

NanoTrace Dual Moisture/Oxygen Analyzer

DF-760E

Instruction Manual



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DF-760E Operator Manual
Manual Version 082416

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

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

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

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

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.

Read Me First...

Unpacking Procedure

Follow the procedure below to unpack your NanoTrace Dual 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 NanoTrace Dual analyzers are shipped with the following:

Item	Part Number
One bottle of Electrolyte	ε-Lectrolyte Gold
One bottle of Replenishment Solution	RSA
Power cord with 115 VAC connector NOTE: No power cord is supplied with 220 VAC units	211531
USB Memory Stick, Flash Drive (SONY USM512J)	211169
VCR Filter Gasket	210432
Aspirator	210566
Zero Gas Purifier	210592
Instruction Manual	211591

4. Open the analyzer door, remove any shipping materials and verify that nothing has come loose during transit.
5. Locate the purifier packed separately and follow the instructions on page 129 for proper installation.
6. The analyzer is set at the factory to operate on 110 VAC or 220 VAC. Examine the voltage indicator on the rear panel to verify that the voltage is set as ordered.
7. Save the original container in the event you may need to ship the analyzer to another location or back to the factory (see Shipping in the Service section). Note that shipping regulations require that the purifier be removed from the analyzer and packaged separately as it is considered hazardous material.

Installation and Maintenance

The NanoTrace Dual Analyzer provides years of accurate and dependable service if it is set up, operated and maintained properly. It is essential to make a careful and complete installation as outlined in the *Installation and Start Up* section of this manual. It is assumed that NanoTrace Dual 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.

Unlike much UHP analytical equipment, NanoTrace Dual Analyzer does not require constant maintenance. However the maintenance intervals for zero and span calibrations, as well as addition of Replenishment Solution to the oxygen sensor and purifier maintenance, must be determined and followed carefully.

Thank You

Thank you for selecting the NanoTrace Dual Analyzer. Servomex designs, manufactures, exhaustively tests, and supports every analyzer under the tightest quality controls. You should expect every Servomex analyzer to arrive in perfect working order and, with good maintenance, provide years of trouble-free service. Please call your nearest Servomex Business Center if you need assistance.

1 Table of Contents

1	Table of Contents.....	3
1.1	Table of Figures	6
2	Cautions.....	9
2.1	Symbols and Explanations	9
2.2	Important Warnings	10
3	Specifications.....	17
3.1	Oxygen.....	17
3.2	Moisture	17
3.3	General.....	17
4	Installation, Start Up and Shut Down	21
4.1	Analyzer Installation	22
4.1.1	General Warnings.....	22
4.1.2	Carrying the Analyzer	22
4.1.3	Locating and Mounting the Analyzer	22
4.1.4	Add Electrolyte to the Oxygen Sensor	23
4.1.5	Vacuum Source	23
4.1.6	Pneumatic Pressure Line Connection	25
4.1.7	Sample Gas Connections	25
4.1.8	Electrical Connections.....	26
4.1.9	Hydrogen Service Safety System	27
4.2	Analyzer Start Up	28
4.2.1	Gas Delivery System.....	29
4.2.2	Gas Pressure and Flow Settings.....	29
4.2.3	Moisture	30
4.2.4	Oxygen	31
4.2.5	Backflow Prevention System	31
4.2.6	Purifier Installation.....	32
4.2.7	Download System Data	32
4.3	Analyzer Shut Down Or Disconnection.....	32
5	Options	35
5.1	Key Lock	35
5.2	Operating Voltage.....	35
5.3	Serial Communications	35
5.4	Analog Voltage Output	35
5.5	Hydrogen Service Safety System.....	35
5.6	Vacuum Pump.....	35
5.6.1	Installation of the Vacuum Pump	36
5.6.2	Moisture Sample Gas Outlet Connection to Vacuum Pump	38
5.6.3	Electrical Connections.....	38
6	Connecting to External Devices	41
6.1	Serial Communication Port – J5	41
6.2	Analog Signal Outputs – J4, J10.....	42
6.3	4-20 mA Outputs – J4, J10	42
6.4	Relay Ports – J2, J3, J8, J9.....	43
7	User Interface	45
7.1	Data Display Screen.....	45

7.2	Keypad	46
7.3	Menu Structure	46
7.4	Main Menu	46
7.5	Moisture Menu	47
7.5.1	Moisture Controls Menu	47
7.5.2	Moisture Calibrate Menu	49
7.5.3	Moisture Data History Routine	55
7.5.4	Moisture Data Downloader Routine	57
7.5.5	View Moisture Logs Menu	59
7.5.6	Moisture Alarm Setup Menu	61
7.5.7	Moisture Analog Output Setup Routine	65
7.5.8	Moisture Graph Setup	66
7.5.9	Moisture Diagnostics Menu	67
7.6	Oxygen Menu	71
7.6.1	Oxygen Controls Menu	72
7.6.2	Oxygen Calibrate Menu	74
7.6.3	Maintenance	86
7.6.4	View Oxygen Data History	87
7.6.5	Oxygen Data Download Routine	88
7.6.6	View Oxygen Logs	91
7.6.7	Oxygen Alarm SetUp	93
7.6.8	Oxygen Analog Output Setup	97
7.6.9	Oxygen Graph Setup Screen	98
7.6.10	Oxygen Diagnostics Menu	99
7.7	System Menu	101
7.7.1	Isolate Analyzer	102
7.7.2	Restore Sample Gas Flow	103
7.7.3	GSF Setup	103
7.7.4	Gas Delivery	106
7.7.5	Adjust Contrast	108
7.7.6	Power Up Default	109
7.7.7	Test Relays	110
7.7.8	Test Analog Outputs	111
7.7.9	Date/Time	113
7.7.10	Communications	114
7.7.11	Download System Data	114
7.7.12	System Info	116
8	Sample Gas Preparation and Delivery	119
8.1	Introduction	119
8.2	Sample Flow Rate and Pressure	119
8.2.1	Moisture	119
8.2.2	Oxygen	119
8.3	Flow Rate Effects on Sensor Performance	120
8.3.1	Moisture	120
8.3.2	Oxygen	120
8.3.3	Checking for Plumbing Leaks using Flow Rate Effects	120
8.4	Sample Gas Scale Factor	121
8.4.2	Background Gas Effects on Indicated Flow Rate	121
8.4.3	Pressure Effects on Oxygen Sensor Performance	122
8.4.4	Sample Outlet Backpressure Effects	122
8.4.5	Flammable Sample Gas	122
8.4.6	Sample Gas Temperature	122
8.4.7	Protecting the Analyzer from Process Upsets	123
9	Service	125
9.1	Return Material Authorization number	125
9.2	Cautions Related To Maintenance	125

9.3	Maintenance	125
9.3.1	Oxygen Calibration	125
9.3.2	Storage Conditions	126
9.3.3	Oxygen Sensor Maintenance	127
9.3.4	Procedure for Adding Replenishment Solution to the Oxygen Sensor	127
9.3.5	Moisture Cell Maintenance	128
9.3.6	Vacuum Pump Maintenance	128
9.3.7	Gas Purifier Maintenance	128
9.3.8	Fuse Replacement	131
9.3.9	Power Cord Replacement	132
9.4	Replaceable Parts List	133
9.5	Troubleshooting Guide for the NanoTrace Dual Analyzer	135
10	Theory of Operation	141
10.1	The Oxygen Measurement	141
10.1.1	The Oxygen Sensor	141
10.1.2	The Oxygen Electrolyte Conditioning System	141
10.2	The Moisture Measurement	142
10.2.1	Moisture and the IR Spectrum	142
10.2.2	Absorption Spectroscopy	143
11	Safety	145
11.1	General Warnings	145
11.2	Material Safety Data Sheet (MSDS) for Electrolyte Solution	147
11.3	Material Safety Data Sheet (MSDS) for Replenishment Solution	153
11.4	Material Safety Data Sheet (MSDS) for Gas Purifier	156
12	Warranty	163
13	Index	165
14	Appendix A – User Menu Screens	168
14.1	Moisture Menus	168
14.2	Oxygen Menus	169
14.3	System Menus	171
15	Appendix B – Hydrogen Service Safety System	173
15.1	Instrument	173
15.2	Vacuum Pump	173
15.3	Installation	173
15.4	Operation	174

1.1 Table of Figures

Figure 1: Overall View	20
Figure 2: Major Internal Components	21
Figure 3: Aspirator Installation.....	24
Figure 4: Rear Panel Gas Connections and Controls	26
Figure 5: AC Power Input.....	27
Figure 6: Data Display Screen	28
Figure 7: Block Diagram of Gas Flow Path	33
Figure 8: Vacuum Pump Assembly	36
Figure 9: Vacuum Pump Mount Dimensions	37
Figure 10: Vacuum Pump Dimensions	37
Figure 11: Vacuum Pump Power Connections and Controls	38
Figure 12: Block Diagram of Gas Flow Path with Optional Vacuum Pump	39
Figure 13: Rear Panel Electrical Connectors	41
Figure 14: Data Display Screen	45
Figure 15: Keypad	46
Figure 16: Main Menu	46
Figure 17: Moisture SubMenu	47
Figure 18: Moisture Controls SubMenu	47
Figure 19: Isolate Sensor Warning	48
Figure 20: Moisture Gas Valve Control	49
Figure 21: Moisture Calibrate SubMenu	49
Figure 22: Moisture Check/Adjust Zero Screen	50
Figure 23: Moisture User Zero Offset Screen.....	51
Figure 24: Moisture Set Zero Gas Valves Screen.....	51
Figure 25: Moisture Manual Zero Screen.....	52
Figure 26: Moisture AutoZero Screen	53
Figure 27: Moisture AutoZero Setup Screen	54
Figure 28: Moisture Data History	55
Figure 29: Moisture Data History Screen	56
Figure 30: Install Media	56
Figure 31: Example of Data Download	56
Figure 32: Moisture Data Downloader	57
Figure 33: Moisture Data Downloader Screen	57
Figure 34: View Location Screen	58
Figure 35: Keyboard Display.....	58
Figure 36: Delete Selection	59
Figure 37: Moisture View Logs SubMenu	59
Figure 38: Moisture Zero Log Screen.....	60
Figure 39: System Error Log Screen	60
Figure 40: Pump Capacity Test Log.....	61
Figure 41: Moisture Alarm Setup SubMenu.....	61
Figure 42: Moisture Alarm Setup Screen	63
Figure 43: Moisture Temperature Alarm Setup.....	63
Figure 44: Moisture Pressure Range Alarm Setup	64
Figure 45: Moisture System Alarm Setup	64
Figure 46: Moisture Analog Output Setup SubMenu	65
Figure 47: Moisture Analog Output Setup Screen.....	66
Figure 48: Moisture Graph Setup SubMenu.....	66
Figure 49: Moisture Graph Setup Screen	66
Figure 50: Diagnostics SubMenu	67
Figure 51: Moisture Active Zero Setup Screen	67
Figure 52: System Monitor.....	68
Figure 53: Purge Start.....	69
Figure 54: Purifier Purge Time Line.....	69
Figure 55: Purge Cancel	70
Figure 56: Pump Capacity Test	70

Figure 57: Pump Pressure Failure	70
Figure 58: Pump Capacity Test Log.....	71
Figure 59: Oxygen SubMenu	71
Figure 60: Oxygen Controls Menu.....	72
Figure 61: Oxygen Sensor Gas Valve Control Screen	73
Figure 62: Oxygen Sensor On/Off Control Screen	73
Figure 63: Oxygen Calibrate Menu.....	74
Figure 64: Check/Adjust Zero Screen	74
Figure 65: Oxygen Manual Zero.....	75
Figure 66: Oxygen Auto Zero Screen	76
Figure 67: Oxygen AutoZero Setup Screen	77
Figure 68: Oxygen GSF Screen	79
Figure 69: Check Adjust Oxygen Span.....	80
Figure 70: Oxygen Manual Span	80
Figure 71: Oxygen AutoSpan Check.....	81
Figure 72: Oxygen AutoSpan Recal.....	82
Figure 73: Oxygen AutoSpan SetUp Screen	82
Figure 74: Oxygen Signal Filter Control Screen.....	83
Figure 75: Oxygen Sensor Data Screen - Automatic	84
Figure 76: Install New Oxygen Sensor Calibration Data	84
Figure 77: Oxygen Sensor Data Screen - Manual	85
Figure 78: Oxygen Maintenance Menu.....	86
Figure 79: Replenish Sol'n Reminder Setup Screen	86
Figure 80: Oxygen Data History Menu	87
Figure 81: Oxygen Data History Screen	87
Figure 82: Install Media	88
Figure 83 Oxygen Data Downloader Menu	88
Figure 84: Oxygen Data Downloader Screen.....	89
Figure 85: View Location Screen.....	89
Figure 86: Keyboard Display	90
Figure 87: Delete Selection	90
Figure 88: View Oxygen Logs Menu.....	91
Figure 89: Oxygen Zero Log.....	91
Figure 90: Oxygen Span Log	92
Figure 91: Oxygen Replenishment Sol'n Addition Log.....	92
Figure 92: Oxygen OverRange Log	92
Figure 93: Oxygen Over Temperature Log	93
Figure 94: Oxygen Alarm SetUp Menu	93
Figure 95:Oxygen Alarm SetUp Screen.....	95
Figure 96: Oxygen Temperature Alarm SetUp Screen	95
Figure 97: Oxygen Flow Alarm SetUp Screen.....	96
Figure 98: Oxygen Electrolyte Alarm SetUp Screen	96
Figure 99: Oxygen Sensor-Off Alarm SetUp Screen	97
Figure 100: Oxygen Analog Output Setup Menu.....	97
Figure 101: Output SetUp Screen	98
Figure 102: Oxygen Graph Setup Menu	98
Figure 103: Oxygen Graph SetUp Screen.....	99
Figure 104: Oxygen Diagnostics Menu.....	99
Figure 105: Oxygen Sensor Diagnostics Screen	99
Figure 106: Oxygen Sensor Temperature Compensation Screen.....	100
Figure 107: Active Zero Setup Screen	100
Figure 108: System Menus.....	102
Figure 109: Isolate Analyzer.....	102
Figure 110: Isolate Analyzer Warning	103
Figure 111: Restore Sample Gas Flow	103
Figure 112: GSF Setup.....	104
Figure 113: GSF Setup Screen	104
Figure 114: Moisture GSF Pressure Setting	104

Figure 115: Purifier Warning.....	105
Figure 116: Fan Failure Alarm	105
Figure 117: Gas Delivery.....	106
Figure 118: Gas Delivery System Status	106
Figure 119: Back Flow Prevention Warning	107
Figure 120: Re-established flow delay	107
Figure 121: Adjust Contrast.....	108
Figure 122: Adjust Display Contrast Screen	108
Figure 123: Power Up Default.....	109
Figure 124: Power Up Default Screen.....	109
Figure 125: Test Relays Menu.....	110
Figure 126: Test Moisture Relays.....	110
Figure 127: Test Oxygen Relay	111
Figure 128: Test Analog Outputs Menu	111
Figure 129: Test Moisture Analog Output.....	112
Figure 130: Test Oxygen Analog Output	112
Figure 131: Date/Time.....	113
Figure 132: Date/Time Setup Screen.....	113
Figure 133: Communications	114
Figure 134: Communications Setup Screen.....	114
Figure 135: Download System Data.....	115
Figure 136: Insert Media	115
Figure 137: Media Warning.....	115
Figure 138: Download Time Line	116
Figure 139: System Info	116
Figure 140: System Info Screen	117
Figure 141: Firmware Upgrade	117
Figure 142: Gas Purifier Installation	131
Figure 143: Schematic of NanoTrace Dual Oxygen Sensor	141
Figure 144: Schematic of Moisture Cell.....	142
Figure 145: Hydrogen Service Safety System	177
Figure 146: Pump Purge Option	178

2 Cautions

2.1 Symbols and Explanations

The following symbols are used on the analyzer labels and throughout this manual.

CAUTION CONSULT MANUAL - ATTENTION CONSULTER LE MANUEL



This symbol alerts the user to the presence of hazardous conditions that may be dangerous to individuals or equipment. To maintain safety consult the manual when this symbol is marked on a label, and read sections of the manual marked with this symbol.

Ce symbole informe l'utilisateur de la présence de conditions dangereuses qui peuvent être dommageables aux personnes ou à l'équipement. Pour assurer la sécurité, consulter le manuel lorsque ce symbole apparaît sur l'étiquette et lire les articles du manuel affichant ce symbole.

NOTE - REMARQUE



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

Ce symbole attire l'attention de l'utilisateur sur des renseignements concernant des opérations importantes et / ou la maintenance.

CAUSTIC LIQUID - CAUSTIQUE LIQUIDE



This symbol alerts the user to the presence of caustic liquid. Refer to the MSDS, in the Safety section of the manual, for handling instructions.

Ce symbole informe l'utilisateur de la présence de liquide caustique. Consulter la fiche signalétique dans la section Sécurité du manuel pour obtenir des directives sur la manipulation.

ELECTRICAL SHOCK HAZARD - RISQUE DE CHOC ÉLECTRIQUE



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

Ce symbole informe l'utilisateur de la présence d'un courant alternatif qui peut être dangereux pour les personnes.

2.2 Important Warnings

CAUTION: READ THE MANUAL

ATTENTION: LIRE LE MANUEL



Do not setup or operate this analyzer without a complete understanding of the instructions in this manual. This analyzer must be operated in a manner consistent with its intended use and as specified in this manual. Servomex cannot be responsible for direct or consequential damages that result from installing or operating the analyzer in a manner not described in this manual.

Ne pas installer ou utiliser cet analyseur sans une compréhension complète des instructions de ce manuel. Cet analyseur doit être utilisé de manière conforme à l'usage prévu et tel que stipulé dans ce manuel. Servomex ne peut pas être tenu responsable des dommages directs ou indirects résultant de l'installation ou du fonctionnement de l'analyseur si ceux-ci sont réalisés d'une manière qui n'est pas décrite dans ce manuel.

CAUTION: HAZARDOUS AC

ATTENTION : TENSION DANGEREUSE



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.

Un courant alternatif dangereux circule dans cet appareil. Ne pas enlever le couvercle supérieur ou celui de gauche. Aucune pièce pouvant être réparée par l'utilisateur ne se trouve sous ces couvercles. Ne pas brancher cet analyseur dans une prise de courant avant que tous les câbles d'interconnexion et les tuyaux n'aient été branchés. Débrancher l'analyseur du courant avant d'installer ou de retirer les connexions externes, le capteur, les pièces électroniques, ou lors du chargement ou de la vidange de l'électrolyte. Débrancher l'analyseur de la prise de courant avant de déplacer l'analyseur.

CAUTION: POWER CORD SAFETY

ATTENTION : SÉCURITÉ DU CORDON D'ALIMENTATION



The power cord provides the protective earth connection. Ensure that the power cord is plugged into a properly grounded outlet that conforms to national and local electrical codes. Avoid damaging the power cord. Do not bend it excessively, step on it, or place heavy objects on it. A damaged cord can be a shock or fire hazard. Never use a power cord if it is damaged. Do not use a power cord with inadequate specifications (less than 120 VAC, 10 Amps) or without a protective earth wire.

Le cordon d'alimentation assure la mise à la terre. S'assurer que le cordon d'alimentation est branché dans une prise ayant une mise à la terre conforme aux normes électriques nationales et locales. Éviter d'endommager le cordon d'alimentation. Ne pas le plier excessivement, marcher dessus ou placer des objets lourds sur lui. Un cordon endommagé peut entraîner un risque d'électrocution ou d'incendie. Ne jamais utiliser un cordon d'alimentation endommagé. Ne pas utiliser un cordon d'alimentation dont les spécifications sont inappropriées (moins de 120 V ca, 10 ampères) ou sans fil de mise à la terre de protection.

CAUTION: 220 VAC POWER CORD

ATTENTION : LE CORDON D'ALIMENTATION DE 220 V CA



A 220 VAC power cord is not supplied with the analyzer. The customer supplied 220 VAC power cord should be rated for 250 VAC, 10 Amps and equipped with an IEC 60320 C13 connector for connecting to the analyzer. This power cord provides the protective ground for the analyzer so it must have a protective earth wire. Ensure that the power cord is plugged into a properly grounded outlet. The power cord should have the appropriate safety agency approvals for your location.

Un cordon d'alimentation de 220 V ca n'est pas fourni avec l'analyseur. Le cordon d'alimentation de 220 V ca fourni par le client devrait avoir les spécifications de 250 V ca, 10 ampères et être muni d'un connecteur IEC60320 C13 pour le branchement à l'analyseur. Ce cordon d'alimentation assure la mise à la terre pour protéger l'analyseur, il doit donc comporter un fil de mise à la terre de protection. S'assurer que le cordon d'alimentation est branché dans une prise comportant une mise à la terre. Le cordon d'alimentation doit être conforme aux normes de l'organisme de sécurité de l'endroit où il est utilisé.

CAUTION: CHECK AC OPERATING VOLTAGE

ATTENTION : VÉRIFICATION DE LA TENSION CA



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.

L'analyseur a été réglé en usine pour fonctionner sur un courant ca de 110 ou 220 V. Vérifiez la tension indiquée sur l'appareil à l'entrée du courant. L'analyseur peut être endommagé s'il fonctionne sur une tension différente que celle indiquée. Pour modifier la tension utilisée, il faut retourner l'analyseur à l'usine.

CAUTION: USE PROPER LIFTING, CARRYING AND MOUNTING

ATTENTION : MÉTHODES DE LEVAGE, DE TRANSPORT ET DE MONTAGE APPROPRIÉES



The weight of this analyzer is greater than 30 kg. Proper methods of lifting and carrying can help to protect against injury. The instrument should be lifted and carried by two individuals. Make sure that your balance is centered and your feet are properly spaced 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. Keep your back straight.

The DF-760 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.

Cet analyseur pèse plus de 30 kg. Des méthodes appropriées de levage et de transport peuvent vous aider à vous protéger contre les blessures. L'appareil doit être soulevé et transporté par deux personnes. Lorsque vous soulevez l'appareil, s'assurer que votre centre d'équilibre est bien positionné et que vos pieds sont correctement espacés d'une distance équivalente à la largeur entre vos épaules. Plier les genoux et s'assurer que votre dos est droit. Saisir l'instrument avec vos doigts et votre paume et ne lever que si votre dos est droit. Soulever avec les jambes, pas le dos. Transporter l'appareil en le gardant près de votre corps. Abaisser l'appareil en pliant les genoux. Garder le dos droit.

Le DF-760 est conçu pour être monté sur un support. Vérifier que les coulisses ou les rails du support peuvent supporter un analyseur de 30 kg. Utiliser des vis dans les quatre emplacements du panneau avant du support.

CAUTION: FOR INDOOR USE, ONLY

ATTENTION : UTILISATION À L'INTÉRIEUR SEULEMENT



The DF-760 is for indoor use only. It should not be located in an area where it will be subjected to particulate, condensed moisture, caustic atmosphere, temperature extremes, or operation outside of any limits listed in section 3, Specifications.

Le DF-760 ne s'utilise qu'à l'intérieur. Il ne doit pas être placé dans un endroit où il peut être soumis à de la matière particulaire, à de l'eau de condensation, à un milieu caustique, à des températures extrêmes ou à un fonctionnement dépassant les limites énumérées à l'article 3 Spécifications.

CAUTION: CAUSTIC ELECTROLYTE

ATTENTION : ÉLECTROLYTE CAUSTIQUE



The electrolyte is a caustic solution. Review the Material Safety Data Sheet (MSDS), located in the Safety section of this manual, before handling the electrolyte solution.



The oxygen sensor is shipped dry and must be charged with electrolyte before turning on the analyzer.

L'électrolyte est une solution caustique. Consulter la fiche signalétique (MSDS), qui se trouve à la section Sécurité de ce manuel, avant de manipuler la solution d'électrolyte.

Le capteur d'oxygène est livré sec et doit être rechargé avec de l'électrolyte avant d'allumer l'analyseur.

CAUTION: DO NOT SHIP WITH ELECTROLYTE

ATTENTION : NE PAS TRANSPORTER AVEC DE L'ÉLECTROLYTE



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



NE PAS TRANSPORTER L'ANALYSEUR SI DE L'ÉLECTROLYTE SE TROUVE DANS LE CAPTEUR. BIEN VIDANGER ET RINCER LE CAPTEUR D'OXYGÈNE AVANT LE TRANSPORT.

CAUTION: OXYGEN SENSOR USE WITH PURE OXYGEN
ATTENTION : UTILISATION DU CAPTEUR D'OXYGÈNE AVEC
DE L'OXYGÈNE PUR



The DF-760 should not be used with pure oxygen. The oxygen sensor can be permanently damaged by operation with a pure oxygen sample gas.

Le DF-760 ne doit pas être utilisé avec de l'oxygène pur. Le capteur d'oxygène peut être endommagé de façon permanente s'il est utilisé avec un échantillon gazeux d'oxygène pur.

CAUTION: INERT, TOXIC AND COMBUSTIBLE GASES

ATTENTION : GAZ INERTES, TOXIQUES ET COMBUSTIBLES



The DF-760, DF-750 and DF-745 analyzers have been designed for use with inert, non-toxic, non-combustible sample gases only, such as nitrogen, helium or argon. The DF-760, DF-750 or DF-745 may be used with the combustible gas hydrogen if the analyzer has been factory ordered with the Hydrogen Service Safety System option. The DF-750 and DF-745 may be used with the reactive gas pure oxygen. The DF-740 is intended for use with the toxic gas ammonia. The DF-730 is intended for use with the toxic gas HCl. The DF-745SG approved gas list is ever expanding, but it includes: N₂, O₂, H₂, He, Ar, CO₂, CO, SF₆, Ne, Kr, Xe and N₂O. Check your order paperwork to determine whether your analyzer is intended for use with a toxic or combustible gas. For toxic and combustible gases, observe the following special installation and operation precautions:

- 1) Be sure to know the sample gas composition and the safe handling requirements for that gas composition.
- 2) Install a shutoff valve on the sample gas inlet so that gas can be turned off in an emergency.
- 3) Check all external plumbing connections for tightness before pressurizing the sample system.
- 4) Vent the analyzer outlet into the appropriate facility vent system -- away from personnel (for toxic gases) and away from sources of ignition (for combustible gases).
- 5) Turn off the sample gas before disconnecting the analyzer.
- 6) For many toxic gases a breathing air safety monitor can be purchased (from a safety products distributor) that will notify the user if an unsafe amount of the toxic gas is detected.

Servomex cannot be responsible for direct or consequential damages that result from using the analyzer with these gases.

Les analyseurs DF-760, DF-750 et DF-745 peuvent uniquement être utilisés avec des échantillons gazeux inertes, non toxiques et non combustibles, comme l'azote, l'hélium ou l'argon. Le DF-760, DF-750 ou DF-745 peuvent être utilisés avec de l'hydrogène gazeux combustible si l'analyseur a été commandé à l'usine avec l'option Système de sécurité pour utilisation avec hydrogène. Le DF-750 et DF-745 peuvent être utilisés avec de l'oxygène gazeux pur réactif. Le DF-740 est prévu pour être utilisé avec le gaz toxique ammoniac. Le DF-730 est prévu pour être utilisé avec le gaz toxique HCl. D'autres gaz s'ajouteront à la liste de gaz approuvés pour le DF-745SG, mais celle-ci comprend : N₂, O₂, H₂, He, Ar, CO₂, CO, SF₆, Ne, Kr, Xe et le N₂O. Vérifier la documentation de votre commande pour déterminer si votre analyseur est conçu pour être utilisé avec un gaz toxique ou combustible. Pour les gaz toxiques et combustibles, respecter les précautions d'installation et de fonctionnement particulières suivantes :

- 1) S'assurer de connaître la composition de l'échantillon gazeux et les exigences pour manipuler en toute sécurité cette composition gazeuse.
- 2) Installer une soupape d'arrêt à l'entrée de l'échantillon gazeux afin de pouvoir stopper l'entrée de gaz en cas d'urgence.
- 3) Vérifier si tous les branchements de plomberie externes sont étanches avant de pressuriser le système de l'échantillon.
- 4) Acheminer la sortie de l'analyseur dans le système de ventilation approprié, éloignée du personnel (pour les gaz toxiques) et éloignée des sources d'ignition (pour les gaz combustibles).
- 5) Stopper l'échantillon gazeux avant de débrancher l'analyseur.
- 6) Pour de nombreux gaz toxiques un appareil de contrôle de la sécurité de l'air respirable peut être acheté (chez un distributeur de produits de sécurité) afin d'informer l'utilisateur si une quantité dangereuse de gaz toxique est détectée.

Servomex ne peut pas être tenu responsable des dommages directs ou indirects résultant de l'utilisation de l'analyseur avec ces gaz.

CAUTION: OXYGEN SENSOR OVERPRESSURE

ATTENTION : SURPRESSION DU CAPTEUR D'OXYGÈNE



Over-pressurizing the oxygen sensor can result in permanent damage to the sensor. Limit the backpressure to the analyzer to ± 1 psig (± 0.07 barg).

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

Sur-pressuriser le capteur d'oxygène peut causer des dommages permanents au capteur. Limiter la contre-pression à l'analyseur à $\pm 0,07$ barg.

S'assurer que la soupape d'isolement en aval (si installée) est ouverte avant de libérer le débit de gaz.

CAUTION: TRIPPING HAZARD

ATTENTION : RISQUE DE TRÉBUCEMENT



Route the power cord and plumbing so that they cannot be stepped on or tripped over.

Acheminer le cordon d'alimentation et la tuyauterie de manière à ce qu'on ne puisse pas les piétiner ou trébucher dessus.

EMI DISCLAIMER



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

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

3 Specifications

3.1 Oxygen

Lowest Detection Level (LDL): 75 ppt @ Constant Conditions

Resolution: Analytical (Smallest Detectable Change): 50 ppt

Display: 10 ppt

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

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

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

Range: 0-20 ppm

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

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

3.2 Moisture

Lowest Detection Level (LDL): 200 ppt @ Constant Conditions

Resolution: Analytical (Smallest Detectable Change): 100 ppt

Display: 10 ppt

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

Speed of Response: Typically <3 minutes to reach 90 percent of an upward step change

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

Range: 0-20 ppm

Background Gas Compatibility: All inert and passive gases including N₂, H₂, He, Ar and O₂

Return Pressure: Variable from 200 – 760 Torr based on background gas

3.3 General

Construction: NEMA 1, 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: 7.4 inch VGA Color (640X480)

EMI Sensitivity: Tested to standards EN61000-3-3 and EN61326-1

Weight: 72 pounds (32.6 kg)

Environmental:

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

Indoor Use Only

Pollution Degree: 2

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

Gas Inlet, Sample:

Flow Rate: 2.5 slpm N₂

Inlet Pressure: 30 to 150 psig (2 to 10 barg)

Sample Temperature: 10° C to 80°C (50° F to 176° F)

Gas Inlet, Oxygen Span:

Inlet Pressure: 10 to 15 psig (0.7 to 1.0 barg)

Gas Inlet, Pneumatic:

Gas: N₂ or air

Inlet Pressure: 70 to 100 psig (4.8 to 6.9 barg)

Gas Inlet, Aspirator:

Flow Rate: 15 slpm

Gas: N₂ or air

Inlet Pressure: 80 psig (5.5 barg)

Gas Path Construction Materials:

300 series stainless steel electro-polished

1/4-inch VCR-type compatible sample inlet fitting

1/8-inch compression sample outlet fitting

1/4-inch compression vacuum fitting

Kel-f valve seats

Polyethylene vacuum tubing

Output Signals & Status Indicators:

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

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

Audible/Visual Alarm Status Indicators: Four Oxygen and four Moisture levels, Temperature, Electrolyte Condition, Moisture cell Diagnostic, Loss of Flow, Zero Verification or Calibration in Process, Moisture Analyzer off-line, Oxygen Analyzer analog output freeze during calibration.

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

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

Power:

100 to 120 VAC, 50/60 Hz, standard, 5 Amps

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

Transient Overvoltage Rating: Category II of IEC 606364-4-443,

Temporary Overvoltage Rating: 1200 V short term up to 5 seconds, 250 V > 5 seconds on 220 VAC analyzer

Warranty: One year from ship date on the entire instrument. In addition, five years on the oxygen sensor. See *Warranty* section.

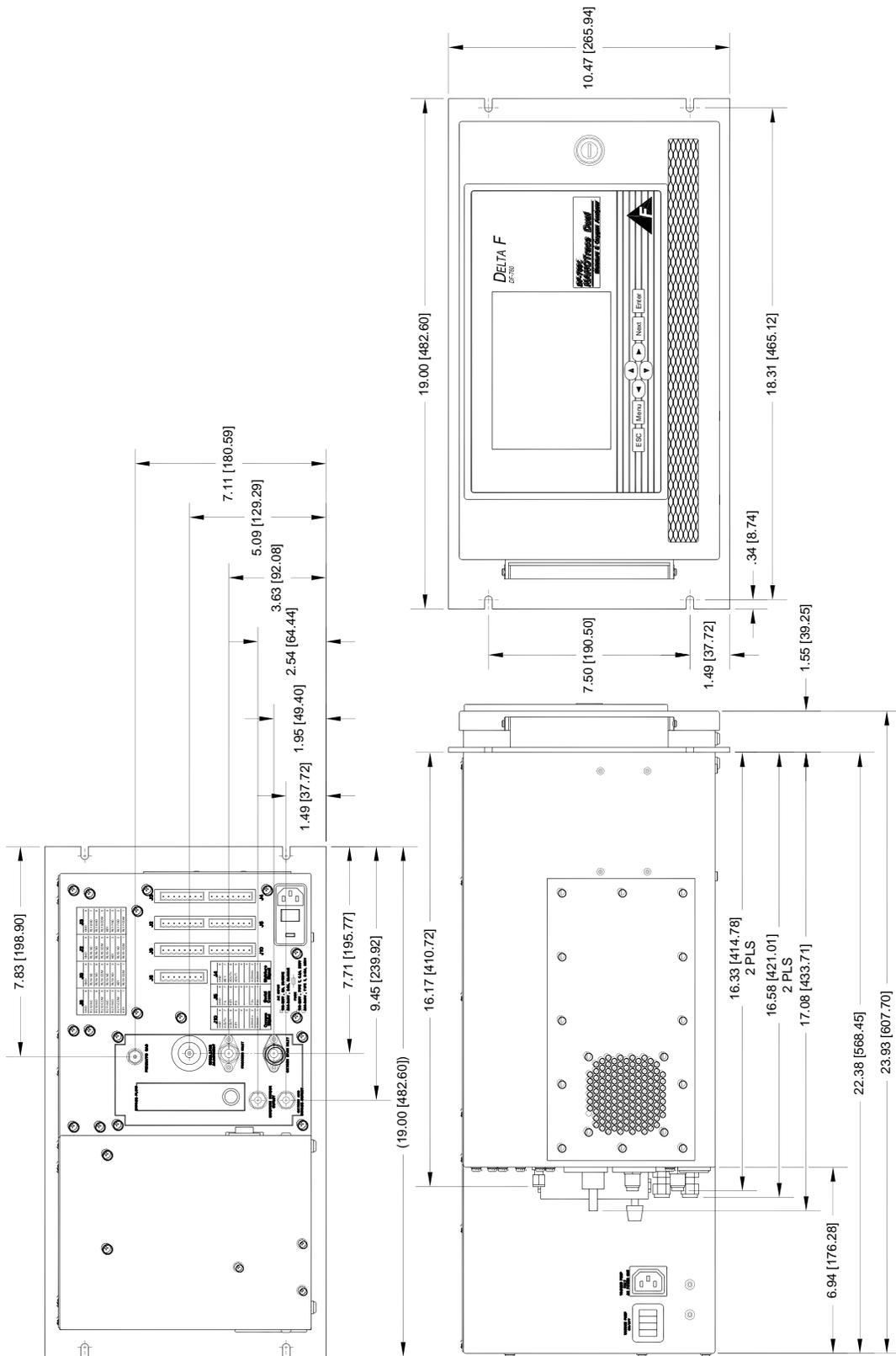


Figure 1: Overall View

4 Installation, Start Up and Shut Down

The NanoTrace Dual analyzer is designed to measure the Moisture and Oxygen content of a sample gas simultaneously. This manual is written with the assumption that the user will be using the analyzer in this fashion. In addition, it may be operated to measure either Moisture or Oxygen.

Installation of the analyzer requires the following steps be followed:

- Mounting the analyzer
- Filling the Oxygen sensor with electrolyte
- Connecting the N₂/Air supply to the aspirator
- Connecting an exhaust tube to the aspirator outlet, if needed
- Connecting the pneumatic pressure service to the pneumatic inlet fitting
- Connecting the sample gas line to the analyzer inlet fitting
- Making the power connection to the analyzer
- Installation of the zero gas purifier

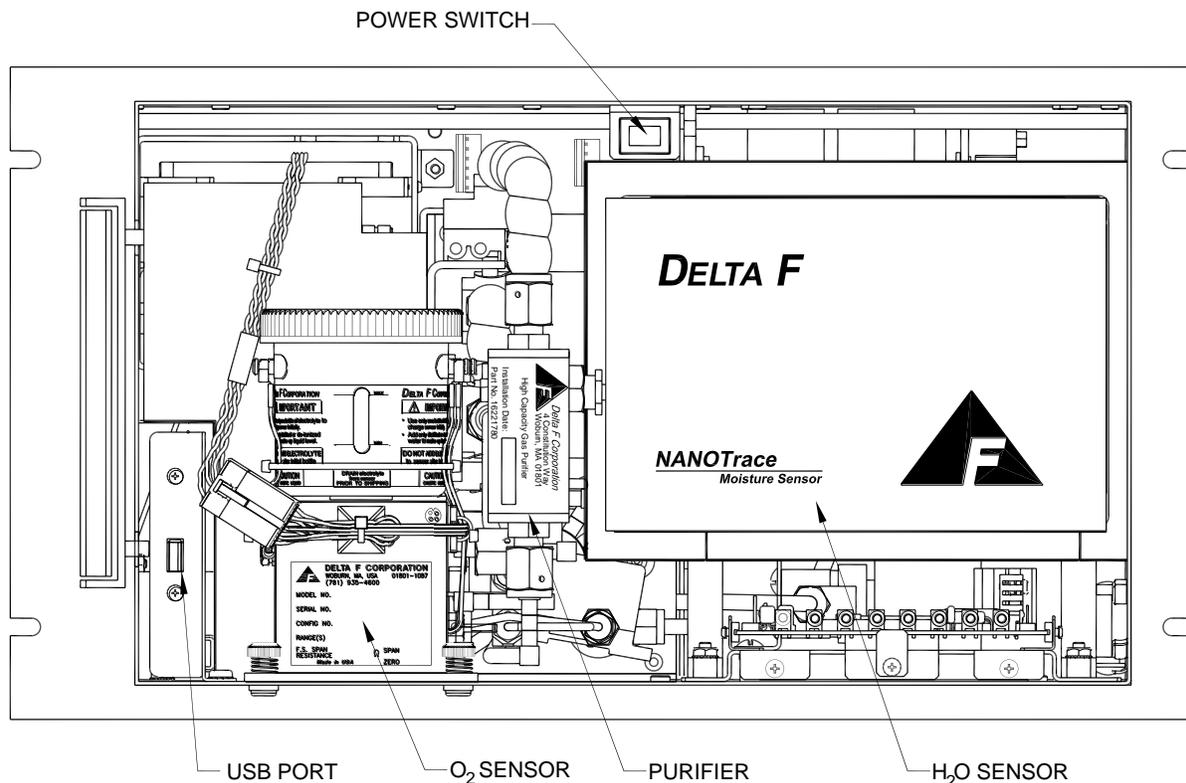


Figure 2: Major Internal Components

4.1 Analyzer Installation

4.1.1 General Warnings

Read section **2.2 Important Warnings** before installing this analyzer.

DANGER



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

NOTE



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

NOTE



Use only Delta F \mathcal{E} -Lectrolyte Gold in the oxygen sensor. Failure to do so will void warranty. Install one bottle only.

NOTE



Do not apply power before adding electrolyte to the oxygen sensor and thoroughly purging the sample line.

NOTE



For the specific instance of measuring moisture in a background gas of pure Oxygen, it is imperative that the Oxygen analyzer not be exposed to the process gas. The Oxygen analyzer is not designed for use in a pure O₂ background.

4.1.2 Carrying the Analyzer

CAUTION



The weight of this analyzer is greater than 30 kg. Proper methods of lifting and carrying can help to protect against injury. The instrument should be lifted and carried by two individuals. Make sure that your balance is centered and your feet are properly spaced 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. Keep the instrument close to your body while carrying. Lower the instrument by bending your knees. Keep your back straight.

4.1.3 Locating and Mounting the Analyzer

CAUTION



The DF-760 is for indoor use only. It should not be located in an area where it will be subjected to particulate, condensed moisture, caustic atmosphere, temperature extremes, or operation outside of any limits listed in section 3 Specifications.

The DF-760 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.

4.1.4 Add Electrolyte to the Oxygen Sensor

1. Open the front door of the analyzer.
2. Locate the oxygen sensor (see Figure 2) and remove the gold cap from the top.
3. Pour one full bottle (100 mL) of Servomex \mathcal{E} -Lectrolyte Gold into the sensor.
4. Replace the cap securely on the top of the sensor.
5. Allow the sensor to sit for 60 minutes before connection to gas flow or power.



For best performance at initial start or anytime the electrolyte is changed, it is important to allow the sensor to sit with electrolyte in it for 60 minutes *before* the gas is allowed to flow through the sensor, or power is connected.



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

4.1.5 Vacuum Source

4.1.5.1 Aspirator

The standard vacuum source provided with the DF-760 analyzer is a factory installed aspirator as shown in Figure 3.

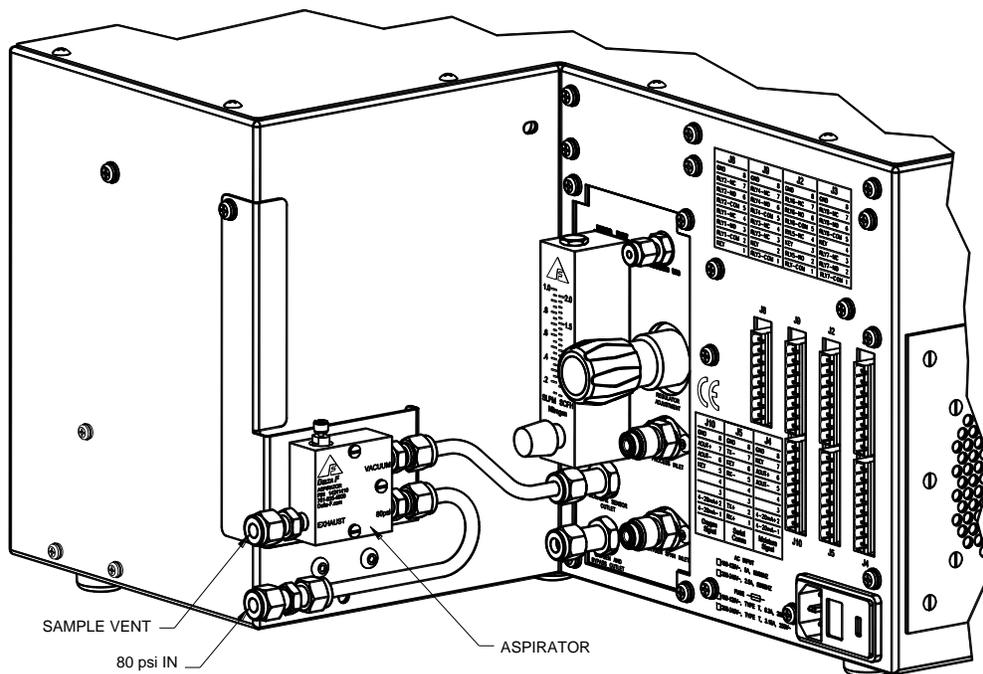


Figure 3: Aspirator Installation

A regulated source of dry compressed gas (either N₂ or air) is required at 80 psi (5.5 barg) and a flow rate of approximately 15 slpm. Connection is made to the aspirator by way of a ¼ inch compression fitting labeled “80 psi IN”. It is very important to note that the diameter of the gas supply line must be a minimum of ¼ inch to provide sufficient flow. If operation in Helium background is anticipated, a shut off valve should be installed at the inlet to the aspirator.

For ease of installation, the aspirator source can also supply the pneumatic gas inlet by way of a 1/8 inch adapter.

The gas at the sample vent port is comprised of the analyzer sample gas and the compressed gas, and any noise can be mitigated by simply installing a ¼ inch tube of approximately 3 ft in length. Backpressure should be minimized at this port (max 1.0 psig) and if the exhaust must be vented for safety reasons it must be done to a header of greater diameter.

The aspirator needle valve should be opened (CCW) completely.



Be sure to use a backup wrench when making all connections to the aspirator.

4.1.5.2 Vacuum Pump

An optional vacuum pump can be purchased for those cases where there is insufficient gas pressure or flow to operate the aspirator, or when the analyzer is installed in a portable cart and connection to a continuous gas supply is inconvenient. See page 35 for information on the installation of the optional vacuum pump.

4.1.6 Pneumatic Pressure Line Connection

The pneumatic gas connection is a 1/8 inch compression fitting as shown in Figure 4 and requires 70 – 100 psig (4.8 - 6.9 barg) air or N₂ pressure. For ease of installation, the pneumatic feed line can be connected directly to the 1/4 inch aspirator source by way of a 1/8 inch adapter.

4.1.7 Sample Gas Connections

4.1.7.1 Sample Gas Inlet Connection

Sample gas is connected to the analyzer via a 1/4 inch male swivel VCR fitting labeled Process Inlet at the rear of the instrument as shown in Figure 4. Sample pressure of 30 – 150 psig is required and is regulated internally.

Pre-purge the line by connecting to the analyzer (with a new VCR *filter* gasket) only finger tight and flowing gas for 15 minutes. Then tighten the inlet fitting.

NOTE: A VCR *filter* gasket (supplied) should always be used to protect the gas delivery system from any particulate matter that may have collected in the line.

When power is applied to the analyzer, the internal gas control valves will automatically go to a state as determined by the user. See the section on Power Up Defaults on page 109 for additional information.

NOTE: When received from the factory, the oxygen sensor and moisture cell will both be isolated with pressure in the system. See the sections on Moisture and Oxygen Gas Valves Control on pages 48 and 72 for instructions on starting the gas flow through either sensor.

See Figure 7 for an overview of the gas flow through the analyzer.

See the section on Gas Pressure and Flow Settings on page 29 for important information on plumbing and powering up the analyzer.



For the specific instance of measuring moisture in a background gas of pure Oxygen, it is imperative that the Oxygen sensor not be exposed to the process gas. The Oxygen sensor is not designed for use in a pure Oxygen background.

4.1.7.2 Sample Gas Outlet Connection

The sample gas outlet connection is a 1/4 inch compression fitting labeled Moisture Sensor Outlet as shown in Figure 4. A 1/4 inch stainless tube is connected from the analyzer sample outlet to the Aspirator assembly. See Figure 3. The Oxygen and bypass outlet are vented separately.

Open the needle control valve (CCW) on the top of the aspirator assembly completely.

NOTE: If the Hydrogen Service Safety System is included, the sample outlet line must be made of steel. See page 173 for additional information.

See page 35 for information on the installation of the optional vacuum pump.

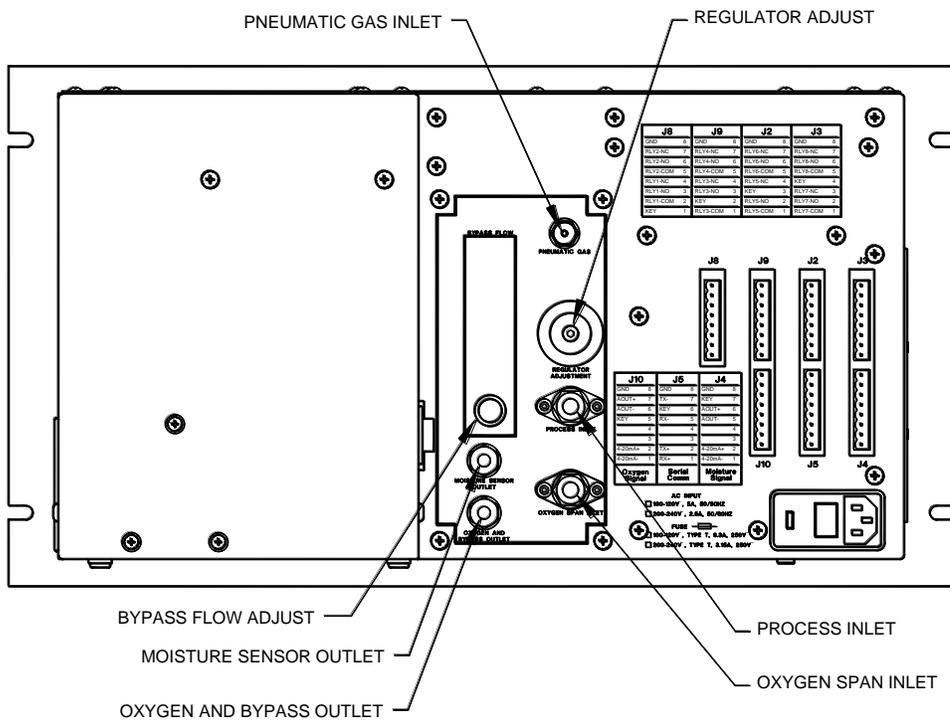


Figure 4: Rear Panel Gas Connections and Controls

4.1.8 Electrical Connections

Open the door and locate the power switch in the center of the upper rail. Be sure it is in the OFF position.

CAUTION



The analyzer has been factory set to operate on either 110 or 220 VAC. Check the voltage setting marked near the AC inlet. See Figure 5. 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.

The power cord provides the protective earth connection. Ensure that the power cord is plugged into a properly grounded outlet that conforms to national and local electrical codes. Avoid damaging the power cord. Do not bend it excessively, step on it, or place heavy objects on it. A damaged cord can be a shock or fire hazard. Never use a power cord if it is damaged. Do not use a power cord with inadequate ratings (less than 120 VAC, 10 Amps) or without a protective earth wire.

CAUTION



A 220 VAC power cord is not supplied with the analyzer. The customer supplied 220 VAC power cord should be rated for 250 VAC, 10 Amps and be equipped with an IEC 60320 C13 connector for connecting to the analyzer. This power cord provides the protective ground for the analyzer so it must have a protective earth wire. Ensure that the power cord is plugged into a properly grounded outlet. The power cord should have the appropriate safety agency approvals for your location.

Plug the line cord (supplied with 110 VAC units only) into the receptacle at the back of the analyzer. Connect the line cord to the power source.

4.1.9 Hydrogen Service Safety System

This optional system is designed to safeguard the DF-760 from explosion hazards when operating on hydrogen sample gas under normal pressure and flow conditions as detailed in the Operating Instruction Manual. The instrument chassis and the remote pump, if equipped, are both protected by maintaining a safe condition within their respective enclosures. If installed, this option impacts the electrical wiring, gas plumbing and operation of the analyzer. See page 173 for additional installation and operation information.

NOTE, if equipped with the Hydrogen Safety Service System, when shipped from the factory the analyzer will be configured through the GSF screen to measure hydrogen. As a result, the Hydrogen Safety Service System will be enabled out of the box.

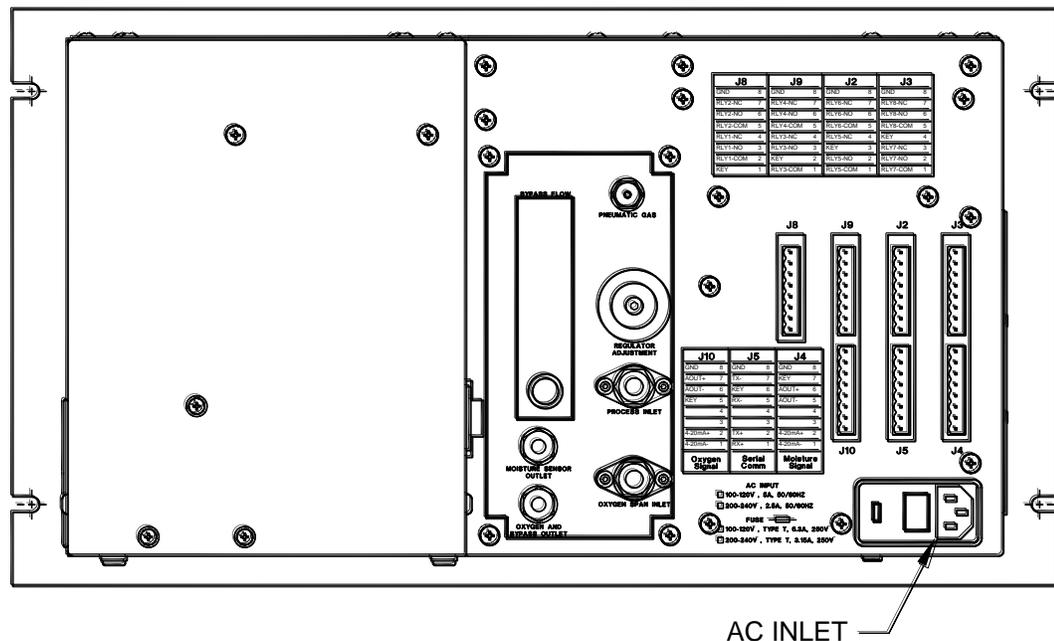


Figure 5: AC Power Input

4.2 Analyzer Start Up

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

NOTE: Shipping regulations require that the zero gas purifier be packaged separate from the analyzer. As a result it must be installed by the end user. See page 129 for instructions.

Open the door and turn on the power using the main power switch inside the analyzer. See Figure 2. The pump, if equipped, should turn on (see page 26) and the analyzer will undergo a series of Diagnostic Procedures while the various startup screens are displayed. Next, the Servomex logo is briefly displayed and then the data displays appear with the “Warming Up” screens flashing. The warm up process takes approximately six to nine minutes after which the display will look similar to Figure 6 (values shown are only representative). It is important to note that the ultimate warm up time may take as much as 90 minutes depending on the conditions.

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

See the section on Power Up Defaults on page 109 for setting user selectable preferences at the time of power up.

During the Warm Up process the gas valves to each sensor can be opened and gas flow started and flow rates and pressures can be set. See the section on Gas Pressure and Flow Settings on page 29 for important information on the gas delivery system and setting proper pressures and flow rates.

NOTE



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

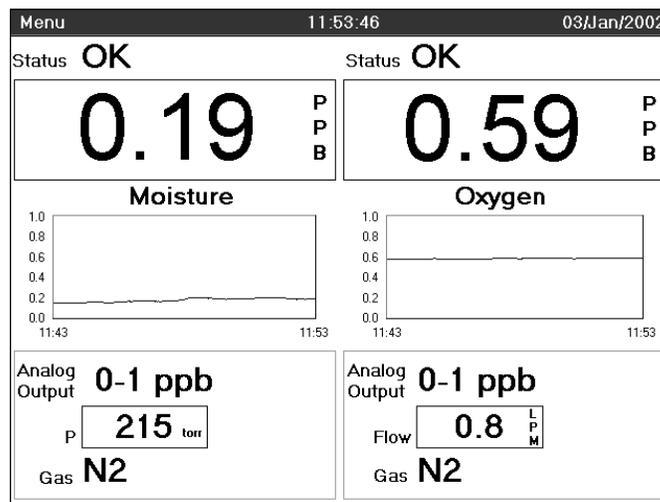


Figure 6: Data Display Screen

4.2.1 Gas Delivery System

The gas delivery system as shown in Figure 7 is designed to deliver a gas flow rate of 1 liter per minute to both the moisture and oxygen sensor while maintaining the highest standards of gas purity and delivery for ultra-trace analysis. Features include a single inlet line for the gas sample, a bypass loop to maintain constant purging, and essentially dead-leg free delivery. The gas delivery system also allows the user to perform zero calibration adjustments for both the oxygen and moisture cells as well as a span calibration for the oxygen sensor.

The connections at the rear of the gas delivery system include a pneumatic gas connection (1/8" compression), a 1/4" VCR swivel connection for the process inlet, a 1/4" VCR swivel connection for oxygen span gas, a 1/4" compression outlet for the moisture cell, and a 1/4" compression outlet for the oxygen sensor and bypass loop. Also on the rear of the gas delivery system are a sample gas regulator to adjust the internal sample pressure and a bypass flow meter.

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

The process inlet to the moisture analyzer, as well as the zero gas inlet, are heated to 60 C. This is done to mitigate any effects of adsorption-desorption of trace moisture on the walls of the tubing.

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

4.2.2 Gas Pressure and Flow Settings

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

1. Power up the unit. See page 28. If the unit is equipped with a Hydrogen Safety System, no flow will enter the system until the unit is on power.
2. Ensure that the needle valve on the aspirator is fully open.
3. Completely open (turn fully clockwise) the inlet regulator on the rear of the analyzer. For operation in Nitrogen, Argon and Oxygen the regulator is closed (turned counter clockwise) to the approximate middle, or 50% of its range. For operation in Helium and Hydrogen it should be closed to 80-90% of its range.
4. Open the flowmeter bypass valve on the rear of the analyzer and flow in the bypass loop will be indicated on the flowmeter. Adjust the flowmeter bypass valve to 0.5 slpm. See Figure 4.
5. Purge for 15 minutes before opening gas valves.

6. The state of the gas control valves for each of the sensors is indicated on the main display. The default state of a factory-shipped instrument is isolation for both sensors. This can be adjusted in the Power Up Default section. If the sensors are in isolation, establish process flow via the Controls menu. See page 48 for the Moisture valves and page 72 for the Oxygen valves.
7. Once flow has been established through the moisture cell, observe the pressure indicator on the main display. For all gases, with the exception of helium, the pressure in the moisture cell is only controlled by adjusting the needle control valve on the aspirator. See Table 1 for appropriate pressure settings. In the case of helium, the vacuum source must be off, and the needle control valve wide open.
8. It is important to ensure that a minimum of 0.2 slpm flows through the bypass loop at all times to prevent backflow. See page 31 for additional information on back pressure prevention.
9. The proper pressure ranges listed in Table 1 will automatically appear on the display when the background GSF is selected.
10. Note: For light gases (hydrogen and helium), the flow indication for the oxygen sensor will be adjusted automatically by approximately 0.3 to compensate for the lighter gas. As a result, the flow rate through the oxygen sensor should always be set to a reading of 1.0 slpm no matter what background gas is in use.

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

*A shut off valve must be installed at the inlet to the aspirator to disable the vacuum.

Table 1: Recommended Sample Outlet Vacuum Pressure

4.2.3 Moisture

Start the gas flow through the Moisture cell by going to the Moisture Controls Menu as shown on page 47 and select Gas Valves. On the Gas Valves screen Figure 20, highlight “Restore Process Gas Flow” and hit Apply, and then hit Done.

On initial start-up, after the six 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 moisture analyzer will take approximately six minutes to re-equilibrate.

See the section on Gas Flow and Pressure Regulation on page 29 for important information on setting proper pressures and flow rates.

See the section on “Power Up Defaults on page 109 for setting user selectable preferences at the time of power up.

4.2.4 Oxygen

Start the gas flow through the Oxygen Sensor by going to the Oxygen Controls Menu as shown on page 72 and select Gas Valves. On the Gas Valves screen Figure 61, highlight “Restore Process Gas Flow” and hit Apply, and then hit Done.

See the section on Gas Pressure and Flow Settings on page 29 for important information on setting proper pressures and flow rates.

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

On initial start-up from the factory, the display will show “Sensor Off” indicating that the oxygen sensor polarizing voltage is automatically turned off and must be manually turn on. See page 72. Also, see the section on page 109 for further information on changing this function on future power ups. After turning the oxygen sensor polarization voltage on, it should take less than 5 minutes for the analyzer to come on scale (< 20ppm). The concentration of oxygen is automatically shown in parts per million (ppm) or parts per billion (ppb) on the display.

See the section on “Power Up Defaults” on page 109 for setting user selectable preferences at the time of power up.

After analyzer start-up, the oxygen sensor can be used to check for leaks in plumbing system. See page 120 for additional information.

NOTE



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

NOTE



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

4.2.5 Backflow Prevention System

It is imperative that flow be maintained through the analyzer. For this reason a flow detection system is installed in the bypass loop to monitor the flow rate. In the event of loss of sufficient flow the analyzer is automatically isolated to prevent ambient air from contaminating the plumbing system. For additional information see page 106.

4.2.6 Purifier Installation

Shipping regulations require that the zero gas purifier be packaged separate from the analyzer. As a result, the purifier must be installed by the user but this should be done after the analyzer is operational. See page 129 for instructions.

4.2.7 Download System Data

The final step of the installation, after a couple days of dry down, should be to download the diagnostics (see section 7.7.11) and send them 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.

4.3 Analyzer Shut Down Or Disconnection

In order 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 the standard isolation process and computer shut down which takes approximately 40 seconds.

Long Term Shut Down - From the Main Menu go to System, and select Isolate Analyzer. A routine automatically starts that closes the downstream valve and allows pressure to build in the moisture cell after which an upstream valve closes as well. In addition the oxygen sensor is isolated. 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.

NOTE: See the section on Power up Default on page 109 for setting user selectable preferences at the time of power up.

Loss of power will result in automatic valve closure and the following restoration of power will result in the “Scan Disk” function occurring before system start-up.

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

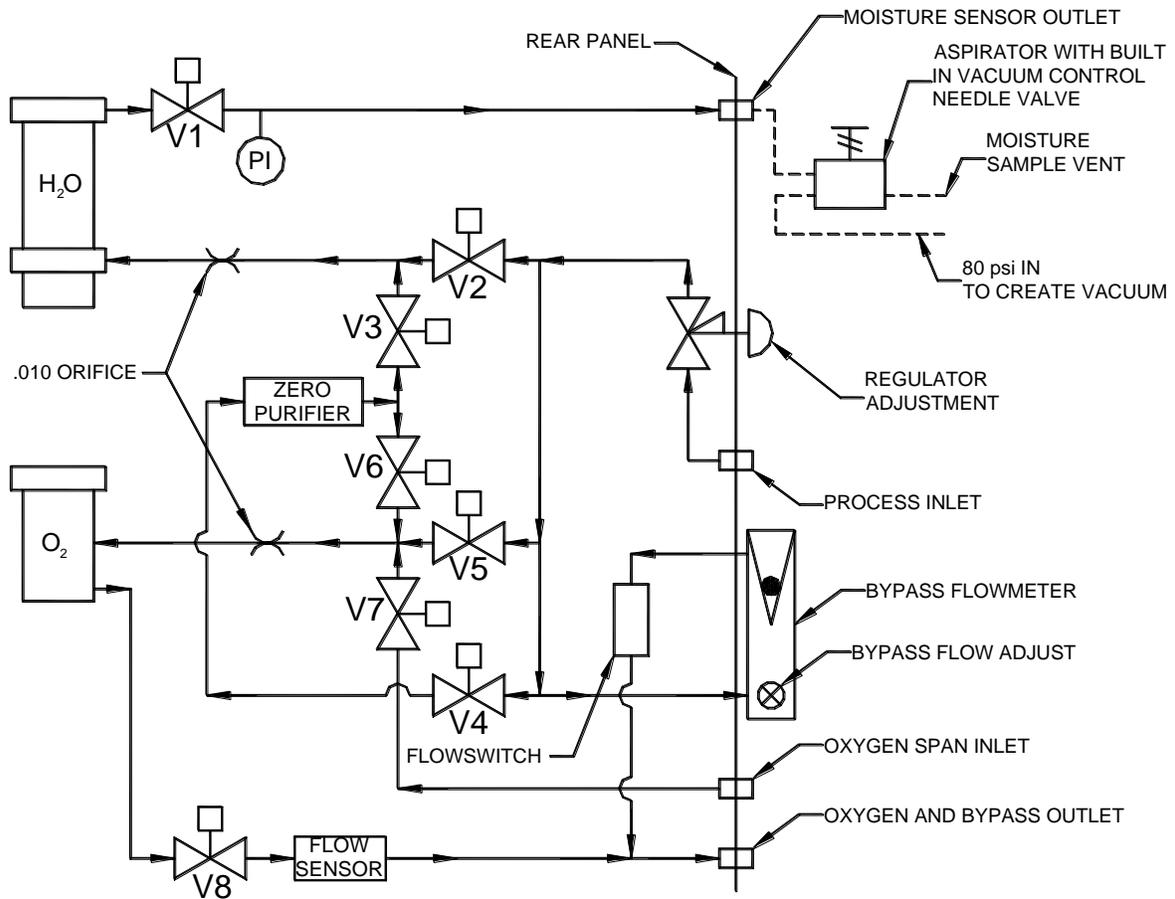


Figure 7: Block Diagram of Gas Flow Path

5 Options

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

5.1 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.

If the analyzer is operating, the key lock does not prevent adjustments from the front panel.

5.2 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.

5.3 Serial Communications

The analyzer can be set for communications by RS-232 or RS-485.

The serial communications option is not adjustable in the field.

See page 41, 113 and 114 for additional information.

5.4 Analog Voltage Output

The maximum analog voltage output can be set at the factory to 0-1, 0-2, 0-5 or 0-10 Volts DC.

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

See page 42, 65 and 97 for additional information.

5.5 Hydrogen Service Safety System

This option enables the analyzer to be safely used in a hydrogen background application.

See page 173 for additional information.

5.6 Vacuum Pump

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

NOTE: If a pump is being retrofitted to an analyzer configured with an aspirator, then the aspirator assembly must be removed completely to uncover the pump power connector and breaker switch. The pump connection should be made directly to the Moisture Sample Outlet as described in section 5.6.2.

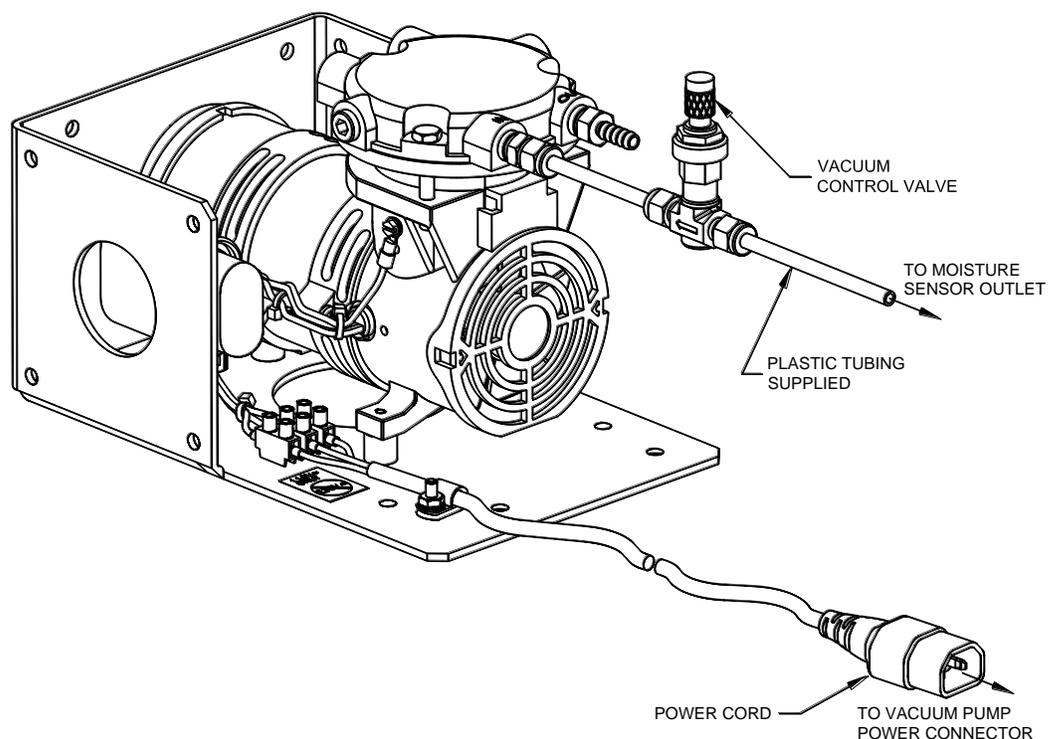


Figure 8: Vacuum Pump Assembly

5.6.1 Installation of the Vacuum Pump

- Mount the vacuum pump to the bracket
- Connect the line from the moisture sample outlet to the needle control valve and vacuum pump
- Make the electrical power connection to the vacuum pump

5.6.1.1 Vacuum Pump Mounting

Mount the vacuum pump within 8 feet of the analyzer. Refer to Figure 9 and Figure 10 for mounting hole and pump dimensions.

CAUTION



Be sure the pump outlet is at atmospheric pressure before starting. The pump is not designed to start against any backpressure.

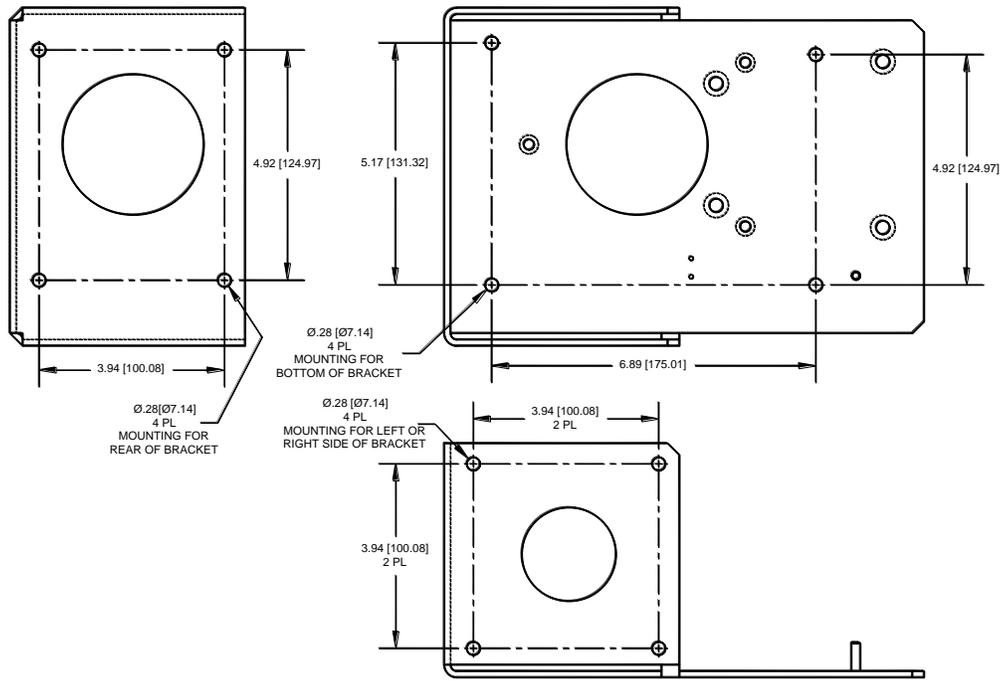


Figure 9: Vacuum Pump Mount Dimensions

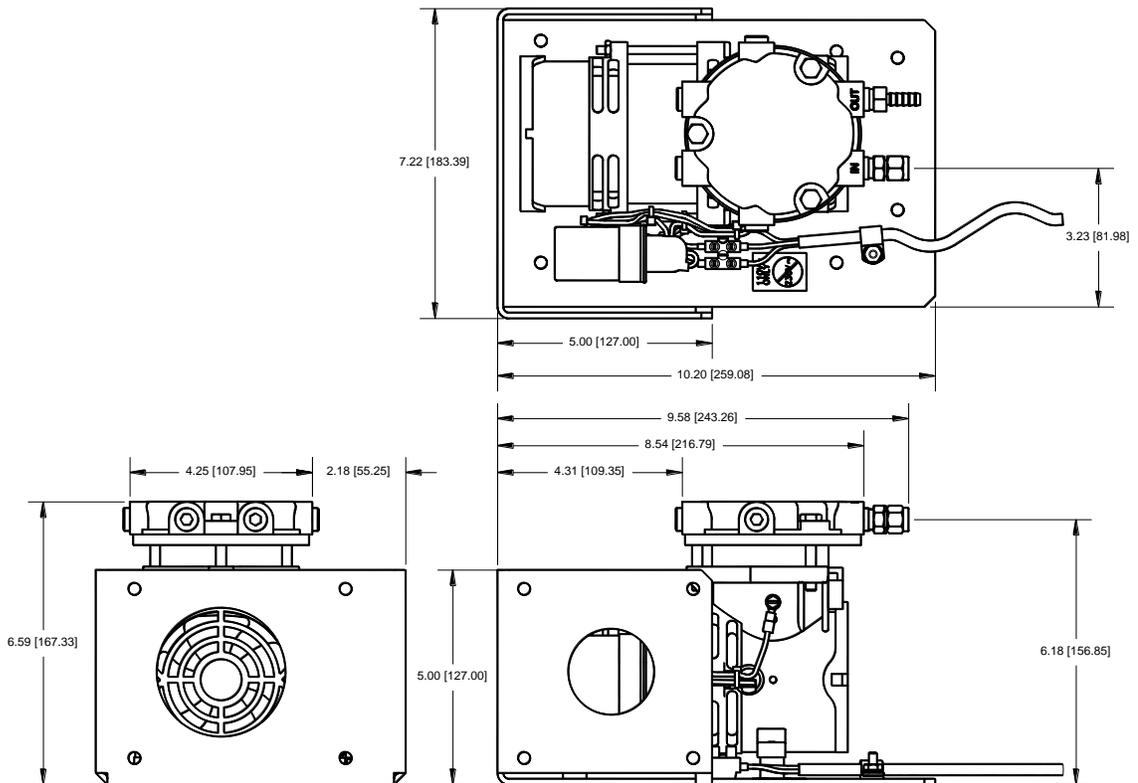


Figure 10: Vacuum Pump Dimensions

5.6.2 Moisture Sample Gas Outlet Connection to Vacuum Pump

The sample gas outlet connection is a ¼ inch compression fitting labeled Moisture Sensor Outlet as shown in Figure 4. Use the polyethylene tubing provided with the analyzer to connect between the outlet fitting and the ¼ inch fittings on the needle control valve and vacuum pump (included separately). See Figure 8. **Open the needle control valve completely.**

NOTE: If the Hydrogen Service Safety System is included, the sample outlet line must be made of steel. See page 173 for additional information.

5.6.3 Electrical Connections

Plug the vacuum pump power cord into the vacuum pump power receptacle on the rear of the analyzer. Turn on the vacuum pump power breaker that is adjacent to the receptacle. The pump will not turn on until the main analyzer power switch is turned on. See Figure 11.

NOTE: The voltage supplied at the vacuum pump power connector is the same as the input voltage to the analyzer. For example, if 110VAC is supplied to the analyzer then 110VAC is supplied to the pump.

CAUTION



Be sure the pump outlet is at atmospheric pressure before starting.
The pump is not designed to start against any backpressure.

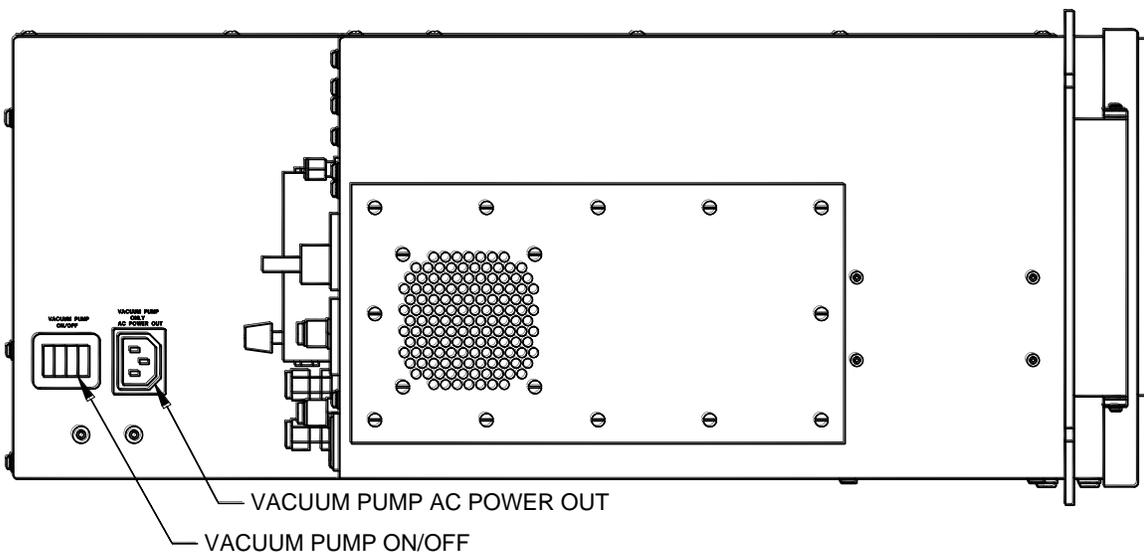


Figure 11: Vacuum Pump Power Connections and Controls

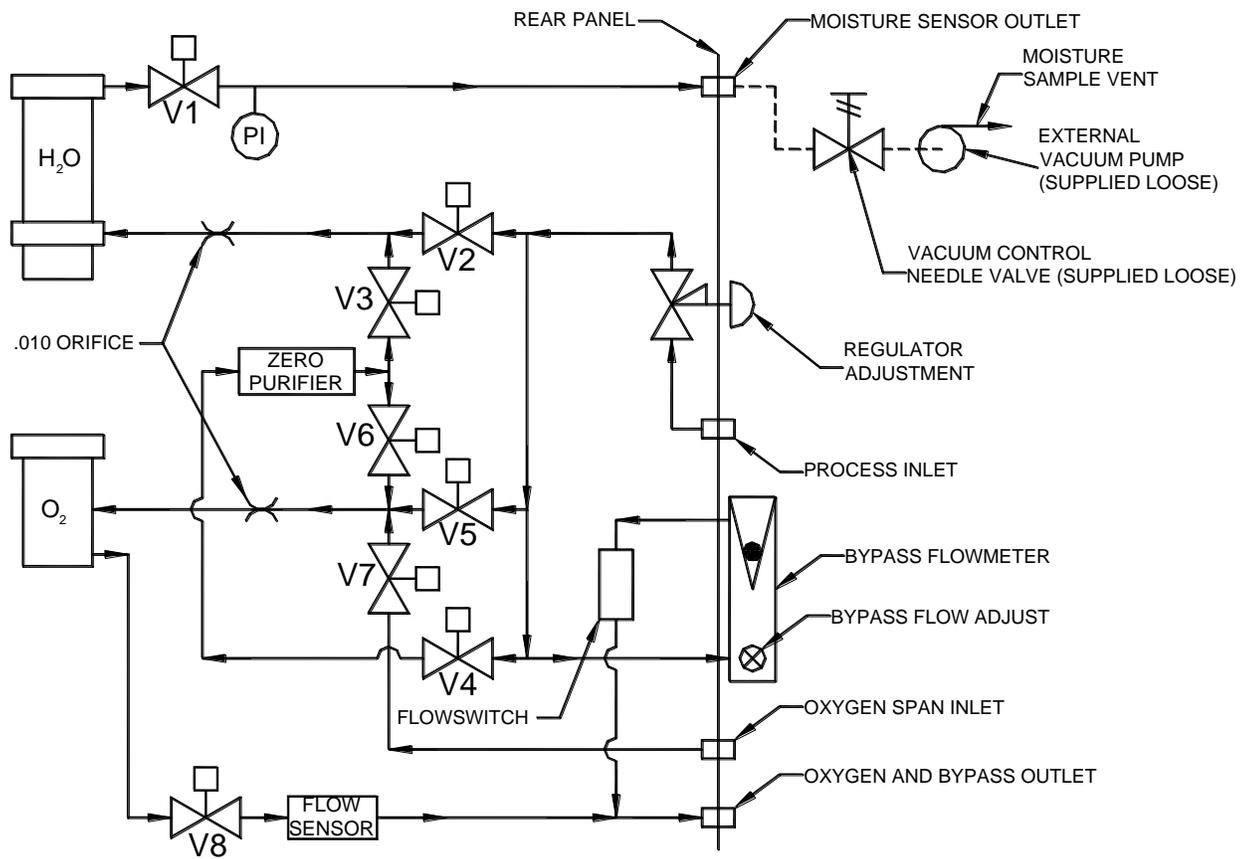


Figure 12: Block Diagram of Gas Flow Path with Optional Vacuum Pump

6 Connecting to External Devices

The analyzer can be interfaced to a variety of external devices via the ports on the rear panel. Alarm contacts, voltage, and current outputs, and serial communications are supported. All outputs, analog or digital, are fully isolated from earth ground.

NOTE



During the six minute warm up period at startup, all analog and digital outputs are held to an artificial 0.01 lppb reading to avoid the reporting of false readings.

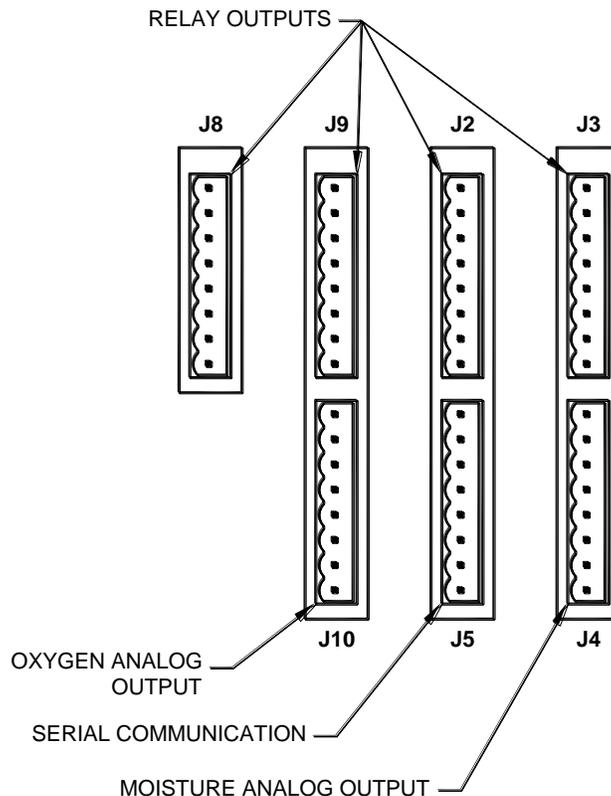


Figure 13: Rear Panel Electrical Connectors

6.1 Serial Communication Port – J5

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

Up to 32 units may be accessed via RS-485. Operating parameters are 8 bits, no parity, and one stop bit. Baud rate may be selected from the menu on the display.

See Table 2 and Table 3 for wiring information.

See the chapter on Communications on page 113 for additional information on setting unit ID's and baud rates.

A program to facilitate serial communications is available from Delta F.

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

Table 2: Pin-out of Serial Comm Connector J5

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

Table 3: Serial Communications Connections

6.2 Analog Signal Outputs – J4, J10

Two sets of analog voltage outputs correlating to the front panel display readings are provided on the rear of the analyzer. The analog voltage output for the oxygen signal is provided through connector J10. The analog voltage output for the moisture signal is provided through connector J4. The full scale voltage for each is set at the factory at the time of order to: 0 to 1 VDC, 0 to 2 VDC, 0 to 5 VDC, or 0 to 10 VDC. These outputs are electrically isolated from all other analyzer outputs, and from chassis (Earth) ground. See page 65 and page 97 for additional information on setting the Moisture and Oxygen Analog Outputs. These outputs may be tested with the use of the analog voltage test routine found on page 111.

6.3 4-20 mA Outputs – J4, J10

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

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

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

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

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

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

6.4 Relay Ports – J2, J3, J8, J9

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

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

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

Relays 1, 2, 3, and 4 are assignable to moisture signals and relays 5, 6, 7, and 8 are assignable to oxygen signals.

The relay wiring can be tested with the Relay test routine found on page 110.

Pin #	Moisture Relay	Description
J8-8	GND	Ground
J8-7	RLY2-NC	Relay 2 Normally Closed
J8-6	RLY2-NO	Relay 2 Normally Open
J8-5	RLY2-COM	Relay 2 Common
J8-4	RLY1-NC	Relay 1 Normally Closed
J8-3	RLY1-NO	Relay 1 Normally Open
J8-2	RLY1-COM	Relay 1 Common
J8-1	KEY	Unused
J9-8	GND	Ground
J9-7	RLY4-NC	Relay 4 Normally Closed
J9-6	RLY4-NO	Relay 4 Normally Open
J9-5	RLY4- COM	Relay 4 Common
J9-4	RLY3-NC	Relay 3 Normally Closed
J9-3	RLY3-NO	Relay 3 Normally Open
J9-2	Key	Unused
J9-1	RLY3-COM	Relay 3 Common

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

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

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

7 User Interface

7.1 Data Display Screen

The front panel display consists of the Graphical User Interface (GUI), as displayed on the view screen in Figure 14 below.

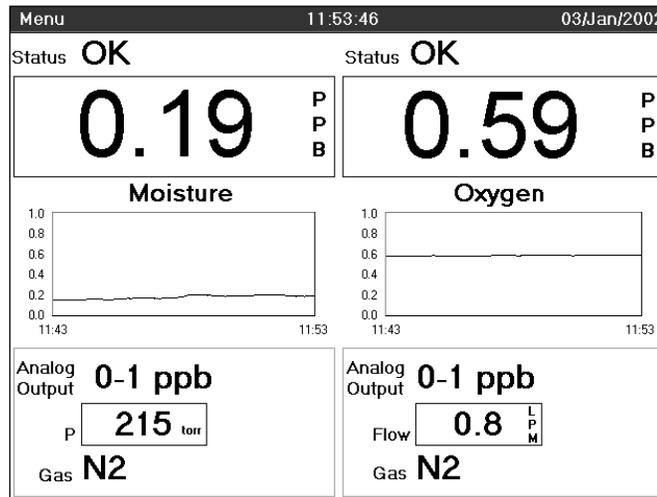


Figure 14: Data Display Screen

The left half of the front panel relates information from the moisture analyzer. The right half of the front panel relates information from the oxygen analyzer. Among the common elements of each side (from top to bottom) are:

- Alarm status indicator – ‘1, etc.’ denotes an alarm condition (if enabled), ‘OK’ denotes no alarm conditions (if enabled).
- The Data Line, providing the most recent concentration measurement in the large number displays. This box will also provide indication of abnormal operating conditions for each sensor.
- A strip chart history of concentration measurements
- A ppb output range, for the analog outputs, as designated by the user.
- Background gas as set by user

Elements specific to the moisture or oxygen measurement side of the front panel are:

- Gas pressure within the moisture analyzer
- Gas flow rate within the oxygen analyzer

For the oxygen sensor on the bottom right side of the front panel, the unique element is the system flag that alerts the user to potential maintenance conditions.

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

7.2 Keypad

The keypad allows the user to control all of the features of the Dual analyzer. The layout of the keypad on the front panel is represented in Figure 15.

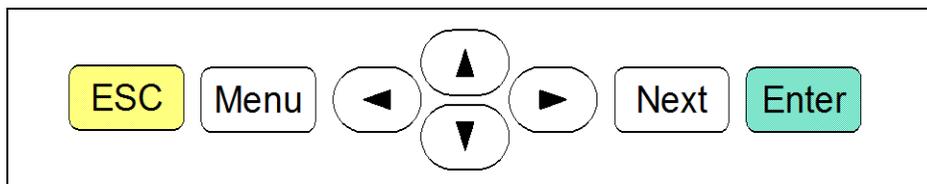


Figure 15: Keypad

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

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

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

The ‘Next’ key allows the user to change between active inputs within a dialogue box. The down arrow key will also accomplish this activity.

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.

7.3 Menu Structure

The NanoTrace Dual Moisture/Oxygen menu tree consists of main menus, sub-menus and screens and is depicted below. See Appendix A on page 168 for a summary of the available menus.

7.4 Main Menu

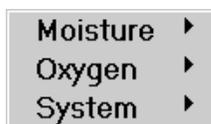


Figure 16: Main Menu

The Main Menu is accessed by pressing the Menu key on the front panel. The main menu provides access to the three sub-menus for Moisture, Oxygen, and System. 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.

7.5 Moisture Menu

The Moisture SubMenu relates to the operation of the moisture cell without affecting oxygen sensor operation. Use the arrow keys (▲ and ▼) to navigate up and down through the list. Select the highlighted item with the Enter key on the front panel.

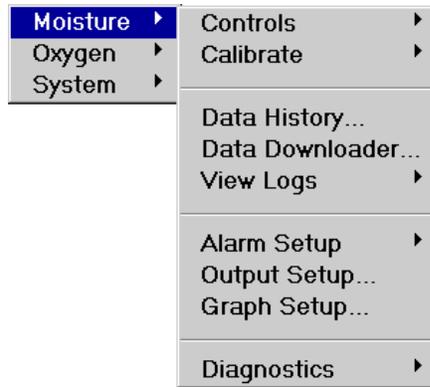


Figure 17: Moisture SubMenu

7.5.1 Moisture Controls Menu

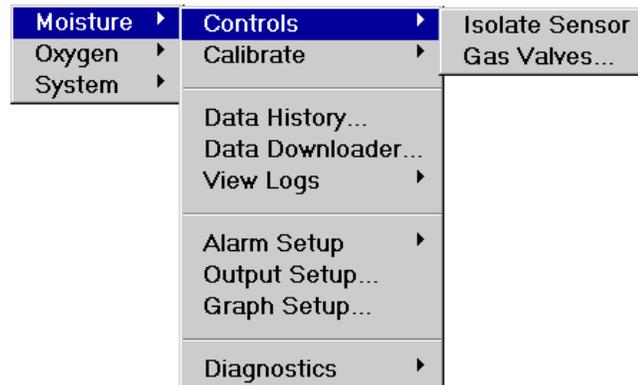


Figure 18: Moisture Controls SubMenu

The Moisture Controls menu provides access to one item related to the control of the signal filter as well as two items related to the control of the gas flowing through the moisture cell.

7.5.1.1 Isolate Sensor

Isolate Sensor allows the internal gas lines and the moisture sensing cell volume to be isolated in the case of an impending break in the external delivery lines. Highlight this item

and hit the **Enter** key to begin the isolation process. The Isolate Sensor Warning will appear for 40 seconds.

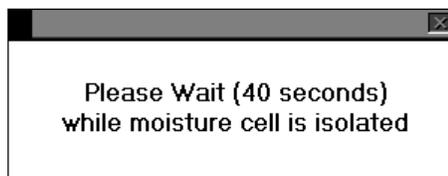


Figure 19: Isolate Sensor Warning

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

CAUTION



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.

CAUTION



When in isolation mode the moisture cell's pressure transducer will yield an incorrect reading of the actual cell pressure. Because the displayed moisture reading is dependant 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.

7.5.1.2 Gas Valves Control

The moisture gas valves control screen as shown in Figure 20 is used to control the flow of gas through the moisture cell.

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

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

necessary for performing zero calibrations or for assessing the relative purity level of the incoming gas.

See Figure 118 on page 106 for additional information on the various gas valves and their control.



Figure 20: Moisture Gas Valve Control

7.5.2 Moisture Calibrate Menu

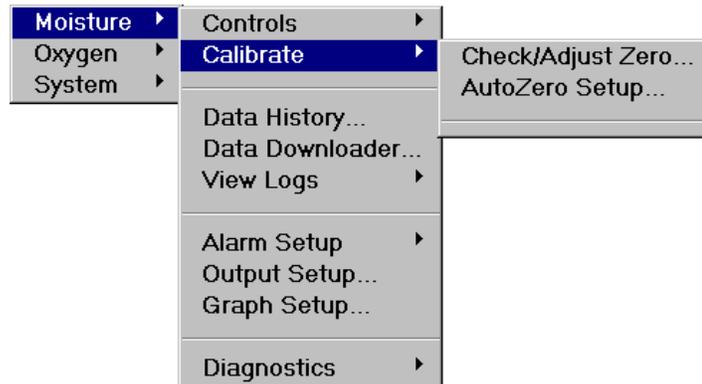


Figure 21: Moisture Calibrate SubMenu

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

However, sample line contributions to moisture offsets in ppb measurements, especially at the sub-ppb level, are difficult to remove even with a correctly operating system. The dry down process of the analyzer and/or gas supply system can literally take many months. The moisture analyzer has an array of zeroing features that enable the user to establish *temporary* performance near 0.0 ppb during the dry down process. Monitoring the zero

reference number during that time, or repeated restoration of the factory zero, will give the user a sense of the offset being induced by the user zero actions.

7.5.2.1 Check/Adjust Zero

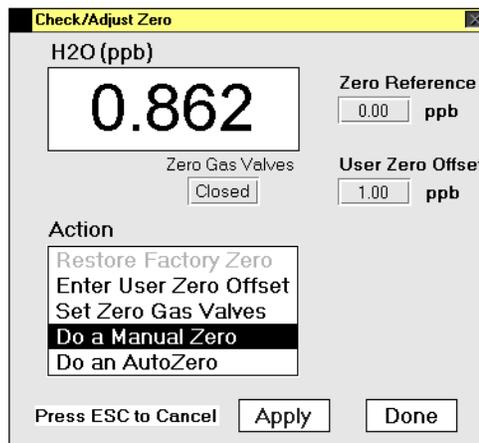


Figure 22: Moisture Check/Adjust Zero Screen

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

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

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

The Active Zero Offset is another offset feature. When this feature is turned on, the User Zero Offset display is inactive and Active Zero Offset will be displayed instead. See page 67 for additional information on the Active Zero feature.

A relay is available on the Moisture Analog Output Setup Screen (see page 66) 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.

7.5.2.1.1 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 negative 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 22, hit the Enter key on the front panel, and the zero

offset box will appear on the screen as shown in Figure 23. With the left and right arrow keys move the cursor to the right of the digit you want to change. With the up and down arrow keys set the number to the desired value.

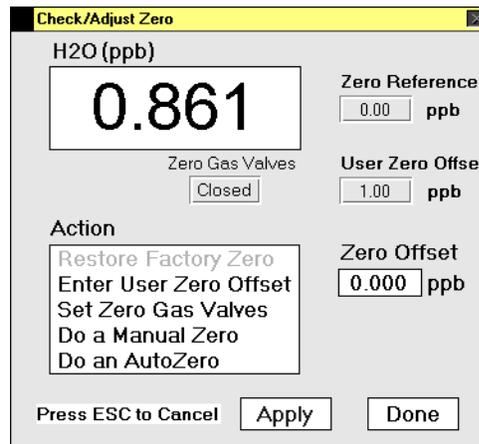


Figure 23: Moisture User Zero Offset Screen

When done hit the Enter key which will move the highlighted area to the Apply button and hit Enter to set the value. Use the Next key to go back and change the value or move to the Done button, followed by hitting the Enter key to leave the screen. Using the ESC key at any time will exit the screen making no changes and return to the main display.

7.5.2.1.2 Set Zero Gas Valves

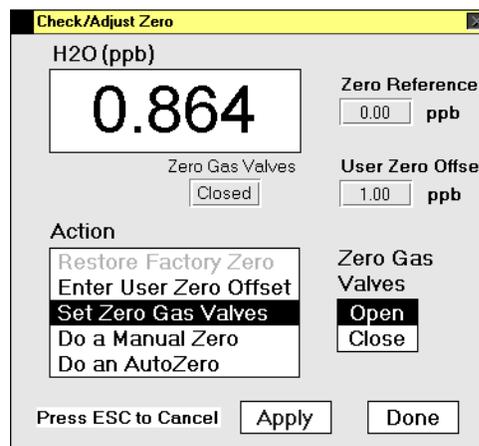


Figure 24: Moisture Set Zero Gas Valves Screen

The state of the Zero Gas Control Valves can be toggled on or off from this screen. Use the arrow keys (▲ and ▼) to highlight Set Zero Gas Valves on the Check/Adjust Zero screen, Figure 22, hit the Enter key on the front panel, and the Zero Gas Valves box will appear on the screen as shown in Figure 24. Use the arrow keys (▲ and ▼) to highlight Open or Close and hit Enter which will move the highlighted area to the Apply button. Hit Enter again to change the valve state. Use the Next key to move back to the control box or to the Done button followed by hitting Enter to leave the screen. Using the ESC key at any time will exit the screen making no changes and return to the main display.

7.5.2.1.3 Do A Manual Zero

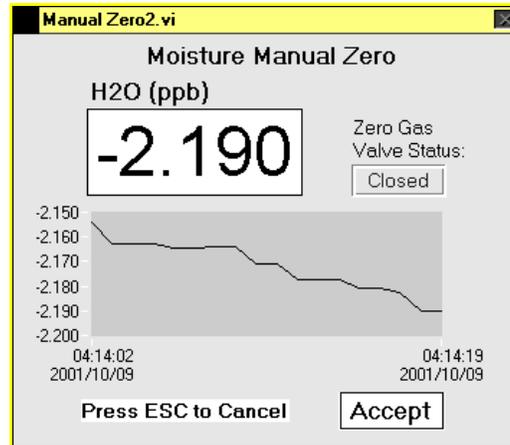


Figure 25: Moisture Manual Zero Screen

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

For this purpose, it is necessary to ensure that moisture free gas is entering the sensor. This can be accomplished by opening the zero gas valves for the moisture cell. See Figure 24. When switching to a gas that is moisture free, it is important to wait a period necessary to allow the reading to re-stabilize.

NOTE: If oxygen is included in the background gas calculation, see page 103, the on-board zero gas purifier is automatically prevented from being used. As a result an adjustment of the moisture zero, must be done manually and the zero gas must be supplied from the outside through the sample inlet.

After opening the zero gas valve and selecting **Do a Manual Zero**, a screen will appear which displays a trace of the recent moisture reading. See Figure 25. Observe the trace until the reading is stable and then press **Enter**. This action will accept the present value as the new zero setting for the moisture cell and the **Zero Reference** field will be updated. After this action, the user will be brought back to the main display.

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

Once complete the gas valves must be returned to the original state with process gas going directly through the sensor. See Figure 24.

A relay is available on the Moisture Analog Output Setup Screen (see page 66) 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.

7.5.2.2 Do an AutoZero

The AutoZero command enables the user to zero the moisture cell in an automated manner. In addition, the AutoZero procedure can be scheduled to run automatically by using the AutoZero Setup procedure described on page 54.

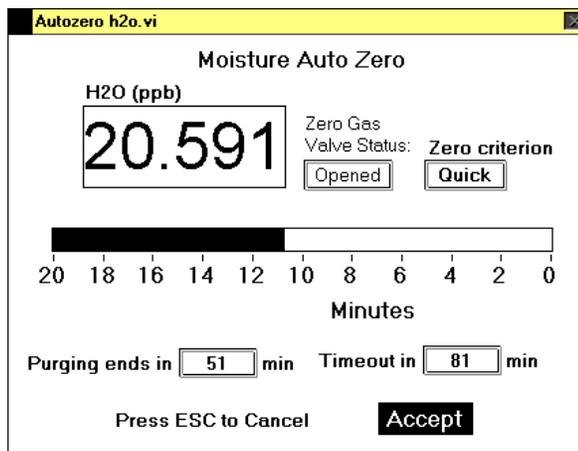


Figure 26: Moisture AutoZero Screen

NOTE: If oxygen is included in the background gas calculation, see page 103, the on-board zero gas purifier is automatically prevented from being used. As a result an adjustment of the moisture zero, must be done manually and the zero gas must be supplied from the outside through the sample inlet.

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

Before the AutoZero process can be started various criteria must be set using the AutoZero Setup screen Figure 27. See page 54 for additional information.

After selecting “Do an AutoZero” from Figure 24 a screen similar to Figure 26 will appear. Throughout the zero process the screen displays the current moisture reading as well as the valve status and selected zero criteria. If a Pre-Zero purge time has been set in the AutoZero Setup screen, then the zero purifier will be valved in and the gas will flow through the purifier to purge the plumbing for that amount of time. Once the pre-purge is complete, the twenty minute autozero cycle begins. During this twenty minute cycle, the analyzer applies stability criteria. If after twenty minutes the moisture reading has acceptable stability the analyzer automatically accepts the reading, updates the **Zero Reference**, and returns to the Data Display Screen. If the reading is not stable, the analyzer continues the stability monitoring until the criteria has been met or until the cycle timer expires. In the latter case, the analyzer returns to operation on sample gas with no adjustment to the zero calibration and reports a failed zero calibration. See the section on AutoZero Setup below for a description of the **Cycle Timeout** function. The Zero Ref in the Check/Adjust Zero screen may change as a result of this process. Pressing **ESC** during the calibration process will abort the action. The user may also restore the factory calibration from the Check/Adjust Zero screen.

A relay is available on the Moisture Analog Output Setup Screen (see page 66) to signal that a zero calibration is taking place. Also, the analog output signal can either be frozen or allowed to update during the calibration process.

7.5.2.3 AutoZero Setup

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 anytime will exit the screen making no changes and return to the main display.

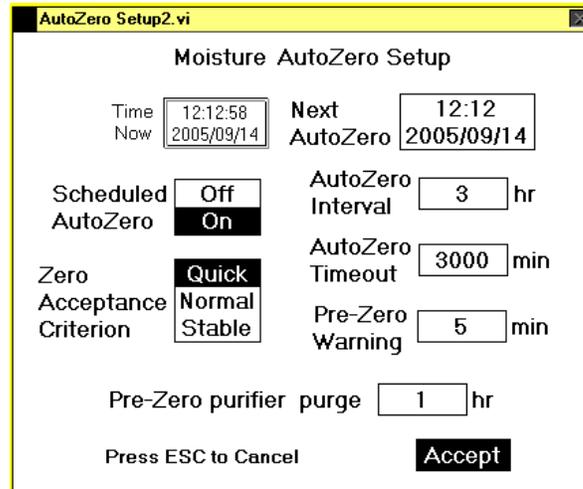


Figure 27: Moisture AutoZero Setup Screen

Moisture AutoZero Setup allows for unattended, automatic zeroing of the moisture analyzer at preset times, preceded automatically by a purge of zero gas if desired.

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

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

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

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

With the **AutoZero Timeout** the user can set the allowed time for stabilization (after completion of any pre-zero purge). If the required stable period is not achieved during this

time, the AutoZero is automatically aborted and the Fail Zero flag is set in the Zero Cal Log as shown in Figure 38.

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

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

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

A relay is available on the Moisture Analog Output Setup Screen (see page 66) 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.

7.5.3 Moisture Data History Routine

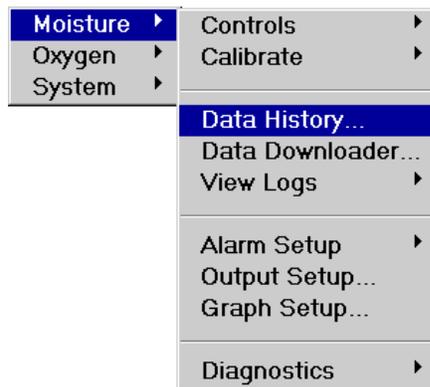


Figure 28: Moisture Data History

The Data History Screen (Figure 29) enables the user to see the data history displayed in strip chart form on the front display. By default, the data history screen displays data for the most recent 24 hour period sampled at a rate of 1 point per minute (fixed) and the y-axis is auto-scaling. Note, the Data History Screen is also accessed from the Data Downloader screen (Figure 33).

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

The data history may be downloaded to a USB memory stick (Flash Drive) by using the Next key to move to the Download box and hitting Enter. A screen will appear, (see

Figure 30) requesting that a memory stick be placed in the external USB socket located behind the front door on the left side of the chassis.

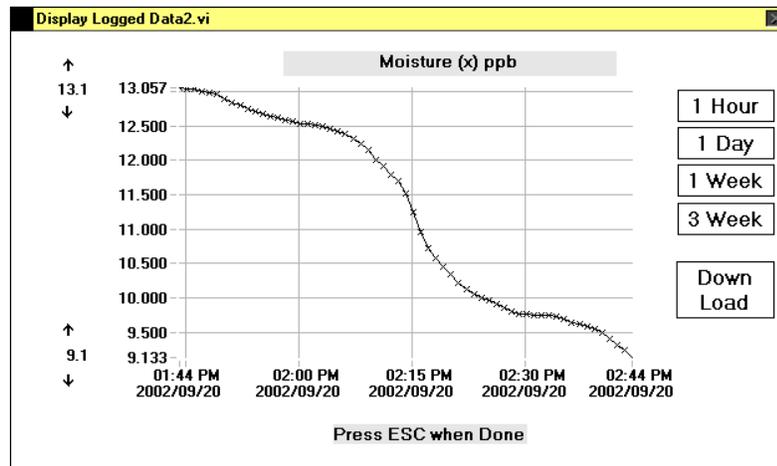


Figure 29: Moisture Data History Screen

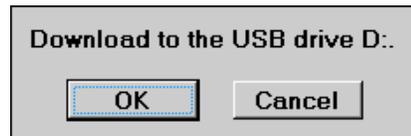


Figure 30: Install Media

```

Firmware version  0.6.1
Serial #         ND-10016
Model #         DF-760
Start time      05-01-2003 03:07 PM
End time       05-22-2003 03:07 PM
Date           Time           H2O
5/16/03       1:24 PM         5.423
5/16/03       1:25 PM         5.423
5/16/03       1:26 PM         5.421
5/16/03       1:27 PM         5.416
5/16/03       1:28 PM         5.411
5/16/03       1:29 PM         5.406

```

Figure 31: Example of Data Download

The downloaded file will be in tab delimited form and will include all moisture and oxygen data in the system up to 3 weeks old if available. The download process will take up to 15 seconds and the display will indicate downloading is in progress. Once the download is complete, control of the analyzer will be returned to the operator. See Figure 31 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.

7.5.4 Moisture Data Downloader Routine

The Moisture Data Downloader screen, Figure 33, enables the user to label data with unique location names as well as to view and download specified data.

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

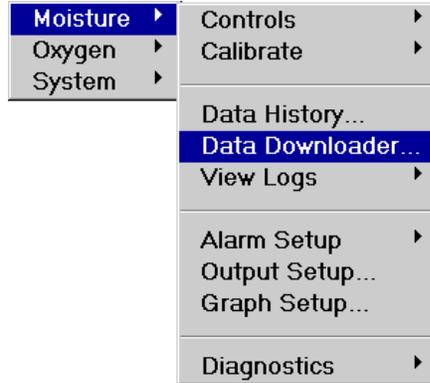


Figure 32: Moisture Data Downloader

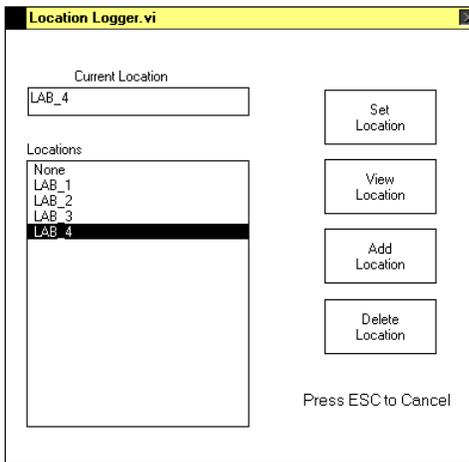


Figure 33: Moisture Data Downloader Screen

7.5.4.1 Set Location

The set location function is used to choose a location from a list of existing locations previously entered into the system (see Add Location on page 58). On the Moisture Data Downloader screen Figure 33, 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.

7.5.4.2 View Location

The view location function is used to view data previously stored in the system sorted by location. On the Moisture Data Downloader screen Figure 33, 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 34.

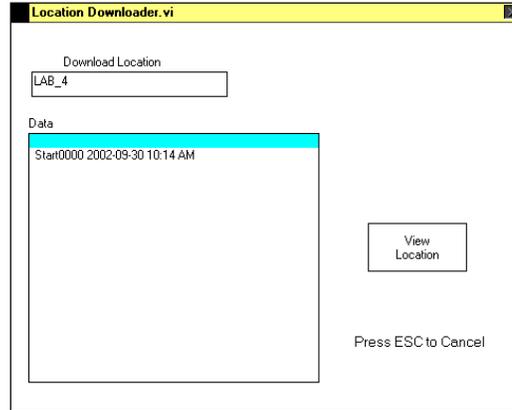


Figure 34: View Location Screen

Use the arrow keys (▲ and ▼) to select the data block desired and use the **Next** key to move to **View Location** and press **Enter**. The data history screen will appear as shown in Figure 29. From the data history screen, the data may also be downloaded to a USB memory stick by way of the remote USB port found behind the front door.

7.5.4.3 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 35 that is used to enter the name of the new location.

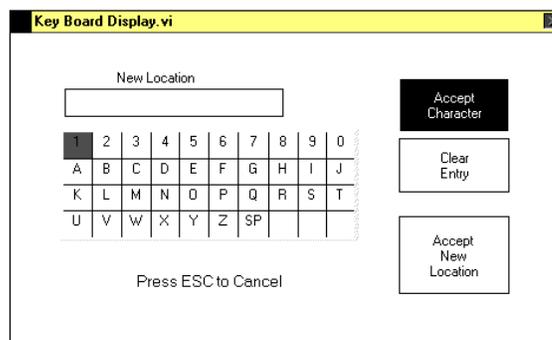


Figure 35: Keyboard Display

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.

7.5.4.4 Delete Location

The delete location function is used to remove a location from the list of available names. On the Moisture Data Downloader screen Figure 33, 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 36) and the user can either accept the deleted selection with the Enter key or can hit ESC to cancel the action. If accepted, the name will be removed from the list of available locations.

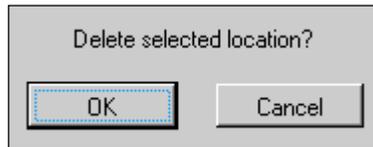


Figure 36: Delete Selection

7.5.5 View Moisture Logs Menu

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

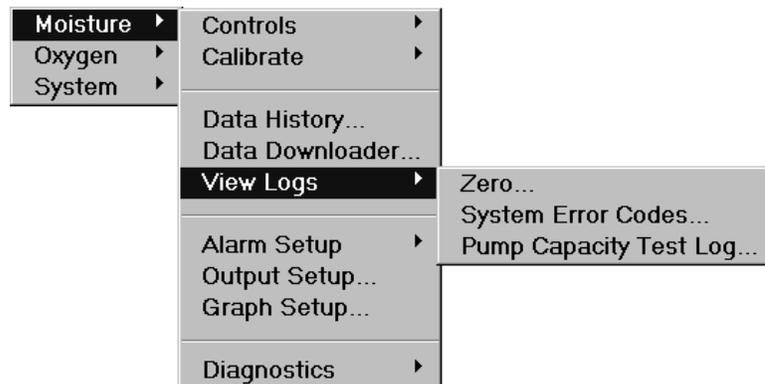


Figure 37: Moisture View Logs SubMenu

7.5.5.1 Moisture Zero Log

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

Moisture Zero Cal Log			
Date & Time	Notes	Min	ZRef
05/16/2005 11:12	Manual Nzero Aborted	0.1	NaN
05/16/2005 10:40	Automatic Szero Aborted	0.4	-21.72
05/16/2005 10:34	Automatic Szero Aborted	0.1	-44.14
05/16/2005 10:33	Manual Nzero Aborted	0.1	0.00
05/13/2005 07:52	Manual Nzero	0.1	7.78
05/13/2005 07:51	Manual Nzero	0.1	7.94
05/13/2005 07:44	Manual Nzero	0.1	9.81
05/13/2005 07:31	Manual Nzero	0.0	2.40
05/13/2005 07:30	Manual Nzero	0.0	-14.45

Figure 38: Moisture Zero Log Screen

7.5.5.2 System Error/Event Codes

The System Error Log reports functional errors and events related to the system. If the error persists for more than 30 minutes, the code is displayed, if warranted. In addition, a system alarm will trip if configured to do so. See page 64 for additional information on setting System Alarms.

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

System Error Log	
* : Send System Data to Customer Support. Refer to User Manual for code.	
Date & Time	Notes
12/31/2009 12:10	Error 101 peak not found*

Figure 39: System Error Log Screen

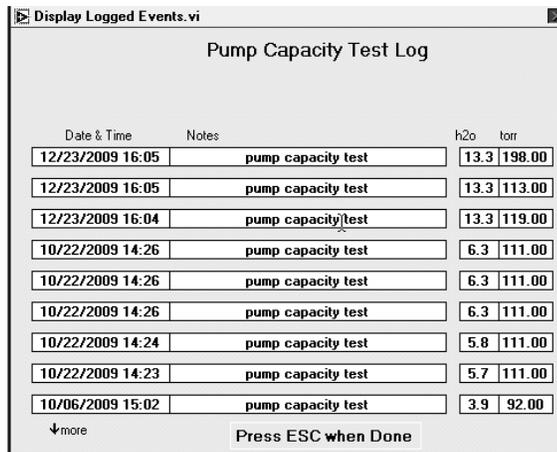
Following is a list of System Error/Event Codes and their descriptions:

- 101 = peak unstable or not found
- 133 = data acquisition system event
- 141 = sample gas pressure outside of pressure matrix range.
- 191 = fan condition voltage out of range – “Fan Failure”

Contact Delta F for assistance in interpreting the various codes if one should appear on the screen.

7.5.5.3 Pump Capacity Test Log

The pump capacity test can be used to determine the ultimate vacuum that the aspirator or pump is capable of pulling. Proper flow through the analyzer is a direct result of the proper balance between the pressure on the analyzer inlet and the vacuum at the analyzer outlet. If either is incorrect, the flow will suffer and the moisture readings will not accurately reflect the condition of the process gas. See page 70 for additional information on the pump test. As the last step of the test, the system automatically puts an entry in the pump capacity test log for future reference. See Review of this information can be useful in detecting a trend in the pump condition which can result in a need to rebuild the pump.



Date & Time	Notes	h2o	torr
12/23/2009 16:05	pump capacity test	13.3	198.00
12/23/2009 16:05	pump capacity test	13.3	113.00
12/23/2009 16:04	pump capacity test	13.3	119.00
10/22/2009 14:26	pump capacity test	6.3	111.00
10/22/2009 14:26	pump capacity test	6.3	111.00
10/22/2009 14:26	pump capacity test	6.3	111.00
10/22/2009 14:24	pump capacity test	5.8	111.00
10/22/2009 14:23	pump capacity test	5.7	111.00
10/06/2009 15:02	pump capacity test	3.9	92.00

Figure 40: Pump Capacity Test Log

7.5.6 Moisture Alarm Setup Menu

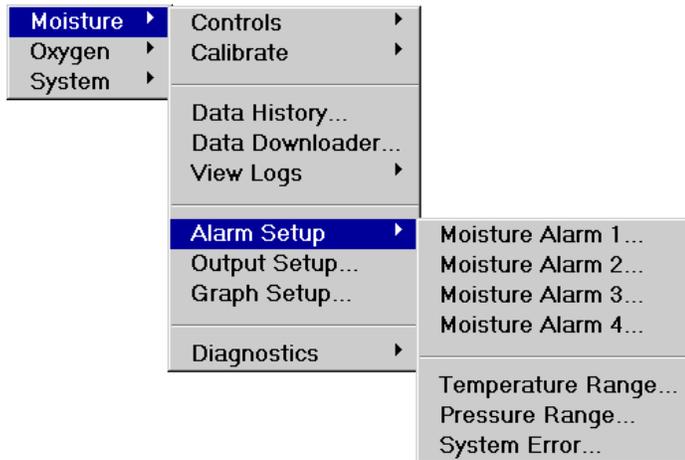


Figure 41: Moisture Alarm Setup SubMenu

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

The temperature alarm indicates an out of specification 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, and under certain conditions will trip alarms if enabled.

NOTE: When any hydrogen is included in the background gas matrix (see discussion regarding GSF on page 103 for additional information), an additional alarm is enabled to monitor the cabinet exhaust fan status. If the system detects a failure in the operation of the cabinet exhaust fan while operating in a hydrogen background, the system immediately isolates the moisture cell until the fan is repaired. A warning describing this condition will appear over the main display and the user will be unable to restore gas flow until the fan is repaired. See Fan Alarm on page 105.

An alarm warning will overwrite the moisture level readout if an alarm condition exists. To acknowledge the alarm simply hit the **Enter** button and its number or letter will appear in the Alarm Status line above the display. See page 45. This action will not clear the alarm. Only restoration of the condition that existed prior to the alarm will clear the alarm. Following is a list of alarm code abbreviations that can appear in the Status Line:

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

Table 8: Alarm Codes

7.5.6.1 Moisture Alarm Setup

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

Use the **Next** key to move from between fields and use the arrow keys (▲ and ▼) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Using the **ESC** key at anytime will exit the screen making no changes and return to the main display.

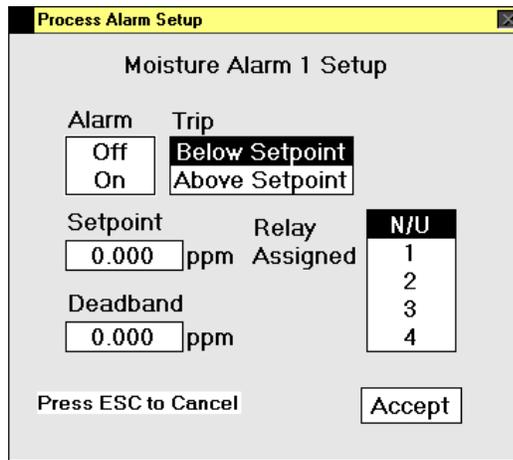


Figure 42: Moisture Alarm Setup Screen

7.5.6.2 Moisture Temperature Range Alarm Setup

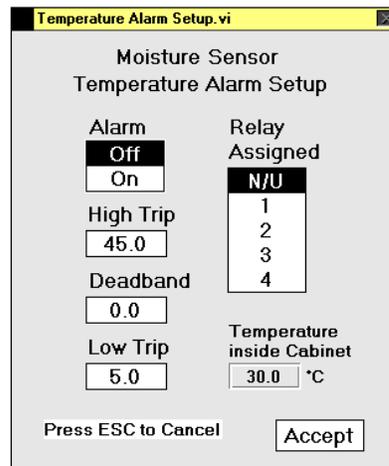


Figure 43: Moisture Temperature Alarm Setup

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

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 anytime will exit the screen making no changes and return to the main display.

7.5.6.3 Moisture Pressure Range Alarm Setup

The system is constantly monitoring the pressure in the gas path and the result is displayed on the front panel. If enabled on the Pressure Alarm Setup screen, an alarm can be assigned

to trip if the pressure exceeds preset limits. The user may assign the pressure alarm to one of four relays.

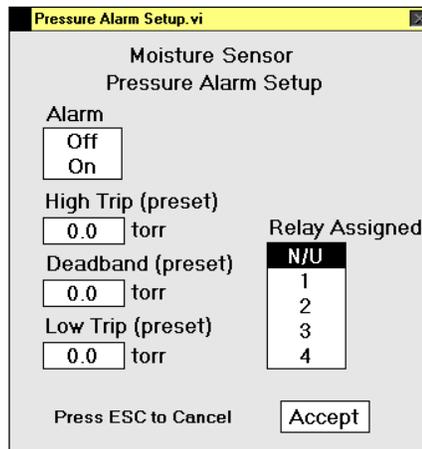


Figure 44: Moisture Pressure Range Alarm Setup

The limits are not user adjustable but are set automatically on the basis of the background gases entered in the GSF screen. See page 103 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 anytime will exit the screen making no changes and return to the main display.

7.5.6.4 Moisture System Alarm Setup

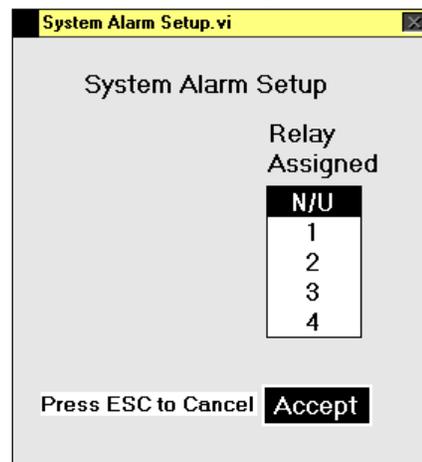


Figure 45: Moisture System Alarm Setup

If left for more than 30 minutes, a System Error Code will trip a System Alarm if configured to do so. See page 60 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 anytime will exit the screen making no changes and return to the main display.

7.5.7 Moisture Analog Output Setup Routine

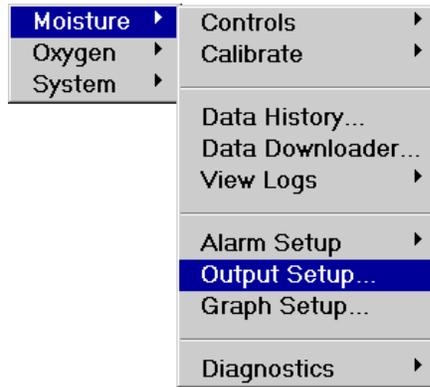


Figure 46: Moisture Analog Output Setup SubMenu

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

Three ranges can be entered 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.

A window as narrow as 10% of the analyzer’s decades can be set for the full-scale analog output.

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

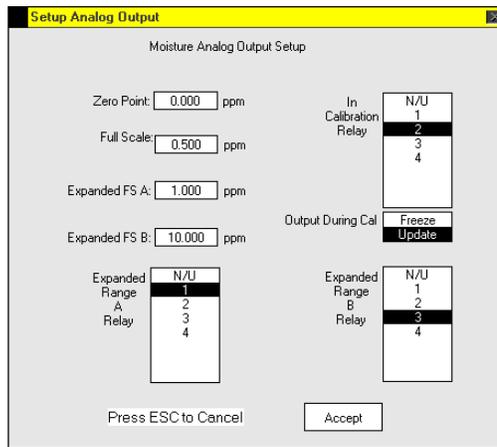


Figure 47: Moisture Analog Output Setup Screen

7.5.8 Moisture Graph Setup

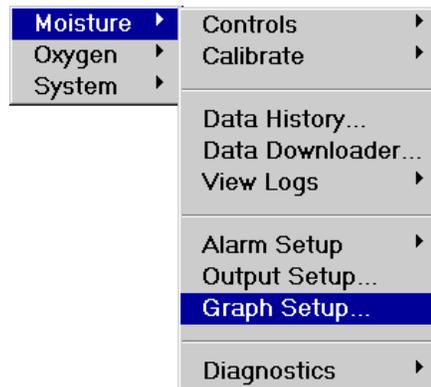


Figure 48: Moisture Graph Setup SubMenu

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

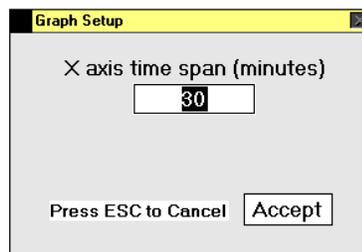


Figure 49: Moisture Graph Setup Screen

7.5.9 Moisture Diagnostics Menu

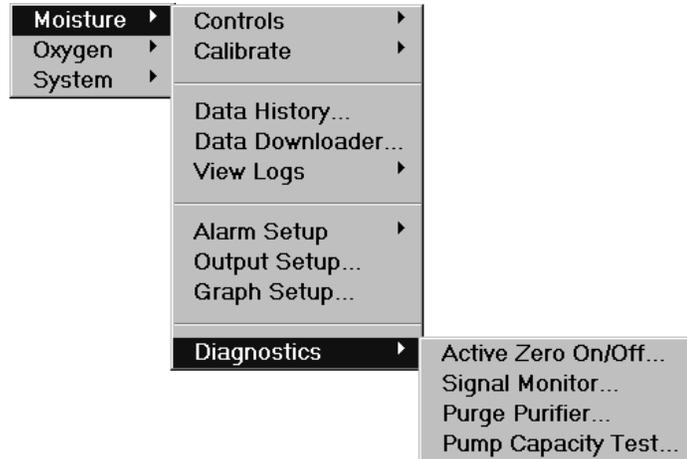


Figure 50: Diagnostics SubMenu

7.5.9.1 Active Zero On/Off

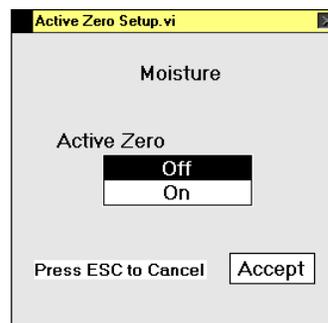


Figure 51: Moisture Active Zero Setup Screen

The Active Zero Offset feature is designed to automatically compensate for the analyzer's gradual zero baseline cleanup. This gradual cleanup is natural and occurs after a fresh startup or after 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 startup, or after a high H₂O upset event. It is similar to the User Zero Offset feature in that a small positive offset is added to the analyzer H₂O readings (display and output) to compensate for the long term downward trending in the readings during cleanup. The Active Zero Offset provides an automatic addition of offset that occurs in miniscule steps, and within set guidelines, corresponding to predictable behavior during cleanup.

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

The current Active Zero Offset value is shown in the Check/Adjust Zero screen as shown in Figure 22. 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 negative 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 cleanup) exceeding -0.3 ppb will result in negative readings until the next user calibration is performed resetting the Active Zero Offset value to zero.

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

7.5.9.2 Signal Monitor

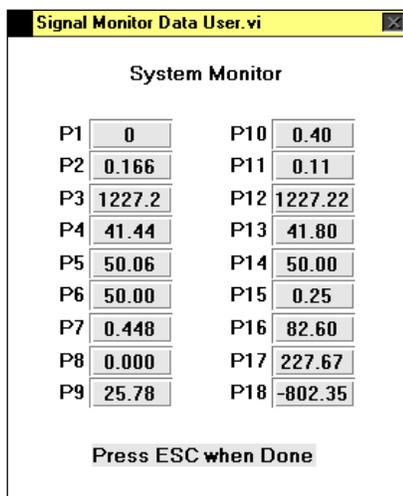


Figure 52: System Monitor

The Signal Monitor depicts 18 system parameters in numerical order. Each parameter is unique for each system. In the event of a system error, these parameters can be used as a diagnostic tool. See page 60 for additional information on system errors.

7.5.9.3 Purge Purifier

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

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

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

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

Select **Purge Purifier** from the **Diagnostics** screen and Figure 53 will appear. Use the **Next** key to toggle **OK**, and when ready press **Enter** and Figure 54 will appear.

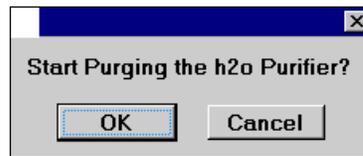


Figure 53: Purge Start

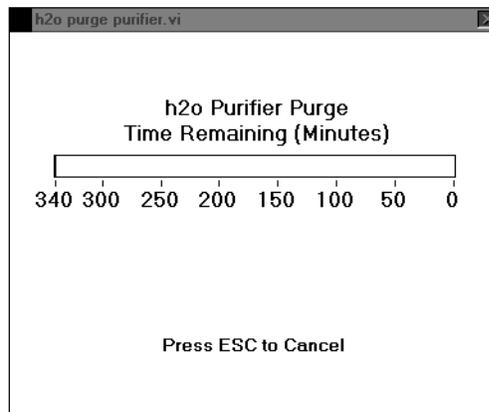


Figure 54: Purifier Purge Time Line

As the timeline progresses, the analyzer is going through a preset sequence of cycles which alternately flow the process gas through the zero and process legs of the gas panel. During this time, the analyzer should not be used for process measurements. The purge cycle can be terminated at any time by hitting the **ESC** key which will bring up Figure 55. Use the **Next** key to toggle between the options and use the **Enter** key to either end the process or, by canceling, allow it to continue. When the process is complete, control of the analyzer will be returned to the user.

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

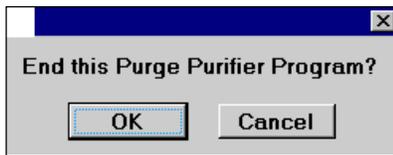


Figure 55: Purge Cancel

7.5.9.4 Pump Capacity Test

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

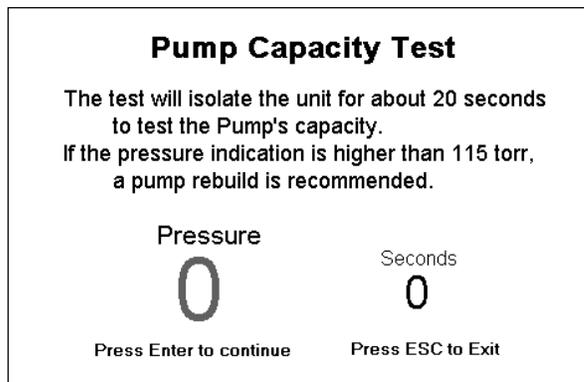


Figure 56: Pump Capacity Test

The test is automatic in nature, in that once started, the analyzer isolates the moisture cell by closing the upstream and downstream valves and then the vacuum is monitored for 20 seconds and is displayed on the screen. Any pressure lower than 115 Torr is considered acceptable. If the aspirator or pump is unable to pull 115 Torr, a failure is indicated by the appearance of Figure 57 and the recommendation to rebuild the pump or check for leaks. At the end of the 20 second test, whether the aspirator or pump passes or fails, the user must hit Escape to return to the main display.

After the pump test is complete, an entry is automatically put in the pump capacity test log as shown in Figure 58. See page 61 for additional information on the pump test log.

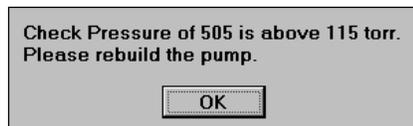


Figure 57: Pump Pressure Failure

Display Logged Events.vi

Pump Capacity Test Log

Date & Time	Notes	h2o	torr
12/23/2009 16:05	pump capacity test	13.3	198.00
12/23/2009 16:05	pump capacity test	13.3	113.00
12/23/2009 16:04	pump capacity test	13.3	119.00
10/22/2009 14:26	pump capacity test	6.3	111.00
10/22/2009 14:26	pump capacity test	6.3	111.00
10/22/2009 14:26	pump capacity test	6.3	111.00
10/22/2009 14:24	pump capacity test	5.8	111.00
10/22/2009 14:23	pump capacity test	5.7	111.00
10/06/2009 15:02	pump capacity test	3.9	92.00

↓more Press ESC when Done

Figure 58: Pump Capacity Test Log

7.6 Oxygen Menu

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

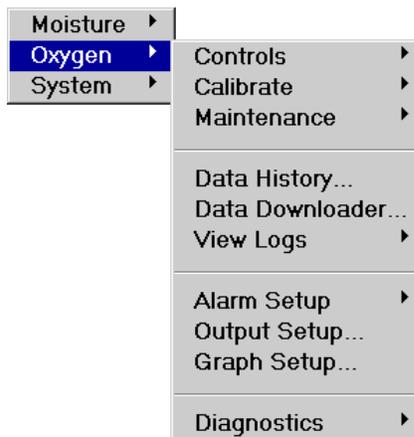


Figure 59: Oxygen SubMenu

7.6.1 Oxygen Controls Menu

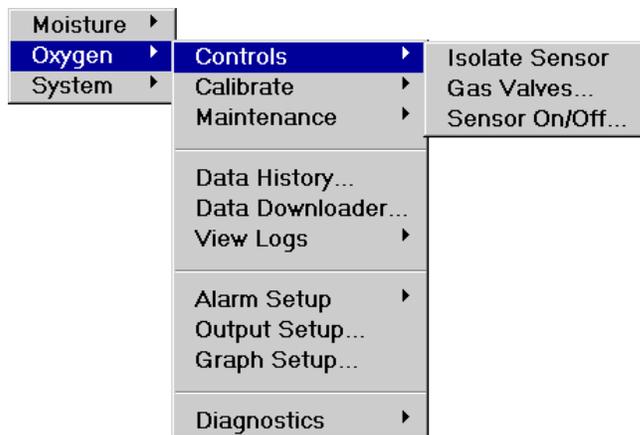


Figure 60: Oxygen Controls Menu

7.6.1.1 Isolate Sensor

Isolate Sensor Sub-Routine – Selecting this option allows the oxygen sensor to be isolated while maintaining moisture analyzer operation or other interruptions to the instrument.

7.6.1.2 Gas Valves

The oxygen gas valves control dialogue screen depicts a live indication of the gas flow through the oxygen sensor in liters per minute. In addition, four options exist for gas valve control.

- Isolating the sensor closes the upstream and downstream valves for the oxygen sensor. This is done to prevent contamination of the sensor when in transport or for changing process lines.
- Restoring process gas flow will open the upstream and downstream valves of the oxygen sensor to allow for gas flow from the sample inlet for normal operation.
- Restoring zero gas flow will divert the sample inlet flow through the gas purifier and then through the oxygen sensor. Flowing the sample through the purifier is necessary for performing zero calibrations or for assessing the purity level of the incoming gas.
- Restoring Span Gas Flow controls valves for span calibrations on the oxygen sensor.

See Figure 118 on page 106 for additional information on the various gas valves and their control.

7.6.1.3 Sensor On/Off

The oxygen sensor power can be toggled ON or OFF. The sensor ON command applies the required polarizing voltage to the sensor. In addition, the analyzer is programmed to protect the oxygen sensor from extended operation at high oxygen

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

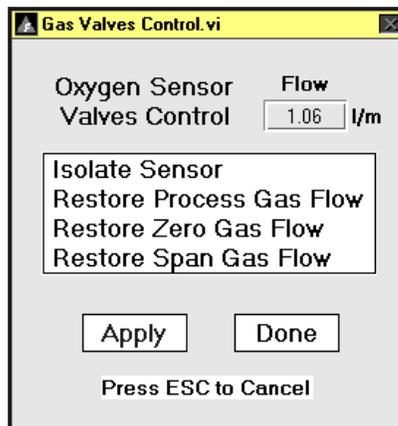


Figure 61: Oxygen Sensor Gas Valve Control Screen

NOTE: After the high oxygen level condition has been repaired the system will not automatically turn the sensor back on. The user must access this screen and manually turn the sensor back on after the problem has been solved. Similarly, if maintenance is expected to bring about a high concentration of oxygen into the sensor lines, it is advised to turn the oxygen sensor OFF.

NOTE: If there is a non-zero entry in the GSF setup screen for O₂, then the polarization voltage to the O₂ sensor is automatically turned off and the O₂ sensor is automatically isolated from gas flow.

An alarm/relay combination may be assigned to the sensor on/off signal in order to indicate the current status. See page 97 for additional information.

The state of the sensor polarizing voltage at the time of analyzer power up is determined by parameters set on the Power-up defaults screen. See page 109 for additional information on Power-up default settings.

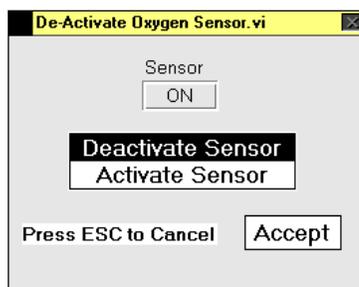


Figure 62: Oxygen Sensor On/Off Control Screen

NOTE



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

7.6.2 Oxygen Calibrate Menu

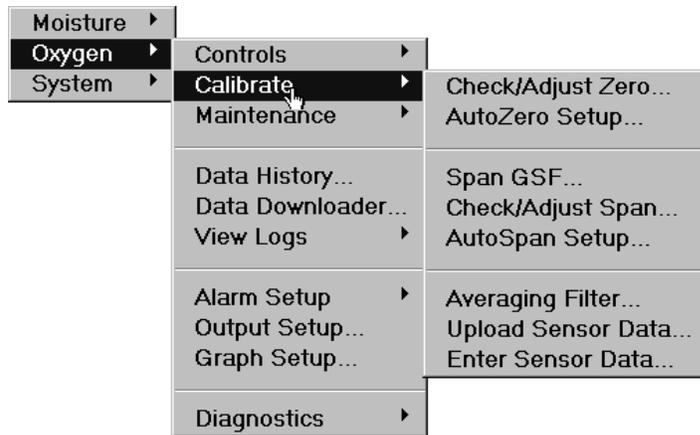


Figure 63: Oxygen Calibrate Menu

7.6.2.1 Check/Adjust Zero

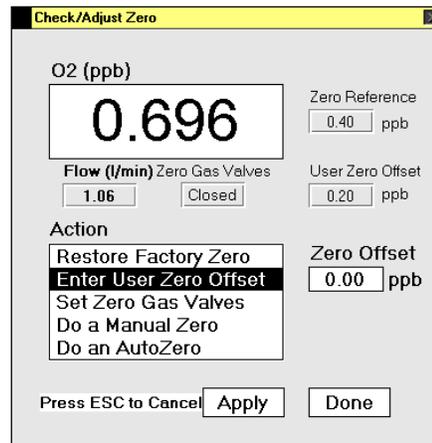


Figure 64: Check/Adjust Zero Screen

It is important to note that sample line contributions to oxygen offsets in ppb measurements, especially at the sub-ppb level, are difficult to remove even with a correctly operating system. The dry down process of the analyzer and/or gas supply system can literally take many months. The oxygen 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.

This Check/Adjust Zero screen Figure 64 enables the user to pick from numerous zero calibration related functions.

The Zero Reference value in the upper right hand corner is a reflection of the deviation of the oxygen sensor's present zero current from the original factory calibration based on any user zero actions. Instruments are shipped from the factory with the zero reference set to 0.00. After a manual or auto zero is performed, the zero reference may change.

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

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

Manual Zero: This option enables the user to perform a re-zero of the oxygen sensor's output. See page 75.

AutoZero: This option initiates a sequence to automatically perform a calibration between the electronic zero and the sensor, accept the new calibration data, and then automatically return the analyzer to the process measurement mode. See page 76.

A relay is available on the Oxygen Output Setup Screen (see page 97) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

7.6.2.1.1 Do A Manual Zero

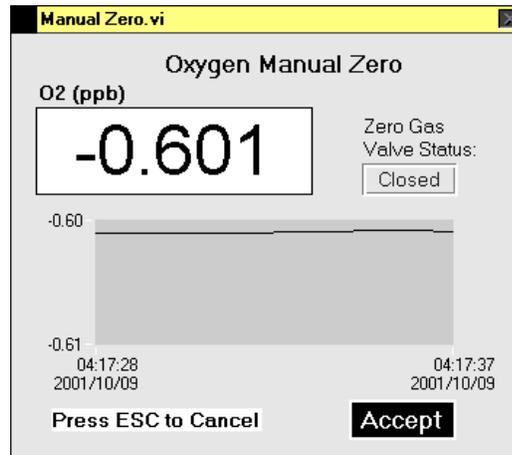


Figure 65: Oxygen Manual Zero

The manual zero command enables the user to zero the oxygen sensor in an interactive manner.

NOTE: If oxygen is included in the background gas calculation, see page 103, the oxygen sensor automatically isolated and the on-board zero gas purifier is automatically prevented from being used. As a result an adjustment of the oxygen zero, must be done manually and the zero gas must be supplied from the outside through the sample process inlet.

For the purpose of a manual zero operation, it is necessary to ensure that oxygen free gas is entering the sensor. This can be accomplished by opening the zero gas valves for the oxygen sensor. See Figure 64 above. When switching to a gas that is oxygen free, it is important to wait a period necessary to allow the reading to re-stabilize.

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

After selecting “**Do a Manual Zero**” a screen will appear which displays a trace of the recent oxygen reading. See Figure 65. Observe the trace until the reading is stable and then press **Enter**. This action will accept the present value as the new zero setting for the oxygen sensor and the **Zero Reference** field will be updated. After this action, the user will be brought back to the main display and the **Oxygen Cal Log** is updated as shown in Figure 89.

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

Pressing **ESC** during the calibration process will abort the action. Whether the calibration is complete or aborted, pressing **done** from the previous screen will allow the user to return to the main display and the **Oxygen Cal Log** is updated as shown in Figure 89.

A relay is available on the **Oxygen Output Setup Screen** (see page 97) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

7.6.2.1.2 Do An Auto Zero

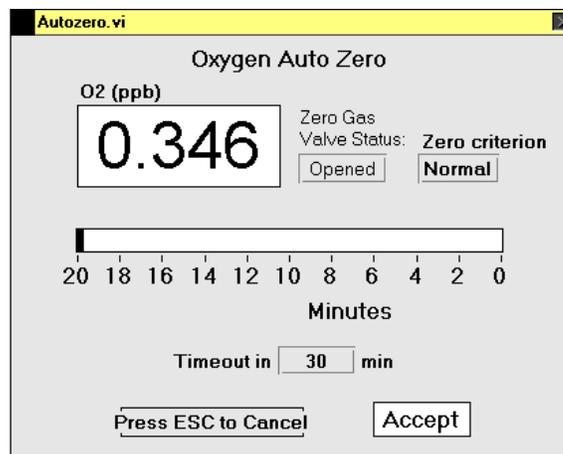


Figure 66: Oxygen Auto Zero Screen

The **AutoZero** command enables the user to zero the oxygen sensor in an automated manner. In addition, the **AutoZero** procedure can be scheduled to run automatically by using the **AutoZero Setup** procedure described on page 77.

NOTE: If oxygen is included in the background gas calculation, see page 103, the on-board zero gas purifier is automatically prevented from being used. As a result an adjustment of the oxygen zero, must be done manually and the zero gas must be supplied from the outside through the sample inlet.

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

Before the AutoZero process can be started various criteria must be set using the AutoZero Setup screen Figure 67. See page 77 for additional information.

After selecting “Do an AutoZero” from Figure 64 a screen similar to Figure 66 will appear. Throughout the zero process the screen displays the current moisture reading as well as the valve status and selected zero criteria. A graphical timer begins counting down from 20 minutes. During the 20 minute cycle, the analyzer applies stability criteria. If after 20 minutes the moisture reading has acceptable stability the analyzer automatically accepts the reading, updates the **Zero Reference**, and returns to the Data Display Screen. If the reading is not stable, the analyzer continues the stability monitoring until the criteria has been met or until the cycle timer expires. In the latter case, the analyzer returns to operation on sample gas with no adjustment to the zero calibration and reports a failed zero calibration. See the section on AutoZero Setup below for a description of the **Cycle Timeout** function. The Zero Ref in the Check/Adjust Zero screen may change as a result of this process. Pressing **ESC** during the calibration process will abort the action. The user may also restore the factory calibration from the Check/Adjust Zero screen.

A relay is available on the Oxygen Analog Output Setup Screen (see page 98) to signal that a zero calibration is taking place. Also, the analog output signal can either be frozen or allowed to update during the calibration process.

7.6.2.2 AutoZero Setup

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 anytime will exit the screen making no changes and return to the main display.

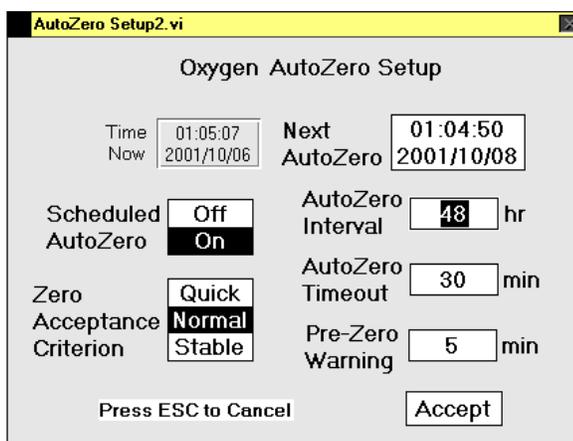


Figure 67: Oxygen AutoZero Setup Screen

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

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

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

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

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

With the **AutoZero Timeout** the user can set the allowed time for stabilization. If the required stable period is not achieved during this time, the **AutoZero** is automatically aborted and the **Fail Zero** flag is set in the **Zero Cal Log** as shown in Figure 89.

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

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

A relay is available on the **Oxygen Analog Output Setup Screen** (see page 98) to signal that a zero calibration is taking place. Also, the analog output signal can either be frozen or allowed to update during the calibration process.

7.6.2.3 Span GSF

As with moisture, **GSF** (gas scale factor) allows correction of reported ppb for different background gases. In the case of the oxygen sensor, it is used to correct for changes in the rate of oxygen diffusion when background gases other than nitrogen are present in the span calibration gas.

The **GSF** in oxygen measurements is far less critical than for moisture measurements. In many applications, the sample **GSF** does not need to be altered from the default value of 1.00. However, if the sample gas has a significantly different diffusivity compared with nitrogen (e.g., helium and hydrogen), the **GSF** should be applied.

The **O2 GSF** may be calculated or entered directly. It is advisable that the entry be calculated for any gas listed on the screen.

Span Gas Mixture		O2 GSF Mode	
N2:	<input type="text" value="100"/>	%	<input type="text" value="Calculated"/>
Ar:	<input type="text" value="0"/>	%	<input type="text" value="Entered"/>
H2:	<input type="text" value="0"/>	%	O2 GSF <input type="text" value="1.00"/>
He:	<input type="text" value="0"/>	%	
Press ESC to Cancel		<input type="button" value="Accept"/>	

Figure 68: Oxygen GSF Screen

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

A relay is available on the Oxygen Output Setup Screen (see page 97) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

7.6.2.4 Check/Adjust Span

The Span Reference value is a reflection of the deviation from the original factory calibration. Instruments are shipped from the factory with the Span Reference set to 1000. After a manual or autospan is performed this value may change. NOTE: The Span Reference Value should not fall outside the range of 500 to 1500. If the value is outside this range, contact Servomex.

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

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

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

To turn the span valves on, use the arrows and move to Set Span Valves and hit Apply. Then move to Do A Manual Span and hit Apply.

If Do An AutoSpan Check is highlighted and the APPLY button is hit, an additional box appears which allows input of a Check Limit. This field is used in the AutoSpan Check process as described on page 81.

A relay is available on the Oxygen Output Setup Screen (see page 97) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

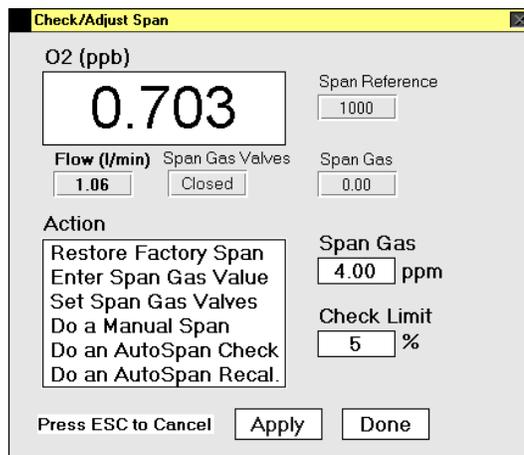


Figure 69: Check Adjust Oxygen Span

7.6.2.4.1 Do A Manual Span

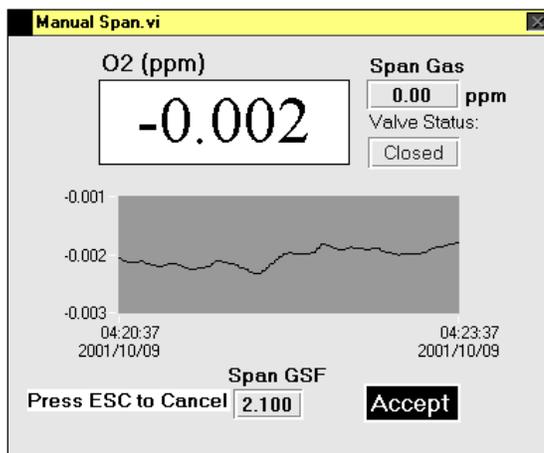


Figure 70: Oxygen Manual Span

A manual calibration can be performed after the span gas is connected to the oxygen span inlet and the analyzer is stable. The pressure of the span gas should be 15 PSI. The O₂ flow rate for span should be set to match what they get when on process gas. This is generally 0.2 – 0.3 LPM. After initiating a manual calibration, it may take up to five minutes before convergence occurs and the 60 second time bar begins to move. During convergence, the analyzer is verifying stability of the reading before accepting the data. If the convergence does not occur within 5-10 minutes, check the following:

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

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

A relay is available on the Oxygen Output Setup Screen (see page 97) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

7.6.2.4.2 Do An AutoSpan Check

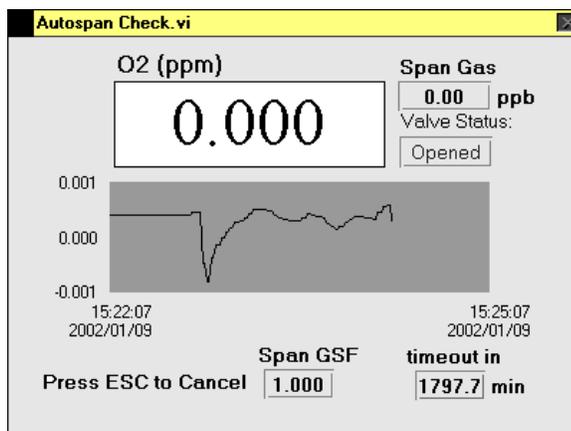


Figure 71: Oxygen AutoSpan Check

As opposed to the Manual Span mode, in the AutoSpan mode, whether check or recal, the analyzer takes complete control of the process. In the span check mode a complete re-calibration does not take place. Rather the final span reading is simply compared to the previous reading to see if the two values are within the user specified percentage set on the Check/Adjust Span Screen in the Check Limit field. See page 79 for additional information.

After the span gas bottle is attached to the oxygen span inlet on the rear of the analyzer, the gas value is entered in the Check/Adj Span screen as shown on page 79.

Similarly, the Span GSF value, if needed is entered in the Span GSF screen as described on page 78.

The TimeOut is set in the AutoSpan Setup screen as described on page 82.

A relay is available on the Oxygen Output Setup Screen (see page 97) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

7.6.2.4.3 Do An AutoSpan Recal

Like the AutoSpan check process, the AutoSpan Recal process is also fully automated. After the span gas bottle is attached to the oxygen span inlet on the rear of the analyzer, the Span Gas value is entered in the Check/Adj Span screen as shown on page 79.

Similarly, the Span GSF value, if needed is entered in the Span GSF screen as described on page 78.

The TimeOut is set in the AutoSpan Setup screen as described on page 82.

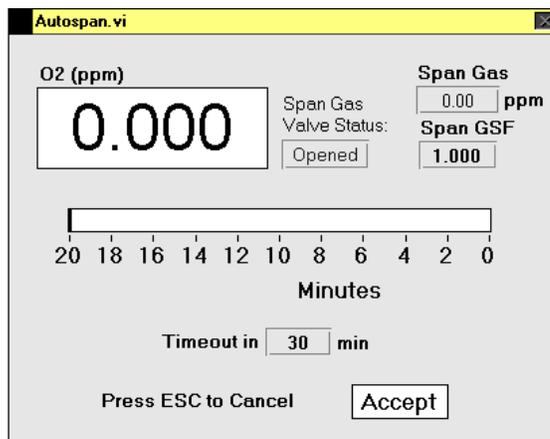


Figure 72: Oxygen AutoSpan Recal

7.6.2.5 AutoSpan Setup

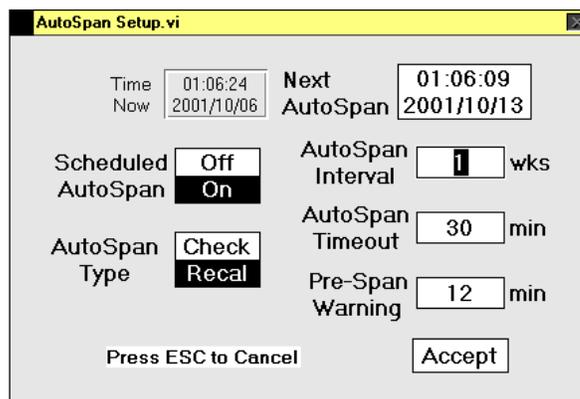


Figure 73: Oxygen AutoSpan Setup Screen

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

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

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

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

A relay is available on the Oxygen Output Setup Screen (see page 97) to signal that a span or zero calibration is taking place, and the analog output signal can also be frozen or allowed to update during the calibration process.

7.6.2.6 Averaging Filter

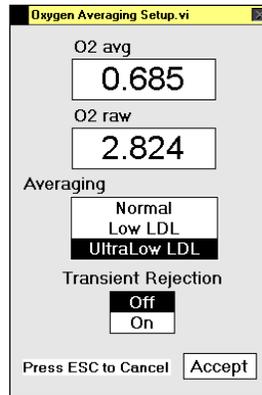


Figure 74: Oxygen Signal Filter Control Screen

This screen displays the offset between the displayed reading O2 AVG and the real-time reading O2 RAW. The difference between the two readings illustrates the time lag and noise reduction effects of the filter while in use. Observing the relative changes to these readings can help the user to establish optimum filter settings for a specific process or application.

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

- Normal
- Low LDL
- Ultralow LDL

The use of one particular technique over another will depend upon the noise level or speed of response required for the application. Selecting Ultralow LDL will provide for the least noise in the signal but the slowest response time. Selecting Normal will yield a faster response but a noisier signal. Units are shipped from the factory with the setting at Low LDL which provides a useful trade-off of noise with respect to response for most applications.

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

7.6.2.7 Upload Sensor Data

The Oxygen Sensor Data screen displays the calibration values that were established when the oxygen sensor and analyzer were calibrated at the factory (new) or when a replacement oxygen sensor was last installed.

If a replacement oxygen sensor is required, the replacement sensor is factory calibrated and arrives with installation instructions and the Upload Sensor Data screen can be used to automatically install the new calibration data from a USB Memory Stick. (See Section 7.6.2.8 for installing the calibration data manually.)

Refer to the instructions on page 31 for information on the installation and start-up of the new oxygen sensor.



For best performance at initial start or anytime the electrolyte is changed, it is important to allow the sensor to sit with electrolyte in it for 60 minutes *before* the gas is allowed to flow through the sensor, and *before* power is applied to the sensor.

After the new oxygen sensor is installed, click the Load New Oxygen Data button on the Oxygen Data Screen, see Figure 75.

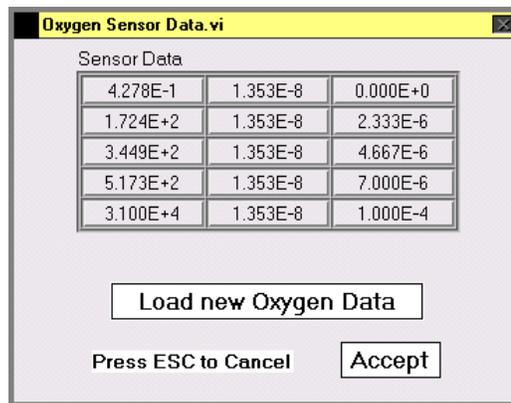


Figure 75: Oxygen Sensor Data Screen - Automatic

The screen in Figure 76 will then appear.

Install the flash drive in the USB connector and click OK.

The system will install the new calibration data and return operation to the user when complete.

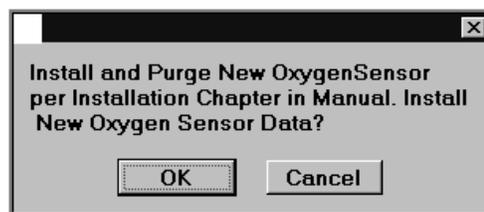


Figure 76: Install New Oxygen Sensor Calibration Data

7.6.2.8 Enter Sensor Data

If a replacement oxygen sensor is required, the replacement sensor is factory calibrated and arrives with installation instructions and calibration data. The Enter Sensor Data screen can be used to manually install the calibration data through use of the keypad. (See Section 7.6.2.7 for installing the calibration data automatically)

Refer to the instructions on page 31 for information on the installation and start-up of the new oxygen sensor.



For best performance at initial start or anytime the electrolyte is changed, it is important to allow the sensor to sit with electrolyte in it for 60 minutes *before* the gas is allowed to flow through the sensor, and *before* power is applied to the sensor.

After the new oxygen sensor is installed, select Enter Sensor Data from the Oxygen Calibration screen and input the two 10 digit numbers found on the sheet accompanying the replacement oxygen sensor. When complete, double check the accuracy of the two numbers, move to the Load New Oxygen Data button and hit Enter.

The system will install the new calibration data and return operation to the user when complete.

New Oxygen Sensor Data

Use "Next" key to select an action

10-digit Data #1 0

10-digit Data #2 0

Use arrow keys to select a digit

Digit #1	0	1	2	3	4	5	6	7	8	9
Digit #2	0	1	2	3	4	5	6	7	8	9

Press ESC to Cancel

Press "Enter" to Accept a digit

Clear Last Digit

Accept New Data

Figure 77: Oxygen Sensor Data Screen - Manual

7.6.3 Maintenance

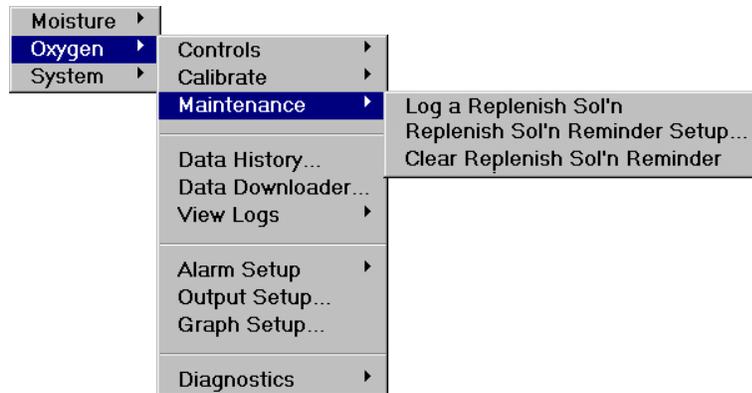


Figure 78: Oxygen Maintenance Menu

7.6.3.1 Log a Replenishment Solution Addition

This command, allows the user to acknowledge that replenishment solution has been added to the oxygen sensor and if the “Replenish Sol’n” reminder flag is active on the display, it will be cleared. Solution additions are tracked in the Replenish Sol’n Log as shown on page 92. The current date is then used to automatically calculate the date for the next solution addition reminder based on the criteria as set on the Replenish Sol’n Reminder Setup screen below.

7.6.3.2 Replenish Sol’n Reminder Setup

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



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

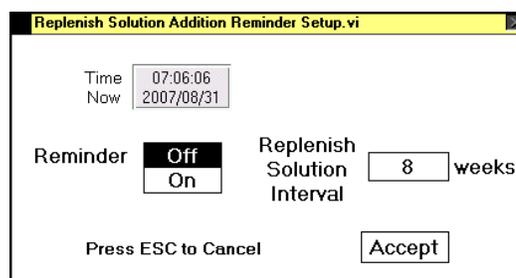


Figure 79: Replenish Sol’n Reminder Setup Screen

7.6.3.3 Clear Replenish Sol’n Reminder

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

7.6.4 View Oxygen Data History

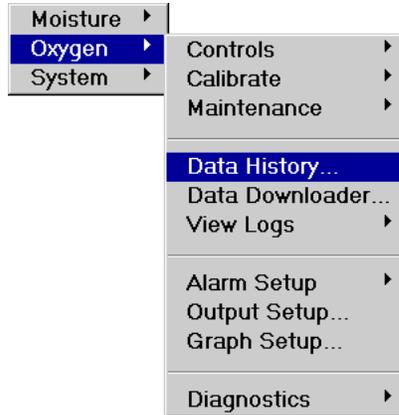


Figure 80: Oxygen Data History Menu

The Data History Screen enables the user to see the data history displayed in strip chart form on the front display. By default, the data history screen displays data for the most recent 24 hour period sampled at a rate of 1 point per minute and the y-axis is auto-scaling. Note, the Data History Screen is also accessed from the Data Downloader screen (Figure 84).

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

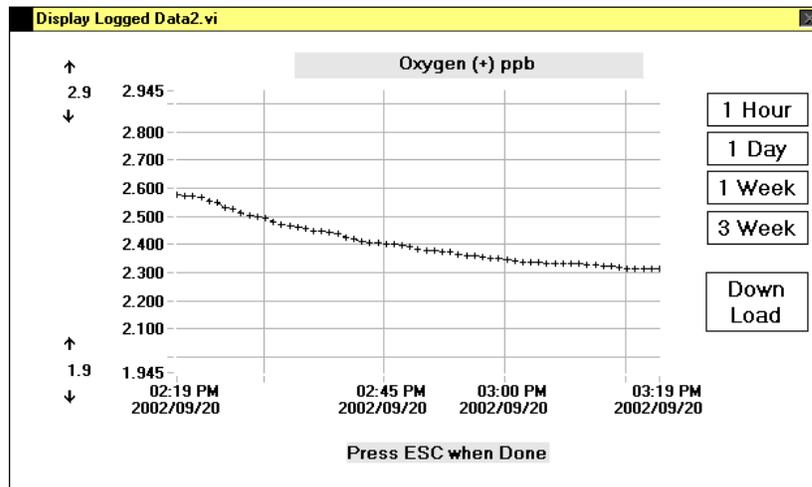


Figure 81: Oxygen Data History Screen

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

The data history may be downloaded to a USB memory stick (Flash Drive) by using the Next key to move to the Download box and hitting Enter. A screen will appear, (see

Figure 82) requesting that a memory stick be placed in the external USB socket located behind the front door on the left side of the chassis.

The downloaded file will be in tab delimited form and will include all moisture and oxygen data in the system up to 3 weeks old if available. The download process will take up to 15 seconds and the display will indicate downloading is in progress. Once the download is complete, control of the analyzer will be returned to the operator. See Figure 31 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.

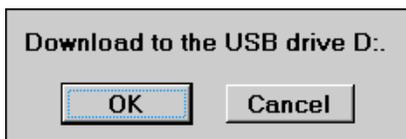


Figure 82: Install Media

7.6.5 Oxygen Data Download Routine

The Oxygen Data Downloader screen, Figure 84, enables the user to label data with unique location names as well as to view and download specified data.

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

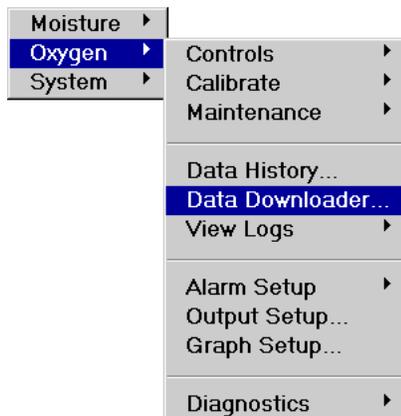


Figure 83 Oxygen Data Downloader Menu

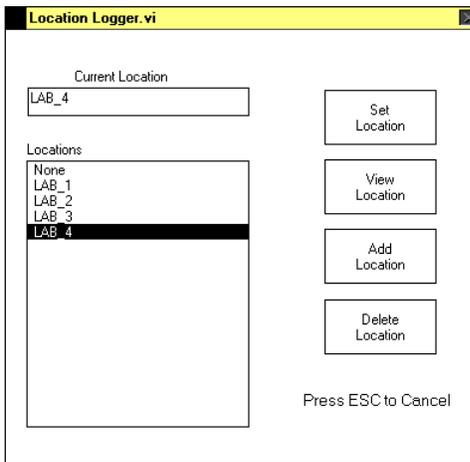


Figure 84: Oxygen Data Downloader Screen

7.6.5.1 Set Location

The set location function is used to choose a location from a list of existing locations previously entered into the system (see Add Location on page 90). On the Moisture Data Downloader screen Figure 84, 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.

7.6.5.2 View Location

The view location function is used to view data previously stored in the system sorted by location. On the Location Logger screen Figure 84, 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 85.

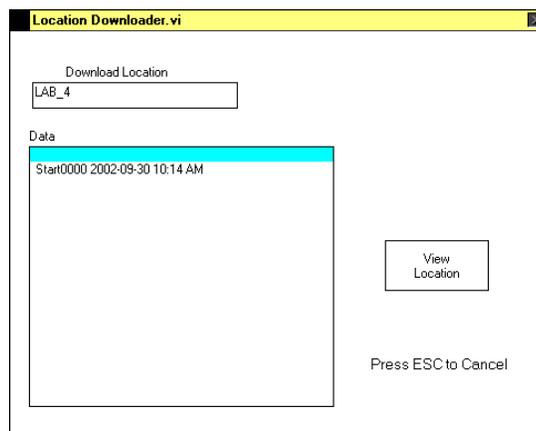


Figure 85: View Location Screen

Use the arrow keys (▲ and ▼) to select the data block desired and use the **Next** key to move to **View Location** and press **Enter**. The data history screen will appear as shown in Figure 81. From the data history screen, the data may also be downloaded to USB memory stick by way of the remote USB port located behind the front door.

7.6.5.3 Add Location

The user can create a new location stamp by moving the cursor to the **Add Location** button and hitting enter. This brings up the keyboard shown in Figure 86 that is used to enter the name of the new location.

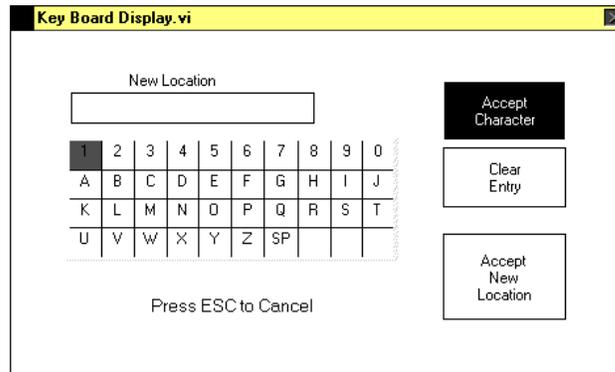


Figure 86: Keyboard Display

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.

7.6.5.4 Delete Location

The delete location function is used to remove a location from the list of available names. On the Location Logger screen Figure 84, 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 87) and the user can either accept the deleted selection with the **Enter** key or can hit **ESC** to cancel the action. If accepted, the name will be removed from the list of available locations.

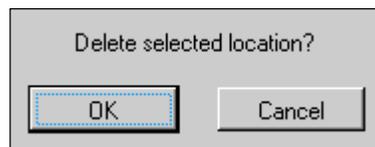


Figure 87: Delete Selection

7.6.6 View Oxygen Logs

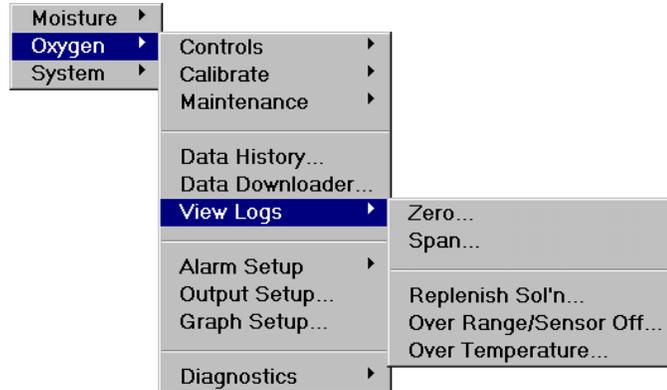


Figure 88: View Oxygen Logs Menu

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

7.6.6.1 View Oxygen Zero Log

The screenshot shows a window titled 'Display Logged Events.vi' with a sub-title 'Oxygen Zero Cal Log'. It contains a table with the following data:

Date & Time	Notes	Min	ZRef
07/16/2001 15:18	Manual zero	0.1	0.40
07/16/2001 13:51	Manual zero	0.1	-0.22

At the bottom of the window, there is a button labeled 'Press ESC when Done'.

Figure 89: Oxygen Zero Log

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

7.6.6.2 View Oxygen Span Log

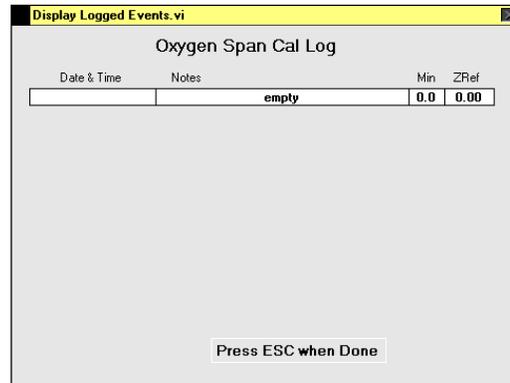


Figure 90: Oxygen Span Log

7.6.6.3 View Oxygen Replenishment Sol'n Addition Log

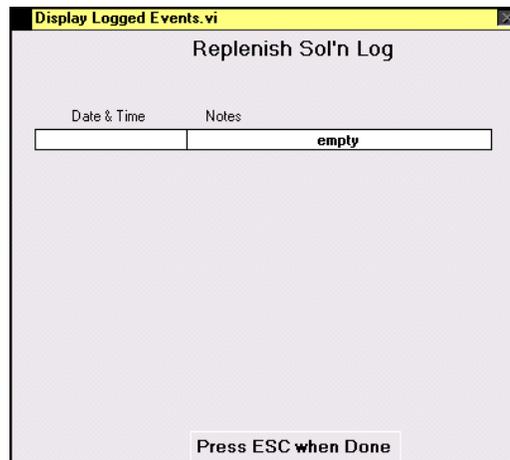


Figure 91: Oxygen Replenishment Sol'n Addition Log

7.6.6.4 View Oxygen OverRange/Sensor Off Log

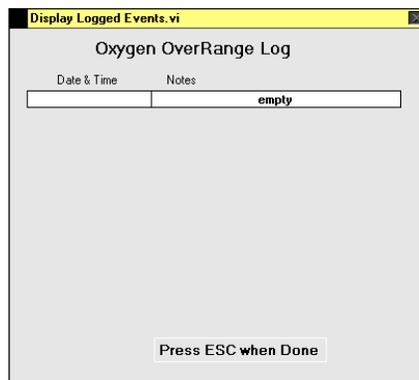


Figure 92: Oxygen OverRange Log

7.6.6.5 View Oxygen Over Temperature Log

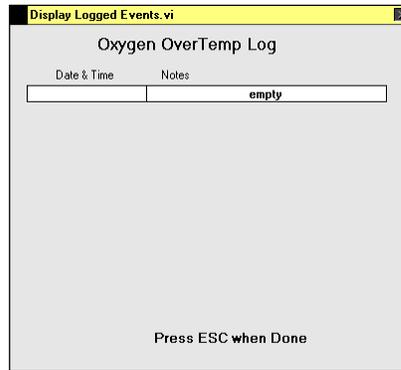


Figure 93: Oxygen Over Temperature Log

7.6.7 Oxygen Alarm SetUp

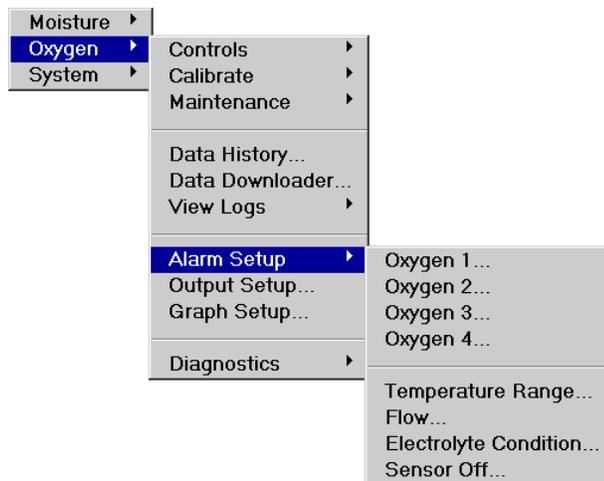


Figure 94: Oxygen Alarm SetUp Menu

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

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

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

NOTE: When any hydrogen is included in the background gas matrix (see discussion regarding GSF on page 103 for additional information), an additional alarm is enabled to monitor the cabinet exhaust fan status. If the system detects a failure in the operation of the cabinet exhaust fans while operating in a hydrogen background, the system immediately isolates the oxygen and moisture cells until the fan is repaired. A warning describing this

condition will appear over the main display and the user will be unable to restore gas flow until the fan is repaired. See Fan Alarm on page 105.

An alarm warning will overwrite the moisture level readout if an alarm condition exists. To acknowledge the alarm simply hit the **Enter** button and its number or letter will appear in the Alarm Status line above the display. See page 45. This action will not clear the alarm. Only restoration of the condition that existed prior to the alarm will clear the alarm.

Following is a list of alarm code abbreviations that can appear in the Status Line:

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

Table 9: Alarm Codes

7.6.7.1 Oxygen Alarm Setup

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

Use the **Next** key to move from between fields and use the arrow keys (▲ and ▼) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Using the **ESC** key at anytime will exit the screen making no changes and return to the main display.

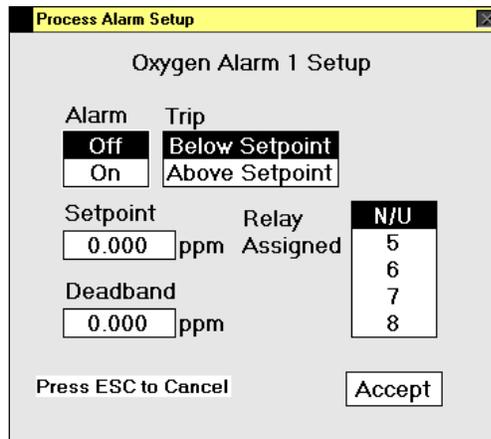


Figure 95: Oxygen Alarm SetUp Screen

7.6.7.2 Oxygen Temperature Alarm Setup

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

Use the Next key to move from between fields and use the arrow keys (▲ and ▼) to change the highlighted selections and to enter numerical values. When done, use the Next key to move to the Accept button and hit the Enter key to return to the main display. Using the ESC key at anytime will exit the screen making no changes and return to the main display.

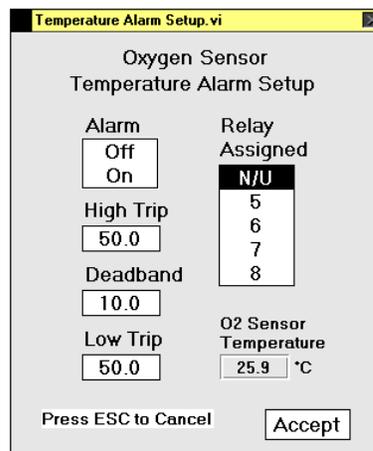


Figure 96: Oxygen Temperature Alarm SetUp Screen

7.6.7.3 Oxygen Flow Alarm Setup

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

Use the **Next** key to move from between fields and use the arrow keys (▲ and ▼) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Using the **ESC** key at anytime will exit the screen making no changes and return to the main display.

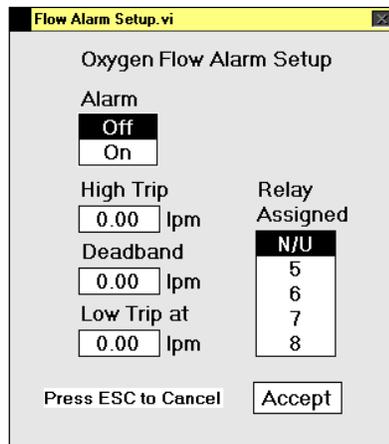


Figure 97: Oxygen Flow Alarm SetUp Screen

7.6.7.4 Oxygen Electrolyte Alarm Setup

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

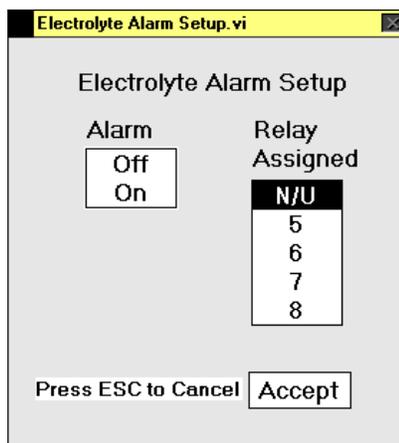


Figure 98: Oxygen Electrolyte Alarm SetUp Screen

Use the **Next** key to move from between fields and use the arrow keys (▲ and ▼) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Using the **ESC** key at anytime will exit the screen making no changes and return to the main display.

7.6.7.5 Oxygen Sensor Off Alarm Setup

In the event that the oxygen sensor polarization voltage has been manually or automatically turned off, an alarm can be enabled to indicate the current sensor status. For additional information on control of the oxygen sensor see page 73. The user may assign the sensor off alarm to one of four relays.

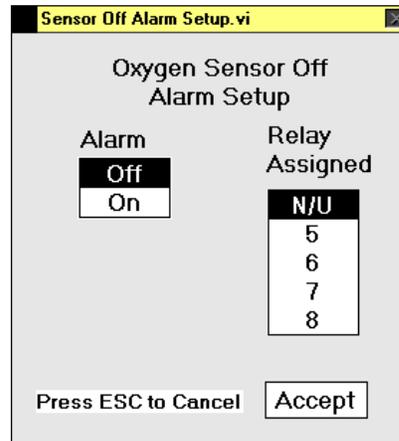


Figure 99: Oxygen Sensor-Off Alarm SetUp Screen

Use the **Next** key to move from between fields and use the arrow keys (▲ and ▼) to change the highlighted selections and to enter numerical values. When done, use the **Next** key to move to the **Accept** button and hit the **Enter** key to return to the main display. Using the **ESC** key at anytime will exit the screen making no changes and return to the main display.

7.6.8 Oxygen Analog Output Setup

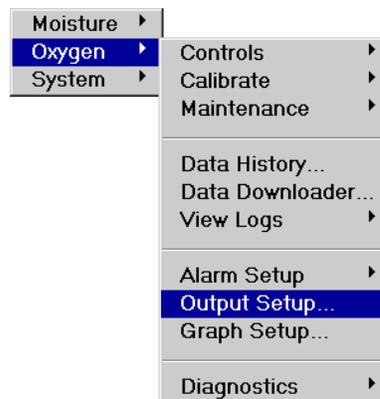


Figure 100: Oxygen Analog Output Setup Menu

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

Three ranges can be entered in this screen. The range of the primary Full Scale (FS) must be less than that of the Expanded Full Scale “A” (FS A) which must be less than that of the Expanded Full Scale “B” (FS B). The analyzer auto-ranges between the three outputs depending on the current analyzer reading. Relay contacts can then be assigned to signal a change in range. If only one expanded range is required, rather than two, then the value of FS B should be set to equal the FS A value. A window as narrow as 10% of the analyzer’s decades can be set for the full-scale analog output.

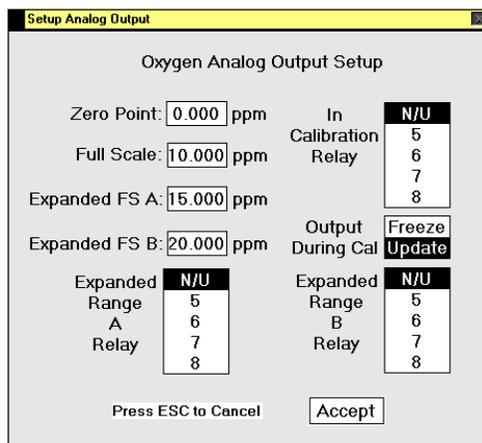


Figure 101: Output Setup Screen

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

7.6.9 Oxygen Graph Setup Screen

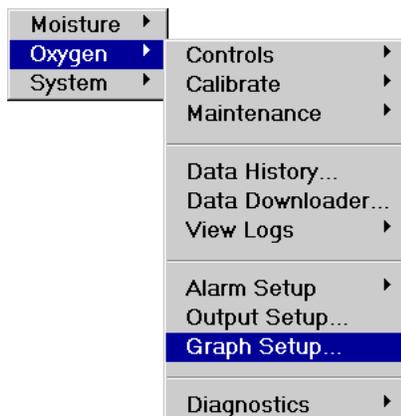


Figure 102: Oxygen Graph Setup Menu

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

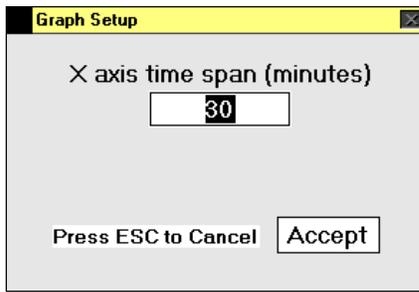


Figure 103: Oxygen Graph SetUp Screen

7.6.10 Oxygen Diagnostics Menu

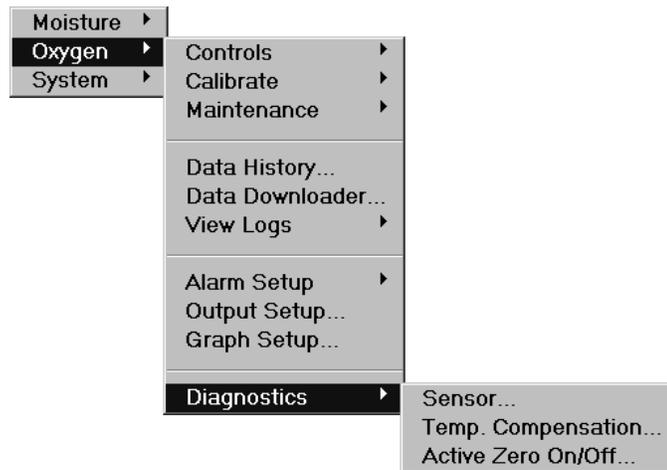


Figure 104: Oxygen Diagnostics Menu

7.6.10.1 Oxygen Sensor Diagnostics

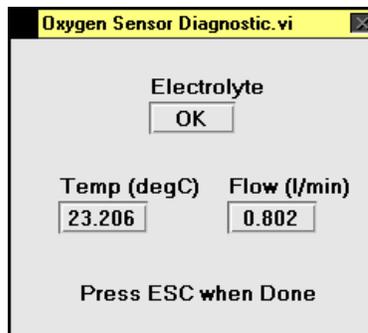


Figure 105: Oxygen Sensor Diagnostics Screen

This SubRoutine contains read-only parameters. It assists the user in allowing determination of the three parameters, electrolyte level, oxygen cell temperature, and gas flow. Generally, these values require no user action. If out of specification any of these parameters may alarm the system if enabled. See page 93 for additional information.

7.6.10.2 Oxygen Sensor Temperature Compensation Screen

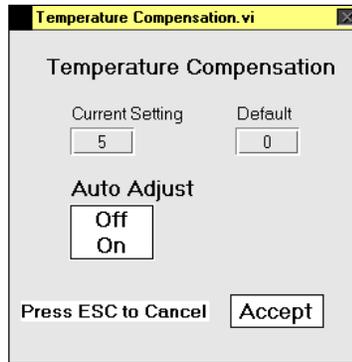


Figure 106: Oxygen Sensor Temperature Compensation Screen

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

The factory (default) setting and current setting are shown. First change the Automatic Adjust to OFF. Then use the arrow up and down keys to adjust the 'New Setting' for different compensation, between 0 and 19. If the analyzer reading increases with temperature (under compensation), then increase the set point (closer to 19). If the analyzer reading decreases with increased temperature (over-compensation), decrease the set point.

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

7.6.10.3 Active Zero On/Off

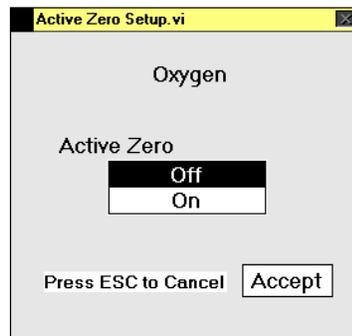


Figure 107: Active Zero Setup Screen

The **Active Zero** Offset feature is designed to automatically compensate for the analyzer's gradual zero baseline cleanup. This gradual cleanup is natural and occurs after a fresh startup or after a prolonged or abnormally high oxygen exposure. This feature ensures that accurate low ppb O₂ readings can be made as soon as possible after initial startup, or after a high O₂ upset event. It is similar to the User Zero Offset feature in that a

small positive offset is added to the analyzer O₂ readings (display and output) to compensate for the long term downward trending in the readings during cleanup. The Active Zero Offset provides an automatic addition of offset that occurs in miniscule steps, and within set guidelines, corresponding to the predictable behavior of a typical system during cleanup.

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

The current Active Zero Offset value is shown in the CHECK/ADJUST ZERO menu. 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 O₂ readings may be decreasing too rapidly for the Active Zero Offset feature to operate properly and negative O₂ readings may result.

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

If the Active Zero Offset feature is turned off, the User Zero Offset value will appear in its' place in the CHECK/ADJUST ZERO 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.

7.7 System Menu

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

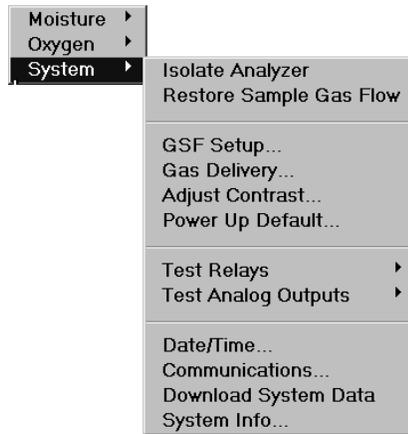


Figure 108: System Menus

7.7.1 Isolate Analyzer

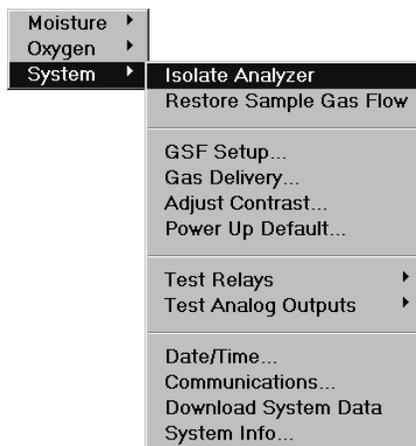


Figure 109: Isolate Analyzer

This command allows the analyzer as a whole to be isolated, for instance, prior to shipping or movement. It acts in the same fashion as the isolate sensor functions in the Moisture and Oxygen SubMenus. After selecting this command the isolation process takes 40 seconds to complete and the warning in Figure 110 appears on the screen. When complete, the warning automatically disappears. The Restore Sample Gas Flow command below returns the analyzer to normal operation.

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

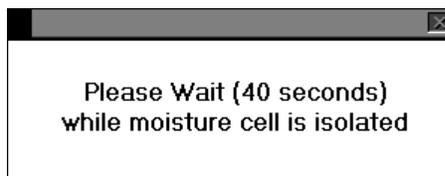


Figure 110: Isolate Analyzer Warning

7.7.2 Restore Sample Gas Flow

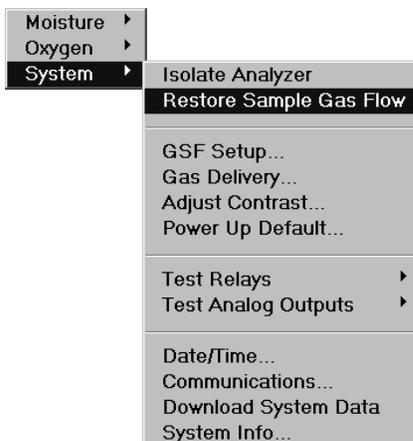


Figure 111: Restore Sample Gas Flow

This command allows the user to return the analyzer gas flow back 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.

7.7.3 GSF Setup

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

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

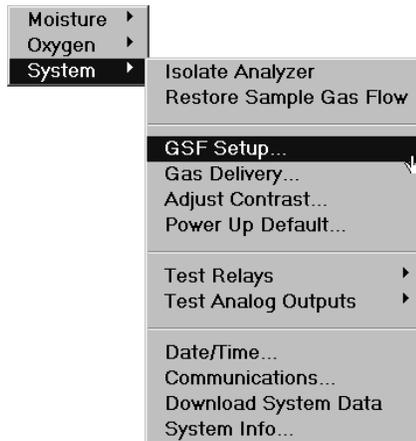


Figure 112: GSF Setup

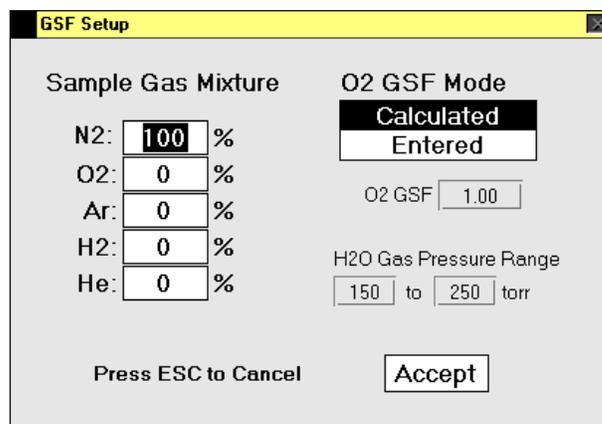


Figure 113: GSF Setup Screen

After the percentages of all background gas are entered, the Accept button is hit and the system confirms that the total is 100%. Next if appropriate, the system indicates the proper pressure setting as in Figure 114 and the limits are set on the Pressure Alarm Screen.

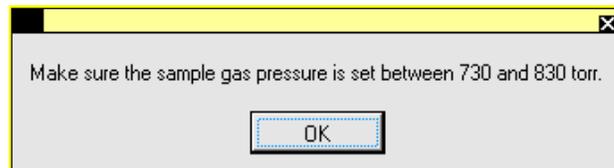


Figure 114: Moisture GSF Pressure Setting

See page 63 for additional information on setting the Pressure Alarm.

The O2 GSF may be calculated or entered directly. It is advisable that the entry be calculated for any gas listed on the screen.

NOTE: If oxygen is included in the background gas calculation, the Oxygen sensor is automatically isolated and the polarization voltage is turned off. In addition, if a non-zero number is entered in the Oxygen field in the GSF setup screen, the Purifier Warning screen

automatically appears and requires the user to indicate which type of purifier is installed in the analyzer before proceeding. See Figure 115.

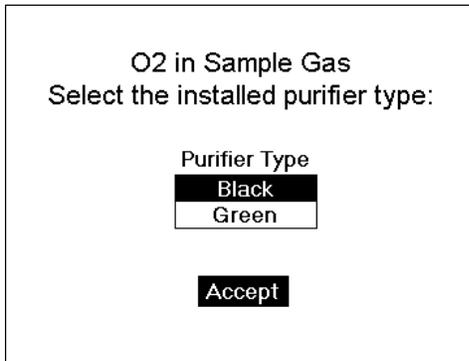


Figure 115: Purifier Warning

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

NOTE: An entry of any percentage of Hydrogen in the GSF calculation will automatically engage the Hydrogen Safety Service System option if equipped. See page 173 for additional information.

7.7.3.1 Fan Failure

The analyzer constantly monitors the condition of the cabinet exhaust fans and if hydrogen is entered as a gas in the GSF Setup, and the system detects a failure in the exhaust fan circuitry the entire analyzer will automatically isolate. A message of "Fan Failure" as shown in Figure 116 will flash over the moisture reading on the main display and the user will be unable to restore any flow until the fan problem has been fixed.

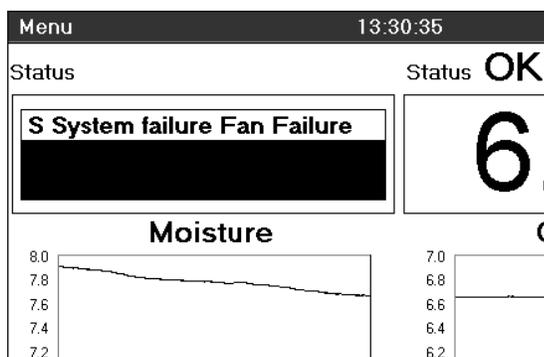


Figure 116: Fan Failure Alarm

7.7.4 Gas Delivery

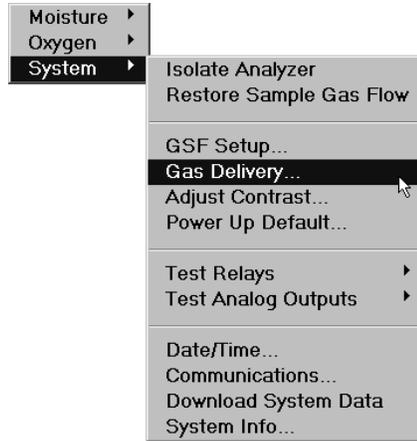


Figure 117: Gas Delivery

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

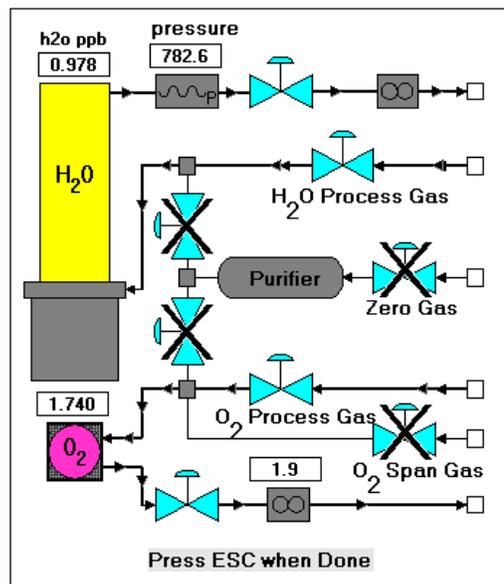


Figure 118: Gas Delivery System Status

7.7.4.1 Back Flow Prevention System

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

During normal operation the gas flow is constantly monitored by a flowswitch mounted in the bypass loop that is set to trip when the flow drops below .1 lpm. In the event that flow is reduced, the switch will automatically isolate the gas panel valves. In addition the pressure reading will be forced to zero. When the system detects a zero pressure reading a message will be displayed which states that backflow prevention is engaged and to check sample and bypass flow. See Figure 119. The analyzer will remain in isolation and the user will not have control of any valves at this point.

CAUTION



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

The user must determine the cause of the loss of gas flow and remedy the situation. When flow has been restored to the analyzer the pressure reading will go to a non-zero value and a message will be then appear stating that sample flow has been restored and to wait five minutes to restore internal sample flow to the sensors. See Figure 120.

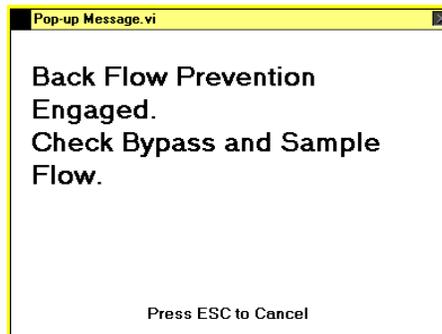


Figure 119: Back Flow Prevention Warning

A five minute timeline is displayed and the user will still not have valve control until the five minutes are up. During this time, the **ESC** key may be hit to cancel the five minute delay and return control to the user. Once the Esc key is hit, or the five minute waiting period has expired, all remaining messages are cleared from the screen and the system will remain in isolation until the user restores flow. See page 103 for additional information on restoring gas flow.

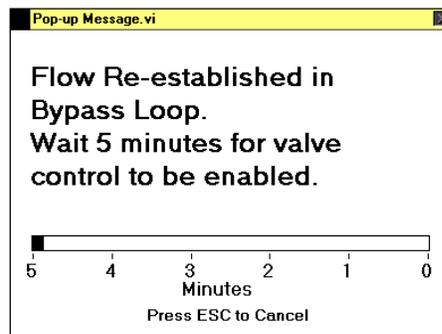


Figure 120: Re-established flow delay

This event will trigger a system alarm (192) for the moisture cell. See page 60 for additional information on system alarms.

7.7.5 Adjust Contrast

The Adjust Contrast screen enables the user to modify the contrast of the front display screen. From the **System** menu, select **Adjust Contrast**. Use the up and down arrows (▲ and ▼) as indicated to make adjustments. Hit **ESC** on the key pad when done.

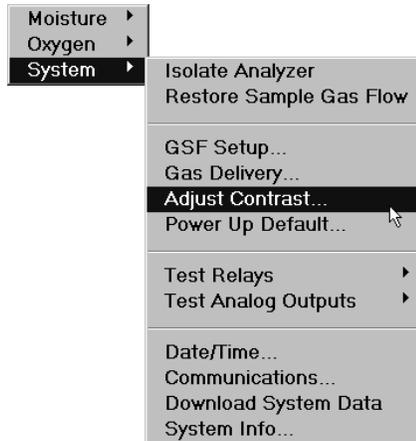


Figure 121: Adjust Contrast

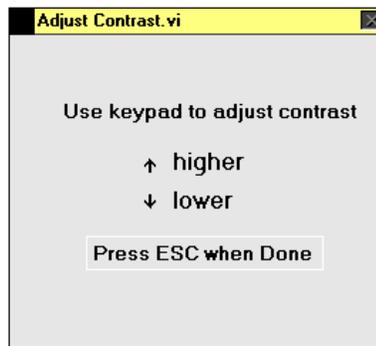


Figure 122: Adjust Display Contrast Screen

7.7.6 Power Up Default

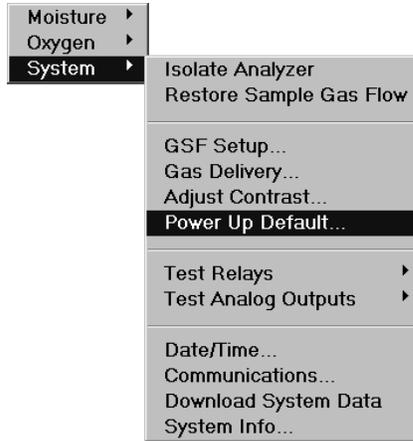


Figure 123: Power Up Default

The Power Up Default SubRoutine enables the user to determine the default states during analyzer power up. The power up states are useful because they determine whether, for instance, the sensors are protected from ambient air contamination or whether they are configured the best way for rapid station to station transfer and measurement.

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

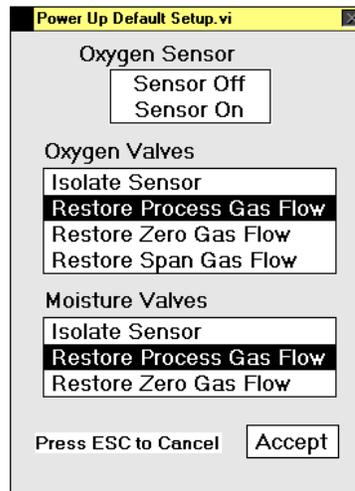


Figure 124: Power Up Default Screen

NOTE: If the analyzer auto-reboots due to a system error 20006, the power-up defaults are ignored and the analyzer returns to the mode of operation found immediately before the error. This reboot action is identified in the system error log as an error 222. See page 60 for additional information on system error codes.

7.7.7 Test Relays

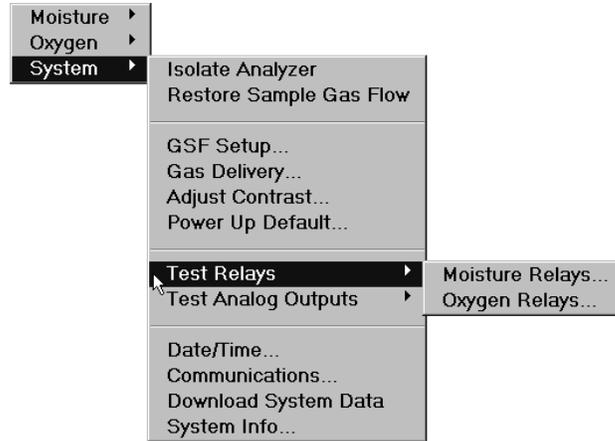


Figure 125: Test Relays Menu

7.7.7.1 Test Moisture Relays

The **Test Relays** screen, as shown in Figure 126, is used to assure that the moisture relays numbered 1 – 4 are functioning properly. When the Test Relays screen is selected, the NEXT key is used to move to the number field where the arrow keys (▲ and ▼) are used to choose the appropriate relay number. The NEXT key is then used to move to the Activate/Deactivate field where the arrow keys (▲ and ▼) are used to toggle between the two options. The NEXT key is then used to move to the Apply field where the Enter key is hit to change the relay state. This process can be repeated as often as needed. When done, the NEXT key is used to move to the Done field and the Enter key is hit to leave the screen. The condition of the relays before the test is restored when the test is concluded. See the section on relay ports found on page 43 for additional information.

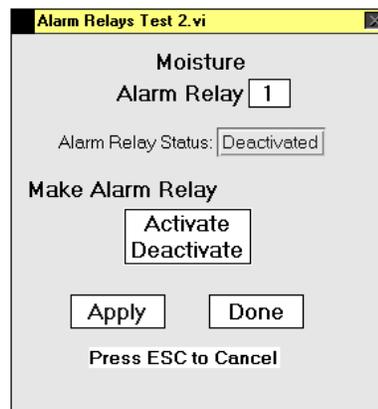


Figure 126: Test Moisture Relays

7.7.7.2 Test Oxygen Relays

The **Test Relays** screen, as shown in Figure 127, is used to assure that the oxygen relays numbered 5 – 8 are functioning properly. When the Test Relays screen is selected, the NEXT key is used to move to the number field where the arrow keys (▲ and ▼) are

used to choose the appropriate relay number. The NEXT key is then used to move to the Activate/Deactivate field where the arrow keys (▲ and ▼) are used to toggle between the two options. The NEXT key is then used to move to the Apply field where the Enter key is hit to change the relay state. This process can be repeated as often as needed. When done, the NEXT key is used to move to the Done field and the Enter key is hit to leave the screen. The condition of the relays before the test is restored when the test is concluded. See the section on relay ports found on page 43 for additional information.

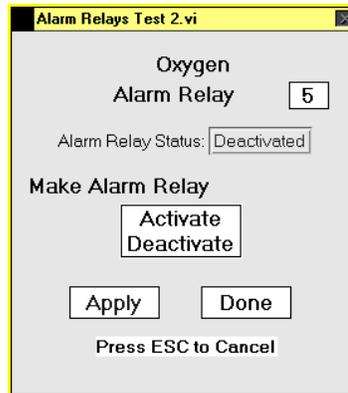


Figure 127: Test Oxygen Relay

7.7.8 Test Analog Outputs

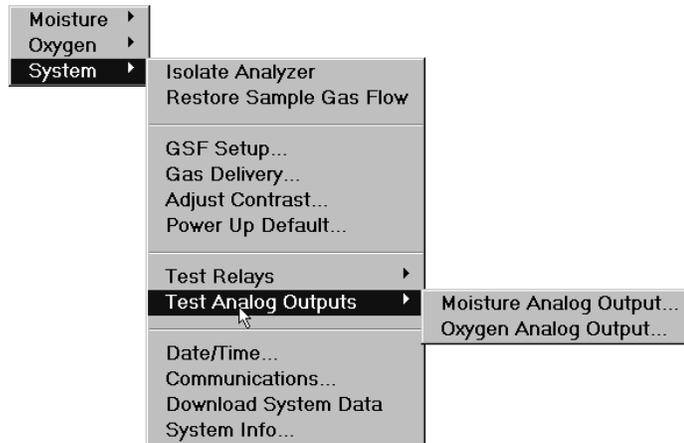


Figure 128: Test Analog Outputs Menu

7.7.8.1 Test Moisture Analog Output

The Test Output screen, as shown in Figure 129 is used to calibrate the moisture analog recorder output. When the Test Output screen is selected, the NEXT key is used to move to the percentage field where the arrow keys (▲ and ▼) are used to choose the appropriate setting. The NEXT key is then used to move to the Apply field where the Enter key is hit to set the analog output to the selected value. The analog output response should match the value that was entered. For example, if 80 percent is entered for the percent full scale level, and the analog output is set for 0 to 10 VDC, the analog output is

8.000 VDC. This process can be repeated as often as needed. When done, the NEXT key is used to move to the Done field and the Enter key is hit to leave the screen. The condition of the analog output before the test is restored when the test is concluded. See the section on analog outputs found on page 42 for additional information.

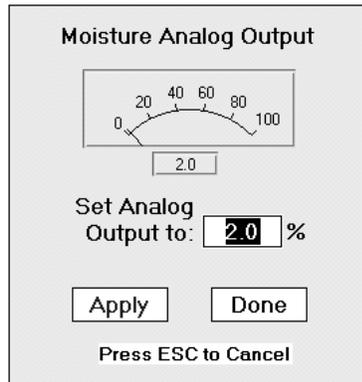


Figure 129: Test Moisture Analog Output

7.7.8.2 Test Oxygen Analog Output

The Test Output screen, as shown in Figure 130 is used to calibrate the oxygen analog recorder output. When the Test Output screen is selected, the NEXT key is used to move to the percentage field where the arrow keys (▲ and ▼) are used to choose the appropriate setting. The NEXT key is then used to move to the Apply field where the Enter key is hit to set the analog output to the selected value. The analog output response should match the value that was entered. For example, if 80 percent is entered for the percent full scale level, and the analog output is set for 0 to 10 VDC, the analog output is 8.000 VDC. This process can be repeated as often as needed. When done, the NEXT key is used to move to the Done field and the Enter key is hit to leave the screen. The condition of the analog output before the test is restored when the test is concluded. See the section on analog outputs found on page 42 for additional information.

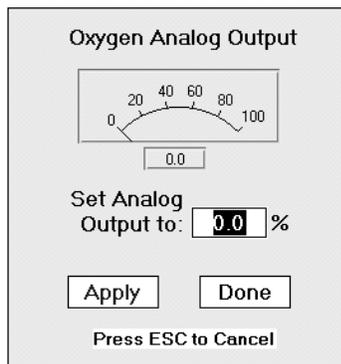


Figure 130: Test Oxygen Analog Output

7.7.9 Date/Time

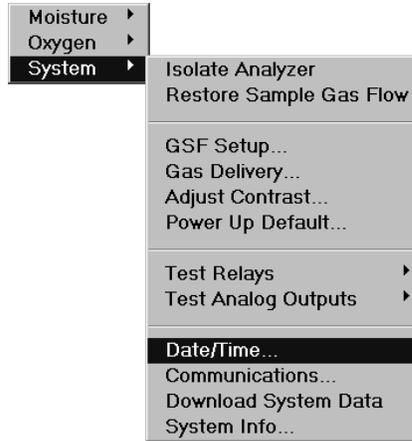


Figure 131: Date/Time

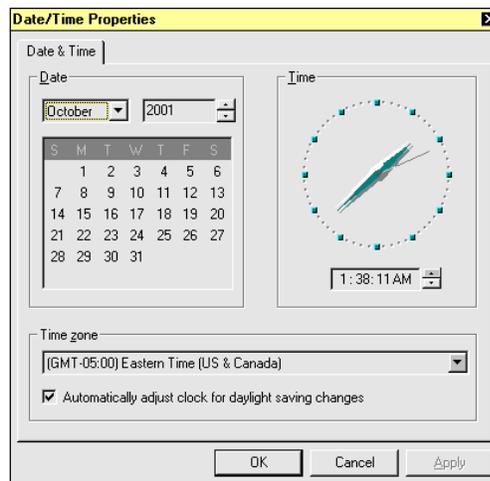


Figure 132: Date/Time Setup Screen

Accessed from the **System** menu, the Date/Time Screen is used to set various calendar and clock related parameters.

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

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

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

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

7.7.10 Communications

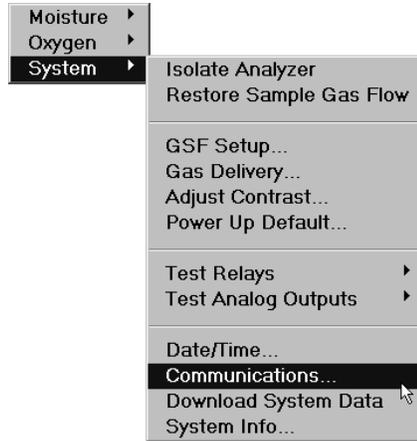


Figure 133: Communications

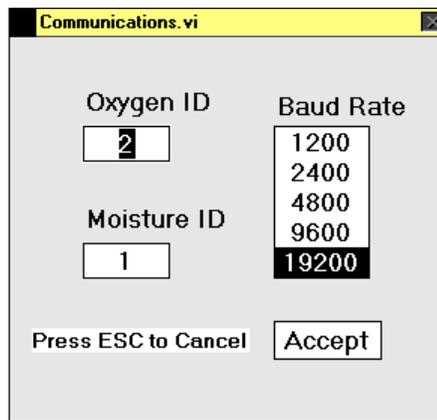


Figure 134: Communications Setup Screen

The Communications screen is used to set parameters related to serial PC communications. Accessed from the **System** menu, the **Next** key is used to moved 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 41 for additional information.

7.7.11 Download System Data

In the event that problems develop with the analyzer, the contents of the internal system data files can easily be downloaded to a USB memory stick (Flash Drive) and the files can either be mailed or e-mailed to Servomex for evaluation. Install a memory stick into the external USB port that is located behind the front door and on the left side of the analyzer. After selecting Down Load System Data, hit **Enter** and Figure 136 will appear.

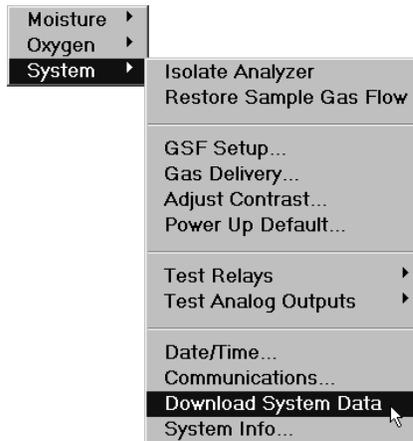


Figure 135: Download System Data

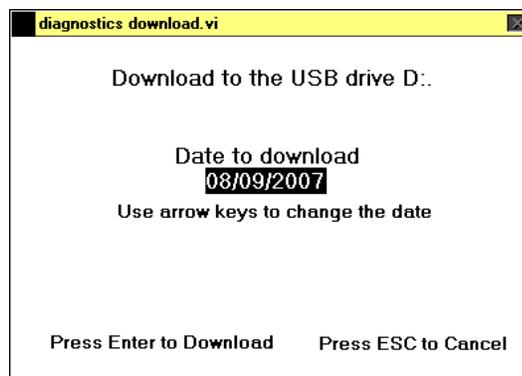


Figure 136: Insert Media

The system downloads data for ten days ending with the date set on the screen as shown in Figure 136. 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 **▼**).

Hit **Enter** and the download process will begin and a time bar will appear as in Figure 138. The process should only take a minute or two and when complete control will be returned to the user.

If there is insufficient space available on the media a warning will appear as in Figure 137

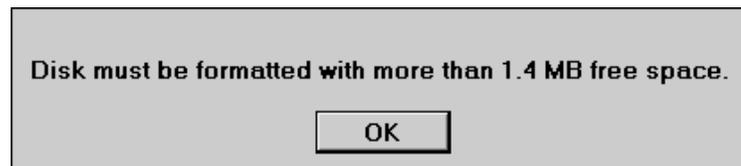


Figure 137: Media Warning

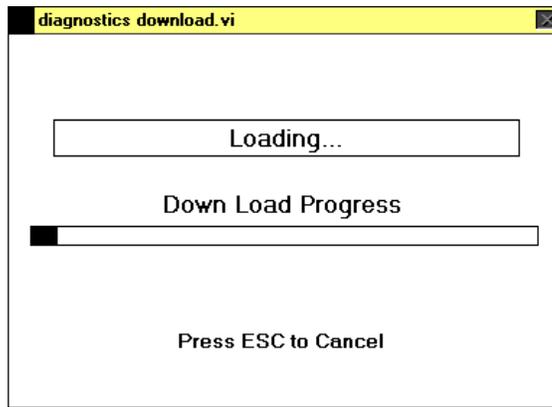


Figure 138: Download Time Line

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 diskette, which can then be used to forward the information to Delta F for evaluation.

7.7.12 System Info

The System Info screen gives the user information regarding the configuration of the analyzer as well as the version of firmware currently installed. The Service Menu is password protected. Contact the factory regarding this function.

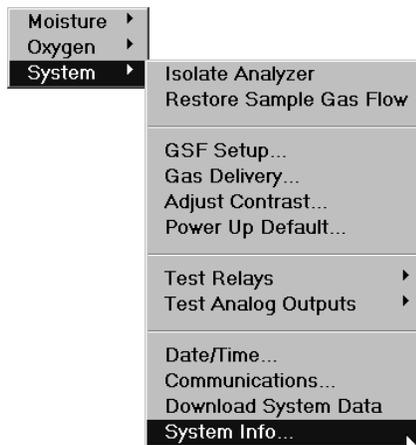


Figure 139: System Info

7.7.12.1 Firmware Upgrade

While the Firmware Upgrade box is highlighted, hitting the Enter key will bring up the Firmware Upgrade dialog box as in Figure 141 below.

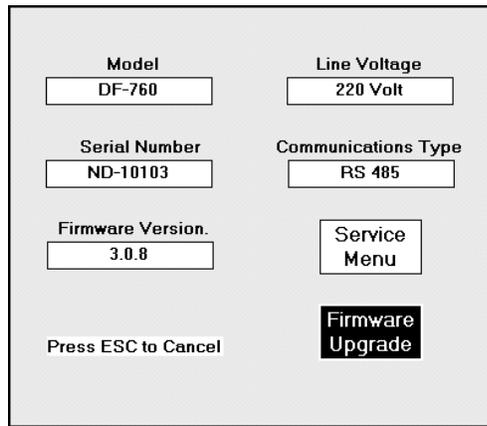


Figure 140: System Info Screen



Figure 141: Firmware Upgrade

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

8 Sample Gas Preparation and Delivery

8.1 Introduction

The DF-760 consists of two separate analyzers, joined together by a common gas delivery system. It is important to note key differences in the method of operation of each analyzer to ensure a properly functioning system. Parameters such as flow, pressure, and background gas will have major effects on total system performance.

8.2 Sample Flow Rate and Pressure

8.2.1 Moisture

Proper moisture analyzer operation is dependant upon the pressure of the sample gas. For each sample gas, there is a unique pressure range that the analyzer must operate under. See Table 10 for the proper settings. Proper analyzer operation is contingent upon maintaining the sample pressure for a given background gas within this range. The pressure can be adjusted by balancing the inlet regulator setting with the throttling valve in the aspirator or, if equipped, with the needle valve in the vacuum pump assembly. When adjusting sample pressure, be aware of the effects on the oxygen sensor that is sharing the feed.

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

Table 10: Sample Outlet Pressure

8.2.2 Oxygen

The oxygen sensor is factory calibrated at a flow rate of 1.0 slpm, in N2, and should be operated at that level for optimal accuracy. However, the oxygen sensor is relatively unaffected by gas sample flow rate, within limits. Sample flow rate should be maintained within the recommended range of 0.5 to 1.5 slpm as indicated on the front panel display. The oxygen sensor can be operated at flow rates outside that range, but it should be recalibrated at that different flow rate to maintain optimal accuracy.

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

8.3 Flow Rate Effects on Sensor Performance

8.3.1 Moisture

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

8.3.2 Oxygen

In a leak-free system, higher flow rates may cause O₂ readings to increase by a few percent of reading above the level that would be displayed if flow was within the recommended 0.2 to 0.3 slpm range. Lower flow rates similarly cause O₂ readings to decrease by a few percent of reading.

The relative insensitivity to flow rate changes is the basis for the sample system leak detection described below. It is recommended that the oxygen sensor, rather than the moisture cell be used for leak-detection, due to the higher presence of oxygen in ambient air as well as the faster response of the oxygen sensor to small changes in concentration. The sensor output should be virtually constant for readings between 0.1 and 0.3 slpm. Therefore, if O₂ readings become higher at lower flows, then ambient O₂ is leaking into the sample system, or venting from a dead space (closed pocket with trapped higher O₂ level gas) in the sample system. A higher flow rate dilutes the O₂ entering the sample system decreasing the reading. O₂ readings in a leak free sample system should not go up or down significantly with flow changes between 0.1 and 0.3 slpm.

8.3.3 Checking for Plumbing Leaks using Flow Rate Effects

Significant measurement error can be caused by leaks in the plumbing system. A simple test of analyzer as well as overall system integrity can be performed to identify leaks.

Observe the analyzer oxygen readout at two flow levels: 0.2 and 1.5 slpm. Only a slight increase, if any, in readout will occur in a tight system as the flow is increased. If leakage in the plumbing system exists, then the increased flow results in a substantial decrease in oxygen readout -- typically dropping by 25 to 50 percent.

As time passes, in a tight system, any sensitivity to flow should minimize as the system purges of trapped oxygen.

When flow sensitivity is observed, check the external plumbing for leaks. Familiarity with this process can result in the ability to actually estimate the distance from the analyzer to the leak by the amount of time the change in flow rate effects the oxygen reading.

WARNING



Always maintain a minimum of .25 lpm flow through the bypass when doing a flow sensitivity test.

8.4 Sample Gas Scale Factor

The Gas Scale Factor (GSF) is used to correct for effects when background gases other than nitrogen are present in the sample stream. The Sample GSF can be adjusted by entering the composition of the background gas in percent for either oxygen or moisture in their respective menus. In the case of the oxygen sensor, the GSF corrects for the difference in the diffusivity of oxygen with respect to the particular background gas. For information on setting the oxygen GSF see page 103. In the case of the moisture cell, the effects of molecular interactions are accounted for. For information on setting the moisture GSF see page 103.

8.4.1.1 Disclaimer

The method used to correct the oxygen calibration of the DF-760 Moisture/Oxygen Analyzer for measurement in non-nitrogen background gases is derived from well-known theoretical equations.

Although significant empirical work has been done in this field, it is generally accepted that the equation may be only 85-90 percent accurate. In addition, there is further error introduced when correcting for a "multi" component background gas. This may result in up to an additional 3-5 percent error.

An alternate method when using a non-nitrogen or "multi" component background gas for spanning is to obtain a certified Calibration standard that has been prepared in a background gas that models the average process sample. Care must still be used, however, as certified standards may also have an inaccuracy associated with them.

Questions regarding the calculation of a background gas correction factor for a specific application should be directed to Servomex.

8.4.2 Background Gas Effects on Indicated Flow Rate

If the molecular weight of the background gas is significantly different from N_2 , the indicated flowrate as displayed on both the bypass flowmeter and the front panel display will not be accurate. The flowmeters used in the DF-700 series analyzers are calibrated for use in air (or N_2). Most other gases have molecular weights within ± 25 percent of air. Since the required flow rate is not extremely critical most gases produces reasonably correct readings. The exceptions are light gases such as Helium and Hydrogen whose flow rates should be set to approximately one-third that of Nitrogen.

8.4.3 Pressure Effects on Oxygen Sensor Performance

If the analyzer is not vented to atmosphere, the oxygen sensor pressure is influenced by the conditions downstream of the analyzer. A recalibration under your operating conditions may be desirable to remain within the stated accuracy specifications. However, in most cases the error introduced is relatively small, and may not affect the process application.

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

8.4.4 Sample Outlet Backpressure Effects

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

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

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

8.4.5 Flammable Sample Gas

There is nothing within the analyzer sample system that can ignite a flammable sample gas. However, it is critical to ensure that the sample gas does not escape from the sample system into the analyzer enclosure, or the room, where ignition is possible.

Also, the analyzer enclosure can be purged with nitrogen, or the entire Analyzer can be mounted in a purged enclosure, so that any sample gas that escapes the plumbing is diluted. Servomex does not provide an analyzer equipped with these protective features. Note that these methods may not be compliant with local or national requirements in your country. Ensure that you comply with all necessary regulations and standards.

8.4.6 Sample Gas Temperature

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

The analyzer has software to correct the sensor output for sensor temperature changes. Temperature compensation adjustments apply to temperature drift only when the oxygen level is below 10 ppb. Ideally, the analyzer should be operated at a nominal temperature of 70° F. Calibration temperature should be close to operating temperature. If the analyzer is to be operated at an average ambient temperature outside 65° F to 80° F, it should be recalibrated at the operating temperature for optimal performance.

NOTE



The temperature can be displayed at any time by accessing the Diagnostics Menu for either the Moisture or Oxygen sensors. This temperature value is updated at intervals of 15 to 45 seconds.

8.4.7 Protecting the Analyzer from Process Upsets

The analyzer should be protected from extended exposure to high concentrations of oxygen or hostile gases. Automatically controlled solenoid valves should be installed to switch the analyzer over to an N₂ purge when the process reaches some identifiable condition.

Gas line maintenance operations must also be examined for their effect on the analyzer. For example, in many pipeline process or normal gas applications the plumbing system is cleaned with either a liquid solvent or detergent solution. Since either causes damage to the sensor, switch the analyzer over to a N₂ bypass purge, or shut off sample flow and power to the analyzer prior to initiating the potentially hazardous process.

9 Service

9.1 Return Material Authorization number

If the analyzer is being returned to the factory, call to 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

9.2 Cautions Related To Maintenance

CAUTION: HAZARDS AFFECTING SERVICE PERSONNEL



Service personnel perform activities that expose them to hazards, such as electrolyte filling, disconnecting pressurized sample and vent lines, replacing power cords, and replacing fuses. Read section **2.2 Important Warnings** 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. Make sure that the oxygen sensor cap is tight. Make sure that internal and external fittings are connected properly and tightened adequately. Make sure that inlet and outlet valves are in the appropriate position for normal operation. Make sure that 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.

9.3 Maintenance

9.3.1 Oxygen Calibration

All NanoTrace Dual Moisture/Oxygen Analyzers are calibrated with certified gas standards at the factory prior to shipment. If the analyzer is operated within its specified conditions, no initial calibration is required upon receipt from the factory.

Depending upon the nature of the application, Delta F suggests verifying the span calibration of the analyzer approximately every 12 months using a gas with a known level of oxygen. Span checks can be performed with gases in the range of 0 to 10 ppm. However, reliable standard gas mixtures are readily available in the 4-7 ppm range.

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

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

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

Oxygen Zero Check Frequency Guidelines		
Typical Reading	Maximum O ₂ Impurity	Zero Check Frequency
1.0 ppb and greater	10 ppb	Once every month
0.2 to 1.0 ppb 5 ppb Twice per month	5 ppb	Twice per month
0 to 0.2 ppb 1 ppb Once per week	1 ppb	Once per week

Table 11: Zero Check Frequency

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

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

NOTE



If the Active Zero Offset feature is in use, and the “Cal Zero” message appears on the display, it is mandatory to do a zero calibration.

9.3.2 Storage Conditions

If the analyzer is to be stored for extended periods of time, be sure that the temperature of storage location does not exceed 50° C (122° F). Storage in direct sunlight can cause

temperatures to exceed the recommended limits even though ambient temperatures may be below the maximum temperature.

Store the analyzer with the electrolyte removed from the sensor.

9.3.3 Oxygen Sensor Maintenance

The analyzer does not require routine maintenance other than the addition of Replenishment Solution to the oxygen sensor. Exposure to dry gas for an extended time gradually extracts water from the sensor. The electrolyte level needs to be replenished occasionally.

CAUTION



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

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

One bottle of \mathcal{E} -Lectrolyte Gold contains 130 cc. This quantity is sufficient for satisfactory operation. It is not necessary to add additional solution.

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

The Oxygen Analyzer is equipped with an Electrolyte Condition alarm to indicate that the electrolyte level is low. The operation of this alarm is described in the *Alarms* section on page 96.

9.3.4 Procedure for Adding Replenishment Solution to the Oxygen Sensor

The procedure to add replenishment solution to the sensor is as follows:

1. Open the front door.
2. Unscrew the sensor cover. Remember, the electrolyte is caustic; be careful of drips of electrolyte from the cover.
3. Add replenishment solution using the supplied squeeze bottle. Fill to the max level indicator line on the reservoir label. Be careful not to spill the solution on the electronics or on the outside of the sensor. **Do not overfill.**
4. Replace the oxygen sensor cover securely.
5. Close the front door.



For best performance at initial start or anytime the electrolyte is changed, it is important to allow the sensor to sit with electrolyte in it for 60 minutes *before* the gas is allowed to flow through the sensor, or power is connected.

NOTE



When an Analyzer is operating at low ppb levels, adding solution to the electrolyte level may result in a temporary increase in the oxygen reading due to the presence of dissolved oxygen in the solution and the introduction of oxygen due to agitation. More frequent additions (using smaller quantities of solution), and adding solution with minimal disturbance to the electrolyte in the reservoir, minimizes this effect and the resulting potential temporary interruptions in service.

9.3.5 Moisture Cell Maintenance

None required.

9.3.6 Vacuum Pump Maintenance

If equipped, the vacuum pump requires periodic maintenance every 6 – 12 months in order to maintain proper pressure and individual installations will ultimately determine the appropriate maintenance interval. A good working pump will pull down to approximately 120 torr or less when the moisture cell is isolated. But when pump performance degrades to the point that proper pressure cannot be attained a significant improvement in performance can often be achieved by simple cleaning of the cylinder and piston assembly. A rebuild kit is available from Servomex to return the pump to original specifications. See the list on page 133 for cleaning fluid and rebuild kit part numbers.

9.3.6.1 Cleaning Vacuum Pump Piston and Cylinder Assembly

1. Disconnect power and vent all lines
2. Remove head bolts, head, gasket and valve plate assembly (note orientation of head)
3. Remove cylinder and shims.
4. Clean residue from walls using a soft cloth and non-petroleum, non-oil based solvent.
5. Replace cylinder including all shims. Be sure to orient the shims exactly the same as they were removed.
6. Install valve plate, head gasket and head
7. Install head bolts and torque to 80 in-lbs.

9.3.7 Gas Purifier Maintenance

The Gas Purifier removes oxygen from typical trace level sample gas stream to provide sub-ppb oxygen concentrations for use as a zero reference gas during Analyzer calibration.

Calibration systems are supplied with a 3000 ppm-hr purifier. Replacement purifiers can be ordered from Servomex.

NOTE



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

9.3.7.1 Determining When to Change the Purifier

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

There are two observable signs of breakthrough:

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

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

1. Establish a stable oxygen reading by diverting the low ppb process gas through the gas purifier at a flow rate of 0.5 slpm.
2. Increase the flow rate to 2.0 slpm. If after several minutes, there is an increase in the analyzer's reading, replace the purifier.

9.3.7.2 Preparation for Gas Purifier Installation or Replacement

NOTE



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

Removal and installation requires the following tools and parts:

- 5/8 – inch open end wrench (for plumbing caps on initial installation)
- 1 3/8 -inch open end wrench (for purifier body)
- 3/4 -inch open end wrench (for VCR fitting on calibration panel)
- Two VCR-type gaskets and retainers Servomex P/N 210431 or Cajon P/N SS-4-VCR-2-GR



Extreme caution must be used when loosening and tightening the fittings on the purifier. In particular, care must be taken to avoid contacting the delicate electrical connections on the side of the oxygen sensor with the wrenches.

9.3.7.3 Gas Purifier Installation/Replacement Procedure

NOTE



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

1. Shut off the vacuum source and wait 5 minutes for the pressure to equalize. *In order to minimize the possibility of an ambient intrusion it is critical that the pump not be running.*
2. Using the moisture gas valve control screen (see page 49) start the gas flow through the zero purifier.
3. Write the installation date on the gas purifier label.
4. Install new gaskets and retainers on the purifier. Gently replace the cap nuts on the purifier to minimize exposure to ambient air.
5. Open the door and locate the purifier position. See page 21.
6. If installing a new purifier at initial startup, remove the VCR plugs installed in the plumbing system allowing gas to escape from the lower plug.
7. If replacing a spent purifier, remove the purifier allowing gas to escape from the lower fitting.
8. Remove both VCR-type cap nuts from the new purifier and quickly install the purifier **with the arrow pointing up**. It may be necessary to slightly spring the calibration system plumbing to insert the gas purifier. Be sure not to scratch the gasket surfaces.
9. Screw the fitting nuts at both ends finger-tight allowing gas to escape for two minutes.
10. Using a backup wrench tighten the nut at the bottom of the purifier 1/4 turn beyond finger-tight and allow the gas to escape from only the top fitting for an additional two minutes. Then tighten the top fitting 1/4 turn beyond finger-tight.
11. Continue to allow the gas to flow through the purifier for 24 hours or until the original analyzer reading is achieved.

After installation is complete, low ppb process gas must be allowed to flow through the gas purifier to purge ambient gas from the gas lines and valves. Effective purging of the system can be accomplished by repeatedly opening and closing the valves in the process and zero legs to start and stop the flow of gas. To automate this purge process see the purifier purge routine found in the diagnostics menu (see page 68).

NOTE



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

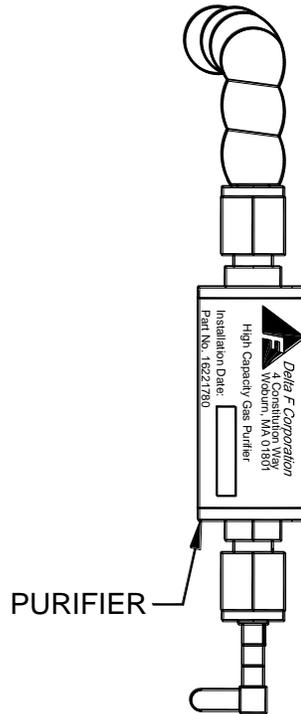


Figure 142: Gas Purifier Installation

NOTE



Proper purging of the purifier after installation is critical to proper operation of the calibration system.

9.3.8 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.

Mains fuses are located in the AC inlet module. Facing the AC inlet there is a tab, on the left side of the inlet, that is pried to open the fuse cover. Gently pry the tab with a straight blade screwdriver, being careful not to damage the tab. The cover will flip open to expose a red fuse carrier. Use the screwdriver to pry the fuse carrier out of the AC inlet. Both sides of the AC line are fused. Note the position of the two fuses. This fuse carrier can accommodate different length fuses, and it is important to install the new fuses in the same position as the original fuses.

Replacement fuses may be purchased from Servomex (See replacement parts list, section 9.4) or purchase the following:

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

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

9.3.9 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 as long as 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 as long as 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.

9.4 Replaceable Parts List

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

PART NO.	PART DESCRIPTION
	<u>Printed Circuit Boards</u>
210574	Oxygen Board
210867	Moisture Board
212652	Front Display
	<u>Hardware Items</u>
210462	Oxygen Sensor
Electrolyte Gold	Electrolyte Solution
210515	Replenishment Solution
211278	Vacuum Pump – 110 VAC
210606	Vacuum Pump – 240VAC
210588	Vacuum Pump Rebuild Kit
211284	Vacuum control needle valve
210592	Purifier – Black Label
210933	Gas Panel Ass'y with heater – w/o purifier
210398	Cap, Gold, Oxygen sensor
210432	VCR Filter Gasket
210431	VCR Gasket
211134	Fuse 6.3 Amps (110VAC)
211133	Fuse 3.15 Amps (220VAC)
211531	Power Cord – 110 VAC
210597	Linear Power Supply
211156	Switching Power Supply
211169	USB Memory Stick (Flash Drive)
210566	Aspirator

Table 12: Replaceable Parts List

9.5 Troubleshooting Guide for the NanoTrace Dual Analyzer

9.5.1.1 Oxygen Troubleshooting

Observation	Possible Remedy (see Key below)
Analyzer reads Over-Range	Y, C, Q, I
Analyzer spikes excessively when moved using portable feature	B, J, I
Analyzer output has unacceptable peak-to-peak noise	J, H, X, I
Zero baseline gradually drifting positive	G, A, B, C, D, Q, H, AB, I
Zero baseline gradually drifting negative	P
Zero baseline high, but stable (> 15 ppb above factory zero)	G, A, B, C, D, E, Q, AB, I
Very slow analyzer purge down (doesn't drop below 10 ppb in 7 days)	G, A, B, C, D, E, Q, H, AB, I
Zero baseline drifting up and down (exclusive of temperature)	H, Q, I
Repetitive negative spiking	J, X, Z, A, B, C, D, E, Q, H, I, AA
Repetitive positive spiking	J, X, Z
O ₂ reading is drifting excessively with ambient temperature (> 0.3 ppb/C)	E, G, P, R, AB, I
Electrolyte Condition Alarm ON	A, N, C, D, H, I
O ₂ reading does not decrease upon switch to on-board Delta F purifier (Assumes sample gas contains some O ₂)	O
Span reading is unacceptably high (> 50% high)	T, V, S, I
Span reading is unacceptably low (> 50% low)	T, S, I, H
Unacceptably Slow Speed of Response	L, G, H, I
Analyzer indicates high temperature	AB, I

9.5.1.2 Key:

A	Add Delta F Replenishment Solution if level is near or below "MIN" mark
B	Remove some electrolyte if level is near or above "MAX" mark
C	Measure applied voltages on electrode pairs:
	Sensor Electrodes (wht/yel* and wht/red/blk) 1.300 ± 0.005 VDC
	Secondary Electrodes (wht/blue* and wht/red) 2.1 ± 0.3 VDC
	Stablex Electrodes (white* and blue) 1.55 ± 0.005 VDC
	* is the common lead of the voltmeter.
D	Measure the DC currents on electrode pairs: Secondary Electrodes 2.0 ± 0.2 mADC (disconnect wht/red wire at reservoir terminal, and insert ammeter between wht/red wire and reservoir terminal) Stablex Electrodes < 13 uADC (disconnect white wire at reservoir terminal, and insert ammeter between white wire and reservoir terminal)
E	Check sensor temperature in Diagnostics Menu. It should be approx. equal to the current ambient temperature.
G	Perform the low flow leak test: Obtain stable oxygen readings at flow = 2.0 scfh and flow = 1.0 scfh. The reading at flow = 1.0 scfh should be no more than 2 ppb higher than that at 2.0 scfh. Locate and fix any ambient leaks upstream of the analyzer. See page 120.

H	Empty electrolyte, rinse sensor thoroughly with DEIONIZED water, and refill sensor with fresh electrolyte. Allow the sensor to sit for 60 minutes before flowing gas or powering up. Restart analyzer on zero gas and allow a minimum of 4 days for the analyzer to purge down.
I	Contact the Servomex Customer Support for additional assistance with the results of the troubleshooting.
J	Adjust Filter Settings to Ultra Low LDL. Transient Rejection ON.
L	Adjust Filter Settings to Normal, Transient Rejection OFF
N	Make sure sensor cap is secure.
O	Check for purifier breakthrough. With the on-board purifier in-line, obtain stable oxygen readings at a flow rate of 2.0 scfh and at a flow rate of 0.5 scfh. The reading at 2.0 scfh should not be higher than the reading at 0.5 scfh. If it is, replace the purifier.
P	This is typical Analyzer behavior following a start-up. Perform a Manual or Auto Zero Calibration.
Q	Examine outside of sensor for evidence of electrolyte residue.
R	Quantify the drift effect with temperature changes (identify a \pm correlation). Appropriately adjust the temperature compensation set point.
S	Make sure the span background gas is properly accounted for using SPAN GSF in the menu.
T	Check the accuracy and age of the calibration reference cylinder.
V	Perform a low flow leak test while the span gas cylinder is connected. Obtain a stable reading at a flow rate of 2.0 scfh and at a flow rate of 0.5 scfh. Reading should be lower at 0.5 scfh. If not, investigate for leakage and fix.
X	Remove any devices being driven by the analyzer output, i.e. chart recorders or Data Acquisition Systems. Also disconnect anything controlled by the analyzer alarm relays. Verify proper operation with these devices removed.
Y	Verify that a flow rate of 2.0 scfh of zero gas has been established. Allow 10 minutes time after zero gas connection to come on scale.
Z	Assure that spiking is not due to EMI (i.e. radio communications).
AA	Remove any devices downstream of the analyzer which may cause backpressure.
AB	Make sure the fan is operating and proper ventilation exists.

9.5.1.3 Moisture Troubleshooting

The DF-700 series moisture analyzer constantly performs internal monitoring of the analyzer operation. In the event of a failure a system alarm will be displayed on the front panel. In addition, the failure will be logged in the System Error Log (see page 60). 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 on page 68.

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 in order to prevent damage to the analyzer during shipment.

CAUTION



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

CAUTION



Shipping regulations require that the zero gas purifier be packaged separate from the analyzer. As a result it must be removed before analyzer shipment. See page 129 for instructions.

1. Isolate the analyzer gas path properly by following the steps on page 102.
2. Turn off the power switch. Disconnect any source of AC power from the analyzer.
3. Disconnect all external electrical connections (alarms, data output, communications etc.).
4. Mark each for reattachment later.
5. Following the procedure below remove the oxygen sensor and drain the electrolyte.
 - a. Using 5/8 and 7/8 inch open wrenches, very carefully disconnect the gas inlet.
 - b. Using two 7/16 inch open wrenches, very carefully disconnect the gas outlet.
 - c. Separate the electrical connector in the cable harness.
 - d. Loosen the two thumb screws and carefully pull the sensor forward and out of the cabinet.
 - e. Remove the cap and carefully dispose of the electrolyte according to local codes.
 - f. Thoroughly rinse the sensor with water.
 - g. Replace the cap and re-install the sensor by reversing steps d through a above.
6. Ensure that all internal components are adequately secured and put the analyzer in its original container.

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

10 Theory of Operation

10.1 The Oxygen Measurement

10.1.1 The Oxygen Sensor

The sensor in the NanoTrace Dual Analyzer operates on a Coulometric principle. Oxygen in the sample gas is reduced in an electrochemical reaction that results in a measurable current flow. The use of this technique is widely recognized for its ability to provide a precise oxygen measurement. A schematic of the sensor configuration is shown in Figure 143.

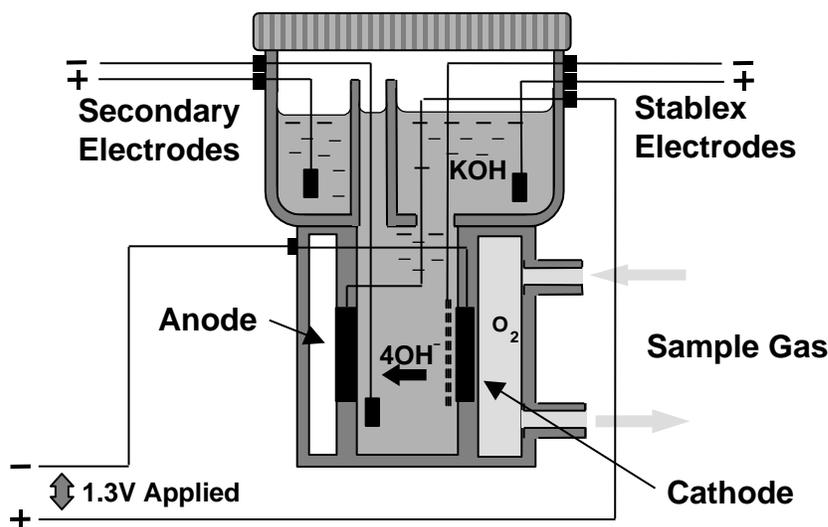


Figure 143: Schematic of NanoTrace Dual Oxygen Sensor

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

10.1.2 The Oxygen Electrolyte Conditioning System

The oxygen sensor in the NanoTrace Dual Analyzer is equipped with Servomex's patented electrolyte conditioning system and is composed of two specialized electrode pairs.

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

The Stablex electrode pair effectively isolates the sensor cathode from the interference caused by oxygen that is dissolved in the electrolyte. The Stablex cathode, located directly in front of the sensor cathode, removes dissolved oxygen. Stablex provides an active dissolved oxygen barrier and removes the need to sparge the electrolyte. (Sparging involves bubbling pure nitrogen through the electrolyte and it causes significant levels of electrochemical interference to the oxygen measurement process)

10.2 The Moisture Measurement

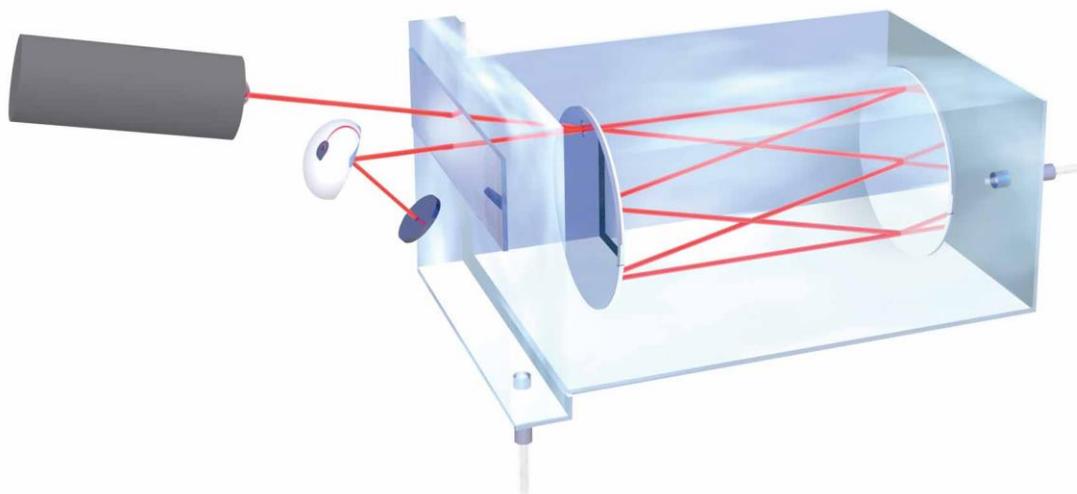


Figure 144: Schematic of Moisture Cell

10.2.1 Moisture and the IR Spectrum

The NanoTrace Moisture Analyzer uses infrared (IR) absorption as its detection method. IR absorption is but a subset of the overall field of “spectroscopy,” which measures the interaction of light and matter.

The basis of absorption spectroscopy is when an electromagnetic wave (i.e., the scientific description of “light”) with a particular wavelength impinges on a substance that absorbs a fraction of the total electromagnetic radiation. The wavelength of radiation is well known, for instance, in differentiating colors in the visible light spectrum.

In the infrared spectral region, the wavelength of light overlaps with discrete 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. Conversely, if the strength of a single vibrational absorbance is known, a single wavelength is often used to determine the amount of a particular substance. This is how we measure moisture.

10.2.2 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:

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

A_{λ} \equiv Absorbance at wavelength λ

T \equiv Transmittance

I_0 \equiv Reference Intensity of Light

I \equiv Measured Intensity of Light after Absorption

ϵ_{λ} \equiv Molar Absorptivity at wavelength λ

b \equiv Path length

C \equiv Molar concentration

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

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

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

σ_{λ} \equiv Molecular Cross Section ($\text{cm}^2/\text{molecule}$) 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). In gases, this concentration is also known more specifically as parts per billion in volume PPB_v .

11 Safety

11.1 General Warnings

Refer to section **2.2 Important Warnings** for a full list of safety warnings.

DANGER



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

CAUTION



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

CAUTION



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

DANGER



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

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

CAUTION



Over-pressurizing the oxygen sensor can result in permanent damage to the sensor. Limit the backpressure to the analyzer to ± 1 psig (± 0.7 barg).

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

CAUTION



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

EMI DISCLAIMER



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

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

11.2 Material Safety Data Sheet (MSDS) for Electrolyte Solution

1. IDENTIFICATION OF THE SUBSTANCE

Trade Name Electrolyte Solution, *E*-electrolyte Gold, *E*-electrolyte Blue, *E*-electrolyte Black, DF-E05, DF-E06, DF-E07, DF-E09

Manufacturer Delta F Corp., 4 Constitution Way, Woburn, MA 01801-1087, USA, Tel + 1-781-935-4600

Emergency Contact USA: 1-800-424-9300
International: 1-813-979-0626 (collect)

Supplier and contact in UK
(for use in the UK only)

2. COMPOSITION

CAS #	Component	EC Code/class	Concentration	Risk Phrase	Risk Description
7732-18-5	Water	231-791-2			
1310-58-3	Potassium Hydroxide in aqueous solution	215-181-3 C	0.77N: 4.3% w/w	R35	Causes severe burns

3. HAZARDS IDENTIFICATION

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

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

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

Potential Health Effects:

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

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

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

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

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

4. FIRST-AID MEASURES

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

5. FIRE FIGHTING MEASURES

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

6. ACCIDENTAL RELEASE MEASURES

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

7. HANDLING AND STORAGE

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

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

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

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

9. Physical & Chemical Properties

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

10. Stability & Reactivity

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

11. Toxicological Information

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

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

12. Ecological Information

Mobility	Completely soluble in water
Degradability	Will degrade by reaction with carbon dioxide from the atmosphere to produce a non-hazardous product.
Accumulation	No
Ecotoxicity	Information not available. No long-term effects expected due to degradation. The preparation is already in dilute solution and adverse aquatic effects are not expected due to further dilution. The preparation is corrosive, and direct contact with fauna will cause burns.

13. Disposal Considerations

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

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

15. Regulatory Information

US FEDERAL

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

SARA Section 302 Extremely Hazardous Substances		None of the chemicals have a TQP
SARA Codes	CAS# 1310-58-3	Immediate, Reactive
Section 313		No chemicals are reportable under Section 313
Clean Air Act		Does not contain any hazardous air pollutants Does not contain any Class 1 Ozone depleters Does not contain any Class 2 Ozone depleters
Clean Water Act	CAS# 1310-58-3	Listed as a Hazardous Substance under the CWA None of the chemicals are listed as Priority Pollutants under the CWA None of the chemicals are listed as Toxic Pollutants under the CWA
OSHA		None of the chemicals are considered highly hazardous by OSHA
STATE	CAS# 7732-18-5 CAS# 1310-58-3	Not present on state lists from CA, PA, MN, MA, or NJ. Can be found on the following state right to know lists; CA, NJ, PA, MN, MA.
California Prop 65		California No Significant Risk Level: None of the chemicals are listed.
European/International Regulations		
European Labeling in Accordance with EC Directives		
Classification	Corrosive	
Hazard Symbol	C	
EC Number	215-181-3	
Risk Phrases	R35	Causes severe burns.
	R22	Harmful if swallowed
Safety Phrases	S1/2	Keep locked up and out of reach of children.
	S26	In case of contact with the eyes, rinse immediately with plenty of water and seek medical advice.
	S36	Wear suitable protective clothing.
	S37/39	Wear suitable gloves and eye/face protection.
	S45	In case of accident or if you feel unwell, seek medical advice immediately (show label where possible).
WGK (Water Danger/Protection)	CAS# 7732-18-5	No information available
Canada – DSL/ NDSL	CAS# 1310-58-3 CAS# 7732-18-5 CAS# 1310-58-3	1 Listed on Canada’s DSL List Listed on Canada’s DSL List
Canada - WHMIS	Classification E, D1B	Classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.
Canadian Ingredient Disclosure List	CAS# 1310-58-3	Listed on the Canadian Ingredient Disclosure List

16. Other Information

MSDS Creation Date: 09/30/94

MSDS Revised: May 1, 2007

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information. Liability is expressly disclaimed for loss or injury arising out of use of this information or the use of any materials designated. Users should make their own investigation to determine the suitability of the information for their particular purpose.

11.3 Material Safety Data Sheet (MSDS) for Replenishment Solution

1. IDENTIFICATION OF THE SUBSTANCE

Trade Name Replenishment Solution, RS-A

Manufacturer Delta F Corp., 4 Constitution Way, Woburn, MA
01801-1087, USA, Tel + 1-781-935-4600

Emergency Contact USA: 1-800-424-9300
International: 1-813-979-0626 (collect)

Supplier and contact in UK
(for use in the UK only)

2. COMPOSITION

CAS #	Component	EC Code/class	Concentration	Risk Phrase	Risk Description
7732-18-5	Water (contains trace salts)	215-181-3 C	100%		

3. HAZARDS IDENTIFICATION

Main Hazard None

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

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

Potential Health Effects:

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

4. FIRST-AID MEASURES

Skin Contact Not applicable.
Eye Contact Not applicable.

Ingestion Not applicable.
Inhalation Not applicable.

5. FIRE FIGHTING MEASURES

Special Exposure Hazard Not applicable

Extinguishing Media Not combustible. Select extinguishing media appropriate to the surrounding fire conditions.

Protective Equipment

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. ACCIDENTAL RELEASE MEASURES

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

7. HANDLING AND STORAGE

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

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Personal Protection

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

9. Physical & Chemical Properties

Molecular Formula	H ₂ O containing trace salts
Physical State	Colorless, odorless liquid
pH	6.0-8.0
Solubility	Complete (100%)
Boiling Point	100°C
Melting Point	0°C
Flash Point	Not applicable
Flammability	Not flammable
Explosion Limits	Not applicable
Specific Gravity	1.00
Vapor Pressure	17.5 mm Hg @ 20°C

10. Stability & Reactivity

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

11. Toxicological Information

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

12. Ecological Information

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

13. Disposal Considerations

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

14. Transportation Information

Not regulated.

15. Regulatory Information

16. Other Information

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

MSDS Creation Date: 09/30/94

MSDS Revised: December 7, 2006

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information. Liability is expressly disclaimed for loss or injury arising out of use of this information or the use of any materials designated. Users should make their own investigation to determine the suitability of the information for their particular purpose.

11.4 Material Safety Data Sheet (MSDS) for Gas Purifier



The Source for Gas Purification

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

MATERIAL SAFETY DATA SHEET

Hydrogen (H) Gas Purifier Media

Delta F Part Number: 16233870

Patent: U.S. 6,059,859

SECTION 1 - PRODUCT IDENTIFICATION

Trade name and Synonyms: Hydrogen (H) Gas Purifier media
Chemical name: Titanium Dioxide and Nickel
Formula: TiO₂, Ni, NiO
Product CAS No.: Chemical mixture
Product use: Hydrogen Purifier, removes oxygen, moisture and other molecular impurities from H₂ gas and Hydrogen-Inert gas mixtures.

SECTION 2 – COMPOSITION / INFORMATION ON INGREDIENTS

Hazardous components in the solid mixture inside the purifier body

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

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

SECTION 3 – HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

Black extrusions and Gray Pellets

Odorless

Flash Point: Not Determined

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

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

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

Routes of Entry:

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

Potential Health Effects:

EYE CONTACT causes irritation.

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

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

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

Carcinogenicity: Nickel

NTP? YES

IARC? YES

OSHA? NO

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

Carcinogenicity: Titanium Dioxide

NTP? NO

IARC? NO

OSHA? NO

Chronic Health Hazards:

Refer to Potential Health Effects and Carcinogenicity.

Medical Conditions Generally Aggravated by Exposure:

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

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

SECTION 4 – FIRST AID MEASURES

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

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

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

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

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

SECTION 5 – FIRE-FIGHTING MEASURES

Flash Point: Not Determined

Auto-Ignition: Not Applicable

LEL: Not Applicable

UEL: Not Applicable

NFPA Hazard Classification: Nickel

Health: 1 Flammable: 2 Reactivity: 0

HMIS Hazard Classification: Nickel

Health: 2* Flammable: 2 Reactivity: 0

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

NFPA Hazard Classification: Titanium Dioxide

Health: 0 Flammable: 0 Reactivity: 0

HMIS Hazard Classification: Titanium Dioxide

Health: 1* Flammable: 0 Reactivity: 0

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

Extinguishing Media: Use water, carbon dioxide or foam.

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

Unusual Fire and Explosion Hazards: This product will remain stable when housed in the purifier body. When nickel is exposed air at temperatures below 175°F (79°C) will remain stable. At temperature above 175°F (79°C), oxidation will occur. Nickel when exposed to excess air and moisture, the oxidation process

may generate temperatures high enough to cause combustion. Exposing this product to atmospheres containing hydrogen and temperatures above 300°F (150°C) will render this product pyrophoric. Exposure of the pyrophoric product to air at room temperature will cause ignition.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Allow media to cool before taking any action.

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

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

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

SECTION 7 - HANDLING AND STORAGE

****Note**** In the unlikely event that the purifier media is liberated from the purifier body the following procedures should be observed. Notify Safety personnel. **Allow media to cool before taking any action.** Wash thoroughly after handling media. Keep container closed. Avoid breathing dust. Keep away from sunlight, heat or fire. Store in cool, dry location away from incompatible materials

SECTION 8 – EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Limits Ingredients:	PEL-OSHA	TLV-ACGIH
Titanium Dioxide CAS NO.: 13463-67-7	10mg/m ³ (Total Dust) 5mg/m ³ (Respirable Dust)	10mg/m ³ (Total Dust)
Sodium Oxide CAS NO.: 1313-59-3	Not Established	Not Established
Graphite, Synthetic CAS NO.: 7782-42-5	2.5mg/m ³ (Respirable Dust)	2mg/m ³ (Respirable Dust)
Nickel CAS NO.: 7440-02-0	1 mg/m ³	1.5 mg/m ³ (Inhalable Fraction)
Nickel Oxide CAS NO.: 1313-99-1	1 mg/m ³ (as Ni, insoluble compounds)	0.2 mg/m ³ (as Ni, Inhalable fraction)
Silica, Amorphous CAS NO.: 7631-86-9	6mg/m ³	10mg/m ³
Magnesium Oxide CAS NO.: 1309-48-4	10mg/m ³ (Fume, total dust) 5mg/m ³ (Fume respirable fraction)	10mg/m ³ (Fume)

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

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

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

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

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Black extrusions and Grey Pellets

Odor: Odorless

Specific Gravity (H₂O=1): 0.9 g/cc (Bulk Density)

Melting Point: Not Determined

Vapor Pressure (mm Hg): Not Applicable

Vapor Density (Air=1): Not Applicable

Evaporation Rate: Not Applicable

% Solubility in Water: Insoluble

pH: Not Determined

SECTION 10 – STABILITY AND REACTIVITY

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

Avoid: Heat and humidity.

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

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

Polymerization: Polymerization is not expected to occur.

SECTION 11- TOXICOLOGICAL INFORMATION

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

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

SECTION 12 – ECOLOGICAL INFORMATION

Ecotoxicity: No data available.

Environmental Fate: No data available.

SECTION 13 – DISPOSAL CONSIDERATIONS

US EPA Waste Number: Not Regulated

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

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

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

SECTION 14 – TRANSPORT INFORMATION

INTERNATIONAL

UN Number: UN3190

UNITED STATES

EPA Waste Number: Not Regulated

DOT Classification: 4.2 Spontaneously combustible material

DOT Proper Shipping Name: Self Heating Solid, Inorganic, N.O.S. (Nickel mixture)

Packing Group: II

CANADA

PIN Number: UN3190

TDG Class: 4.2 Spontaneously combustible material

EC DGL: Spontaneously combustible substance

SECTION 15 – REGULATORY INFORMATION

US FEDERAL REGULATIONS

TSCA: IN TSCA

SARA 311 and 312 Hazard Categories

Immediate (Acute) Health Hazard: Yes

Delayed (Chronic) Health Hazard: Yes

Fire Hazard: Yes

Reactivity Hazard: No

Sudden Release of Pressure: No

SARA Section 313 Notification:

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

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

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

VOLATILE ORGANIC COMPOUNDS (VOC): None

US STATE REGULATIONS

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

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

Components: Nickel and Nickel Oxide

VOLATILE ORGANIC COMPOUND (CARB): Not determined

CANADIAN REGULATIONS

DSL/NDL: DSL

WHMIS Classification: Class B Division 6
Class D Division 2 Subdivision A
Class D Division 2 Subdivision B

EUROPEAN REGULATIONS

EINECS: Yes

OTHER REGULATIONS

MITI (Japan): Yes

AICS (AUSTRALIA): Yes

SECTION 16 – OTHER INFORMATION

Prepared by: Aeronex Inc., Research and Development Department

Phone Number: See Header

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

12 Warranty

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

Servomex's five (5) year Oxygen Sensor Warranty offers extended protection such that, if any Sensor of a Delta F Oxygen Analyzer fails under normal use, such sensor may be returned to the Seller and, if such sensor is determined by the Seller to be defective, the Seller shall provide the Buyer a repaired or replacement sensor. The Warranty of the replacement sensor will expire at the end of the warranty term for the original sensor.

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

13 Index

4

4-20mA Outputs, 42

A

Active Zero, 67, 100
Add Location, Moisture, 58
Add Location, Oxygen, 90
Analog Output Setup, 65
Analog Output Setup, Oxygen, 97
Analog Signal Outputs, 42
Analyzer
 Specifications
 General, 17
 Moisture, 17
 Oxygen, 17
 Start Up, 28
 Warranty, 163

B

Back Flow Prevention System, 106

C

case purge, 173
Cautions, 9
 Symbols and Explanations, 9
Check/Adjust Zero, Moisture, 50
Communications, 114

D

Data Download, Moisture, 57
Data Download, Oxygen, 88
Delete Location, Moisture, 59
Delete Location, Oxygen, 90
Diagnostics, 67
Display SetUp Screen, Oxygen, 98

E

Error Codes, 60
External Devices, Connecting to
 4-20mA Outputs, 42
 Analog Signal Outputs, 42
 Relay Ports, 43

Serial Communications, 41
External Devices, Connecting to, 41

F

Fan Failure, 105
Fan Failure Alarm, 105
Flow Sensitivity Test, 120

G

Gas Delivery, 106
Gas Flow and Pressure Regulation, 29
Gas Scale Factor, 104
Gas Scale Factor, GSF, 121
Gas Valves, 72
Gas Valves, Moisture, 48
Graph Setup, 66
GSF Setup, 104

H

Hydrogen service, 173

I

In Calibration Relay, Moisture, 65
In Calibration Relay, Oxygen, 98
Installation and Setup, 21
 Analyzer Start Up, 28
 Electrical Connections, 26
 Pneumatic Pressure Gas Connections, 25
 Sample Gas Connections, 25
Isolate Moisture Cell, 48
Isolate Oxygen Sensor, 72

K

Key Lock, 35

M

Main Menu
 Controls Menu, 47
Maintenance, Oxygen Sensor, 86
Manual Zero, Moisture, 52
Moisture Alarm, 62
Moisture Alarm Setup Menu, 61
Moisture Calibrate Menu, 49

Moisture Controls Menu, 47
Moisture Data Downloader Routine, 57
Moisture Data History Routine, 55
Moisture Pressure Range Alarm, 64
Moisture System Alarm, 64
Moisture Temperature Range Alarm, 63
Moisture Zero Log, 59, 60

N

nitrogen case purge, 173

O

Oxygen Alarm SetUp, 93
Oxygen Calibrate Menu, 74
Oxygen Controls, 72
Oxygen Data Download Routine, 88
Oxygen Data History Routine, 88
Oxygen Diagnostics Menu, 99
Oxygen Flow Sensitivity, 120
Oxygen Sensor Diagnostics, 99
Oxygen Sensor On/Off, 72
Oxygen Sensor Temperature Compensation, 100

P

Pre-Zero purifier purge, 55
Procedure
 Adding Replenishment Solution to the Sensor,
 127
Process Upsets, Protection from, 123
Pump Capacity Test, 61, 70
Pump case purge, 173
Purge Purifier, 68
purge, pre-zero, 55

R

Relay Ports, 43
Replenishment Solution Addition, 86
Restore Sample Gas Flow, 103

S

Safety, 145
Sample Gas Flammability, 122
Sample Gas Preparation and Delivery, 119
 Background Gas Effects, 121
 Backpressure Effects, 122
 Flow Rate Effects
 Sensor Performance, 120
 Moisture Sample Flow Rate and Pressure, 119
 Oxygen Flow Rate Effects

 Leakage Checks, 120
 Oxygen Sample Flow Rate and Pressure, 119
 Pressure Effects
 Sensor Performance, 122
 Sample Gas Flammability, 122
 Sample Gas Temperature, 122
 Sample GSF, 121
Sample Gas Temperature, 122
Sample GSF, 121
Service, 125
 Maintenance
 Calibration, 126
 Gas Purifier, 129
 Gas Purifier, when to change, 129
 Sensor, 127
 Storage Conditions, 127
 Replaceable Parts List, 134
 Return Material Authorization number, 125
 Shipping, 137
 Return Material Authorization number, 125, 137
Set Location, Moisture, 57
Set Location, Oxygen, 89
Set Password, 112
Shipping, 137
Signal Monitor, 68
System Error Codes, 60
System Info, 116
System Menu, 101

T

Temperature Compensation, 100
Test Analog Outputs, 111
Test Relays, 110
Theory of Moisture Measurement, 142
Theory of Oxygen Measurement, 141

U

User Interface, 45
 Data Display Screen, 45
 Keypad, 46
 Main Menu, 46
 Menu Structure, 46

V

View Location, Moisture, 58
View Location, Oxygen, 89
View Moisture Logs Menu, 59
View Oxygen Logs, 91

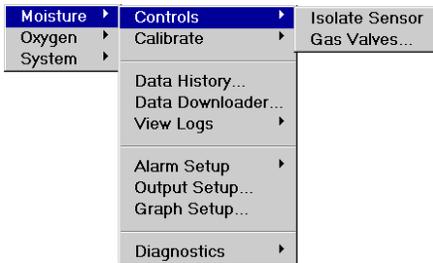
W

Warranty, 163

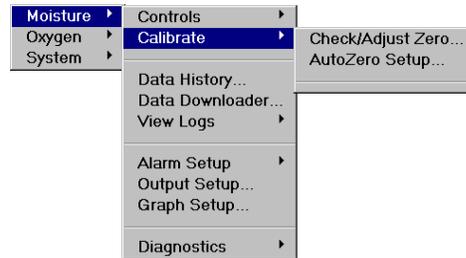
14 Appendix A – User Menu Screens

Following are depictions of the User Interface Menus divided into three sections, Moisture, Oxygen and System.

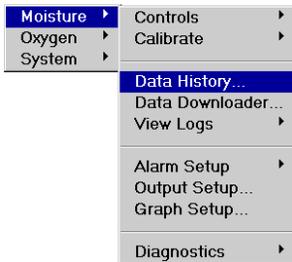
14.1 Moisture Menus



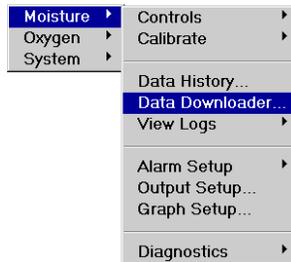
Page 47



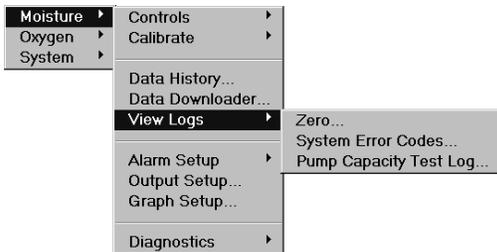
Page 49



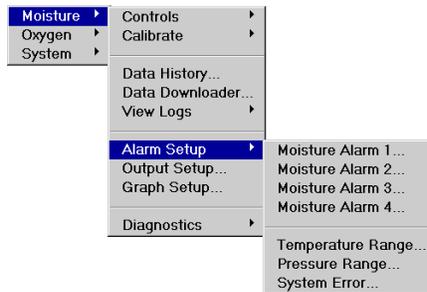
Page 55



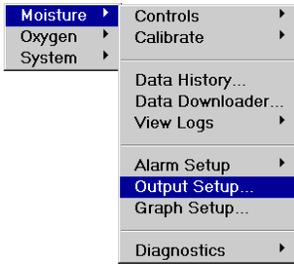
Page 56



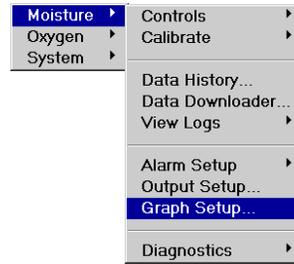
Page 59



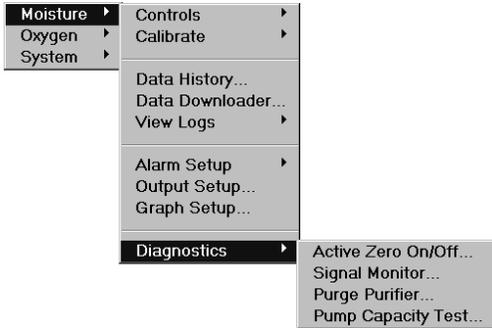
Page 61



Page 65

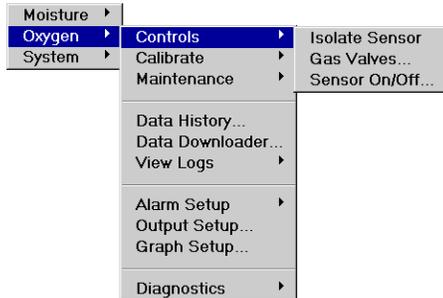


Page 66

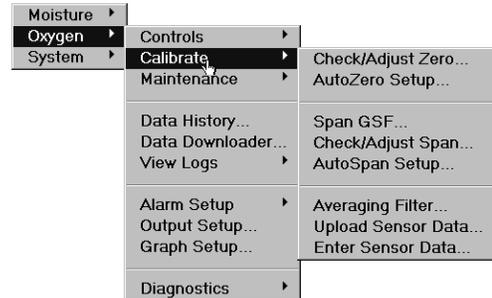


Page 67

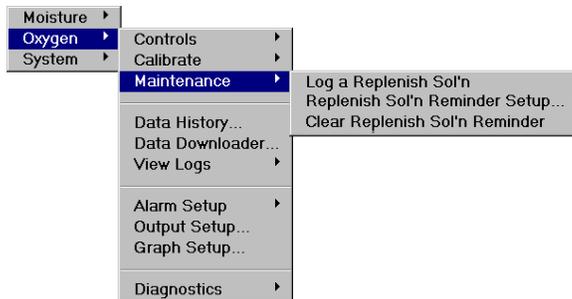
14.2 Oxygen Menus



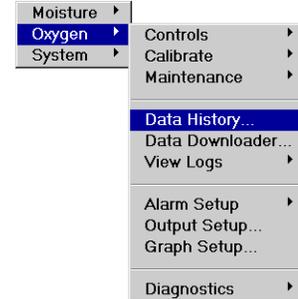
Page 72



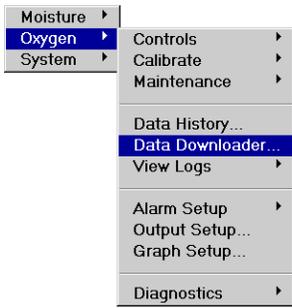
Page 74



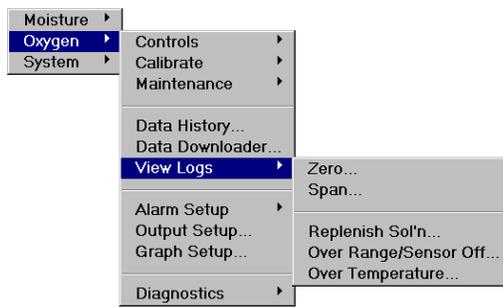
Page 86



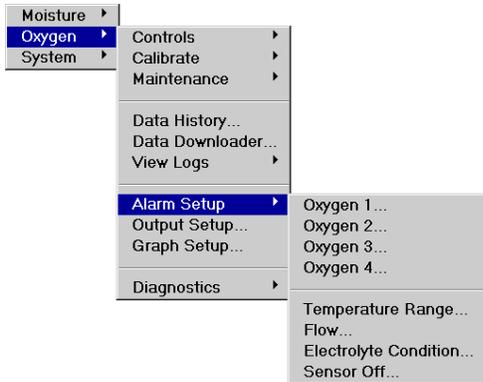
Page 87



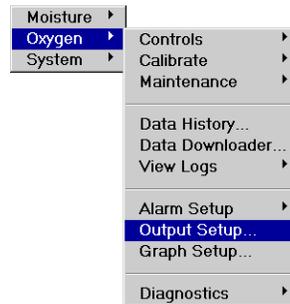
Page 88



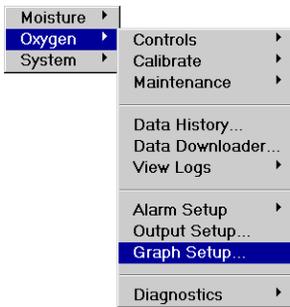
Page 91



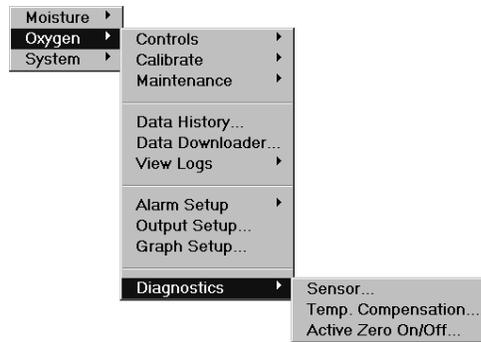
Page 93



Page 97

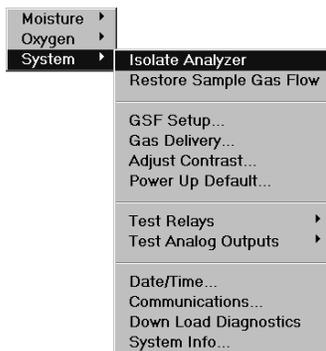


Page 98

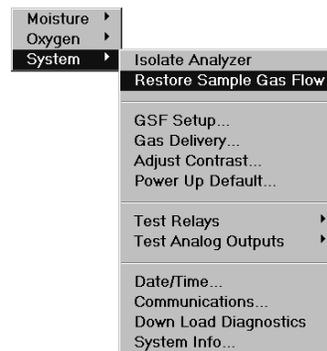


Page 99

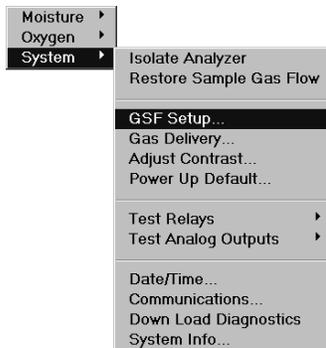
14.3 System Menus



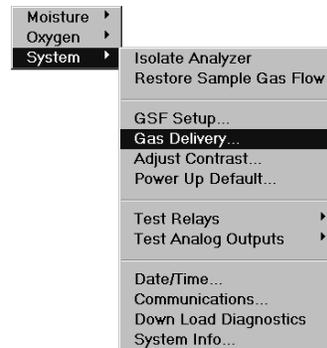
Page 102



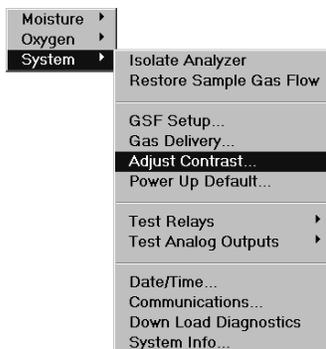
Page 103



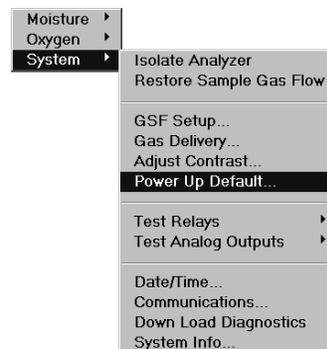
Page 103



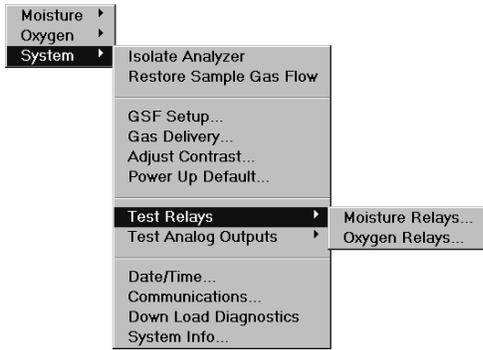
Page 106



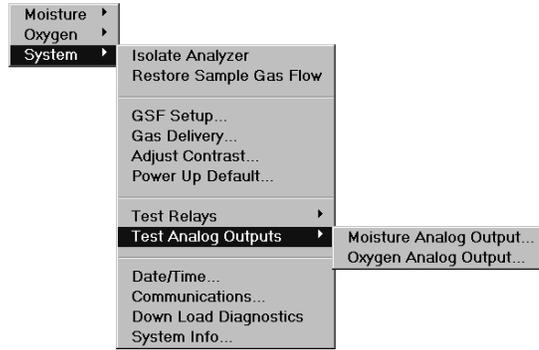
Page 108



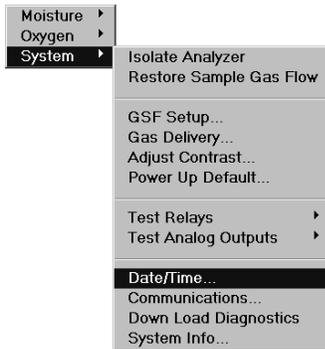
Page 109



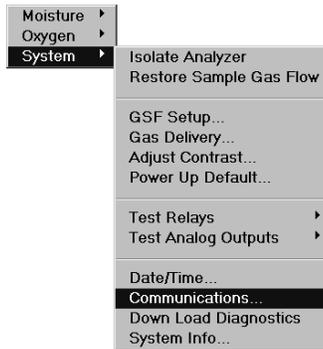
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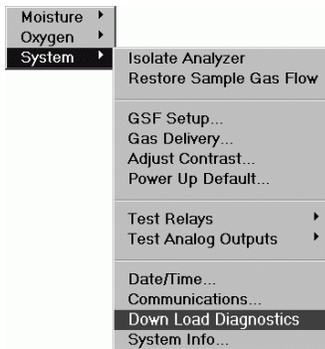
Page 111



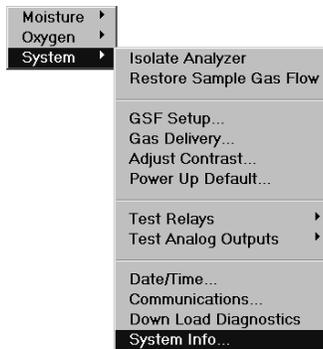
Page 113



Page 114



Page 115



Page 116

15 Appendix B – Hydrogen Service Safety System

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

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

15.1 Instrument

- **Air circulation fans** pull air in through the front door (and vent through the rear) of the chassis. The fans are rated at 50 cfm (125 cfm max) which will maintain the internal chassis space below the lower explosive limit (LEL)¹.
- **Sample delivery interlock valve** blocks flow of sample gas from entering the instrument chassis under various conditions as described below. It consists of a normally closed pneumatically actuated UHP springless diaphragm valve positioned on the sample inlet bulkhead.
- **Analyzer case purge valve** introduces nitrogen purge flow into the chassis upon closure of the sample delivery interlock valve. It consists of a normally open pneumatically actuated valve which feeds a customer supplied and regulated source of nitrogen purge gas through a bulkhead on the rear of the cabinet.²
- **Instrument controls and logic**³ default, manage and actuate the above mentioned components to maintain safe operating conditions.

15.2 Vacuum Pump

- If equipped with a vacuum pump, **an enclosure** equipped with a nitrogen case purge is provided to maintain a safe condition. In addition, an interlock is provided to detect and react to loss of Nitrogen purge flow. See Figure 146 on page 178.

15.3 Installation

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

- If the analyzer has the optional vacuum pump, the pump enclosure must be mounted to a nearby wall or inside the rack shared by the analyzer. See Figure 146 on page 178.

- The sample gas inlet connection is made to an interlock valve mounted at the sample gas inlet on the rear of the analyzer. NOTE: The installation of this option changes the sample inlet connection to female VCR, from male.
- The sample gas outlet is connected by a ¼ inch metal tube from the analyzer sample outlet, to the aspirator. If the analyzer has the optional vacuum pump, the sample gas outlet is connected by a ¼ inch metal tube from the analyzer sample outlet, to the needle control valve (supplied loose), and then to the sample inlet on the pump enclosure.
- A customer supplied and regulated source of nitrogen purge gas is connected to both the ¼ inch compression fitting on the case purge valve mounted on the rear of the analyzer, and also, if equipped with the vacuum pump, to the 1/8 inch compression purge inlet fitting on the vacuum pump enclosure. Using the customer supplied regulator adjust the flow into both enclosures to approx. 30 scfh as indicated on a rotameter.
- If required, the pump enclosure sample outlet and/or analyzer sample outlets need to be connected by ¼ inch metal tube and compression fittings to an appropriate exhaust system.
- The pump power cord is connected from the rear of the analyzer to the rear of the pump enclosure.

15.4 Operation

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

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

NOTE: The back flow prevention screen (see page 31) will be displayed and the user must hit **ESC** to acknowledge the screen and remove it.

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

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

- The pump case purge system continuously feeds a customer regulated supply of nitrogen into the pump enclosure to (1) maintain the oxygen level well below the maximum safe level (5% for hydrogen) in the event that the pump diaphragm fails and leaks sample gas into the enclosure and (2) maintain appropriate flow for adequate pump cooling. The purge flow rate is set to 30 scfh as indicated on a rotometer mounted on the side of the pump enclosure. An in-line flow switch will trip at a flow rate of less than 26 scfh assuring adequate flow. Loss of purge flow breaks the contacts in the flow switch, which in turn trips a mercury relay that removes electrical power to the pump.

CAUTION



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

CAUTION



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

CAUTION



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

CAUTION



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

CAUTION



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

NOTES

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

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

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

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

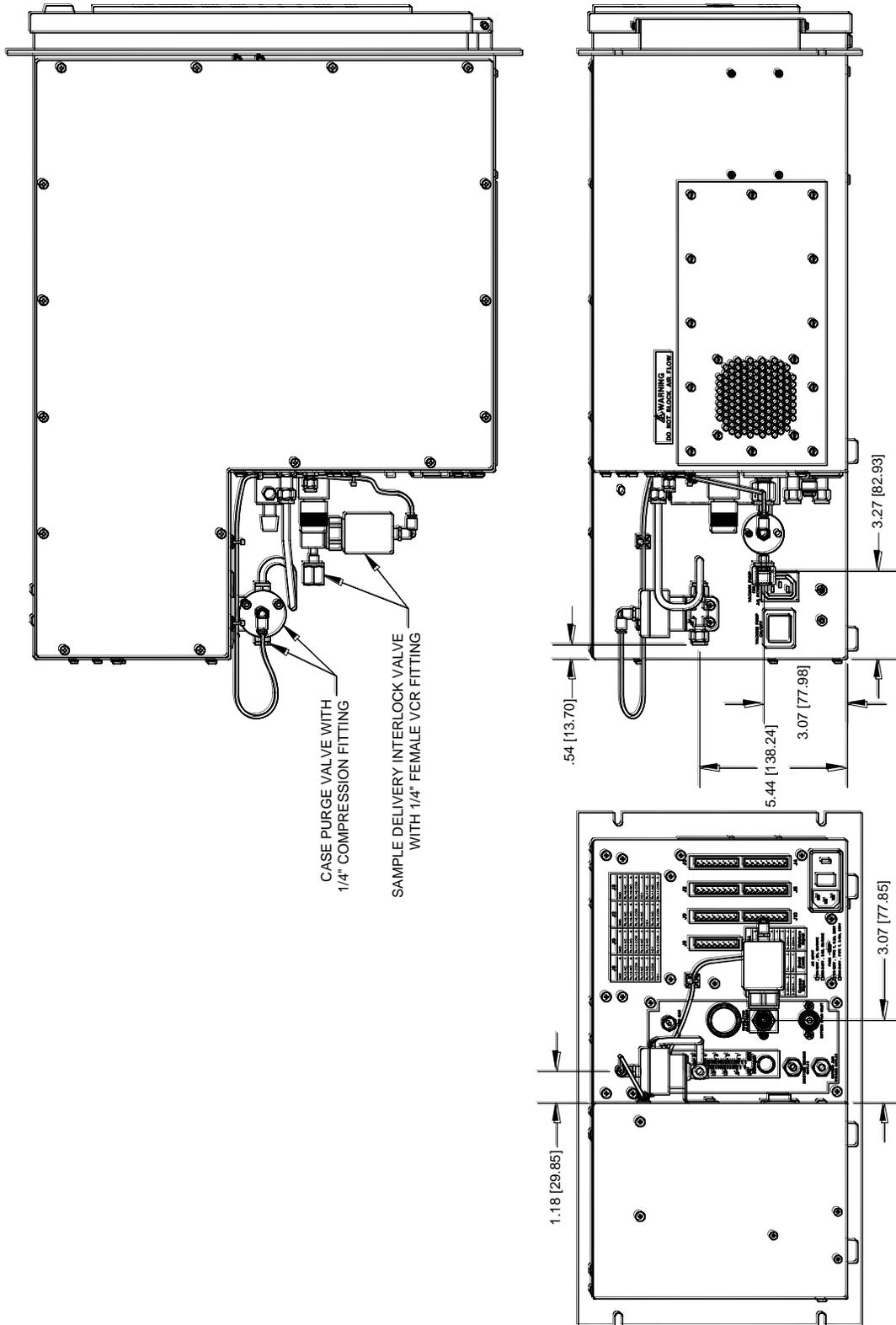


Figure 145: Hydrogen Service Safety System

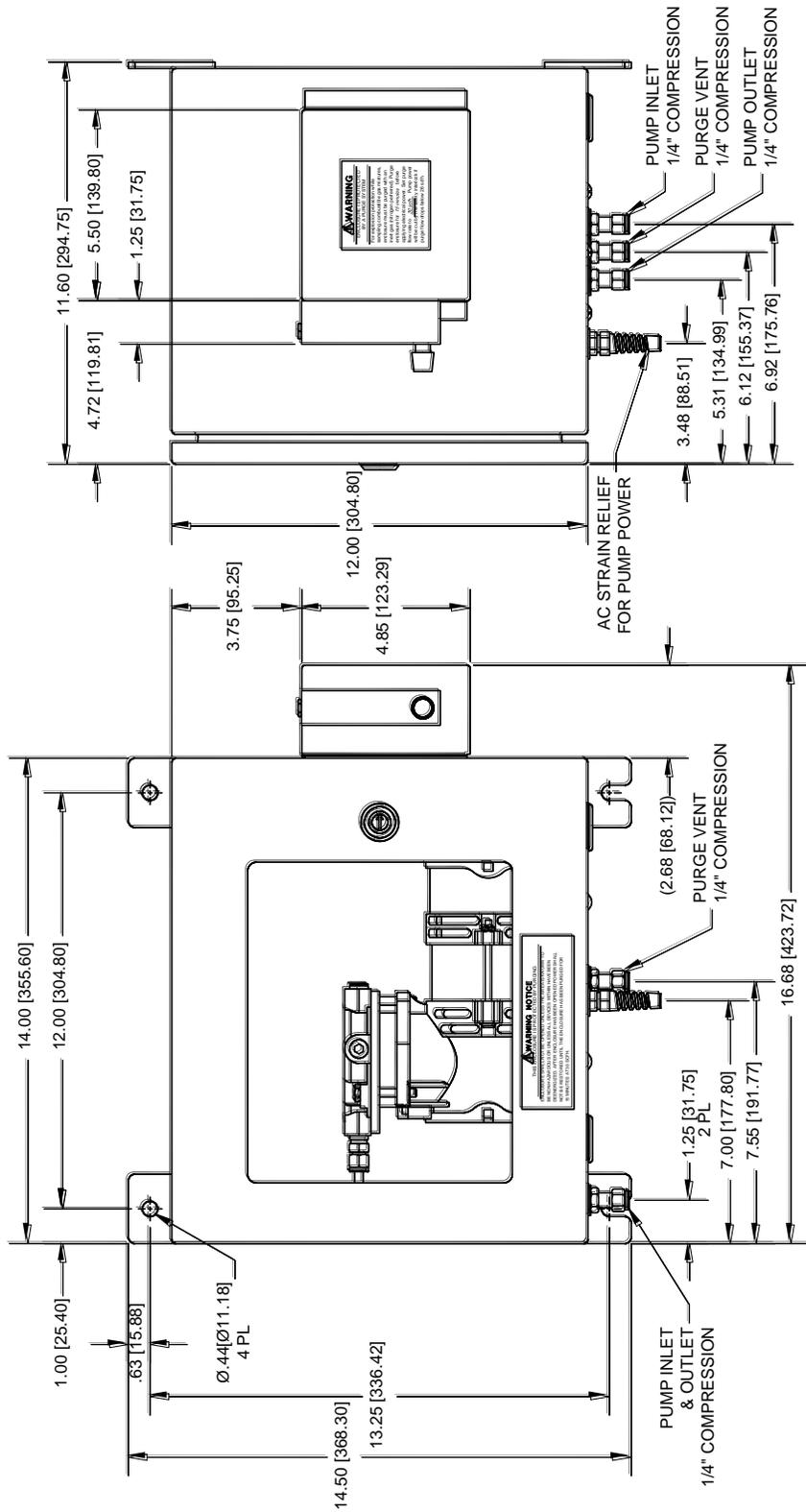


Figure 146: Pump Purge Option