6.1 Data Display Screen	26
6.2 Keypad	27
6.3 Menu Structure	27
6.3.1 Main Menu	28
6.3.2 Isolate Analyzer	28
6.3.3 Restore Sample Gas Flow	30
6.3.4 Controls Menu.....	31
6.3.5 Calibrate Menu	32
6.3.6 Data History Routine	36
6.3.7 Data Downloader Routine	38

6.3.8	View Logs Menu	41
6.3.9	View System Error Codes	43
6.3.10	Analyzer Setup	45
6.3.11	Analog Output Setup	51
6.3.12	Graph Setup	52
6.3.13	Scheduled Reboot	53
6.3.14	Diagnostics Menu	54
6.3.15	Power Up Default (applicable to analyzers with iso valves)	65
6.3.16	Date/Time	67
6.3.17	Communications	69
6.3.18	Download System Data	70
6.3.19	System Info	72
7.	Sample Gas Preparation and Delivery	75
7.1	Introduction	75
7.2	Sample Pressure	75
7.3	Flow Rate Effects on Sensor Performance	75
7.4	Flammable Sample Gas	75
8.	Service	77
8.1	Return Material Authorization number	77
8.2	Cautions Related to Maintenance	77
8.3	Maintenance	77
8.3.1	Storage Conditions	77
8.3.2	Fuse Replacement	77
8.3.3	Moisture Cell Maintenance	78
8.3.4	Power Cord Replacement	78
8.4	Troubleshooting Guide for the NanoTrace Analyzer	79
8.4.1	Moisture Troubleshooting	79
8.5	Shipping	80
8.6	Storage and Disposal	80
8.6.1	Storage	80
8.6.2	Disposal in accordance with the Waste Electrical and Electronic Equipment (WEEE) Directive	81
9.	Theory of Operation	83
9.1	The Moisture Measurement	83
9.1.1	Moisture and the IR Spectrum	83
9.2	Absorption Spectroscopy	84
10.	Specifications	85
10.1	Moisture Detection	85
10.2	General	85
10.3	Output Signals & Status Indicators	86
10.4	Laser	86
10.5	Power	86
10.6	Compliance	86
11.	Warranty	87
12.	Index	88

Appendix B: NanoTrace DF-700 Series Moisture Analyzers Serial Digital Communication Protocol Programming Guide90

Table of Figures

Figure 1: Analyzer Markings Shown in Rear Area View	4
Figure 2: Sensor Markings – Side	4
Figure 3: Sensor Marking – Front	5
Figure 4: DF-740 Analyzer (front)	6
Figure 5: DF-740 Analyzer (rear)	7
Figure 6: DF-740 Analyzer (left)	7
Figure 7: Vacuum Pump Outline Drawing	8
Figure 8: Vacuum Pump Mounting Dimensions	9
Figure 9: Major Internal Components	10
Figure 10: Backup Wrench Use	13
Figure 11: VCR Gasket (with supplied mounting bracket)	14
Figure 12: DF-740 Analyzer Gas Panel	14
Figure 13: Vacuum Pump Assembly	15
Figure 14: Starting Gas Flow	17
Figure 15: Data Display Screen	18
Figure 16: Block Diagram of Gas Flow Path	20
Figure 17: Rear Panel Electrical Connectors	22
Figure 18: Data Display Screen	26
Figure 19: Keypad	27
Figure 20: Main Menu (Without Isolation Valves Option)	28
Figure 21: Isolate Analyzer	29
Figure 22: Isolate Warning	29
Figure 23: Restore Sample Gas Flow	30
Figure 24: Controls Selection from Main Menu	31
Figure 25: Isolate Warning	32
Figure 26: Gas Valves Control Dialog Box	32
Figure 27: Calibrate Menu	33
Figure 28: Check/Adjust Zero Menu	34
Figure 29: Check/Adjust Zero Screen	34
Figure 30: Manual Zero Screen	35
Figure 31: Data History Menu	37
Figure 32: Data History Screen	38
Figure 33: Install Media	38
Figure 34: Example of Data Download	38
Figure 35: Data Downloader Menu	39
Figure 36: Data Downloader Screen	39
Figure 37: View Location Screen	40
Figure 38: Keyboard Display	41
Figure 39: Delete Selection	41
Figure 40: View Logs Menu Selection	42
Figure 41: View Zero Log Menu	42
Figure 42: Zero Log Screen	43

Figure 43: View System Error Code Log Menu.....	43
Figure 44: System Error Log Screen	43
Figure 45: Vacuum Source Test Log Menu	44
Figure 46: Vacuum Source Test Log	45
Figure 47: Sample GSF Menu	46
Figure 48: Sample GSF Setup Screen.....	46
Figure 49: GSF Pressure Setting Message	47
Figure 50: Alarm Setup Menu Selection	47
Figure 51: Alarm Setup Screen.....	48
Figure 52: Temperature Alarm Setup	49
Figure 53: Pressure Range Alarm Setup.....	50
Figure 54: System Alarm Setup	50
Figure 55: Analog Output Setup Menu	51
Figure 56: Analog Output Setup Screen.....	52
Figure 57: Graph Setup Menu	52
Figure 58: Graph Setup Screen.....	53
Figure 59: Scheduled Reboot Menu Selection	53
Figure 60: Next Scheduled Reboot.....	54
Figure 61: Diagnostics Menu Selection.....	55
Figure 62: Active Zero Setup Screen	55
Figure 63: Test Relays Menu Selection	56
Figure 64: Test Alarm Relays Screen.....	57
Figure 65: Test Analog Outputs Menu Selection.....	58
Figure 66: Test Analog Voltage Output Screen	59
Figure 67: Signal Monitor Menu Selection	59
Figure 68: Signal Monitor Screen.....	60
Figure 69: Vacuum Source Capacity Test Menu	61
Figure 70: Pump Capacity Test	62
Figure 71: Pump Pressure Failure.....	62
Figure 72: Cell Pressure Calibration Menu Selection	63
Figure 73: Cell Pressure Calibration Screen.....	64
Figure 74: Manual Cell Pressure Override Menu Selection	64
Figure 75: Manual Cell Pressure Override	65
Figure 76: Power Up Default Menu Selection	66
Figure 77: Power Up Default Screen	67
Figure 78: Date/Time Menu	67
Figure 79: Date/Time Setup Screen	68
Figure 80: Date/Time Edit Screen	68
Figure 81: Communications Menu Selection	69
Figure 82: Communications Setup Screen	70
Figure 83: Download System Data Menu	70
Figure 84: System Data Download	71
Figure 85: Media Warning	71
Figure 86: Not ready Drive d:\	71

Figure 87: Download Timeline 72

Figure 88: System Info Menu..... 73

Figure 89: System Info Screen 73

Figure 90: Firmware Upgrade 74

Figure 91 The WEEE label..... 81

Figure 92: Schematic of Moisture Cell..... 83

About this manual

Safety information

The following icons are used throughout this manual to identify any potential hazards that could cause acute 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 warns of specific hazards from the presence of electrical voltage and current.

Other information provided by the manual



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

Note: Notes give extra information about the equipment.

Scope of the manual

This manual is the **Installation and Operation Manual** for the **NANO Trace DF-740 Analyzer**. An additional manual, The **NanoTrace DF-700 Series QuickStart Guide** is also available for this product. .

Getting Started

Thank you for selecting the NanoTrace DF-740 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-740 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-740 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.

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, the sensor, the electronics, or when charging or draining electrolyte. Disconnect the analyzer from AC power before moving the analyzer.

WARNING: AC POWER GROUND REQUIRED



Ensure that power cord ground wire is 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.

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-740 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.

WARNING: AMMONIA IS A TOXIC GAS



Ammonia is a toxic gas. Exposure to high concentrations of ammonia causes immediate burning of the eyes, nose, throat, and respiratory tract and can result in blindness, lung damage or death. Ensure ammonia does not flow into your work area. Before installing or removing ammonia sample feed line, ensure valve to facility supply is closed.

WARNING: SAMPLE AND CALIBRATION GASES MAY BE TOXIC OR ASPHYXIANT



Make sure that the external connections are leak free at full operating pressure before you use sample or calibration gases.



When there is a risk of release of potentially harmful gases into the operating environment, always use suitable monitoring equipment.



The DF-740 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 8, Specifications**.

1.2 Laser Safety



The DF-740 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). 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 is shown in **Figure 1**, **Figure 2**, and **Figure 3**.

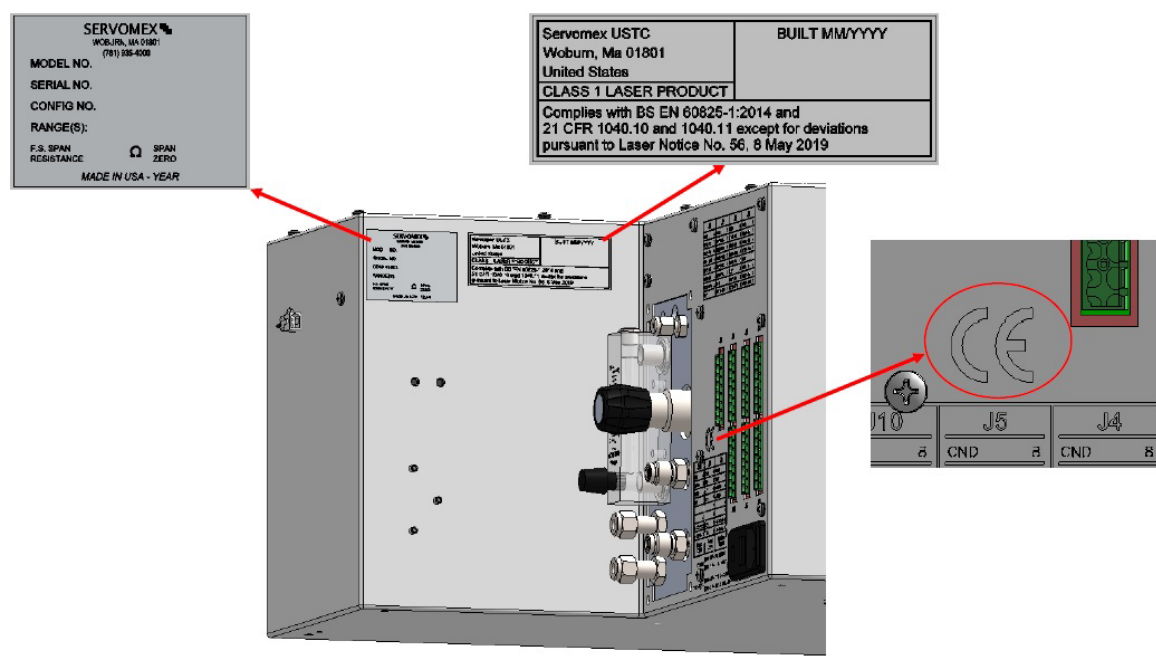


Figure 1: Analyzer Markings Shown in Rear Area View

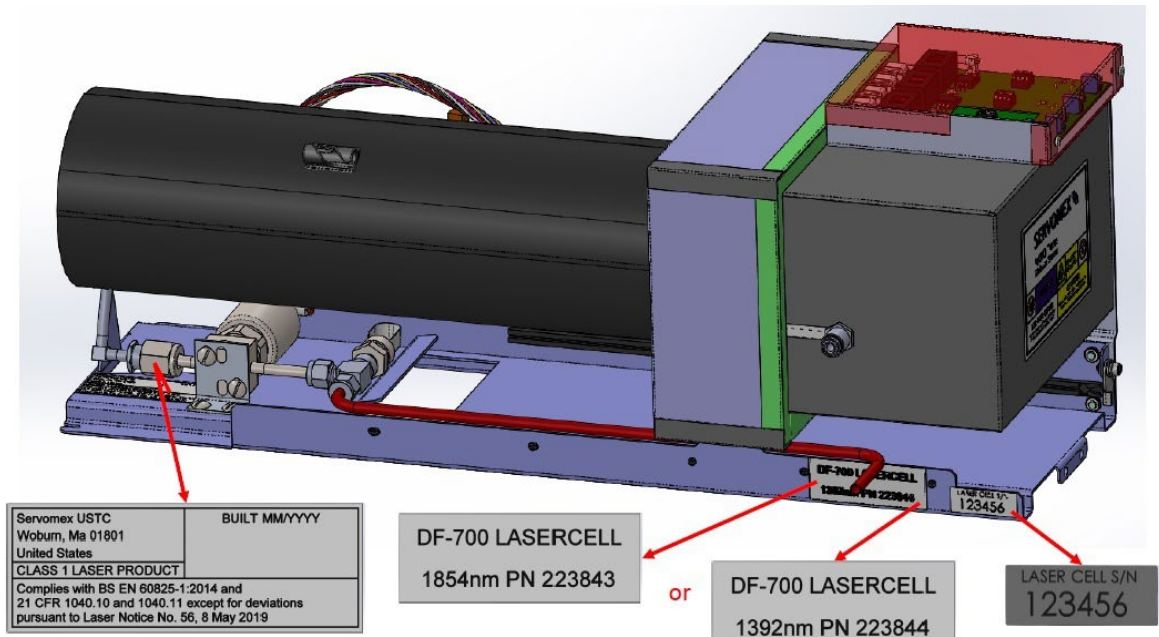


Figure 2: Sensor Markings – Side

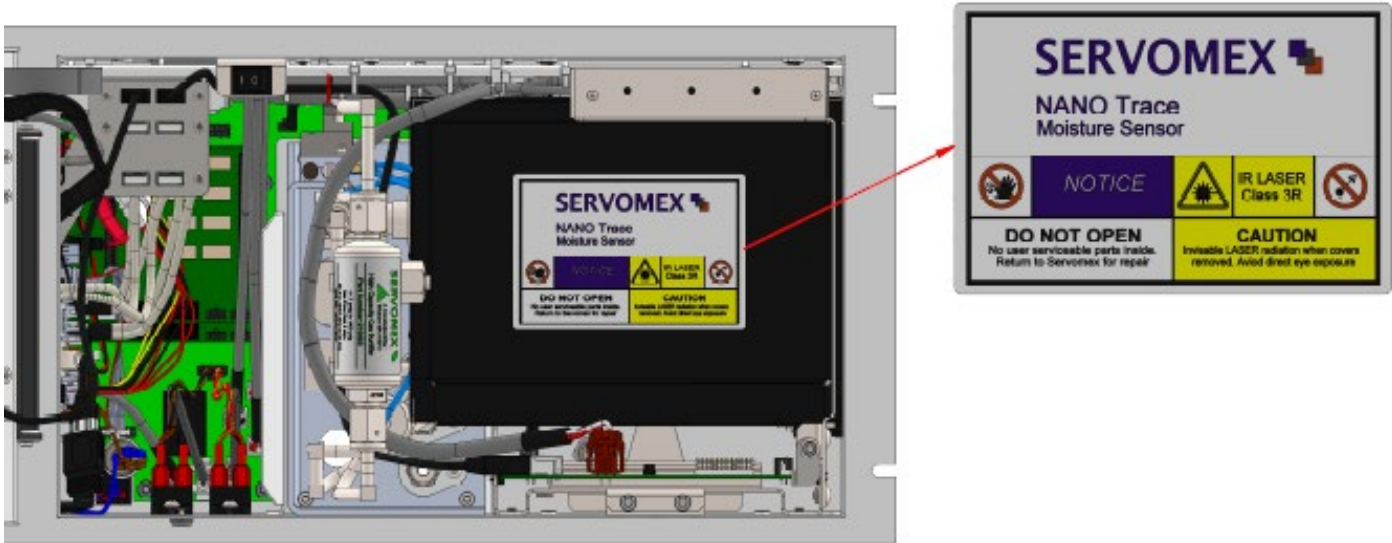


Figure 3: Sensor Marking – Front

2. Introduction

2.1 Product Description

The NanoTrace DF-740 Moisture Analyzer is an instrument designed for continuous UHP (Ultra High Purity) analysis of moisture content in process gases. It is housed in a steel chassis for rack-mounting. Its external features include a 6 x 9-inch LCD screen, push-button keys for user-interface, a gas panel containing ports for input and output of gasses (process and pneumatic), connectors for digital and analog data output, and an IEC 60320 C-13 receptacle for connection to electrical power. The internal components include of a moisture cell, isolation valves, 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 technique employed is provided in [Chapter 9 Theory of Operation](#).

The analyzer requires the use of a separately housed high-capacity pump in normal operation (see [Figure 7](#).)

2.1.1 Product Dimensions

The figures below ([Figure 4](#), [Figure 5](#), and [Figure 6](#)) provide dimensioned front, rear, and left side views of the DF-740 Analyzer.

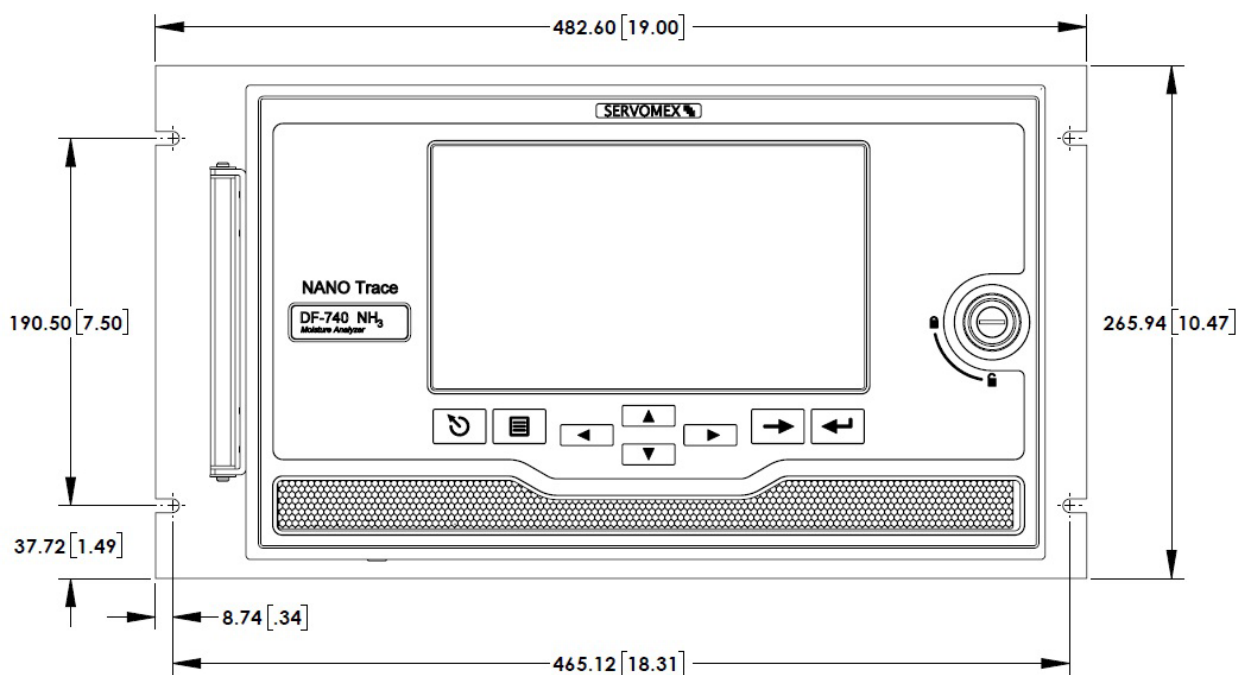


Figure 4: DF-740 Analyzer (front)

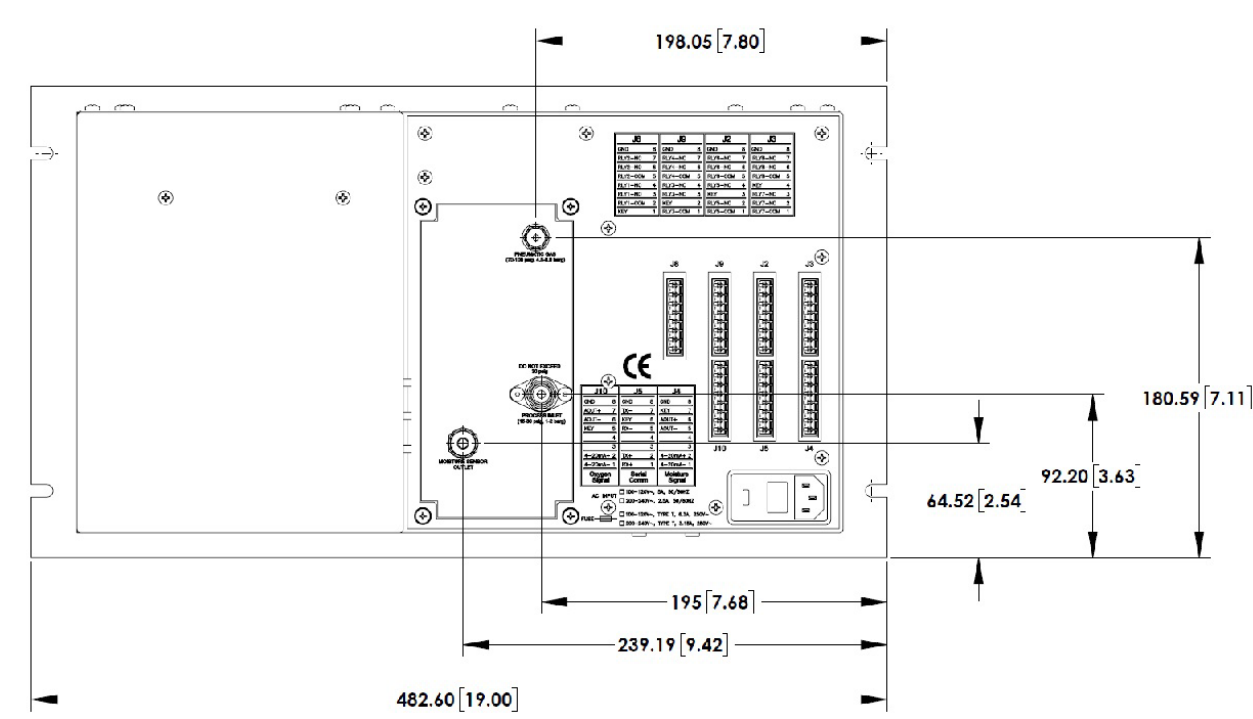


Figure 5: DF-740 Analyzer (rear)

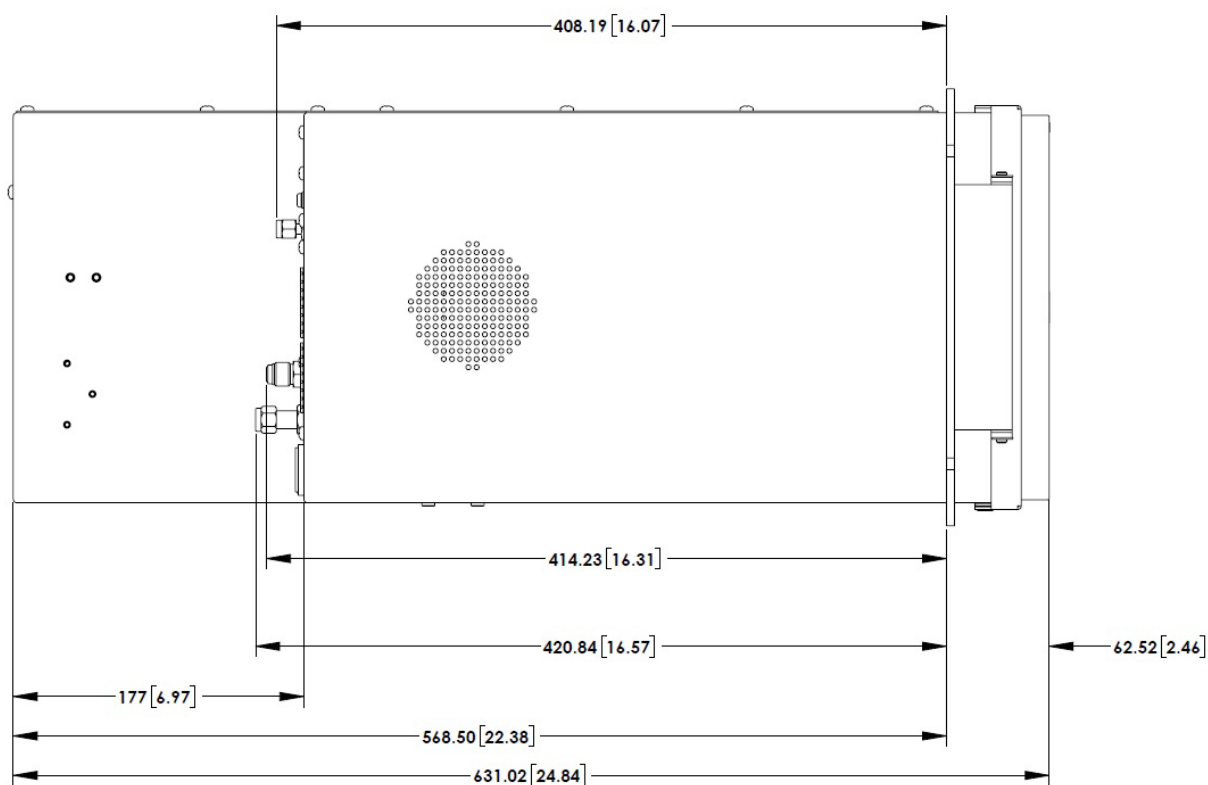


Figure 6: DF-740 Analyzer (left)

Introduction

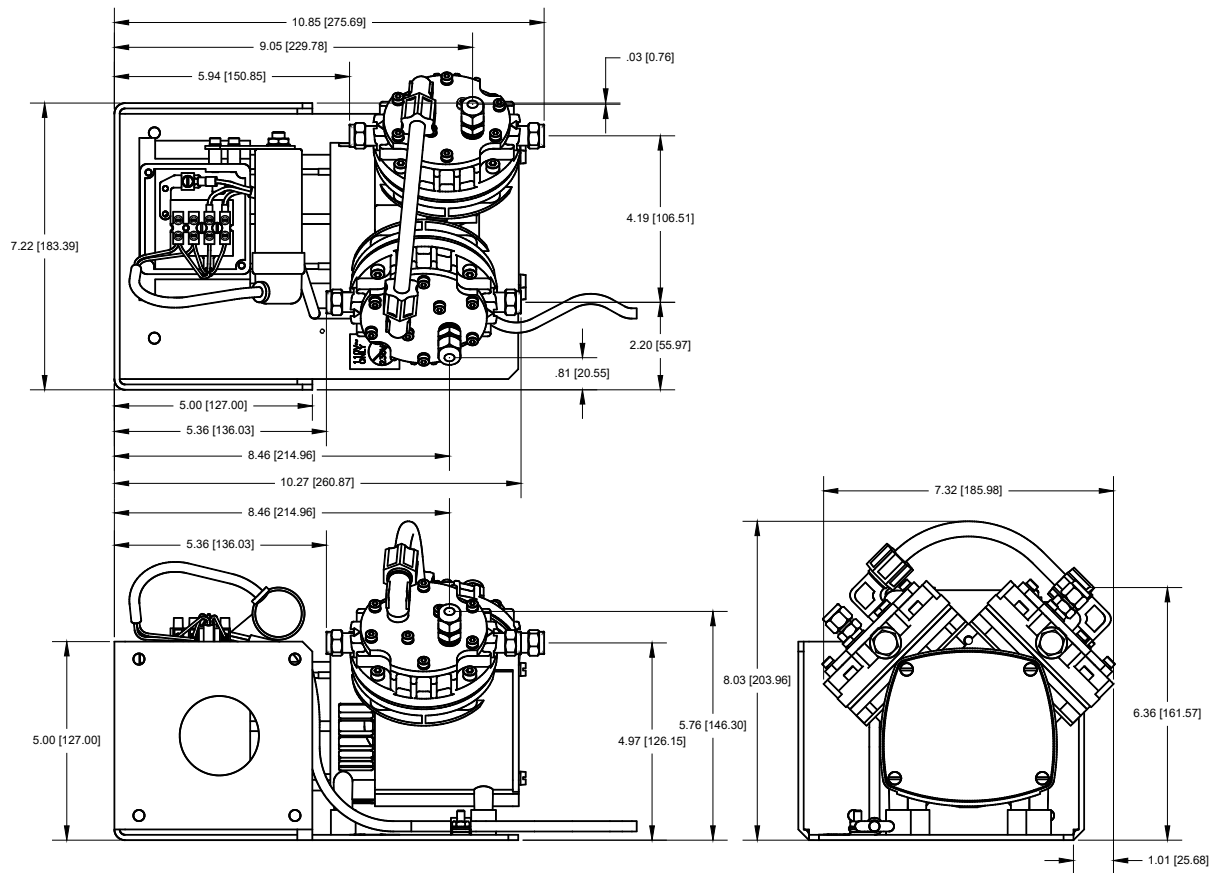


Figure 7: Vacuum Pump Outline Drawing

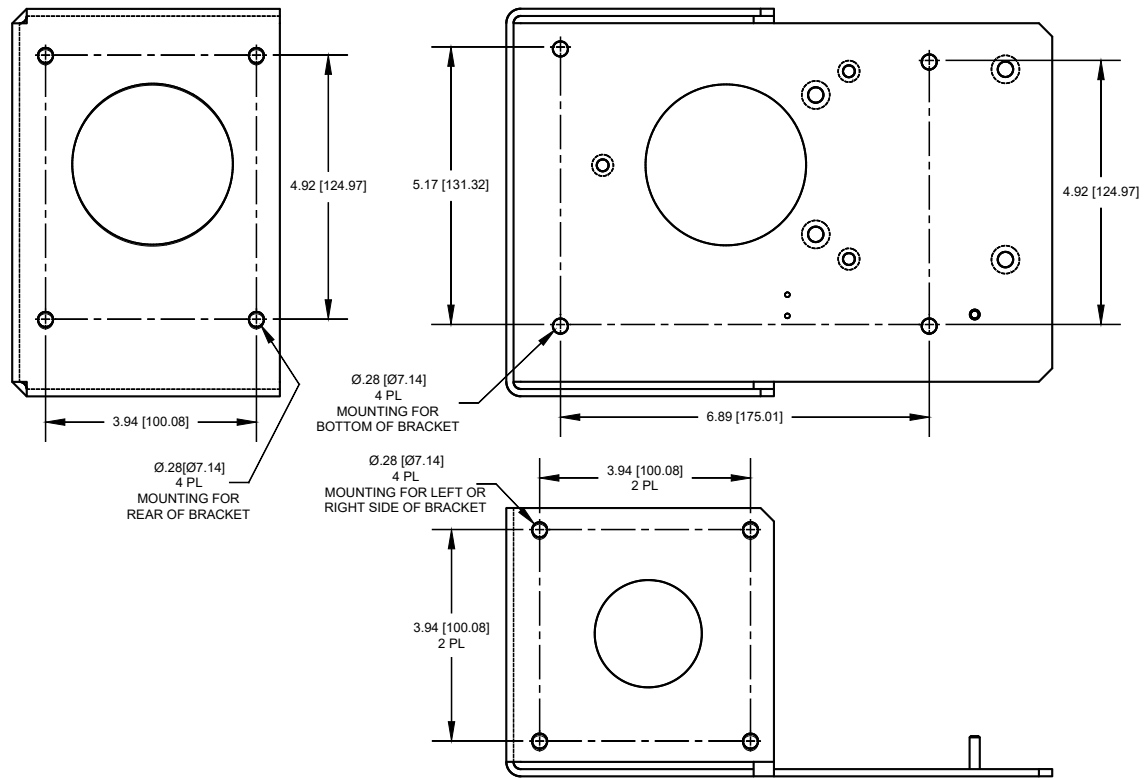


Figure 8: Vacuum Pump Mounting Dimensions

2.1.3 Internal Components

The DF-740 Analyzer's major internal components are shown in **Figure 9**, below.

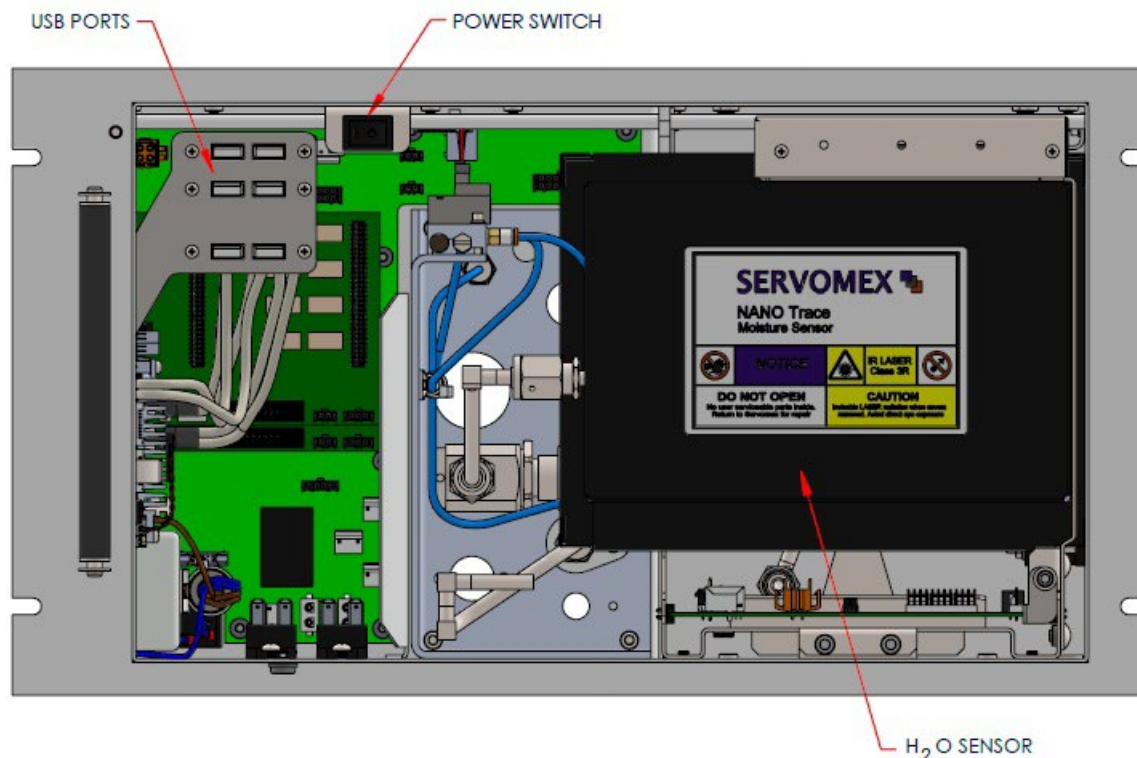


Figure 9: Major Internal Components

2.2 Specifications Summary

A summary of DF-740 characteristics is provided in the paragraphs below. Complete specifications are provided in **Chapter 10 Specifications**.

2.2.1 Moisture Detection

Lowest Detection Level (LDL): 10 ppb @ Constant Conditions

Accuracy: Greater of $\pm 5\%$ of reading or ± 5 ppb (whichever is greater) @ Constant Conditions

Background Gas Compatibility: NH_3 , H_2 , N_2

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

Max Power: 50mW/30mW

Beam Divergence: 436 mrad

Pulse Pattern: CW

Classification: Laser Device- Class 3, Analyzer-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)

2.2.4 Environmental Operating Conditions

General: Indoor use only 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: 80% humidity for temperatures up to 31°C, decreasing linearly to 50% relative humidity at 40°C

3. Installation, Start-up, and Shutdown

3.1 Unpacking Procedure

Follow the procedure below to unpack your DF-740 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. All standard NanoTrace analyzers are shipped with the following:

Item	Part Number
Power Cord	2527-0314, 115 VAC Connector (US) ¹ 2527-0321, 220 VAC Connector (UK) ¹ 2527-0338, 220 VAC Connector (EU) ¹
USB, Clip Flash Drive, 4 GB	220562
Gasket, VCR	210431
Instruction Manual (supplied digitally in USB, Clip Flash Drive)	225488
Quick Start Guide (In digital format and stored on USB, Clip Flash Drive P/N 220562)	NANOTRACE700Q
Pump, Vacuum (shipped in separate packaging)	212892 (110V pump) 210979 (220V pump)
Notes: ¹ Customer may select from US, UK, and EU style power cable when ordering. If other type is required, customer must supply.	

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:

1. Mounting the analyzer and vacuum pump.
2. Connecting outlet tube to the vacuum pump and connecting vacuum outlet to vent.
3. Connecting the pneumatic pressure service to the pneumatic inlet fitting.
4. Connecting the sample gas line to the analyzer inlet fitting.
5. Wiring connections to data and relay outputs.
6. Making the power connection to the analyzer and pump.

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.



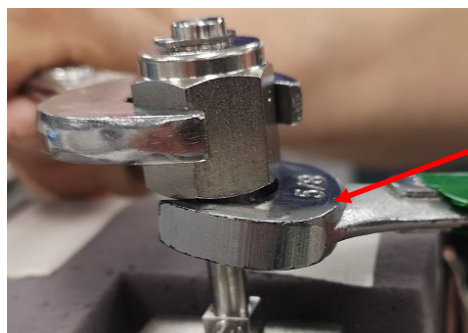
The DF-740 is for indoor use only. It should not be in an area where it will be subjected to particulate, condensed moisture, caustic atmosphere, temperature extremes, or operation outside of any limits listed in **Chapter 8 Specifications**.

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

NOTE



Use backup wrenches as shown in **Figure 10** when removing or installing VCR connectors, otherwise torque may be applied to analyzer plumbing and cause damage.



Backup Wrench

Figure 10: Backup Wrench Use



Figure 11: VCR Gasket (with supplied mounting bracket)

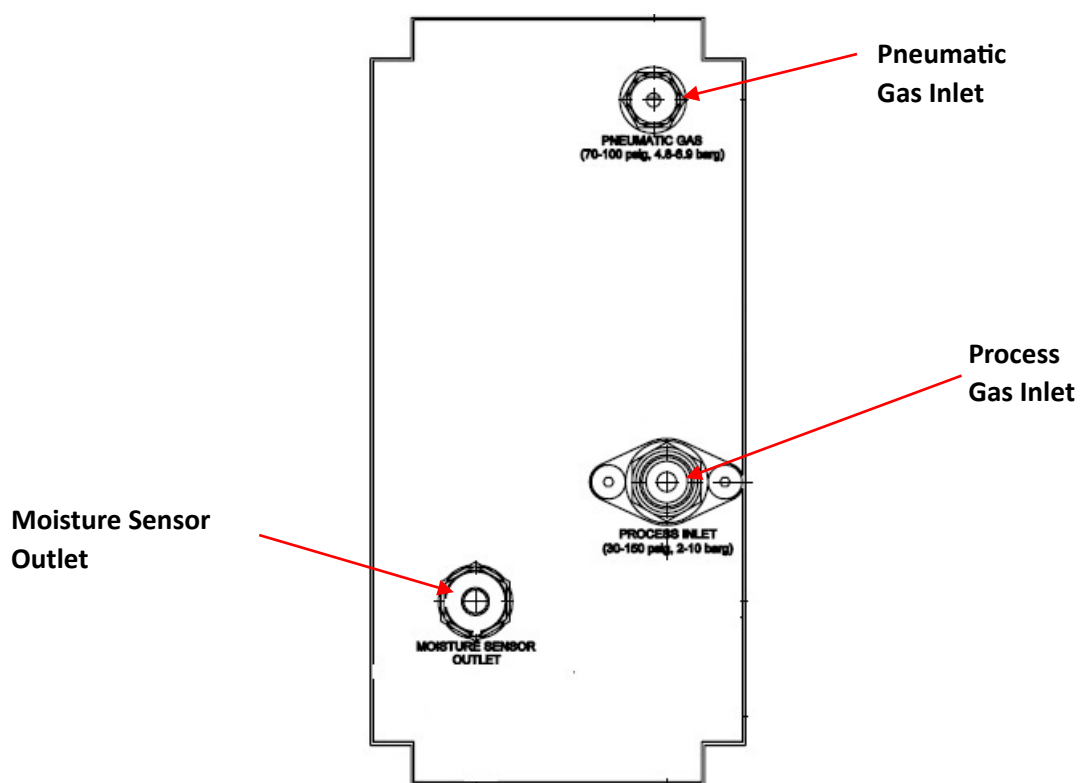


Figure 12: DF-740 Analyzer Gas Panel

2. Connect the stainless-steel sample gas feed to the process gas inlet fitting (see **Figure 12**) using VCR gasket (**Figure 11**).
3. Connect the pneumatic supply to the analyzer **Pneumatic Gas Inlet** (see **Figure 12**).
4. If the analyzer has a vacuum pump, install vacuum pump within eight feet of the analyzer by securing mounting bracket to appropriate surface with screws.

NOTE

For H₂ service, the sample outlet line must be made of stainless steel.

WARNING: AMMONIA IS A TOXIC GAS

Ammonia is a toxic gas. Exposure to high concentrations of ammonia causes immediate burning of the eyes, nose, throat, and respiratory tract and can result in blindness, lung damage or death. Ensure ammonia does not flow into your work area. Before installing or removing ammonia sample feed line, ensure valve to facility supply is closed.

5. Connect sample vent line from vacuum pump facility vent.
6. Connect a line from the moisture sample outlet to the pump vacuum control valve (see **Figure 13**).

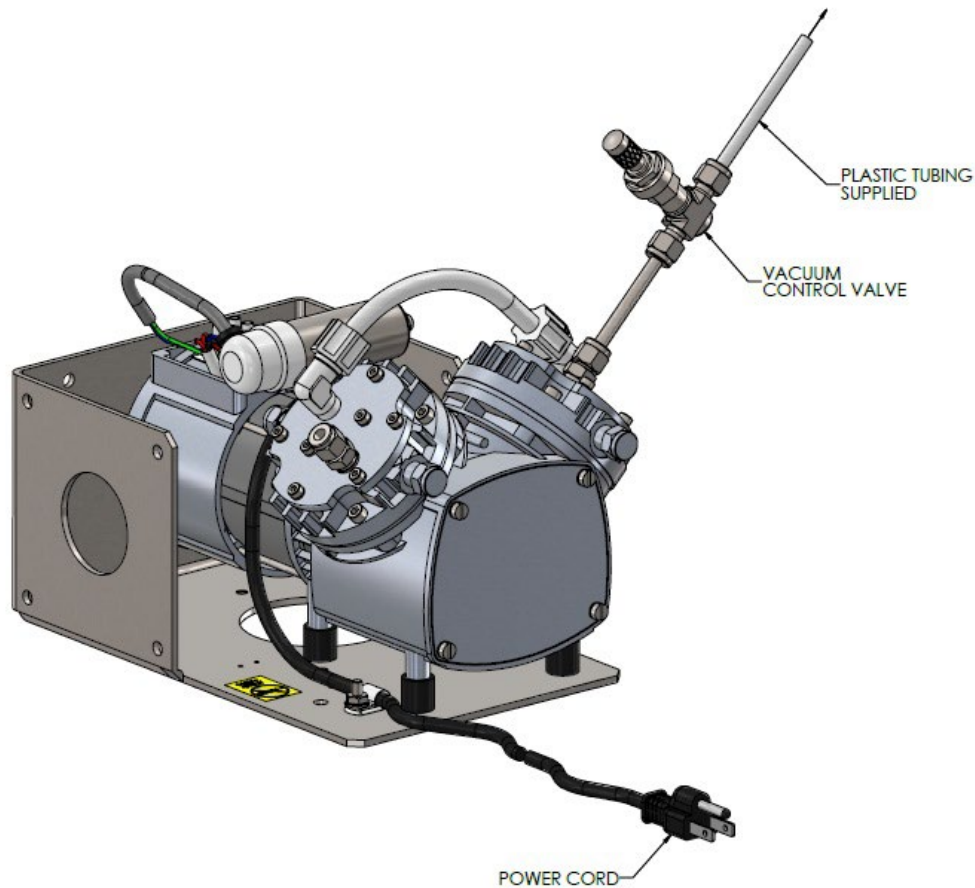


Figure 13: Vacuum Pump Assembly

7. Connect analyzer and pump) to electrical power. Be sure to verify that you are connecting to the

correct voltage (110VAC or 220VAC) for your analyzer and pump. Contact Servomex if you received an analyzer or pump that is not compatible with your facility power.

8. Open valve controlling sample gas supply to analyzer. Check for leaks. If leaks are detected, shut off supply and fix leaks.

NOTE

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

9. Turn on analyzer. After booting up, the analyzer goes into warm-up.

NOTE

Analyzer is isolated during warm-up.

10. Allow the sample inlet to purge for at least 10 minutes.
11. Establish sample gas flow by pressing the menu key and selecting **Restore Sample Gas Flow** as shown in **Figure 14**. Verify that the main screen indicates flow.

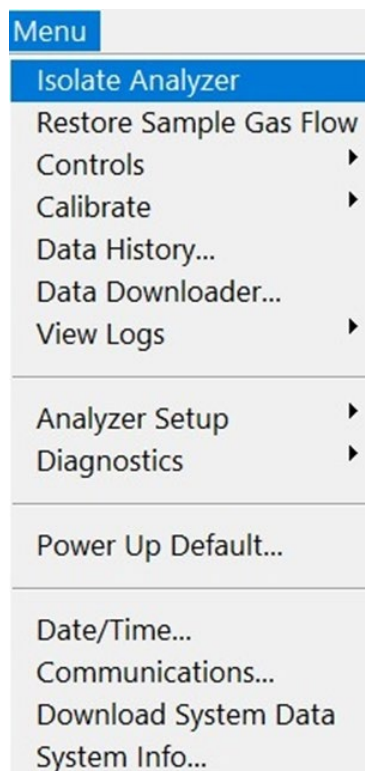


Figure 14: Starting Gas Flow

NOTE

Proceed to **3.4.2 Gas Pressure and Flow Settings** to complete initial set-up of analyzer.

3.4 Analyzer Start-up

Open the door and turn on the power using the main power switch inside the analyzer (see **Figure 9**). Plug pump power cord connector into grounded electrical outlet. The pump should turn on. The analyzer will undergo a series of diagnostic procedures and various start-up screens are displayed. Next, the Servomex logo is briefly displayed and then the data displays appear with the “Warming Up” screens flashing. The warm-up process takes 6 to 15 minutes. During warm-up, the display is like **Figure 15** (values will vary). The analyzer may take up to 90 minutes to completely warm up depending on environmental conditions.

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.

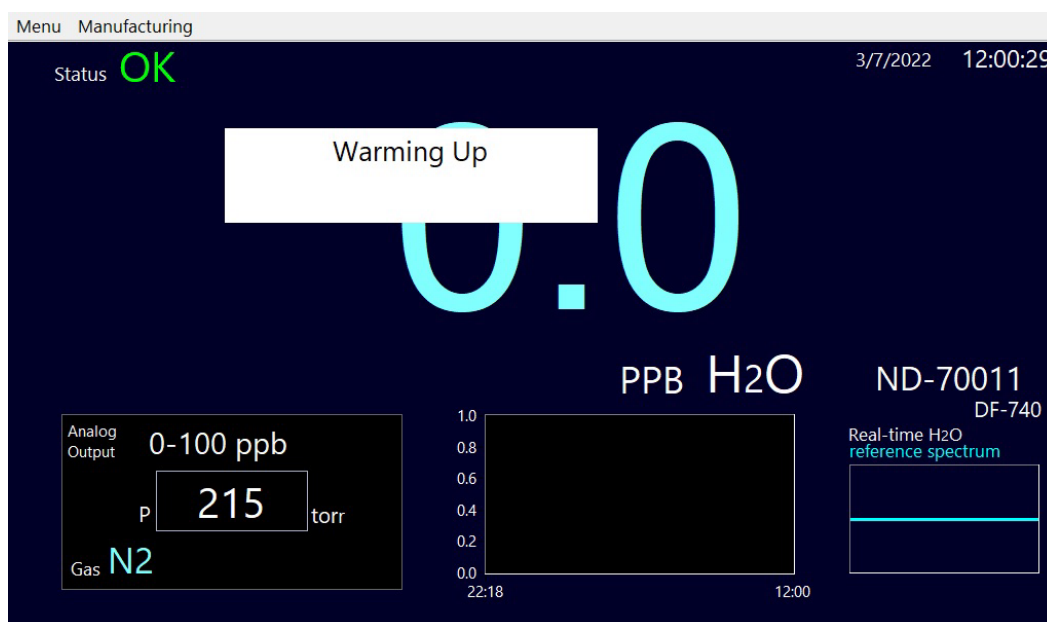


Figure 15: Data Display Screen

3.4.1 Gas Flow and Pressure Regulation

The gas delivery system is designed to deliver a gas flow rate of 0.5 liter per minute to the moisture sensor while maintaining the highest standards of gas purity and delivery for ultra-trace analysis.

Connections at the rear of the gas delivery system include a ¼" VCR swivel connection for the process inlet, a ¼" compression outlet for the moisture cell, and a pneumatic gas connection (1/8" compression).

Background Gas	Pressure	Vacuum Source
N ₂	150 - 250 Torr	ON
H ₂	300 - 400 Torr	ON
NH ₃	70 - 80 Torr	ON

Table 1: Recommended Sample Outlet Vacuum Pressure

3.4.2 Gas Pressure and Flow Settings

The following procedure assumes all electrical and plumbing connections have been made according to instructions in this manual.

WARNING: AMMONIA IS A TOXIC GAS



Ammonia is a toxic gas. Exposure to high concentrations of ammonia causes immediate burning of the eyes, nose, throat, and respiratory tract and can result in blindness, lung damage or death. Ensure ammonia does not flow into your work area. Before installing or removing ammonia sample feed line, ensure valve to facility supply is closed.

1. If analyzer is not on, power up analyzer. (See 3.4 **Analyzer Start Up**). Confirm analyzer is in **Isolated** state.

NOTE: 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 6.3.15 **Power Up Default**.
2. Ensure the supply pressure is 18 PSIG (nominal).
3. Establish flow through the analyzer by accessing the main menu and selecting **Restore Sample Gas Flow**.
4. Adjust the vacuum control valve on pump to achieve the proper pressure for the sample gas in use (refer to **Table 1**).
5. 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.

3.4.3 Download System Data

The final step of the installation, after a couple days of dry down, is to download the system data files (see **6.3.18 Download System Data**) which may optionally be sent by e-mail to Servomex for review.

This will allow the factory to confirm that the analyzer is working properly by comparison with data stored at the time of shipment, and in addition will set a baseline for comparison with future downloads, if any.

3.5 Analyzer Shut Down

To minimize the time required for the analyzer to re-achieve a zero baseline on start-up, the following steps should be followed when shutting the analyzer down.

Short Term Shut Down. A short-term shut down, for example to move and restart the analyzer, can be accomplished by simply shutting off the power switch behind the front door. This action initiates isolation and computer shut down which takes approximately 40 seconds.

Long Term Shut Down. Select **Isolate Analyzer** on the Main Menu. A routine closes the downstream valve and allows pressure to build in the moisture cell after which an upstream valve closes as well. Throughout this process a message appears over the display instructing the user to wait 40 seconds. Once complete, the message disappears, and the user may shut the power off with the switch behind the front door that initiates the computer shut down sequence that takes an additional 40 seconds.

Additional long-term isolation security can be achieved by closing the valve on the rotameter on the rear of the instrument as well as completely closing the sample inlet regulator.

If the analyzer is being disconnected from gas, be sure to tightly cap all gas connections. Refer to **Figure 16** for a reference diagram of the gas flow path including isolation valves.

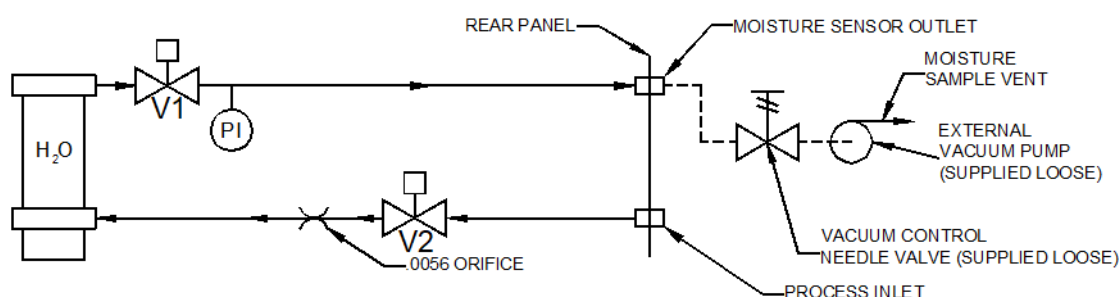


Figure 16: Block Diagram of Gas Flow Path

4. Options

The following options to the DF-740 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 wired for operation at either 100-120 Volts AC or 200-240 Volts AC.

The operating voltage is not adjustable in the field.

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.

4.4 Analog Voltage Output

The analog voltage output can be set at the factory to 0-1, 0-5-, or 0-10-volts DC.

The analog voltage output is not adjustable in the field.

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. Refer to **Figure 17**.

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.

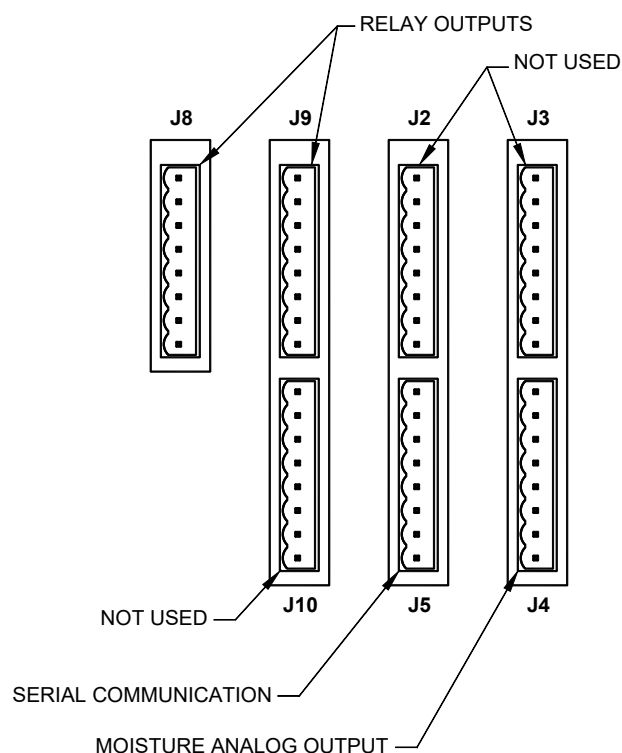


Figure 17: Rear Panel Electrical Connectors

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 23 for wiring information.

See **Communications** on page 67 for additional information on setting unit ID's and baud rates. A program to facilitate serial communications is available from Servomex. Please contact us at 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-740 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 51 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 57.

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, or 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 56.

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

6. User Interface

6.1 Data Display Screen

The **Data Display Screen**, shown in **Figure 18** below, is located on the analyzer front panel above the **Keypad**. The **Keypad** and **Data Display Screen** constitute the analyzer user interface.



Figure 18: Data Display Screen

Display elements include:

- Alarm status indicator – OK denotes no alarm conditions. Message and error code displayed in event of alarm.
- Measurement range.
- Most recent H₂O measurement.
- 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 flagged with a warning if any of the level or system alarms are tripped.

6.2 Keypad

The **Keypad**, used with **Data Display Screen**, allows the user to control all the features of the analyzer. The layout of the keypad on the front panel is represented in **Figure 19** below.

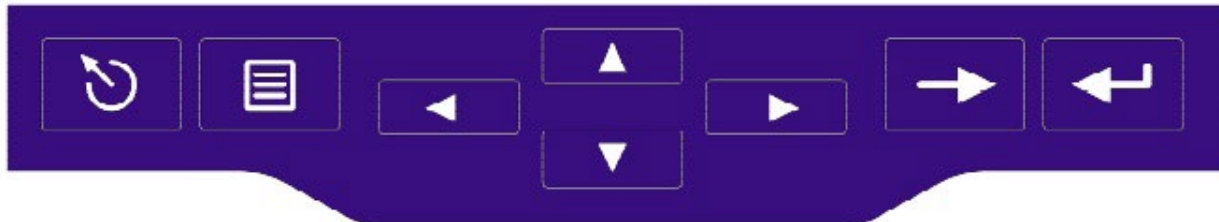


Figure 19: Keypad

The **Menu** key activates the menu structure 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.

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. The main menu is depicted in **Figure 20** below.

6.3.1 Main Menu

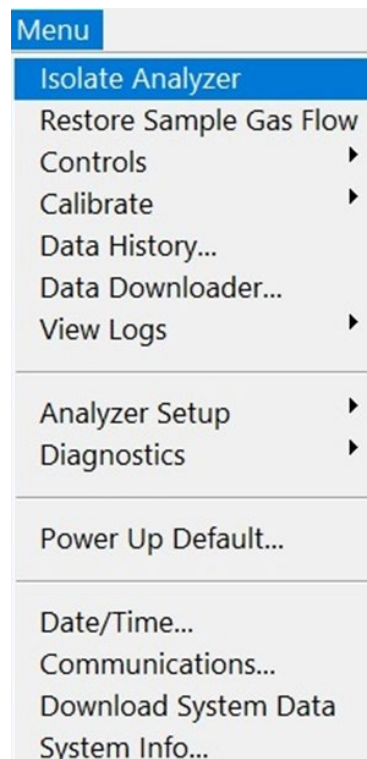


Figure 20: Main Menu (Without Isolation Valves Option)

The Main Menu 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. **Figure 20** shows the main menu for the DF-740.

6.3.2 Isolate Analyzer

The **Isolate Analyzer** menu selection is shown in **Figure 21**, below.

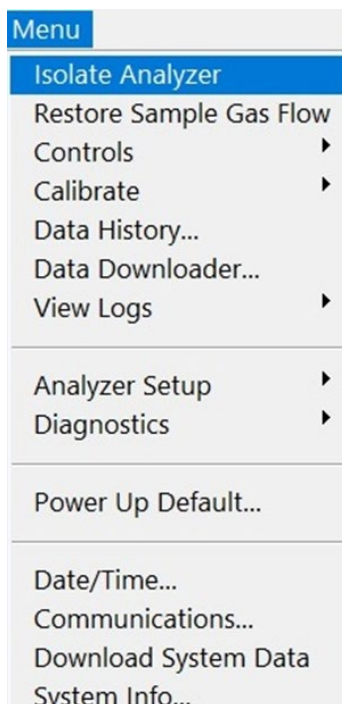


Figure 21: Isolate Analyzer

The **Isolate Analyzer** function allows the internal gas lines and the moisture sensing cell volume to be isolated for a planned removal of the external delivery lines. It is also considered the first step in the shut-down procedure. Select **Isolate Analyzer** and hit the **Enter** key to initiate the isolation process. The Isolate Warning shown in **Figure 22** will appear for 40 seconds.

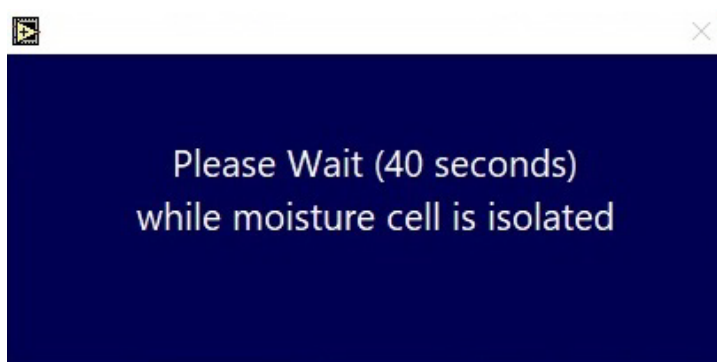


Figure 22: Isolate Warning

When the moisture cell is isolated from gas flow, the **Isolated** message appears at the bottom of the main display and the pressure alarm is disabled.



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

6.3.3 Restore Sample Gas Flow

The **Restore Sample Gas Flow** menu selection is shown in **Figure 23**, below.

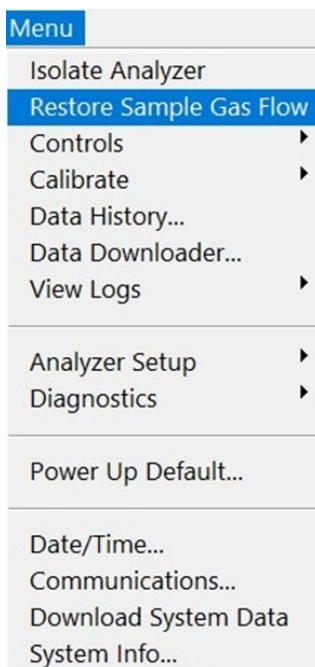


Figure 23: Restore Sample Gas Flow

Restore Sample Gas Flow allows the user to return 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

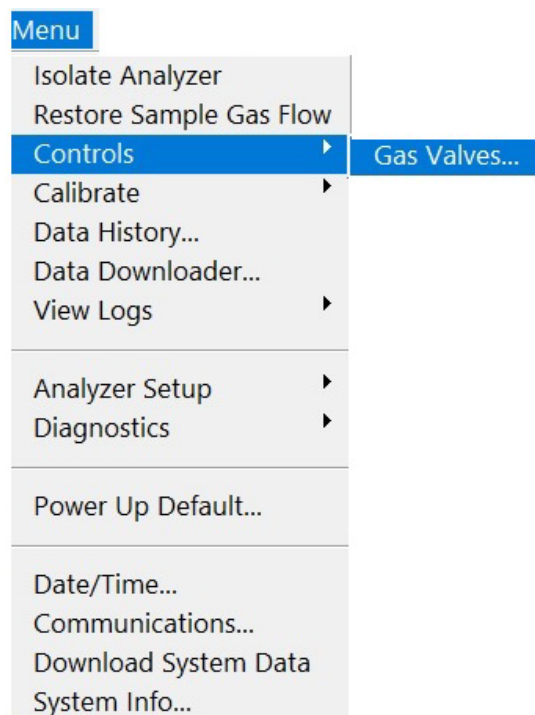


Figure 24: Controls Selection from Main Menu

The **Controls** menu selection (**Figure 24**) accesses the **Gas Valves** submenu, which opens the gas control dialog box.

6.3.4.1 Gas Valves Control

The gas valves control dialog box, as shown in **Figure 26**, is used to control the flow of gas through the moisture cell.

Two 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. When finished, select **Done**, and then press **Enter** 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 25**) advising the user to wait 40 seconds for the moisture cell to be fully isolated.

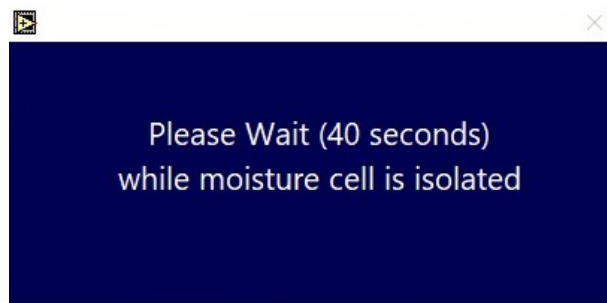


Figure 25: Isolate Warning

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.

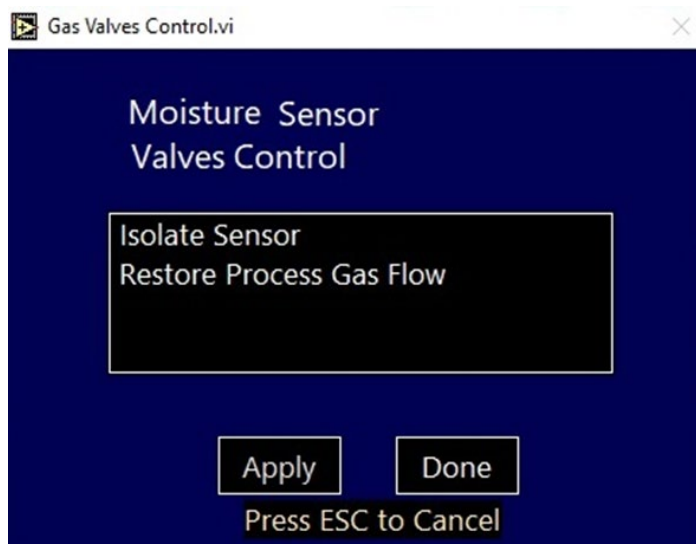


Figure 26: Gas Valves Control Dialog Box

6.3.5 Calibrate Menu

The **Calibrate** menu selection is shown in **Figure 27**, below.

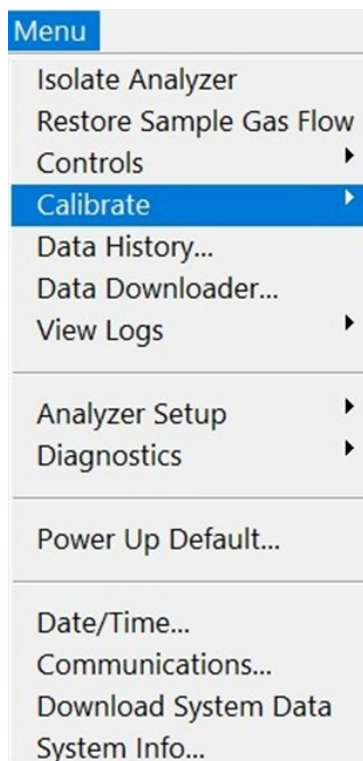


Figure 27: Calibrate Menu

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.

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

Any zero action whether completed or aborted is recorded in the **Zero Cal Log** as shown in **Figure 44**.

6.3.5.1 Check/Adjust Zero

The **Check/Adjust Zero** menu selection is shown in **Figure 28**, below. This menu selection accesses the Check/Adjust Zero screen, shown in **Figure 29**.

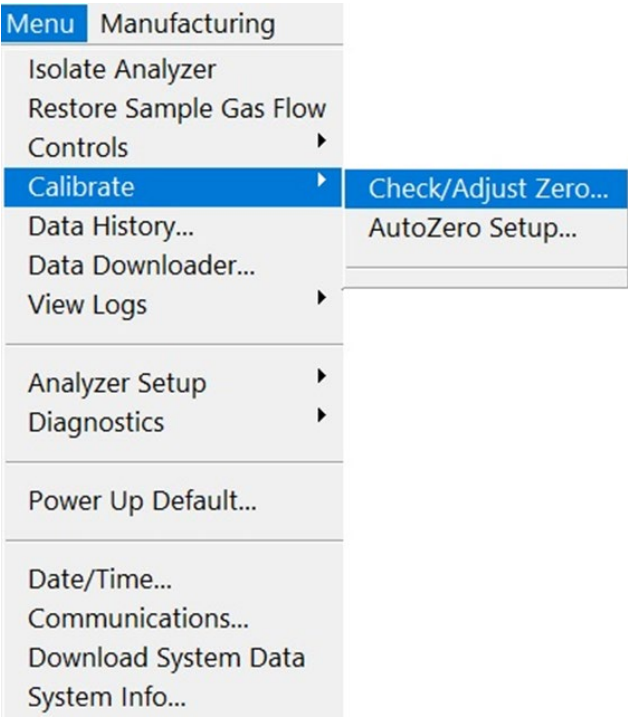


Figure 28: Check/Adjust Zero Menu

The **Check/Adjust Zero** screen displays information including a live reading of moisture in ppb (or ppm) and **Zero Reference** and **Zero Offset** values.

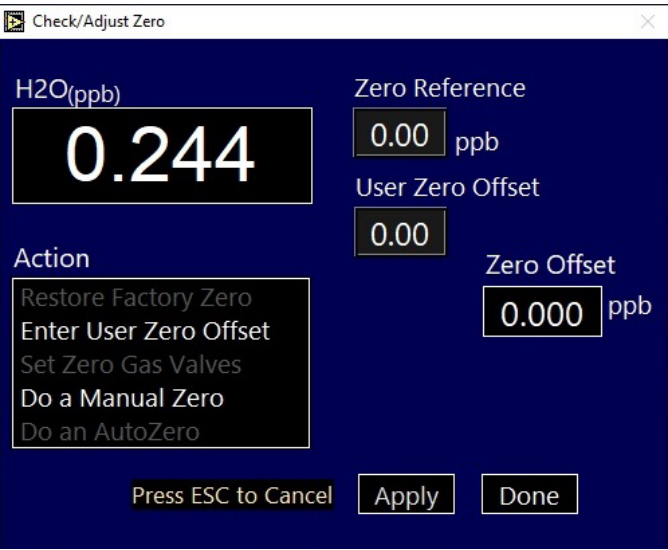


Figure 29: Check/Adjust Zero Screen

The **Zero Reference** value is based on 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 user has previously calibrated the moisture cell, **Restore Factory Zero** will be enabled on this screen. Enacting this will erase any user zero and restore the factory set point.

The **User Zero Offset** and **Active Zero Offset** are two mechanisms to modify the zero baseline. When the Active Zero feature is turned on, the **User Zero Offset** display is inactive and **Active Zero Offset** will be displayed instead. Refer to **6.3.14.1 Active Zero On/Off** for additional information on the **Active Zero** feature.

A relay is available on the Analog Output Setup Screen (see page 52) 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.

6.3.5.1.1 User Zero Offset

The **User Zero Offset** function enables the user to add a given moisture ppb value to the displayed concentration. This can be useful in preventing incorrect 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 29**), and then press the **Enter** key on the front panel. The zero offset box will appear on the screen. 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, press the **Enter** key which will move the highlighted area to the **Apply** button and press **Enter** again to set the value. Use the **Next** key to go back and change the value or move to the **Done** button, followed by pressing 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.

6.3.5.1.2 Do A Manual Zero

The manual zero command enables the user to zero the moisture cell by applying a correction that compensates for residual moisture in the analyzer not present in the sample gas.

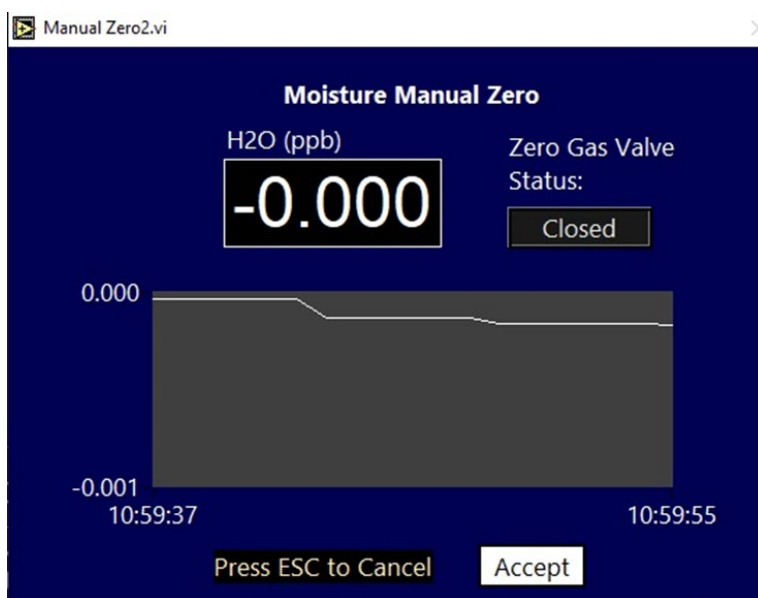


Figure 30: Manual Zero Screen

For this purpose, it is necessary to ensure that moisture free gas (sub ppb) is entering the sensor through the process inlet. When switching to a gas that is moisture free, it is important to wait the necessary time to allow the reading to re-stabilize.

It is extremely important to note that moisture is inherently slow to move and as a result the process of doing a zero calibration can take many hours before the reading is at baseline. A premature zero, although acceptable, will result in an incorrect reading as the plumbing and analyzer continue to dry out requiring another zero action.

After selecting **Do a Manual Zero**, a screen will appear which displays a trace of the recent moisture reading. See **Figure 30**. Observe the trace until the reading is stable and then press **Enter**. Then press the **Next** key. 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 **Check/Adjust Zero** screen.

Pressing **ESC** during the calibration process will abort the action and return to the main display. Whether the calibration is complete or aborted, pressing **Done** from the previous screen will allow the user to return to the main display.

Once complete, the gas source 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 52) 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** menu selection is shown in **Figure 31**, below.

The Data History Screen (**Figure 32**) 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, and the display will actively update.

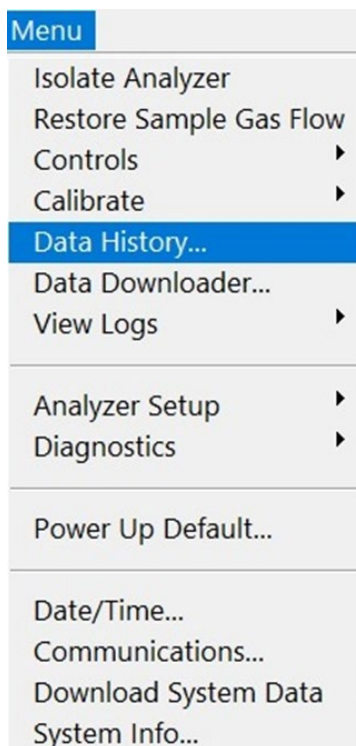


Figure 31: Data History Menu

The 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 will appear, requesting that a memory stick can be placed in the external USB socket (see **Figure 33**.) 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 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 36** 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.

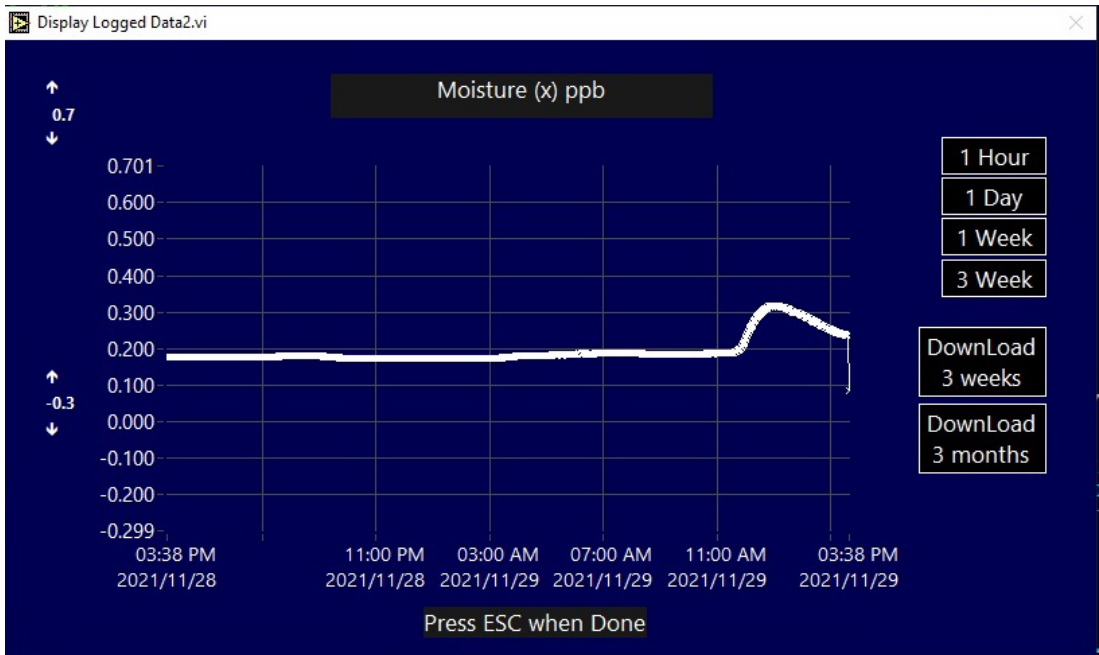


Figure 32: Data History Screen

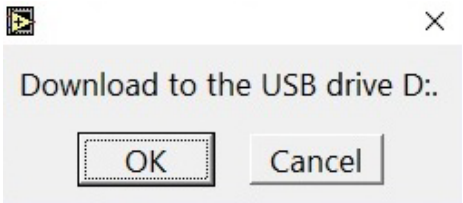


Figure 33: Install Media

```
Firmware version 7.1.16
Serial # ND-70010
Model # DF-740
Location USTC
Start time 11-29-2021 03:49 PM
End time 11-29-2021 03:51 PM
Date Time H2O
11/29/2021 3:48 PM 0.213
11/29/2021 3:49 PM 0.213
11/29/2021 3:50 PM 0.214
```

Figure 34: Example of Data Download

6.3.7 Data Downloader Routine

The **Data Downloader** menu selection is shown in **Figure 35**, below.

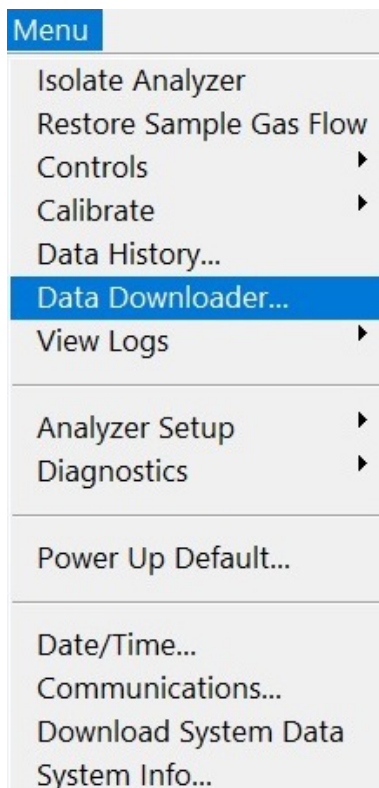


Figure 35: Data Downloader Menu

When the user selects **Data Downloader** from the main menu, the Data Downloader screen, **Figure 36**, displays. This screen enables the user to label data with unique location names as well as to view and download specified data.

The **Next** key is used to toggle through the diverse options on the screen and the arrow keys (▼ and ▲) move up and down through the location list.

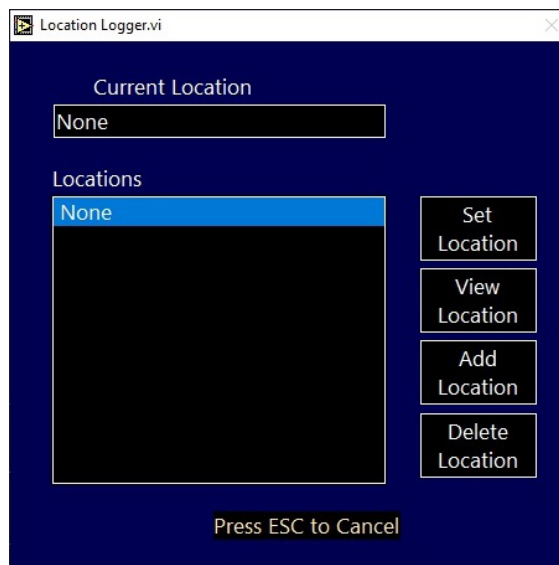


Figure 36: Data Downloader Screen

6.3.7.1 Set Location

The **Set Location Function** is used to choose a location from a list of existing locations previously entered the system (see **6.3.7.3 Add Location**). On the Moisture Data Downloader screen, **Figure 36**, 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

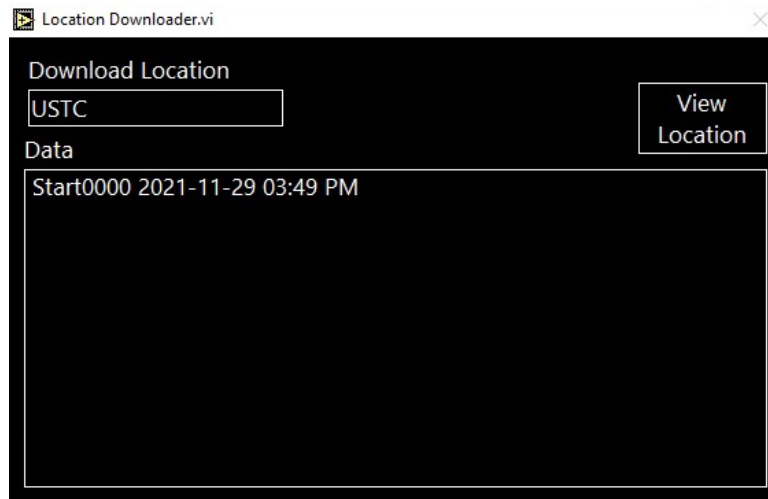


Figure 37: View Location Screen

The view location screen (**Figure 37**) is used to view data previously stored in the system sorted by location. On the Data Downloader screen (**Figure 36**), use the **Next** key to move to the list of existing names and then use the arrow keys (▲ and ▼) to select the location desired. Then use the **Next** key to move to **View Location** and press **Enter**. The View Location screen will appear as in **Figure 37**.

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 32**. 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 38** that is used to enter the name of the new location.

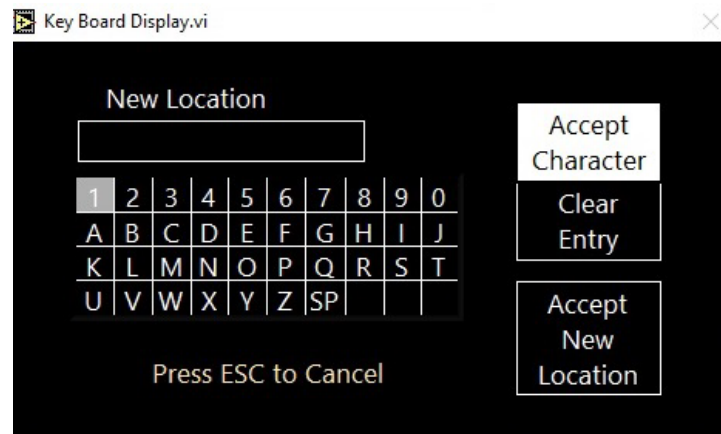


Figure 38: Keyboard Display

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 36**), 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 39**) and the user can either accept the deletion 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.

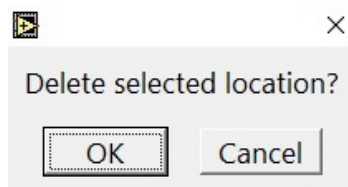


Figure 39: Delete Selection

6.3.8 View Logs Menu

The **View Logs** menu selection is shown in **Figure 40**, below.

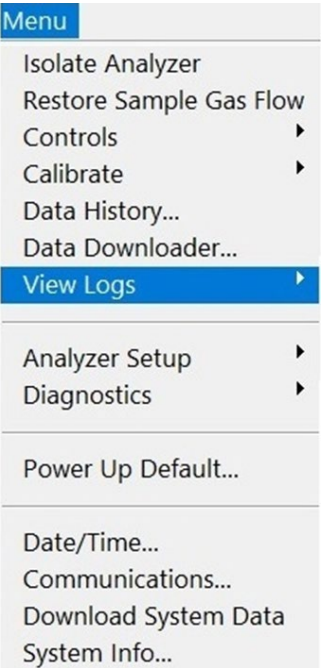


Figure 40: View Logs Menu Selection

View Logs allows the user to easily access past events that may be related 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

The **View Zero Log** menu selection, shown in **Figure 41**, accesses the **View Zero Log** screen shown in **Figure 42**.

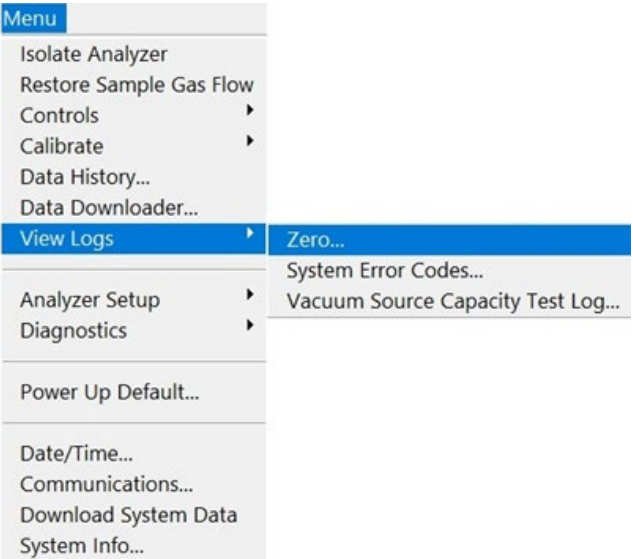


Figure 41: View Zero Log Menu

The **Zero Log (Figure 42)** reports on adjustments made to the moisture cell zero setting. The date and time of the zero calibration is noted.

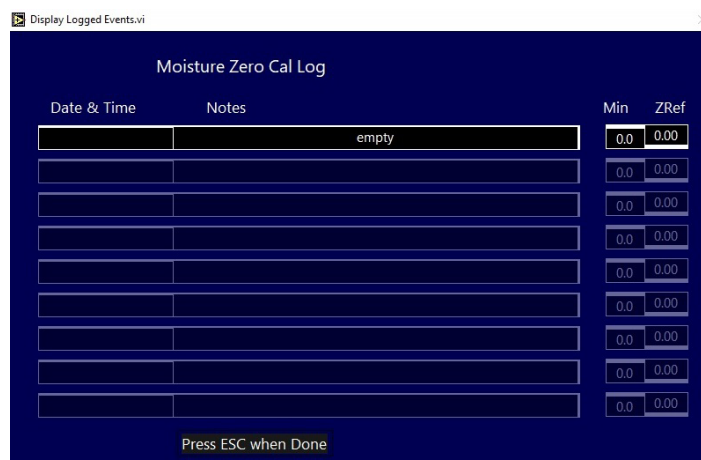


Figure 42: Zero Log Screen

6.3.9 View System Error Codes

The **View System Error Codes** menu selection is shown in **Figure 43**, below.

Figure 43: View System Error Code Log Menu

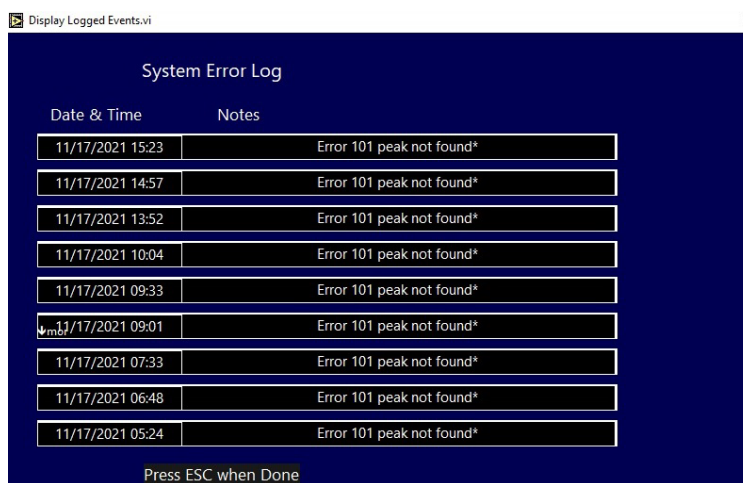


Figure 44: System Error Log Screen

The System Error Log (**Figure 44**) reports functional errors in the moisture system. If the error persists for more than 30 minutes, the code is displayed. In addition, a system alarm relay will trip if configured to do so. See page 59 for additional information on setting System Alarms. NOTE: The 30-minute clock is delayed for 60 minutes on a “cold” system start up. **Table 5** 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 5: 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.

6.3.9.1 Vacuum Source Capacity Test Log

The **Vacuum Source Test Log** menu selection is shown in **Figure 45**, below.

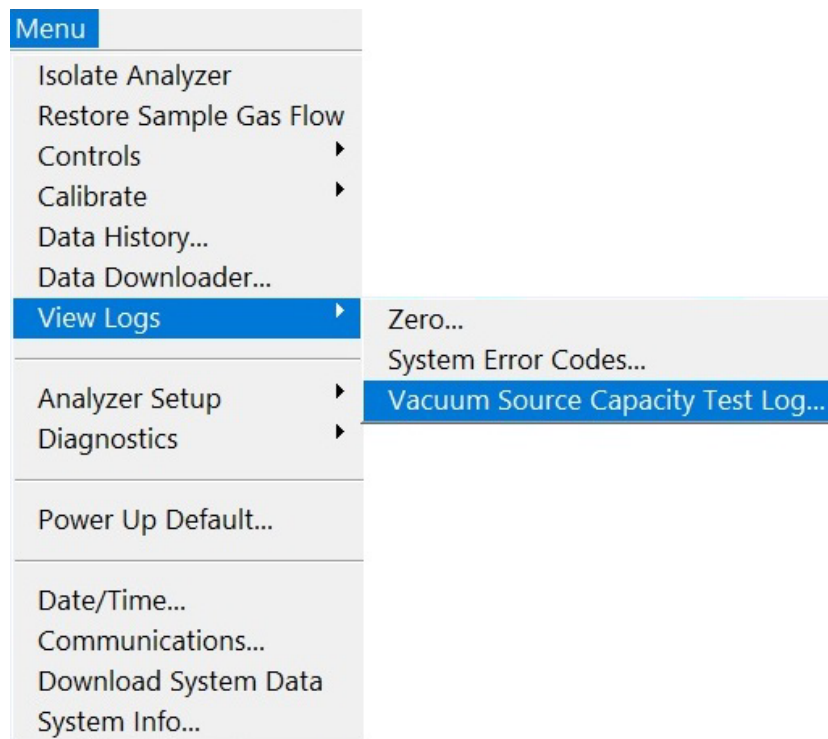


Figure 45: Vacuum Source Test Log Menu

The vacuum source capacity test is used to determine the vacuum that the 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 **6.3.14.5 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 (refer to **Figure 46**) for future reference. Review of this information can be useful in detecting a trend in the vacuum source condition which can indicate in a need to rebuild the pump.

Date & Time	Notes	h2o	torr
10/27/2020 12:58	pump capacity test	203.8	3.00
10/27/2020 09:31	pump capacity test	0.1	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 46: Vacuum Source Test Log

6.3.10 Analyzer Setup

The **Analyzer Setup** menu selection is shown in **Figure 47**. This menu selection accesses five submenus for analyzer setup.

6.3.10.1 Sample GSF

The **Sample GSF** menu selection is shown in **Figure 47**, below. This menu selection is used to access the Sample GSF Setup Screen as shown in **Figure 48**.

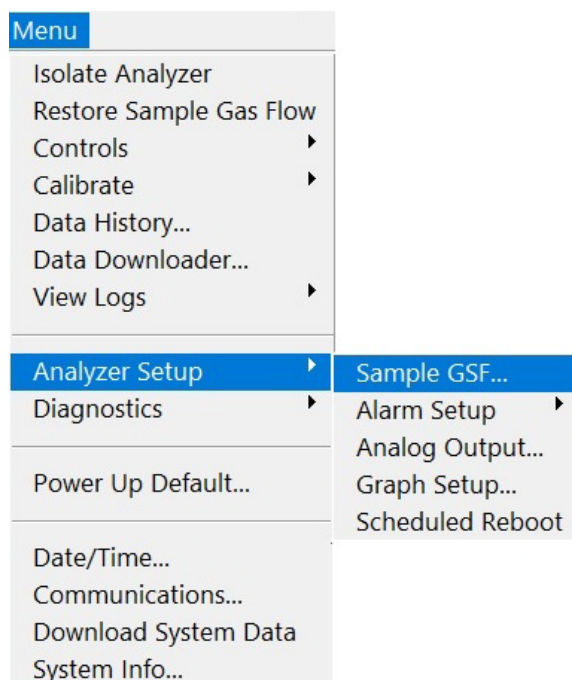


Figure 47: Sample GSF Menu

The GSF setup (Gas Scale Factor) is critical for obtaining quantitatively correct results. It accounts for the fact that moisture molecules have different absorption features in different buffer 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** at any time will exit the screen making no changes and return to the main display.

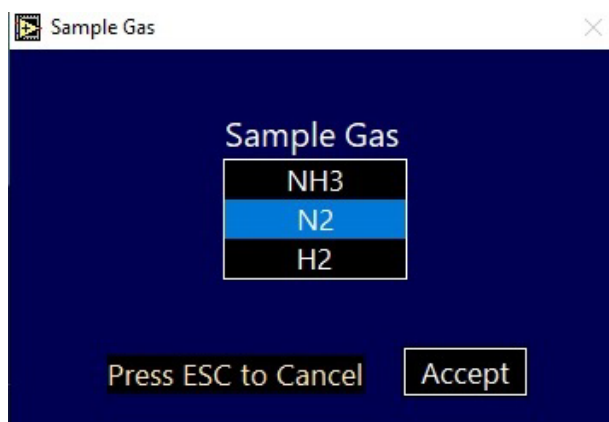


Figure 48: Sample GSF Setup Screen

After selecting the background gas, select the **Accept** button and press **Enter** to confirm that the sample gas selection. The system indicates the proper pressure setting as in **Figure 49** and the limits are set on the Pressure Alarm Screen. See page 49 for additional information on setting the **Pressure Alarm**.

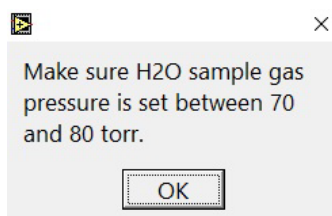


Figure 49: GSF Pressure Setting Message

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

6.3.10.2 Alarm Setup

The **Alarm Setup** menu selection is shown in **Figure 50**, below. This menu selection accesses submenus for **Moisture 1 -4**, **Temperature Range**, **Pressure Range**, and **System Error** alarms. The screens corresponding to these menu selections are shown in **Figure 51** through **Figure 54**.

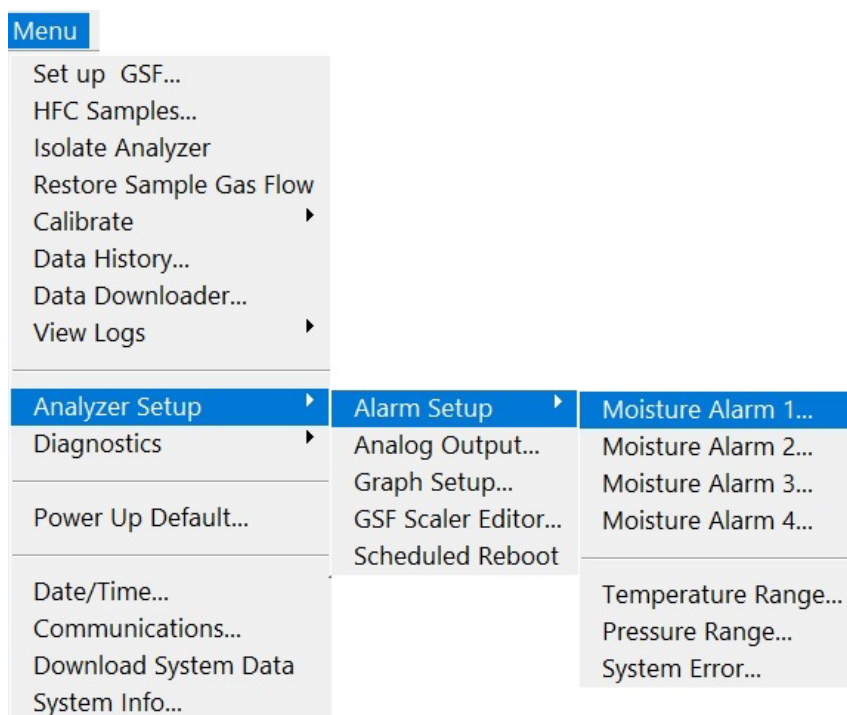


Figure 50: Alarm Setup Menu Selection

The moisture analyzer includes a total of seven alarms. The four moisture concentration alarms dead bands are user-set.

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 6: Alarm Codes

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

The pressure range alarm is related to the pressure in the gas path.

Finally, system errors are monitored. The analyzer can be configured to trip a relay if a system error is present for more than 20 minutes (60 minutes during warm-up).

NOTE: When hydrogen is the background gas, 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.

An alarm warning will overwrite the moisture level readout if an alarm condition exists. To acknowledge the alarm, press the **Enter** button and the Alarm number or letter will appear in the Alarm Status line in the display (refer to **Table 6: Alarm Codes**). This action will not clear the alarm. Only correction of the condition that caused the alarm will clear the alarm.

6.3.10.3 Moisture Alarm Setup

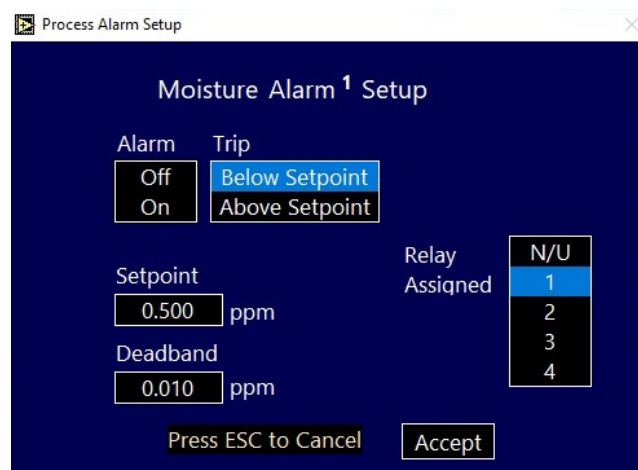


Figure 51: Alarm Setup Screen

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 deviation from the nominal setpoint that the output value must exceed before an alarm is triggered. 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.

6.3.10.4 Temperature Range Alarm Setup

The screenshot shows the 'Temperature Alarm Setup' window. It has a dark blue background with white text. The title is 'Moisture Sensor Temperature Alarm Setup'. There are several input fields and buttons:

- Alarm:** A toggle switch with 'Off' (highlighted in blue) and 'On' (black) options.
- Deadband:** A numerical input field showing '0.0'.
- High Trip:** A numerical input field showing '21.0'.
- Low Trip:** A numerical input field showing '5.0'.
- Relay Assigned:** A list box with options 'N/U', '1' (highlighted in blue), '2', '3', and '4'.
- Temperature inside Cabinet:** A numerical input field showing '30.0 °C'.
- Buttons:** 'Press ESC to Cancel' and 'Accept'.

Figure 52: 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 pre-set 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.

6.3.10.5 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 pre-set limits. The user may assign the pressure alarm to one of four relays.

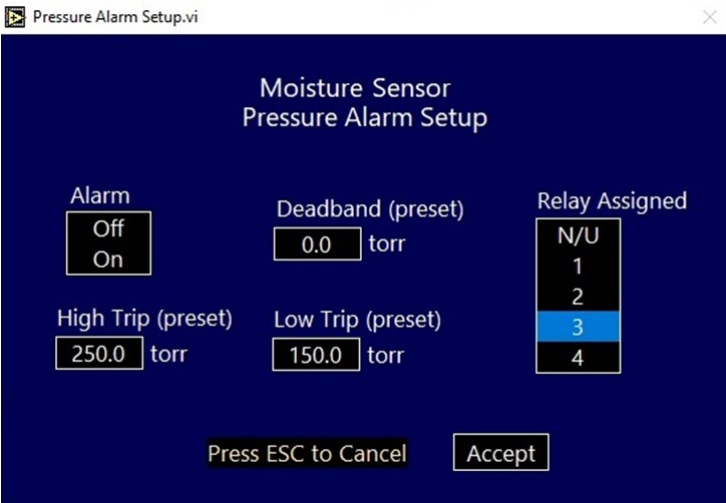


Figure 53: Pressure Range Alarm Setup

The limits are not user adjustable but are set automatically based on the background gases entered in the GSF screen. See page 45 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.

6.3.10.6 System Alarm Setup



Figure 54: 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 43 for additional information on System Error Codes.

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

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.

6.3.11 Analog Output Setup

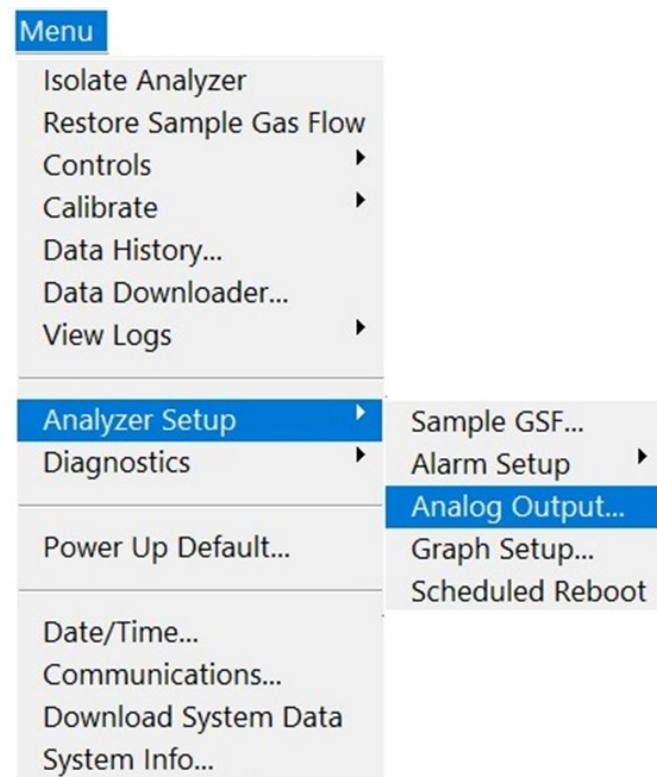


Figure 55: Analog Output Setup Menu

The Analog Output Setup menu selection is shown in **Figure 55**. This selection accesses the Moisture Analog Setup screen shown in **Figure 56**.

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 100 ppb to 10.00 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. If only one expanded range is required, rather than two, then the value of FS B should be set to equal the FS A value.

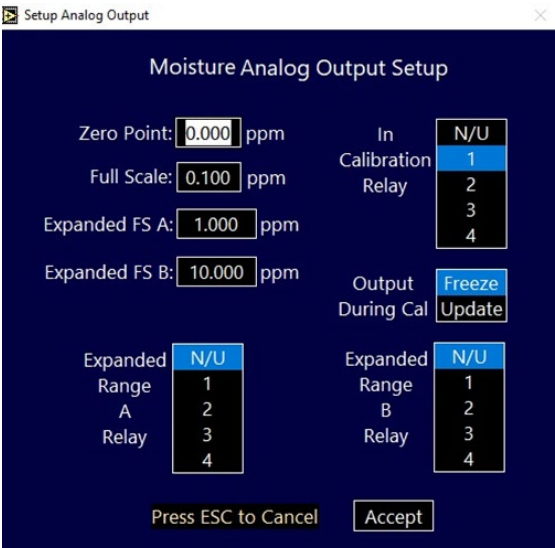


Figure 56: Analog Output Setup Screen

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.

6.3.12 Graph Setup

The **Graph Setup Menu Selection** is shown in **Figure 57**, below. This menu selection accesses the **Graph Setup** screen in **Figure 58**.

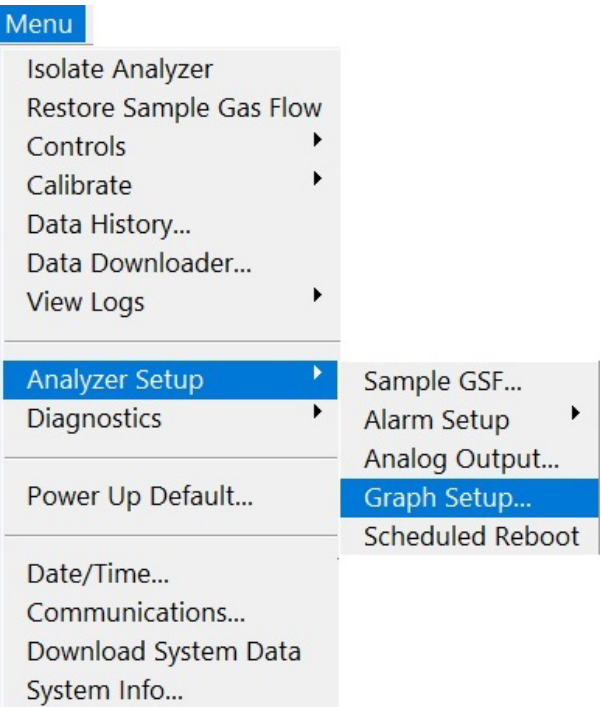


Figure 57: Graph Setup Menu

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

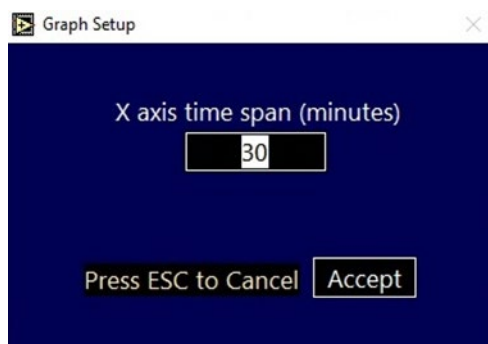


Figure 58: Graph Setup Screen

6.3.13 Scheduled Reboot

The **Scheduled Reboot** menu selection is shown in **Figure 59**, below. This menu selection accesses the **Next Scheduled Reboot** screen shown in **Figure 60**.

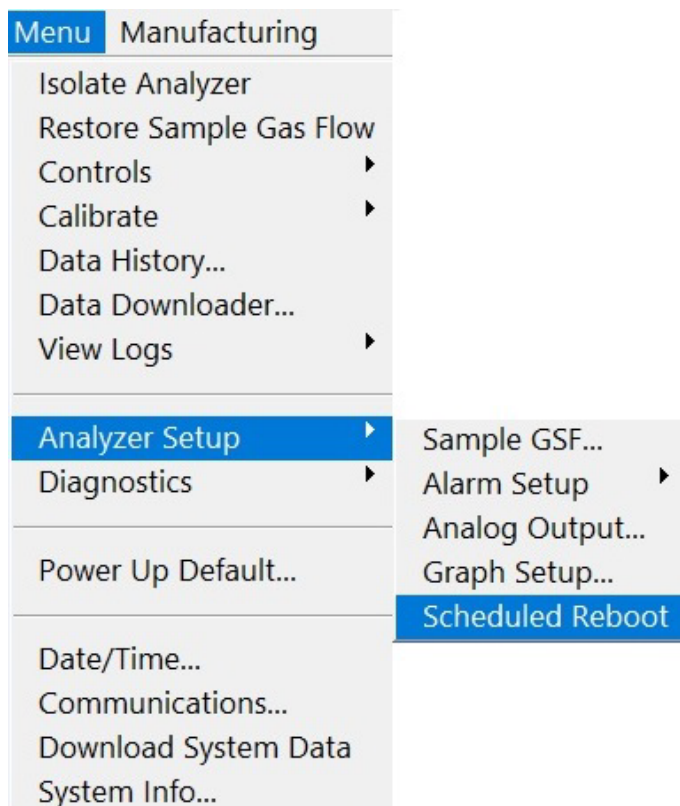


Figure 59: Scheduled Reboot Menu Selection

Scheduled reboot allows scheduling of a periodic automatic reboot of the analyzer. The time interval is settable to between 1 and 5 weeks. Time is settable to any time using 24-hour clock notation. Navigation is accomplished using the **Next** and arrow buttons. The next scheduled reboot is displayed near the bottom of the screen as shown in **Figure 60**

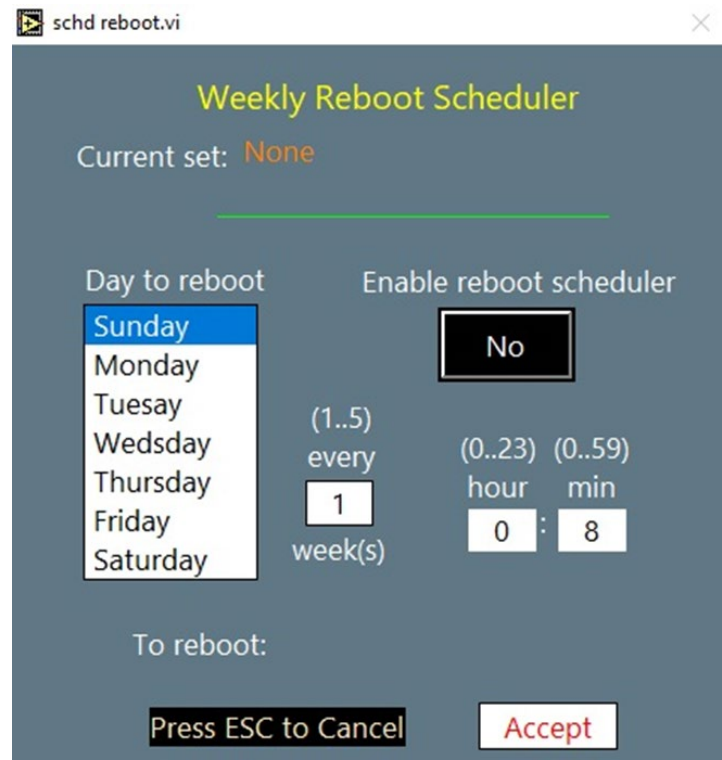


Figure 60: Next Scheduled Reboot

6.3.14 Diagnostics Menu

The **Diagnostics** menu is used to select one of five diagnostic submenus. It is shown in **Figure 61** with the **Active Zero On/Off** selected. This selection access the **Active Zero On/Off** screen (**Figure 62**).

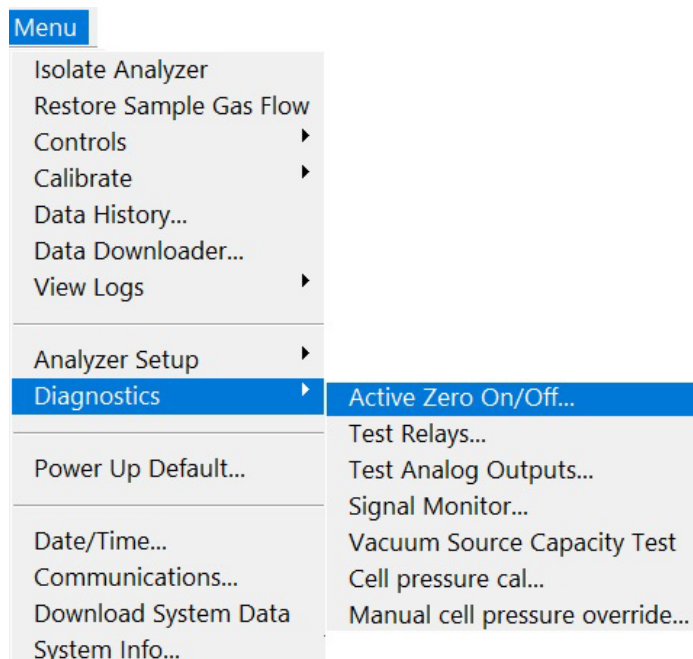


Figure 61: Diagnostics Menu Selection

6.3.14.1 Active Zero On/Off Screen



Figure 62: Active Zero Setup Screen

The **Active Zero Offset** feature is designed to automatically compensate for the analyzer's gradual zero baseline clean-up. This gradual clean-up is natural and occurs after a fresh startup or after a prolonged or abnormally high moisture exposure. This feature ensures that accurate low ppb H₂O readings can be made as soon as possible after initial start-up, 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 clean-up. 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 clean-up, 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 30**. 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 incorrect H₂O readings may result.

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

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

6.3.14.2 Test Relays

The **Test Relays** menu selection is shown in **Figure 63**, below.

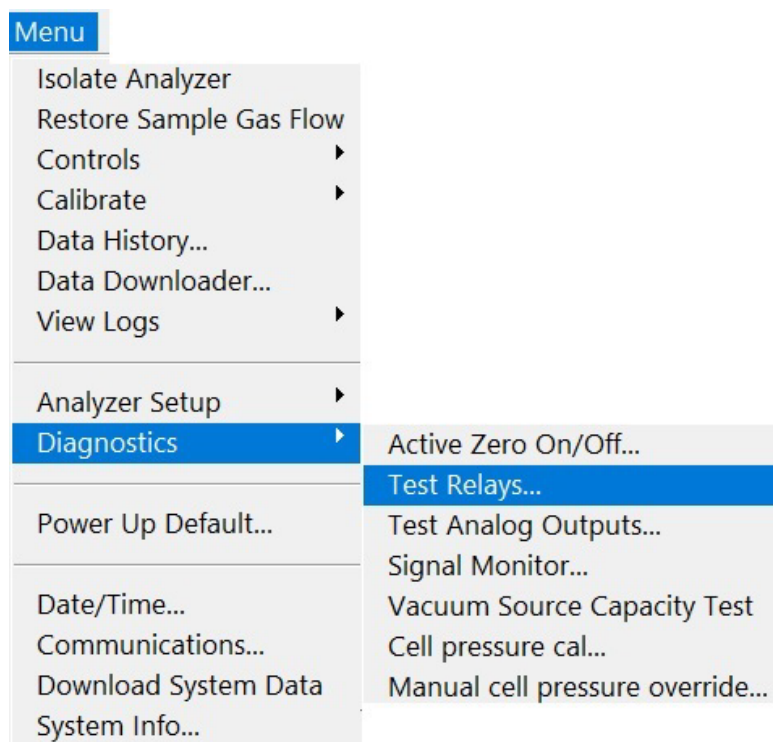


Figure 63: Test Relays Menu Selection

The **Test Relays** screen, as shown in **Figure 69**, is used to assure that the relay outputs are functioning properly. When the Test Relays screen is selected, the **NEXT** key is used to move to the number field where the arrow keys (▲ and ▼) are used to choose the appropriate relay number. The **NEXT** key is then used to move to the **Activate/Deactivate** field where the arrow keys (▲ and ▼) are used to toggle between the two options. The **NEXT** key is then used to move to the **Apply** field where the **Enter** key is hit to change the relay state. This process can be repeated as often as needed. When done, the **NEXT** key is used to move to the **Done** field and the **Enter** key is hit to leave the screen. The condition of the relays before the test is restored when the test is concluded. See the section on relay ports found on page 25 for additional information.



Figure 64: Test Alarm Relays Screen

6.3.14.3 Test Analog Voltage Output

The **Test Analog Outputs** menu selection is shown in **Figure 65**, below. This menu selection accesses the **Test Analog Outputs** screen shown in **Figure 66**. This screen is used to calibrate the analog recorder output.

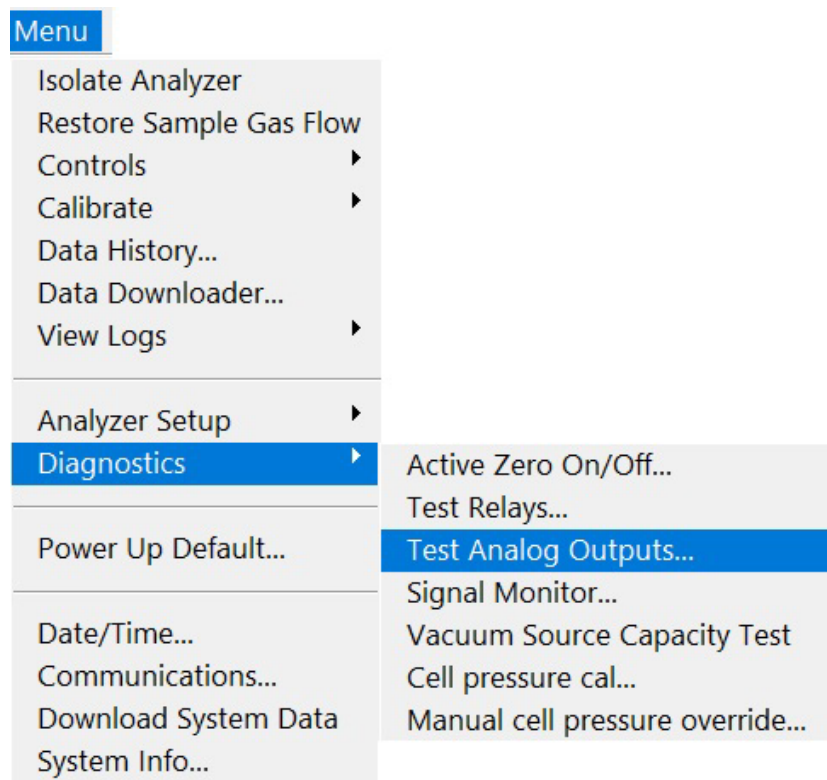


Figure 65: Test Analog Outputs Menu Selection

When the Test Output screen is displayed, 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 23 for additional information.

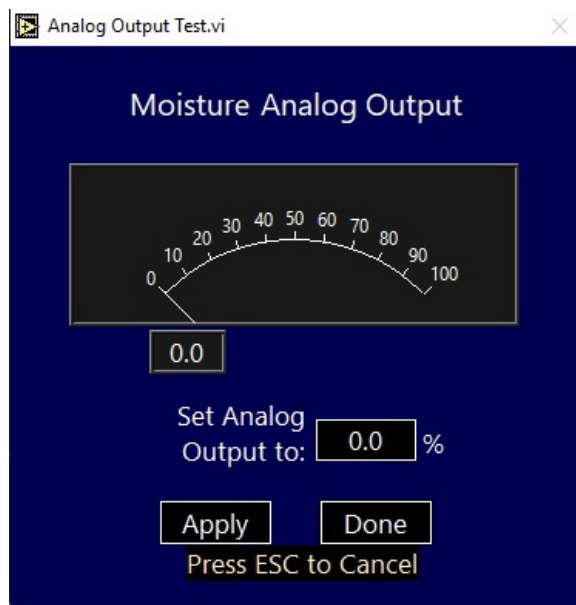


Figure 66: Test Analog Voltage Output Screen

6.3.14.4 Signal Monitor

The **Signal Monitor** menu selection is shown in **Figure 67**, below.

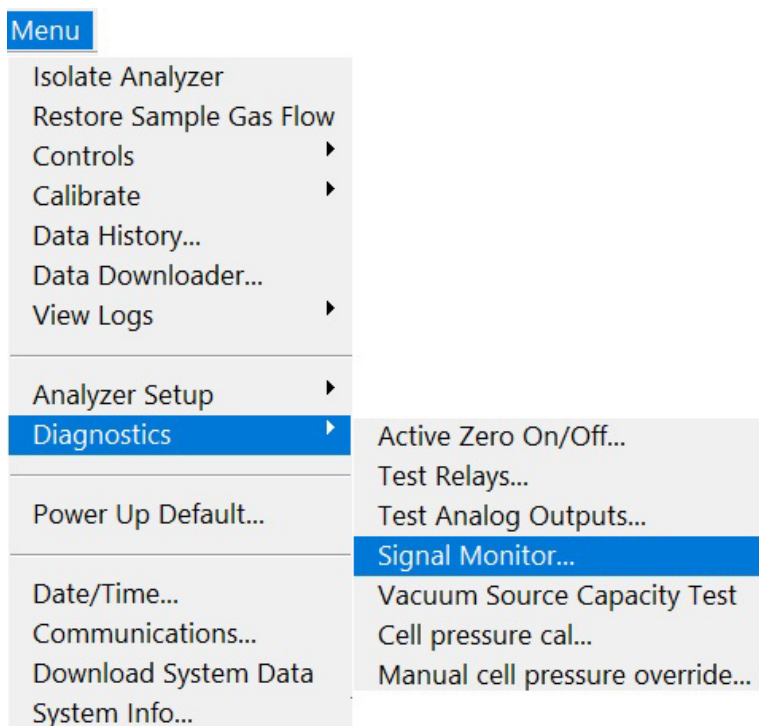


Figure 67: Signal Monitor Menu Selection

The Signal Monitor screen (**Figure 68**) depicts 18 system parameters, which are defined in **Table 7**. 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.

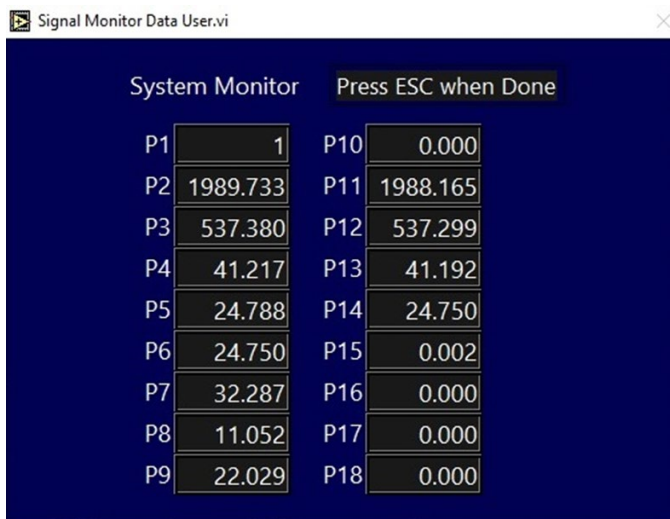


Figure 68: Signal Monitor Screen

Parameter	Definition
P1	Peak Acquisition
P2	Sample Detector DC
P3	P Chamber
P4	Cell Temp (= T gas)
P5	T Laser
P6	T Laser Set Point
P7	Baseline Adjust In
P8	Fan Condition
P9	Ambient Temp
P10	Fit RMS Error (filtered)
P11	Original SDC
P12	Original P Chamber
P13	Original Cell Temp
P14	Original T Laser Set Point
P15	Original Fit RMS Error (filtered)
P16	Raw PPB SD (Past 24 hours)
P17	Max. Raw PPB (Past 24 hours)
P18	Min. Raw PPB (Past 24 hours)

Table 7 Signal Monitor Parameter Definitions

6.3.14.5 Vacuum Source Capacity Test

The **Vacuum Source Capacity Test** menu selection is shown in **Figure 69**, below. This menu selection access the Pump Capacity Test screen shown in **Figure 70**.

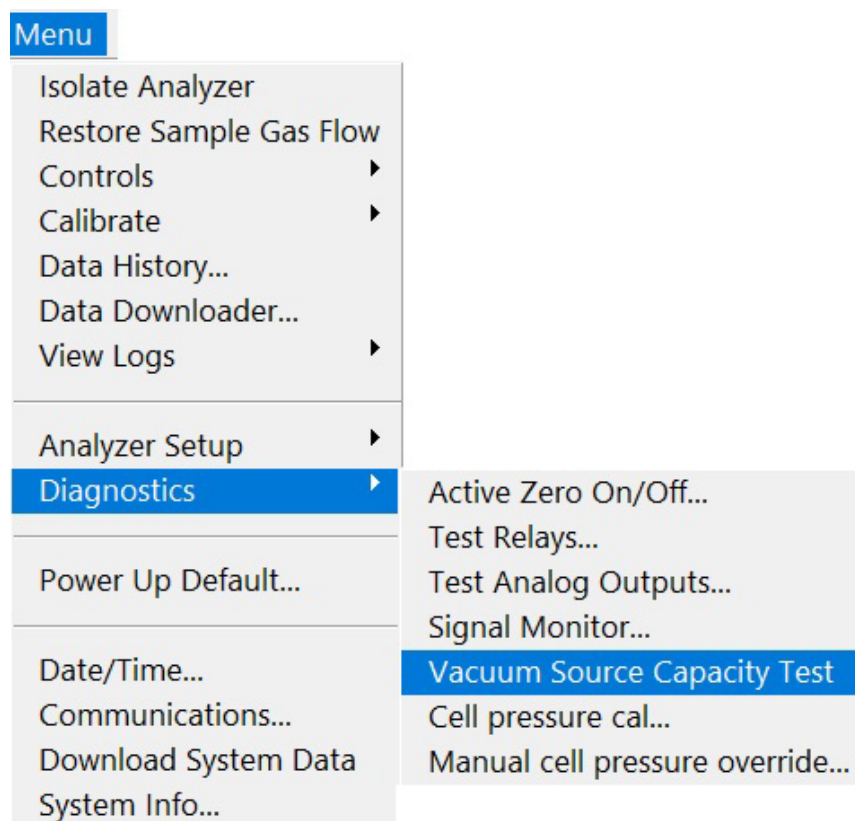


Figure 69: Vacuum Source Capacity Test Menu

The vacuum source capacity test can be used to determine the vacuum that the pump can pull. When the test is started, the analyzer isolates the moisture cell by closing the upstream and downstream valves. Then, vacuum is monitored and displayed on the screen for 20 seconds. Any pressure lower than 30 Torr is considered acceptable. If the pump is unable to pull 30 Torr, a failure is indicated by the appearance of **Figure 76** and the recommendation to rebuild the pump or check for leaks. At the end of the 20 second test, whether pump passes or fails, the user must hit **Esc** to return to the main display.

After the Vacuum Source Capacity test is complete, an entry is automatically put in the pump capacity test log as shown in **Figure 48**. See page 43 for additional information on the pump test log.

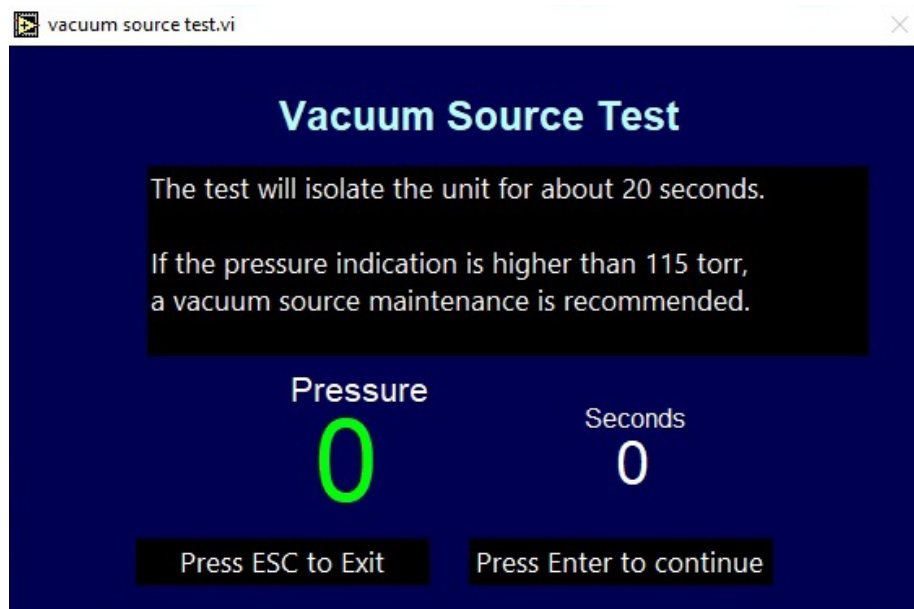


Figure 70: Pump Capacity Test



Figure 71: Pump Pressure Failure

6.3.14.6 Cell Pressure Calibration

The **Cell Pressure Calibration** menu selection is shown in **Figure 72** below. This menu selection accesses the **Cell Pressure Calibration** screen show in **Figure 73**.

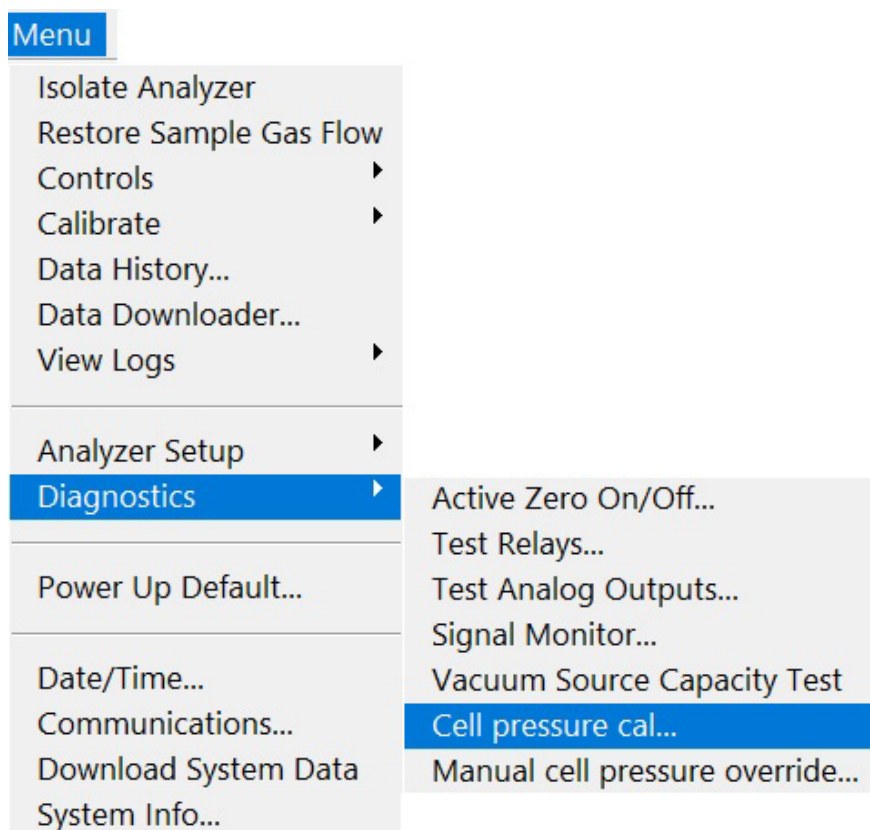


Figure 72: Cell Pressure Calibration Menu Selection

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

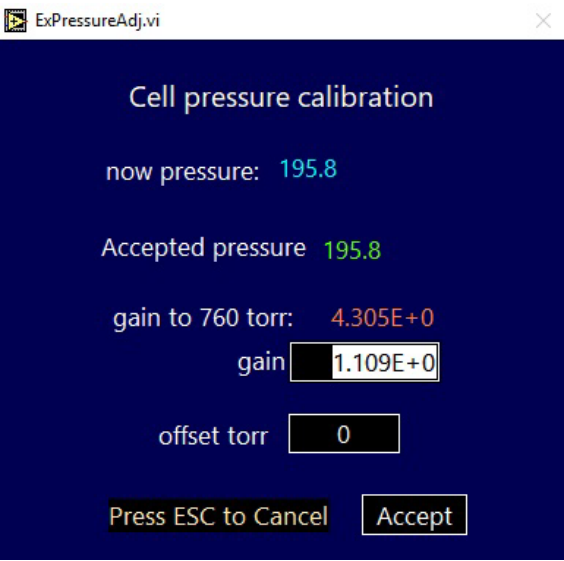


Figure 73: Cell Pressure Calibration Screen

6.3.14.7 Manual Cell Pressure Override

The Manual **Cell Pressure Override** menu selection is shown in **Figure 74** below. This menu selection accesses the **Manual Cell Pressure Override** screen show in **Figure 75**.

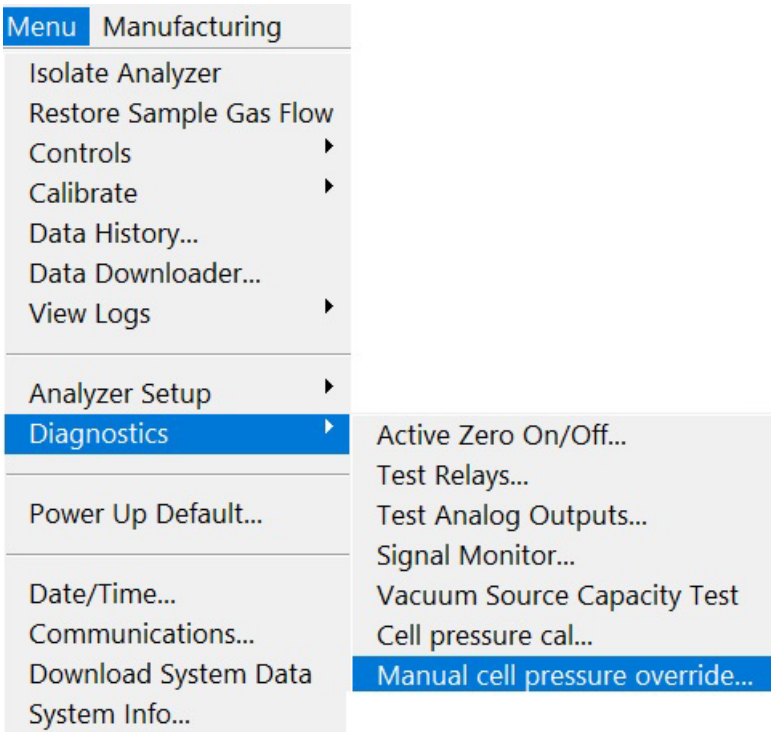


Figure 74: Manual Cell Pressure Override Menu Selection

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

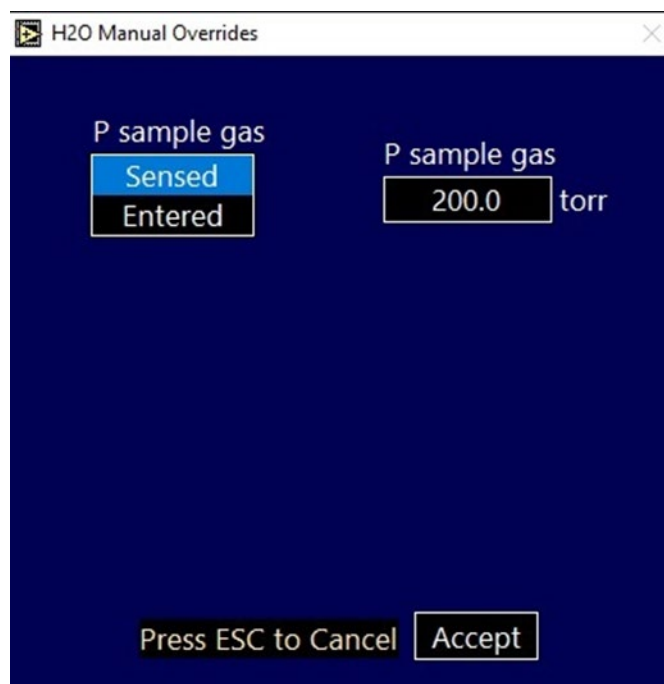


Figure 75: Manual Cell Pressure Override

6.3.15 Power Up Default (applicable to analyzers with iso valves)

The **Power Up Default** menu selection is shown in **Figure 76**, below. This menu selection accesses the **Power Up Default** screen shown in **Figure 77**.

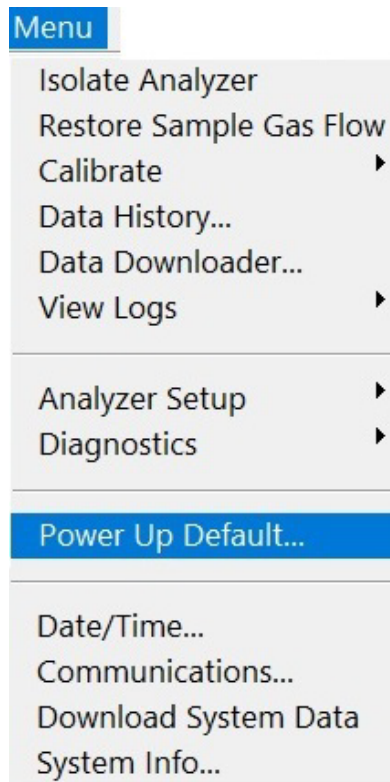


Figure 76: Power Up Default Menu Selection

The Power Up Default selection allows the user to set the default state of the isolation valves after analyzer power up. This feature is available only on analyzers that have the isolation valves option.

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.

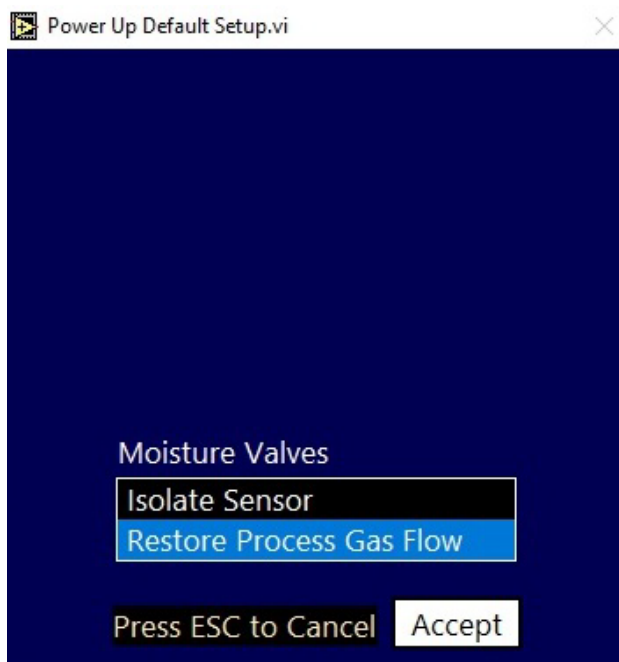


Figure 77: Power Up Default Screen

6.3.16 Date/Time

The **Date/Time** menu selection is shown in **Figure 78**, below. This menu selection accesses the **Date/Time Setup** screen shown in **Figure 79**.

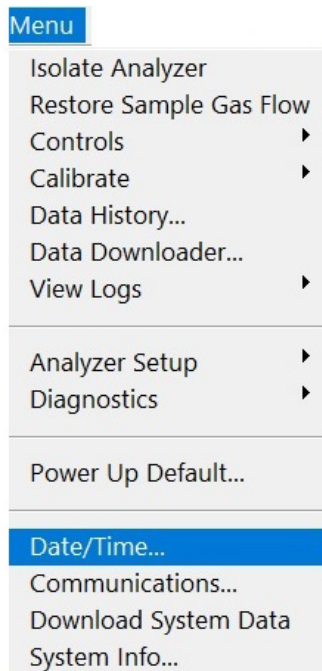


Figure 78: Date/Time Menu

The Date/Time Screen is used to set various calendar and clock related parameters.

The **Next** key is used to move from field to field, and the arrow keys (▲ and ▼) are used to change the numerical digits and units.

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

Select **Change date and time** and press the **Enter** key to access the **Date/Time Edit** screen (Figure 80). Use the arrow keys to change the date and time in this screen. When done, select **OK** and then press **Enter** key to confirm.

Pressing 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.

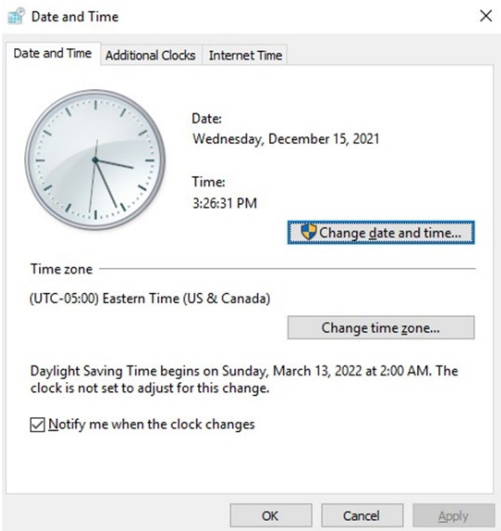


Figure 79: Date/Time Setup Screen

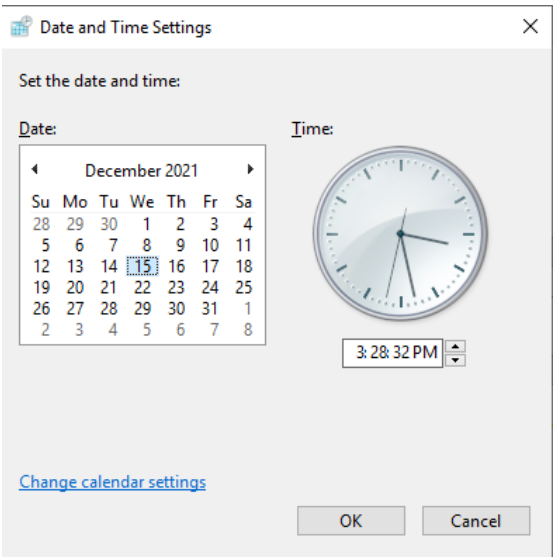


Figure 80 Date/Time Edit Screen

6.3.17 Communications

The **Communications** menu selection is shown in **Figure 81**, below. This menu selection access the **Communications Setup** screen shown in **Figure 82**.

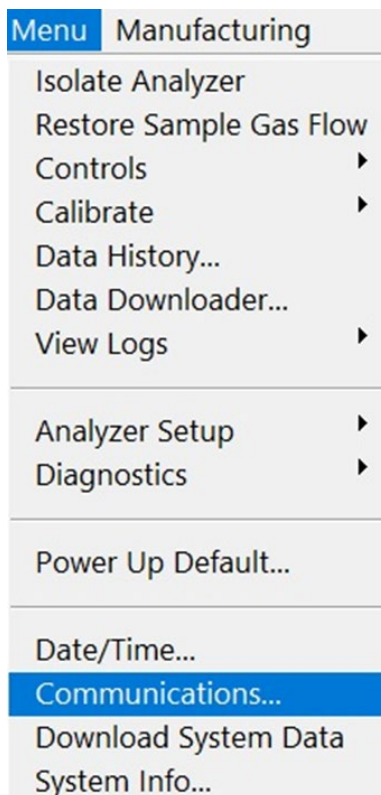


Figure 81: Communications Menu Selection

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 22 for additional information.

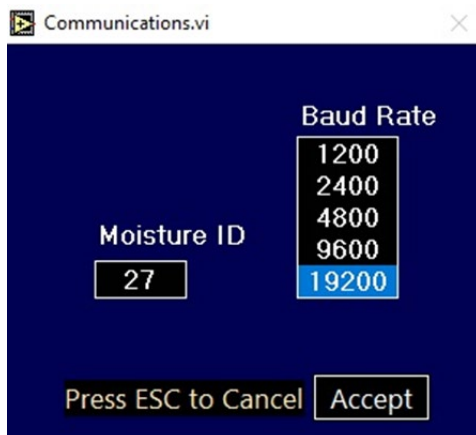


Figure 82: Communications Setup Screen

6.3.18 Download System Data

The **Download System Data** menu selection is shown in **Figure 83**, below.

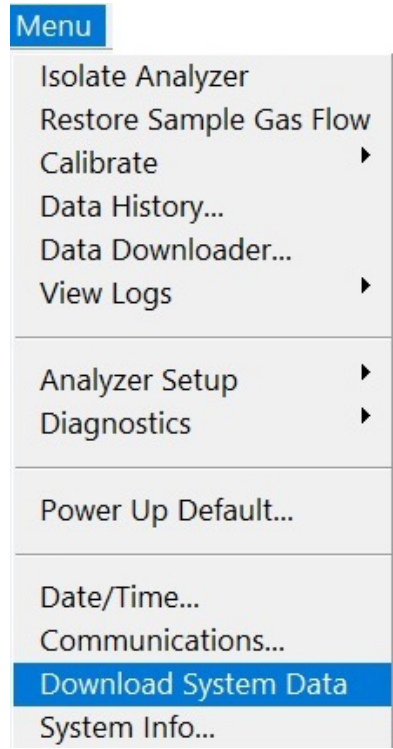


Figure 83 Download System Data Menu

The contents of the internal system data files can 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 USB socket located behind the front door and on the left side of the analyzer. After selecting **Enter** from the **Download System Data** menu, **Figure 89** is displayed.

The system downloads data for ten days ending with the date set on the screen as shown in **Figure 89**. 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 ).

Press **Enter** and the download process will begin, and a time bar will appear as in **Figure 92**. The process should only take a minute or two and when complete control will be returned to the user.

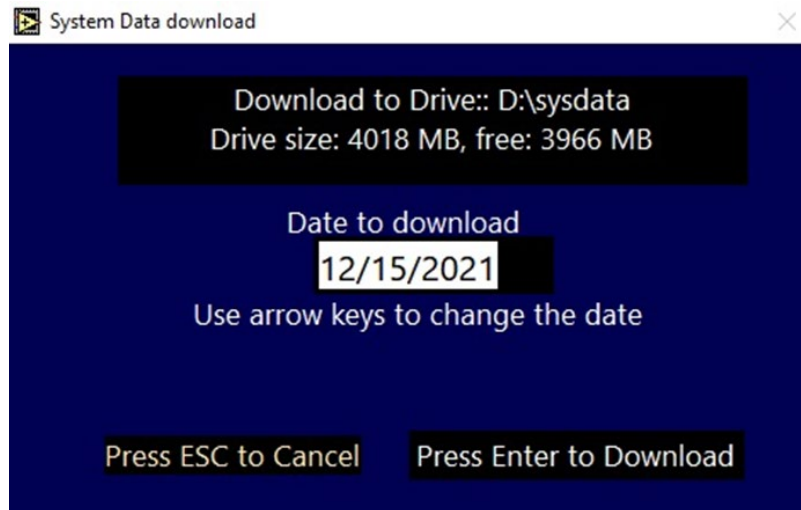


Figure 84: System Data Download

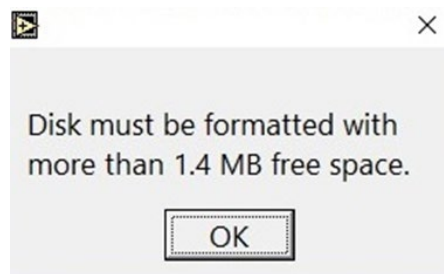


Figure 85: Media Warning

If there is insufficient space available on the media a warning will appear as in **Figure 90**.

If Drive D is not ready, a message will appear as in **Figure 91** below.



If not ready message appears, select OK, check that USB is inserted correctly and try again.

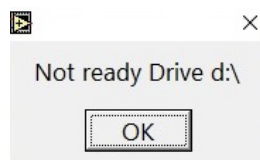


Figure 86: Not ready Drive d:

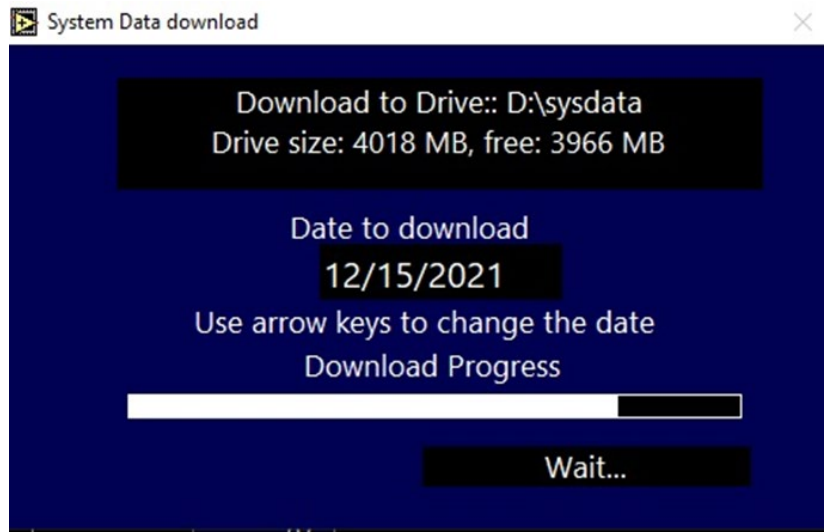


Figure 87: Download Timeline

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.

6.3.19 System Info

The **System Info** menu selection is shown in **Figure 88**, below. This menu selection accesses the **System Info** screen shown in **Figure 89**.

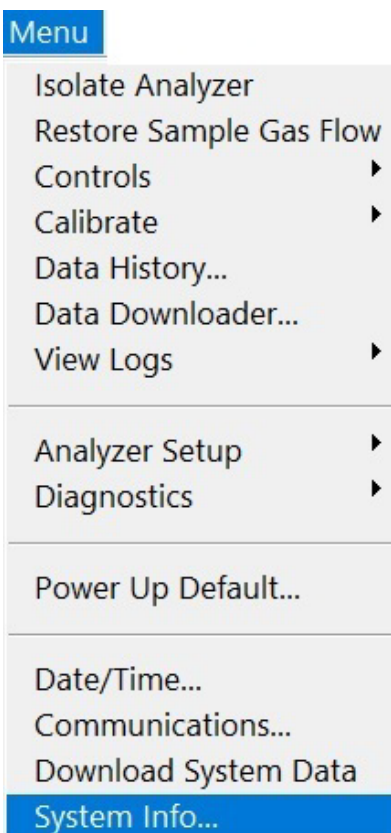


Figure 88: System Info Menu

The **System Info** screen (**Figure 89**) 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.

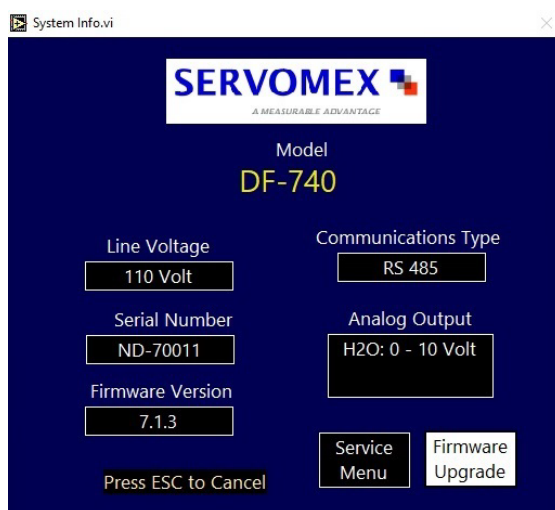


Figure 89: System Info Screen

6.3.19.1 Firmware Upgrade

While the **Firmware Upgrade** box is highlighted, hitting the **Next** key will bring up the Firmware Upgrade dialog box as in **Figure 90** below.

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

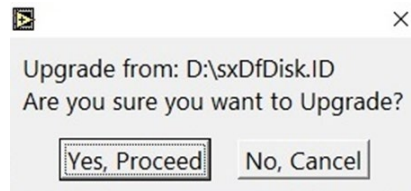


Figure 90: Firmware Upgrade

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 8.**) The pressure can be adjusted by balancing the inlet regulator setting with the needle valve in the vacuum pump assembly. When using a mixture of background gases, the required pressure range may be different than for either gas individually. A message on the screen will indicate the required pressure in this case.

Background Gas	Pressure	Vacuum Source
N ₂	150 - 250 Torr	ON
H ₂	300 - 400 Torr	ON
NH ₃	70 - 80 Torr	ON

Table 8: Sample Outlet Pressure

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 Flammable Sample Gas

The only flammable gas that the DF-740 can be used with is hydrogen. If used with hydrogen, 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 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 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 the 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.

8.3.4 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, a power cord is not provided because the power plug requirements differ from country to country. 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 your country 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.

8.4 Troubleshooting Guide for the NanoTrace Analyzer

8.4.1 Moisture Troubleshooting

The DF-700 series moisture analyzer constantly monitors analyzer performance. In the event of a failure, a system alarm is displayed on the front panel. In addition, the failure is logged in the System Error Log (see **6.3.9 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 48.

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. If analyzer has isolation valves, isolate the analyzer moisture cell by following the steps in **4.2.2 Isolate Analyzer**.
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.) and mark for reattachment later.
4. Mark each connector for reattachment later.
5. Ensure that all internal components are secured and put the analyzer in its original container.

If the analyzer is to be returned to the factory, call the nearest Servomex Business office to obtain a **Return Material Authorization number**. 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

8.6 Storage and Disposal

8.6.1 Storage

Make sure all gas inlets and outlets are tightly capped. If analyzer has regulator, ensure regulator is fully closed. 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.

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

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

Hint:	<i>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 Return Authorization Number (RAN) (refer to 8.5 Shipping.)</i>
--------------	--

The label shown in **Figure 91** is fitted to the analyzer.



Figure 91 The WEEE 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

9. Theory of Operation

9.1 The Moisture Measurement

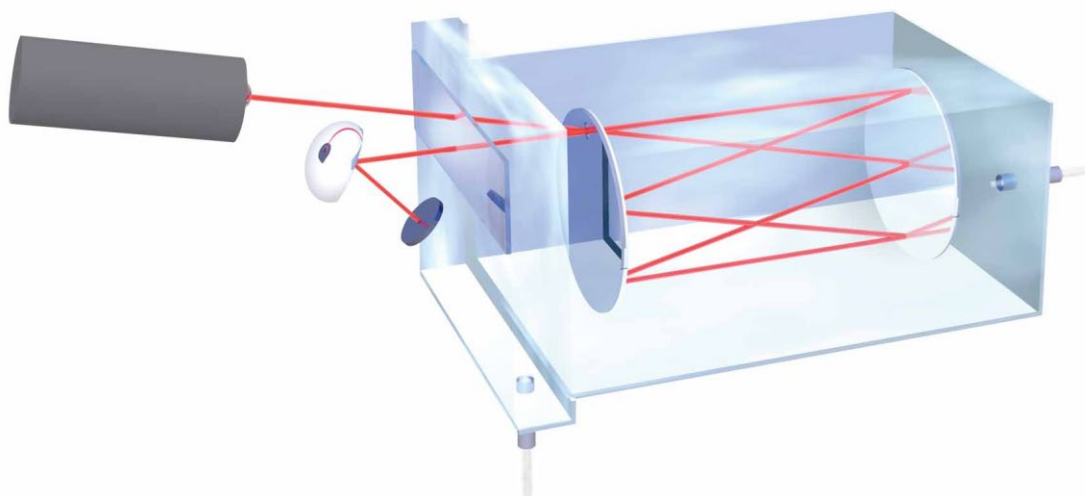


Figure 92: Schematic of Moisture Cell

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 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 Herriott) is shown in **Figure 92**. 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 (specifically light) 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-740 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.

9.2 Absorption Spectroscopy

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

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

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

Definitions:

$A_{\lambda} \equiv$ Absorbance at wavelength λ

$T \equiv$ Transmittance

$I_0 \equiv$ Reference Intensity of Light

$I \equiv$ Measured Intensity of Light after Absorption

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

$b \equiv$ Path length

$C \equiv$ Molar concentration

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

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

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

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

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

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

10. Specifications

10.1 Moisture Detection

Lowest Detection Level (LDL): 10 ppb @ Constant Conditions

Accuracy: Greater of $\pm 5\%$ of reading or ± 5 ppb @ Constant Conditions

Speed of Response: Less than 3 minutes @ 1 lpm

Upset Recovery Time: Less than 5 minutes from a high ppb upset to within 100 ppb of the previously stable reading.

Range: 0-10 ppm (NH_3), 0-20 ppm (N_2, H_2)

Background Gas Compatibility: N_2 , H_2 , NH_3

Cell Pressure: Variable from 70- 400 Torr (93.33 mbar – 533.29 mbar, 9.33 – 53.33 KPa), depending on background gas)

10.2 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)

Environmental:

Altitude: 2000 meters (6500 feet), max

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

Humidity: 0 - 95% relative humidity non-condensing

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

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

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

Gas Inlet, Sample:

Flow Rate: 0.25 slpm

Inlet Pressure (nominal): 18 psig (1.24 Barg, 124.1 Kpag)

Vent: Vent to atmosphere. Vent pressure limits: -2 to 2 psig, (-0.14 to 0.14 barg, -13.7 to 0.13 kpag)

Gas Inlet, Pneumatic:

Gas: N_2 or air

Specifications

Inlet Pressure: 70 to 100 psig (4.8 to 6.9 barg, 482.6 - 689.5Kpa)

Span Gas: Not required.

Zero Gas: Optional. Recommended if operating near LDL

Gas Path Construction Materials:

316 Stainless Steel, 304 Stainless Steel, Indium, Passivated Steel, Hastelloy C22, Gold, Invar, Acrylic, Buna-N, Sapphire, PCTFE, Polypropylene,

10.3 Output Signals & Status Indicators

Alarm Relays: Four non-latching relays, 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: Isolated 4-20mA dc output and a choice of 0-1, 0-5, or 0-10 VDC (minimum load resistance: 1K), User Scalable 0-2 ppb to 0-20 ppm moisture.

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

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

10.4 Laser

Max Power: 50mW/30mW

Beam Divergence: 436 mrad

Pulse Pattern: Continuous Wave

Classification: The DF-740 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)

10.5 Power

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

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

10.6 Compliance

EMC: EU EMC Directive: (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. Warranty

Servomex warrants each instrument it manufactures to be free from defects in material and workmanship at the F.O.B. point specified in the order, its liability under this warranty being limited to repairing or replacing, at the Seller's option, items which are returned to it prepaid within one (1) year from delivery to the carrier and found, to the Seller's satisfaction, to have been so defective.

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

Index

4

4-20mA Outputs, 24

A

about this manual, ix

scope of manual, ix

symbols, ix

Active Zero On/Off, 55

Add Location, 40

Alarm Setup, 47

Alarm Setup, Moisture, 48

Analog Output Setup, 51

Analog Signal Outputs, 23

Analyzer

Specifications

General, 85

Moisture, 85

Warranty, 87

Analyzer Shut Down, 20

C

Check/Adjust Zero, 33

Communications, 69

D

Data Download, 39

Data History Routine, 36

Delete Location, 41

Display Setup, Moisture, 52

Download System Data, 70

E

Error Codes, 43

External Devices, Connecting to

4-20mA Outputs, 24

Analog Signal Outputs, 23

Relay Ports, 25

Serial Communications, 22

External Devices, Connecting to, 22

F

Firmware Upgrade, 74

G

Gas Flow and Pressure Regulation, 18

I

In Calibration Relay, 52

Installation and Setup, 12

Isolate Analyzer, 28, 30, 32, 33, 36, 38, 41, 42, 43, 44, 45, 47, 52, 53, 54, 56, 57, 59, 61, 62, 64, 65, 67, 69, 70, 72

K

Key Lock, 21

M

Main Menu

Controls Menu, 31

Manual Zero, 35

Moisture Alarm Setup, 48

Moisture Controls Menu, 31

Moisture Data History Routine, 36

Moisture Display Setup, 52

Moisture Temperature Range Alarm, 49

P

Pressure Range Alarm Setup, 49

Pump Capacity Test, 61

Pump Capacity Test Log, 44

R

RAN, 81

Relay Ports, 25

Restore Sample Gas Flow, 30

Return Authorization Number, 81

S

Sample Flow Rate, 75

Sample Gas Flammability, 75

Sample Gas Preparation and Delivery, 75

Flow Rate Effects

Sensor Performance, 75

Sample Gas Flammability, 75

Sample GSF, 45

Service, 77

Maintenance

Storage Conditions, 77

Return Material Authorization number, 77

Shipping, 80

Return Material Authorization
number, 77, 80

Set Location, 40

Shipping, 80

Signal Monitor, 59

symbols, ix

System Alarm Setup, 50

System Error Codes, 43

T

table of figures, vi
Test Analog Voltage Output, 58
Test Relays, 56
Theory of Moisture Measurement, 83

U

User Interface, 26
 Data Display Screen, 26
 Keypad, 27
 Menu Structure, 27
User Zero Offset, 35

V

View Location, 40
View Moisture Logs, 41

W

Warranty, 87

Z

Zero Log, 42

Appendix A: 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**

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

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

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

Byte assignment

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

Command 24: Get ppb in Text

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

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

Command 32: Analog Output Range

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

Data Bytes in ASCII text:

"AnalyzerModel Mode zero FullScale InCalRelay CalFreeze ExpRangeARelay ExpRangeAFS"

ExpRangeBRelay ExpRangeBFS NULL"

where

AnalyzerModel: NTOA: oxygen, NTHA: moisture

Mode: S: set; R: read settings;

for the read ('R') case the remaining parameters in the command are returned

zero: in ppm, the minimum output scale

FullScale: in ppm, the maximum output scale

InCalRelay: 0-4, 0 for no assigned relay, relay for calibration

CalFreeze: 0:Off; 1:On, when on, no analog output update

ExpRangeARelay: 0-4, 0 for no assigned relay **ExpRangeAFS:**

expanded range A full scale in ppm **ExpRangeBRelay:** 0-4, 0 for

no assigned relay **ExpRangeBFS:** expanded range B full scale in

ppm

NULL: string terminator, NUL character

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

Ex. Code:

Get **AOut Range** from an oxygen analyzer with a 485 ID 1:

Command:

Hex: 0101 2033 4E54 4841 2052 2030 2E30 3030 3030 3020 302E 3030 3030 3030 2030 2030 2030
2030 2E30 3030 3030 3020 3020 302E 3030 3030 3030 0009 A90D

ASCII: 3NTHA R 0.000000 0.000000 0 0 0 0.000000 0 0.000000

*Note: the characters after the "R" are ignored and do not have to be present.

: non-printable ASCII

Reply:

Hex: 0201 202B 302E 3030 3030 3030 2031 2E30 3030 3030 3020 3020 3020 3020 322E 3030 3030
3030 2030 2033 2E30 3030 3030 3007 EA0D

ASCII: +0.000000 1.000000 0 0 0 2.000000 0 3.000000

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 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

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

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: 0100 30

Command 67: Read Watchdog Timer Delay

<u>Command</u>	<u>Cmd#</u>	<u>Bytes</u>	<u>Re p ly</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 ly</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

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