

Model 60i

Instruction Manual

Multi-Gas Analyzer

Part Number

105561-00 13Mar2024



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WEEE Compliance

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:



Thermo Fisher Scientific has contracted with one or more recycling/disposal companies in each EU Member State, and this product should be disposed of or recycled through them. Further information on Thermo Fisher Scientific's compliance with these Directives, the recyclers in your country, and information on Thermo Fisher Scientific products which may assist the detection of substances subject to the RoHS Directive are available at: www.thermo.com/WEEERoHS.

About This Manual

This manual provides information about installing, operating, maintaining, and servicing the Model 60i. It also contains important alerts to ensure safe operation and prevent equipment damage. The manual is organized into the following chapters and appendices to provide direct access to specific operation and service information.

- Chapter 1 “[Introduction](#)” provides an overview of product features, describes the principles of operation, and lists the specifications.
- Chapter 2 “[Installation](#)” describes how to unpack, set up, and start up the analyzer.
- Chapter 3 “[Operation](#)” describes the front panel display screens, the front panel pushbuttons, and the menu-driven firmware.
- Chapter 4 “[Calibration](#)” provides the procedures for calibrating the analyzer and describes the required equipment.
- Chapter 5 “[Preventive Maintenance](#)” provides maintenance procedures to ensure reliable and consistent instrument operation.
- Chapter 6 “[Troubleshooting](#)” presents guidelines for diagnosing analyzer failures, isolating faults, and includes recommended actions for restoring proper operation.
- Chapter 7 “[Servicing](#)” presents safety alerts for technicians working on the analyzer, step-by-step instructions for repairing and replacing components, and a replacement parts list. It also includes contact information for product support and technical information.
- Chapter 8 “[Component Description](#)” describes the function and location of the system components, provides an overview of the firmware structure, and includes a description of the system electronics and input/output connections.
- Chapter 9 “[Optional Equipment](#)” describes the optional equipment that can be used with this analyzer.
- Appendix A “[Warranty](#)” is a copy of the warranty statement.
- Appendix B “[C-Link Protocol Commands](#)” provides a description of the C-Link protocol commands that can be used to remotely control an analyzer using a host device such as a PC or datalogger.

- Appendix C “[MODBUS Protocol](#)” provides a description of the MODBUS Protocol Interface which is supported both over RS-232/485 (RTU protocol) as well as TCP/IP over Ethernet.
- Appendix D “[Geysitech \(Bayern-Hessen\) Protocol](#)” provides a description of the Geysitech (Bayern-Hessen or BH) Protocol Interface which is supported both over RS-232/485 as well as TCP/IP over Ethernet.
- Appendix E “[Interfacing a DCS/PLC with the Model 60i Multi-Gas Analyzer](#)” provides information on how to establish data communications between a DCS/PLC and the 60i, describes typical 60i communications functions, and provides an example of how to set up the 60i to trigger calibration events.





Safety

Review the following safety information carefully before using the analyzer. This manual provides specific information on how to operate the analyzer. If the analyzer is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.


Safety and Equipment Damage Alerts

This manual contains important information to alert you to potential safety hazards and risks of equipment damage. Refer to the following types of alerts you may see in this manual.

Safety and Equipment Damage Alert Descriptions

Alert	Description
 DANGER	A hazard is present that could result in death or serious personal injury if the warning is ignored. ▲
 WARNING	A hazard or unsafe practice could result in serious personal injury if the warning is ignored. ▲
 CAUTION	A hazard or unsafe practice could result in minor to moderate personal injury if the warning is ignored. ▲
 Equipment Damage	A hazard or unsafe practice could result in property damage if the warning is ignored. ▲

Safety and Equipment Damage Alerts in this Manual

Alert	Description
 WARNING	The Model 60i is supplied with a three-wire grounded power cord. Under no circumstances should this grounding system be defeated. ▲

Alert	Description
<div data-bbox="609 441 686 510" data-label="Image"> </div> <div data-bbox="711 436 816 464" data-label="Section-Header"> <p>CAUTION</p> </div>	<p>The service procedures in this manual are restricted to qualified service personnel only. ▲</p> <p>If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲</p> <p>If the LCD panel breaks, do not let the liquid crystal contact your skin or clothes. If the liquid crystal contacts your skin or clothes, wash immediately using soap and water. ▲</p>
<div data-bbox="609 583 686 653" data-label="Image"> </div> <div data-bbox="711 579 922 609" data-label="Section-Header"> <p>Equipment Damage</p> </div>	<p>Do not attempt to lift the analyzer by the cover or by external fittings. ▲</p> <p>Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲</p> <p>Disconnect the serial cable before changing RS-232 and RS-485 selection to prevent damage to any connected equipment. ▲</p> <p>Never clean the mirrors unless you are certain they need cleaning. Any contact with the mirror surface will degrade it to some degree. ▲</p> <p>Never rub a mirror to remove debris, especially gold surface mirrors. Instead, stream solvent on the mirror surface to dislodge any debris. Compressed air may be used to dry the mirrors. ▲</p> <p>Use only analytical grade isopropyl alcohol or methanol to clean the mirrors. ▲</p> <p>Replacement of the filter wheel should only be performed at an authorized Thermo Fisher Scientific service center. To retain maximum performance, the wheel must be characterized using equipment and procedures that are only available at an authorized service center. ▲</p> <p>Do not use solvents or other cleaning products to clean the outside case. ▲</p> <p>Do not remove the LCD panel or frame from the LCD module. ▲</p> <p>The LCD polarizing plate is very fragile, handle it carefully. ▲</p> <p>Do not wipe the LCD polarizing plate with a dry cloth, as it may easily scratch the plate. ▲</p>

Alert	Description
	Do not use alcohol, acetone, MEK or other ketone based or aromatic solvent to clean the LCD module, but rather use a soft cloth moistened with a naphtha cleaning solvent. ▲
	Do not place the LCD module near organic solvents or corrosive gases. ▲
	Do not shake or jolt the LCD module. ▲


FCC Compliance

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note This equipment has been tested and found to comply within the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his or her own expense. ▲

WEEE Symbol

The following symbol and description identify the WEEE marking used on the instrument and in the associated documentation.

Symbol	Description
	Marking of electrical and electronic equipment which applies to waste electrical and electronic equipment falling under the Directive 2002/96/EC (WEEE) and the equipment that has been put on the market after 13 August 2005. ▲

Where to Get Help

For additional assistance, worldwide service is available from Thermo Fisher Scientific. Contact one of the phone numbers below for product support and technical information or visit us on the web at www.thermo.com/aqi.

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Chapter 1

Introduction

The Model 60*i* Multi-Gas Analyzer measures gas concentrations using non-dispersive infrared (NDIR) spectroscopy. The Model 60*i* combines proven detection technology, easy to use menu-driven firmware, and advanced diagnostics to offer unsurpassed flexibility and reliability. The Model 60*i* has the following features:

- 320 x 240 graphics display
- Menu-driven firmware
- Multiple user-defined analog outputs
- Analog input options
- High sensitivity
- Linearity through all ranges
- Highly specific to targeted gases
- Self-aligning optics
- Automatic temperature and pressure compensation
- User-selectable digital input/output capabilities
- Standard communications features include RS232/485 and Ethernet
- C-Link, MODBUS, Geysitech (Bayern-Hessen), streaming data, and NTP (Network Time Protocol) protocols. Simultaneous connections from different locations over Ethernet.

For details of the analyzer's principle of operation and product specifications, see the following topics:

- [“Principle of Operation”](#) on page 1-2
- [“Specifications”](#) on page 1-10

Thermo Fisher Scientific is pleased to supply this analyzer. We are committed to the manufacture of instruments exhibiting high standards of quality, performance, and workmanship. Service personnel are available for assistance with any questions or problems that may arise in the use of this analyzer. For more information on servicing, see the [“Servicing”](#) chapter.

Principle of Operation

The Model 60*i* measures combustion by-products, using a variation of infrared (IR) absorbance spectroscopy. With this technique, the concentration of individual pollutants in the sample is measured based on that compound's capacity to absorb infrared energy of a specific wavelength. The Model 60*i* is a non-dispersive infrared (NDIR) analyzer, meaning that it uses band-pass optical filters rather than a diffraction grating or prism to create an IR beam with a limited range of wavelengths.

The basic design of a simple single-beam NDIR that could be used to measure a single component is shown schematically in [Figure 1–1](#). As illustrated in this figure, infrared light, or radiation, with a broad range of wavelengths is generated by a glowing metal filament that is heated to a temperature of several hundred degrees Celsius. The radiation passes through a rotating blade, or “chopper,” that interrupts and synchronizes the beam so that the intensity of the radiation reaching the detector is modulated. If the radiation beam were not chopped, the detector would become saturated and insensitive.

The chopped beam next passes through an optical filter that allows only a narrow range of wavelengths to pass. The filter is designed to selectively pass a wavelength that the target compound will absorb. If the target compound has strong absorbance peaks at more than one wavelength, the peak that is most unique to that compound will usually be selected.

After passing through the optical filter, the radiation enters a sample cell containing the gas mixture to be analyzed. Depending on the concentration of the target gas in the cell, some portion of the infrared energy will be absorbed. The radiation that is not absorbed then leaves the cell and impinges on the detector, which converts the IR energy to an electrical signal.

The higher the concentration of target compound in the cell, the smaller the electrical signal produced by the detector.

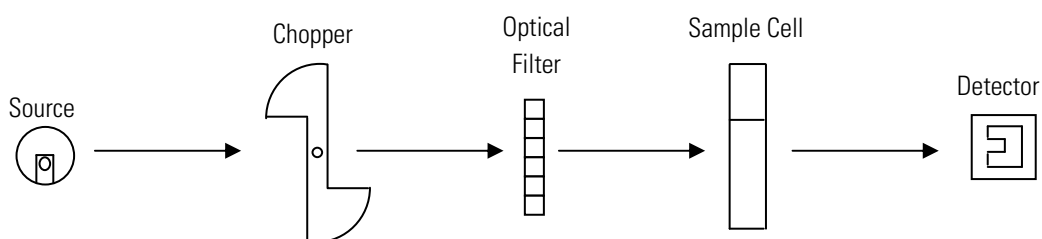


Figure 1–1. Example of Simple Single-Beam NDIR

Since most compounds absorb IR radiation only at specific wavelengths determined by molecular structure, it is possible to measure the concentration of one specific component in a mixture. For example, the absorbance spectra of carbon monoxide and carbon dioxide are shown in [Figure 1–2](#). Based on the absorbance spectra shown in these figures, the concentration of carbon monoxide (CO) can be determined by measuring the absorbance of infrared energy at a wavelength of approximately 4.6 micrometers, and the concentration of carbon dioxide (CO₂) can be determined by measuring infrared absorbance at a wavelength of approximately 4.2 micrometers.

The Model 60*i* measures the concentration of individual components in a mixture using the same basic analytical approach shown in [Figure 1–1](#). However, the analyzer design includes a number of unique features which extend the operation beyond that seen in the most basic instruments.

As shown in [Figure 1–3](#), the Model 60*i* design replaces the chopper and fixed optical filter with a spinning wheel that contains a series of carefully selected optical filters. The filters are separated by a series of metal spokes, so that it can function as both a “chopper” that modulates the IR signal and as a mechanism for rapidly interchanging optical filters.

In addition, the analytical sample cell in the Model 60*i* is a multi-pass design, meaning that it contains a series of mirrors that force the beam of radiation to bounce back and forth and make multiple passes through the sample gas before reaching the exit. By making multiple passes through the cell, the effective path length is increased, which increases the opportunity for the IR radiation to interact with the sample, and improves the sensitivity of the analyzer.

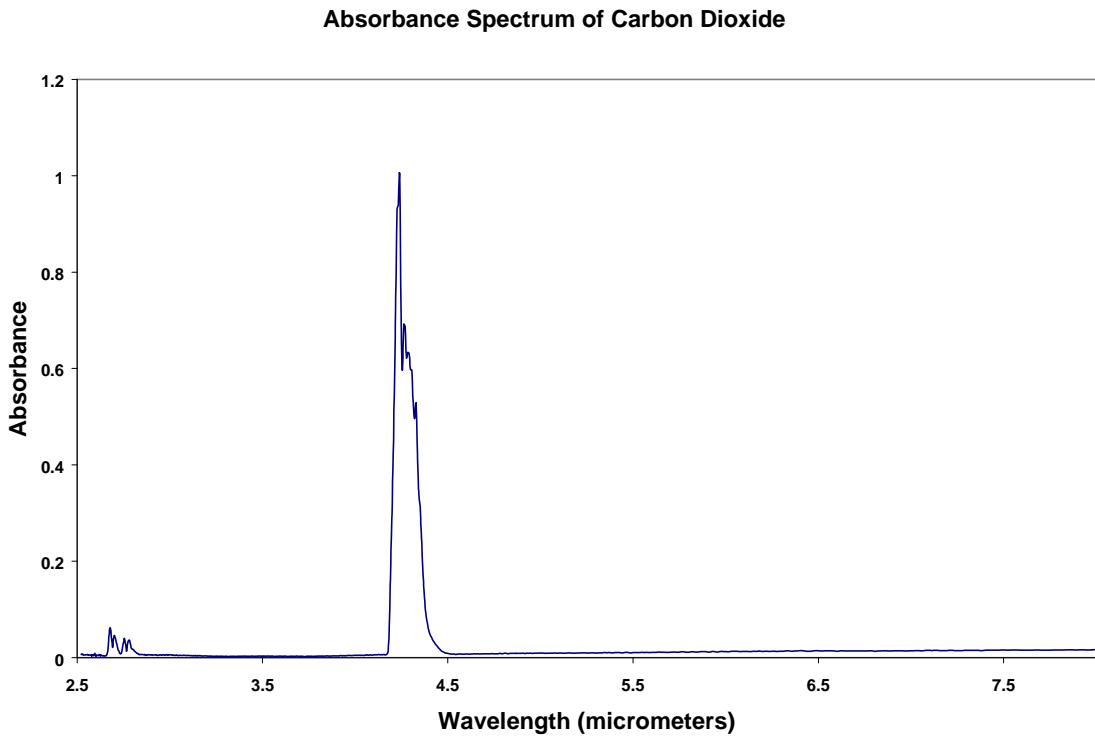
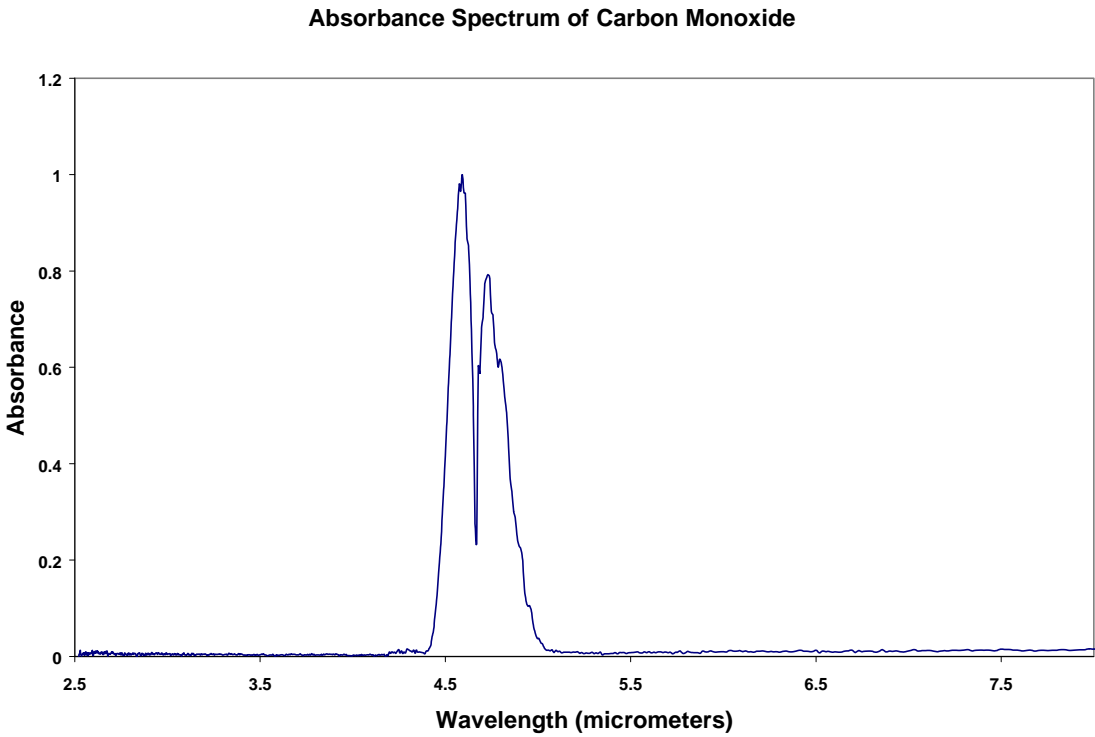


Figure 1–2. Absorbance Spectra of Carbon Monoxide and Carbon Dioxide

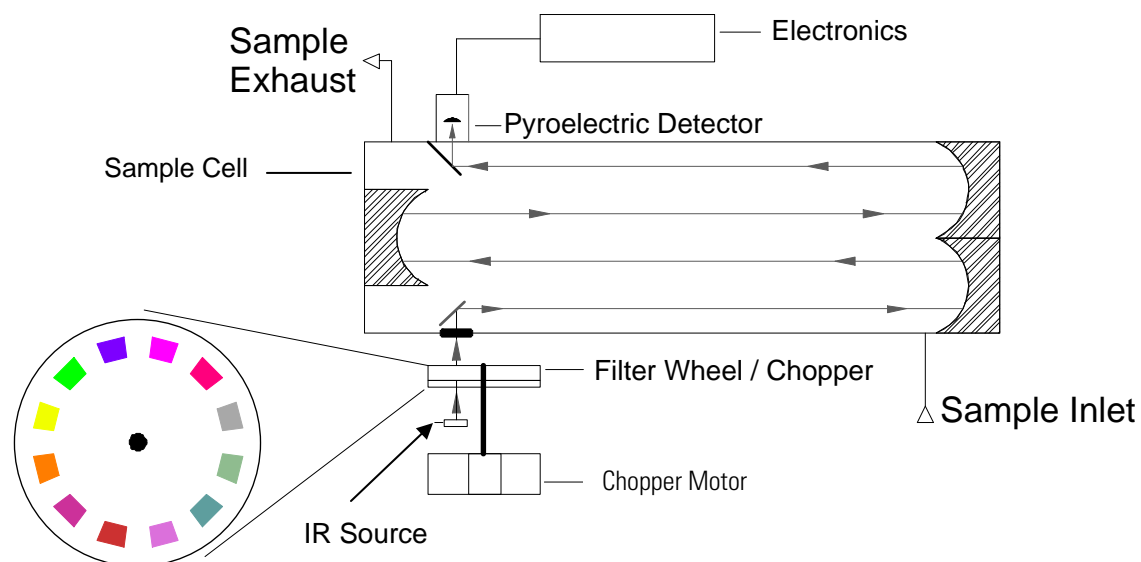


Figure 1–3. Example of Spinning Optical Filter Wheel NDIR

The optical filters used in each version of the analyzer are selected based on consideration of the infrared absorbance spectra for each targeted gas and the IR absorbance characteristics of non-target gases that can be expected in the intended application. By knowing the IR absorbance that each gas will exhibit at each wavelength featured in the filter wheel, and by including a reference filter, the instrument firmware can calculate concentrations while compensating for interference from the non-target gases and for any fluctuations in performance of the analyzer hardware.

In addition to measuring by-products of combustion, the Model 60*i* can also report the concentration of oxygen in the sample gas. Depending on the instrument configuration, oxygen is measured using either an optional electrochemical oxygen sensor or an optional paramagnetic oxygen sensor.

The optional electrochemical oxygen sensor, shown in [Figure 1–4](#), determines the oxygen concentration by measuring the rate of an oxidation/reduction reaction that occurs in a closed cell that is exposed to the sample stream. The cell is similar to a battery in construction, and consists of an enclosure that holds two electrodes. The negatively charged cathode, which is also called the working electrode, is formed from a flat PTFE tape coated with an active catalyst. The positively charged anode is formed from a block of lead. The entire cell is sealed from exposure to the atmosphere, and is filled with a conductive electrolyte that allows transfer of ionic species between the two electrodes. The two electrodes are connected to pins which protrude from the bottom of the assembly, which allow the sensor to be electrically connected to the instrument.

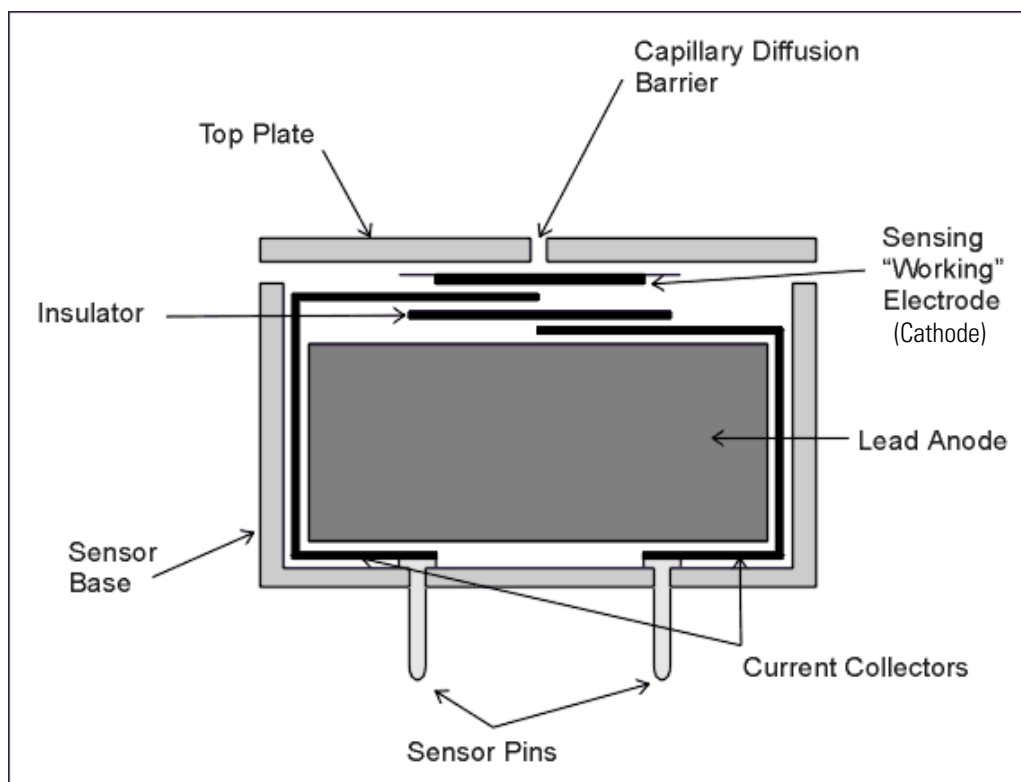
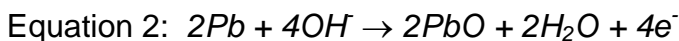
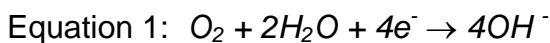


Figure 1–4. Example of an Optional Electrochemical Oxygen Sensor

Oxygen entering through the capillary or membrane located above the working electrode reacts with the working electrode to form a negatively charged hydroxyl (OH^-) ion, as indicated in **Equation 1**. This ion moves through the electrolyte in the oxygen sensor to the positively charged electrode. The (OH^-) ion reacts with the lead and releases electrons, as indicated in **Equation 2**. The flow of electrons is passed through a fixed resistance and can be measured as a voltage drop.



Since these reactions occur very rapidly, the current produced is proportional to the rate at which oxygen reaches the working electrode. The measured current flow can be mathematically converted to a measurement of the oxygen concentration at the entrance to the diffusion barrier, which may be a capillary or a membrane.

Note that because the lead anode is oxidized in **Equation 2**, these sensors have a limited life. Once all the available lead has been oxidized, they no longer function. Typically, oxygen sensors have a six to twelve month lifetime. However this lifetime can vary depending on usage conditions.

The optional paramagnetic oxygen sensor provides functionality similar to that of the optional electrochemical sensor. However, it works on a totally different principal and should function indefinitely without replacement. In addition to the extended operating life, the paramagnetic sensor provides somewhat better analytical performance in terms of response time, precision, and freedom from drift.

The paramagnetic sensor takes advantage of the fact that oxygen is a paramagnetic compound, and is attracted to a magnetic field. Other gases that are likely to be present at a significant concentration level are diamagnetic, and will be slightly repelled by, or will have no significant interaction with these fields.

Within this sensor, a small dumbbell shaped body is suspended in the magnetic field formed by a permanent magnet. The dumbbell is slightly diamagnetic and is repelled away from the strongest portion of the magnetic field. When oxygen enters the sensor, it is attracted to the strongest areas of the magnetic field and slightly alters the field characteristics, causing the dumbbell to shift positions. The change in position is measured by an optical sensor and can be related to the concentration of oxygen in the gas.

Flow schematics showing the overall instrument design and the relationship between the various analytical components are presented in [Figure 1–5](#) and [Figure 1–6](#). The Model 60*i* outputs the measurement results to the front panel display and also makes the data available over the serial or Ethernet connection.

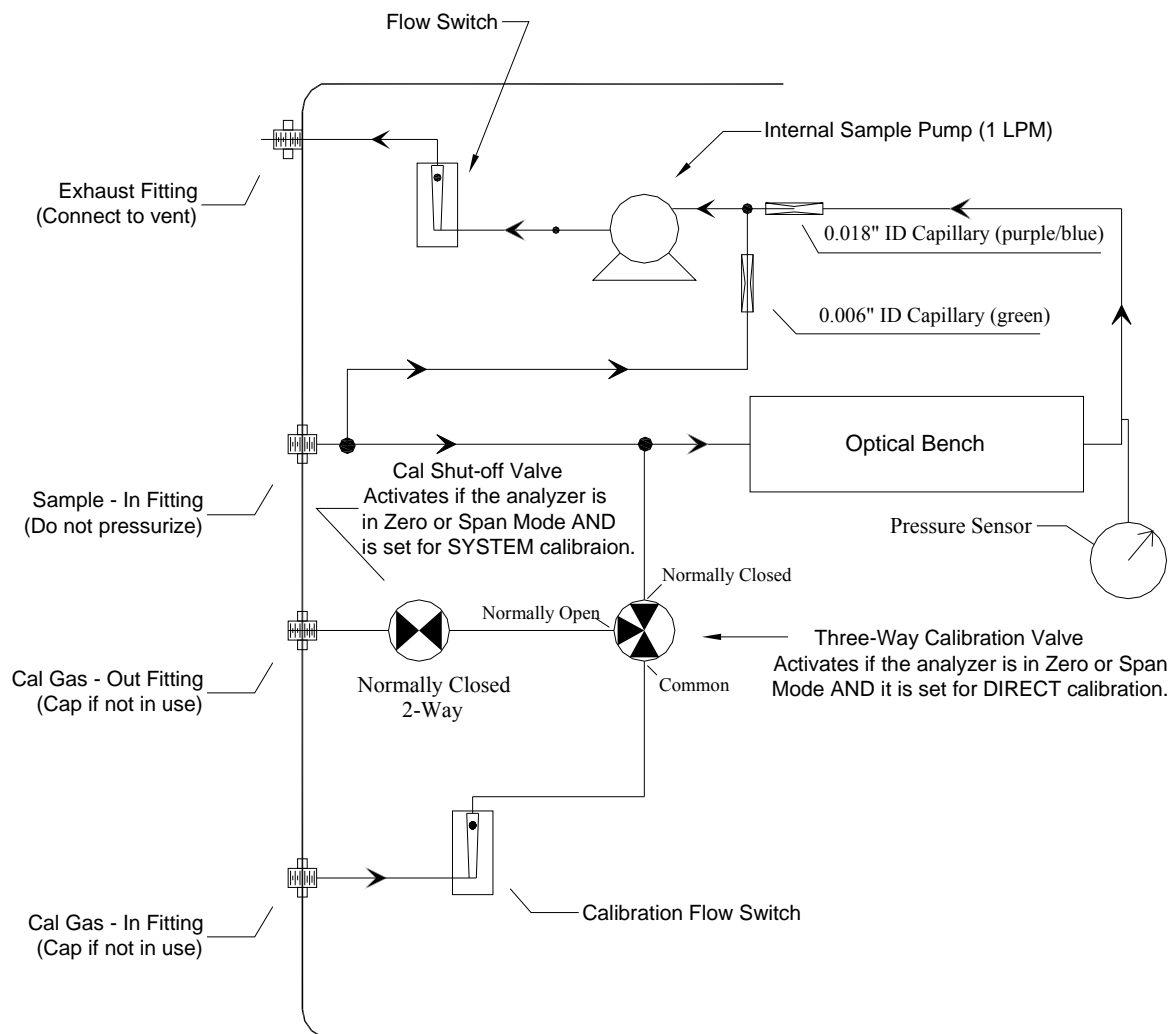


Figure 1–5. Model 60i Standard Analyzer Flow Schematic

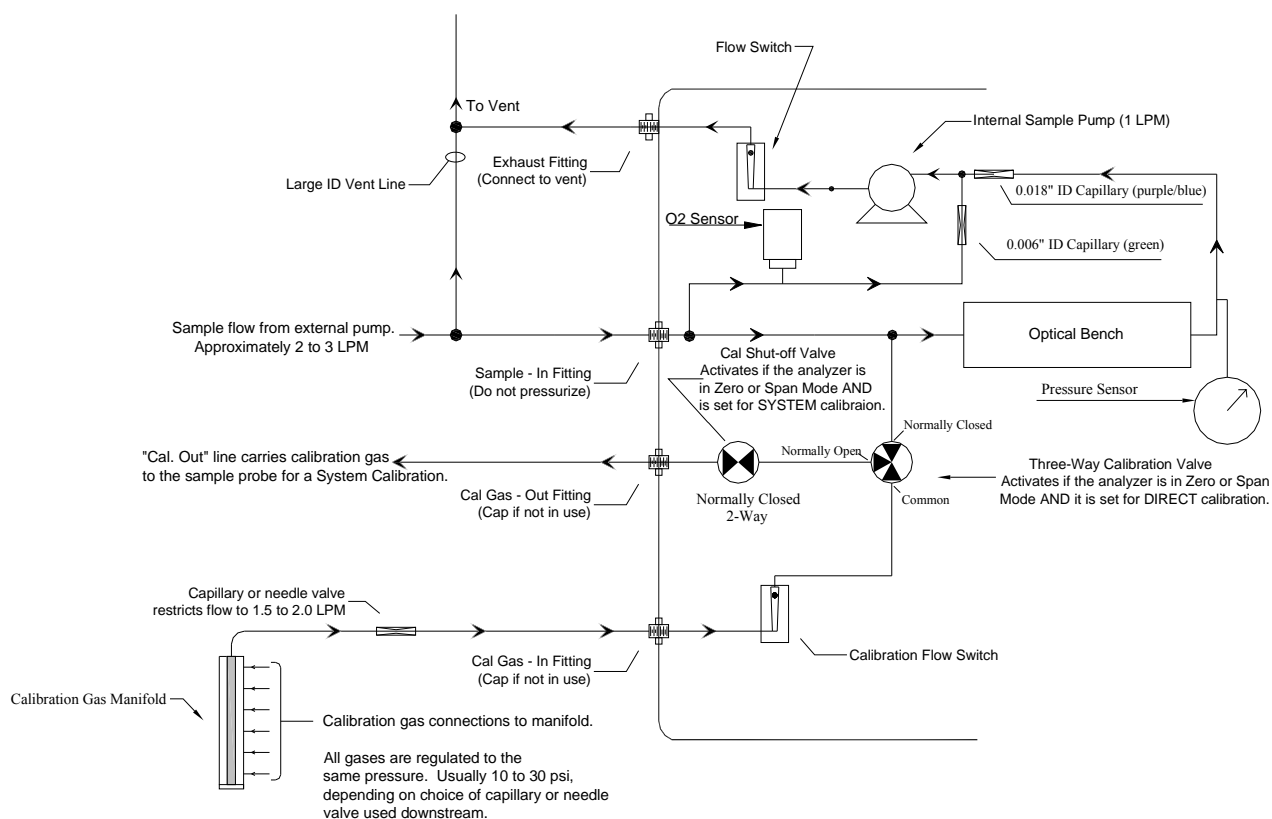


Figure 1–6. Model 60i Flow Schematic with O₂ Sensor Option

Specifications

Table 1–1 lists the Model 60i design specifications and Table 1–2 lists the performance specifications.

Table 1–1. Model 60i Design Specifications

Custom ranges	CO: 100 to 2500 ppm CO ₂ : 5 to 25% NO: 100 to 2000 ppm NO ₂ : 50 to 500 ppm SO ₂ : 100 to 10,000 ppm O ₂ : 5 to 25%
Operating temperature	5 °C to 45 °C (may be safely operated over the range of 0 to 45 °C in non-condensing environments). Performance specifications based on operation within 15 °C -35 °C range.
Flow Rate	1.0 liter per minute, minimum
Power requirements	100 VAC @ 50/60 Hz 115 VAC @ 50/60 Hz 220–240 VAC @ 50/60 Hz ± 10% at 275 watts
Physical dimensions	425mm (16.75") (W) x 218mm (8.62") (H) x 584mm (23") (D)
Weight	22.2kg (49 lbs).
Analog outputs	6 voltage outputs; 0–100 mV, 1, 5, 10 V (user selectable), 5% of full scale over/under range (user selectable), 12 bit resolution, measurement output user selectable per channel
Digital outputs	1 power fail relay Form C, 10 digital relays Form A, user selectable alarm output, relay logic, 100 mA @ 200 VDC
Digital inputs	16 digital inputs, user select programmable, TTL level, pulled high
Serial Ports	1 RS-232 or RS-485 with two connectors, baud rate 1200–115200, data bits, parity, and stop bits, protocols: C-Link, MODBUS, Geysitech (Bayern-Hessen), and streaming data (all user selectable)
Ethernet connection	RJ45 connector for 10Mbps Ethernet connection, static or dynamic TCP/IP addressing

Table 1–2. Model 60i Performance Specifications

Parameter	CO	CO ₂	NO	NO ₂	SO ₂	O ₂ * EC	O ₂ * PM
Full Scale Range ⁽¹⁾	2500 ppm 3000 mg/m ³	0-25% 500,000 mg/m ³	2000 ppm 2500 mg/m ³	500 ppm 1000 mg/m ³	10,000 ppm 25,000 mg/m ³	0-25%	0-25%
Accuracy ^(2, 3)	2% of full scale or 5% of measured value, whichever is smaller					0.20%	0.10%
Zero Noise ⁽⁴⁾	< 0.2 ppm	< 0.03%	< 0.2 ppm	< 0.1 ppm	< 0.1 ppm	0.50%	0.50%
Limit of Detection ⁽⁵⁾	0.5 ppm	0.05%	0.5 ppm	0.2 ppm	0.2 ppm	0.20%	0.10%
Display Resolution	0.1 ppm	0.01%	0.1 ppm	0.1 ppm	0.1 ppm	0.1%	0.01%
Zero Drift/ 24 Hours ⁽⁶⁾	< 1.0 ppm	< 0.15%	< 1.2 ppm	< 1.0 ppm	< 0.5 ppm	< 0.2%	< 0.1%
Span Drift/ 24 Hours ⁽⁶⁾	< 1%	< 1%	< 1%	< 1%	< 1%	< 0.2%	< 0.1%
% of Span							
Response Time ⁽⁷⁾	70 Sec	70 Sec	70 Sec	70 Sec	70 Sec	60/45 Sec	60/45 Sec

- (1) The 60i has one physical measurement range. User defined ranges can be used to scale analog outputs as needed for specific installations.
- (2) Specification applies to concentrations equal to or greater than 20 ppm for SO₂, 40 ppm for CO, NO, NO₂ and 1% for CO₂.
- (3) A one-time multipoint calibration can be used to increase accuracy and may be required for measurement ranges smaller than full scale.
- (4) Zero noise is defined as the standard deviation of the signal measured over 30 minutes using a 120 second averaging time.
- (5) Limit of detection is defined as equal to or greater than 2 standard deviations of the noise while sampling contaminant free zero gas.
- (6) Based on operation at stable temperature and pressure.
- (7) Measured from first observed change in signal to 90% of final reading.
- * Specifications for oxygen measurement are presented as electrochemical sensor – EC and paramagnetic sensor – PM, and are stated in concentration units.

Chapter 2

Installation

Installing the Model 60*i* includes the following recommendations and procedures:

- “Lifting” on page 2-1
- “Unpacking and Inspection” on page 2-1
- “Set Up” on page 2-2
- “Startup” on page 2-9
- “Shutdown” on page 2-9
- “Important Tips” on page 2-9

Lifting

When lifting the instrument, use a procedure appropriate to lifting a heavy object, such as bending at the knees while keeping your back straight and upright. Grasp the instrument at the bottom in the front and at the rear of the unit. Although one person can lift the unit, it is desirable to have two persons lifting, one by grasping the bottom in the front and the other by grasping the bottom in the rear.



Equipment Damage Do not attempt to lift the instrument by the cover or external fittings. ▲

Unpacking and Inspection

Carefully unpack and inspect the instrument in a non-condensing environment (15-35 °C). Check for possible damage during shipment. Remove packing material and any shipping screws. Remove any protective plastic material from the case exterior. Check that all connectors and circuit boards are firmly attached.

Set Up

Setting up the instrument involves:

- Connecting Gas Lines
- Making Data and I/O Connections
- Connecting Power

Connecting Gas Lines

For information about connecting gas lines to the Model 60*i*, refer to [Figure 2–1](#), [Figure 2–2](#), and [Table 2–1](#).

[Figure 2–1](#) indicates the numbered steps that are described in [Table 2–1](#).

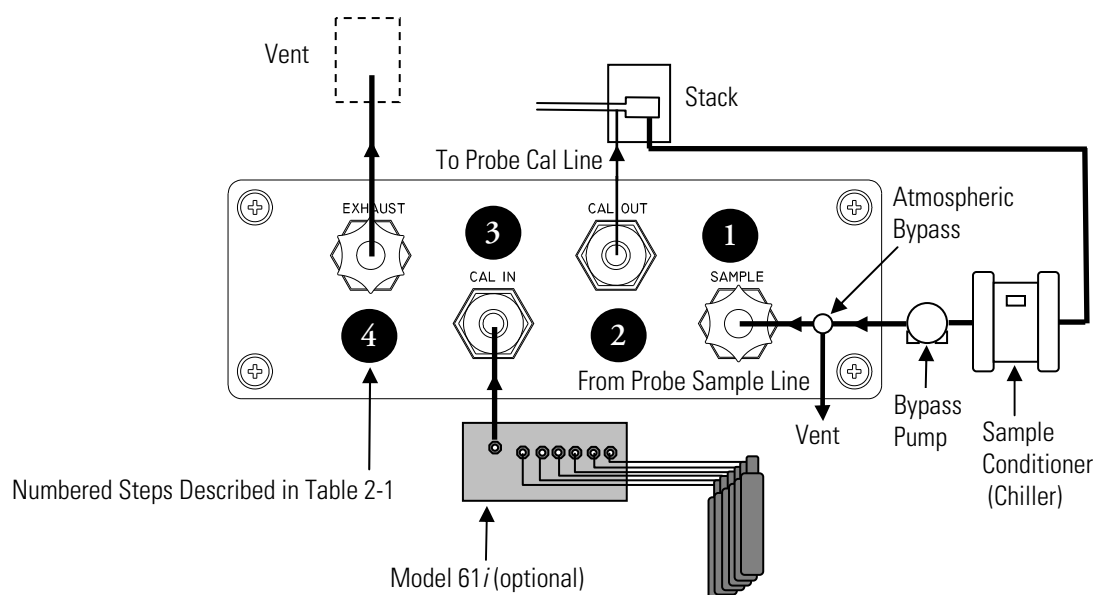


Figure 2–1. Model 60*i* Rear Panel Gas Connections

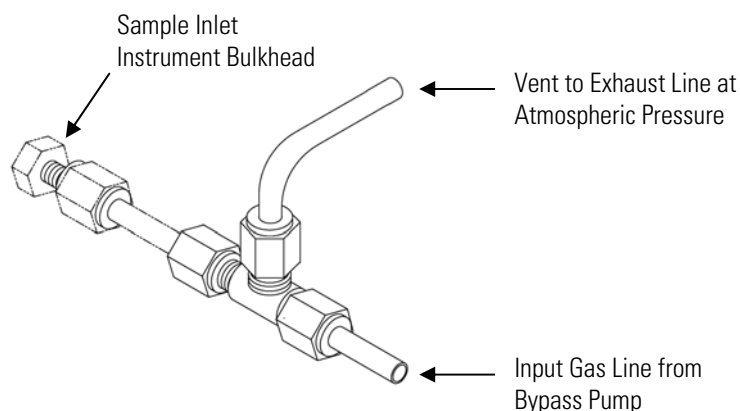


Figure 2–2. Atmospheric Bypass Plumbing

Table 2–1 describes the numbered steps shown in Figure 2–1.

Table 2–1. Connecting Gas Lines

Step	Action
1	<p>Connect the sample line from the chiller/bypass pump to the SAMPLE bulkhead on the rear panel. Ensure that the sample line is not contaminated by dirty, wet, or incompatible materials. All tubing should be constructed of FEP Teflon®, 316 stainless steel, or similar with an OD of 1/4-inch.</p> <p>Note Sample gas must be filtered, conditioned, and delivered to the analyzer at atmospheric pressure. The filter should have a nominal pore size of 1 micron or less and the dew point must be between 2 to 8 °C. ▲</p> <p>Note It may be necessary to use an atmospheric bypass plumbing arrangement if gas pressure is greater than atmospheric pressure. ▲</p>
2	Connect umbilical calibration gas line to CAL OUT.
3	Connect the output from the calibration manifold (span gases and zero air) to CAL IN via 1/4-inch tubing.
4	Connect the EXHAUST bulkhead to a suitable vent. The exhaust line should be 1/4-inch OD with an ID of 1/8-inch or greater. The length of the exhaust line should be less than 10 feet. Verify that there is no restriction in this line.

Note The diagram and instructions presented here assume that calibration gases will be introduced using the optional Model 61*i* calibration system. For systems that do not feature the Model 61*i*, see the “[Calibration](#)” chapter for details on alternative plumbing arrangements. ▲

Making Data and I/O Connections

Data acquisition and external control are implemented through terminal block PCB assemblies with a D-Sub connector on one side and a series of screw terminals on the other. These assemblies provide a convenient mechanism for connecting wires from a data system to the analyzer's input/output (I/O) and digital output (DO) connectors. Refer to the I/O and DO functions and pin assignments that are outlined in the following tables.

Note The pin numbers on the rear panel connectors do not match the pin numbers on the terminal boards. See [Table 2-2](#), [Table 2-3](#), and [Table 2-4](#) for detailed information. ▲

The following terminal block PCB assemblies are available for *i*Series instruments:

- I/O terminal block PCB assembly, 37 pin (standard)
- D/O terminal block PCB assembly, 37 pin (standard)
- 25-pin terminal block PCB assembly, (included with optional I/O expansion Board)

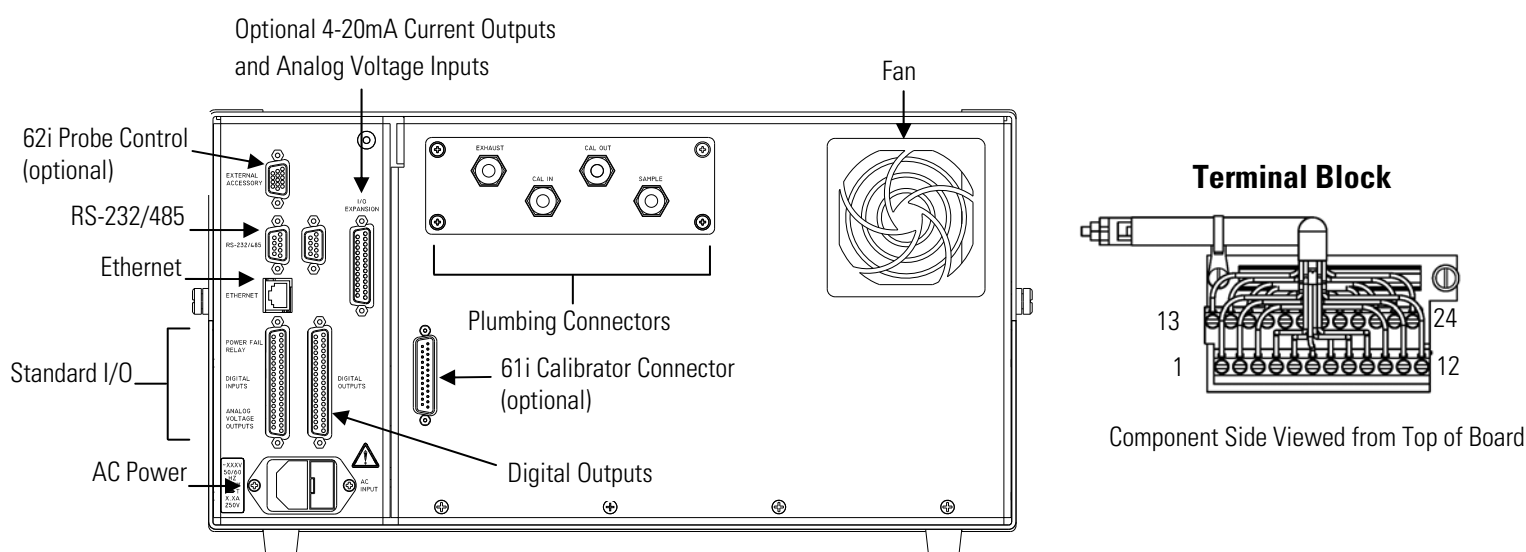


Figure 2-3. Rear Panel Connectors

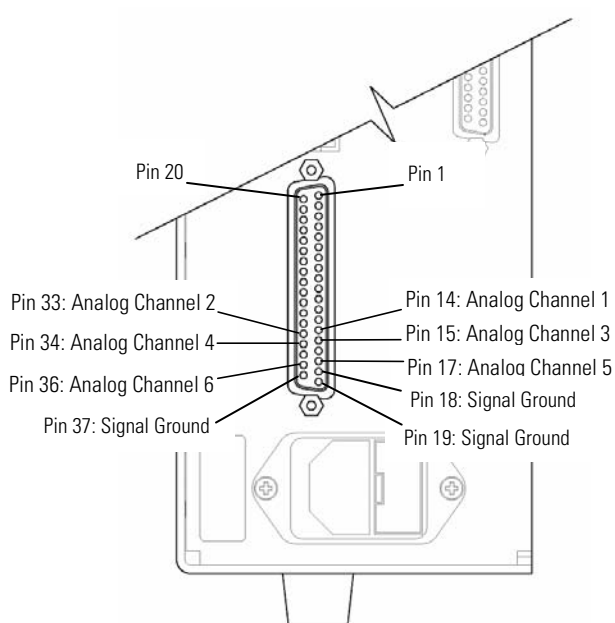


Figure 2–4. Pinouts of Analog Voltage Outputs

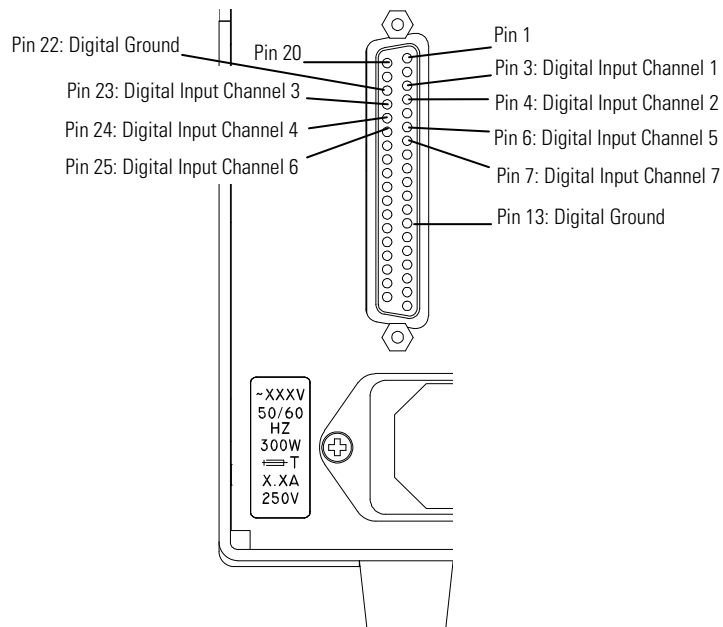


Figure 2–5. Pinouts of Digital Inputs

Table 2–2. Default Analog Voltage Outputs and Digital Inputs (Left Side 37-Pin Connector)

Rear Panel Connector Pin	Terminal Block Screw Number	Description	Default Assignment*
14	1	Analog Out #1	O ₂ Concentration
33	3	Analog Out #2	CO ₂ Concentration
15	5	Analog Out #3	CO Concentration
34	7	Analog Out #4	NO _x Concentration
17	9	Analog Out #5	SO ₂ Concentration
36	11	Analog Out #6	None
16,18,19,35,37	2,4,6,8,10,12	Signal Grounds	NA
1	13	Power Fail (NC)	NA
20	14	Power Fail (Com)	NA
21	15	Power Fail (NO)	NA
3	16	TTL Input 1	Turn Pump Off
4	17	TTL Input 2	Trigger Blowback
23	18	TTL Input 3	Zero IR bench
24	19	TTL Input 4	Zero O ₂ sensor
13,22	20,24	Digital Grounds	NA
6	21	TTL Input 5	Span using Cyl 1
25	22	TTL Input 6	Span using Cyl 2
7	23	TTL Input 7	Span using Cyl 3

Note The pin numbers on the rear panel connectors do not match the pin numbers on the terminal boards. ▲

***Note** All channels are user definable. If any customization has been made to the analog output configuration or TTL inputs, the default selections may not apply. Defaults shown are for a fully-equipped analyzer. ▲

Table 2–3. Digital Outputs (Right Side 37-Pin Connector)

Rear Panel Connector Pin	Terminal Block Screw Number	Signal Description	Default Assignments
1	1	Relay1_ContactA	Local/Remote
20	2	Relay1_ContactB	
2	3	Relay2_ContactA	Service
21	4	Relay2_ContactB	
3	5	Relay3_ContactA	Zero Mode
22	6	Relay3_ContactB	
4	7	Relay4_ContactA	Span Mode
23	8	Relay4_ContactB	
5	9	Relay5_ContactA	Blowback
24	10	Relay5_ContactB	
6	11	Relay6_ContactA	Purge
25	12	Relay6_ContactB	
7	13	Relay7_ContactA	General Alarm
26	14	Relay7_ContactB	
8	15	Relay8_ContactA	Detector Temp
27	16	Relay8_ContactB	
9	17	Relay9_ContactA	Sample Flow
28	18	Relay9_ContactB	
10	19	Relay10_ContactA	Reference Intensity
29	20	Relay10_ContactB	
	21	(not used)	
30, 31, 32, 33	22	+24V	
	23	(not used)	
34, 35, 36, 37	24	+24V	

Table 2–4. Optional Analog Current Outputs and Analog Voltage Inputs (I/O Expansion Board 25-Pin Connector)

Rear Panel Connector Pin	Terminal Block Screw Number	Signal Description
15	1	IOut1
13	2	Isolated ground
17	3	IOut2
16	4	Isolated ground
19	5	IOut3
18	6	Isolated ground
21	7	IOut4
20	8	Isolated ground
23	9	IOut5
22	10	Isolated ground
25	11	IOut6
24	12	Isolated ground
1	13	Analog_In1
2	14	Analog_In2
3	15	Analog_In3
4	16	Ground
5	17	Analog_In4
6	18	Analog_In5
7	19	Analog_In6
8	20	Ground
9	21	Analog_In7
10	22	Analog_In8
11	23	Ground
14	24	Ground

Connecting Power

Before the power cord is connected, be sure that the front panel power switch is Off and be sure to verify that the local power matches the label on the back of the analyzer.



WARNING The Model 60i is supplied with a three-wire grounded power cord. Under no circumstances should this grounding system be defeated. ▲

Startup

Use the following procedure to start the instrument.

1. Turn the power On and allow 90 minutes for the instrument to stabilize.
2. Set instrument parameters such as operating ranges and averaging times to appropriate settings. For more information about instrument parameters, see the “[Operation](#)” chapter.
3. Before beginning the actual monitoring, perform a calibration as described in the “[Calibration](#)” chapter.

Shutdown

Use the following procedure to shutdown the instrument.

1. Connect a clean air source to the SAMPLE connection and allow the instrument to purge pollutants for at least 10 minutes.
2. Turn the power Off.
3. Cover instrument gas ports when not in use.

Important Tips

DO NOT

- Do not pressurize the analyzer with sample gas.
- Do not allow liquids to enter the sample port.
- Do not expose the instrument to vibration or magnetic interference.
- Do not remove/adjust the small circular entrance or exit mirrors in the optical bench.

DO

- Use an external pump with atmospheric bypass dump to deliver the sample gas to the instrument.
- Filter/condition sample stream. Sample dew point must be between 2 and 8 °C.
- Operate the instrument in a climate controlled environment (15-35 °C preferred).
- Set DHCP to Off when changing the IP address. If DHCP is On, the instrument will respond with “Not Settable if DHCP is On.” For more information on using DHCP, see “[Use DHCP](#)” on page 3-65 and the DHCP C-link command in the “[C-Link Protocol Commands](#)” appendix.



Chapter 3

Operation

This chapter describes the front panel display screens, front panel pushbuttons, and menu-driven firmware. For details, see the following topics:

- “Display” on page 3-1
- “Pushbuttons” on page 3-2
- “Firmware Overview” on page 3-5
- “System Menu” on page 3-9
- “Range/Units Menu” on page 3-18
- “Averaging Time” on page 3-21
- “Calibration Menu” on page 3-21
- “Instrument Controls Menu” on page 3-45
- “Diagnostics Menu” on page 3-85
- “Alarms Menu” on page 3-92
- “Service Menu” on page 3-103
- “Password Menu” on page 3-129

Display

The 320 x 240 graphics liquid-crystal display (LCD) shows the sample concentrations, instrument parameters, instrument controls, and error messages. Some menus contain more items than can be displayed at one time. For these menus, use  and  to move the cursor up and down to each item.

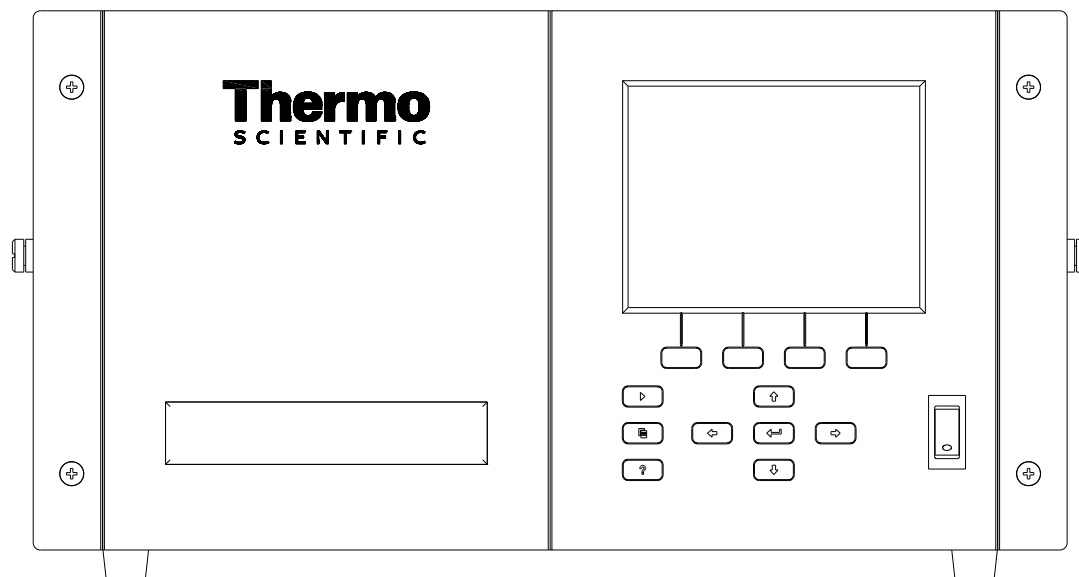


Figure 3–1. Front Panel Display



CAUTION If the LCD panel breaks, do not let the liquid crystal contact your skin or clothes. If the liquid crystal contacts your skin or clothes, wash it off immediately using soap and water. ▲

Pushbuttons

The Pushbuttons allow the user to traverse the various screens/menus.

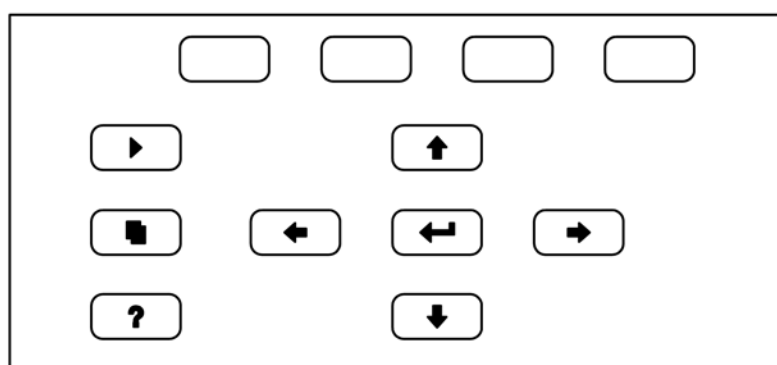






















Figure 3–2. Front Panel Pushbuttons


Table 3–1 lists the front panel pushbuttons and their functions.

Table 3–1. Front Panel Pushbuttons

Key Name	Function
 = Soft Keys	The  (soft keys) are used to provide shortcuts that allow the user to jump to user selectable menu screens. For more information on processing soft keys, see “Soft Keys.”
 = Run	The  is used to display the Run screen. The Run screen normally displays the current concentrations.
 = Menu	The  is used to display the Main Menu when in the Run screen, or to back up one level in the menu system. For more information about the Main Menu, see “Main Menu” later in this chapter.
 = Help	The  is context-sensitive, that is, it provides additional information about the screen that is being displayed. Press  for a brief explanation about the current screen or menu. Help messages are displayed using lower case letters to easily distinguish them from the operating screens. Press  to return to the Run screen, or any other key to exit a help screen.
  = Up, Down   = Left, Right	The four arrow pushbuttons ( ,  ,  , and ) move the cursor up, down, left, and right or change values and states in specific screens.
 = Enter	The  is used to select a menu item, accept/set/save a change, and/or toggle on/off functions.

Soft Keys

The soft keys are multi-functional keys that use part of the display to identify their function. The soft keys provide a shortcut to the most often used menus and screens. They are located directly underneath the display, and user-defined labels in the lower part of the display indicate the function of each key at that time.

To change a soft key, place the menu cursor “>” on the item of the selected menu or screen you wish to set. Press  followed by the selected soft key within 1 second of pressing the right-arrow key. The “edit soft key prompt” will be displayed for configuration of the new label.

Note When assigning menu items to soft keys, be sure that you do not unintentionally provide access to functions that would normally not be active at the operator level. Refer to “[Service/Access Level](#)” in this chapter for a description of the operator level. ▲

Note Not all menu items may be assigned to soft keys. If a particular menu or screen item cannot be assigned, the “edit soft key prompt” screen will not come up upon entering right-arrow-soft key combinations. All items

under the Service menu (including the menu itself) cannot be assigned soft keys. ▲






```


EDIT SOFT KEY PROMPT:
CURRENTLY: RANGE
          RANGE
BCDEFGHIJKLMNOP BKSP
PQRSTUVWXYZ PAGE
0123456789 ./- SAVE


RANGE  AVG  DIAGS  ALARM


```

Alphanumeric Entry Screen


The alphanumeric entry screen is used to enter strings consisting of letters, numbers, and other characters. The cursor may be positioned within the entry line using the  and  keys. If a character is entered over an existing character, that character will be overwritten. Use the  and  keys to switch between the entry line and the keyboard as well as to move within the keyboard. To select a character to add to the string, use the cursor keys to position the cursor over the desired character, and then press the  key to add that character to the entry line.

On the right side of the keyboard are special functions. BKSP is used to move the cursor in the entry line one place to the left, deleting the character that was to the left of the cursor and moving any character at or to the right of the cursor one place to the left. PAGE is used to change the keyboard character page. For the English language, this switches between upper and lower-case alphabetic characters. SAVE stores the string from the entry line into the parameter. Alternately, if the active cursor is moved to the entry line,  may be pressed to store the string from the entry line into the parameter.

Entry Line	→		
Keyboard	→	BCDEFGHIJKLMNOP BKSP	
		PQRSTUVWXYZ PAGE	
		0123456789 ./- SAVE	
		RANGE AVG DIAGS ALARM	

			
		abcdefghijklmnopqrstuvwxyz BKSP	
		opqrstuvwxyz PAGE	
		0123456789 ./- SAVE	
		RANGE AVG DIAGS ALARM	

Firmware Overview

The Model 60*i* utilizes the menu-driven firmware as illustrated by the flowchart in [Figure 3–3](#). For detailed information on access levels, refer to “[Service/Access Level](#)” on page [3-84](#). The Power-Up screen, shown at the top of the flowchart, is displayed each time the instrument is turned on. This screen is displayed while the instrument is warming up and performing self-checks. After the warm-up period, the Run screen is automatically displayed. The Run screen is the normal operating screen. The appearance and contents of the Run screen can be altered using commands listed in the Service menu and described later in this chapter. This screen provides the current instrument readings along with some additional information concerning the instrument status. From the Run screen, the Main Menu can be displayed by pressing . The Main Menu contains a list of submenus. Each submenu contains related instrument settings. This chapter describes each submenu and screen in detail. Refer to the appropriate sections for more information.

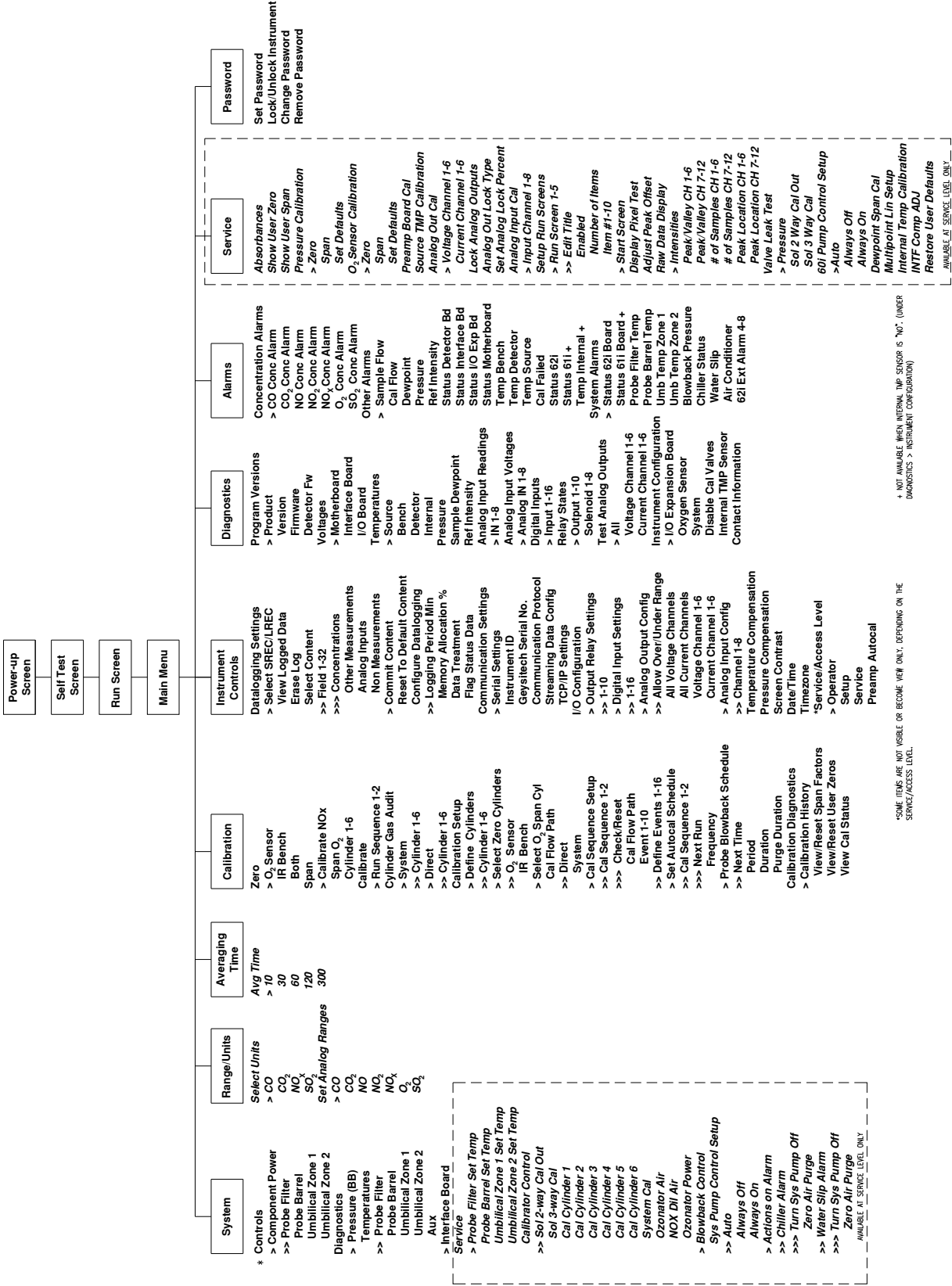


Figure 3–3. Model 60i Flowchart of Menu-Driven Firmware

Power-Up Screen

The Power-up screen is displayed when power is applied to the Model 60i. This screen is displayed while the internal components are warming up and diagnostic checks are being performed.

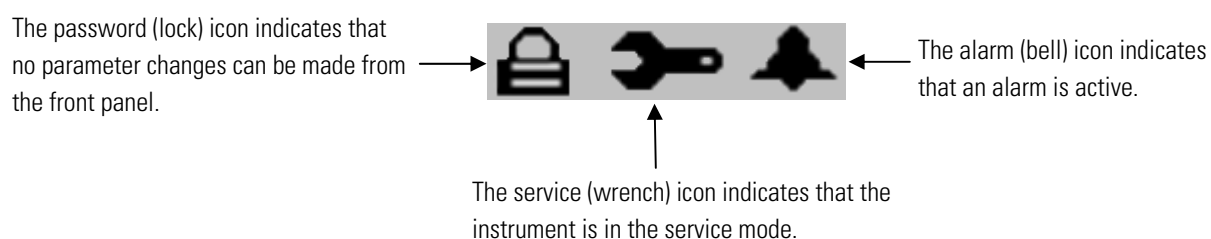


Run Screen

The Run screen displays the current concentration readings. The status bar displays the time, the password (lock) icon, service (wrench) icon, alarm (bell) icon, and solenoid valve status, if installed.

Note Time is always displayed in 24-hour format. ▲

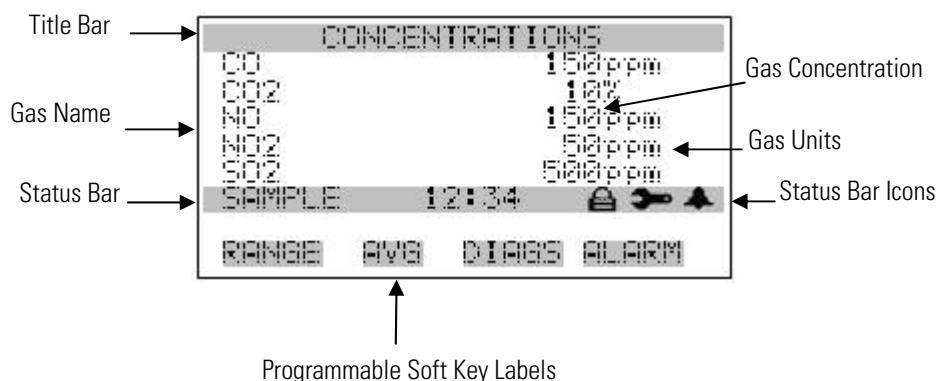
Status Bar Icons



The exact layout of the Run screen varies depending on the instrument configuration. A typical Run screen is shown in the following illustration.

The status bar displays the current time (24-hour format), alarm, service, and password icons.

The word "SAMPLE" on the left of the status bar indicates the analyzer is in "SAMPLE" mode. Other modes appear in the same area of the display as "ZERO" or "SPAN".



Custom Run Screens

Up to five Custom Run Screens can be configured. For more information on custom run screens, see “[Setup Run Screens](#)” on page 3-115.

Main Menu

The Main Menu contains a number of submenus. Instrument parameters and settings can be read and modified within the submenus according to their function. The concentration readings appear above the Main Menu and submenus in every screen. The Service menu is visible only when the instrument is in Service Level mode, and the System menu is visible only when the System option has been enabled in the Instrument Configuration menu.

The Model 60i provides three different menu systems or access levels. These are designated as Service Level, Setup Level and Operator Level.

The Service Level menu provides access to all critical operating and configuration parameters (Service menu). Service Level locks out any remote actions and includes parameters and functions that are useful when making adjustments or diagnosing the Model 60i.






Access to Service Level menus should usually be restricted to trained service technicians, since changes in this portion of the firmware can result in instrument malfunctions that could be difficult to diagnose and correct.

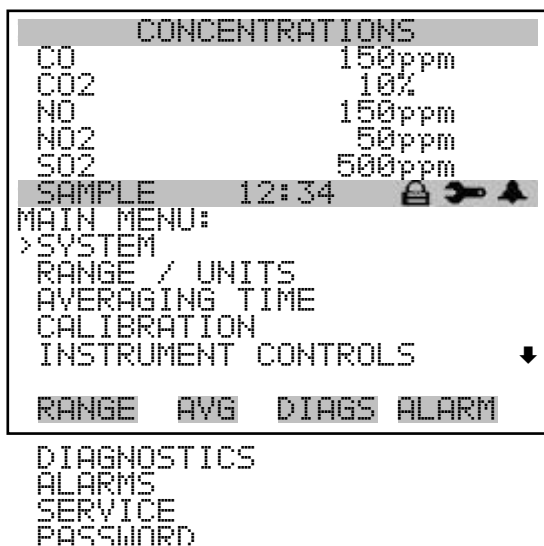
Note The Access Level should be in Service when not in use, as it prevents remote operation. ▲

For more information on the Service Level mode, see “[Service Menu](#)” later in this chapter and for more information on the Instrument Configuration menu, see “[Diagnostics](#)” also in this chapter.

The Setup Level menu system provides access to all of the operating parameters that are used in initial setup and programming of automated functions. Note that the Setup Level does not allow access to the Service menu.

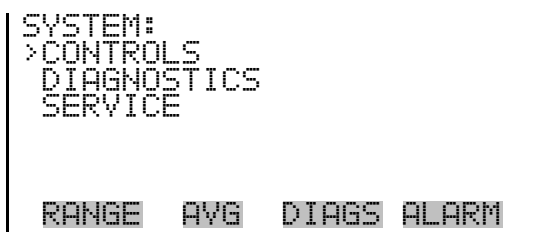
The Operator Level menu provides a simpler interface that allows the instrument to run and be calibrated, but restricts access to critical parameters and instrument configuration menus.

- Use  and  to move the cursor up and down.
- Press  to make a selection.
- Press  to return to the Main Menu or  to return to the Run screen.



System Menu

The System menu is used to configure and monitor the status of the 62i Multi-Gas Probe Controller and the 61i Calibrator, if the 60i is used in a system.



System Controls

The System Controls menu is used to configure component power for the 62i.

```
SYSTEM CONTROLS:
>COMPONENT POWER

RANGE  AVG  DIAGS  ALARM
```

Component Power

The Component Power menu is used to configure component power for the 62i Multi-Gas Probe Controller.

- In the Main Menu, choose System > Controls > **Component Power**.

```
COMPONENT POWER:
>PROBE FILTER          OFF
PROBE BARREL           OFF
UMBILICAL ZONE 1       OFF
UMBILICAL ZONE 2       OFF

RANGE  AVG  DIAGS  ALARM
```

Probe Filter Power

The Probe Filter Power screen is used to enable or disable power for the sample probe's filter heater.

- In the Main Menu, choose System > Controls > Component Power > **Probe Filter**.

```
PROBE FILTER POWER:
CURRENTLY:          OFF
SET TO:             ON ?

    ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM
```

Probe Barrel Power

The Probe Barrel Power screen is used to enable or disable power for the sample probe's barrel heater.

- In the Main Menu, choose System > Controls > Component Power > **Probe Barrel**.

```

PROBE BARREL POWER:
CURRENTLY:          OFF
SET TO:             ON ?

        ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM

```

Umbilical Zone 1 Power

The Umbilical Zone 1 Power screen is used to enable or disable power for the heater in the first section or zone of the sampling umbilical. If the umbilical is less than 150 feet long, Zone 1 may control the entire line.

- In the Main Menu, choose System > Controls > Component Power > **Umbilical Zone 1**.

```

UMBILICAL POWER - ZONE 1 :
CURRENTLY:          OFF
SET TO:             ON ?

        ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM

```

Umbilical Zone 2 Power

The Umbilical Zone 2 Power screen is used to enable or disable power for the heater in the second section or zone of the sampling umbilical.

- In the Main Menu, choose System > Controls > Component Power > **Umbilical Zone 2**.

```

UMBILICAL POWER - ZONE 2 :
CURRENTLY:          OFF
SET TO:             ON ?

        ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM

```

System Diagnostics

The System Diagnostics menu is used to view diagnostic information involving system pressures, temperatures, and 62i interface board voltages.

- In the Main Menu, choose System > **Diagnostics**.

```
SYSTEM DIAGNOSTICS:
>PRESSURE
TEMPERATURES
INTERFACE BOARD 62i

RANGE  AVG  DIAGS  ALARM
```

System Pressures

The System Pressures screen displays the blowback pressure.

- In the Main Menu, choose System > Diagnostics > **Pressure**.

```
SYSTEM PRESSURES:
BB PRESSURE      00.0  psi

RANGE  AVG  DIAGS  ALARM
```

System Temperatures

The System Temperatures screen displays the current probe filter temperature, probe barrel temperature, umbilical zone 1 and 2 temperatures, and chiller temperature.

- In the Main Menu, choose System > Diagnostics > **Temperatures**.

```
SYSTEM TEMPERATURES:
PROBE FILTER      0.0
PROBE BARREL      0.0
UMBILICAL ZONE 1  0.0
UMBILICAL ZONE 2  0.0
AUX               0.0

RANGE  AVG  DIAGS  ALARM
```

Interface Board 62i

The Interface Board 62i screen is used to display the voltage readings on the 62i interface board. This menu is displayed only when the 60i system option under Instrument Configuration is enabled. (See “[Instrument Configuration](#)” under the Diagnostics menu for more information.)

- In the Main Menu, choose System > Diagnostics > **Interface Board 62i**.

```

INTERFACE BRD62 VOLTAGES:
  3.3 SUPPLY      3.2 V
  5.0 SUPPLY      5.0 V
 15.0 SUPPLY     15.1 V
 24.0 SUPPLY     24.2 V
-15.0 SUPPLY    -15.1 V

  RANGE  AVG  DIAGS  ALARM

```

System Service Menu

The System Service menu is used to set temperatures for system components controlled by the 62*i*, can be used to manually control the 60*i* and 61*i* calibration solenoids, and can be used to manually trigger a probe blowback. It is also used to control the system sample pump, and determine actions taken in the event of a chiller alarm or water slip alarm. (See “[System Alarms](#)” under the Alarms menu for more information.)

- In the Main Menu, choose System > **Service**.

```

SYSTEM SERVICE:
PROBE FILTER SET TEMP 175
PROBE BARREL SET TEMP 175
UMB ZONE 1 SET TEMP 160
UMB ZONE 2 SET TEMP 160
CALIBRATOR CONTROL

  RANGE  AVG  DIAGS  ALARM

BLOWBACK CONTROL
SYS PUMP CONTROL SETUP
ACTIONS ON ALARM

```

Probe Filter Set Temperature

The Probe Filter Set Temperature screen is used to change the probe filter set temperature.

- In the Main Menu, choose System > Service > **Probe Filter Set Temp**.

```

PROBE FILTER SET TEMP:
CURRENTLY:      175 °C
SET TO:        175 °C

      ↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

  RANGE  AVG  DIAGS  ALARM

```

Probe Barrel Set Temperature

The Probe Barrel Set Temperature screen is used to change the probe barrel set temperature.

- In the Main Menu, choose System > Service > **Probe Barrel Set Temp**.

```

PROBE BARREL SET TEMP:
CURRENTLY: 175 °C
SET TO: 173 °C

      ↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Umbilical Zone 1 and Zone 2 Set Temperature

The Umbilical Zone 1 Set Temperature screen is used to change the set temperature for umbilical zone 1. The Umbilical Zone 2 Set Temperature screen operates the same way.

Note Zone 2 is not typically used for umbilicals less than 150 feet long. ▲

- In the Main Menu, choose System > Service > **Umb Zone 1 Set Temp.**

```

UMBILICAL ZONE 1 SET TEMP:
CURRENTLY: 165 °C
SET TO: 163 °C




      ↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Calibrator Control

Used for testing purposes, the Calibrator Control screen is used to open and close solenoids in the 60i and 61i, and to activate the ozonator. Refer to the Multi-Gas System Manual for complete details.

To toggle a solenoid Open or Closed, press  or  to select the solenoid, then press  to toggle it Open or Closed.

- In the Main Menu, choose System > Service > **Calibrator Control.**


```

CALIBRATOR CONTROLS:
SOL 2WAY CAL OUT  CLOSED
SOL 3WAY CAL      CLOSED
CAL CYLINDER 1    CLOSED
CAL CYLINDER 2    CLOSED
CAL CYLINDER 3    CLOSED ↓
RANGE  AVG  DIAGS  ALARM

CAL CYLINDER 6    CLOSED
SYSTEM CAL        CLOSED
OZONATOR AIR      CLOSED
NOX DIL AIR       CLOSED
OZONATOR POWER    CLOSED

```

Blowback Control

The Blowback screen is used to manually activate a probe blowback. Press  to toggle the blowback solenoid On and Off and save the setting.

- In the Main Menu, choose System > Service > **Blowback Control**.

```

BLOWBACK:
CURRENTLY:          OFF
SET TO:             ON ?

          ← TOGGLE VALUE




RANGE  AVG  DIAGS  ALARM

```

System Pump Control Setup

The System Pump Control Setup screen is used to set the system pump to Always On, Always Off, or put it in the Auto mode. When the setting is Always On, the pump runs as long as this setting is active. When the setting is Always Off, the pump does not run. When the setting is Auto (the recommended setting), the pump runs continuously if there is no Chiller Alarm or Water Slip Sensor Alarm. If there is a Chiller Alarm or Water Slip Sensor Alarm, the pump can be set to remain on or can be shut off until the alarm is cleared, and a zero air purge can be initiated until the alarm is cleared. (See “[Actions on Alarm](#)” below.)

Note If the chiller alarm is set to turn the pump off and the water slip alarm is set to leave it on (or vice versa), the pump will turn off. Similarly, if the chiller alarm is set to perform a zero air purge and the water slip alarm is not (or vice versa), the zero air purge will occur. ▲

To change the pump setting between Always On, Always Off, and Auto, press   to choose the setting, and press  to save the selection.

- In the Main Menu, choose System > Service > **Sys Pump Control Setup**.

```

SYS PUMP CONTROL:
CURRENTLY:          ALWAYS ON
SET TO:             AUTO?

          ↑↓ CHANGE VALUE
          ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

Actions on Alarm

The Actions on Alarm menu is used to specify how the system responds to a chiller alarm or a water slip alarm, when the System Pump Control is in Auto mode.

- In the Main Menu, choose System > Service > **Actions on Alarm**.

```
ACTIONS ON ALARM:
>CHILLER ALARM
  WATER SLIP ALARM

RANGE  AVG  DIAGS ALARM
```

Chiller Alarm

The Chiller Alarm menu can be used to shut off the system pump or perform a zero air purge when a chiller alarm is detected. (Refer to “[System Pump Control Setup](#)” above.)

- In the Main Menu, choose System > Service > Actions on Alarm > **Chiller Alarm**.

```
ACTIONS ON CHILLER AL:
>TURN SYS PUMP OFF
  ZERO AIR PURGE

RANGE  AVG  DIAGS ALARM
```

Turn System Pump Off

The Turn System Pump Off screen is used to toggle between Yes and No, as to whether the system pump should shut off when a chiller alarm is detected.

- In the Main Menu, choose System > Service > Actions on Alarm > Chiller Alarm > **Turn Sys Pump Off**.

```
SYSTEM PUMP OFF:
CURRENTLY: NO
SET TO: YES ?
      ← TOGGLE VALUE

RANGE  AVG  DIAGS ALARM
```


Zero Air Purge

The Zero Air Purge screen is used to toggle between Yes and No, as to whether the system is purged with zero air when a chiller alarm is detected. When the zero air purge feature is enabled, the 61*i* sends zero air to the probe to flush the sample line (and the 60*i* if the system pump is set to remain on).

- In the Main Menu, choose System > Service > Actions on Alarm > Chiller Alarm > **Zero Air Purge**.

```

PURGE ZERO AIR:
CURRENTLY: NO
SET TO: YES      ?
                ← TOGGLE VALUE

RANGE  AVG  DIAGS ALARM

```

Water Slip Alarm

The Water Slip Alarm menu can be used to shut off the system pump or perform a zero air purge when a water slip alarm is detected. (Refer to “[System Pump Control Setup](#)” above.)

- In the Main Menu, choose System > Service > Actions on Alarm > **Water Slip Alarm**.

```

ACTIONS ON WATER SLIP AL:
>TURN SYS PUMP OFF
ZERO AIR PURGE

RANGE  AVG  DIAGS ALARM

```

Turn System Pump Off

The Turn System Pump Off screen is used to toggle between Yes or No, as to whether the system pump should shut off when a water slip alarm is detected.

- In the Main Menu, choose System > Service > Actions on Alarm > Water Slip Alarm > **Turn Sys Pump Off**.

```
SYSTEM PUMP OFF:
CURRENTLY: NO
SET TO: YES ?
      ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM
```

Zero Air Purge

The Zero Air Purge screen is used to toggle between Yes or No, as to whether the system is purged with zero air when a water slip alarm is detected. When the zero air purge feature is enabled, the 61*i* sends zero air to the probe to flush the sample line (and the 60*i* if the system pump is set to remain on).

- In the Main Menu, choose System > Service > Actions on Alarm > Water Slip Alarm > **Zero Air Purge**.

```
PURGE ZERO AIR:
CURRENTLY: NO
SET TO: YES ?
      ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM
```

Range/Units Menu

The Range/Units menu is used to select the concentration units for each of the gases that can be measured (except oxygen), and to configure output ranges for analog outputs used to track concentration readings.





- In the Main Menu, choose **Range / Units**.




```
RANGE / UNITS:
>SELECT UNITS
SET ANALOG RANGES

RANGE  AVG  DIAGS  ALARM
```

Select Units

The Select Units screen is used to configure how the concentration is expressed for CO, CO₂, NO_x and the SO₂ group). Depending on the specific gas, units of parts per million (ppm), milligrams per cubic meter (mg/m³), or percent (%) may be available.

Select a gas by pressing  or , then step through the available units by pressing the  or .

Items that have been changed will display a “?” to the right until the new settings are saved. Changes can be saved by pressing  or can be cancelled by pressing , or .

Note When switching the selected units, the instrument’s analog ranges all default to the highest range. Therefore, whenever you change units, you should also check the range settings. ▲

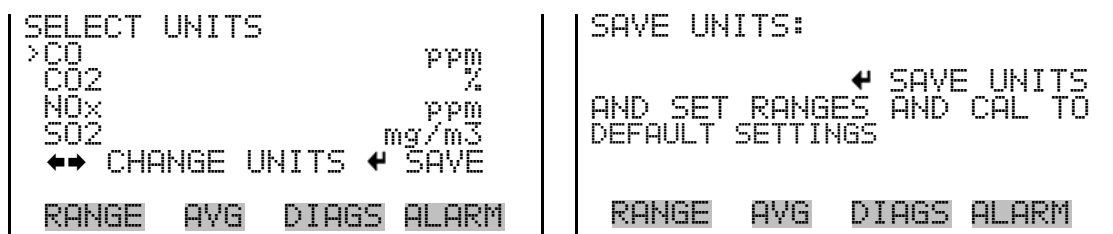
Table 3–2 lists the options available for each gas.

Note The units selected for NO_x will apply to both NO and NO₂ at other locations in the firmware. ▲

Table 3–2. Types of Selections Available for Select Units Menu Items

Gas	Selections Available
CO	ppm, mg/m ³
CO ₂	ppm, mg/m ³ , %
NO _x	ppm, mg/m ³
SO ₂	ppm, mg/m ³

- In the Main Menu, choose Range / Units > **Select Units**.






Set Analog Ranges

The Set Analog Ranges screen defines the scaling, or concentration range, of the analog outputs. For example, selecting a concentration range of 100 ppm scales the analog output to display concentrations between 0 and 100 ppm. The upper end of the range can be set to any integer value up to a maximum that is dependent on the specific gas under consideration. The smallest analog range for each channel is limited by the measurement

capabilities of the analyzer as indicated in the performance specifications shown in the “[Introduction](#)” chapter.

The Set Analog Ranges screen lists all the gases that the analyzer is configured to report, along with the current range setting and units for each gas. The concentration units displayed on the Set Analog Ranges screen are those that were chosen in the Select Units screen discussed previously.


To change the analog output range for any gas, move the cursor to the appropriate line using  and  and press . This will open an editing screen that will allow the operator to change the concentration that will produce a full scale analog output.

- In the Main Menu, choose Range / Units > **Set Analog Ranges**.

SET ANALOG RANGES:		
>CO	2500	ppm
CO2	25.0	%
NO	2000	ppm
NO2	500	ppm
NOx	1000	ppm
↓		
RANGE	AVG	DIAGS ALARM
O2	25.0	%
SO2	2000	mg/m3

Set CO Range

The Set CO Range screen displays the current concentration range for the analog output assigned to report CO, and allows the range value to be edited. There is an identical screen for each gas that the analyzer is configured to measure.

Note The screen displays the maximum setting. If you attempt to enter a value above the upper limit or below the lower limit, a prompt is displayed to indicate this, and the value you attempted to enter is automatically changed to the limit value. You still need to press  to save the change. ▲

- In the Main Menu, choose Range / Units > Set Analog Ranges > **CO**.

```

SET CO RANGE: (MAX: 2500)
RANGE: 1000 ppm
SET TO: 00000000 ppm?

↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE




RANGE  AVG  DIAGS  ALARM

```

Averaging Time

The Averaging Time screen allows the user to change the time period over which the concentration measurements are averaged. Available averaging times are 10, 30, 60, 120, and 300 seconds. The concentration measurement shown on the front panel display is updated every 10 seconds. However, the value shown on the display is actually the average value measured over the course of the selected averaging time. For example, if the averaging time is set to 60 seconds, the concentration readings shown on the display at any given time are the average concentrations measured over the last 60 seconds. Note that the selected averaging time is also applied to data that is collected over the analog outputs or through the digital I/O system.

Increased averaging time reduces random variations or noise in the displayed values. This improves the apparent signal to noise ratio and the instrument's minimum detectable concentration. However, increased averaging time also causes the instrument to have longer response times and prevents the instrument from tracking rapid changes in concentration. If a specific averaging time is not required by regulations, the 120 second averaging time is suggested for routine flue gas monitoring.

To change the averaging time, use the  and  keys and then save the change by pressing .

- In the Main Menu, choose **Averaging Time**.

```

AVG TIME: 10/30/60/120/300
CURRENTLY: 120
SET TO: 60 ?

↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Calibration Menu

The Calibration menu is used to:

- Define the composition of span cylinders.
- Select a cylinder for use in zero adjustment.
- Select a calibration gas flow path.

- Schedule automated calibration checks, adjustments, or probe blowbacks.
- Perform manual zero and span adjustments.

In addition, the firmware provides access to a calibration diagnostics screen that provides a record of recent calibrations and diagnostic data.

An overview of the calibration firmware functionality follows (Table 3–3) along with a flow chart of the calibration firmware structure (Figure 3–4).

Note This “Operation” chapter describes only the menu systems and firmware. For a detailed description of calibration procedures and the necessary equipment, see the “Calibration” chapter. ▲

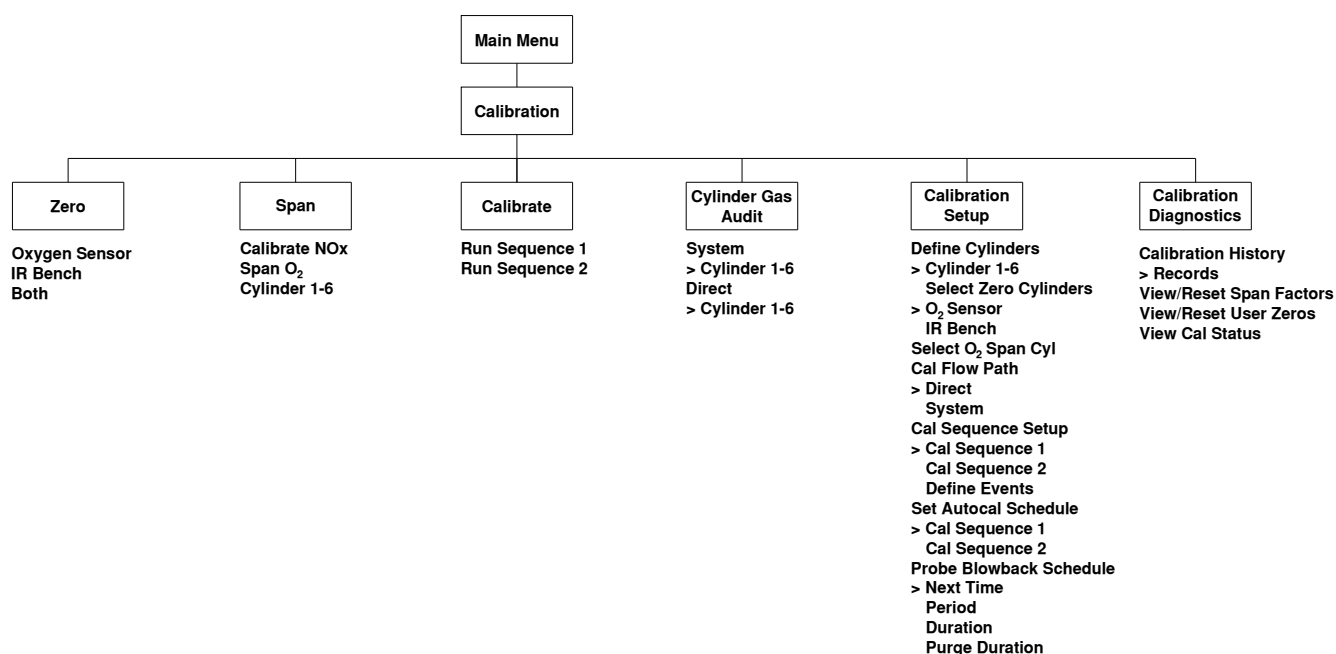


Figure 3–4. Calibration Firmware Structure

The Calibration Menu includes five top level selections (Table 3–3).

Table 3–3. Calibration Menu Top Level Selections

Menu Selection	Description
Zero	Used to set the instrument's zero reading for all concentration measurements.
Span	Used to set the instrument span coefficient for each individual component that the instrument can measure.
Calibrate	Used to execute a selected calibration sequence.
Calibration Set Up	Opens a series of sub-menus and commands that allow the operator to enter data that describes the calibration cylinders that will be used and to select which cylinders will be used to zero and span each measurement channel. Also used to set up the calibration sequences, set auto calibration schedules, and set probe blowback schedule.
Calibration Diagnostics	Used to view calibration diagnostic information.

- In the Main Menu, choose **Calibration**.

```

CALIBRATION:
>ZERO
SPAN
CALIBRATE
CALIBRATION SETUP
CALIBRATION DIAGNOSTICS

RANGE  AVG  DIAGS  ALARM


```

Zero

The Zero menu is used to access commands that will adjust the analyzer zero, or background, for each measurement channel. When Zero is selected, the screen displays the following three options:

- O₂ SENSOR
- IR BENCH
- BOTH

The operator then has the opportunity to zero just the O₂ sensor, to zero just the infrared bench (all other gases), or to zero both measurement systems at the same time. The specific cylinder that will be used to zero each measurement system is also indicated.




To start a zero adjustment, move the cursor to the appropriate line and press .

- In the Main Menu, choose Calibration > **Zero**.

```
CALIBRATE ZERO:
>O2 SENSOR      CYLINDER 2
IR BENCH        CYLINDER 2
BOTH            CYLINDER 2

RANGE  AVG  DIAGS  ALARM
```

The display will now indicate which measurement device was selected, such as O2, IR, or O2+IR, and the selected calibration. Note that the choice of cylinder and a description of the mixture that each cylinder contains must be entered in the Calibration Setup menu, described later in this chapter.

From the Calibrate Zero adjustment screen that follows, press  to start the actual zero adjustment process. A countdown timer will then appear in the status bar, indicating the time required to complete the zero adjustment process. This time is the averaging time plus 60 seconds. Press  to save the zero and apply the zero correction. Pressing  before the adjustment process is complete will terminate the zero adjustment without saving changes.

```
CALIBRATE ZERO:      (O2+IR)
ZERO USING CYLINDER 2
CONTAINS: CO

PRESS → TO ZERO

RANGE  AVG  DIAGS  ALARM
```

Span

The Span menu is used to access commands that will adjust the analyzer span factor for each measurement channel. When Span is selected, the screen displays the following options:

- CALIBRATE NOX
- SPAN O2
- CYLINDER 1-6

The measurement channel that will be spanned is determined by which cylinder the operator selects. The span coefficient is used to adjust the instrument response such that the concentration reading produced when sampling a known cylinder matches the concentration entered by the operator.

For example, if the cylinder that is selected contains CO and SO₂, a span adjustment will be made on both of those measurement channels. As noted elsewhere, span adjustments can be made using blended cylinders or cylinders that contain only a single pollutant. While both methods will produce good results, spanning with blended cylinders does not allow the analyzer to correct for cross interferences as efficiently as it will with single component span gases. Note that selecting a cylinder that contains oxygen will not adjust the oxygen sensor span. The oxygen sensor span adjustment is only triggered by the “Span O₂” command.

Note For detailed information about generating NO_x span gas, refer to “[Calibrating NO, NO₂, and NO_x](#)” on page 4-29. ▲

- In the Main Menu, choose Calibration > **Span**.

```

CALIBRATE SPAN:
>CALIBRATE NOX
SPAN O2
CYLINDER 1 ►      CO2 O2
CYLINDER 2 ►      SO2
CYLINDER 3 ►      CO CO2 O2↓
RANGE  AVG  DIAGS  ALARM

```

Calibrate NO_x

The Calibrate NO_x selection is used to perform a span adjustment on the NO₂ channel using an ozone based NO₂ generator (located in the Model 6100z calibrator). Selecting this will open a series of screens that step through the span procedure for systems using an NO₂ generator rather than an NO₂ cylinder. For a full description of this procedure, refer to the “[Calibration](#)” chapter.

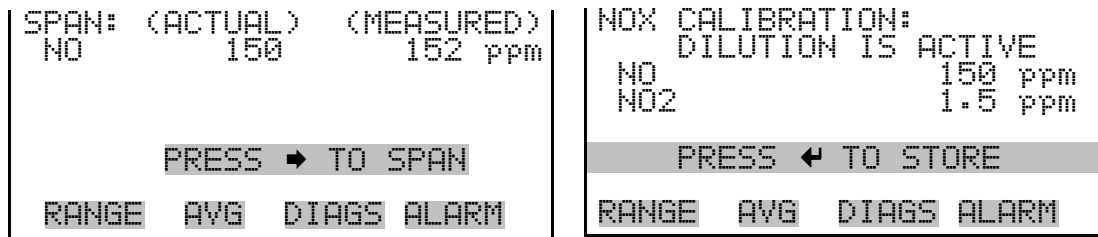
- In the Main Menu, choose Calibration > Span > **Calibrate NO_x**.

```

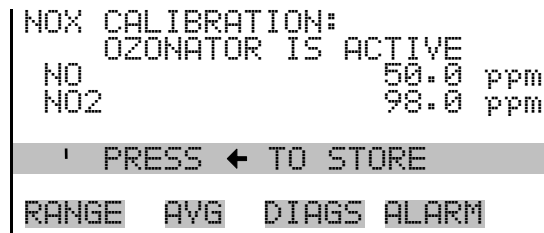
NOX CALIBRATION:
ENSURE THAT CYLINDER 6 IS
DEFINED AS SPAN GAS NO
← SPAN NO      → SKIP
RANGE  AVG  DIAGS  ALARM

```

Press  to span NO or press  to skip to the next step if NO has already been spanned.





Press  to store.



Span O₂ Sensor

When Span O₂ is selected, the display shows the oxygen concentration that is currently being measured along with the actual oxygen concentration of the span cylinder, as entered in the cylinder definition screen. Note that since multiple cylinders are likely to contain oxygen, the oxygen span cylinder must be specifically designated during calibration setup. (Main Menu > Calibration > Calibration Setup > **Select O₂ Span Cylinder.**)

If the optional Model 61*i* Calibrator is being used, the cylinder designated as the oxygen span source will be opened when this screen is displayed. If a digital output is assigned to track the oxygen span cylinder state, that output will also be activated.

To start the actual span adjustment, wait for the measured value to stabilize then press the right arrow key and follow the on-screen prompts. A countdown timer will then appear in the status bar, indicating the time required to complete the span adjustment process. This time is the averaging time plus 60 seconds. Press  to save the span and apply the span correction. Pressing  before the adjustment process is complete will terminate the span adjustment without saving changes.

- In the Main Menu, choose Calibration > Span > **Span O₂.**

```

02 SPAN#
      (ACTUAL) (MEASURED)
02    0.00000  0.0 %
-----
PRESS → TO SPAN
-----
RANGE  AVG  DIAGS ALARM

```

Span Cylinders

When Span is selected, the screen displays a list of cylinders that are numbered one through six. The contents of each cylinder are displayed to the right of the cylinder number and can be entered or edited in the “[Calibration Setup](#)” menu that is discussed on page 3-28.

To adjust the span coefficient for a specific gas, move the cursor to indicate a cylinder containing the gas or gases of interest and press . The display will then show the contents of that cylinder, including the concentration of each gas.

Press to start the span adjustment or press to step back and select a different cylinder. When the span adjustment starts, a countdown timer will appear in the status bar, indicating the time required to complete the process. Pressing before the adjustment process is complete will terminate the span factor adjustment without saving changes.

- In the Main Menu, choose Calibration > Span > **Cylinder (1-6)**.

```

SPAN# (ACTUAL) (MEASURED)
CO      500      472 ppm
CO2     20.5     19.3 ppm
O2      21.9     20.1 %
-----
PRESS → TO SPAN
-----
RANGE  AVG  DIAGS ALARM

```

```

SPAN# (ACTUAL) (MEASURED)
CO      500      470 ppm
CO2     20.5     19.2 ppm
O2      21.7     20.1 %
-----
READY TO SPAN IN 72
-----
RANGE  AVG  DIAGS ALARM

```

Calibrate



The Calibrate menu allows the operator to trigger one of two full calibration sequences that can include zero and span adjustments for any or all measurement channels. The sequence of calibration events is identical to

the sequence that would be triggered by the Auto Cal function and is controlled by parameters located in the calibration setup menu that follows.

- In the Main Menu, choose Calibration > **Calibrate**.

```
CALIBRATE:
>RUN SEQUENCE 1
  RUN SEQUENCE 2

RANGE  AVG  DIAGS  ALARM
```

Use the cursor to select either run sequence, press  to display the associated screen, then press  to start the sequence. “Standing By” changes to “Running” when the sequence starts.

```
RUN SEQUENCE 1:
SEQUENCE 1: STANDING BY
SEQUENCE 2: STANDING BY
  EVENT: NONE

PRESS => TO RUN SEQUENCE

RANGE  AVG  DIAGS  ALARM
```

```
RUN SEQUENCE 1:
SEQUENCE 1: RUNNING
SEQUENCE 2: STANDING BY
  EVENT 3: SPAN CYL 1


PRESS ← TO STOP EVENTS

RANGE  AVG  DIAGS  ALARM
```

Calibration Setup

The Calibration Setup menu is used to:

- Enter information that describes the contents of the gas cylinders that will be used for span calibration.
- Select which cylinders will be used as the zero for the optional oxygen sensor and infrared bench, and as the span for the O₂ sensor.
- Select between the direct calibration of the analyzer and the system calibration.
- Reset the zero background and span factors back to the original default values.
- Define the calibration sequences, the events that make up those sequences, and set the auto calibration schedule.
- Define the probe blowback schedule, including the time between blowbacks and the duration.

To use the Calibration Setup menu, move the cursor to the item of interest and press .

- In the Main Menu, choose Calibration > **Calibration Setup**.

```

CALIBRATION SETUP:
> DEFINE CYLINDERS
  SELECT ZERO CYLINDERS
  SELECT O2 SPAN CYL
  CAL FLOW PATH
  CAL SEQUENCE SETUP

RANGE  AVG  DIAGS  ALARM

SET AUTOCAL SCHEDULE
PROBE BLOWBACK SCHEDULE

```

Define Cylinders

The Define Cylinders menu is used to describe the composition of the span gas cylinders that will be used to calibrate the Model 60i. When Define Cylinders is selected, the screen displays a list of cylinder numbers, along with a list of span gases that are contained in each cylinder.




- In the Main Menu, choose Calibration > Calibration Setup > **Define Cylinders**.

```

DEFINE CAL CYLINDERS:
>CYLINDER 1          CO  CO2
CYLINDER 2          SO2
CYLINDER 3          NO
CYLINDER 4
CYLINDER 5          ↓

RANGE  AVG  DIAGS  ALARM

```

To select a cylinder, use   to move the cursor and then press  to open the Define Cylinder screen for the selected cylinder. The screen will then list all compounds that the 60i analyzer is capable of reporting or correcting for, and will display the current span concentration for each one. If the cylinder does not contain a specific gas, the concentration entry for that gas should be set to zero.

Note If the cylinder contains a gas that your analyzer is not configured to measure, the concentration of that gas should still be entered to enable interference corrections. ▲

- In the Main Menu, choose Calibration > Calibration Setup > Define Cylinders > **Cylinder (1-6)**.




```

DEFINE CYLINDER 1:
>CO      500  ppm
CO2      18   %
NO       0   ppm
NO2      0   ppm
O2       0.0  %

```

RANGE **AVG** **DIAGS** **ALARM**




SO2 0 ppm

The Define Cal Cylinders screen presents six lines corresponding to the six gases that are used for calibration. Each line shows the gas identifier (molecular formula) for the gas at the left, the concentration in the center, and the concentration units on the far right. To edit a concentration value, move the cursor using   and then press  to open the numeric editing screen.

```

SET CYL 1 O2 SPAN CONC:
      CONC:      21 %
      SET TO:    20.8 %

```

 CHANGE VALUE  MOVE CURSOR  SAVE

RANGE **AVG** **DIAGS** **ALARM**

The concentration units (ppm, mg/m³, %) are not specified here, so the concentration must be entered in the same units that were selected in the Range/Units menu. If the span mix does not contain all of the listed gases, the concentration values for the missing gases must be entered as zero.

If a span cylinder uses air as the balance gas, and if the oxygen content has not been certified by the vendor, the oxygen concentration should be entered as 20.9 percent.

If the span gas was prepared with nitrogen as the balance gas, the oxygen content should be entered as zero. The oxygen content of a cylinder being used to supply span gas to the optional oxygen sensor should be certified by the vendor or by an independent analysis. It is not unusual for the oxygen content of air cylinders to vary significantly from ambient air. Refer to [Table 3-4](#) for a cylinder definition example.

Important Note It is critically important that the information entered in these screens is complete and accurate. If the span cylinder contains pollutants that are not entered into the cylinder definition, the calibration procedure will be compromised and concentration readings will not be valid. ▲





Table 3–4. Cylinder Definition Example



	Calibration Cylinder 1	Calibration Cylinder 2	Calibration Cylinder 3	Calibration Cylinder 4	Calibration Cylinder 5	Calibration Cylinder 6
NO	100 ppm	0	0	0	0	0
CO	0	0	500 ppm	0	0	0
CO ₂	0	0	20%	0	0	0
NO ₂	0	0	0	0	1000 ppm	0
SO ₂	500 ppm	0	0	0	0	0
O ₂	0	0	0	0	0	20.9%

Cylinder 1: Span gas for NO and SO₂ channels
 Cylinder 2: Zero gas for IR bench only
 Cylinder 3: Span gas for CO and CO₂ channels
 Cylinder 4: Zero for all channels
 Cylinder 5: Span gas for NO₂ channel
 Cylinder 6: Span gas for O₂

Select Zero Cylinders

The Select Zero Cylinders screen is used to select which cylinder, or cylinders, will be used to provide the zero gas for each measurement system (optional oxygen sensor and IR bench).

The current selection or configuration for each measurement device is indicated to the right. To change a selection, move the cursor with   and then press   to increment or decrement the cylinder number. If a change is made, a question mark will appear to the right of the cylinder number.

Press  to save the changes or  to exit without saving.

- In the Main Menu, choose Calibration > Calibration Setup > **Select Zero Cylinders**.

```




SELECT ZERO CYLINDERS:
>O2 SENSOR      CYLINDER 2
IR BENCH        CYLINDER 3
SELECTING TWO DIFFERENT
CYLINDERS WILL DISALLOW
ZEROING BOTH AT ONCE !

RANGE  AVG  DIAGS  ALARM
  
```

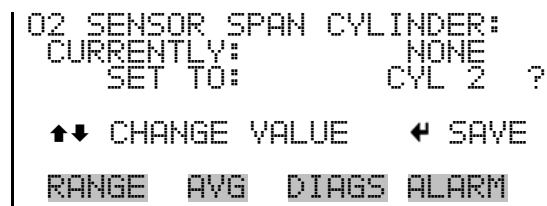
The IR bench can be zeroed on either ultra-high purity (UHP) air or with UHP nitrogen. The optional oxygen sensor can be zeroed with UHP nitrogen, or with one of the span gases that is prepared in nitrogen balance.

If UHP nitrogen is used as the zero gas, the O₂ sensor and IR bench can be set to use the same zero cylinder, in which case, the Zero menu discussed previously will allow all of the measurement channels to be zeroed simultaneously in a single step. Otherwise, the two will need to be zeroed independently.

Select O₂ Span Cylinder

The Select O₂ Span Cylinder screen is used to select which cylinder will be used to provide the span gas for the optional oxygen sensor. To change the current setting, press   to step through the cylinder numbers, and the press  to save the setting. If a change is made, a question mark will appear to the right of the cylinder number until the change has been saved.

- In the Main Menu, choose Calibration > Calibration Setup > **Select O₂ Span Cylinder**.



```
O2 SENSOR SPAN CYLINDER:
CURRENTLY:      NONE
SET TO:         CYL 2  ?

↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM
```

Cal Flow Path

This selection opens a screen that allows the operator to view and change the flow path of calibration gases. Based on the selection made in this screen, the calibration gases will be introduced directly into the sample stream through the analyzer's internal plumbing (**direct** calibration), or they will be routed back to the CAL OUT bulkhead on the rear panel (**system** calibration). In a source monitoring application, the CAL OUT bulkhead is typically connected to a line that runs to the probe system. By running the zero and span gases through the probe, it is possible to troubleshoot the entire system plumbing and possible to "calibrate-out" inaccuracies that might result from leaks in the probe, sample conditioner, or lines.

Note A selection made here applies only to manual zero and span. If using sequences, the flow path must be selected within a calibration sequence setup. ▲

If a change is made, a question mark will appear to the right until the change has been saved.

- In the Main Menu, choose Calibration > Calibration Setup > **Cal Flow Path**.


```

SET CAL FLOW PATH:
CURRENTLY:          SYSTEM
SET TO:             DIRECT ?

↑↓  CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Cal Sequence Setup

The Cal Sequence Setup menu is used to define a full calibration sequence. A calibration sequence typically consists of a series of a zero adjustments, span adjustments, and/or system purges that are programmed to occur in a fixed order and to extend over a fixed interval.

In order to provide greater flexibility, the firmware allows the operator to define two different calibration sequences that can be utilized at different times.

For example, calibration sequence 1 might include only a zero adjustment and could be programmed to occur automatically every 24 hours, while sequence 2 might include both a zero and a span adjustment that would occur only when specifically requested by the operator.

To implement a calibration sequence, the operator first defines the composition of the span gas cylinders, as described previously in this chapter, and then defines a series of events that constitute the calibration sequence.

Once a sequence and all timing variables are defined, the analyzer can also be programmed to perform the calibration routine automatically at a pre-set time. Alternately, the operator can trigger a calibration sequence as needed from the front panel, with a signal from a PLC or data logger, or through the analyzer's RS-232/Ethernet communication system.

- In the Main Menu, choose Calibration > Calibration Setup > **Cal Sequence Setup**.

```

CAL SEQUENCE SETUP:
>CAL SEQUENCE 1
CAL SEQUENCE 2
DEFINE EVENTS

RANGE  AVG  DIAGS  ALARM

```

Cal Sequence

Selecting Cal Sequence 1 or Cal Sequence 2 displays the Sequence menu.


- In the Main Menu, choose Calibration > Calibration Setup > Cal Sequence Setup > **Cal Sequence 1**.

```

SEQUENCE 1:
>CHECK/RESET          CHECK
CAL FLOW PATH         DIRECT
EVENT 1               NONE
EVENT 2               NONE
EVENT 3               NONE↓
RANGE  AVG  DIAGS  ALARM
                        ↓
EVENT 10              NONE

```

Check/Reset

Selecting Check/Reset displays the Sequence Status menu for the sequence selected in the previous menu. Reset causes the span factors to be changed during calibration. Check has no effect on calibration, although it is noted in the data logger. To toggle the setting between Check and Reset, and to save the selection, press .

- In the Main Menu, choose Calibration > Calibration Setup > Cal Sequence Setup > Cal Sequence 1 > **Check/Reset**.




```

SEQUENCE 1 STATUS:
CURRENTLY:          CHECK
SET TO:             RESET  ?
                    ← TOGGLE VALUE
RANGE  AVG  DIAGS  ALARM

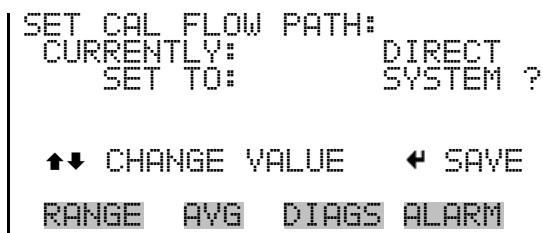
```

Cal Flow Path

Selecting Cal Flow Path displays the Set Cal Flow Path menu, which is used to select a direct or system flow path for each sequence. In a direct calibration, the gases are routed directly to the analyzer optical bench, bypassing the probe, sampling umbilical, and sample conditioning system. In a system calibration, the gases are routed through the system components mentioned previously.

To toggle the setting between Direct and System flow path, press , and press , and press  to save the selection.

- In the Main Menu, choose Calibration > Calibration Setup > Cal Sequence Setup > Cal Sequence 1 > **Cal Flow Path**.

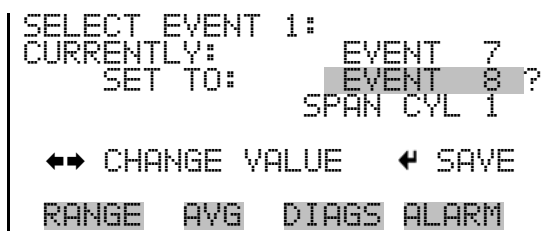


Select Events

Selecting Event 1-Event 10 displays the Select Event screen. An event is a step in the calibration sequence, and may be assigned any event from the list of up to 16 defined events. This is used to select which events are needed and in what order they will occur in the sequence. If the event is defined (for the “Set To”), a brief description is shown below the event number. To scroll through the list of up to 16 events, press , and press to save the selection.

Note There is a “No Event” selection for any of the 10 events in the sequence that are not being used. ▲

- In the Main Menu, choose Calibration > Calibration Setup > Cal Sequence Setup > Cal Sequence 1 > **Event (1-10)**.






Define Events

The Define Events menu is used to define various events that may be assigned during a calibration sequence. Typical events include a zero adjustment of the IR bench or a span adjustment of the oxygen sensor. As many as 16 events can be defined (As many as 10 of these can be chosen in any order to create the cal sequence as mentioned above.) Refer to Step 4 of the “[Completed Worksheet Example](#)” on page 4-37 to see a list of typical events.

In the Main Menu, choose Calibration > Calibration Setup > Cal Sequence Setup > **Define Events**.

```

EDIT EVENTS:
>EVENT 1          ZERO 02
EVENT 2          ZERO 1R
EVENT 3          PURGE 5m 0s
EVENT 4          PURGE 5m 5s
EVENT 5          ZERO ALL↓
  RANGE  AVG  DIAGS  ALARM
  
```





To select an event to edit, move the cursor using   and press  to open the Edit Event menu.

- In the Main Menu, choose Calibration > Calibration Setup > Cal Sequence Setup > Define Events > **Event (1-16)**.

```

EDIT EVENT:
>EVENT TYPE      ZERO
ZERO CHANNEL     ALL
DELAY            0m 0s
DURATION         5m 0s
  RANGE  AVG  DIAGS  ALARM
  
```

Event Type The Event Type screen is used to set the event type to zero, span, span NO_x, or purge.

To change an event type from the current type, position the cursor at the Event Type, press  to open the Set Event Type screen, press   to scroll between zero, span, span NO_x, and purge, and press  to save the selection.

```

SET EVENT TYPE:
>CURRENTLY:      ZERO
SET TO:          SPAN ?
  ↑↓ CHANGE VALUE  ← SAVE
  RANGE  AVG  DIAGS  ALARM
  
```

The Edit Event screen contents will change depending on which event type is selected. The following Edit Event screens show the menu selections for the zero, span, span NO_x, and purge event types. [Table 3-5](#) provides a description of the associated screens. Note that the zero cylinder is already assigned via the Calibration Setup menu.

Zero Event Type Menu

Note that the zero cylinder is already assigned previously in the “Select Zero Cylinder” screen.

```

EDIT EVENT:
>EVENT TYPE          ZERO
ZERO CHANNEL         ALL
DELAY                2m 0s
DURATION              5m 0s

RANGE  AVG  DIAGS  ALARM

```

Span Event Type Menu

```

EDIT EVENT:
>EVENT TYPE          SPAN
SPAN CYLINDER        CYL 1
DELAY                0m 0s
DURATION              5m 0s

RANGE  AVG  DIAGS  ALARM

```

Span NOx Event Type Menu

```

EDIT EVENT:
>EVENT TYPE          SPAN NOX
DELAY                0m 0s
DURATION              5m 0s
DURATION B            0m 0s

RANGE  AVG  DIAGS  ALARM

```

Purge Event Type Menu

```

EDIT EVENT:
>EVENT TYPE          PURGE
DURATION              5m 0s

RANGE  AVG  DIAGS  ALARM

```

Table 3–5. Edit Event Screens

Menu Choice	Description
Event Type	Used to change the event type to Zero, Span, Span NOx, or Purge.
Span Cylinder	Used to change the span cylinder for span type events.
Zero Channel	Used to specify the zero channel as O2, IR, or All.
Delay	Used to configure the delay for a specific event. Refer to the “ Calibration ” chapter for a more detailed description.
Duration	Used to configure the run time for a specific event. Refer to the “ Calibration ” chapter for a more detailed description.

Set Autocal Schedule

The Set Autocal Schedule menu is used to program the Model 60i to execute calibrations on a routine basis without operator input.

To implement the auto-calibration function, you define the composition of the span gas cylinders, define events, create either one or two calibration sequences with the order of the selected events, and then set the autocal schedule. This programs the analyzer to execute each calibration sequence at a set interval, starting at a specific date and time.

- In the Main Menu, choose Calibration > Calibration Setup > **Set Autocal Schedule**.

```

SET AUTO CAL SCHEDULE:
>CAL SEQUENCE 1
  CAL SEQUENCE 2

RANGE  AVG  DIAGS  ALARM

```

Cal Sequence

The Cal Sequence menu is used to configure two autocal schedules. If no frequency value is entered, the Next Run will show “Disabled” even when a date was entered for the next run (which shuts off that sequence and disables that autocal).

- In the Main Menu, choose Calibration > Calibration Setup > Set Autocal Schedule > **Cal Sequence 1 (or 2)**. Note that the Cal Sequence 1 and Cal Sequence 2 menus operate the same way.

```

SEQUENCE 1:
>NEXT RUN      1d 25h 0m
FREQUENCY      1d 0h

RANGE  AVG  DIAGS  ALARM

```

Next Run The Next Run screen is used to configure the next run time (schedule the first execution) for the selected autocal sequence. [Table 3–6](#) describes how to use the front panel pushbuttons to set the date and time.

- In the Main Menu, choose Calibration > Calibration Setup > Set Autocal Schedule > Cal Sequence 1 (or 2) > **Next Run**.

```

NEXT DATE AND TIME:
25 MAR 2008 02:55
PRESS ← TO EDIT

RANGE  AVG  DIAGS  ALARM

```

Press  to display the Next Date and Time edit screen.





```

NEXT DATE AND TIME:
25 MAR 2008 02:55
SETTING: DAYS
                → SET MONTHS
                ↑↓ CHANGE VALUE
                ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM



```

Table 3–6. Front Panel Pushbutton Usage to Set Date and Time

Pushbutton	Function
 	Changes the currently settable parameter.
	Scrolls through the time parameters.
	Saves the new date and time to the system clock.

Frequency

The Frequency screen is used to configure the frequency of the selected autocalibration sequence, from the starting point of the Next Run previously discussed. Note that a frequency of 0d 0h disables the next run (and turns off the cal sequence).

Press  to save the changes or  to exit without saving.

- In the Main Menu, choose Calibration > Calibration Setup > Set Autocal Schedule > Cal Sequence 1 (or 2) > **Frequency**.

```

EDIT FREQUENCY:
  FREQ:          1d  5h
  SET TO:        1d  7h?
                ↔ MOVE CURSOR
  ↑↓ CHANGE VALUE  ← SAVE
RANGE  AVG  DIAGS  ALARM
  
```

Probe Blowback Schedule Menu

The Probe Blowback Schedule menu is used to configure the probe blowback schedule for the 62i.



- In the Main Menu, choose Calibration > Calibration Setup > **Probe Blowback Schedule**.




```

PROBE BLOWBACK SCHEDULE:
>NEXT TIME      0d 0h 5m
PERIOD          0d 1h 0m
DURATION        5s
PURGE DURATION  0m 0s
RANGE  AVG  DIAGS  ALARM
  
```

Next Blowback Time Screen

The Next Blowback Time screen is used to configure the starting point for the first blowback that the period then references for future blowbacks.

- In the Main Menu, choose Calibration > Calibration Setup > Probe Blowback Schedule > **Next Time**.
- Push  to edit the existing date and time.
- Pushing  steps the cursor between: Days, Months, Years, Hours, and Minutes.

- Pushing   changes the value.
- Pushing  saves the value.

```

NEXT DATE AND TIME:
13 MAR 2008 04:24
PRESS ← TO EDIT

RANGE  AVG  DIAGS  ALARM

```

```

NEXT DATE AND TIME:
13 MAR 2008 04:24
SETTING: DAYS
      → SET MONTHS
      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

Blowback Period Screen

The Blowback Period screen is used to configure the period between probe blowbacks. This parameter controls how often the blowback will occur.

- In the Main Menu, choose Calibration > Calibration Setup > Probe Blowback Schedule > **Period**.

```

PROBE BLOWBACK PERIOD:
CURRENTLY: 0d 1h 0m
SET TO:    0d 2h 0m

      ↔ MOVE CURSOR
      ↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Blowback Duration Screen

The Blowback Duration screen is used to set the duration of the blowback in seconds. This parameter controls how long the blowback valve stays open.

- In the Main Menu, choose Calibration > Calibration Setup > Probe Blowback Schedule > **Duration**.

```

PROBE BLOWBACK DURATION:
CURRENTLY: 5s
SET TO:    7s?

      ↔ MOVE CURSOR
      ↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Blowback Purge Duration Screen

The Probe Blowback Purge Duration screen is used to configure the duration that data records will be marked as “blowback” in the data logger, or how long the digital output will stay enabled after each blowback. The

appropriate value depends on the system design parameters, such as sample line length and pumping rate.

- In the Main Menu, choose Calibration > Calibration Setup > Probe Blowback Schedule > **Purge Duration**.

```
PROBE BB PURGE DURATION:
CURRENTLY:      0m  4s
SET TO:         0m  6s?

      ↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM
```

Calibration Diagnostics

The Calibration Diagnostics menu is used to access calibration diagnostic information for troubleshooting or monitoring instrument performance.

- In the Main Menu, choose Calibration > **Calibration Diagnostics**.

```
CALIBRATION DIAGNOSTICS:
>CALIBRATION HISTORY
VIEW/RESET SPAN FACTORS
VIEW/RESET USER ZEROS
VIEW CAL STATUS

RANGE  AVG  DIAGS  ALARM
```




Calibration History

The Calibration History screen is used to view a list that shows the date, time, and type of the most recent calibration events.

- In the Main Menu, choose Calibration > Calibration Diagnostics > **Calibration History**.

```
CAL HISTORY:
>28MAR08 10:02 - CHECK
 28MAR08 05:50 - ZERO
 27MAR08 08:25 - CHECK
 27MAR08 03:12 - CHECK
 26MAR08 06:35 - CHECK  ↓

RANGE  AVG  DIAGS  ALARM
```

To see a detailed report on any event, use   to scroll to an event and press .

A screen will appear that shows the type of event (zero or span), the time and date of that event, the reference intensity that was measured during

“zeros”, and the cylinder that was used in the event. Note that a span history will also display an (M) or (S) to indicate multigas span or single gas span. The data that is reported in the calibration history screens can be used to track basic instrument functions and to help identify calibration problems that may occur due to instrument failure. For example, a sudden drop in reference intensity suggests that the source or detector is failing; a continuous increase in span factors over time suggests a loss of sensitivity.

```

28MAR08 10:02
CHECK CYLINDER 4
CO      205  NO      205
NO2     42  CO2     14
SO2    140  N2O
O2      20
RANGE  AVG  DIAGS  ALARM

```



View/Reset Span Factors


The View/Reset Span Factors screen displays the value of the current span factors. Span factors are multipliers that are used to “fine-tune” the analyzer’s factory-set internal calibration.

After the factory calibration is performed, the span factor for each channel is 1.0. Each time a span adjustment is run, the span factor for the affected channel is adjusted up or down to force the instrument reading to match the span concentration that was entered in the cylinder definition table.

For example, if the span concentration is 1000 ppm, but the factory calibration produces a reading of 900 ppm, the analyzer will automatically calculate and apply a span factor of 1.111 to all readings on that channel. By tracking changes in the span factor, it may be possible to identify problems with the analyzer or calibration system.

Resetting Span Factors

Position the cursor at the desired gas on the View/Reset Span Factors screen, press  to set the span factor to 1 for that gas, and press  to save the setting.

Important Note Be sure to press  to save the setting, otherwise the setting will be lost after a power cycle. ▲

- In the Main Menu, choose Calibration > Calibration Diagnostics > **View/Reset Span Factors**.

```



VIEW/RESET SPAN FACTORS:
PRESS ← TO RESET SPAN
PRESS ← TO SAVE SPAN
>CO      1.0000
CO2      1.0000
NO       1.0000↓
RANGE   AVG   DIAGS  ALARM
NO2      1.0000
O2       1.0000
SO2      1.0000

```

View/Reset User Zeros

The View/Reset User Zeros screen displays the zero values that were recorded for each channel during the most recent zero calibration. At the time of shipment, the user values are all zeros. Sudden changes in the user zero may suggest a problem with the analyzer or the calibration system.

Resetting User Zeros

Position the cursor at the desired gas on the View/Reset User Zeros screen, press  to set the user zero to 0 for that gas, and press  to save the setting.

Important Note Be sure to press  to save the setting, otherwise the setting will be lost after a power cycle. ▲

- In the Main Menu, choose Calibration > Calibration Diagnostics > **View/Reset User Zeros.**

```

VIEW/RESET USER ZEROS:
PRESS ← TO RESET ZERO
PRESS ← TO SAVE ZERO
>CO      0.0041
CO2     -0.0010
NO       0.0007↓
RANGE   AVG   DIAGS  ALARM
NO2      0.0160
O2       0.0000
SO2      0.0000

```

View Cal Status

The View Cal Status screen is used to view the calibration status. If a calibration fails, the View Cal Status screen indicates that the calibration failed until that calibration is successful.

- In the Main Menu, choose Calibration > Calibration Diagnostics > **View Cal Status.**

```

CAL STATUS:
>CO          OK
CO2          OK
NO           OK
NO2          OK
O2           OK↓
RANGE  AVG  DIAGS  ALARM
SO2                                OK
  
```

Instrument Controls Menu

The Instrument Controls menu contains selections that are used to control instrument operational parameters. The firmware controls listed in this menu enable control of the listed instrument functions.

- In the Main Menu, choose **Instrument Controls**.

```

INSTRUMENT CONTROLS:
>DATA LOGGING SETTINGS
COMMUNICATION SETTINGS
I/O CONFIGURATION
TEMPERATURE COMPENSATION
PRESSURE COMPENSATION ↓
RANGE  AVG  DIAGS  ALARM

SCREEN CONTRAST
DATE/TIME
TIMEZONE
SERVICE / ACCESS LEVEL
  
```

Datalogging Settings

The *i*Series instruments include a built-in data logging capability as a standard feature. The operator is allowed to create two different types of records, which for historical reasons are named lrecs (long records) and srecs (short records). Each record can contain up to 32 different fields or data items, and records can be created at user-defined intervals ranging from 1 to 60 minutes.

Record generation is tied to the instrument's real-time clock. For example, if the logging period for srecs is set to 30 minutes, a new srec will be generated on every hour and every half hour (10:00, 10:30, 11:00 ...). Lrecs and srecs can be interleaved. For example, an srec containing just the current concentration level could be generated every five minutes while an lrec containing a full set of diagnostic data could be generated once every hour.

The analyzer's computer system includes three megabytes of flash memory, which is enough to store a full lrec containing 32 data items and a full srec containing 32 items once each minute for a week (>20,000 total records). If logging is limited to the minimum content of date, time, concentration

and error flags, the analyzer can store data once each minute for approximately three months (>190,000 records).

- In the Main Menu, choose Instrument Controls > **Datalogging Settings**.

```
DATALOGGING SETTINGS:
>SELECT SREC/LREC      SREC
VIEW LOGGED DATA
ERASE LOG
SELECT CONTENT
COMMIT CONTENT

RANGE  AVG  DIAGS  ALARM

RESET TO DEFAULT CONTENT
CONFIGURE DATALOGGING
```

Select SREC/LREC

The Select SREC/LREC screen is used to select short record (srec) or long record (lrec) format for other operations in this menu.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Select SREC/LREC**.

```
SELECT LOG TYPE:
CURRENTLY:      SREC
SET TO:         LREC ?

      ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM
```

View Logged Data

The View Logged Data screen is used to select the starting point to view the logged data by number of records or date and time.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **View Logged Data**.

```
SELECT START POINT BY:
SET TO: # OF RECS

      ↑↓ CHANGE      ← ACCEPT

RANGE  AVG  DIAGS  ALARM
```

Use  or  to change between “# of Recs” and “Date/Time”.

Number of Records

The Number of Records screen is used to select the starting point from which to display the number of previous records. The screen also displays the total number of that record type in the log.





- In the Main Menu, choose Instrument Controls > Datalogging Settings > View Logged Data > # of recs > .

```

SET # BACK FROM CURRENT:
TOTAL LRECS: 00000000
                20

      ↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM
  
```

The Record Display screen (read only) displays the selected records. Use   to page up and down and   to pan left and right to view data.


```

time    date    flags
10:01  06/20/05  FC008890
10:02  06/20/05  FC008890
10:03  06/20/05  FC008890
10:04  06/20/05  FC008890
      ↑↓ PGUP/DN  ↔ PAN L/R

RANGE  AVG  DIAGS  ALARM
  
```

Date and Time

The Date and Time screen is used to select a starting point from which to view logged data. For example, if “01 AUG 2007 10:00” is entered, then the first logged data record that is displayed is the first record after this time. If set to one minute logging, this would be at “01 AUG 2007 10:01”.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > View Logged Data > **Date/Time** > .

```

DATE AND TIME:
01 AUG 2007 10:00
↑↓ CHG DAYS
→ SET CURSOR TO MONTHS
← ACCEPT AS SHOWN

RANGE  AVG  DIAGS  ALARM

```

The Record Display screen (read only) displays the selected records.


```

time    date    flags
10:01  08/01/07  FC008890
10:02  08/01/07  FC008890
10:03  08/01/07  FC008890
10:04  08/01/07  FC008890
↑↓ PGUP/DN  ↔ PAN L/R

RANGE  AVG  DIAGS  ALARM

```

Erase Log

The Erase Log screen is used to erase all saved data for the selected record type (either all short records or all long records, not both). When you press  to erase, the screen displays a “confirm to erase” message to help prevent accidental erasures.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Erase Log**.

```

ERASE LREC LOG FILE DATA?

                               ← ERASE

RANGE  AVG  DIAGS  ALARM

```

```

ERASE LREC LOG FILE DATA?

                               ← ERASE
ARE YOU SURE YOU WANT TO?
PRESS → TO CONFIRM ERASURE

RANGE  AVG  DIAGS  ALARM

```


Select Content

The Select Content menu allows the operator to select which data fields will be included in each record (for the selected record type: srec or lrec). When this menu is selected, the screen displays a list showing the current settings for each of the 32 available fields. The available data fields are organized into the following groups; Concentrations, Other Measurements, Analog Inputs, and Non-Measurements. If the I/O board is not present, Analog Inputs will not be available.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Select Content**.

```

LREC FIELDS:
>FIELD 1          CO
FIELD 2          CO2
FIELD 3          NO
FIELD 4          NO2
FIELD 5          NOX↓
RANGE  AVG  DIAGS  ALARM
FIELD 6          SO2
FIELD 7          O2
  
```

To change the content of any field, move the cursor to the appropriate line and press .

```

DATA IN LREC FIELD 1:
>CONCENTRATIONS
OTHER MEASUREMENTS
ANALOG INPUTS
NON-MEASUREMENTS
RANGE  AVG  DIAGS  ALARM
  
```

Important Note Any changes made in this menu are considered proposed changes at this point and will not be saved or implemented until finalized in the Commit Content menu, which appears under this Datalogging menu. ▲

Concentrations

The Concentrations screen lists all the individual gases that the analyzer is equipped to measure (Table 3-7). It allows the user to select a concentration reading that will be included in the selected data field.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > *select field (1-32)* > **Concentrations**.

```

CONCENTRATIONS:
>NONE
CO
NO
CO2
NOX
<---
↓
RANGE  AVG  DIAGS  ALARM
  
```

O2
SO2
NO2

Table 3–7. Data in Srec/Lrec Fields – Concentrations

Table with 2 columns: Data, Description. Rows include: None (Leaves that record field blank), CO (Tracks CO concentration), NO (Tracks NO concentration), CO2 (Tracks CO2 concentration), NOx (Tracks combined NO and NO2 concentration), SO2 (Tracks SO2 concentration), NO2 (Tracks NO2 concentration).

Other Measurements

The Other Measurements screen lists data fields other than concentration measurements (Table 3–8). It allows the user to select an item to be included in the data record, such as bench pressure or source temperature.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > select field (1-32) > Other Measurements.

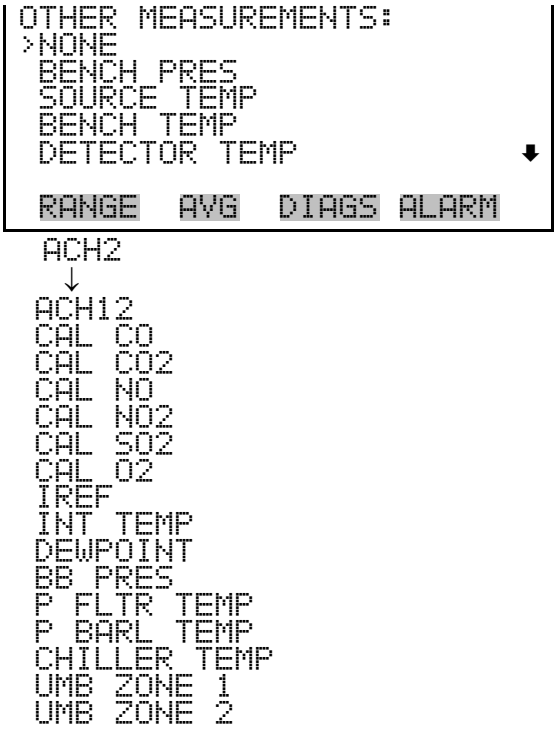


Table 3–8. Data in Srec/Lrec Fields – Other Measurements

Data	Description
None	Leaves that record field blank.
Bench pres	Reports the pressure measured at the bench outlet.
Source temp	Reports the temperature measured at the source housing.
Bench temp	Reports the temperature measured at the wall of the IR bench adjacent to the heaters.
Detector temp	Reports the temperature measured at the base of the detector assembly.
ACH2-ACH12	Reports absorbances for each channel. See Table 3–17 .
Cal CO	Indicates the CO contents of the currently selected cylinder.
Cal CO ₂	Indicates the CO ₂ contents of the currently selected cylinder.
Cal NO	Indicates the NO contents of the currently selected cylinder.
Cal NO ₂	Indicates the NO ₂ contents of the currently selected cylinder.
Cal SO ₂	Indicates the SO ₂ contents of the currently selected cylinder.
Cal O ₂	Indicates the O ₂ contents of the currently selected cylinder.
IREF	Tracks raw signal intensity for reference channel.
Int temp	Reports the ambient temperature measured inside the analyzer.
Dewpoint	Indicates the sample dewpoint value.
BB pres	Indicates the blowback pressure.*
P fltr temp	Indicates the probe filter temperature.*
P barl temp	Indicates the probe barrel temperature.*
Chiller temp	Indicates the chiller temperature.*
Umb zone 1	Indicates the umbilical zone 1 temperature.*
Umb zone 2	Indicates the umbilical zone 2 temperature.*

*Available when the instrument is configured as a system.

Analog Inputs

The Analog Inputs screen lists analog inputs ([Table 3–9](#)). It allows the user to select an analog input signal (none or analog inputs 1-8) that will be included in the selected data field.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > *select field (1-32)* > **Analog Inputs**.

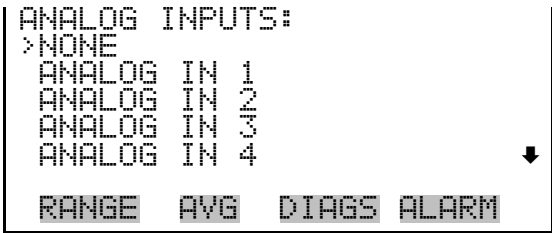


Table 3–9. Data in Srec/Lrec Fields – Analog Inputs

Data	Description
None	Leaves that record field blank.
Analog In 1-8	Tracks voltage inputs from external devices.

Non-Measurements

The Non-Measurements screen lists status information items available for data fields (Table 3–10). It allows the user to select a status related item that will be included in the selected data field.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > select field (1-32) > Non-Measurements.

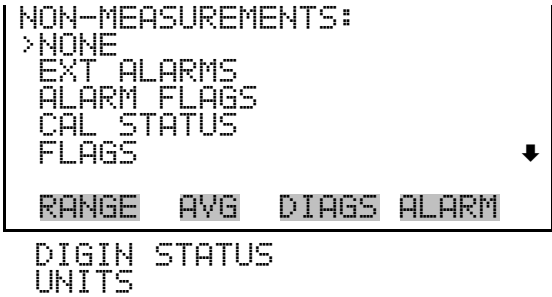


Table 3–10. Data in Srec/Lrec Fields – Non-Measurements

Data	Description
None	Leaves that record field blank.
Ext Alarms	Logs external alarms.
Alarm Flags	Logs concentration alarms.
Cal Status	Indicates the calibration status.
Flags	Indicates various diagnostic or alarm conditions.
Digin Status	Indicates status of raw digital inputs.
Units	Indicates the types of units (ppm, mg/m³, %) of the available gases.

Commit Content

The Commit Content screen is used to save any changes that have been made to the selected data fields that are tied to the selected record type. If no changes have been made “NO CHANGES TO RECORD LIST!” will appear.

Important Note Be aware that performing this action will delete all of your previously logged data. ▲

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Commit Content**.

```
CHANGE LREC FORMAT AND
ERASE LREC LOG FILE DATA?
                        ◀ COMMIT

RANGE  AVG  DIAGS  ALARM
```

```
CHANGE LREC FORMAT AND
ERASE LREC LOG FILE DATA?
                        ◀ COMMIT
ARE YOU SURE YOU WANT TO?
PRESS ▶ TO CONFIRM CHANGES

RANGE  AVG  DIAGS  ALARM
```

Reset to Default Content

The Reset to Default Content screen is used to reset all of the datalogging field items to default values for the selected record type. For more information about selecting the content of logged data fields, see “[Select Content](#)” described previously.

Important Note Be aware that performing this action will delete all of your logged data. ▲

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Reset to Default Content**.

```
RESET LREC DATA AND
ERASE LREC LOG FILE DATA?
                        ◀ RESET

RANGE  AVG  DIAGS  ALARM
```

```
RESET LREC DATA AND
ERASE LREC LOG FILE DATA?
                        ◀ RESET
ARE YOU SURE YOU WANT TO?
PRESS ▶ TO CONFIRM RESET

RANGE  AVG  DIAGS  ALARM
```

Configure Datalogging

The Configure Datalogging menu is used to configure the datalogging for the currently selected record type.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Configure Datalogging**.

```
DATALOGGING SETTINGS:
>LOGGING PERIOD MIN    60
MEMORY ALLOCATION %     50
DATA TREATMENT         AVG
FLAG STATUS DATA      OFF

RANGE  AVG  DIAGS  ALARM
```

Logging Period Min

The Logging Period Min screen is used to select the time period in minutes between logged data points for the selected record type (srec or lrec). The list of choices includes: off, 1, 5, 15, 30, and 60 minutes (default).

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Logging Period Min**.

```
SET PERIOD FOR SREC:
CURRENTLY:           60 MIN
SET TO:              30 MIN ?

↑↓ CHANGE VALUE    ← SAVE

RANGE  AVG  DIAGS  ALARM
```

Memory Allocation Percent

The Memory Allocation Percent screen is used to select the percentage of total memory that will be allocated to lrecs. Percentages between 0 and 100% are available in increments of 10. Changing this value results in log erasure for both srecs and lrecs.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Memory Allocation %**.

```

SET PERCENT LRECS:
CURRENTLY:      50%
SET TO:         60% ?

↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Data Treatment

The Data Treatment screen is used to select the data type for the selected record: whether the data should be averaged over the interval, the minimum or maximum measured during the interval, or the current value (last value measured). Data treatment doesn't apply to all data, just to the concentration measurements. All other data points log the current value at the end of the interval.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Data Treatment**.

```

SET LREC DATA TYPE:
CURRENTLY:  AVG
SET TO:     CUR      ?

↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Flag Status Data

The Flag Status Data screen is used to set flag status data On/Off. Refer to “Flag Status” on page B-16.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Flag Status Data**.

```

SET LREC FLAG STATUS DATA:
CURRENTLY:  OFF
SET TO:     ON      ?

↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Communication Settings

The Communication Settings menu is used for communications control and configuration.

- In the Main Menu, choose Instrument Controls > **Communication Settings**.

```
COMMUNICATION SETTINGS:
>SERIAL SETTINGS
  INSTRUMENT ID
  GEYSITECH SERIAL NO
  COMMUNICATION PROTOCOL
  STREAMING DATA CONFIG  ↓
  RANGE  AVG  DIAGS  ALARM
TCP/IP SETTINGS
```

Serial Settings

The Serial Settings menu is used for serial communications control and configuration.

- In the Main Menu, choose Instrument Controls > Communication Settings > **Serial Settings**.

```
SERIAL SETTINGS:
>BAUD RATE          9600
  DATA BITS        8
  PARITY            NONE
  STOP BITS         1
  RS-232/485 SEL    RS-232
  RANGE  AVG  DIAGS  ALARM
```

Baud Rate

The Baud Rate screen is used to set the RS-232/RS485 interface baud rate. Baud rates of 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 are available. The analyzer's default baud rate is set to 9600 to provide backwards compatibility with the older C-series analyzers.

- In the Main Menu, choose Instrument Controls > Communication Settings > Serial Settings > **Baud Rate**.

```
BAUD RATE:
  CURRENTLY:      9600
  SET TO:         57600 ?
                ↑↓ CHANGE VALUE
                ← SAVE VALUE
  RANGE  AVG  DIAGS  ALARM
```


Data Bits The Data Bits screen is used to set the number of serial data bits. Selections of 7 or 8 are available, with 8 being the default value.

- In the Main Menu, choose Instrument Controls > Communication Settings > Serial Settings > **Data Bits**.

```

DATA BITS:
CURRENTLY:      8
SET TO:         7 ?

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

Parity The Parity screen is used to select the parity bit for the serial port. Selections of NONE, EVEN, or ODD are available, with NONE being the default value.

- In the Main Menu, choose Instrument Controls > Communication Settings > Serial Settings > **Parity**.

```

PARITY:
CURRENTLY:      NONE
SET TO:         ODD ?

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

Stop Bits The Stop Bits screen is used to select the number of stop bits for the serial port. Selections of 1 and 2 are available, with 1 being the default value.

- In the Main Menu, choose Instrument Controls > Communication Settings > Serial Settings > **Stop Bits**.

```

STOP BITS:
CURRENTLY:      1
SET TO:         2 ?

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

RS-232/RS-485 Selection

The RS-232/RS-485 Selection screen allows the user to choose between the RS-232 or RS-485 specification for serial communication.



Equipment Damage Disconnect the serial cable before changing the RS-232 and RS-485 selection to prevent damage to any equipment currently connected to the instrument. ▲

- In the Main Menu, choose Instrument Controls > Communication Settings > Serial Settings > **RS-232/485 Sel.**

```
RS-232/RS-485 SELECTION:
** WARNING **
DISCONNECT THE SERIAL
CABLES BEFORE CHANGING
THE SELECTION!
      ← TO CONTINUE
RANGE  AVG  DIAGS  ALARM
```

```
RS-232/RS-485 SELECTION:
CURRENTLY:      RS-232
SET TO:         RS-485 ?
MAKE SURE THAT THE CABLE
IS OFF: PRESS → TO CONFIRM
      ← TOGGLE VALUE
RANGE  AVG  DIAGS  ALARM
```

Instrument ID

The Instrument ID screen allows the operator to edit the instrument identification number (ID). The ID is used to identify the instrument when using the C-Link or MODBUS protocols to control the instrument or collect data. It may be necessary to edit the ID number if two or more of the same instrument are connected to one computer. Valid instrument ID numbers are from 0 to 127. The Model 60i has a default instrument ID of 60.

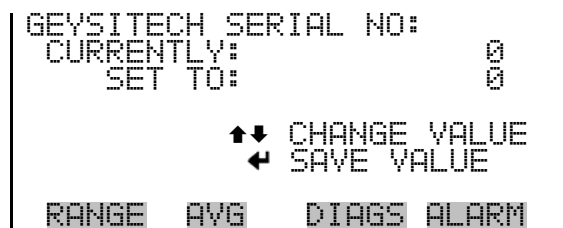
- In the Main Menu, choose Instrument Controls > Communication Settings > **Instrument ID.**

```
INSTRUMENT ID:
CURRENTLY:      48
SET TO:         60 ?
      ↑↓ CHANGE VALUE
      ← SAVE VALUE
RANGE  AVG  DIAGS  ALARM
```

Geysitech Serial No

A Geysitech serial number is included in the response to a Geysitech protocol DA command. Refer to “[Data Sampling/Data Query Command \(DA\)](#)” on page [D-4](#) for detailed information and examples.

Valid Geysitech serial numbers can be set from 0 to 255. A Geysitech serial number defaults to zero. To set the Geysitech serial number, select Main Menu > Instrument Controls > Communication Settings > **Geysitech Serial No.**



Communication Protocol

The Communication Protocol screen is used to select the communication protocol used for serial communications. Possible settings are C-link, streaming, Geysitech, and MODBUS.

C-link Protocol - C-link is a bi-directional protocol that provides access to all instrument functions including reading the various concentrations and other analog values or variables, reading the status of the digital outputs of the instrument, and triggering or simulating the activation of a digital input to the instrument. Refer to Appendix B for detailed C-link information.

Streaming Protocol - The streaming protocol provides a one-way reporting capability in which data records are exported to a serial device on a regular basis without prompting.

Geysitech (Bayern-Hessen) protocol - The Geysitech (Bayern-Hessen) protocol support for the Model 60*i* enables the user to read the various concentrations. Refer to Appendix D for detailed Geysitech (Bayern-Hessen) information.

MODBUS protocol – The MODBUS protocol is a serial communications protocol that allows for communication between devices connected to the same network.

The MODBUS protocol support for the Model 60*i* enables the user to read the various concentrations and other analog values or variables, read the status of the digital outputs of the instrument, and to trigger or simulate the activation of a digital input to the instrument. Refer to Appendix C for detailed MODBUS protocol information.

- In the Main Menu, choose Instrument Controls > Communication Settings > **Communication Protocol**.

```
COMMUNICATION PROTOCOL:
CURRENTLY:             CLINK
SET TO:                STREAMING ?

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

Streaming Data Configuration

The Streaming Data Configuration menu is used to select the 8 output items that will be included in a streaming record, set the streaming interval and data format, and add or delete the “timestamp” and “data label” from each record.

- In the Main Menu, choose Instrument Controls > Communication Settings > **Streaming Data Config.**

```
STREAMING DATA CONFIG:
>INTERVAL              10 SEC
ADD LABELS             NO
PREPEND TIMESTAMP      YES
ADD FLAGS              YES
ITEM 1                 CO ↓

RANGE  AVG  DIAGS  ALARM
```

Streaming Data Interval

The Streaming Data Interval screen is used to adjust how frequently a streaming data record is exported. The following interval times are available: 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, 240, and 300 seconds.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > **Interval.**

```
STREAMING DATA INTERVAL:
CURRENTLY:             10 SEC
SET TO:                20 SEC ?

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

Add Labels

The Add Labels menu item allows the operator to toggle between YES and NO. If set to YES, then each data point in the streaming record will have a label attached.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > **Add Labels.**

Prepend Timestamp The Prepend Time Stamp menu item allows the operator to toggle between YES and NO. If set to YES, then each streaming data record will start with a time and date stamp indicating when that record was generated.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > **Prepend Timestamp**.

Add Flags The Add Flags menu item allows the operator to toggle between YES and NO. If set to YES, then each streaming data record will include a set of flags that indicate various diagnostic or alarm conditions.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > **Add Flags**.

Item # The Item selection screen shows the operator which data fields will be included in the streaming records and also allow those selections to be edited. The editing function operates in a manner that is similar to the Select Content submenu that is used to configure the data logging. When the item number is selected, the submenu displays a list of data fields that can be included in the streaming records. The available fields are organized into the following groups; Concentrations, Other Measurements, Analog Inputs, and Non-Measurements. If the I/O board is not present, Analog Inputs will not be available.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > **Item (1-8)**.

```

CHOOSE STREAM DATA:
>CONCENTRATIONS
OTHER MEASUREMENTS
ANALOG INPUTS
NON-MEASUREMENTS

RANGE  AVG  DIAGS  ALARM

```

Concentrations The Concentrations screen lists all the individual gases that the analyzer is equipped to measure (Table 3-11). It allows the user to select a concentration reading that will be included in the selected streaming record.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > Item # > **Concentrations**.

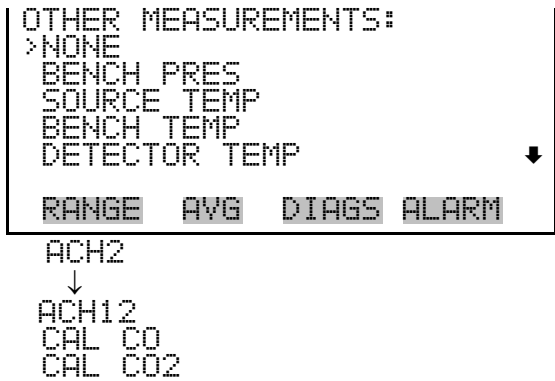


Table 3–11. Data in Streaming Records – Concentrations

Data	Description
None	Leaves that record field blank.
CO	Tracks CO concentration.
NO	Tracks NO concentration.
CO ₂	Tracks CO ₂ concentration.
NO _x	Tracks combined NO and NO ₂ concentration.
O ₂	Tracks O ₂ concentration.
SO ₂	Tracks SO ₂ concentration.
NO ₂	Tracks NO ₂ concentration.

Other Measurements The Other Measurements screen lists data fields other than concentration measurements (Table 3–12). It allows the user to select an item that will be included in the streaming record, such as bench pressure or source temperature.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > Item # > Other Measurements.



```

CAL NO
CAL NO2
CAL SO2
CAL O2
IREF
INT TEMP
DEWPOINT
BB PRES
P FLTR TEMP
P BARL TEMP
CHILLER TEMP
UMB ZONE 1
UMB ZONE 2

```

Table 3–12. Data in Streaming Records – Other Measurements

Data	Description
None	Leaves that record field blank.
Bench pres	Reports the pressure measured at the bench outlet.
Source temp	Reports the temperature measured at the source housing.
Bench temp	Reports the temperature measured at the wall of the IR bench, adjacent to the heaters.
Detector temp	Reports the temperature measured at the base of the detector assembly.
ACH2-ACH12	Reports absorbances for each channel. See Table 3–17 .
Cal CO	Indicates the CO contents of the currently selected cylinder.
Cal CO ₂	Indicates the CO ₂ contents of the currently selected cylinder.
Cal NO	Indicates the NO contents of the currently selected cylinder.
Cal NO ₂	Indicates the NO ₂ contents of the currently selected cylinder.
Cal SO ₂	Indicates the SO ₂ contents of the currently selected cylinder.
Cal O ₂	Indicates the O ₂ contents of the currently selected cylinder.
IREF	Tracks raw signal intensity for reference channel.
Int temp	Reports the ambient temperature measured inside the analyzer.
Dewpoint	Indicates the sample dewpoint value.
BB pres	Indicates the blowback pressure.*
P fltr temp	Indicates the probe filter temperature.*
P barl temp	Indicates the probe barrel temperature.*
Chiller temp	Indicates the chiller temperature.*
Umb zone 1	Indicates the umbilical zone 1 temperature.*
Umb zone 2	Indicates the umbilical zone 2 temperature.*

*Available when the instrument is configured as a system.

Analog Inputs

The Analog Inputs screen lists analog inputs (Table 3–13). It allows the user to select an analog input signal (none or analog inputs 1-8) that will be included in the streaming record.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > Item # > **Analog Inputs**.

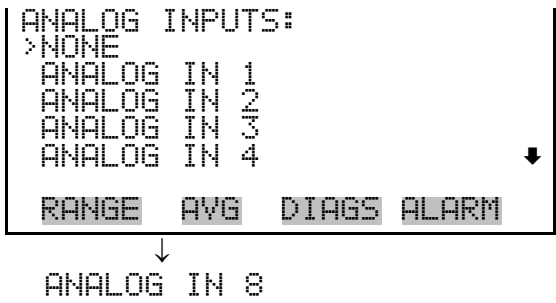


Table 3–13. Data in Streaming Records – Analog Inputs

Data	Description
None	Leaves that record field blank.
Analog In 1-8	Tracks voltage inputs from external devices.

Non-Measurements

The Non-Measurements screen lists status information items available for streaming records (Table 3–14). It allows the user to select a status related item that will be included in the streaming record.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > Item # > **Non-Measurements**.

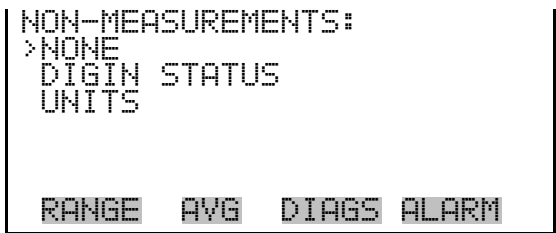


Table 3–14. Data in Streaming Records – Non-Measurements

Data	Description
None	Leaves that record field blank.
Digin Status	Indicates status of raw digital inputs.
Units	Indicates the types of units (ppm, mg/m ³ , %) of the available gases.

TCP/IP Settings

The TCP/IP Settings menu is used for defining parameters that are required for Ethernet communications.

Note The instrument power must be cycled after any of these parameters have been changed for the change to take effect. ▲

- In the Main Menu, choose Instrument Controls > Communication Settings > **TCP/IP Settings**.

```

TCP/IP SETTINGS:
>USE DHCP                OFF
IP ADDR      192.168.1.60
NETMASK      255.255.255.0
GATEWAY      192.168.1.1
HOST NAME    iSeries ↓
RANGE  AVG  DIAGS  ALARM
NTP SVR                      0.0.0.0
  
```

Use DHCP

The Use DHCP screen is used to specify whether to use DHCP or not. When DHCP is enabled, the network dynamically provides an IP address for the instrument. The instrument's power must be cycled for a change to this parameter to take affect. For additional information, see the DHCP command in the “[C-Link Protocol Commands](#)” appendix.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Use DHCP**.

```

DHCP:
CURRENTLY:                OFF
SET TO:                   ON ?
          ← TOGGLE VALUE
CYCLE POWER TO CHANGE DHCP
RANGE  AVG  DIAGS  ALARM
  
```

IP Address The IP Address screen is used to edit the IP address. The IP address can only be changed when DHCP is Off. If DHCP is On, the instrument will respond with “Not Settable if DHCP is On.” For more information on DHCP, see “[Use DHCP](#)” described previously.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **IP Address**.

```
IP ADDRESS:
CURRENT: 192.168.1.200
SET TO: 192.168.001.01
  ↔ MOVE CURSOR
  ↑↓ CHANGE VALUE
  ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

Netmask The Netmask screen is used to edit the netmask. The netmask is used to determine the subnet on which the instrument can directly communicate to other devices. The netmask can only be changed when DHCP is Off. If DHCP is On, the instrument will respond with “Not Settable if DHCP is On.” For more information on DHCP, see “[Use DHCP](#)” in this chapter.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Netmask**.

```
NETMASK:
CURRENT: 255.255.255.0
SET TO: 255.255.255.000
  ↔ MOVE CURSOR
  ↑↓ CHANGE VALUE
  ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

Default Gateway The Default Gateway screen is used to edit the gateway address. The default gateway can only be changed when DHCP is Off. If DHCP is On, the instrument will respond with “Not Settable if DHCP is On.” For more information on DHCP, see “[Use DHCP](#)” in this chapter. Any traffic to addresses that are not on the local subnet will be routed through this address.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Gateway**.

```

DEFAULT GATEWAY:
CURRENT: 192.168.1.1
SET TO: 192.168.001.001
      ↔ MOVE CURSOR
      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

Host Name

The Host Name screen is used to edit the host name. When DHCP is enabled, this name is reported to the DHCP server.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Host Name**.

```

HOST NAME:
CURRENT: iSeries
      001 ?
      ABCDEFGHIJKLMNOP BKSP
      OPQRSTUVWXYZ PAGE
      0123456789 ./- SAVE

RANGE  AVG  DIAGS  ALARM

```

Network Time Protocol Server

The Network Time Protocol (NTP) Server screen is used to edit the IP address of the NTP server. An NTP server may be used to periodically synchronize the instrument's real-time clock with a standard. More information about the NTP servers and a list of public servers may be found at <http://www.ntp.org>.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **NTP SVR**.

```

NTP SERVER IP ADDRESS:
CURRENT: 192.168.1.200
SET TO: 192.168.001.01
      ↔ MOVE CURSOR
      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

I/O Configuration

The I/O Configuration menu deals with configuration of the analyzer's I/O system.

Note The digital outputs may take up to one second after the assigned state occurs to show up on the outputs. ▲

Note Analog Input Config is displayed only if the optional I/O expansion board is installed. ▲

- In the Main Menu, choose Instrument Controls > **I/O Configuration**.

```
I/O CONFIGURATION:
>OUTPUT RELAY SETTINGS
DIGITAL INPUT SETTINGS
ANALOG OUTPUT CONFIG
ANALOG INPUT CONFIG

RANGE  AVG  DIAGS  ALARM
```


Output Relay Settings The Output Relay Settings menu displays a list of the available 10 digital output relays, and allows the user to select the logic state and instrument parameter for the relay selected.

- In the Main Menu, choose Instrument Controls > I/O Configuration > **Output Relay Settings**.

```
OUTPUT RELAY SETTINGS:
>1  NOP          SERVICE
2  NOP          NONE
3  NOP          UNITS
4  NOP          GEN ALARM
5  NOP          NONE ↓

RANGE  AVG  DIAGS  ALARM
```

Logic State The Logic State menu item is used to change the selected I/O relay to either normally open or normally closed. The default state is open, which indicates that a relay connected between the digital output pin and ground is normally open, and closes to trigger the digital output action.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Setup > *select relay (1-10)*.
- With cursor at Logic State, press  to toggle and set the logic state to normally open or normally closed.

```

OUTPUT RELAY SETUP:
>LOGIC STATE      OPEN
INSTRUMENT STATE

RANGE  AVG  DIAGS  ALARM

```

Instrument State

The Instrument State submenu allows the user to select the instrument state that is assigned to the selected relay output. The submenu lists signal types of Concentration Alarms, Other Alarms, System Alarms, or Non-Alarm to choose from.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Setup > *select relay* > **Instrument State**.

```

CHOOSE SIGNAL TYPE:
>CONCENTRATION ALARMS
OTHER ALARMS
SYSTEM ALARMS
NON-ALARM

RANGE  AVG  DIAGS  ALARM

```

Concentration Alarms

The Concentration Alarms status screen allows the user to select a concentration alarm status for the selected relay output. The currently selected item is shown by “<--” after it.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Settings > *select relay* > Instrument State > **Concentration Alarms**.

```

CONC ALARM STATUS ITEMS:
>NONE                                <--
CONC MAX CO
CONC MIN CO
CONC MAX CO2
CONC MIN CO2
                                     ↓
RANGE  AVG  DIAGS  ALARM

```

```

CONC MAX NO
CONC MIN NO
CONC MAX NO2
CONC MIN NO2
CONC MAX NOX
CONC MIN NOX
CONC MAX O2
CONC MIN O2

```

```
CONC MAX SO2
CONC MIN SO2
```

Other Alarms

The Other Alarms status screen allows the user to select an alarm status to be assigned to the selected relay output other than concentrations or system related functions. The currently selected item is shown by “<--” after it.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Settings > *select relay* > Instrument State > **Other Alarms**.

```
OTHER ALARM STATUS ITEMS:
>NONE                                <--
GEN ALARM
INT TEMP
BENCH TEMP
DETECTOR TEMP                        ↓
RANGE  AVG  DIAGS  ALARM

PRESSURE
SAMPLE FLOW
CAL FLOW
DEWPOINT
REF INTENSITY
MB STATUS
MIB STATUS
I/O BD STATUS
DET BD STATUS
CAL FAILED
```

System Alarms

The System Alarms status screen allows the user to select a system alarm status for the selected relay output. This screen is available only if the analyzer is configured as part of a system. The currently selected item is shown by “<--” after it.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Settings > *select relay* > Instrument State > **System Alarms**.

```
SYSTEM ALARM STATUS ITEMS:
>NONE                                <--
UMB Z1 TEMP
UMB Z2 TEMP
PROBE FLT TEMP
621 STATUS                          ↓
RANGE  AVG  DIAGS  ALARM

PROBE BRL TEMP
```

Non-Alarm

The Non-Alarm status screen allows the user to select a non-alarm status for the selected relay output. The selected item is shown by “<--” after it.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Settings > *select relay* > Instrument State > **Non-Alarm**.

```

NON ALARM STATUS ITEMS:
>NONE                                <--
LOCAL/REMOTE
SERVICE
SAMPLE MODE
ZERO MODE                            ↓
RANGE  AVG  DIAGS  ALARM

SPAN MODE
CYLINDER 1-6
BLOWBACK
PURGE
CHECK CAL
EVENT RUNNING
NO DILUTION
NO OZONATOR
CAL SYSTEM

```

Digital Input Settings

The Digital Input Settings menu displays a list of the 16 digital inputs available, and allows the user to select the logic state and instrument state (action) for the selected relay. The actual use of these inputs will vary based on analyzer configuration.

Note The digital inputs must be asserted for at least one second for the action to be activated. ▲

Note Not all of the I/O available in the instrument are brought out on the supplied terminal board. If more I/O is desired, an alternative means of connection is required. ▲

- In the Main Menu, choose Instrument Controls > I/O Configuration > **Digital Input Settings**.


```

DIGITAL INPUT TYPE:
>1  NOP  AOUTS TO ZERO
2   NOP  AOUTS TO FS
3   NOP  NONE
4   NOP  NONE
5   NOP  NONE
                                     ↓
RANGE  AVG  DIAGS  ALARM

```

Logic State

The Logic State menu item is used to change the selected I/O relay to either normally open or normally closed. The default state is open, which indicates that a relay connected between the digital input pin and ground is normally open and closes to trigger the digital input action. If nothing is connected to the digital input pin, the state should be left at open to prevent the action from being triggered.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Digital Input Settings > *select relay (1-16)*.
- With the cursor at Logic State, press  to toggle and set the logic state to normally open or normally closed.

```

DIGITAL INPUT SETUP:
>LOGIC STATE      OPEN
  INSTRUMENT STATE
RANGE  AVG  DIAGS  ALARM

```

Instrument State

The Instrument State submenu allows the user to choose the instrument action that is tied to the selected digital input.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Digital Input Settings > *select relay* > **Instrument State**.

```

CHOOSE EVENT:
>CALIBRATION INPUTS
  EVENT INPUTS
  NON-CALIBRATION INPUTS
RANGE  AVG  DIAGS  ALARM

```


Calibration Inputs

Items in the Calibration Inputs menu are used to configure calibration for instruments controlled a PLC or data logger. The selected item is shown by “<--” after it.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Digital Input Settings > *select relay* > Instrument State > **Calibration Inputs**.

```

CALIBRATION INPUTS:
>NONE                      <--
CYLINDER 1
CYLINDER 2
CYLINDER 3
CYLINDER 4
                                ↓
RANGE  AVG  DIAGS  ALARM
CYLINDER 5
CYLINDER 6
CHECK CAL
SPAN MODE
ZERO IR
ZERO O2
SPAN NOX
OZONATOR
STORE CAL
STORE 1
STORE 2
COMPUTE NO2 SPAN
SPAN O2
  
```

Event Inputs

The Event Inputs menu is an extension of calibration inputs used to trigger actions that are tied to the selected digital input. These events are those defined in the calibration sequence menu, which are used to create the two calibration sequences. Refer to “Appendix E” for associated information. The selected item is shown by “<--” after it.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Digital Input Settings > *select relay* > Instrument State > **Event Inputs**.

```

EVENT INPUTS:
>NONE                      <--
RUN EVENT 1
RUN EVENT 2
RUN EVENT 3
RUN EVENT 4
                                ↓
RANGE  AVG  DIAGS  ALARM
↓
  
```

```
RUN EVENT 16
HALT EVENTS
RUN SEQ 1
RUN SEQ 2
```

Non-Calibration Inputs

The Non-Calibration Inputs menu is used to configure digital inputs for selected actions. Aouts to Zero and Aouts to FS sets the analog outs to zero or full scale when triggered. External alarms 1, 2, and 3 will show the instrument alarm when triggered. The user may configure these to any external component. When the Blowback is triggered, the Lrec Flags record the instrument in Blowback mode and the data is flagged as invalid. The Chiller Alarm may be triggered to record this fault and also cause Actions on Alarms whereby the system can respond by turning off the sample pump or purging air through the probe. Save Cals is used in conjunction with a PLC to store calibration changes. Lock Outputs holds the analog outputs at their current response or at a fixed percent of range. The selected item is shown by "<--" after it.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Digital Input Settings > *select relay* > Instrument State > **Non-Calibration Inputs**.

```
NON-CALIBRATION  INPUTS:
>NONE             <--
AOUTS TO ZERO
AOUTS TO FS
DATA INVALID
EXT ALARM 1
↓
RANGE  AVG  DIAGS  ALARM
EXT ALARM 2
EXT ALARM 3
BLOWBACK
CHILLER ALARM
SAVE CALS
LOCK OUTPUTS
```

Analog Output Configuration (Select Channel)

The Analog Output Configuration menu displays a list of the analog output channels available for configuration. Channel choices include all voltage channels, all current channels, individual voltage channels 1-6, and individual current channels 1-6 (if the I/O expansion board option is installed). The Allow Over/Under Range item scales the output to allow the operator to detect signals that have gone outside the normal range.

- In the Main Menu, choose Instrument Controls > I/O Configuration > **Analog Output Config**.

```

OUTPUT CHANNELS:
>ALLOW OVER/UNDER RANGE
ALL VOLTAGE CHANNELS
ALL CURRENT CHANNELS
VOLTAGE CHANNEL 1
VOLTAGE CHANNEL 2
                                     ↓
RANGE  AVG  DIAGS  ALARM
                                     ↓
VOLTAGE CHANNEL 6
CURRENT CHANNEL 1-6
  
```

Allow Over/Under Range

The Allow Over/Under Range screen is used to select whether or not the analog outputs are allowed to exceed the maximum selected value of 100 mV, 1 V, 5 V, 10 V, or 20 mA or the minimum selected value of 0 V, 0 mA, or 4 mA. By default, this parameter is set to on and 5% over and under range is allowed for all analog output channels.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Output Config > **Allow Over/Under Range**.

```

ALLOW OVER/UNDER RANGE:
CURRENTLY:                ON
SET TO:                   OFF  ?
                            ← TOGGLE VALUE
RANGE  AVG  DIAGS  ALARM
  
```

Analog Output Configuration (Select Action)

The Analog Output Configuration menu displays a list of the analog output configuration choices from which the user selects the parameter to assign to the selected output channel. Configuration choices include selecting the range, setting minimum/maximum values, and choosing the signal to output. (Choosing the signal to output is not displayed unless a specific voltage or current channel is selected.)

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Output Config > **All Voltage Channels, All Current Channels, Voltage Channel 1-6** or **Current Channel 1-6**.

```

ANALOG OUTPUT CONFIG:
>SELECT RANGE
  SET MINIMUM VALUE
  SET MAXIMUM VALUE
  CHOOSE SIGNAL TO OUTPUT

RANGE INST  DIAGS ALARM
  
```

Select Output Range

The Select Output Range screen is used to select the hardware range for the selected analog voltage output channel. Possible ranges for the voltage outputs are: 0-100 mV, 0-1, 0-5, and 0-10 V.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Output Config > *select channel* > **Select Range**.

```

SELECT OUTPUT RANGE:
SELECTED OUTPUT:      V1
CURRENTLY:            0-10V
SET TO:               0-5V ?

↑↓ CHANGE VALUE      ← SAVE

RANGE  AVG  DIAGS  ALARM
  
```

Set Minimum and Maximum Value

The Set Minimum and Maximum Value screens are used to edit the zero (0) and full-scale (100) values, respectively, in percentages for the selected analog output channel. See [Table 3-15](#) for a list of choices. The Minimum and Maximum Value screens function the same way. The following example shows the set Minimum Value screen.

- In the Main Menu, choose Instrument Controls > IO Configuration > Analog Output Config > *select channel* > **Set Minimum** or **Maximum Value**.

```

MINIMUM OUTPUT PERCENT:
SELECTED OUTPUT:      V1
CURRENTLY:            0.0000 %
SET TO:               0.0000 % ?

↑↓ CHANGE VALUE      ← SAVE

RANGE  AVG  DIAGS  ALARM
  
```

Table 3–15. Analog Output Zero to Full Scale Table

Output	Zero % Value	Full Scale 100% Value
CO	Zero (0)	Range Setting
CO2	Zero (0)	Range Setting
NO	Zero (0)	Range Setting
NO2	Zero (0)	Range Setting
NOx	Zero (0)	Range Setting
O2	Zero (0)	Range Setting
SO2	Zero (0)	Range Setting
All "Other Measurements"	User-set alarm min value	User-set alarm max value

Choose Signal To Output

The Choose Signal to Output screen displays a list of the available analog output signal group choices grouped into: Concentrations, Other Measurements, Analog Inputs, and Non-Measurements. (Analog Inputs are available only if the optional I/O expansion board is installed). This allows the user to assign a specific measurement result or parameter to the selected output channel. The Concentrations screen is shown in the following example. See [Table 3–16](#) for a list of items for each signal group choice.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Output Config > *select channel* > **Choose Signal To Output**.

```

CHOOSE SIGNAL TYPE:
>CONCENTRATIONS
  OTHER MEASUREMENTS
  ANALOG INPUTS
  NON-MEASUREMENTS

  RANGE  AVG  DIAGS  ALARM
  
```

```

CONCENTRATIONS:
>NONE
  CO
  CO2
  NO
  NO2
                                     <--
                                     ↓
  RANGE  AVG  DIAGS  ALARM
  
```

Table 3–16. Signal Type Group Choices

Concentrations	Other Measurements	Analog Inputs	Non-Measurements
None	None	None	None
CO	Bench Pres	Analog Input 1 (if the I/O expansion board is installed)	Digin Status
NO	Source Temp	Analog Input 2 (if the I/O expansion board is installed)	Units
CO2	Bench Temp	Analog Input 3 (if the I/O expansion board is installed)	
NOx	Detector Temp	Analog Input 4 (if the I/O expansion board is installed)	
O2	ACH2-ACH12	Analog Input 5 (if the I/O expansion board is installed)	
SO2	Cal CO	Analog Input 6 (if the I/O expansion board is installed)	
NO2	Cal CO2	Analog Input 7 (if the I/O expansion board is installed)	
	Cal NO	Analog Input 8 (if the I/O expansion board is installed)	
	Cal NO2		
	Cal SO2		
	Cal O2		
	IREF		
	Int Temp		
	Dewpoint		
	BB Pres		
	P Filter Temp		
	P Barrel Temp		
	Chiller Temp		
	Umb Zone 1		
	Umb Zone 2		

Analog Input Configuration

The Analog Input Configuration menu displays a list of the 8 analog input channels available for configuration. This screen is displayed only if the optional I/O expansion board is installed. Configuration includes entering a descriptor, units, decimal places, choice of 2-10 points in the table, and corresponding number of points selected.

- In the Main Menu, choose Instrument Controls > I/O Configuration > **Analog Input Config.**

```

ANALOG INPUT CONFIG:
>CHANNEL 1          IN1
CHANNEL 2          IN2
CHANNEL 3          IN3
CHANNEL 4          IN4
CHANNEL 5          IN5↓
RANGE  AVG  DIAGS  ALARM
  
```

↓
CHANNEL 8

```

ANALOG INPUT 01 CONFIG:
>DESCRIPTOR          IN1
UNITS                V
DECIMAL PLACES       2
TABLE POINTS         2
POINT 1              ↓
RANGE  AVG  DIAGS  ALARM
  
```

POINT 2

Descriptor

The Descriptor screen allows the user to enter the descriptor, or name, for the selected analog input channel. The descriptor is used in datalogging and streaming data to report what data is being sent out. The descriptor may be from 1 to 3 characters in length, and defaults to IN1 to IN8 (user input channel number).

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > *select channel* > **Descriptor**.

```

ANALOG INPUT DESCRIPTOR:
CURRENTLY: IN1
          IN1
          ABCDEFGHIJKLMNOP  BKSP
          OPQRSTUVWXYZ     PAGE
          0123456789 ./-   SAVE
RANGE  AVG  DIAGS  ALARM
  
```

Units

The Units screen allows the user to enter the units for the selected analog input channel. The units are displayed on the diagnostic screen and in datalogging and streaming data. The units may be from 1 to 3 characters in length, and defaults to V (volts).

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > *select channel* > **Units**.

```

ANALOG INPUT UNITS:
CURRENTLY: V
          0
          ABCDEFGHIJKLMN  BKSP
          OPQRSTUVWXYZ    PAGE
          0123456789 . / -  SAVE

RANGE  AVG  DIAGS  ALARM
  
```

Decimal Places

The Decimal Places screen allows the user to select how many digits are displayed to the right of the decimal point, from 0 to 6, with a default of 2.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > *select channel* > **Decimal Places**.

```

DECIMAL PLACES:
CURRENTLY:      2
SET TO:        3 ?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
  
```

Number of Table Points

The Number of Table Points screen allows the user to select how many points are used in the analog input conversion table for the selected channel. The instrument uses linear interpolation between the points in this table to determine what the reading value is, based on the analog input voltage and the units that were selected. Each point in the table consists of an analog input voltage value (0-10 V) and a corresponding reading value. Only two points are necessary for linear inputs, however, a larger number of points may be used to approximate non-linear inputs. The points range from 2 to 10, with a default of 2.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > *select channel* > **Table Points**.

```

NUMBER OF TABLE POINTS:
CURRENTLY:      2
SET TO:        10 ?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
  
```


Table Point

The Table Point submenu allows the user to set up an individual table point.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > *select channel* > **Point (1-10)**.

```
TABLE POINT 01 CONFIG:
>VOLTS                0.00
USER VALUE            0.00

RANGE  AVG  DIAGS  ALARM
```

Volts

The Volts screen allows the user to set the input voltage for the selected table point in the conversion table from 0.00 to 10. The default table is a two-point table with point 1: 0.00 V = 000.0 U and point 2: 10.00 V = 10.0 U, where U is the previously entered unit of measure.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > *select channel* > *select point* > **Volts**.

```
TABLE POINT 01 VOLTS:
CURRENTLY:           0.00
SET TO:              00.00

↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM
```

User Value

The User Value screen allows the user to set the output value for the corresponding input voltage for the selected table point in the conversion table, from -9999999 to 9999999. The default table is a two-point table with point 1: 0.00 V = 000.0 U and point 2: 10.00 V = 10.0 U, where U is the previously entered unit of measure.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > *select channel* > *select point* > **User Value**.

```
TABLE POINT 01 USER VAL:
CURRENTLY:      0.00
SET TO:        00000.00

      ↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM
```

Temperature Compensation

The Temperature Compensation screen provides compensation for any changes to the instrument's output signal due to internal instrument temperature variations. The effects of internal instrument temperature changes on the analyzer's subsystems and output have been empirically determined. This empirical data is used to compensate for any changes in temperature.

- In the Main Menu, choose Instrument Controls > **Temperature Compensation**.

```
TEMPERATURE COMPENSATION:
CURRENTLY:      ON
SET TO:        OFF ?

      ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM
```

Pressure Compensation

The Pressure Compensation screen provides compensation for any changes to the instrument's output signal due to variations in sample pressure. The effects of pressure changes on the analyzer's subsystems and output have been empirically determined.

When pressure compensation is On, the first line of the pressure compensation screen represents the current sample pressure. When pressure compensation is Off, the first line of the display shows the factory standard pressure of 760 mm Hg.

- In the Main Menu, choose Instrument Controls > **Pressure Compensation**.

```
PRESSURE COMPENSATION:
COMP PRES:     743.0 mmHg
CURRENTLY:      ON
SET TO:        OFF ?

      ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM
```

Screen Contrast

The Screen Contrast screen is used to change the contrast of the display. Values between 0 and 100% in increments of 5 are available. Changing the screen contrast may be necessary if the instrument is operated at extreme temperatures or lighting conditions.

Notes The optimal contrast will change with changes in temperature. ▲

The optimal contrast will change from one LCD screen to another. If the LCD screen is replaced, the contrast may need to be reset. ▲

If the display contrast is not optimal, but the content on the screen is visible, select Instrument Controls > **Screen Contrast** and adjust the screen contrast. If the content on the screen is not visible, use the “set contrast 10” C-Link command to set the screen contrast to mid range, then optimize the contrast. See “Contrast Levels” in the “[C-Link Protocol Commands](#)” appendix for more information on this command. ▲

- In the Main Menu, choose Instrument Controls > **Screen Contrast**.

```

SCREEN CONTRAST:
CURRENTLY:      50 %
SET TO:         60 % ?

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
  
```

Date/Time

The Date/Time screen allows the user to view and change the system date and time (24-hour format). The internal clock is powered by its own battery when instrument power is off.

- In the Main Menu, choose Instrument Controls > **Date/Time**.

```

DATE AND TIME:
01 MAY 2009  07:16:18
PRESS ← TO EDIT

RANGE  AVG  DIAGS  ALARM
  
```

```
DATE AND TIME:
01 JUL 2009 12:32:16 ?
SETTING: DAYS
    → SET MONTHS
    ↑↓ CHANGE VALUE
    ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

Timezone

The Timezone screen is used to set the timezone for the NTP time server. This should be set to the timezone that the instrument is located in. If the exact timezone is not shown in the list, it may be entered via a CLINK command (see Appendix B). The selections are: UTC (GMT), EST (GMT+5), CST (GMT+6), MST (GMT+7), PST (GMT+8), YST (GMT+9), HST (GMT+10), NST (GMT+11), DLW (GMT+12), CET (GMT-1), EET (GMT-2), BST (GMT-3), DLT (GMT-4), ECH (GMT-5), FOX (GMT-6), GLF (GMT-7), CCT (GMT-8), JST (GMT-9), GST (GMT-10), LMA (GMT-11), DLE (GMT-12), EDT (GMT+5/4), CDT (GMT+6/5), MDT (GMT+7/6), and PDT (GMT+8/7).

Note The current timezone may say NULL before the timezone is set for the first time, or if the timezone was cleared with a C-link command. ▲

- In the Main Menu, choose Instrument Controls > **Timezone**.

```
TIMEZONE FOR TIMESERVER:
CURRENTLY: UTC (GMT)
SET TO: UTC (GMT)

    ↑↓ CHANGE VALUE
    ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

Service/Access Level

The Model 60i provides three different menu systems, or access levels. These are designated as Service Level, Setup Level and Operator Level.

The Service Level menu provides access to all critical operating and configuration parameters (Service menu). Service Level locks out any remote actions and includes parameters and functions that are useful when making adjustments or diagnosing the Model 60i.

Access to Service Level menus should usually be restricted to trained service technicians, since changes in this portion of the firmware can result in instrument malfunctions that could be difficult to diagnose and correct.

Note The Service Level mode should be turned Off when not in use, as it prevents remote operation. ▲

The Setup Level menu system provides access to all of the operating parameters that are used in initial setup and programming of automated functions.

The Operator Level menu provides a simpler interface that allows the instrument to run and be calibrated, but restricts access to critical parameters and instrument configuration menus. Refer to [Figure 3–3](#) for more details.

- In the Main Menu, choose Instrument Controls > **Service/Access Level**.

```

SET ACCESS LEVEL:
CURRENTLY:          OPER
SET TO:             SERVICE ?

↑↓ CHANGE VALUE    ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Diagnostics Menu

The Diagnostics menu provides access to diagnostic information and functions. This menu is useful when troubleshooting the instrument. The analog input readings and analog input voltages are displayed only if the optional I/O expansion board is installed.

- In the Main Menu, choose **Diagnostics**.

```

DIAGNOSTICS:
>PROGRAM VERSIONS
VOLTAGES
TEMPERATURES
PRESSURE
SAMPLE DEWPOINT ↓

RANGE  AVG  DIAGS  ALARM

```

```

REF INTENSITY
ANALOG INPUT READINGS
ANALOG INPUT VOLTAGES
DIGITAL INPUTS
RELAY STATES
TEST ANALOG OUTPUTS
INSTRUMENT CONFIGURATION
CONTACT INFORMATION

```

Program Versions

The Program Versions screen (read only) shows the version numbers of the programs installed. Prior to contacting the factory with any questions regarding the instrument, please note the product model name and the program version numbers.

- In the Main Menu, choose Diagnostics > **Program Versions**.

```
PROGRAM VERSIONS:
  PRODUCT:      MODEL 60i
  VERSION:      00.04.26.125
  FIRMWARE:     10.17.88
  DETECTOR FW:  11.03.100

  RANGE  AVG  DIAGS  ALARM
```

Voltages

The Voltages menu displays the current diagnostic voltage readings. This screen enables the power supply to be quickly read for low or fluctuating voltages without having to use a voltage meter. The I/O board item is displayed only if the optional I/O expansion board is installed.

- In the Main Menu, choose Diagnostics > **Voltages**.

```
VOLTAGES:
>MOTHERBOARD
INTERFACE BOARD
I/O BOARD

  RANGE  AVG  DIAGS  ALARM
```

Motherboard Voltages

The Motherboard Voltages screen (read only) is used to display the voltage readings on the motherboard.

- In the Main Menu, choose Diagnostics > Voltages > **Motherboard**.

```
MOTHERBOARD VOLTAGES:
  3.3 SUPPLY      3.3 V
  5.0 SUPPLY      5.1 V
 15.0 SUPPLY     15.2 V
 24.0 SUPPLY     24.1 V
 -3.3 SUPPLY     -3.3 V

  RANGE  AVG  DIAGS  ALARM
```

Interface Board Voltages

The Interface Board Voltages screen (read only) is used to display the voltage readings on the measurement interface board.

- In the Main Menu, choose Diagnostics > Voltages > **Interface Board**.

```

INTERFACE BOARD VOLTAGES:
> 3.3 SUPPLY          3.3 V
  5.0 SUPPLY          5.0 V
 15.0 SUPPLY         15.0 V
 24.0 SUPPLY         24.1 V
-15.0 SUPPLY        -15.0 V↓
  RANGE  AVG  DIAGS  ALARM
 18.0 IR SUPPLY    18.0 V
 18.0 MOT SUPPLY   18.0 V
  
```

I/O Board Voltages

The I/O Board Voltages screen (read only) is used to display the voltage readings on the I/O expansion board. This menu is displayed only if the optional I/O expansion board is installed.

- In the Main Menu, choose Diagnostics > Voltages > **I/O Board**.

```

I/O BOARD VOLTAGES:
 3.3 SUPPLY          3.3 V
 5.0 SUPPLY          5.0 V
24.0 SUPPLY         24.0 V
-3.3 SUPPLY         -3.3 V
  RANGE  INST  DIAGS  ALARM
  
```

Temperatures

The Temperatures screen (read only) displays the temperature readings taken at several points inside the analyzer. The source temperature is the temperature reported by a sensor located at the source housing. The bench temperature is the temperature reported by a sensor attached to the aluminum bench housing near the bench heaters. The detector temperature reports the actual temperature of the IR detector. The internal temperature is the ambient temperature inside the analyzer, and is reported by a sensor located on the measurement interface board.

- In the Main Menu, choose Diagnostics > **Temperatures**.

```
TEMPERATURES:
SOURCE          32.6 °C
BENCH           45.5 °C
DETECTOR        48.0 °C
INTERNAL        26.1 °C

RANGE  AVG  DIAGS  ALARM
```

Pressure

The Pressure screen (read only) displays the current optical bench pressure. The pressure is measured by a pressure transducer in line with the optical bench.

- In the Main Menu, choose Diagnostics > **Pressure**.

```
PRESSURE:          760.0 mmHg

RANGE  AVG  DIAGS  ALARM
```

Sample Dewpoint

The Sample Dewpoint screen (read only) displays the approximate water content in the sample in terms of dewpoint in °C and the water concentration in ppm.

- In the Main Menu, choose Diagnostics > **Sample Dewpoint**.

```
DEWPOINT:          5.8 °C
H2O CONC:          9200 ppm

RANGE  AVG  DIAGS  ALARM
```

Ref Intensity

The Ref Intensity screen (read only) displays the measurement of the source intensity. If the source fails, this measurement will drop to zero.

- In the Main Menu, choose Diagnostics > **Ref Intensity**.


```

REF INTENSITY:      45386

RANGE  AVG  DIAGS  ALARM

```

Analog Input Readings

The Analog Input Readings screen (read only) displays the eight user-scaled analog input readings (if the I/O expansion board option is installed).

- In the Main Menu, choose Diagnostics > **Analog Input Readings**.

```

ANALOG INPUT READINGS:
>CO          10.2 ppm
SO2          18.2 ppb
CO2          250 ppm
FL1          20.42 lpm
IO7           0.0 V ↓
RANGE  AVG  DIAGS  ALARM

```

Analog Input Voltages

The Analog Input Voltages screen (read only) displays the eight raw analog input voltage readings (if the I/O expansion board option is installed).

- In the Main Menu, choose Diagnostics > **Analog Input Voltages**.

```

ANALOG INPUT VOLTAGES:
>ANALOG IN 1      6.24 V
ANALOG IN 2      4.28 V
ANALOG IN 3       0.00 V
ANALOG IN 4       0.00 V
ANALOG IN 5       0.00 V ↓
RANGE  AVG  DIAGS  ALARM

```

Digital Inputs

The Digital Inputs screen (read only) displays the state of the 16 digital inputs. If nothing is connected to an input, the internal electronics will pull the voltage up to high and the input will read (1). If a device is connected to an input, the user configures whether the relay is normally open or normally closed. This will dictate whether the input is brought to high (1) or to ground (0) to call for an action. Also, refer to “[Digital Input Settings](#)” on page 3-71.

- In the Main Menu, choose Diagnostics > **Digital Inputs**.


```

DIGITAL INPUTS:
>INPUT 1      1
INPUT 2      1
INPUT 3      1
INPUT 4      1
INPUT 5      1 ↓
  RANGE  AVG  DIAGS  ALARM
INPUT 16      1
  
```

Relay States

The Relay States screen displays the state of the ten digital outputs and eight solenoid outputs, and allows toggling of the state to either On (1) or Off (0). The relays are restored to their original states upon exiting this screen.

- In the Main Menu, choose Diagnostics > **Relay States**.

Press  to toggle the relay state open and closed.

```

RELAY STATE:
>OUTPUT 1      0
OUTPUT 2      0
OUTPUT 3      0
OUTPUT 4      1
OUTPUT 5      0 ↓
  RANGE  AVG  DIAGS  ALARM
      ↓
OUTPUT 10      0
SOLENOID 1-8    1
  
```

Test Analog Outputs

The Test Analog Outputs menu is used to set each of the analog output channels to zero or full scale. Channel choices include all analog outputs, six voltage channels, and six current channels (if the I/O expansion board option is installed).

- In the Main Menu, choose Diagnostics > **Test Analog Outputs**.

```

TEST ANALOG OUTPUTS:
>ALL
VOLTAGE CHANNEL 1
VOLTAGE CHANNEL 2
VOLTAGE CHANNEL 3
VOLTAGE CHANNEL 4 ↓
  RANGE  AVG  DIAGS  ALARM
      ↓
VOLTAGE CHANNEL 6
CURRENT CHANNEL 1-6
  
```

Set Analog Outputs

The Set Analog Outputs screen contains three choices: Set to full scale, set to zero, or reset to normal. Full scale sets the analog outputs to the full-scale voltage or current, zero sets the analog outputs to 0 volts or to the minimum current setting of 4 mA, and reset returns the output to normal operation. The analog outputs are returned to normal operation upon exiting this screen. The following example shows the screen when all analog outputs are set to “normal” operating mode.

- In the Main Menu, choose Diagnostics > Test Analog Outputs > **ALL**, **Voltage Channel (1-6)**, or **Current Channel (1-6)**.

```


SET ANALOG OUTPUTS:
SETTING:                ALL
OUTPUT SET TO:          NORMAL
↑ SET TO FULL SCALE
↓ SET TO ZERO
← RESET TO NORMAL

RANGE  AVG  DIAGS  ALARM

```

Instrument Configuration

The Instrument Configuration screen displays instrument hardware configuration information, which is set at the factory, and is based on what hardware is present and whether or not the analyzer is part of a system.

Note If the analyzer is in Service Level mode, pressing  will toggle the selected item between YES and NO, except for the O₂ sensor which toggles between PM (paramagnetic), EC (electrochemical), and NONE. ▲

- In the Main Menu, choose Diagnostics > **Instrument Configuration**.

```

INSTRUMENT CONFIGURATION:
>I/O EXPANSION BOARD    YES
OXYGEN SENSOR           PM
SYSTEM                  YES
DISABLE CAL VALVES      NO
INTERNAL TMP SENSOR     YES

RANGE  AVG  DIAGS  ALARM

```

Contact Information

The Contact Information screen displays the customer service information.


- In the Main Menu, choose Diagnostics > **Contact Information**.

```
CONTACT INFORMATION:
Americas 01-508-520-0430
Europe +31-765795555
China +86-10-84193588
Asia +91-22-27781102
Web www.thermo.com

RANGE  AVG  DIAGS  ALARM
```

Alarms Menu

The Alarms menu displays a list of items that are monitored by the analyzer. The alarms are grouped into three categories; Concentration Alarms, Other Alams, and System Alarms. If any alarms are active, the alarm (bell) icon is displayed on the right side of the status bar. If the item being monitored goes outside the lower or upper limit, the status of that item will go from “OK” to either “LOW” or “HIGH”, respectively. If the alarm is not a level alarm (high or low), the status will go from “OK” to “FAIL”. The total number of alarms detected is displayed at the top of the menu.

To see the actual reading, or alarm condition, of a specific item and to view the minimum and maximum limits, move the cursor to the item and press .

Note that the motherboard status, interface board status, detector board status, and optional I/O expansion board status are read-only screens that indicate whether power supplies are working and that connections are successful. There are no setting screens for these alarms.

- In the Main Menu, choose **Alarms**.

```
ALARMS:          (TOTAL: 5)
>CONCENTRATION  ALARMS  3
  OTHER ALARMS    1
  SYSTEM ALARMS   2

RANGE  AVG  DIAGS  ALARM
```

Concentration Alarms

The Concentration Alarms menu is used to view and configure concentration alarm limits. Concentration Alarms are all user adjustable and indicate a gas concentration reading that is outside the set limits.

- In the Main Menu, choose Alarms > **Concentration Alarms**.

```

CONCENTRATION ALARMS:
>CO  CONC ALARM      OK
CO2  CONC ALARM      LOW
NO   CONC ALARM      OK
NO2  CONC ALARM      OK
NOX  CONC ALARM      HIGH↓

RANGE  AVG  DIAGS  ALARM

O2  CONC ALARM      OK
SO2 CONC ALARM      HIGH

```

Each Concentration Alarms screen displays the current gas concentration and sets the minimum and maximum alarm limits. Acceptable alarm limits depend on the specific gas. If an unacceptable value is entered, an error message will appear. The minimum alarm may be programmed as a floor trigger (alarm is triggered when the concentration falls below the minimum value) or a ceiling trigger (alarm is triggered when the concentration goes above the minimum value). If the concentration goes beyond either the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > Concentration Alarms > *select an alarm*.

```

CO CONC ALARM IN ppm:
ACTUAL      58.3
>MIN        0020
MAX         1000
MIN TRIGGER  CEILING

RANGE  AVG  DIAGS  ALARM

```

Min and Max Concentration Alarm Limits

The Min and Max Concentration Alarm Limits screens are used to change the minimum and maximum concentration alarm limits. The minimum and maximum concentration alarm limit screens function the same way.

- In the Main Menu, choose Alarms > Concentration Alarms > *select an alarm* > **Min** or **Max**.

```

SET CO MIN:
  MIN:      0.1 ppm
  SET TO:   0.5 ppm?

      ↔ MOVE CURSOR
  ↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Min Trigger Concentration

The Minimum Trigger screen is used to view and set the concentration alarm trigger type to either floor or ceiling. The minimum alarm may be programmed as a floor trigger (alarm is triggered when the concentration falls below the minimum value) or a ceiling trigger (alarm is triggered when the concentration goes above the minimum value). If the concentration goes beyond either the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > Concentration Alarms > *select an alarm* > **Min Trigger**.

```

MIN TRIG(CEILING/FLOOR):
  ACTUAL TRIGGER: CEILING
  SET TRIGGER TO:  FLOOR ?

      ← TOGGLE AND SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

Other Alarms

The Other Alarms screen generally indicates some type of hardware or operational failure. If the item being monitored goes outside the lower or upper limit, the status of that item will go from “OK” to either “LOW” or “HIGH”, respectively. If the alarm is not a level alarm, the status will go from “OK” to “FAIL”.

- In the Main Menu, choose Alarms > **Other Alarms**.

```

OTHER ALARMS:
>SAMPLE FLOW      LOW
CAL FLOW          OK
DEWPOINT         HIGH
PRESSURE         OK
REF INTENSITY     LOW↓

RANGE  AVG  DIAGS  ALARM

STATUS DETECTOR BD  OK
STATUS INTERFACE BD  OK
STATUS I/O EXP BD   OK

```

```

STATUS MOTHERBOARD      OK
TEMP BENCH               OK
TEMP DETECTOR            OK
TEMP SOURCE              OK
CAL FAILED               OK
STATUS 62i               OK
STATUS 61i               OK
TEMP INTERNAL            OK

```

Dewpoint The Dewpoint screen (read only) is used to view the actual current sample dewpoint reading and warning alarm and high alarm limits. Alarm limits range from 10 to 15 degrees C. An alarm is activated if the dewpoint reading goes above the warning alarm or high alarm limit, and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > Other Alarms > **Dewpoint**.

```

DEWPOINT:
ACTUAL          8.0 °C
WARNING ALARM   10.0 °C
HIGH ALARM      15.0 °C

RANGE  AVG  DIAGS  ALARM

```

Pressure The Pressure screen is used to view the current bench pressure reading and the minimum and maximum alarm limits. Acceptable alarm limits range from 250 to 1000 mm Hg. An alarm is activated if the pressure reading is outside the set limits, and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > Other Alarms > **Pressure**.

```

PRESSURE:
ACTUAL          746.9 mmHg
>MIN            250.0 mmHg
MAX             1000.0 mmHg

RANGE  AVG  DIAGS  ALARM

```

Min and Max Pressure Limits

The Min and Max Pressure alarm limit screens are used to change the minimum and maximum alarm pressure limits. The Minimum and Maximum Pressure screens function the same way.

- In the Main Menu, choose Alarms > Other Alarms > Pressure > **Min** or **Max**.

```
PRESSURE:
ACTUAL MIN: 250.0 mmHg
SET MIN TO: 500.0 mmHg?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

Ref Intensity

The Ref Intensity screen (read only) displays the measurement of the source intensity.

- In the Main Menu, choose Alarms > Other Alarms > **Ref Intensity**.

```
REFERENCE INTENSITY:
ACTUAL          50871
MIN             30000
MAX             55000

RANGE  AVG  DIAGS  ALARM
```

Bench Temperature

The Bench Temperature screen displays the bench temperature and the minimum and maximum alarm limits. Acceptable alarm limits range from 40 to 55 °C. If the bench temperature reading is outside the set limits, an alarm is activated, and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > Other Alarms > **Temp Bench**.

```
BENCH TEMPERATURE:
ACTUAL          48.4 °C
>MIN            40.0 °C
MAX             55.0 °C

RANGE  AVG  DIAGS  ALARM
```

Min and Max Bench Temperature Limits

The Min and Max Bench Temperature alarm limit screens are used to change the minimum and maximum bench temperature alarm limits. The

Minimum and Maximum Bench Temperature screens function the same way.

- In the Main Menu, choose Alarms > Other Alarms > Temp Bench > **Min** or **Max**.

```

BENCH TEMPERATURE:
ACTUAL MIN:      40.0 °C
SET MIN TO:      44.0 °C?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
  
```

Detector Temperature

The Detector Temperature screen displays the current detector temperature and the minimum and maximum alarm limits. The detector temperature is regulated at 48 °C. Acceptable alarm limits range from 46 to 49 °C. If the detector temperature reading is outside the set limits, an alarm is activated, and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > Other Alarms > **Temp Detector**.

```

DETECTOR TEMPERATURE:
ACTUAL      48.0 °C
>MIN        46.0 °C
MAX         49.0 °C

RANGE  AVG  DIAGS  ALARM
  
```

Min and Max Detector Temperature Limits

The Min and Max Detector Temperature alarm limit screens are used to change the minimum and maximum detector temperature alarm limits. The Minimum and Maximum Detector Temperature screens function the same way.

- In the Main Menu, choose Alarms > Other Alarms > Temp Detector > **Min** or **Max**.

```
DETECTOR TEMPERATURE:
ACTUAL MIN:          47.5 °C
SET MIN TO:          47.0 °C?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

Source Temperature

The Source Temperature screen displays the current source temperature measured at the source housing and the minimum and maximum alarm limits. Acceptable alarm limits range from 55 to 65 °C. If the temperature reading is outside the set limits, an alarm is activated, and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > Other Alarms > **Temp Source**.

```
SOURCE TEMPERATURE:
ACTUAL          57.6 °C
>MIN           55.0 °C
MAX            65.0 °C

RANGE  AVG  DIAGS  ALARM
```

Min and Max Source Temperature Limits

The Min and Max Source Temperature alarm limit screens are used to change the minimum and maximum source temperature alarm limits. The Minimum and Maximum Source Temperature screens function the same way.

- In the Main Menu, choose Alarms > Other Alarms > Temp Source > **Min** or **Max**.

```
SOURCE TEMPERATURE:
ACTUAL MIN:      58.2 °C
SET MIN TO:      55.0 °C ?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

Internal Temperature

The Internal Temperature screen displays the current internal temperature and the minimum and maximum alarm limits. Acceptable alarm limits range from 8 to 70 °C. If the temperature reading is outside the set limits,

an alarm is activated, and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > Other Alarms > **Temp Internal**.

```

INTERNAL TEMPERATURE:
  ACTUAL          57.6 °C
  >MIN            8.0 °C
  MAX            70.0 °C

  RANGE  AVG  DIAGS  ALARM
  
```

Min and Max Internal Temperature Limits

The Min and Max Internal Temperature alarm limit screens are used to change the minimum and maximum internal temperature alarm limits. The Minimum and Maximum Internal Temperature screens function the same way.

- In the Main Menu, choose Alarms > Other Alarms > Temp Internal > **Min** or **Max**.

```

INTERNAL TEMPERATURE:
  ACTUAL MIN:      8.0 °C
  SET MIN TO:     15.0 °C ?

      ↑↓ INC/DEC
      ↩ SAVE VALUE

  RANGE  AVG  DIAGS  ALARM
  
```

System Alarms

The System Alarms menu is used to display and configure system alarm limits. System alarms generally indicate some type of system related hardware or operational failure. If the item being monitored goes outside the lower or upper limit, the status of that item will go from “OK” to either “LOW” or “HIGH”, and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu. If the alarm is not a level alarm, the status will go from “OK” to “FAIL”, which indicates a problem with the component.

- In the Main Menu, choose Alarms > **System Alarms**.

```

SYSTEM ALARMS:
>STATUS 62i BOARD      OK
STATUS 61i BOARD      OK
PROBE FILTER TEMP      OK
PROBE BARREL TEMP      OK
UMB TEMP ZONE 1        LOW↓
  RANGE  AVG  DIAGS  ALARM

UMB TEMP ZONE 2        LOW
BLOWBACK PRESSURE      LOW
CHILLER STATUS         OK
WATER SLIP             OK
AIR CONDITIONER        OK
62i EXT ALARM 4        OK
      ↓
62i EXT ALARM 8        OK
  
```

Probe Filter Temperature

The Probe Filter Temperature screen displays the current probe filter temperature and the minimum and maximum alarm limits. Acceptable alarm limits range from 0 to 200 °C.

- In the Main Menu, choose Alarms > System Alarms > **Probe Filter Temp.**

```

PROBE FILTER TEMPERATURE:
  ACTUAL          175.0 °C
>MIN             150.0 °C
MAX              200.0 °C
  RANGE  AVG  DIAGS  ALARM
  
```

Min and Max Probe Filter Temperature Limits

The Min and Max Probe Filter Temperature alarm limit screens are used to change the minimum and maximum probe filter temperature alarm limits. The Minimum and Maximum Probe Filter Temperature screens function the same way.

- In the Main Menu, choose Alarms > System Alarms > Probe Filter Temp > **Min** or **Max**.

```

PROBE FILTER TEMPERATURE:
  ACTUAL MIN:    150.0 °C
  SET MIN TO:    155.0 °C ?
                ↑↓ INC/DEC
                ← SAVE VALUE
  RANGE  AVG  DIAGS  ALARM
  
```

Probe Barrel Temperature

The Probe Barrel Temperature screen displays the current probe barrel temperature and the minimum and maximum alarm limits. Acceptable alarm limits range from 0 to 200 °C.

- In the Main Menu, choose Alarms > System Alarms > **Probe Barrel Temp.**

```

PROBE BARREL TEMPERATURE:
  ACTUAL          153.0 °C
>MIN             150.0 °C
MAX              170.0 °C

RANGE  AVG  DIAGS  ALARM

```

Min and Max Probe Barrel Temperature Limits

The Min and Max Probe Barrel Temperature alarm limit screens are used to change the minimum and maximum probe barrel temperature alarm limits. The Minimum and Maximum Probe Barrel Temperature screens function the same way.

- In the Main Menu, choose Alarms > System Alarms > Probe Barrel Temp > **Min** or **Max**.

```

PROBE BARREL TEMPERATURE:
  ACTUAL MIN:    150.0 °C
  SET MIN TO:    155.0 °C ?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

Umbilical Temperature Zone 1

The Umbilical Temperature Zone 1 screen displays the current umbilical Zone 1 temperature and the minimum and maximum alarm limits. The Umbilical Temperature Zone 2 screen functions the same way. Acceptable alarm limits range from 0 to 200 °C.

- In the Main Menu, choose Alarms > System Alarms > **Umb Temp Zone 1.**

```
UMB TEMP ZONE 1:
  ACTUAL          160.0 °C
>MIN             50.0 °C
  MAX            170.0 °C

RANGE  AVG  DIAGS  ALARM
```

Min and Max Umbilical Temperature Zone 1 Limits

The Min and Max Umbilical Temperature Zone 1 alarm limit screens are used to change the minimum and maximum umbilical temperature zone 1 alarm limits. The Minimum and Maximum Umbilical Temperature Zone 1 screens function the same way.

- In the Main Menu, choose Alarms > System Alarms > Umb Temp Zone 1 > **Min** or **Max**.

```
UMB TEMP ZONE 1:
  ACTUAL MIN:     50.0 °C
  SET MIN TO:     55.0 °C ?

  ↑↓ INC/DEC
  ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

Blowback Pressure

The Blowback Pressure screen displays the current blowback pressure and the minimum and maximum alarm limits. Acceptable limits are 0 to 100 psi.

- In the Main Menu, choose Alarms > System Alarms > **Blowback Pressure**.

```
BLOWBACK PRESSURE:
  ACTUAL          60.0 psi
>MIN             50.0 psi
  MAX            70.0 psi

RANGE  AVG  DIAGS  ALARM
```

Min and Max Blowback Pressure Limits

The Min and Max Blowback Pressure alarm limit screens are used to change the minimum and maximum blowback pressure alarm limits. The Minimum and Maximum Blowback Pressure screens function the same way.

- In the Main Menu, choose Alarms > System Alarms > Blowback Pressure > **Min** or **Max**.

```

BLOWBACK PRESSURE:
  ACTUAL MIN    40.0 psi
  SET MIN TO:   40.0 psi

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
  
```

Service Menu




The Service menu provides access to all critical operating and configuration parameters, and advanced diagnostic functions.

Access to Service menus should usually be restricted to trained service technicians, since changes in this portion of the firmware can result in instrument malfunctions that could be difficult to diagnose and correct.

The Service Level mode locks out any remote actions, and includes parameters and functions that are useful when making adjustments or diagnosing problems with the Model 60i. Due to the possibility of introducing errors, it is suggested that the instrument should not be left in Service Level mode during routine operation.

Note The Access Level should be in Service when not in use, as it prevents remote operation. ▲

The Service menu appears only when the instrument is in the Service Level mode. When service mode is active, the service (wrench) icon is displayed on the right side of the status bar. To put the instrument into the Service Level mode:

- In the Main Menu, choose Instrument Controls > Service/Access Level > press   to set to Service, then press .

Note The adjustments in the Service menu should only be performed by an instrument service technician. ▲

- In the Main Menu, choose **Service**.

```
SERVICE:
>ABSORBANCES
  SHOW USER ZERO
  SHOW USER SPAN
  PRESSURE CALIBRATION
  O2 SENSOR CALIBRATION
  RANGE  AVG  DIAGS  ALARM

  PREAMP BOARD CAL
  SOURCE TEMP CALIBRATION
  ANALOG OUT CAL
  LOCK ANALOG OUTPUTS
  ANALOG OUT LOCK TYPE
  SET ANALOG LOCK PERCENT
  ANALOG INPUT CAL
  SETUP RUN SCREENS
  DISPLAY PIXEL TEST
  ADJUST PEAK OFFSET
  RAW DATA DISPLAY
  VALVE LEAK TEST
  60i PUMP CONTROL SETUP
  DEWPOINT SPAN CAL
  MULTIPOINT LIN SETUP
  INTERNAL TEMP CALIBRATION
  RESTORE USER DEFAULTS
```

Absorbances

The Absorbances screen is used to view the real-time zero compensated absorbance values. [Table 3–17](#) shows the gas measured by each filter, and corresponds to the positions shown in the Absorbances screen.

- In the Main Menu, choose Service > **Absorbances**.

```
ABSORBANCES:
  0.0126  0.0133  0.0120
  0.0131  0.0124  0.0136
  0.0122  0.0130  0.0133
  0.0125  0.0131  0.0129

  RANGE  AVG  DIAGS  ALARM
```

Table 3–17. Filters (INT = interferent)

Ref	NO ₂	H ₂ O
INT-4	CO	NO-1
INT-7	CO ₂	SO ₂
NO-2	INT-11	INT-12

Show User Zero

The Show User Zero screen is used to view the user zero absorbance values.

- In the Main Menu, choose Service > **Show User Zero**.

```

USER ZEROS:
0.0000  0.0000  0.0000
0.0000  0.0000  0.0000
0.0000  0.0000  0.0000
0.0000  0.0000  0.0000
0.0000  0.0000  0.0000

RANGE  AVG  DIAGS  ALARM
  
```

Show User Span

The Show User Span screen is used to view the user span factor values.

- In the Main Menu, choose Service > **Show User Span**.

```

USER SPANS:
1.0000  1.0000  1.0000
1.0000  1.0000  1.0000
1.0000  1.0000  1.0000
1.0000  1.0000  1.0000

RANGE  AVG  DIAGS  ALARM
  
```

Pressure Calibration

The Pressure Calibration submenu is used to calibrate the pressure sensor, to zero, span, or restore factory default values. The pressure sensor's zero counts and span slope are displayed on the menu.

Note Wait at least 30 seconds for the reading to stabilize before saving the value. ▲

Important Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Pressure Calibration**.

```
PRESSURE SENSOR CAL:
>ZERO                72
SPAN                1.1416
SET DEFAULTS

RANGE  AVG  DIAGS  ALARM
```

Calibrate Pressure Zero

The Calibrate Pressure Zero screen allows the user to view the pressure and adjust the pressure sensor to read zero at zero pressure.

Note A vacuum pump must be connected to the pressure sensor before performing the zero calibration. To avoid damaging the pressure sensor, be sure to release the vacuum slowly to atmospheric pressure when finished. ▲

- In the Main Menu, choose Service > Pressure Calibration > **Zero**.

```
CALIBRATE PRESSURE ZERO:
CURRENTLY:      10.0 mmHg
SET TO:         5.0 mmHg ?

CONNECT VACUUM PUMP AND
← SAVE ZERO PRESSURE

RANGE  AVG  DIAGS  ALARM
```

Calibrate Pressure Span

The Calibrate Pressure Span screen allows the user to view and set the pressure sensor calibration span point.

Note The plumbing going to the pressure sensor should be slowly disconnected so the sensor is reading ambient pressure before performing the span calibration. The operator should use an independent barometer to measure the ambient pressure and enter the value on this screen before calibrating. ▲

- In the Main Menu, choose Service > Pressure Calibration > **Span**.

```

CALIBRATE PRESSURE SPAN:
CURRENTLY: 753.0 mmHg
SET TO: 760.0 mmHg ?

      ↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

Set Default Pressure Calibration

The Set Default Pressure Calibration screen allows the user to reset the pressure calibration values to factory defaults.

- In the Main Menu, choose Service > Pressure Calibration > **Set Defaults**.

```

RESTORE DEFAULT CAL:

      ← RESTORE

RANGE  AVG  DIAGS  ALARM

```

```

RESTORE DEFAULT CAL:

      ← RESTORE
ARE YOU SURE YOU WANT TO?
PRESS → TO CONFIRM RESTORE

RANGE  AVG  DIAGS  ALARM

```

O₂ Sensor Calibration

The O₂ Sensor Calibration screen is used to calibrate either of the optional oxygen sensors after the oxygen sensor has been replaced. The instrument firmware will display the appropriate calibration screens based on the type of O₂ sensor that is installed.

Important Note This calibration should only be performed by a trained service technician when the oxygen sensor has been replaced. Routine calibrations should be performed using the procedures described in the “[Calibration](#)” chapter. ▲

- In the Main Menu, choose Service > **O2 Sensor Calibration**.

```

O2 SENSOR CAL:
>ZERO
SPAN
SET DEFAULTS

RANGE  AVG  DIAGS  ALARM

```

Calibrate O₂ Sensor Zero (Electrochemical O₂ Sensor)

The Calibrate O₂ Sensor Zero screen is used to view and calibrate the electrochemical O₂ sensor on zero air (only after a sensor replacement).

- In the Main Menu, choose Service > O₂ Sensor Calibration > **Zero**.

```
CALIBRATE O2 SENSOR ZERO:
CURRENTLY:      0.0 mV

MAKE SURE READING IS <1 mV
PRESS ← TO SAVE O2 ZERO

RANGE  AVG  DIAGS  ALARM
```

Calibrate O₂ Sensor Span (Electrochemical O₂ Sensor)

The Calibrate O₂ Sensor Span screen is used to view and calibrate the electrochemical O₂ sensor on span gas (only after a sensor replacement).

Note The reading should be greater than 9 mV for a new oxygen sensor. ▲

- In the Main Menu, choose Service > O₂ Sensor Calibration > **Span**.

```
CALIBRATE O2 SENSOR SPAN:
CURRENTLY:      0.0 mV

MAKE SURE READING IS >9 mV
PRESS ← TO SAVE O2 SPAN

RANGE  AVG  DIAGS  ALARM
```

Calibrate O₂ Sensor Zero (Paramagnetic O₂ Sensor)

The Calibrate O₂ Sensor Zero screen is used to view and calibrate the paramagnetic O₂ sensor on zero air (only after a sensor replacement). The zero adjustment potentiometer is located on the paramagnetic O₂ sensor.

- In the Main Menu, choose Service > O₂ Sensor Calibration > **Zero**.

```

CALIBRATE O2 SENSOR ZERO:
CURRENTLY:      0.0 mV

ADJUST READING TO 10 mV
USING ZERO ADJUST POT
PRESS ← TO SAVE O2 ZERO

RANGE  AVG  DIAGS  ALARM
  
```

Calibrate O₂ Sensor Span (Paramagnetic O₂ Sensor)

The Calibrate O₂ Sensor Span screen is used to view and calibrate the paramagnetic O₂ sensor on span gas (only after a sensor replacement). The span adjustment potentiometer is located on the paramagnetic O₂ sensor.

- In the Main Menu, choose Service > O₂ Sensor Calibration > **Span**.

```

CALIBRATE O2 SENSOR SPAN:
CURRENTLY:      0.0 mV

ADJUST READING TO 210 mV
USING SPAN ADJUST POTS
PRESS ← TO SAVE O2 SPAN

RANGE  AVG  DIAGS  ALARM
  
```

Restore O₂ Calibration Defaults

The Restore Default Cal screen is used to reset the calibration values to factory defaults.

- In the Main Menu, choose Service > O₂ Sensor Calibration > **Set Defaults**.

```

RESTORE DEFAULT CAL:

                                ← RESTORE

RANGE  AVG  DIAGS  ALARM
  
```

```

RESTORE DEFAULT CAL

                                ← RESTORE
ARE YOU SURE YOU WANT TO?
PRESS → TO CONFIRM RESTORE

RANGE  AVG  DIAGS  ALARM
  
```

Preamp Board Calibration

The Preamp Board Calibration screen is used to view and adjust the preamp board calibration parameters. The value should be set so that the max count value shown on screen is approximately 50,000.

Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Preamp Board Cal.**

```
PREAMP BOARD CAL:
MAX COUNT:      49100
SET TO:         150
                ↑↓ CHANGE VALUE
                ← SAVE VALUE
RANGE  AVG  DIAGS  ALARM
```

Source Temperature Calibration

The Source Temperature Calibration screen is used to view and set the source temperature sensor offset.

Note Wait at least 30 seconds for the reading to stabilize before saving the value. ▲

Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Source Temp Calibration.**

```
CALIBRATE SOURCE TEMP:
CURRENTLY:      25.0 °C
SET TO:         25.0 °C ?
                ↔ MOVE CURSOR
                ↑↓ CHANGE VALUE  ← SAVE
RANGE  AVG  DIAGS  ALARM
```

Analog Output Calibration

The Analog Output Calibration menu provides access to calibrate the six voltage channels and six current channels (if the I/O expansion board option is installed) and to select the calibration action zero or full scale.

Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Analog Out Cal.**

```

ANALOG OUTPUT CAL:
>VOLTAGE CHANNEL 1
VOLTAGE CHANNEL 2
VOLTAGE CHANNEL 3
VOLTAGE CHANNEL 4
VOLTAGE CHANNEL 5
↓
RANGE  AVG  DIAGS  ALARM

VOLTAGE CHANNEL 6
CURRENT CHANNEL (1-6)

```

To display the Calibrate Zero and the Calibrate Full Scale functions, press

↑ ↓ to scroll to a channel and press ←.

```

ANALOG OUTPUT CAL:
>CALIBRATE ZERO
CALIBRATE FULL SCALE

RANGE  AVG  DIAGS  ALARM

```

Analog Output Calibrate Zero

The Analog Output Calibrate Zero screen is used to calibrate the zero state of the selected analog output. Connect a meter to the output and adjust “Set To” until the meter matches the “Set Output To” reading of 0.0 V for a voltage channel, or 4 mA for a current channel (depending on the selected range). The “Set Output To:” field on the display will show what the meter should read.

- In the Main Menu, choose Service > Analog Out Cal > *Select Channel* > **Calibrate Zero**.

```

ANALOG OUTPUT CAL:  ZERO
CONNECT METER TO OUTPUT!
SELECTED OUTPUT:    V1
SET TO:              100
← SAVE VALUE        ↑↓ INC/DEC
SET OUTPUT TO:      0.0 V

RANGE  AVG  DIAGS  ALARM

```

Analog Output Calibrate Full Scale

The Analog Output Calibrate Full Scale screen is used to calibrate the full scale state of the selected analog output. Connect a volt meter to the output and adjust output until it reads the value shown in the Set Output To: field, in either V or mA, depending on the selected output channel.

- In the Main Menu, choose Service > Analog Out Cal > *Select Channel* > **Calibrate Full Scale**.

```
ANALOG OUTPUT CAL:  SPAN
CONNECT METER TO OUTPUT!
SELECTED OUTPUT:    V1
SET TO:             6397
← SAVE VALUE      ↑↓ INC/DEC
SET OUTPUT TO:      10 V

RANGE  AVG  DIAGS  ALARM
```

Lock Analog Outputs

The Lock Analog Outputs screen is used to enable/disable triggering of analog output lock. When the analog output lock is on, the analog outputs will hold their values as designated by the analog lock type. See “[Analog Out Lock Type](#)” for more information.

- In the Main Menu, choose Service > **Lock Analog Outputs**.

```
LOCK ANALOG OUTPUTS:
CURRENTLY:           OFF
SET TO:              ON ?

← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM
```

Analog Out Lock Type

Some applications may require the analog output locked to show a simulated instrument response during calibrations. The Analog Out Lock Type screen is used to select the analog output lock setting. There are three different "types" of output locks:

- No Lock - Outputs will never be locked, regardless of the state of any of the triggers
- Lock Current – Locks outputs to current value (holds output at value immediately prior to the lock)
- Lock Percent – Locks outputs to set percentage of output range

When either a Lock Current setting or a Lock Percent setting is selected, any of the following triggers will lock the analog outputs:

- Digital input lock – activated by hardware or via MODBUS
- C-link commands – lock outputs, lock action, lock percent
- Front panel/screen activated lock (Lock Analog Outputs screen)

- Unit being in calibration and/or non-sample mode

All of the triggers must be off in order to return the analog outputs to normal operation. For example, while the user could activate the digital input and be guaranteed to lock the outputs, releasing that digital input will not return the outputs to normal operation if one of the other triggers is still active.

The screen and C-link command may report that the trigger is off, but that is ONLY for that particular trigger. The only way to definitively turn off the output locking is to set the lock type to "No Lock".

Note To avoid confusion, use only one lock trigger at a time and be aware of the analyzer's calibration state. ▲

- In the Main Menu, choose Service > **Analog Out Lock Type**.

```

ANALOG OUT LOCK SETTING:
CURRENTLY: NO LOCK
SET TO: NO LOCK

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

Set Analog Lock Percent

When Lock Percent has been selected on the Analog Out Lock Type screen, use the Set Analog Lock Percent screen to set the output range percentage.

The Set Analog Lock Percent screen is used to set the analog output lock percentage to an integer *value*, where *value* is the percent of the output range that the analog outputs will lock to if locking is active. Limits are from -5 to 105, in percent of range. For example, if the user sets the analog lock percent to 105, then when the analog outputs are locked, they will be locked at 10.5 volts if the outputs are set to the 0-10 volt range.

- In the Main Menu, choose Service > **Set Analog Lock Percent**.

```

SET ANALOG LOCK PERCENT:
CURRENTLY:      100
SET TO:         100

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```


Analog Input Calibration

The Analog Input Calibration menu is used to calibrate the eight analog input channels at both zero and full scale.

Note This screen is present only when the I/O expansion board is installed. ▲




Note This adjustment should only be performed by an instrument service technician. ▲

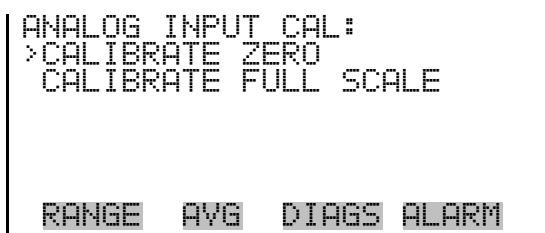
- In the Main Menu, choose Service > **Analog Input Cal.**



```
ANALOG INPUT CAL:
>INPUT CHANNEL 1
  INPUT CHANNEL 2
  INPUT CHANNEL 3
  INPUT CHANNEL 4
  INPUT CHANNEL 5
                                ↓
RANGE  AVG  DIAGS  ALARM

↓
INPUT CHANNEL 8
```

To display the Calibrate Zero and the Calibrate Full Scale functions, press   to scroll to a channel and press .



```
ANALOG INPUT CAL:
>CALIBRATE ZERO
  CALIBRATE FULL SCALE
                                ↓
RANGE  AVG  DIAGS  ALARM
```

Analog Input Calibrate Zero

The Analog Input Calibrate Zero screen is used to calibrate the zero state of the selected analog input.

- In the Main Menu, choose Service > Analog Input Cal > *Select Channel* > **Calibrate Zero**, and disconnect everything from the selected input.

```

ANALOG INPUT CAL:  ZERO
DISCONNECT SELECTED INPUT!
SELECTED INPUT:  INPUT 1
CURRENTLY:  0.24 V

← CALIBRATE INPUT TO ZERO

RANGE  AVG  DIAGS  ALARM





```

Analog Input Calibrate Full Scale

The Analog Input Calibrate Full Scale screen is used to calibrate the full scale state of the selected analog input.

- In the Main Menu, choose Service > Analog Input Cal > *Select Channel* > **Calibrate Full Scale**.

Connect a voltage source of 10 V to the analog input channel.

Note If the voltage provided is slightly different from 10.00 V, then use the   and   to enter the voltage in the “Set to” field. ▲



```

ANALOG INPUT CAL:  SPAN
PROVIDE VOLTAGE TO INPUT!
SELECTED INPUT:  INPUT 1
CURRENTLY:  9.24 V
SET TO:  10.00 V?
← CALIBRATE TO VALUE

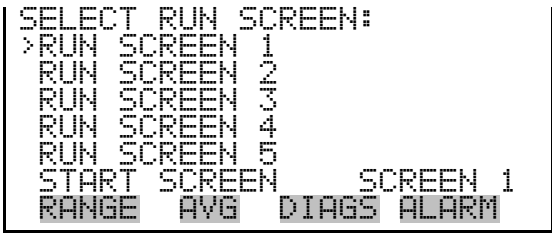
RANGE  AVG  DIAGS  ALARM

```

Setup Run Screens

The Setup Run Screens menu is used to define and edit up to five custom Run screens. The operator can select what information is shown and how it is presented in each Run screen. While in Run mode, pressing  or  to will toggle between the custom Run screens that are turned on (if turned off, the custome Run screens will not be displayed). Please note that any of the screens can be assigned as the start screen, which is displayed on instrument start up. The start screen defaults to screen 1. Some of the Run screens come pre-defined at the factory, but they can still be edited.

- In the Main Menu, choose Service > **Setup Run Screens**.



The Select Run Screen menu is used to select a Run screen to edit and to display the Edit Run Screen menu.

- In the Main Menu, choose Service > Setup Run Screens > *Select a Run Screen*.

Edit Run Screen

The Edit Run Screen menu is used to edit the contents of the selected custom Run screen (Figure 3–5). This menu allows the user to edit the Run screen title, toggle the Run screen On and Off, specify the number of items to be displayed on the Run screen (1-10), and to assign a parameter to each item.

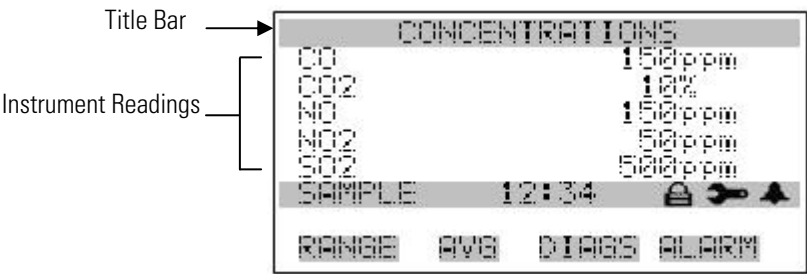
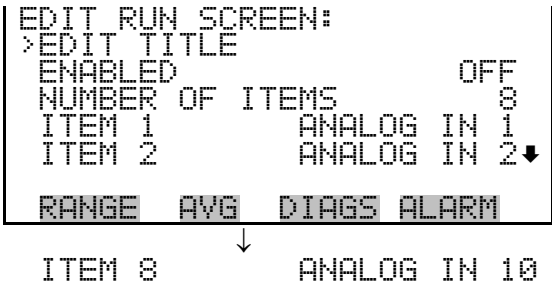


Figure 3–5. Example of Run Screen Contents



Edit Title

The Edit Title screen is used to edit the contents of the title bar (Figure 3–5) on the selected Custom Run screen. Refer to Table 3–18 for a list of the default Run screen titles.

Table 3–18. Default Run Screen Titles

Run Screen	Default Title
1	Concentrations
2	Other Measurements
3	Analog Inputs
4	Calibration Cylinder
5	External Alarms

- In the Main Menu, choose Service > Setup Run Screens > *Select a Run Screen* > **Edit Title**.



```

EDIT RUN SCREEN TITLE:
  CONCENTRATIONS

  ABCDEFGHIJKLMNOP  BKSP
  OPQRSTUVWXYZ      PAGE
  0123456789 . / -  SAVE

  RANGE  AVG  DIAGS  ALARM
  
```

Enabled

The Enabled screen is used to toggle the selected custom Run screen On and Off. When a Run screen is On, it will be displayed when using  to scroll through the available Run screen displays.  to scroll through the available Run screen displays. When a Run screen is Off, it will be skipped when scrolling through the Run screen displays. For example, if Run screens 2 and 3 are set to Off, scrolling down through the available Run screen displays will display only Run screens 1, 4, and 5.

Note You cannot scroll through Run screens when a menu screen is displayed. ▲

- In the Main Menu, choose Service > Setup Run Screens > *Select a Run Screen* > **Enabled**.

```

ENABLE/DISABLE RUN SCREEN:
  CURRENTLY:          OFF
  SET TO:             ON ?

  ◀ TOGGLE VALUE

  RANGE  AVG  DIAGS  ALARM
  
```

Number of Items

The Number of Items menu selection is used to set the number of instrument readings to display on the custom Run screen (Figure 3–5). A maximum of 10 items can be displayed on a Run screen. A Run screen configured for 5 items or less displays the items in the large font; a Run screen with 6-10 items displays the items in the small font.

- In the Main Menu, choose Service > Setup Run Screens > *Select a Run Screen* > **Number of Items**.

```
SET NUMBER OF ITEMS:
CURRENTLY:          5
SET TO:             4  ?

↑↓ CHANGE VALUE    ← SAVE

RANGE  AVG  DIAGS  ALARM
```

Item Number

The Item *number* menu selection is used to assign a selected parameter to a position in the Run screen display list. Item 1 is displayed at the top of the list. If “None” is selected, the associated item will not be displayed on the Run screen and will skip to the next item.

The available data fields are organized into the following groups; Concentrations, Other Measurements, Analog Inputs, and Non-Measurements. If the I/O board is not present, Analog Inputs will not be available.

- In the Main Menu, choose Service > Setup Run Screens > *Select a Run Screen* > **Item number**.

```
SELECT RUN SCREEN ITEM:
CONCENTRATIONS
OTHER MEASUREMENTS
ANALOG INPUTS
NON-MEASUREMENTS

RANGE  AVG  DIAGS  ALARM
```

Concentrations

The Concentrations screen lists all the individual gases that the analyzer is equipped to measure (Table 3–19). It allows the user to select a concentration reading that will be included in the Run screen for the selected item. Note that not all of these gases may be available in your analyzer.

- In the Main Menu, choose Service > Setup Run Screens > *Select a Run Screen* > Item *number* > **Concentrations**.

```
CONCENTRATIONS:
>NONE
CO
NO
CO2
NOx
↓
RANGE  AVG  DIAGS  ALARM
O2
SO2
NO2
```

Table 3–19. Data in Run Screen – Concentrations

Data	Description
None	Leaves that record field blank.
CO	Tracks CO concentration.
NO	Tracks NO concentration.
CO ₂	Tracks CO ₂ concentration.
NO _x	Tracks combined NO and NO ₂ concentration.
O ₂	Tracks O ₂ concentration.
SO ₂	Tracks SO ₂ concentration.
NO ₂	Tracks NO ₂ concentration.

Other Measurements

The Other Measurements screen lists data fields other than concentration measurements (Table 3–20). It allows the user to select an item that will be included in the Run screen, such as bench pressure or detector temperature. Refer to Item Number described previously.

- In the Main Menu, choose Service > Setup Run Screens > *Select a Run Screen* > Item *number* > **Other Measurements**.

```
OTHER MEASUREMENTS:
>NONE
BENCH PRES
SOURCE TEMP
BENCH TEMP
DETECTOR TEMP
↓
RANGE  AVG  DIAGS  ALARM
ACH2
↓
```

```

ACH12
CAL CO
CAL CO2
CAL NO
CAL NO2
CAL SO2
CAL O2
IREF
INT TEMP
DEWPOINT
BB PRES
P FLTR TEMP
P BARL TEMP
CHILLER TEMP
UMB ZONE 1
UMB ZONE 2

```

Table 3–20. Data in Run Screen – Other Measurements

Data	Description
None	Leaves that record field blank.
Bench pres	Reports the pressure measured at the bench outlet.
Source temp	Reports the temperature measured at the source housing.
Bench temp	Reports the temperature measured at the wall of the IR bench adjacent to the heaters.
Detector temp	Reports the temperature measured at the base of the detector assembly.
ACH2-ACH12	Reports absorbances for each channel. See Table 3–17 .
Cal CO	Indicates the CO contents of the currently selected cylinder.
Cal CO ₂	Indicates the CO ₂ contents of the currently selected cylinder.
Cal NO	Indicates the NO contents of the currently selected cylinder.
Cal NO ₂	Indicates the NO ₂ contents of the currently selected cylinder.
Cal SO ₂	Indicates the SO ₂ contents of the currently selected cylinder.
Cal O ₂	Indicates the O ₂ contents of the currently selected cylinder.
IREF	Tracks raw signal intensity for reference channel.
Int temp	Reports the ambient temperature measured inside the analyzer.
Dewpoint	Indicates the sample dewpoint value.
BB pres	Indicates the blowback pressure.*
P fltr temp	Indicates the probe filter temperature.*
P barl temp	Indicates the probe barrel temperature.*
Chiller temp	Indicates the chiller temperature.*
Umb zone 1	Indicates the umbilical zone 1 temperature.*
Umb zone 2	Indicates the umbilical zone 2 temperature.*

*Available when the instrument is configured as a system.

Analog Inputs

The Analog Inputs screen lists analog inputs (Table 3–21). It allows the user to select an analog input signal (none or analog inputs 1-8) that will be included in the Run screen. Refer to Item Number described previously.

- In the Main Menu, choose Service > Setup Run Screens > *Select a Run Screen* > Item *number* > **Analog Inputs**.

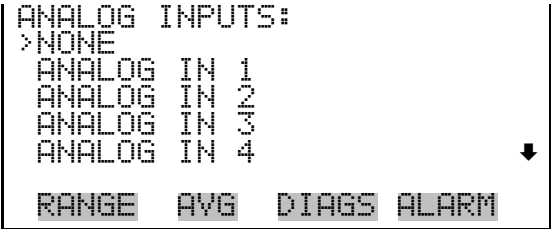


Table 3–21. Data in Run Screen – Analog Inputs

Data	Description
None	Leaves that record field blank.
Analog In 1-8	Tracks voltage inputs from external devices.

Non-Measurements

The Non-Measurements screen lists status information items available for a Run screen (Table 3–22). It allows the user to select a status related item that will be included in the Run screen. Refer to Item Number described previously.

- In the Main Menu, choose Service > Setup Run Screens > *Select a Run Screen* > Item *number* > **Non-Measurements**.

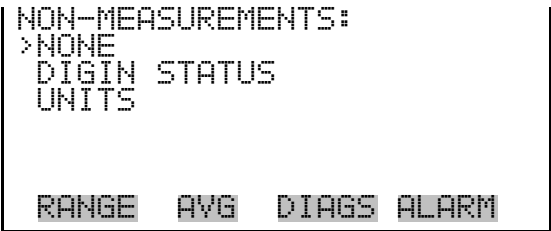


Table 3–22. Data in Run Screen – Non-Measurements

Data	Description
None	Leaves that record field blank.
Digin Status	Indicates status of raw digital inputs.
Units	Indicates the types of units (ppm, mg/m ³ , %) of the available gases.

Start Screen

The Start Screen screen is used to select which of the five custom Run screens will be displayed upon instrument start-up.

- In the Main Menu, choose Service > Setup Run Screens > **Start Screen**.

```

SELECT START SCREEN:
CURRENTLY:      SCREEN 1
SET TO:         SCREEN 1

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

Display Pixel Test

The Display Pixel Test screen is used to test the LCD display by toggling between all pixels on and all pixels off to ensure that they are functioning properly. In the Main Menu, choose Service > **Display Pixel Test**.

```

DISPLAY PIXEL TEST:
DURING TEST PRESS □ OR →
TO EXIT, ← TO TOGGLE

      ← BEGIN TEST
      □ GO BACK TO MENU

RANGE  INST  DIAGS  ALARM

```

Adjust Peak Offset

The Adjust Peak Offset screen is used to center the peaks in the measurement window to optimize data capture. Reducing window delay increases peak offset. An ideal peak offset is -1 to 1. Adjust the Window Delay value and watch for a Peak Offset reading of -1.

- In the Main Menu, choose Service > **Adjust Peak Offset**.

```

PEAK OFFSET ADJUSTMENT:
  PEAK OFFSET:      -1
  WINDOW DELAY:     3000

  ↑↓ CHANGE VALUE   ← SAVE

  RANGE  AVG  DIAGS  ALARM
  
```

Raw Data Display

The Raw Data Display screen is used to view the types of data shown in the following screen. This data can be used when diagnosing problems.

- In the Main Menu, choose Service > **Raw Data Display**.

```


RAW DATA DISPLAY:
> INTENSITIES
  PEAK/VALLEY CH 1-6
  PEAK/VALLEY CH 7-12
  # OF SAMPLES CH 1-6
  # OF SAMPLES CH 7-12

  RANGE  AVG  DIAGS  ALARM

  PEAK LOCATION CH 1-6
  PEAK LOCATION CH 7-12
  
```

Valve Leak Test

The Valve Leak Test screen is used to view the pressure and toggle the 2-way solenoid cal out valve and 3-way solenoid cal valve Open and Closed, which can be helpful when leak testing the instrument plumbing.

Place cursor next to the valve and press  to toggle it open or closed. Exiting this screen automatically closes the valves.

- In the Main Menu, choose Service > **Valve Leak Test**.

```

VALVE LEAK TEST:
  PRESSURE          0.0 mm Hg
> SOL 2WAY CAL OUT  CLOSED
  SOL 3WAY CAL      OPEN

  RANGE  AVG  DIAGS  ALARM
  
```

60i Pump Control Setup

The 60i Pump Control Setup screen is used to set the operating state of the analyzer's internal sample pump. The pump can be set to Always On, Always Off, or to Auto, whereby the pump will automatically shut off to protect the analyzer if there is a dewpoint alarm (i.e. if the dewpoint exceeds 15 °C).

- In the Main Menu, choose Service > **60i Pump Control Setup**.

```
ANA PUMP CONTROL:
CURRENTLY:      ALWAYS ON
SET TO:        AUTO?

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

Dewpoint Span Cal

The Dewpoint Span Cal screen is used to span the dewpoint concentration. The dewpoint reading on this screen is provided by the 60*i*. To use this screen you must have another dewpoint measuring device to compare with the 60*i* reading. The value provided on this screen affects the dewpoint alarm.

- In the Main Menu, choose Service > **Dewpoint Span Cal**.

```
DEWPOINT SPAN CAL:

      MEASURED ACTUAL
DEWPOINT:  5.2  05.00 °C?
      ↔ MOVE CURSOR
      ↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM
```

Multipoint Linearization Setup

Multipoint Linearization is used to compensate for errors caused by variations in operating conditions. It is used during initial setup, as applicable, and is not intended to be used for routine calibration.

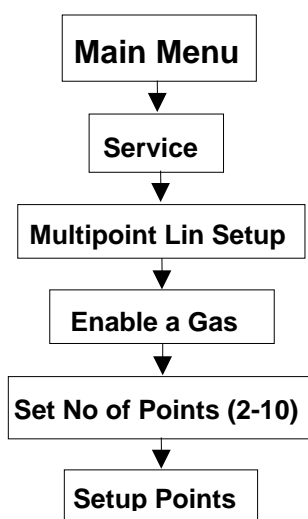
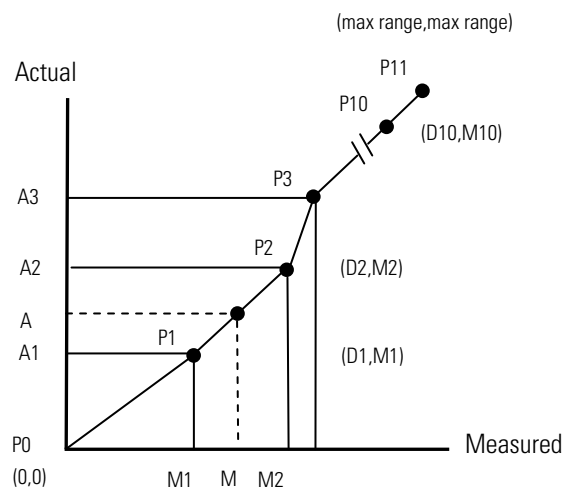
The instrument is calibrated over a wide range at the factory and multipoint linearization is used to focus more closely on specific ranges for particular applications.


The linearization feature is used to improve instrument performance. A ten point table can be entered via the screen or c-link commands. Refer to [Table 3–23](#), the associated graph and the equation that follows which explain how this feature is implemented. If points are entered and the feature is enabled, the measured values are processed linearly between the two closest points in the table to produce the final concentration. Note that a minimum of two points must be entered.

$$A = A_1 + \left(\frac{A_2 - A_1}{M_2 - M_1} \right) (M - M_1)$$

Table 3–23. Point Table Example

Point	Actual	Measured
P0	0	0
P1	D1	M1
P2	D2	M2
P3	D3	M3
P4	D4	M4
P5	D5	M5
P6	D6	M6
P7	D7	M7
P8	D8	M8
P9	D9	M9
P10	D10	M10
P11	Max range	Max range



The Multipoint Lin Setup screen is used to select for which gas the multipoint linearization will be set up, and it shows the operator whether this feature is enabled or disabled for each gas. Position the cursor at the gas of interest and press  to proceed to the “Edit Lin Parameter” screen for that gas.

- In the Main Menu, choose Service > **Multipoint Lin Setup**.

```

MULTIPOINT LIN SETUP:
>CO          ENABLED
CO2          DISABLED
NO           DISABLED
NO2          DISABLED
SO2          DISABLED

RANGE  AVG  DIAGS  ALARM
  
```




Edit Linearization Parameters

The Edit Linearization Parameters screen provides the operator access to enable or disable multipoint linearization for the selected gas, and allows access choose the number of points used and to set up these points. If multipoint linearization for the selected gas is currently disabled, the “Edit Lin Params” screen will indicate this as shown below.

- In the Main Menu, choose Service > Multipoint Lin Setup > *select a gas*.

```
EDIT LIN PARAMS FOR CO2
>LINEARIZATION    DISABLED

RANGE  AVG  DIAGS  ALARM
```

Press  to and the “Enable/Disable? Screen will appear. Press  again to change the setting to”Enabled” and then press  to return to the Edit Linearization Parameters screen.

```
LINEARIZATION ENA/DIS:
CURRENTLY:      DISABLED
SET TO:         ENABLED ?

      ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM
```

With linearization enabled, the “Edit Lin Params” screen will now appear as shown below.




```
EDIT LIN PARAMS FOR CO2
>LINEARIZATION    ENABLED
NO OF POINTS      3
POINT 1
POINT 2
POINT 3

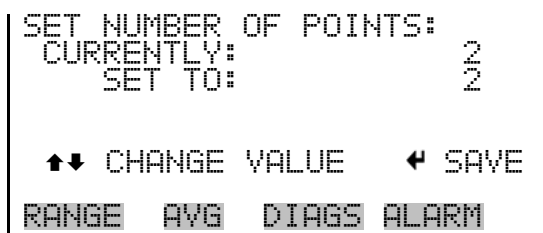
RANGE  AVG  DIAGS  ALARM
```

Set Number of Points

The Set Number of Points screen is used to specify the number of points to be used in the linearization for the selected gas (not including zero air). Up to 10 points can be used.

- In the Main Menu, choose Service > Multipoint Lin Setup > *select an enabled gas* > **No of Points**.

Press  or  to increment/decrement the number of points and press  to save the setting.



Setup Points

The Setup Points screen is used to adjust the measured response of the instrument to the known value of the associated gas standard. By stepping through the desired number of points, a table is created that correlates the analyzer's response to a series of gas standards of known concentration. This table will be used to improve linearity.

Values appearing in the Measured column are derived from the instrument's response to the gas.

Values appearing in the Actual column are entered by the user and represent the known gas concentration.

The Live row displays the current measured value and the known concentration of the standard.

The Stored row displays the most recently saved measured and known values.

It is important to note that the measured concentration won't match the actual concentration (thus the need for linearization). The reason for the stored and live measured value is that the two should agree if the supplied span gas and the instrument's response to it are stable. Once save is pressed, the measured value is stored. After a minute or so, the live value should be the same as the stored value. If it is not, wait until the live value appears to have stabilized, save again, then move on to the next point.

- In the Main Menu, choose Service > Multipoint Lin Setup > *select an enabled gas* > **Point (1-10)**.

```

SETUP POINT 1 FOR CO:
CONC MEASURED ACTUAL
STORED 10.5 12.0 ?
LIVE 9.0 12.0
      ↔ MOVE CURSOR
      ↑↓ CHANGE VALUE ← SAVE
RANGE AVG DIAGS ALARM
  
```

Internal Temperature Calibration

The Internal Temperature Calibration screen is used to view and set the internal temperature sensor offset.

Note Wait at least 30 seconds for the reading to stabilize before saving the value. ▲

Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Internal Temp Calibration**.

```

CALIBRATE INTERNAL TEMP:
CURRENTLY: 25.0 °C
SET TO: 25.0 °C ?
      ↔ MOVE CURSOR
      ↑↓ CHANGE VALUE ← SAVE
RANGE AVG DIAGS ALARM
  
```

Restore Factory Defaults

The Restore User Defaults screen is used to reset user-defined parameters such as the user calibration and configuration values to factory defaults. The restore user defaults screen also resets other parameters, such as alarm limits, datalogging and I/O parameters, range/units, system settings, password, etc., to factory defaults.

- In the Main Menu, choose Service > **Restore User Defaults**.


```
RESTORE FACTORY DEFAULTS:
                                ← RESTORE

RANGE  AVG  DIAGS  ALARM
```

```
RESTORE FACTORY DEFAULTS:
                                ← RESTORE
ARE YOU SURE YOU WANT TO?
PRESS → TO CONFIRM RESTORE

RANGE  AVG  DIAGS  ALARM
```

Password Menu

The Password menu allows the user to configure password protection. If the instrument is “locked,” none of the settings may be changed via the front panel user interface, but they can still be changed via Remote operation. When the front panel is locked, the user can still navigate the menu and view data, instrument parameters and settings, but nothing can be changed. The password (lock) icon on the right side of the status bar indicates that the password lock is active. The items visible under the Password menu are determined by the instrument’s password status.

- In the Main Menu, choose **Password**.

```
PASSWORD MENU:
>SET PASSWORD
LOCK INSTRUMENT
CHANGE PASSWORD
REMOVE PASSWORD
UNLOCK INSTRUMENT

RANGE  AVG  DIAGS  ALARM
```

Set Password

The Set Password screen is used to set the password that is used to unlock the front panel, and is shown if the instrument is unlocked and the password is not set.

- In the Main Menu, choose Password > **Set Password**.

```
ENTER NEW PASSWORD:
██████████

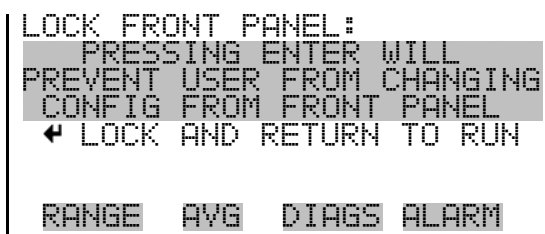
BCDEFGHIJKLMNOP  BKSP
OPQRSTUVWXYZ    PAGE
0123456789 . / -  SAVE

RANGE  AVG  DIAGS  ALARM
```

Lock Instrument

The Lock Instrument screen is used to lock the instrument's front panel so users cannot change any settings from the front panel. The lock instrument screen is shown if the instrument is unlocked and the password is set.

- In the Main Menu, choose Password > **Lock Instrument**.



```
LOCK FRONT PANEL:
PRESSING ENTER WILL
PREVENT USER FROM CHANGING
CONFIG FROM FRONT PANEL
← LOCK AND RETURN TO RUN

RANGE  AVG  DIAGS  ALARM
```

Lock/Unlock and Local/Remote Operation

If the instrument keyboard is locked via the front panel using Password > **Lock Instrument**, the instrument reports being in Remote mode. In this mode, the keypad is locked, data can be viewed but not changed using the front panel interface, and the remote “Set” commands are active.

If the instrument keyboard is unlocked via the front panel using Password > **Unlock Instrument**, the instrument reports being in Local mode, the front panel interface is unlocked, and data can be changed from the front panel.

Refer to “[C-Link Protocol Commands](#)” appendix for detailed information about “mode”, “allow mode”, and “power up mode” commands.

Change Password

The Change Password screen is used to change the password that is used to unlock the instrument's front panel. The Change Password screen is shown if the instrument is unlocked.

- In the Main Menu, choose Password > **Change Password**.



```
ENTER THE PASSWORD:
██████████

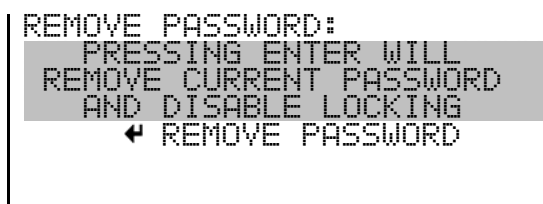
A B C D E F G H I J K L M N  BKSP
O P Q R S T U V W X Y Z      PAGE
0 1 2 3 4 5 6 7 8 9 . / -    SAVE

RANGE  AVG  DIAGS  ALARM
```

Remove Password

The Remove Password screen is used to erase the current password and disable password protection. The Remove Password screen is shown if the instrument is unlocked and the password is set.

- In the Main Menu, choose Password > **Remove Password**.



Unlock Instrument

The Unlock Instrument screen is used to enter the password to unlock the front panel. The Unlock Instrument screen is shown if the instrument is locked.

- In the Main Menu, choose Password > **Unlock Instrument**.



Chapter 4

Calibration

Introduction

Similar to most analytical instruments, the Model 60*i* must be calibrated on a routine basis to ensure data integrity. The calibration procedure involves sequential introduction of contaminant-free zero gas followed by one or more span gases that contain the pollutants of interest at known concentrations. While sampling the zero gas, the instrument output is adjusted to read zero, and while sampling span gas, the instrument output is adjusted to read the correct span concentration.

For a base model analyzer that measures only one gas, a complete calibration can be achieved using a zero gas and a single span component.

As more measurement channels are added, additional span gases are required. The additional span gases can be supplied as individual cylinders, in which case the span adjustments are made one gas at a time, or the span gases can be supplied as a blended mixture that contains multiple pollutants.

If span adjustments are made using a blended span mix, the span procedure can be accomplished with fewer steps or events, which saves time and reduces the number of cylinders required. However, the operator should be aware that running individual span gases is a more effective procedure because it allows the analyzer to automatically correct for any cross interferences that are detected during calibration.

Because calibration of a multi-channel analyzer is a multi-step procedure, the 60*i* firmware provides features that allow the operator to automate the calibration process.

The system design is based on the concept that the analyzer will be connected to a gas delivery system that includes anywhere from two to six individual cylinders or gas supplies. At least one calibration cylinder will be a “zero” gas and up to five cylinders will supply span gases.

The composition of each cylinder/supply must be defined in the Calibration Setup menu. Each calibration event (zero or span) is then triggered with a reference to a specific cylinder or gas supply. Before attempting a calibration, the operator should take the time to fully understand the calibration procedure and to enter a calibration program

that is appropriate to the specific installation. The calibration program is a five step process:

1. Define contents of the calibration cylinders.
2. Select a zero cylinder for the IR bench.
3. Select a zero cylinder for the O₂ sensor (if present).
4. Select a span cylinder for the O₂ sensor (if present).
5. Define a sequence of events, such as “zero O₂ sensor,” that will constitute a full calibration.

The 60*i* allows the operator to define up to two calibration sequences that can include multiple events. Each calibration sequence can be programmed to occur automatically on a user defined interval, or as noted previously, they can be triggered with input from the front panel or a remote data system.

For example, one calibration sequence could be set to check daily zero and span functions for each component. The second sequence could be set to adjust the span values as prompted by the user.

To help clarify the calibration procedure, refer to:

- [Table 3–4. Cylinder Definition Example](#) on page 3-31
- [“Performing a Zero Adjustment”](#) on page 4-20
- [“Performing a Span Adjustment”](#) on page 4-21.

Most of the information provided here is specific to the Model 60*i*. If greater detail is needed concerning data quality issues or CEMS calibration procedures in general, please refer to the *Quality Assurance Handbook for Air Pollution Measurement Systems*¹.

Pre-Calibration

Prior to calibration, perform the following checks and adjustments to be sure the instrument is operating properly.

1. Turn on the instrument and allow it to stabilize for at least two hours.
2. Check that there are no alarms shown.

3. Perform any service checks that may be required using the procedures described in the “[Preventive Maintenance](#)” chapter.
4. Verify or adjust the analog output range settings to those that will be used during routine operation and set the Averaging Time to at least 60 seconds.
5. Before starting the calibration procedure, be sure to define the cylinder contents and set calibration parameters, such as the zero and span durations and the purge time.

Note The zero and span duration times must be long enough to account for the transition process when switching from sample to zero and from zero to span. This transition period is the time required to purge the existing air from the calibration system, including the probe, sample lines and analyzer. Data taken during the purge process and immediately after the purge should generally be disregarded since the zero or span gas is mixing with residual sample. ▲

Zero and Span Frequency

In order to achieve data of the highest quality, the zero and span should be checked or adjusted on a routine basis. Checks and/or adjustments can be performed manually or they can be automated as described later in this chapter. During initial operation, Thermo Fisher Scientific suggests that a zero adjustment should be run once every 12 to 24 hours and a span check should be run on at least one channel every 24 hours.

Depending on local regulations and the initial observations of system performance, it may be possible to reduce frequency as experience is gained with the system.

Equipment Required

The following equipment is needed to calibrate the instrument:

- Zero gas supply or cylinder for each channel
- Span gas standards for each measurement technology (IR and oxygen)
- Pressure regulators for all gas supplies
- A delivery system that will supply each calibration gas at the appropriate time and at the correct flow rate
- A gas dilution or mixing system (optional)

Zero Gas Supply

Calibration requires a supply of zero gas that is free of contaminants that would cause a detectable analyzer response. The optimal zero gas is ultra-high purity (UHP) nitrogen, because it allows simultaneous zero adjustment of the optional oxygen sensor and all of the infra-red channels, and because it generally provides a better level of purity with respect to the CO₂ content.

Scientific gas suppliers can provide UHP nitrogen in compressed gas cylinders or as a Dewar of liquid nitrogen. Nitrogen can also be generated on-site from compressed air using a commercial nitrogen generator. However, if a generator is used, the purity should be verified and additional scrubbers may be needed to remove residual contaminants, including trace levels of oxygen and carbon dioxide.

If the Model 60i is not equipped with an optional oxygen sensor, the zero gas can be high purity air from an on-site zero air generator, such as the Thermo Scientific Model 1160, or from a cylinder. If an air cylinder will be used as the source for zero gas, a high grade cylinder that is intended for use in continuous emissions monitoring (CEMs) applications will be needed. In any case, the zero gas should meet the criteria for purity that are listed in [Table 4–1](#).

If zero gas that meets the listed criteria is not available, it may be possible to use a lower grade zero gas. A decision about required purity levels should be based on local regulations and the actual concentration of pollutants in the sample. If zero gas contaminant levels are less than 0.1% of actual measurement levels, they will have little impact on instrument performance.

Table 4–1. Zero Gas Contaminant Limits

Contaminant	Maximum Concentration
O ₂	500 ppm (for zero nitrogen)
CO	0.5 ppm
CO ₂	10 ppm
NO _x	0.5 ppm
SO ₂	0.5 ppm
Hydrocarbons	0.5 ppm
H ₂ O	5.0 ppm -10 °C dew point

Scrubbers

If a zero gas does not meet necessary criteria, additional gas purifying scrubbers will be required. Scrubbers containing a variety of media that function by adsorption, absorption, or reaction of trace contaminants are available from Thermo Fisher Scientific and most scientific gas suppliers. Some of the more useful gas scrubbing media are listed in [Table 4–2](#). Individual vendors should be consulted for details on their use and effectiveness.

Table 4–2. Gas Scrubbing Media

Media	Commercial Name	Contaminants Removed
Silica Gel	Many	Water
Calcium Sulfate	Drierite	Water
Activated Charcoal	Many	SO ₂ Organics Ozone
Molecular Sieve	Many	Water Organic Compounds
Potassium Permanganate	Purifil	NO _x
Soda Lime	Many	CO ₂ Acid gases

Span Gas Standards

Calibration requires a set of span cylinders that contain a known concentration of each pollutant being monitored. Depending on the specific pollutant, the balance gas can be air or nitrogen. The balance gas has no impact on the calibration procedure, but it may have an impact on the stability of the calibration cylinder. Note that it may be possible to reduce the total number of calibration cylinders by using a span gas prepared in nitrogen as the zero gas for the optional oxygen sensor. For example, a cylinder of 500 ppm CO in nitrogen balance could be used as the span gas for the CO measurement channel and as the zero gas for the oxygen sensor.

Span Gas Concentration

The concentration of each pollutant in the span gas cylinders should be specified so that the instrument can be spanned at a concentration that is about 80% of the expected measurement range for that compound. Refer to [Figure 4–1](#).

The assay of the cylinder should be traceable to a recognized authority, such as The United States National Institute of Standards and Technology (NIST), or an approved gas manufacturer's Certified Reference Material (CRM).

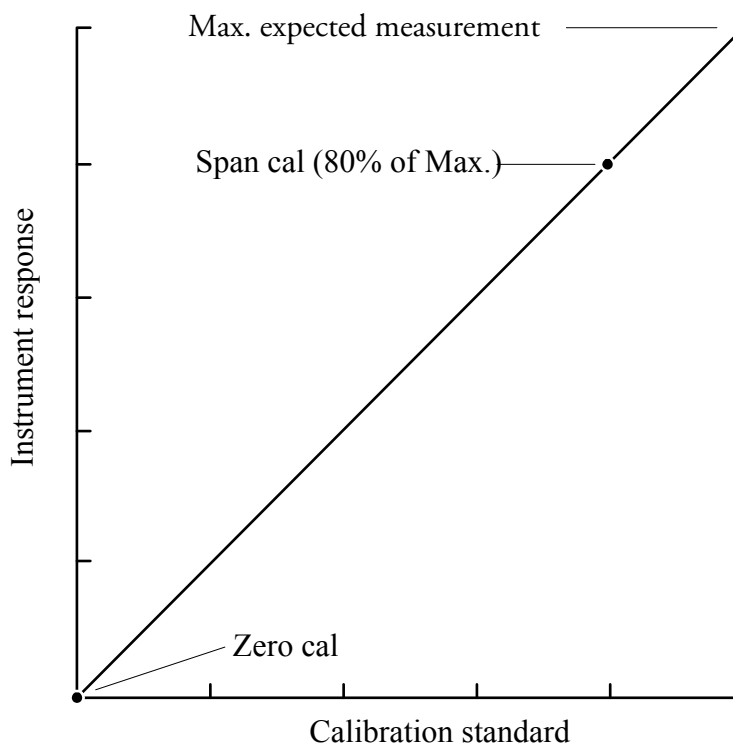


Figure 4-1. IR Channel Calibration

Cylinder Recertification

The gas cylinder(s) should be recertified on a regular basis, as determined by the local quality control program. A recommended protocol for certifying gas cylinders against a certified reference is given in the *Quality Assurance Handbook for Air Pollution Measurement Systems*¹.

Blended Cylinders

When planning the calibration system, note that it may be possible to reduce the number of span cylinders by using blended standards that combine multiple span gases in one cylinder.

As discussed previously, the Model 60i firmware allows the operator to define up to six different calibration cylinders and enter the concentration of each component in each cylinder. In some cases, use of blended cylinders may reduce operating costs, however the operator should be aware that span adjustments made with blended cylinders do not correct for interferences as efficiently as span adjustments made with individual span gases.

Note If multi-component cylinders will be used, be aware that NO₂ cannot be mixed with SO₂ and that NO cannot be mixed with air. A scientific gas supplier can usually provide additional guidance on what gases can be

mixed at specific concentrations, the stability of various span gases and the effect of using nitrogen versus air as the balance. ▲

Pressure Regulators

The regulators used to control delivery pressure of the span gases should be two-stage, high purity grade with a non-reactive diaphragm and internal parts. Delivery pressure capabilities of the regulators should be selected to match the requirements of other components, such as the flow restrictors. Scientific gas suppliers can usually provide assistance in selection of appropriate regulators.

Gas Delivery System

Although other configurations are possible, the calibration gases are typically connected to the 60*i* using the configuration shown in [Figure 4–2](#). Details of alternate system designs are shown in [Figure 4–3](#), [Figure 4–4](#) and [Figure 4–5](#).

The design shown in [Figure 4–3](#) is suggested for systems that utilize the Model 61*i* Calibrator, and the configurations shown in [Figure 4–4](#) and [Figure 4–5](#) are suggested for systems that use a third-party calibration system.

The relative advantages and points of concern for each system design are described in the text associated with each diagram. Whatever design is selected, the operator must be aware of the Model 60*i* internal plumbing system described below and must take appropriate steps to ensure that the calibration gases and sample are delivered to the analytical system at equal pressures. Note that use of the 61*i* as the calibration system provides greater integration capabilities and allows the calibrator operation to be controlled directly from the analyzer.

Calibration
Equipment Required

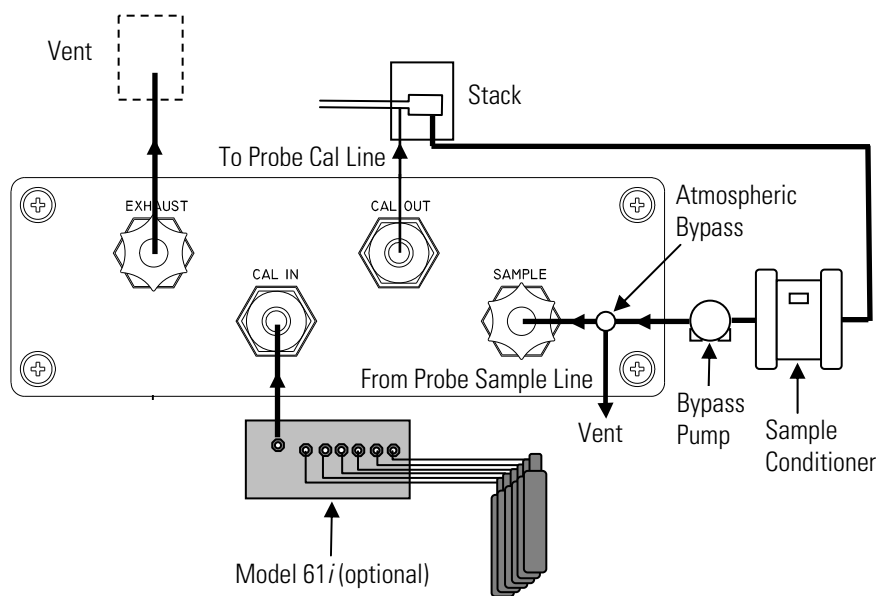


Figure 4-2. Model 60i Rear Panel Connections

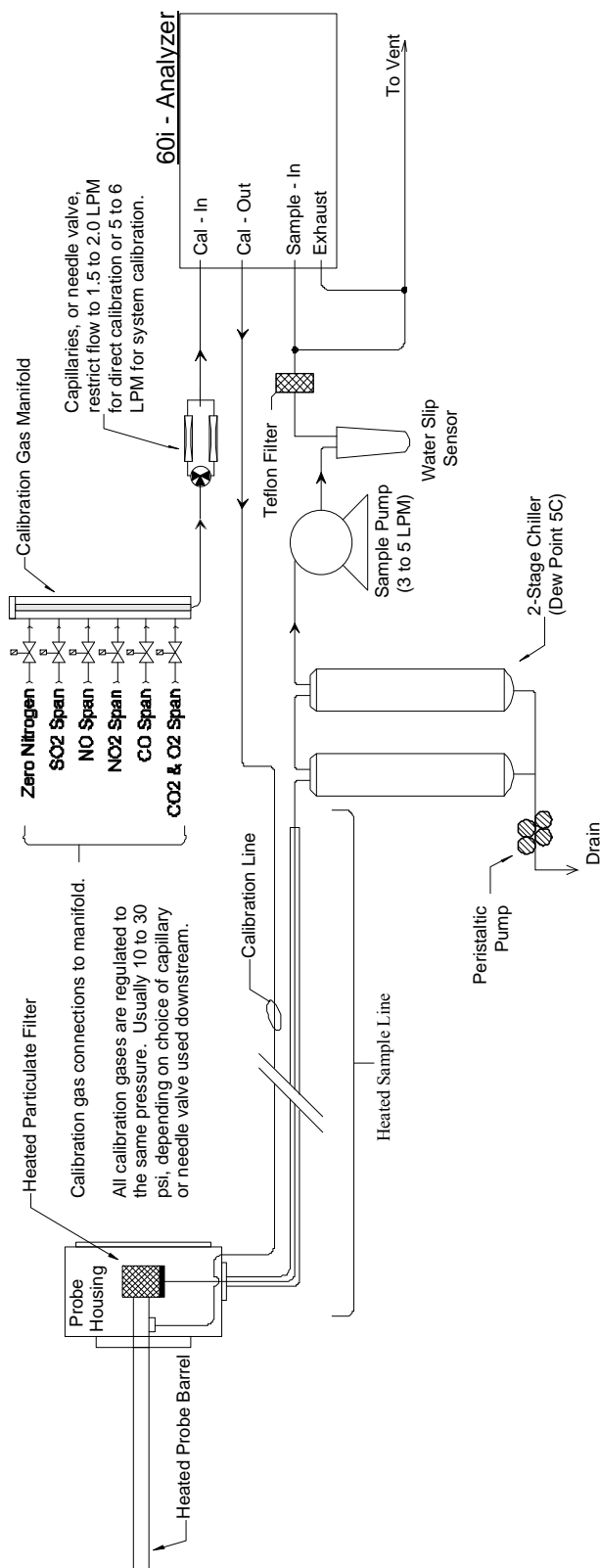


Figure 4–3. Model 60i Plumbing Configuration

In the configuration shown in [Figure 4–3](#), the calibration gas manifold (Model 61*i* or similar) is connected directly to the Model 60*i* “Cal-In” bulkhead and a calibration gas line runs from the “Cal-Out” bulkhead to the sample probe. System calibrations and direct analyzer calibrations are both available. If the system incorporates the 61*i* Calibrator, all calibration functions can be automated and controlled through the 60*i* firmware. In order to prevent pressurization of the inlet during direct instrument calibration, the Teflon particulate filter is located upstream of the atmospheric pressure vent. The vent line must have a large ID to minimize risk of pressurizing the sample inlet. Calibration gas pressures and flows should be adjusted to provide approximately 50% more flow than the pumps demand, typically 1.5 LPM for a direct calibration and 5 to 6 LPM for a system calibration. Please see documentation provided by the system integrator for additional information regarding plumbing and components that are external to the analyzer.

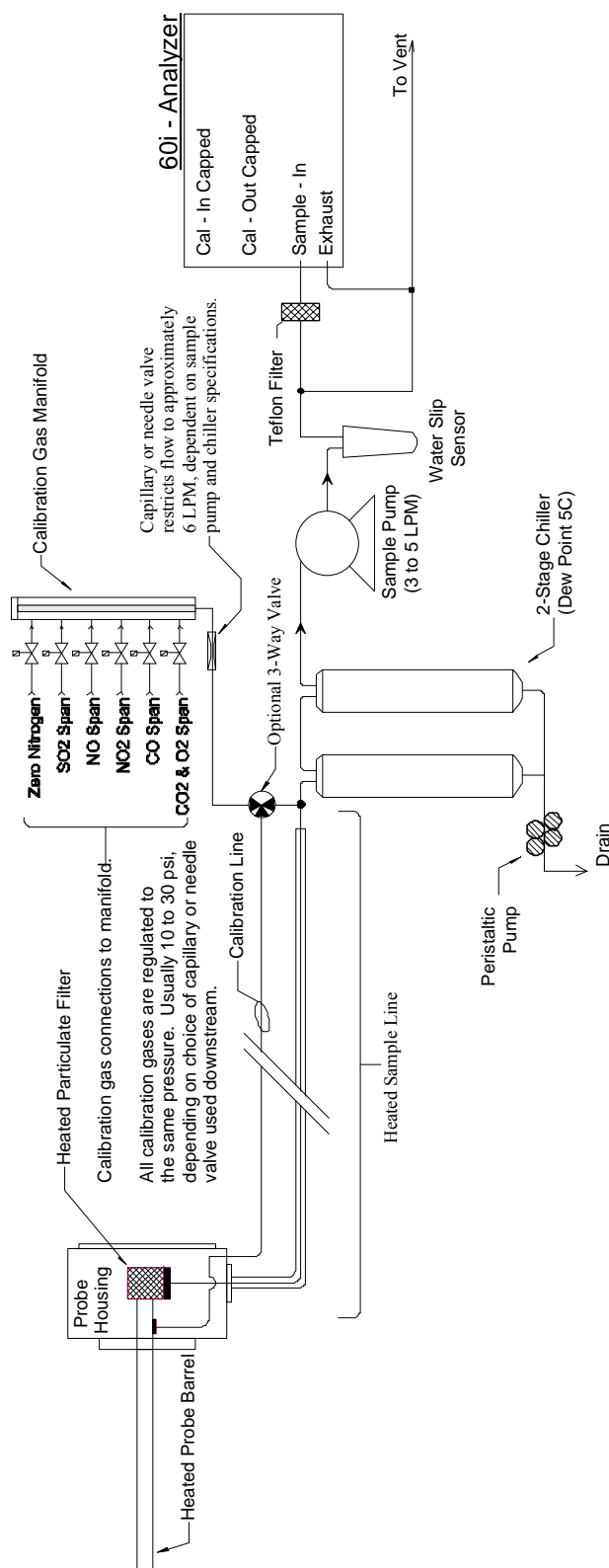


Figure 4-4. Model 60i Plumbing to Allow System Calibration with External Controllers

In the configuration shown in [Figure 4–4](#), the calibration gas manifold is connected directly to a calibration gas line that runs to the sample probe. An optional 3-way valve allows the calibration gases to be introduced to the system just up-stream of the sample conditioner / chiller. The calibration gas manifold is controlled by a third party PLC or data logger that also communicates with the 60*i* through dedicated I/O, Ethernet or RS-232 connections. The 60*i* “Cal-In” and “Cal-Out” bulkheads should be capped and the internal valves should be disabled via Main Menu > Diagnostics > Instrument Configuration > **Disable Cal Valves**. The Teflon particulate filter is located downstream of the atmospheric pressure vent to reduce flow through the filter element. The vent line must have a large ID to minimize risk of developing back-pressure. Please see documentation provided by the system integrator for additional information regarding plumbing and components that are external to the analyzer.

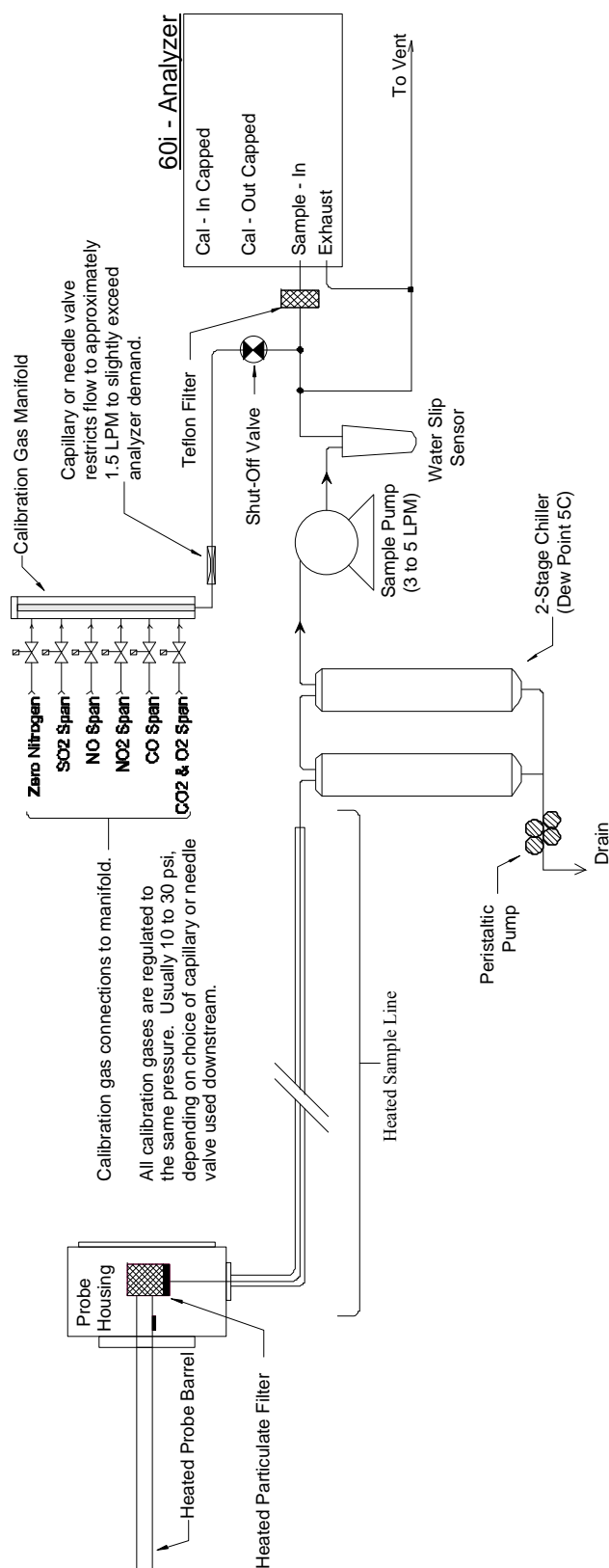


Figure 4–5. Model 60i Plumbing to Allow Direct Analyzer Calibration with External Controllers

In the configuration shown in [Figure 4–5](#), the calibration gas manifold is connected either to the sample line downstream of the sample conditioner or upstream of the conditioner at the junction of the chiller and heated sample line. The calibration manifold is controlled by a third party PLC or data logger that also communicates with the 60*i* through dedicated I/O, Ethernet or RS-232 connections. The 60*i* “Cal-In” and “Cal-Out” bulkheads should be capped and the internal valves should be disabled via Main Menu > Diagnostics > Instrument Configuration > **Disable Cal Valves**. The particulate filter is located downstream of the atmospheric pressure vent to reduce flow through the filter element. The vent line must have a large ID to minimize risk of pressurizing the sample line. If the calibration gases are introduced downstream of the auxiliary sample pump, the capillary should be sized to provide 1.5 to 2.0 LPM of flow. If the calibration gases are introduced upstream of the auxiliary sample pump, the flow should slightly exceed the demands of that pump, typically 5 to 6 LPM. Please see documentation provided by the system integrator for additional information regarding plumbing and components that are external to the analyzer.

Gas Routing Valve

The instrument’s internal plumbing includes two valves ([Figure 4–6](#)) that can route the calibration gases from the CAL IN bulkhead directly into the measurement system for a direct calibration, or the gases can be routed back out through the CAL OUT bulkhead for a system calibration. A system calibration allows the zero and span gases to follow virtually the same flow path as the actual sample gases, and can help compensate for any sampling system bias. In a direct calibration, the gases are routed directly to the analyzer optical bench, bypassing the probe, sampling umbilical, and sample conditioning system. The gas routing valves are controlled by the analyzer firmware and are accessed through the Calibration Setup menu.

If the internal calibration plumbing is not being used, [Figure 4–4](#) and [Figure 4–5](#), the bulkheads should be capped and the solenoid valves should be disabled using the configuration table that is accessed through the Diagnostics menu.

The Model 61*i* Multi-Gas Calibrator (sold separately) may be used to control the application of calibration gases to the 60*i*. The 61*i* models accept up to five calibration gases plus zero air. The 61*ioz* also includes an ozone generator that mixes NO calibration gas with ozone (O₃) to generate NO₂. NO₂ is used to span the NO₂ channel when a stable source of NO₂ is not readily available. For more information about the 61*i*, refer to the *Multi-Gas System Manual*.

Model 61i Flow Control

If the Model 61*i* calibration system is being used to control and deliver calibration gases, the switching of zero and span cylinders and activation of the ozone generator for NO₂ calibration will be automatically controlled by the analyzer firmware. If the Model 61*i* is not being used, the calibration gases can be controlled manually, or with a user-supplied PLC or data logger.

Calibration Gas Flow Rate

Whatever external hardware is used, the flow rate of the calibration gases must be controlled so that it slightly exceeds the total flow required by the analyzer plus any other devices connected to the system. The flow rate of the gases is usually controlled by applying a fixed pressure against a fixed flow restrictor or orifice.

For example, if a system that utilizes an external pump running at 5 lpm is being calibrated through the probe (system calibration), the calibration gases should be delivered at 6 to 8 lpm. If the gas routing valve is set to run direct calibrations rather than system calibrations, then the calibration gas flow should be set to between 1.5 and 2.0 lpm. In either case, the calibration hardware must be configured to avoid high gas flows that would pressurize the analytical bench.

A typical system plumbing arrangement, similar to that used in the Thermo Fisher Scientific 60-Series Continuous Emissions Monitoring System is illustrated in [Figure 4–6](#). If the analyzer was purchased as part of a system, the probe and/ or system instructions should also be consulted for specific details.

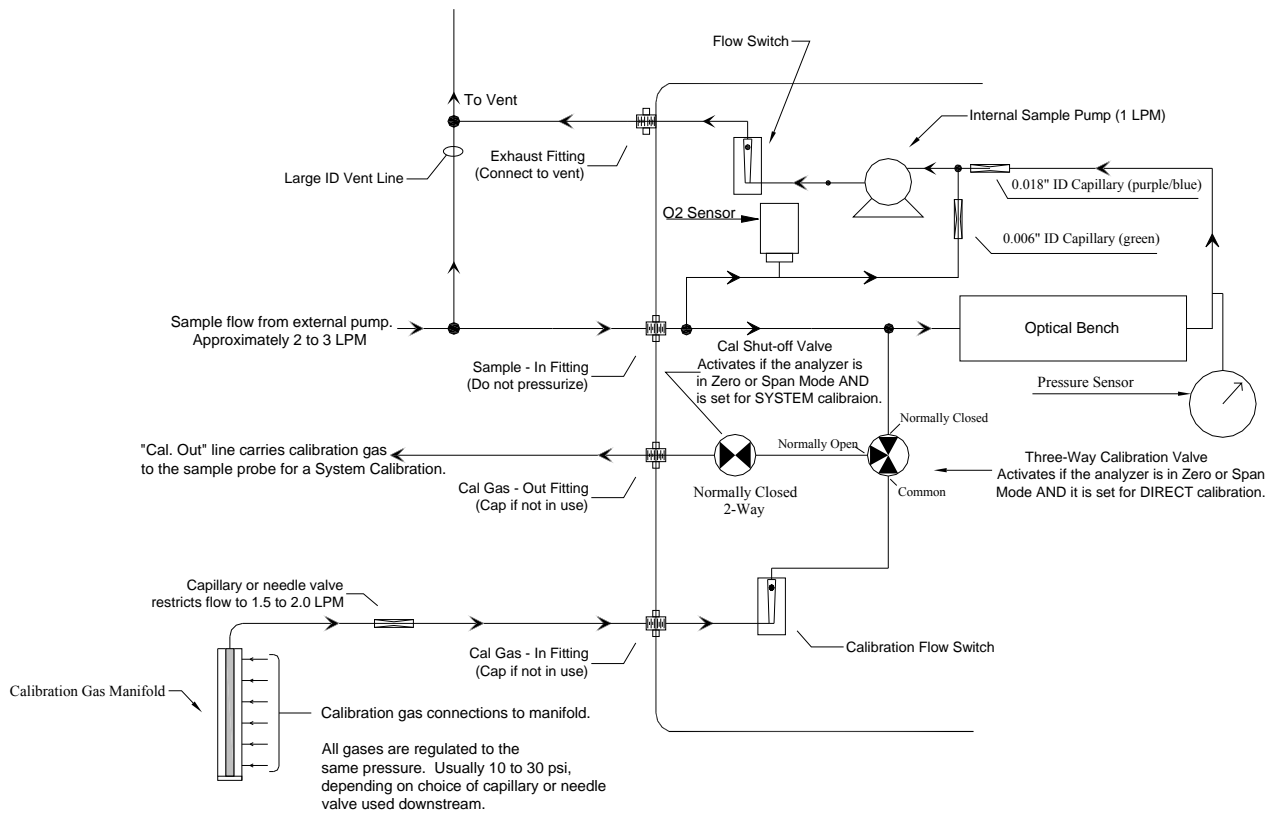


Figure 4-6. Typical Plumbing Arrangement - Model 60i Series CEM System Using the Model 61i Calibrator with NO₂ Generator

Gas Mixing Systems

In most cases, emissions monitoring regulations do not allow the use of a dilution system or gas mixing device for delivery of calibration gases. In applications where mixing or dilution of span gas is allowed, a commercial gas mixer, such as the Thermo Scientific Model 146i, can be utilized, or a system can be assembled from individually purchased components.

If a dilution system is assembled on-site, the flow rates for span gas and dilution gas should be regulated to 1%, and measured to an accuracy of at least 2%. The meter and controller can be two separate devices, or can be combined in one device. The user's manual for the meter should be consulted for calibration information. Note that all flows should be corrected to 25 °C and 760 mm Hg, and that care should be exercised in correcting for water vapor content.

Additional information on the design of gas mixing systems and calibration of flow devices can be found in the *Quality Assurance Handbook for Air Pollution Measurement Systems*¹.

Calibration Process and Procedures

This section presents an overview of the calibration process and provides step-by-step calibration procedures. The calibration process overview (Figure 4–7) shows that calibration begins with defining the calibration cylinders and selecting the zero and O₂ supplies. The next step in the process is choosing to perform a manual calibration or to setup an automatic calibration. Refer to the “[Calibration Worksheet](#)” at the end of this chapter for a sample calibration worksheet and examples of the data that is required to complete a calibration.

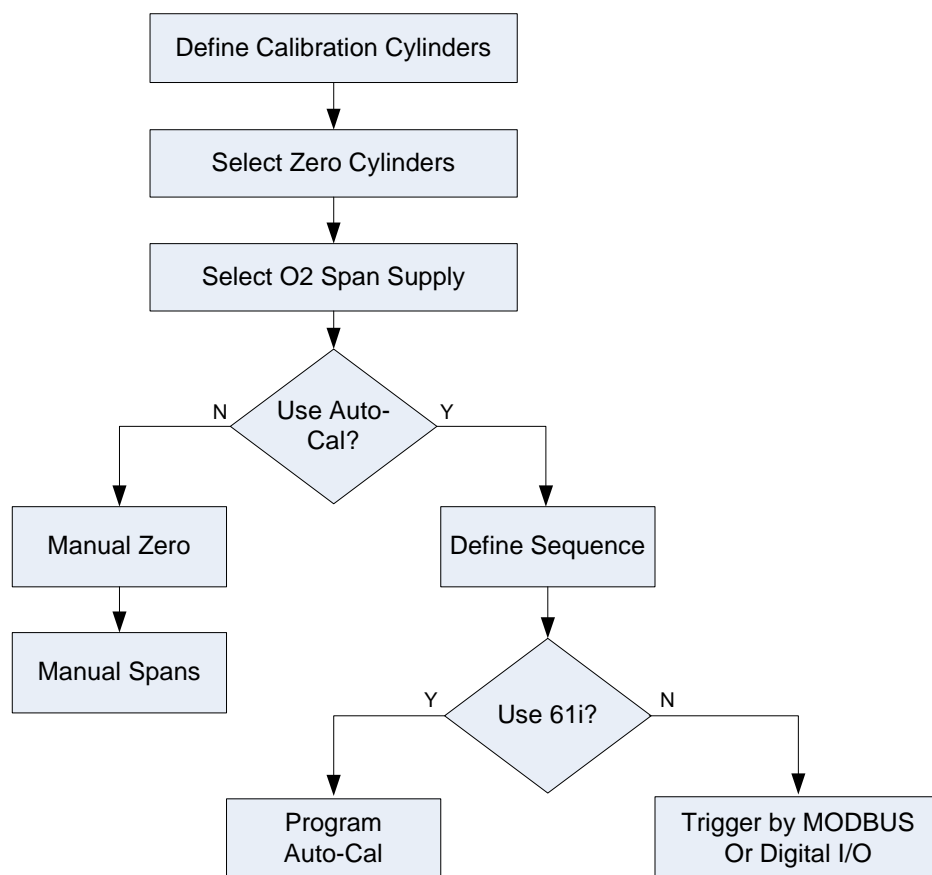


Figure 4–7. Calibration Process Overview

Manual calibration is used for a 60*i* in a standalone configuration. It involves manually stepping through the 60*i* screens to perform zero and span adjustments.


Automatic calibration is used for a 60*i* in a system configuration in addition to a manual calibration. It executes calibrations on a routine basis from a defined calibration sequence of events without operator input.

Note To fully utilize the analyzer’s capability for running calibration events and sequences, the system requires external hardware such as the 61i Calibrator or a valve manifold and PLC to provide digital I/O. ▲

Defining Cylinders

As noted at the start of this chapter, the calibration procedure is designed around the idea that a set of two to six calibration cylinders will be used to perform a full calibration. The composition of each calibration cylinder is described using the Define Cal Cylinders menu (Main Menu > Calibration > Calibration Setup > **Define Cylinders**) (Figure 4–8). See also the “Define Cylinders” menu on page 3-29. The screen lists all of the cylinders by number and displays the contents of each one. See also the “Calibration Worksheet” at the end of this chapter.

Define Cylinders Screen

To operate the screen, scroll the cursor to the cylinder of interest and press . A data entry screen will then open to allow the concentration values to be edited. Note that the concentration units (ppm, %, etc.) are not selected here, so the concentration must be entered in same units that were selected in the Range/Units Menu. If the span mix does not contain all of the listed gases, the concentration values for the missing gases should be entered as zero. For step-by-step instructions on entering cylinder definitions, refer to the “Define Cylinders” menu on page 3-29.

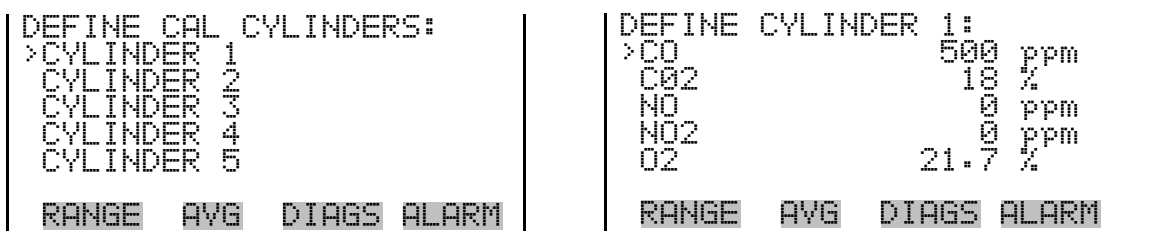


Figure 4–8. Defining Calibration Cylinders

Designating Zero Cylinders

The Select Zero Cylinders screen is used to designate which cylinder, or cylinders, will be used to provide the zero gas for each measurement system (optional oxygen sensor and IR bench). For detailed information on selecting the zero cylinders, refer to “Select Zero Cylinders” on page 3-31. See also the “Calibration Worksheet” at the end of this chapter.

Designating O₂ Span Cylinder

The Select O₂ Span Cylinder screen is used to designate which cylinder will be used to provide the span gas for the optional oxygen sensor. Although more than one gas cylinder may contain oxygen, only the selected O₂ span cylinder will be used when adjusting the oxygen span factor. For detailed information on selecting the O₂ span cylinder, refer to “Select O₂ Span Cylinder” on page 3-32. See also the “[Calibration Worksheet](#)” at the end of this chapter.

Manual Calibration

This section presents step-by-step instructions for performing a basic calibration of the analyzer using the front panel controls.

Manual Calibration Sequence Overview

To perform a full calibration of the instrument, the optional oxygen sensor (if present) and the IR bench should both be zeroed and then spanned. The two measurement technologies operate independently of each other, so it is possible to calibrate the IR channels without calibrating the optional oxygen sensor or vice versa.

It is also possible to perform a zero adjustment on either measurement device without performing a span adjustment. However, a span adjustment should not be run without first running the zero adjustment. Note that if high purity nitrogen is used as the zero gas, the optional oxygen sensor and all the IR channels can be zeroed in one step.

A typical calibration sequence using nitrogen as the zero gas and six individual span supplies would typically involve the following steps:

1. Zero adjust O₂ and IR technologies with high-purity N₂.
2. Span adjust O₂ sensor with high-purity air (O₂ content 20.9%).
3. Span adjust CO measurement channel with CO in air or nitrogen.
4. Span adjust CO₂ measurement channel with CO₂ in air or nitrogen.
5. Span adjust NO measurement channel with NO in nitrogen.
6. Span adjust NO₂ measurement channel with NO₂ in air or nitrogen. (NO₂ can also be generated with a 61*ioz*.)

Calibration

Calibration Process and Procedures

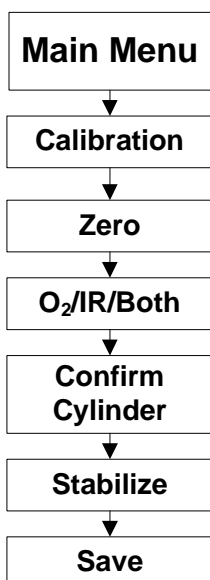
7. Span adjust SO₂ measurement channel with SO₂ in air or nitrogen.

An alternate procedure that uses high purity air as the zero gas for the IR channel would require the following steps (start with step 3 if the O₂ sensor is not installed):

1. Zero adjust O₂ sensor with high-purity N₂.
2. Span adjust O₂ sensor with high-purity air (O₂ content 20.9%).
3. Zero adjust all IR channels with high purity air.
4. Span adjust CO measurement channel with CO in air or nitrogen.
5. Span adjust CO₂ measurement channel with CO₂ in air or nitrogen.
6. Span adjust NO measurement channel with NO in nitrogen.
7. Span adjust NO₂ measurement channel with NO₂ in air or nitrogen.
(NO₂ can also be generated with a 61*ioz*.)
8. Span adjust SO₂ measurement channel with SO₂ in air or nitrogen.

Refer to the detailed steps that follow for performing each step listed above.


Performing a Zero Adjustment





The Zero Adjust procedure is used to set the analyzer reading to zero while sampling high-purity, contaminant free gas. Zero adjustments need to be performed periodically for both the IR bench and the O₂ sensor.

1. Adjust the gas delivery system so that zero gas (high purity nitrogen or air) is delivered to the sample probe or analyzer.
2. Allow the instrument to sample zero gas until a stable reading is obtained. As noted previously, it may take several minutes to purge and flush the entire calibration system and to clear the instrument's averaging buffer. If you do not allow enough time for the system to flush, the "zero" reading will be influenced by readings taken when the instrument was still sampling stack gas.
3. From the Main Menu, choose Calibration > **Zero**.

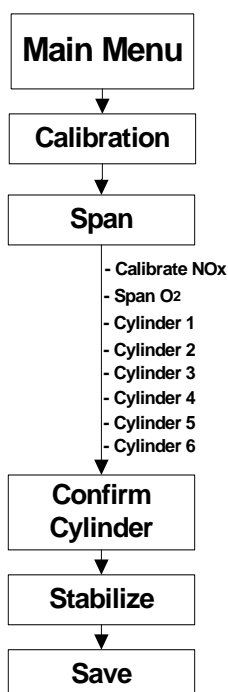
4. Select the analytical sub-system that you want to calibrate (IR bench, O₂ sensor, or Both).

The screen shows the selected event, “ZERO USING CYLINDER X.” If the event and cylinder choice are correct, confirm cylinder selection by pressing .

A countdown timer appears near the bottom of the screen. When the timer reaches zero, the signal should be fully stabilized. If you wish to bypass the countdown timer, press  to jump directly to the next step. At the end of the countdown, the message “PRESS ENTER TO SAVE ZERO” will appear.

5. In the Calibrate Zero screen, press  to save the new zero value and set the reading of the selected sensor(s) to zero.

Performing a Span Adjustment



The Span Adjustment procedure sets the instrument span for one or more components contained in one span cylinder.

If multiple span cylinders are being used, the procedure must be repeated for each cylinder.


If a span cylinder contains a mixture, a new span factor will be calculated for each component in the mixture. If the span cylinder has only one span gas, the analyzer will automatically run a check and make corrections for interference on other channels and then adjust the span factor for the specific gas contained in that cylinder.

1. Turn on the flow from the span gas cylinder that contains the analytical component or components of interest. Ideally, the cylinder will provide a span concentration that is approximately 80% of the current upper range limit (URL) of the analyzer for each compound.


As with the zero adjustment, the total gas flow from the calibrator must exceed the total demand of the system to ensure that no ambient air or stack gas is pulled into the analyzer. However, the flow must not be so high as to create a positive pressure in the analytical bench.


2. Allow the instrument to sample the span gas until a stable response is obtained for the channel under consideration.
3. From the Main Menu, choose Calibration > **Span**.
4. If spanning NO₂ using the Model 61*ioz*, select **Calibrate NO_x**. (Calibrates NO₂ using an NO cylinder if accurate NO₂ cylinder is not

available.) See “Calibrating NO₂ with a Model 61*ioz* Calibration” later in this chapter.

5. If spanning the O₂ sensor, select **Span O₂**.
6. If spanning one or more IR channels, scroll down to the span cylinder of interest and press .

The display shows the current concentration readings and the actual span concentration for each gas that is present in that specific span cylinder. If the actual cylinder concentrations shown on the display do not match the cylinder, the values can be adjusted in the “[Define Cylinders](#)” selection of the Calibration Setup menu.

7. If the cylinder composition shown on the display is correct, press  to start the span adjustment.

A count-down timer appears showing the time remaining for completion of the span adjustment. When the timer reaches zero, press  to complete the procedure. The instrument should now display the correct concentration reading(s).

(Note that in some cases, it may take several seconds for the concentration reading to change so that it matches the actual span concentration.)

8. Record the span concentration and the instrument’s response as required by the local quality assurance program.
9. Repeat the span procedure for each span cylinder.

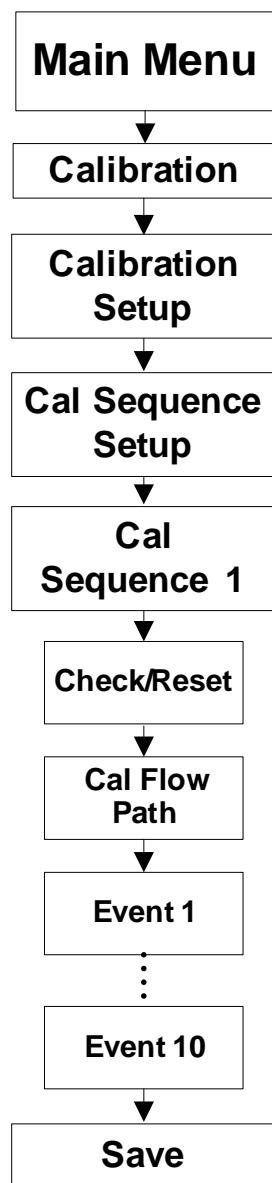
As described in these procedures, a complete manual calibration of the analyzer is a multi-step process that requires the operator to work through several operating screens and may require that the basic zero and span adjustments be repeated for each measurement system and/or channel. In order to simplify the process, the 60*i* allows the operator to define calibration events and then setup an automated calibration sequence that can be executed with a single command.

Using Event Sequences with Auto Calibration

Use the following procedures to define or edit calibration events and establish a calibration sequence.

Note External hardware such as the 61*ioz* Calibrator or a gas delivery manifold and PLC is required to use the calibration events and sequences features. ▲

Define Calibration Sequence 1 and/or Calibration Sequence 2



Use the following procedure to define Calibration Sequence 1 and/or Calibration Sequence 2, as necessary.

1. From the Main Menu select Calibration > Calibration Setup > Cal Sequence Setup > Cal Sequence 1 > **Check/Reset**, and press .
2. Press to toggle between Check and Reset.

Selecting Reset configures the automated calibration function to perform an actual calibration in which the zero offset and span coefficient are adjusted so that the instrument readings are correct at the zero and span concentrations.

When Check is selected, the zero and span valves will be turned on and off at the indicated times, the data records will be marked to indicate a zero or span check, and the calibration history will be updated. However, the internal zero and/or span factors that determine the actual instrument reading will not be changed.
3. Return to the Cal Sequence 1 menu to select the cal flow path, either “direct” or “system”. As mentioned in the “[Operation](#)” chapter under the Calibrations section, a “system” cal flow path sends the calibration gas to the probe inlet, so that it follows the same path as the sample gas. A “direct” cal flow path sends the calibration gas directly to the analyzer, bypassing the sampling system.
4. Return to the Cal Sequence 1 menu to create the order of events. An event corresponds to one step in the sequence. Event 1 occurs first in the sequence and can be assigned any event in the list of up to 16 defined events. See “Defined Events” that follows. Event 2 occurs second in the sequence and can be assigned any event, and so on. As described in the “[Operation](#)” chapter, an event corresponds to a single step in the overall calibration sequence. For example, zeroing the O₂ sensor is one calibration event. A sequence can contain up to 10 events, which are chosen from the list of 16 defined calibration events.

The most common events are pre-defined in the 60i firmware as shown in [Table 4–3](#). Existing events can be viewed or edited and new events can be created by using the “[Define Events](#)” menu, as described in the following section and in the “[Operation](#)” chapter.

Note Events 12-16 in [Table 4–3](#) default to purge, but are intended to be user defined. ▲

IMPORTANT If Span NO_x (Span NO₂) is selected as an event in the sequence, it **MUST** be preceded by a Span NO event, or the NO₂ calibration may not be accurate. Also, cylinder 6 **MUST** be the NO cylinder. ▲

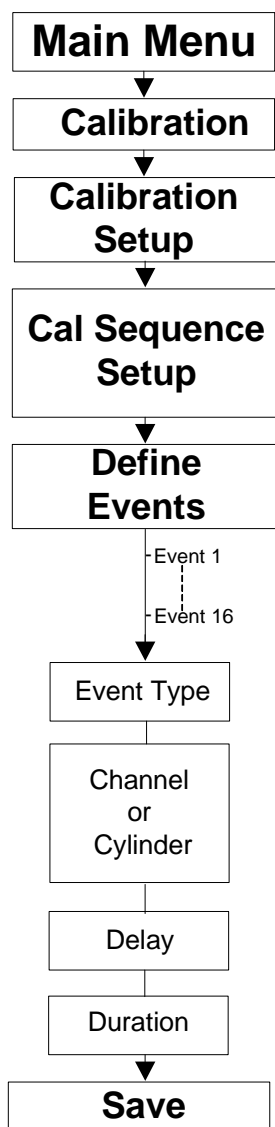
5. If necessary, step back to the Cal Sequence Setup menu, select Cal Sequence 2, and define a second sequence using Steps 2 through 4.

Table 4–3. Default Calibration Events






Event No.	Description	Cylinder	Delay (min)	Duration (min)
1	Zero both	NA (note 1)	5	5
2	Zero O ₂	NA (note 1)	5	5
3	Zero IR	NA (note 1)	5	5
4	Span O ₂	NA (note 1)	5	5
5	Span	1	5	5
6	Span	2	5	5
7	Span	3	5	5
8	Span	4	5	5
9	Span	5	5	5
10	Span	6	5	5
11	Purge	None	5	5
12-16	User defined		5	5

Note 1: Cylinders used for these events are selected elsewhere in the Calibration Setup menu.

Define Events



Use the following procedure to modify the default events or create new calibration events, which are used to create a Calibration Sequence as previously described. As many as 16 events can be defined.

1. From the Main Menu, select Calibration > Calibration Setup > Cal Sequence Setup > **Define Events**.
2. Move the cursor to Event 1 and press .
3. Press  again to select **Event Type**. Set the Event Type to **Purge**, **Zero**, or **Span** by pressing the  or  arrow, and then press  to save the selection.
4. If the event type is “Zero”, set the zero channel to either O2, IR, or All.
If the event type is “Span”, select the span cylinder. The composition of the selected cylinder, as entered in the cylinder definition table, will automatically determine which measurement channel(s) will be adjusted

If the event is “Purge”, go directly to step 6 below and enter the purge duration. Note that a Purge event is typically inserted at the end of a calibration sequence. It defines a time period during which the zero and span cylinders are shut off, but the system has not re-stabilized on actual sample. Data taken during a purge period is flagged as part of the calibration in the instrument’s internal records, and can also be marked as invalid by a data logger that is connected to the 60i rear panel I/O system.

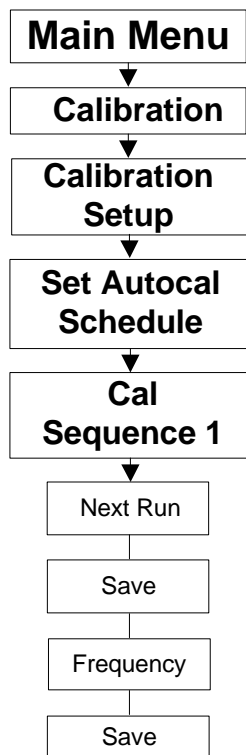
If the event is “Span NO_x”, you will be prompted to enter Duration “A” and Duration “B.” Both “A” and “B” are typically left at the default values. Duration “A” is a period during which the NO dilution air is turned on, but the ozonator is turned off. During this period, the analyzer calculates the dilution ratio based on the decrease in NO concentration that occurred when the dilution air was turned on. Duration “B” is a period during which the dilution air and the ozonator are both turned on. During this period, the NO₂ concentration is automatically calculated based on the decrease in the NO concentration that occurs when the ozonator is turned on. Refer to “Calibrating NO₂ with a Model 61*ioz* calibrator” later in this chapter for more information. Note that in order to use “Span NO_x” as an event type, the analyzer must be connected to the 61*ioz* or

another compatible calibration system. Note also that on the 61ioz calibrator, cylinder #6 must be used as the NO source.

Note A Purge event is a period of time at the end of a calibration when the zero and span gases are shut off, but the system has not re-stabilized on actual sample. Data taken during the Purge period is flagged as part of the calibration in the instrument's internal records and can also be marked by a data logger that is connected to the 60i rear-panel I/O system. ▲





5. **Set the Delay.** The delay is the estimated time required for the calibration gas to reach the analyzer and generate a stable response. During the delay, the zero or span gas will be flowing, but the instrument readings will not be stable, so the data is not used for calibration.
6. **Set the Duration.** The duration is the time period, or length, of the specific event that is being defined. The appropriate value depends on the length of sampling lines, pumping rate and other site-dependent factors. Zero, span and purge durations should be sufficiently long that they allow the analyzer reading to fully stabilize.
7. Go to the next Event and repeat defining or editing the event as described in the previous step. Events that will not be used in a calibration sequence can be left undefined or left with the default definitions.

Scheduling Automatic Calibration



Once calibration events and sequences have been defined, the Model 60i can be programmed to execute calibrations on a routine basis without operator input.

Use the following procedure to configure the 60i for automatic calibration.

1. From the Main Menu select Calibration > Calibration Setup > **Set Autocal Schedule**.
2. Select **Cal Sequence 1** or **Cal Sequence 2**.
3. Select the **Next Run**, press , and set the date and time when the sequence should occur for the first time. Press  to save the new date and time. Any date and time that is later than the current system time can be entered.
4. Press  to return to the Cal Sequence 1 menu, select **Frequency**, and enter the elapsed time that should occur between executions of this calibration sequence. Press  to save the new elapsed time.

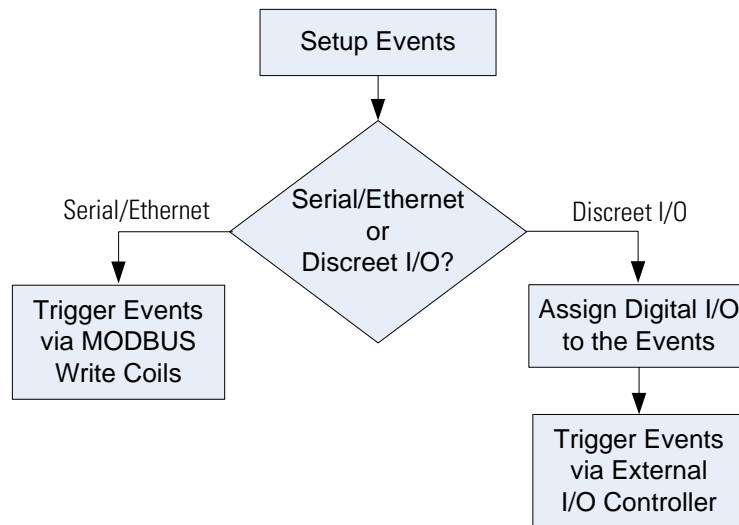
The interval is entered in days and hours and indicates the elapsed time from one start of an autocal sequence to the next start of that same sequence. If the value is set to zero, the automatic calibration function is disabled for the selected sequence.

Controlling Events Via Third Party Digital I/O or MODBUS

In addition to controlling events by autosequencing with the Model 61i as described previously, calibration sequences or individual events can be controlled using a third-party digital I/O controller (PLC, PC, or datalogger) or by using MODBUS write coils.

For example, if you want to trigger an O₂ sensor zero (default event #2), you can assign digital I/O 2 to trigger Event 2. Then every time you activate digital I/O 2, the oxygen sensor will be re-zeroed using the delay and duration specified in the Event 2 definition.

To assign an event to digital I/O, refer to “[Digital Input Settings](#)” on page 3-71.



Events or sequences can also be triggered using the MODBUS write coil function. For detailed information about initiating events via MODBUS, refer to “(0x05) Force (Write) Single Coil” on page C-7 and Table C-3 on page C-13.

Using Third-Party Digital I/O or MODBUS without Events or Sequences

In systems that use a PLC or data logger to control the calibration gases directly, it may be easier to calibrate the 60i without using defined events or calibration sequences. In these systems, the PLC or data logger should turn on the desired calibration gas and allow the system to fully stabilize.

Note The 60i “Cal-In” and “Cal-Out” bulkheads should be capped and the internal valves should be disabled via Main Menu > Diagnostics > Instrument Configuration > **Disable Cal Valves**. ▲

Once the reading is stable, the PLC or data logger issues a calibration command to the 60i and the analyzer will immediately calculate a new zero offset or span factor based on the specific command. Available commands are:

Set O₂ zero offset
 Set O₂ span factor
 Set IR zero offsets
 Set cylinder 1 span factors
 ↓
 Set cylinder 6 span factors

Note that the span channels associated with a cylinder and the span concentrations must have been previously entered in the cylinder definition table.

Calibrating NO, NO₂, and NO_x with an Ozonator

Nitrogen oxides (NO_x) are the sum of nitric oxide (NO) and nitrogen dioxide (NO₂). Because the ratio of NO to NO₂ in a mixture can be unstable, the total NO_x concentration is sometimes considered more important than the individual NO and NO₂ measurements.

$$\text{NO}_x = \text{NO} + \text{NO}_2$$

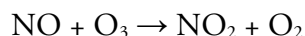
The Model 60*i* reports NO_x by measuring NO and NO₂ on separate channels and adding the two results. In order to get accurate NO_x measurements, both the NO and the NO₂ channel must be calibrated.

If NO and NO₂ span gases are both available, the calibration procedures described earlier should be followed.

If a stable source of NO₂ is not readily available, it may be necessary to span the NO channel using a certified cylinder and to span the NO₂ channel using an ozonator that converts NO to NO₂. When spanning the NO₂ channel with an ozonator system, the span concentration for NO₂ is calculated based on the decrease in NO concentration that occurs when ozone is added to the NO span gas.

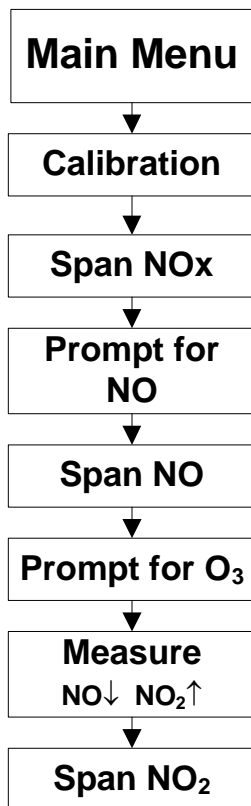
Generating NO₂

If NO₂ calibration gas standards are not available, the optional 61*ioz* Calibrator or similar device may be used as an alternative supply of NO₂ span gas. The 61*ioz* mixes NO calibration gas with ozone (O₃) to generate NO₂.



The ozonator reaction is actually less than 100% efficient, resulting in a certain amount of NO pass through. The amount of NO₂ generated cannot be accurately predicted. However, the NO₂ concentration can be calculated. Since the total NO_x concentration leaving the ozonator must equal the concentration of NO entering the ozonator, the increase in NO₂ is equal to the loss of NO.

Calibrating NO₂ with a Model 61*ioz* Calibrator



Use the following procedure to calibrate the NO₂ channel manually using a Model 61*ioz* Calibrator. [See “Defining Calibration Sequence” earlier in this chapter to Span NO_x (span NO₂) automatically.] When supplying gases by methods other than the 61*ioz*, refer to the “[Manual Calibration](#)” notes in this procedure.

Note If using this procedure, cylinder 6 **must** contain the NO span gas. If not calibrating NO_x, another gas may be defined in cylinder 6. ▲

This calibration procedure involves:


- Spanning the NO channel
- Mixing NO with air (ozonator Off to measure dilution)
- Turning the ozonator On to generate NO₂
- Measuring the decrease in concentration of NO
- Spanning NO₂ channel based on mass balance (decrease in [NO] = increase in [NO₂])

Note NO span gas must be supplied throughout this procedure. ▲

1. Cylinder 6 **MUST** contain the NO span gas. Define cylinder 6 as NO span gas by entering the NO concentration in the cylinder definition table. For step-by-step instructions on entering cylinder definitions, refer to the “[Define Cylinders](#)” menu on page 3-29.


2. From the Main Menu select Calibration > Span > **Calibrate NO_x**.


The NO_x Calibration screen displays a message indicating that cylinder 6 must be defined as NO span gas.

3. If NO channel was already spanned, press  to skip to the NO_x Calibration screen (Step 7), otherwise continue with Step 4.


4. Press  to display the Span screen.

The screen displays the actual and measured NO values.

Manual Calibration: Turn NO gas on before pressing  in Step 5.

5. Press  to begin the span.

6. When the timer elapses, press  to save the NO span value.

7. Press  to begin dilution.

The analyzer flows dilution air through the ozonator, which is off. The NO_x Calibration screen displays the time remaining before the NO and NO₂ values can be saved.


Manual Calibration: Turn on NO with air source.

8. When the timer elapses, press . (This time is “Duration” if using an automated sequence.)

The analyzer stores the NO and NO₂ values that were derived with the ozonator off.

The ozonator turns on and the NO_x Calibration screen displays the Ozonator is Active message.

Manual Calibration: Turn on ozonator.

9. Wait for the timer to indicate that the analyzer is ready to store the values. (This is “Duration B” if using an automated sequence). Press  to store the NO and NO₂ values. These values are used to calculate the NO₂ span coefficient.

The screen displays the “Waiting for Calc” message then returns to the Calibrate Span screen.

Manual Calibration: Turn off ozonator.

References

1. Section 12 of EPA-454/R-98-004, *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume II, Part 1, August 1998, available at www.epa.gov/ttn/amtic/qabook.html, and 40 CFR 50, Appendix C.

Section 12 also provides information on “Calibration of Primary and Secondary Standards for Flow Measurements.”

Specific information on certification of concentration standards is given in EPA-600/R93/224, *EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards*, 1993 Available from www.NTIS.gov (PB94130424).

Calibration Worksheet

Use the calibration worksheet to define and record the parameters used in performing a calibration. Refer to the completed worksheet example on page 4-37 that indicates the types of data used in setting up a calibration.

Facility	
Sample Location	
Instrument Serial Number	
Installation Date	
Operator	

1. Define Calibration Cylinders

Cylinder 1

Balance gas: ☐ Air ☐ Nitrogen

Gas	Concentration	Units		
CO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
CO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
O ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
SO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³

Cylinder 2

Balance gas: ☐ Air ☐ Nitrogen

Gas	Concentration	Units		
CO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
CO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
O ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
SO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³

Cylinder 3

Balance gas: ☐ Air ☐ Nitrogen

Gas	Concentration	Units		
CO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
CO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
O ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
SO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³

Cylinder 4

Balance gas: ☐ Air ☐ Nitrogen

Gas	Concentration	Units		
CO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
CO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
O ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
SO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³

Cylinder 5

Balance gas: ☐ Air ☐ Nitrogen

Gas	Concentration	Units		
CO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
CO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
O ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
SO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³

Cylinder 6

Balance gas: ☐ Air ☐ Nitrogen

Gas	Concentration	Units		
CO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
CO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
NO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
O ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³
SO ₂		<input type="checkbox"/> ppm	<input type="checkbox"/> %	<input type="checkbox"/> mg/m ³

2. Select Zero Cylinders

Parameter	Cylinder #
ZERO O ₂	
ZERO IR	

Note When ZERO O₂ and ZERO IR are set to the same cylinder, the ZERO ALL event may be used. ▲

3. Select O2 Span

Parameter	Cylinder #
O2 Span	

4. Calibration Flow Path (select one)

☐ Direct ☐ System

5. Define Events

Note Events require external hardware such as the 61*ioz* Calibrator. ▲

Event	Event Type	Event Sub-type	Delay (min.)	Duration (min.)	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

6. Setup Auto Cal Sequence

Note Events require external hardware such as the 61*ioz* Calibrator. ▲

- ☐ Check
- ☐ Reset

Auto-Cal Sequence	Event Order	Defined Event
1	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	

Completed Worksheet Example

This completed calibration worksheet indicates the types of data used in setting up a calibration.

Facility	Thermo Fisher Scientific, Franklin, MA USA
Sample Location	Unit 1 inlet
Instrument Serial Number	00001850
Installation Date	July 2, 2007
Operator	D. Mackintosh

1. Define Cal Cylinders

Cylinder	Components	Concentrations
1	O2	Instrument Air
2	CO2, O2	10% CO2 and 10% O2 balance nitrogen
3	CO, SO2, NO	750 ppm CO, 750 ppm SO2, 375 ppm NO balance nitrogen
4	SO2	750 ppm SO2 balance nitrogen
5	NO2	40 ppm NO2 balance air
6	NO	375 ppm NO balance nitrogen

2. Select Zero Cylinders

Parameter	Cylinder #
ZERO O2	3
ZERO IR	1

Note When ZERO O2 and ZERO IR are set to the same cylinder, the ZERO ALL event may be used. ▲

3. Select O2 Span

Parameter	Cylinder #
O2 Span	2

4. Calibration Flow Path (select one)

☐ Direct ☒ System

5. Define Events

Note Events require external hardware such as the 61*ioz* Calibrator. ▲

Event	Event Type	Event Sub-type	Delay (min.)	Duration (min.)	Notes
1	Zero	IR	6	10	Zero all IR channels
2	Span	CYL 2	6	4	Span CO2, O2
3	Span	CYL 3	6	4	Span CO, SO2, NO
4	Zero	O2	6	4	Zero O2
5	Span	CYL 4	6	4	Span SO2
6	Span	CYL 5	6	4	Span NO2
7	Span	CYL 6	6	4	Span NO
8	Zero	IR	6	10	Check zero again and flush cal lines
9	Purge	-	-	8	Wait for sample to resume
10					
11					
12					
13					
14					
15					
16					

6. Setup Auto Cal Sequence

Note Events require external hardware such as the 61*ioz* Calibrator. ▲

Auto-Cal Sequence	Event Order	Defined Event
1	1	4 Zero O ₂
	2	1 Zero IR
	3	5 Span SO ₂
	4	7 Span NO
	5	9 Purge
	6	
	7	
	8	
	9	
	10	

Chapter 5

Preventive Maintenance

This chapter describes the periodic maintenance procedures that should be performed on the instrument to ensure proper operation.

Since usage and environmental conditions vary greatly, you should inspect the components frequently until an appropriate maintenance schedule is determined. This includes the sample pump, solenoid valves, the optional electrochemical O₂ sensor, and IR source which have a limited life.

Clean the optics only when you are certain they need cleaning. Read the Equipment Damage notices in the “[Cleaning the Optics](#)” procedure before cleaning the mirrors.

This chapter includes the following maintenance information and replacement procedures:

- “[Safety Precautions](#)” on page 5-1
- “[Replacement Parts](#)” on page 5-2
- “[Cleaning the Outside Case](#)” on page 5-2
- “[Cleaning the Optics](#)” on page 5-2
- “[Fan Filter Inspection and Cleaning](#)” on page 5-4
- “[Pump Test and Internal Leak Test](#)” on page 5-5
- “[DC Pump Rebuilding](#)” on page 5-6

Safety Precautions

Read the safety precautions before beginning any procedures in this chapter.



WARNING If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component ([Figure 7-1](#)). If an antistatic wrist strap is not available, be sure to touch the instrument chassis

before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲



Equipment Damage Do Not use solvents or other cleaning products to clean the outside case. ▲



Equipment Damage Never clean the mirrors unless you are certain they need cleaning. Any contact with the mirror surface will degrade it to some degree. ▲

Never rub a mirror to remove debris, especially gold surface mirrors. Instead, stream solvent on the mirror surface to dislodge any debris. Compressed air may be used to dry the mirrors. ▲

Use only analytical grade isopropyl alcohol or methanol to clean the mirrors. ▲

Replacement Parts

See the “Servicing” chapter for a list of replacement parts and the associated replacement procedures.

Cleaning the Outside Case



Clean the outside case using a damp cloth, being careful not to damage the labels on the case.



Equipment Damage Do Not use solvents or other cleaning products to clean the outside case. ▲

Cleaning the Optics

Best results are obtained when the optics are clean. The cleanliness of the mirrors should be checked any time the intensity is below 30,000 (viewed on the top line of the Preamp Board Calibration screen in the Service menu), since one cause of low output is light attenuation due to dirt on the mirrors.

Prior to cleaning the mirrors, try increasing the intensity in that Preamp Board Calibration screen as close to 50,000 as possible by pressing . If this increases the intensity to greater than 30,000, the mirrors do not need to be cleaned. Press  to save the new setting, then recalibrate the instrument. If the intensity does not increase, use the following procedure to clean the mirrors.

Read the Equipment Damage notices in this procedure before cleaning the mirrors. If you are certain the mirrors require cleaning, use the following procedure to clean them. Refer to [Figure 7-2](#) to locate the optical bench mirrors.






Equipment Damage Never clean the mirrors unless you are certain they need cleaning. Any contact with the mirror surface will degrade it to some degree. ▲

Never rub a mirror to remove debris, especially gold surface mirrors. Instead, stream solvent on the mirror surface to dislodge any debris. Compressed air may be used to dry the mirrors. ▲




Use only analytical grade isopropyl alcohol or methanol to clean the mirrors. ▲



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component ([Figure 7-1](#)). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. For more information about appropriate safety precautions, see the “Servicing” chapter. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. To remove a mirror, remove the mirror retaining screws and remove the mirror from the optical bench.
3. Carefully clean each mirror by streaming solvent on the surface. Rinse with distilled or deionized water. Dry by blowing clean dry air over the mirror.
4. Reassemble following the above procedure in reverse.
5. The field mirror and the relay mirror do not need realignment, but the entrance mirror and the exit mirror do need to be realigned. Use the following procedure to realign the entrance mirror and the exit mirror:
 - a. From the Main Menu, press  to scroll to Service > press  to scroll to **Preamp Board Calibration** and press .

Note If the Service menu is not displayed, refer to “[Accessing the Service Level](#)” on page 7-4, then return to the beginning of this step. ▲

- b. Adjust the “Set to” value such that the intensity/count value is approximately 45,000. (“Set to” can be as low as zero if the 45,000 count cannot be achieved.)
 - c. Adjust the entrance mirror and the exit mirror by loosening the two screws that bind each to the optical bench and by slowly rotating the knurled flange back and forth to give the highest reading possible on the Max Count display line.
 - d. Beginning with the entrance mirror, adjust the mirror positions to produce the maximum intensity. You may need to go back and forth between the two mirrors a few times to get the highest possible value.
 - e. Recheck alignment of each mirror before tightening the two binding screws on each mirror.
 - f. When the mirrors are adjusted and re-tightened, adjust the Max Count value as close as possible to 52,000 using   and then press  to save the setting.
6. Calibrate the instrument. Refer to the “[Calibration](#)” chapter in this manual.

Fan Filter Inspection and Cleaning

Use the following procedure to inspect and clean the fan filter ([Figure 5-1](#)).

1. Remove the fan guard and filter from the rear of the instrument by unsnapping it.
2. Flush the filter with warm water and let dry (a clean, oil-free purge will help the drying process) or blow the filter clean with compressed air.
3. Re-install the filter and fan guard.

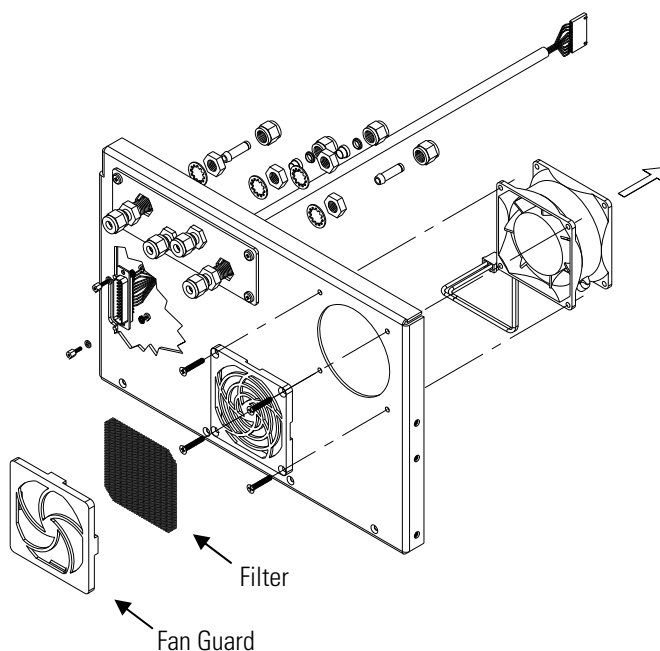







Figure 5–1. Inspecting and Cleaning the Fan

Pump Test and Internal Leak Test

Use the following procedure to test the pump and internal plumbing for leaks.

1. Press  to display the Main Menu.
2. Press  to move the cursor to Service and press  to display the Service menu.

Note If the Service menu is not displayed, refer to “[Accessing the Service Level](#)” on page 7-4, then return to the beginning of this step. ▲

3. Press  to move the cursor to Valve Leak Test and press  to display the Valve Leak Test screen. This screen is used to view the pressure and to toggle both solenoid valves on and off. For more information about this screen, refer to the “Operation” chapter.
4. Disconnect the sample input line from the rear panel, plug the SAMPLE fitting, the CAL IN fitting, and the CAL OUT fitting ([Figure 5–2](#)).

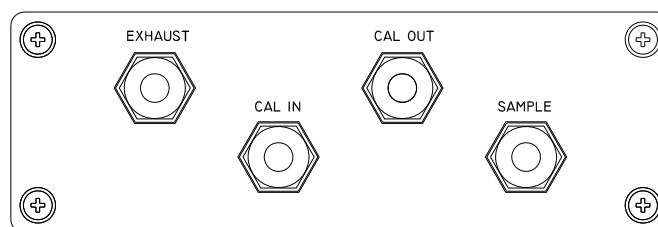


Figure 5-2. Rear Panel Plumbing Fittings

5. If the pump diaphragm is in good condition, there are no plumbing leaks, and the capillary is not blocked, it should take approximately five minutes from the time the inlets are plugged to obtain a reading that is less than approximately 200 mm Hg. Note that the plumbing on the “closed” sides of the solenoid valves can be tested by toggling each solenoid valve On one at a time and observing the pressure.
6. If there are leaks, systematically move the “plug” downstream to locate the source. Tighten any loose fittings and replace any damaged components as needed. Note that the pump diaphragm can be visually inspected for damage by following steps 1-6 of the “[DC Pump Rebuilding](#)” procedure that follows.

DC Pump Rebuilding

Use the following procedure to change the pump diaphragm, valve plates, and seal rings ([Figure 5-3](#)). To replace the DC pump, see the “[DC Pump Replacement](#)” procedure in the “[Servicing](#)” chapter.

Equipment Required:

DC pump rebuild kit (refer to the “[Replacement Parts List](#)” on page [7-5](#)).

2.5 mm Allen wrench

Dental pick or small slotted-head screwdriver

Small Phillips head screwdriver

Marking pencil



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component ([Figure 7-1](#)). If an antistatic wrist strap is not available, be sure to touch the instrument chassis

before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Disconnect the pump from electrical power, make a sketch of the position of any tubes and fittings for ease of reassembly, and remove the pump from the instrument.
3. Mark the position of the pump headplate A, intermediate plate C, and compressor housing L relative to each other by drawing a line on the edges with a pencil or other marker to ensure proper reassembly.

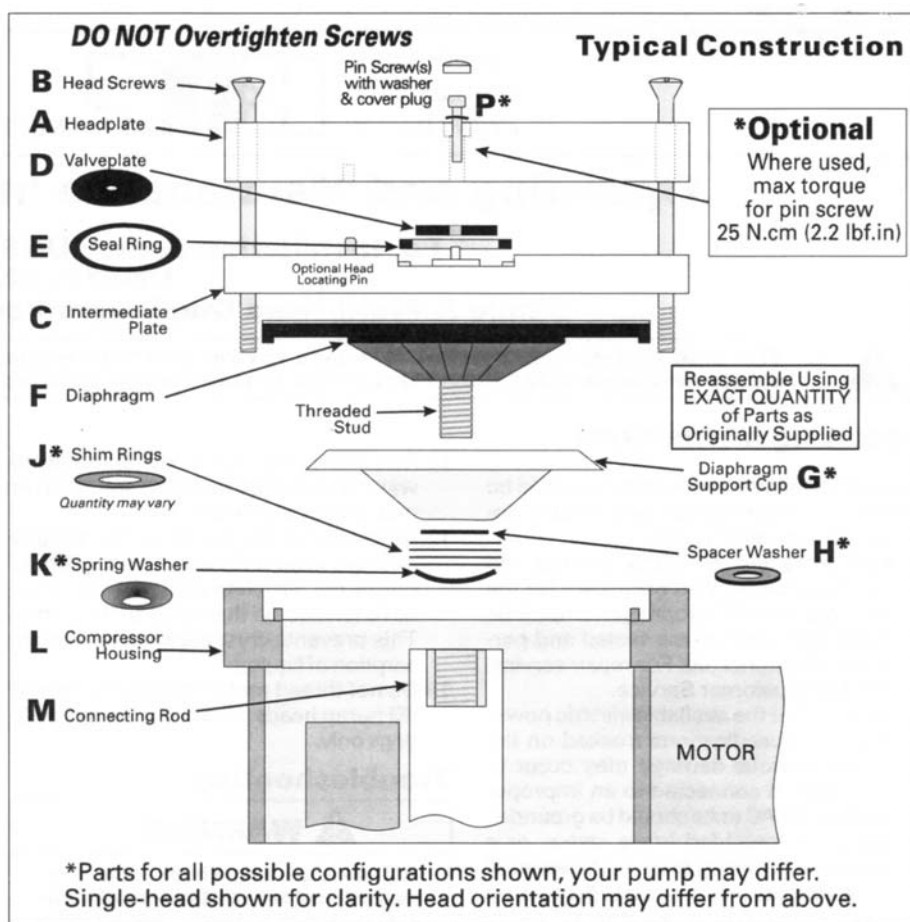


Figure 5–3. Rebuilding the DC Pump

4. Using the pick or a small screwdriver, carefully remove the two cover plugs (over **P**), then remove the two socket head screws **P** and washers with the Allen wrench.
5. Remove the four screws **B** and remove the headplate **A**. Note the positioning of the valve plates **D** and seal rings **E** in relation to the valve ports on the headplate **A** and intermediate plate **C**. Lift off the seal rings and valve plates.
6. Remove the intermediate plate **C**. Carefully clean the head and intermediate plates of any residue using fine steel wool. **DO NOT** scratch the parts.
7. Using the pick or a small screwdriver, loosen the edges of the old diaphragm **F** from the groove in the compressor housing **L**.
8. Unscrew the old diaphragm **F** by turning it counterclockwise using both hands. **DO NOT use tools. IMPORTANT** – Take care not to lose any small parts such as the spacer washers **H**, shim rings **J**, or spring washer **K** positioned between the diaphragm stud and connecting rod.

Holding the pump upside down while removing the diaphragm will help to keep any spacers and washers in place.

9. Place the parts removed in Step 8 onto the threaded stud of the new diaphragm. Carefully screw the new diaphragm **F** into the connecting rod **M**. **Tighten firmly using both hands only – DO NOT use tools.**
If possible, hold the pump upside down when starting the threaded diaphragm stud into the connecting rod.
10. Turn the counterweight under the diaphragm until the diaphragm is flat across. Carefully center the diaphragm over the compressor housing **L**, firmly seating the diaphragm edge into the compressor housing groove.
11. Place the clean intermediate plate **C** onto the compressor housing **L**, according to your previously drawn markings, then place the new valve plates **D** and seal rings **E** on top of the intermediate plate. Make sure the seal rings are properly seated in intermediate plate recesses to avoid pinching.

12. Place the clean headplate **A** on top of the intermediate plate **C** according to your previously drawn markings, then tighten the four screws **B** in a criss-cross pattern. Replace the pin screw(s) **P** and tighten to 25 N.cm (2.2 lbf.in). **DO NOT overtighten.**
13. Replace the cover plugs over the pin screws **P**.
14. Reinstall the pump into the instrument making sure the tubing and fittings are as previously sketched in Step 2.
15. Perform the “[Pump Test and Internal Leak Test](#)” procedure described in this chapter.

Chapter 6

Troubleshooting

This instrument has been designed to achieve a high level of reliability. In the event of problems or failure, the troubleshooting guidelines, board-level connection diagrams, connector pin descriptions, and testing procedures presented in this chapter should be helpful in isolating and identifying problems.

The Service Level mode, described in the “[Operation](#)” chapter, includes parameters and functions that are useful when making adjustments or diagnosing problems.

The Technical Support Department at Thermo Fisher Scientific can also be consulted in the event of problems. In any correspondence with the factory, please note both the serial number and program number of the instrument.

This chapter provides the following troubleshooting and service support information:

- “[Safety Precautions](#)” on page 6-1
- “[Firmware Diagnostic Information](#)” on page 6-1
- “[Troubleshooting Guides](#)” on page 6-2
- “[Board-Level Connection Diagrams](#)” on page 6-8
- “[Connector Pin Descriptions](#)” on page 6-10
- “[Service Locations](#)” on page 6-26

Safety Precautions

Read the safety precautions in the “About This Manual” section and in the “[Servicing](#)” chapter before performing any actions listed in this chapter.

Firmware Diagnostic Information

Diagnostic information that might be useful in troubleshooting hardware problems can be found in the Diagnostics menu. The Diagnostics menu presents a series of information screens that are organized to show pressures, voltages, temperatures, and other information describing the analyzer’s current state. [Table 6-1](#) lists the Diagnostic menu items and describes their function. Refer to the “[Operation](#)” chapter for detailed information about the Diagnostics menu.

Table 6–1. Diagnostic Menu Selections

Menu Item	Description
Program Versions	Shows the version numbers of the installed programs (read only).
Voltages	Displays the current diagnostic voltage readings (read only).
Temperatures	Displays the temperature readings taken at several points inside the analyzer (read only).
Pressure	Displays the current optical bench pressure (read only).
Sample Dewpoint	Displays the water content of the sample as dewpoint and as concentration in ppm.
Ref Intensity	Displays the source intensity for the reference channel. It serves as an indicator of source and detector condition.
Analog Input Readings	Displays the eight user-scaled analog readings (if the I/O expansion board option is installed).
Analog Input Voltages	Displays the eight raw analog voltage readings (if the I/O expansion board option is installed).
Digital Inputs	Displays the state of the 16 digital inputs (read only).
Relay States	Displays the state of the ten digital outputs, eight solenoid outputs, and allows toggling of the state to either On (1) or Off (0).
Test Analog Outputs	Used to set each of the analog output channels to zero or full scale. Channel choices include all analog outputs, six voltage channels, and six current channels (if the I/O expansion board option is installed).
Instrument Configuration	Displays instrument hardware configuration information and allows toggling System indicator as Yes or No.
Contact Information	Displays telephone numbers of the customer service support centers.

Troubleshooting Guides

The troubleshooting guides presented in this chapter are designed to help isolate and identify instrument problems.

[Table 6–2](#) provides general troubleshooting information and indicates the checks that you should perform if you experience an instrument problem.

[Table 6–3](#) lists all the alarm messages you may see on the graphics display and provides recommendations about how to resolve the alarm condition.

Note System alarms are only visible when part of a system. ▲

Table 6–2. Troubleshooting - General Guide

Malfunction	Possible Cause	Action
Does not start (The display does not illuminate, light on power switch does come On, and the pump motor is not running.)	No power or wrong power configuration	Check the line to confirm that power is available and that it matches the voltage and frequency configuration of the instrument.
	Main fuses blown or missing	Unplug the power cord, open the fuse drawer on the back panel, and check the fuses visually or with a multimeter. Replace fuses as necessary.
	Bad switch or wiring connection	Unplug the power cord, disconnect the switch and check operation with a multimeter. Replace switch as necessary.
Display does not come on - light on power switch does come On.	DC power supply failure	Check the green LED on the back edge of the power supply. If the LED is off, the power supply failed.
	Display failure	If possible, check instrument function through RS-232 or Ethernet. Reboot instrument.
	Ribbon cable disconnected	Check ribbon cable on side of display board.
	DC power distribution failure	Check surface mount LEDs labeled “24V PWR” on the motherboard and the interface board. If lit, the power is OK.
Pressure transducer does not hold calibration or is noisy	Pressure transducer defective	Replace pressure transducer.
	Connection to interface board may be defective	Check pins on interface board and crimps on the connector.
Run output noisy	Recorder noise	Replace or repair recorder. Check recorder cable.
	Sample concentration varying	Run instrument on a span gas source - if quiet, there is no malfunction.
	Dirty mirrors	Verify that the mirrors are dirty. Clean if necessary. Important Note: Never clean the mirrors unless you are certain

Malfunction	Possible Cause	Action
Analyzer does not calibrate properly		they need cleaning. Any contact with the mirror surface will degrade it to some degree. Refer to "Cleaning the Optics" in the "Preventive Maintenance" chapter.
	Reference intensity low	Increase pre-amp board gain to 52000 while sampling zero air, replace IR source if necessary.
	Electrochemical (EC) oxygen cell depleted	Replace EC cell.
	Incorrect cylinder definition	Verify that cylinder definitions are correct.
Analyzer does not calibrate properly	System leak	Run leak test described in "Preventive Maintenance" chapter to find and repair leak.
	Pressure transducer out of calibration	Recalibrate pressure transducer.
	Dirty mirrors	Verify that the mirrors are dirty. Clean if necessary.
		Important Note: Never clean the mirrors unless you are certain they need cleaning. Any contact with the mirror surface will degrade it to some degree. Refer to "Cleaning the Optics" in the "Preventive Maintenance" chapter.

Table 6–3. Troubleshooting - Alarm Messages

Alarm Message	Possible Cause	Action
Alarm – Concentration CO Conc CO2 NO NO2 NOX O2 SO2	Concentration has exceeded range limit	Check to ensure range corresponds with expected value. If not, select proper range.
	Concentration low	Check user-defined low set point, set to zero.

Alarm Message	Possible Cause	Action
Alarm – Sample Flow	Flow of sample gas is too low	Check sample capillary for blockage. Replace as necessary. If using sample particulate filter, make sure it is not blocked. Disconnect sample particulate filter from the sample bulkhead, if flow increases, replace the filter.
	Pump defective	Repair or replace pump.
	Pump disconnected	Connect pump.
	Defective or disconnected flow switch/cable	Check flow switch/cable.
	Plumbing connection/configuration	Check plumbing connections.
Alarm – Cal Flow	Calibration gas flow rate is insufficient	Increase cylinder pressure. Check lines for obstructions and clear lines as necessary.
	Defective or disconnected cal flow switch/cable	Check cal flow switch/cable.
	Defective cal solenoid	Cal gas not connected or connected to wrong cylinder.
Alarm – Dewpoint	Problem with external sampling system, such as a chiller or other water removal device	Check external sampling system and service as necessary.
Alarm – Pressure	Leak or loss of flow	Check the pump for a tear in the diaphragm, replace with pump repair kit if necessary. Refer to “Preventive Maintenance” chapter in this manual. Check that capillary is properly installed and silastic tubing is in good shape. Replace if necessary. Check flow system for leaks.
		Remove line from pressure transducer. The pressure reading should go to ambient. Calibrate pressure transducer, if necessary.
Alarm – Probe Filter Temp	Probe filter has over-heated or heater has failed	Check set point against probe filter temp reported in

Alarm Message	Possible Cause	Action
(System alarm)	Temperature sensor failed	System menu. Replace temperature sensor
Alarm – Probe Barrel (System alarm)	Probe barrel has over-heated or heater has failed	Check set point against probe barrel temp reported in System menu.
	Temperature sensor failed	Replace temperature sensor
Alarm – Blowback Pressure (System alarm)	Pressure sensor failed Compressor failed Pressure loss	Replace pressure sensor. Check blowback air source. Check filter and tubing for leaks.
Alarm – Chiller Status (System alarm)	Liquid water passing through chiller Chiller temperature exceeds maximum allowed	Check sampling system temperature, flowrate, and ambient temperature. Check lines for visible water.
Alarm – Reference Intensity	IR source failed Detector failed Dirty mirrors	Replace IR source. Replace detector board assembly. Verify that the mirrors are dirty. Clean if necessary. Important Note: Never clean the mirrors unless you are certain they need cleaning. Any contact with the mirror surface will degrade it to some degree. Refer to “Cleaning the Optics” in the “Preventive Maintenance” chapter.
The following board-related alarms only occur during power up or reboot.		
Alarm – Status 62i Board (System alarm)	Internal cables not connected properly	Check that all internal cables are connected properly.
Alarm – Status Detector Board	Board is defective	Recycle AC power to instrument. If still alarming, change board.
Alarm – Status I/O Exp Board		
Alarm – Status Interface Board		
Alarm – Status Motherboard		
Alarm – Temp Bench	Instrument not warmed up Heaters or heater assembly not plugged in	Allow more time for instrument to reach proper operating temperature. Plug in heaters.

Alarm Message	Possible Cause	Action
	Defective heater or defective heater wires	Check resistance of heater wires. Unplug heater connector and use an ohmmeter to measure resistance across pins 3 and 4. Normal resistance should be approx. 290 Ω . A higher resistance reading indicates that a heater is defective. Checking pins 1 and 2 will result in a 10 k Ω reading. An open reading indicates a failed thermistor or wiring in heater assembly.
	Improper alarm threshold setting	Reset the alarm threshold.
	Overheating – fan problem	Check fan operation.
Alarm – Temp Detector	Defective fan	Replace fan if not operating properly.
	Fan not connected properly	Check fan connection.
	Dirty fan filter	Clean or replace foam filter, refer to “ Preventive Maintenance ” chapter in this manual.
Alarm – Temp Source	Defective fan	Replace fan if not operating properly.
	Fan not connected properly	Check fan connection.
	Dirty fan filter	Clean or replace foam filter, refer to “ Preventive Maintenance ” chapter in this manual.
	Source temperature thermistor open or shorted	Check source temperature thermistor. See “ Servicing ” chapter for details.
	Bad interface board	Replace interface board.
Alarm – Umb Temp Zone 1	Umbilical not heating	Check voltages and continuity.
Alarm – Umb Temp Zone 2 (System alarms)	High temp	Check setpoint.
	No AC voltage to probe	Check probe AC voltage source.
	Bad cable connection at instrument	Check umbilical cable connections at the system interface unit and analyzer connections to the probe control.

Board-Level Connection Diagrams

Figure 6–1 and Figure 6–2 are board-level connection diagrams for the common electronics and measurement system. These illustrations can be used along with the connector pin descriptions in Table 6–4 through Table 6–9 to troubleshoot board-level faults.

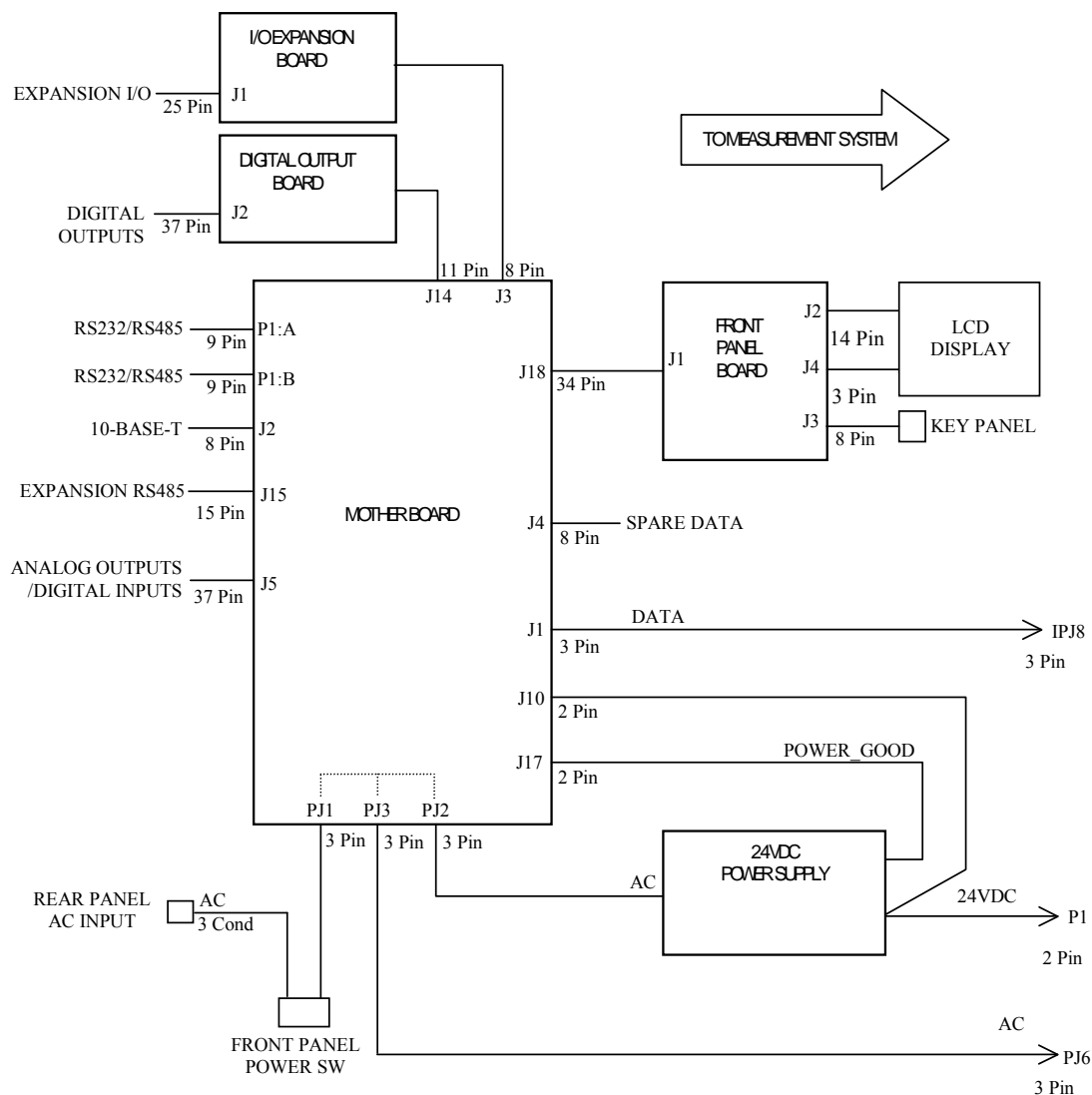


Figure 6–1. Board-Level Connection Diagram - Common Electronics

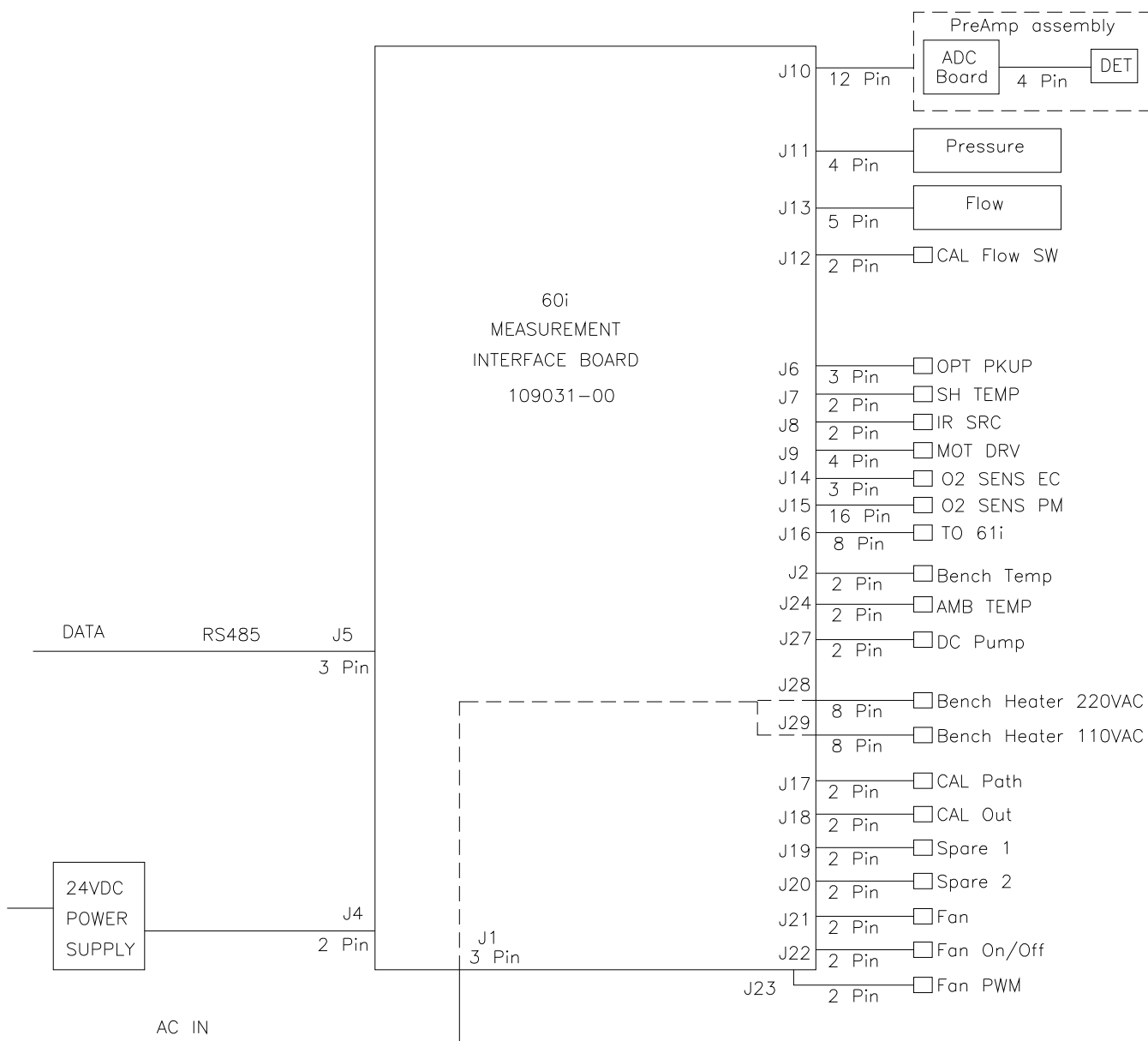


Figure 6–2. Board-Level Connection Diagram - Measurement System

Connector Pin Descriptions

The connector pin descriptions in [Table 6–4](#) through [Table 6–9](#) can be used along with the board-level connection diagrams to troubleshoot board-level faults.

Table 6–4. Motherboard Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
INTF DATA	J1	1	Ground
		2	+RS485 to Interface Board
		3	-RS485 to Interface Board
10-BASE-T	J2	1	Ethernet Output (+)
		2	Ethernet Output (-)
		3	Ethernet Input (+)
		4	NC
		5	NC
		6	Ethernet Input (-)
		7	NC
		8	NC
EXPANSION BD	J3	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	+RS485 to Expansion Board
		8	-RS485 to Expansion Board
INTERFACE 24V	J4	1	+24V
		2	Ground
I/O	J5	1	Power Fail Relay N.C. Contact
		2	Digital Ground
		3	TTL Input 1
		4	TTL Input 2
		5	Digital Ground
		6	TTL Input 5

Connector Label	Reference Designator	Pin	Signal Description
		7	TTL Input 7
		8	TTL Input 8
		9	TTL Input 10
		10	Ground
		11	TTL Input 13
		12	TTL Input 15
		13	Digital Ground
		14	Analog Voltage 1
		15	Analog Voltage 3
		16	Analog Ground
		17	Analog Voltage 5
		18	Analog Ground
		19	Analog Ground
		20	Power Fail Relay COM
		21	Power Fail Relay N.O. Contact
		22	Digital Ground
		23	TTL Input 3
		24	TTL Input 4
		25	TTL Input 6
		26	Digital Ground
		27	TTL Input 9
		28	TTL Input 11
		29	TTL Input 12
		30	TTL Input 14
		31	TTL Input 16
		32	Digital Ground
		33	Analog Voltage 2
		34	Analog Voltage 4
		35	Analog Ground
		36	Analog Voltage 6
		37	Analog Ground
VOLTAGE TEST	J6	1	+5V
		2	+3.3V
			+15V

Troubleshooting

Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
			-15V
SER EN	J7	1	Serial Enable Jumper
		2	+3.3V
24V IN	J10	1	+24V
		2	Ground
RESET PROC	J12	1	Reset-Proc
		2	Ground
DIGITAL I/O	J14	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	SPI Reset
		8	SPI Input
		9	SPI Output
		10	SPI Board Select
		11	SPI Clock
EXT. RS485	J15	1	-RS485 to Rear Panel
		2	-RS485 to Rear Panel
		3	+5V
		4	+5V
		5	+5V
		6	Ground
		7	Ground
		8	Ground
		9	NC
		10	NC
		11	+24
		12	+24
		13	+24
		14	+24
		15	+24
24 MONITOR	J17	1	24V Power Monitor

Connector Label	Reference Designator	Pin	Signal Description
FRONT PANEL BD	J18	2	Ground
		1	Ground
		2	Ground
		3	LCLK – LCD Signal
		4	Ground
		5	Ground
		6	LLP – LCD Signal
		7	LFLM – LCD Signal
		8	LD4 – LCD Signal
		9	LD0 – LCD Signal
		10	LD5 – LCD Signal
		11	LD1 – LCD Signal
		12	LD6 – LCD Signal
		13	LD2 – LCD Signal
		14	LD7 – LCD Signal
		15	LD3 – LCD Signal
		16	LCD Bias Voltage
		17	+5V
		18	Ground
		19	Ground
		20	LCD_ONOFF – LCD Signal
		21	Keypad Row 2 Input
		22	Keypad Row 1 Input
		23	Keypad Row 4 Input
		24	Keypad Row 3 Input
		25	Keypad Col 2 Select
		26	Keypad Col 1 Select
		27	Keypad Col 4 Select
		28	Keypad Col 3 Select
		29	Ground
		30	Ground
		31	Ground
		32	Ground

Troubleshooting

Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
RS232/RS485:A	P1:A	33	+24V
		34	+24V
		1	NC
		2	Serial Port 1 RX (-RS485 IN)
		3	Serial Port 1 TX (-RS485 OUT)
		4	NC
		5	Ground
		6	NC
		7	Serial Port 1 RTS (+RS485 OUT)
		8	Serial Port 1 CTS (+RS485 IN)
		9	NC
		1	NC
		2	Serial Port 2 RX (-RS485 IN)
		3	Serial Port 2 TX (-RS485 OUT)
		4	NC
		5	Ground
		6	NC
		7	Serial Port 2 RTS (+RS485 OUT)
		8	Serial Port 2 CTS (+RS485 IN)
		9	NC
AC IN	PJ1	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground
AC 24VPWR	PJ2	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground
AC INTF BD	PJ3	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground

Table 6–5. Measurement Interface Board (New Version) Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
AC IN	J1	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground
BENCH TEMP	J2	1	Bench Temperature Thermistor
		2	Ground
24V IN	J4	1	+24V
		2	Ground
DATA	J5	1	Ground
		2	+RS485
		3	-RS485
OPT PKUP	J6	1	Optical Pickup Input
		2	Ground
		3	Optical Pickup Source Drive
SH TEMP	J7	1	IR Source Housing Temperature Thermistor
		2	Ground
IR SRC	J8	1	+18V for IR source
		2	Ground
MOT DRV	J9	1	Motor Drive Voltage 1
		2	Motor Drive Voltage 2
		3	Motor Drive Voltage 3
		4	Motor Drive Voltage 4
PREAMP	J10	1	+RS485
		2	-RS485
		3	Optical Pickup
		4	SPI-Data Out
		5	SPI-CLK
		6	SPI-CS
		7	+15V
		8	+5V
		9	Ground

Troubleshooting

Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
		10	-15V
		11	Detector Thermistor
		12	Ground
PRES	J11	1	Chamber Pressure Sensor Input
		2	Ground
		3	+15V
		4	-15V
CAL FLOW SW	J12	1	Cal Flow Sensor Input
		2	Ground
FLOW	J13	1	Sample Flow Sensor Input
		2	Ground
		3	+15V
		4	-15V
		5	Ground
O2 SENS EC	J14	1	O2 Sensor Electrochemical Input
		2	Ground
		3	NC
O2 SENS PM	J15	1	NC
		2	NC
		3	NC
		4	NC
		5	Ground
		6	+5V
		7	NC
		8	NC
		9	Ground
		10	O2 SENSOR Paramagnetic INPUT
		11	NC
		12	NC
		13	NC
		14	O2 SENSOR THERMISTOR INPUT
		15	NC
		16	+5V
TO 61i	J16	1	Reset +

Connector Label	Reference Designator	Pin	Signal Description
		2	Reset -
		3	SPI-SIMO +
		4	SPI-SIMO -
		5	SPI-CS +
		6	SPI-CS -
		7	SPI-CLK +
		8	SPI-CLK -
CAL PATH	J17	1	+24V
		2	Solenoid Driver 1
CAL OUT	J18	1	+24V
		2	Solenoid Driver 2
SPARE1	J19	1	+24V
		2	Solenoid Driver 3
SPARE2	J20	1	+24V
		2	Solenoid Driver 4
FAN	J21	1	+24V (Fused)
		2	Ground
FAN ON/OFF	J22	1	+24V (Fused)
		2	Fan On/Off Control
FAN PWR	J23	1	+24V (Fused)
		2	Fan PWM Control
AMB TEMP	J24	1	Ambient Temperature Thermistor
		2	Ground
DC PUMP	J27	1	+24V (Fused)
		2	Ground
Bench Heater 220 VAC	J28	1	AC-NEUT Bench Heater
		2	AC-HOT
		3	AC-HOT
		4	AC-NEUT
		5	AC-HOT
		6	AC-NEUT
		7	AC-NEUT
		8	AC-HOT

Troubleshooting

Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
Bench Heater 110 VAC	J29	1	AC-HOT Bench Heater
		2	AC-HOT
		3	AC-HOT
		4	AC-HOT
		5	AC-NEUT
		6	AC-NEUT
		7	AC-NEUT
		8	AC-NEUT

Table 6–6. Measurement Interface Board (Old Version) Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
AC IN	J1	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground
AC BENCH1	J2	1	Bench Thermistor
		2	Ground
		3	AC-HOT
		4	Bench Heater AC Control 1
AC BENCH2	J3	1	AC-HOT
		2	Bench Heater AC Control 2
		3	NC
24V IN	J4	1	+24V
		2	Ground
DATA	J5	1	Ground
		2	+RS485 from Motherboard
		3	-RS485 from Motherboard
OPT PKUP	J6	1	Optical Pickup Input
		2	Ground
		3	Optical Pickup Source Drive
AMB TEMP	J7	1	Source Temperature Thermistor
		2	Ground

Connector Label	Reference Designator	Pin	Signal Description
IR SRC	J8	1	+18V for IR source
		2	Ground
MOT DRV	J9	1	Motor Drive Voltage 1
		2	Motor Drive Voltage 2
		3	Motor Drive Voltage 3
		4	Motor Drive Voltage 4
PREAMP	J10	1	+RS485
		2	-RS485
		3	Optical Pickup
		4	SPI – Data Out
		5	SPI - CLK
		6	SPI - CS
		7	+15V
		8	+5V
		9	Ground
		10	-15V
		11	Detector Thermistor
		12	Ground
PRES	J11	1	Chamber Pressure Sensor Input
		2	Ground
		3	+15V
		4	-15V
CAL FLOW SW	J12	1	Cal Flow Sensor Input
		2	Ground
FLOW	J13	1	Sample Flow Sensor Input
		2	Ground
		3	+15V
		4	-15V
		5	Ground
O2 SENS A	J14	1	O2 Sensor Input A
		2	Ground
		3	NC
O2 SENS B	J15	1	NC
		2	NC

Troubleshooting

Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
		3	NC
		4	NC
		5	Ground
		6	+5V
		7	NC
		8	NC
		9	Ground
		10	O2 SENSOR INPUT B
		11	NC
		12	NC
		13	NC
		14	O2 SENSOR THERMISTOR INPUT
		15	NC
		16	+5V
SOL BD	J16	1	+5V
		2	+24V (Fused)
		3	+24V (Fused)
		4	Ground
		5	Ground
		6	Ground
		7	/Reset
		8	NC
		9	SPI – Data Out
		10	SPI – Solenoid Control
		11	SPI - Clock
Z/S	J17	1	+24V
		2	Zero/Span Solenoid Control
SAMPLE	J18	1	+24V
		2	Sample Solenoid Control
SPAN1	J19	1	+24V
		2	Converter Solenoid Control
SPAN2	J20	1	+24V
		2	Span 2 Solenoid Control
FAN	J21	1	+24V (Fused)

Connector Label	Reference Designator	Pin	Signal Description
FAN SW	F22	2	Ground
		1	+24V (Fused)
FAN PWM	F23	2	Fan On/Off Control
		1	+24V (Fused)
DC PUMP	F27	2	Fan PWM Control
		1	+24V (Fused)
		2	Ground

Table 6–7. Front Panel Board Connector Pin Diagram

Connector Label	Reference Designator	Pin	Signal Description
MOTHERBOARD	J1	1	Ground
		2	Ground
		3	LCLK – LCD Signal
		4	Ground
		5	Ground
		6	LLP – LCD Signal
		7	LFLM – LCD Signal
		8	LD4 – LCD Signal
		9	LD0 – LCD Signal
		10	LD5 – LCD Signal
		11	LD1 – LCD Signal
		12	LD6 – LCD Signal
		13	LD2 – LCD Signal
		14	LD7 – LCD Signal
		15	LD3 – LCD Signal
		16	LCD Bias Voltage
		17	+5V
		18	Ground
		19	Ground
		20	LCD_ONOFF – LCD Signal
		21	Keypad Row 2 Input
		22	Keypad Row 1 Input

Troubleshooting

Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
		23	Keypad Row 4 Input
		24	Keypad Row 3 Input
		25	Keypad Col 2 Select
		26	Keypad Col 1 Select
		27	Keypad Col 4 Select
		28	Keypad Col 3 Select
		29	Ground
		30	Ground
		31	Ground
		32	Ground
		33	+24V
		34	+24V
LCD DATA	J2	1	LD0_5V – LCD Signal
		2	LD1_5V – LCD Signal
		3	LD2_5V – LCD Signal
		4	LD3_5V – LCD Signal
		5	LCD_ONOFF_5V – LCD Signal
		6	LFLM_5V – LCD Signal
		7	NC
		8	LLP_5V – LCD Signal
		9	LCLK_5V – LCD Signal
		10	+5V
		11	Ground
		12	-25V
		13	LCD Bias Voltage
		14	Ground
KEYBOARD	J3	1	Keypad Row 1 Input
		2	Keypad Row 2 Input
		3	Keypad Row 3 Input
		4	Keypad Row 4 Input
		5	Keypad Col 1 Select
		6	Keypad Col 2 Select
		7	Keypad Col 3 Select
		8	Keypad Col 4 Select

Connector Label	Reference Designator	Pin	Signal Description
LCD BACKLIGHT	J4	1	LCD Backlight Voltage 1
		2	NC
		3	LCD Backlight Ground

Table 6–8. I/O Expansion Board (Optional) Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
EXPANSION I/O	J1	1	Analog Voltage Input 1
		2	Analog Voltage Input 2
		3	Analog Voltage Input 3
		4	Ground
		5	Analog Voltage Input 4
		6	Analog Voltage Input 5
		7	Analog Voltage Input 6
		8	Ground
		9	Analog Voltage Input 7
		10	Analog Voltage Input 8
		11	Ground
		12	NC
		13	Current Output Return
		14	Ground
		15	Current Output 1
		16	Current Output Return
		17	Current Output 2
		18	Current Output Return
		19	Current Output 3
		20	Current Output Return
		21	Current Output 4
		22	Current Output Return
		23	Current Output 5
		24	Current Output Return
		25	Current Output 6
MOTHER BD	J2	1	+5V

Connector Label	Reference Designator	Pin	Signal Description
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	+RS485 to Motherboard
		8	-RS485 to Motherboard

Table 6–9. Digital Output Board Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
MOTHER BD	J1	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	SPI Reset
		8	SPI Input
		9	SPI Output
		10	SPI Board Select
		11	SPI Clock
DIGITAL OUTPUTS	J2	1	Relay 1 Contact a
		2	Relay 2 Contact a
		3	Relay 3 Contact a
		4	Relay 4 Contact a
		5	Relay 5 Contact a
		6	Relay 6 Contact a
		7	Relay 7 Contact a
		8	Relay 8 Contact a
		9	Relay 9 Contact a
		10	Relay 10 Contact a
		11	NC

Connector Label	Reference Designator	Pin	Signal Description
		12	Solenoid Drive Output 1
		13	Solenoid Drive Output 2
		14	Solenoid Drive Output 3
		15	Solenoid Drive Output 4
		16	Solenoid Drive Output 5
		17	Solenoid Drive Output 6
		18	Solenoid Drive Output 7
		19	Solenoid Drive Output 8
		20	Relay 1 Contact b
		21	Relay 2 Contact b
		22	Relay 3 Contact b
		23	Relay 4 Contact b
		24	Relay 5 Contact b
		25	Relay 6 Contact b
		26	Relay 7 Contact b
		27	Relay 8 Contact b
		28	Relay 9 Contact b
		29	Relay 10 Contact b
		30	+24V
		31	+24V
		32	+24V
		33	+24V
		34	+24V
		35	+24V
		36	+24V
		37	+24V

Service Locations

For additional assistance, worldwide service is available from Thermo Fisher Scientific. Contact one of the phone numbers below for product support and technical information or visit us on the web at www.thermo.com/aqi.

Toll Free U.S. only 1-866-282-0430

U.S., Latin America, and Canada 1-508-520-0430

Europe +31 76 579 5555

China +86 10 8419 3588

Asia Pacific +91 22 27781102

Chapter 7

Servicing

This chapter explains how to replace the Model 60*i* subassemblies. It assumes that a subassembly has been identified as defective and needs to be replaced.

For fault location information, refer to the “[Preventive Maintenance](#)” chapter and the “[Troubleshooting](#)” chapter in this manual.

The Service Level mode section in the “[Operation](#)” chapter also includes parameters and functions that are useful when making adjustments or diagnosing problems.

For additional service assistance, see “[Service Locations](#)” on page 7-54.

This chapter includes the following parts information and component replacement procedures:

- “[Safety Precautions](#)” on page 7-3
- “[Firmware Updates](#)” on page 7-4
- “[Accessing the Service Level](#)” on page 7-4
- “[Replacement Parts List](#)” on page 7-5
- “[Cable List](#)” on page 7-6
- “[External Device Connection Components](#)” on page 7-7
- “[Removing the Measurement Case Assembly and Lowering the Partition Panel](#)” on page 7-8
- “[Optical Bench Replacement](#)” on page 7-10
- “[Bench Heater Assembly Replacement](#)” on page 7-12
- “[Bench Thermistor Assembly Replacement](#)” on page 7-13
- “[Detector Board Assembly Replacement](#)” on page 7-14
- “[Preamp Board Calibration](#)” on page 7-16
- “[Filter Wheel Motor Replacement](#)” on page 7-17
- “[Filter Wheel Replacement](#)” on page 7-19
- “[Chopper Calibration](#)” on page 7-20

- “Optical Pickup Replacement” on page 7-21
- “IR Source Replacement” on page 7-22
- “DC Pump Replacement” on page 7-25
- “Pressure Transducer Assembly Replacement” on page 7-26
- “Pressure Transducer Calibration” on page 7-27
- “3-Way Cal Solenoid/Flow Switch Replacement” on page 7-29
- “Sample Flow Switch Replacement” on page 7-32
- “2-Way Cal Out Solenoid Replacement” on page 7-31
- “Electrochemical Oxygen Sensor Replacement” on page 7-32
- “Paramagnetic Oxygen Sensor Replacement” on page 7-33
- “Oxygen Sensor Calibration” on page 7-34
- “Fan Replacement” on page 7-35
- “DC Power Supply Replacement” on page 7-36
- “Analog Output Testing” on page 7-37
- “Analog Output Calibration” on page 7-40
- “Analog Input Calibration” on page 7-41
- “Source Temperature Thermistor/Cable Assembly Replacement” on page 7-43
- “Source Temperature Calibration” on page 7-44
- “Ambient Temperature Thermistor Assembly Replacement” on page 7-45
- “Internal Temperature Calibration” on page 7-46
- “Fuse Replacement” on page 7-47
- “I/O Expansion Board Replacement” on page 7-47
- “Digital Output Board Replacement” on page 7-49
- “Motherboard Replacement” on page 7-50
- “Measurement Interface Board Replacement” on page 7-50
- “Front Panel Board Replacement” on page 7-52
- “LCD Module Replacement” on page 7-53
- “Service Locations” on page 7-54

Safety Precautions

Read the safety precautions before beginning any procedures in this chapter.



WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲



CAUTION If the LCD panel breaks, do not let the liquid crystal contact your skin or clothes. If the liquid crystal contacts your skin or clothes, wash it off immediately using soap and water. ▲



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component (Figure 7-1). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

Do not attempt to lift the instrument by the cover or other external fittings. ▲

Do not use solvents or other cleaning products to clean the outside case. ▲

Do not remove the LCD panel or frame from the LCD module. ▲

The LCD polarizing plate is very fragile, handle it carefully. ▲

Do not wipe the LCD polarizing plate with a dry cloth, as it may easily scratch the plate. ▲

Do not use alcohol, acetone, MEK or other Ketone based or aromatic solvents to clean the LCD module, but rather use a soft cloth moistened with a naphtha cleaning solvent. ▲

Do not place the LCD module near organic solvents or corrosive gases. ▲

Do not shake or jolt the LCD module. ▲

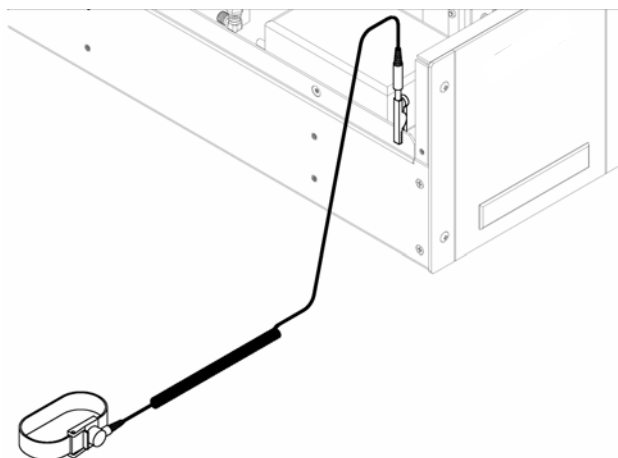


Figure 7-1. Properly Grounded Antistatic Wrist Strap

Firmware Updates






The firmware can be updated by the user in the field via the serial port or over the Ethernet. This includes both the main processor firmware and the firmware in all low-level processors. Refer to the *iPort* manual for the firmware update procedure.

Accessing the Service Level

If the Service menu is not displayed on the Main Menu, use the following procedure to display it.

1. From the Main Menu, choose Instrument Controls > **Service/Access Level**.

The Set Access Level screen appears.

2. Press  or  as appropriate to toggle to **Service**, then press  to save the selection.
3. Press  >  to return to the Main Menu.
4. Return to the procedure.

Replacement Parts List

Table 7–1 lists the replacement parts for the Model 60*i* and Table 7–2 lists the cable assemblies. Refer to Figure 7–2 to identify the component location.

Note Consumables, including but not limited to O₂ sensors, lamps, fuses, and bulbs, are expressly excluded from the Thermo Fisher Scientific warranty. You may purchase consumable items from Thermo Fisher Scientific by calling our customer service department at 1-866-282-0430. ▲

Table 7–1. Model 60*i* Replacement Parts

Part Number	Description
100533-00	Motherboard
101491-31	Processor Board
100480-00	Front Panel Pushbutton Board
100539-00	Digital Output Board
102340-00	Front Panel Connector Board
102496-00	Front Panel LCD Display
100542-00	I/O Expansion Board (optional)
106552-00	Optical Pickup with Cable
105445-00	CaF ₂ Window Assembly
7194	Field Mirror
7195	Entrance Mirror
7193	Relay Mirror
7196	Exit Mirror
105383-00	Motor and Wheel Assembly (for reference only – not field replaceable, not for sale)
122255-00	I/R Source
101427-00	Filter Wheel Motor
105382-00	Filter Wheel (for reference only – not field replaceable, not for sale)
106551-00	Detector Board Assembly
107631-00	2-Way Cal Out Valve/Cable Assembly
106458-00	3-way Cal Solenoid/Flow Switch Assembly (for use without O ₂ sensors)
106458-01	3-way Cal Solenoid/Flow Switch Assembly (used with either O ₂ sensor)
106457-00	Sample Flow Switch
101023-00	Pressure Transducer
7336	Capillary, purple/blue, 1 1/8" x 1/4", .018 ID

Servicing

Replacement Parts List

Part Number	Description
106491-00	DC Pump Assembly (for use without O ₂ sensors)
106491-01	DC Pump Assembly (used with either O ₂ Sensor)
102701-00	Teflon Particulate Filter Kit with Filter Element (optional)
4320	Filter Element, Replacement – Package of 25 Filters (optional)
107237-00	DC Pump Repair Kit
101055-00	AC Receptacle Assembly
101681-00	Power Supply Assembly, 24 VDC, with Base Plate and Screws
100907-00	Fan, 24 VDC
8630	Fan Filter Guard Assembly*
4510	Fuse, 250VAC, 3.0 Amp, SlowBlow (for 100VAC and 110VAC models)*
14007	Fuse, 250VAC, 1.60 Amp, SlowBlow (for 220-240VAC models)*
108542-00	Source Temperature Thermistor with cable (measures temperature at the source housing)
106459-00	Oxygen Sensor, Electrochemical (optional)*
108083-00	Oxygen Sensor, Paramagnetic (optional)
4115	Capillary, green, 1 1/8" x 1/4", .006 ID (used with either O ₂ Sensor)
105132-00	Measurement Interface Board (old version)**
105384-01	Optical Bench Assembly 240V (for reference only – not field replaceable, not for sale)** (used with old MIB 105132-00)
105384-02	Optical Bench Assembly, 120V (for reference only – not field replaceable, not for sale)** (used with old MIB 105132-00)
106779-00	Heater/Thermocouple Assembly (120V)** (used with old MIB 105132-00)
106507-00	Heater/Thermocouple Assembly (240V)** (used with old MIB 105132-00)
109031-00	Measurement Interface Board (new version)**
105384-00	Optical Bench Assembly 240V (for reference only – not field replaceable, not for sale)** (used with new MIB 109031-00)
109417-00	Bench Heater Assembly (not voltage dependent)** (used with new MIB 109031-00)
101688-00	Ambient Thermistor Assembly** (used with new MIB 109031-00)
109389-00	Bench Thermistor Assembly** (used with new MIB 109031-00)

*Expendable item, not covered by warranty

**Verify which MIB version (old or new) before ordering spare parts

Cable List

Table 7–2. Model 60*i* Cables

Part Number	Description
101349-00	AC Power Cable (115 VAC, US)
8926	AC Power Cable (220 VAC, EU)
101036-00	DC Power Supply 24 V Output
101037-00	VAC Motherboard to Measurement Interface Board
101048-00	RS-485/Data Cable
101038-00	AC Power Switch to Motherboard
101364-00	DC Power Supply Status Monitor
101054-00	Motherboard to Front Panel Board
101035-00	DC Power Supply AC Input to Motherboard
101377-00	AC to Power Switch
104686-00	Paramagnetic O ₂ Sensor Cable
106456-00	Electrochemical O ₂ Sensor Cable
106554-00	IR Source to Interface
106564-00	Detector Assembly (ADC) to Interface
106391-00	DB25 Rear Panel to Interface (used with old MIB 105132-00)*
109031-00	RJ45 Communications to 61 <i>i</i> (used with new MIB 109031-00)*

*Verify which MIB version (old or new) before ordering spare parts

External Device Connection Components

Table 7–3 lists the standard and optional cables and components used for connecting external devices such as PCs and dataloggers to an *i*Series instrument.

Table 7–3. External Device Connection Components

Part Number	Description
102562-00	Terminal Block and Cable Kit (DB25) (optional)
102556-00	Terminal Block and Cable Kit (DB37) (optional)
102645-00	Cable, DB37M to Open End Cable, Six Feet (optional)
102646-00	Cable, DB37F to Open End, Six Feet (optional)
102659-00	Cable, DB25M to Open End, Six Feet (optional)
6279	Cable, RS-232 (optional)
102888-00	Terminal Board PCB Assembly, DB37F (standard with all instruments)
102891-00	Terminal Board PCB Assembly, DB37M (standard with all instruments)

Servicing

Removing the Measurement Case Assembly and Lowering the Partition Panel

Part Number	Description
103084-00	Terminal Board PCB Assembly, DB25M (optional) Included with optional I/O Expansion Board in all instruments.

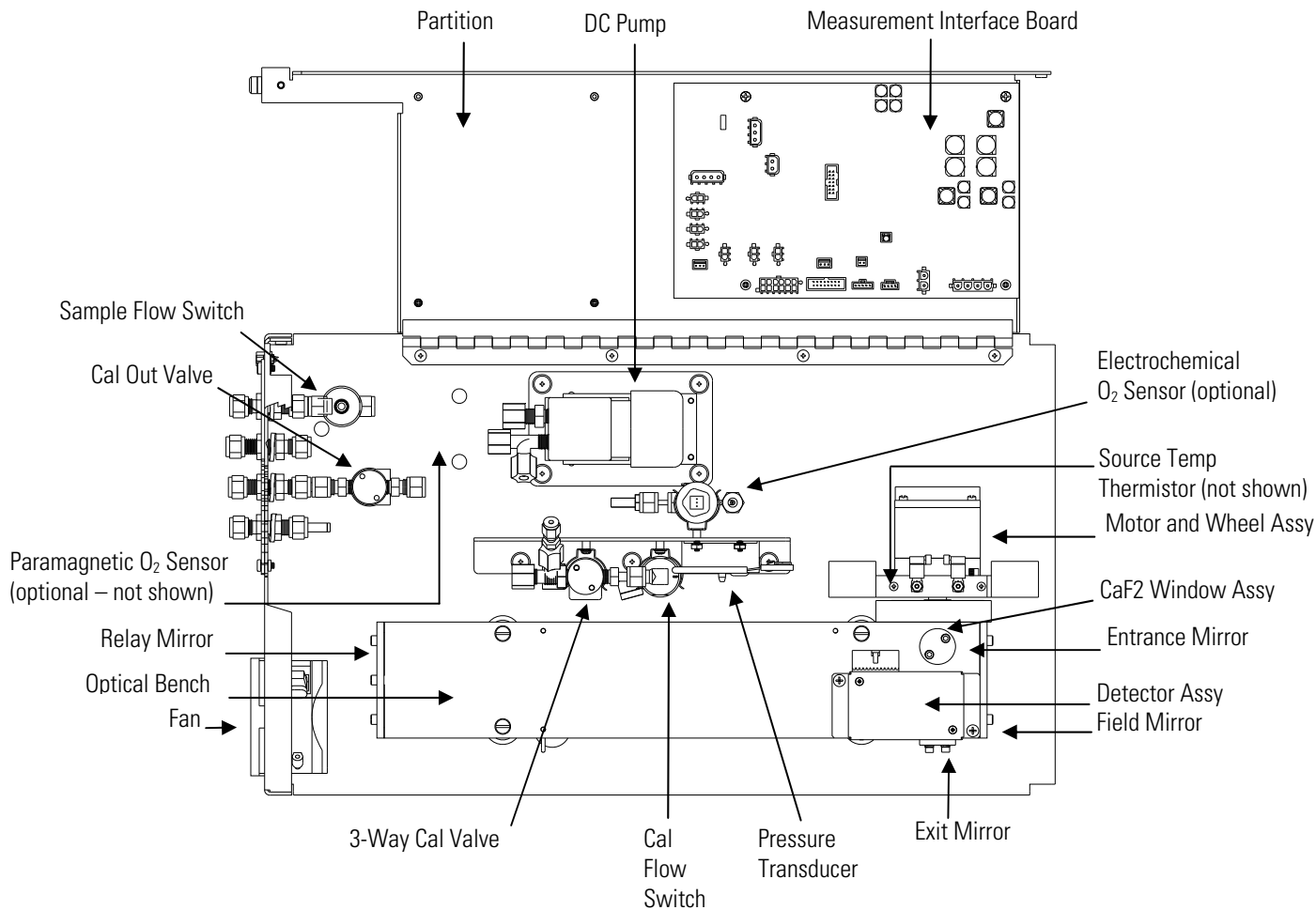


Figure 7–2. Model 60i Component Layout

Removing the Measurement Case Assembly and Lowering the Partition Panel

The measurement case assembly can be removed and the partition panel can be lowered to improve access to connectors and components. Refer to the following steps when a procedure requires lowering the partition panel (Figure 7–3).

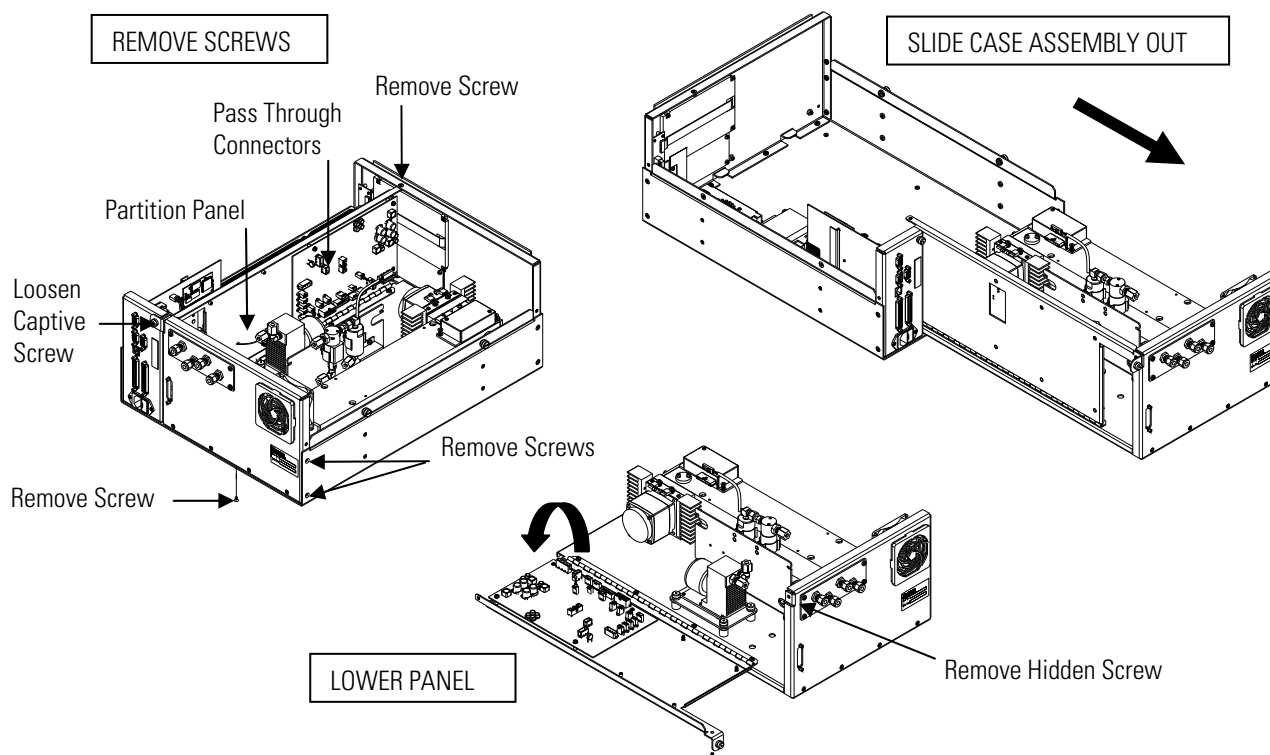


Figure 7-3. Removing the Measurement Case Assembly and Lowering the Partition Panel

Equipment Required:

Philips screwdriver



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component (Figure 7-1). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off and unplug the power cord.
2. If the instrument is mounted in a rack, remove it from the rack.
3. Remove the cover.

4. Disconnect the three connectors that pass through the center of the partition panel that connect to the measurement interface board.
5. Remove two screws from the left side rear of the case (viewed from front).
6. Remove one screw from the bottom rear of the case.
7. Remove one screw from the top front of the partition panel.
8. While holding the case securely, loosen the captive screw at the rear of the measurement case assembly, and pull the measurement case assembly from the rear of the case.
9. Remove the screw at the top rear of the partition panel that secures the top of the panel to the measurement case assembly, and lower the panel, being careful not to put excessive tension on the cables.
10. Re-install the measurement case assembly by following the previous steps in reverse.

Optical Bench Replacement

Use the following procedure to replace the optical bench (Figure 7–4).

Equipment Required:

Optical bench assembly

Philips screwdriver

Flatblade screwdriver

Cutting pliers



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component (Figure 7–1). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

Note After removing the optical bench for cleaning or service, you must install the same filter wheel and detector. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.
2. Cut cable ties as necessary and disconnect all cables from the measurement interface board that come from the optical bench. It is important to note the location of each connector to be sure they are reconnected correctly.
3. Cut tubing ties as necessary and disconnect the optical bench tubing.
4. Remove the optical bench cover, which is attached to the bench with Velcro®, by lifting the end closest to the detector assembly first.
5. Remove the two screws securing the detector assembly and move the detector assembly out of the way to access the optical bench retaining screws. Be sure to keep the O-ring seated in its groove on the bench.
6. Remove the four screws holding the optical bench to the shock mounts and carefully remove the optical bench.
7. Replace the optical bench assembly by following the previous steps in reverse.
8. Calibrate the instrument. Refer to the “[Calibration](#)” chapter in this manual.



Figure 7–4. Removing the Optical Bench

Bench Heater Assembly Replacement

Use the following procedure to replace the bench heater assembly (Figure 7-5).

Equipment Required:

- Bench heater assembly
- Heat conductive compound
- Flatblade screwdriver, 1/4-inch
- Philips screwdriver, small
- Cutting pliers



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component (Figure 7-1). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.
2. Remove the optical bench assembly following the “Optical Bench Replacement” procedure described previously in this chapter.
3. Turn the optical bench over, remove the screw holding each heater to the bottom of the optical bench, and remove the four heaters and thermistor (Figure 7-5). Cut cable ties as necessary.

Note If the heaters are difficult to remove, use a small screwdriver and a hammer to dislodge them. There are smaller diameter thru holes in the bench that allow this. ▲

4. Apply heat conductive compound to the bottom sides of the heaters and install the new heaters and thermistor.
5. Reinstall the bench as described previously and plug the heater cable into the appropriate voltage connector.

6. Calibrate the instrument. Refer to the “[Calibration](#)” chapter in this manual.

Note Older models have 1 assembly that contains both the thermistor and the heaters. The replacement procedure is basically the same as for the individual assemblies. Prior to installing the heaters, verify that the voltage marked on the heater cartridges matches the analyzer voltage. ▲

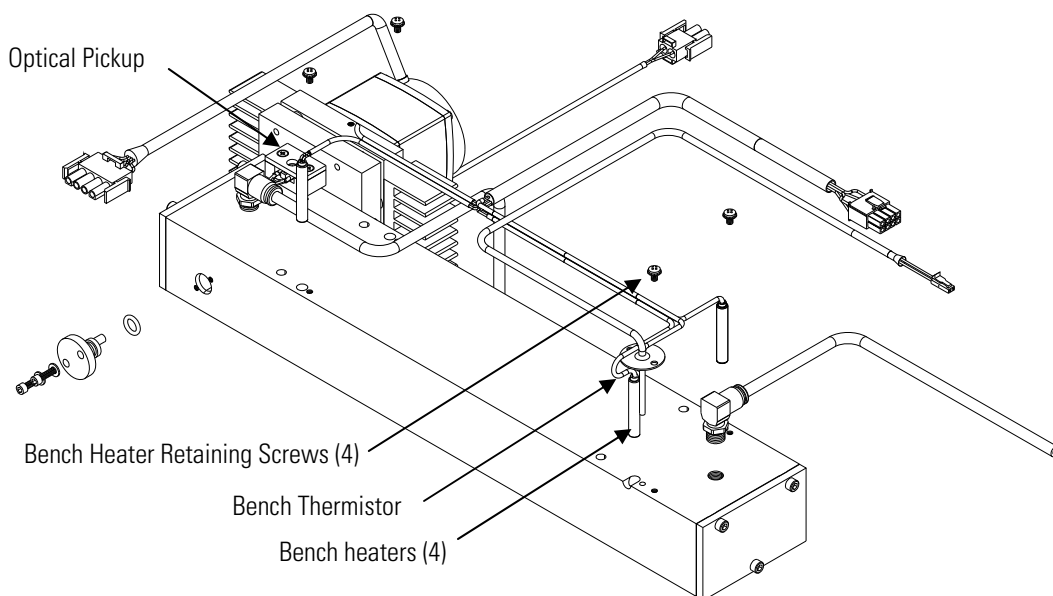


Figure 7–5. Optical Bench Bottom View

Bench Thermistor Assembly Replacement

Use the following procedure to replace the bench thermistor assembly ([Figure 7–5](#)).

Equipment Required:

- Bench thermistor assembly
- Heat conductive compound
- Flatblade screwdriver, 1/4-inch
- Philips screwdriver, small
- Cutting pliers



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap

must be worn while handling any internal component (Figure 7–1). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.
2. Remove the optical bench assembly following the “Optical Bench Replacement” procedure described previously in this chapter.
3. Turn the optical bench over, remove the screw holding the thermistor to the bottom of the optical bench, and remove the thermistor assembly (Figure 7–5). Cut cable ties as necessary.
4. Apply heat conductive compound to the thermistor and install the new thermistor into the bench.
5. Reinstall the bench as described previously and plug the connectors into the appropriate locations.

Detector Board Assembly Replacement

Use the following procedure to replace the detector assembly. Refer to Figure 7–6 and Figure 7–7.

Equipment Required:

Detector board assembly
Philips screwdriver, #2
Cutting pliers
Adjustable wrench
Heat conductive compound



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component (Figure 7–1). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.
2. Disconnect the detector cable from the connector on the detector board assembly. Cut cable ties as necessary.
3. Remove the two detector assembly cover retaining screws and remove the cover ([Figure 7-6](#)).

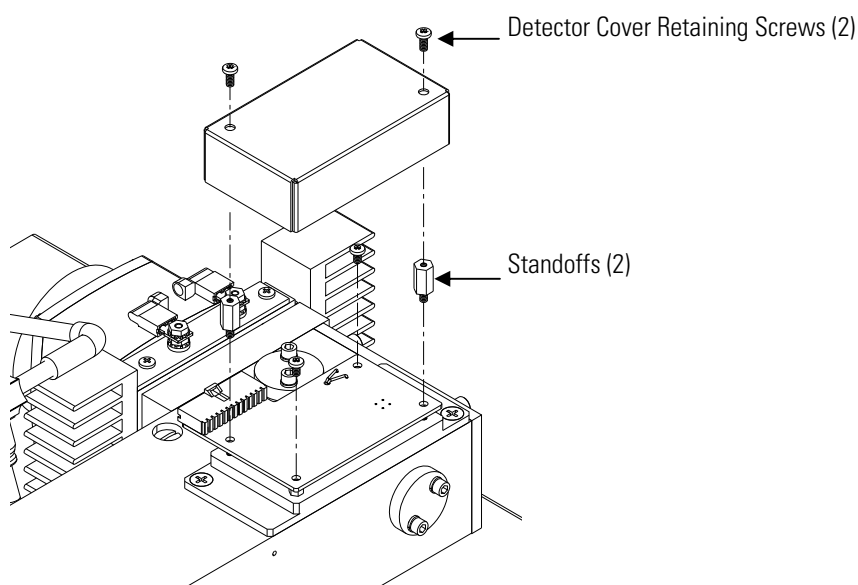


Figure 7-6. Removing the Detector Cover

4. Remove the two standoffs and the two panhead Philips screws ([Figure 7-6](#)).
5. Being careful not to pull the leads off the thermistor or detector, gently pull the detector board assembly straight up to free it from the O-ring seal, position the board to gain access to the thermistor retaining screw, and remove the screw ([Figure 7-7](#)).
6. Place a small amount of heat conductive compound on the underside of the thermistor of the new detector board assembly.
7. Install the new detector board assembly by following this procedure in the reverse order. Be sure that the thermistor wires are inside of the cavity formed by the insulating foam, to avoid pinching the wires.

8. Re-calibrate the instrument.
9. Calibrate the preamp board. Refer to the “[Preamp Board Calibration](#)” procedure that follows.

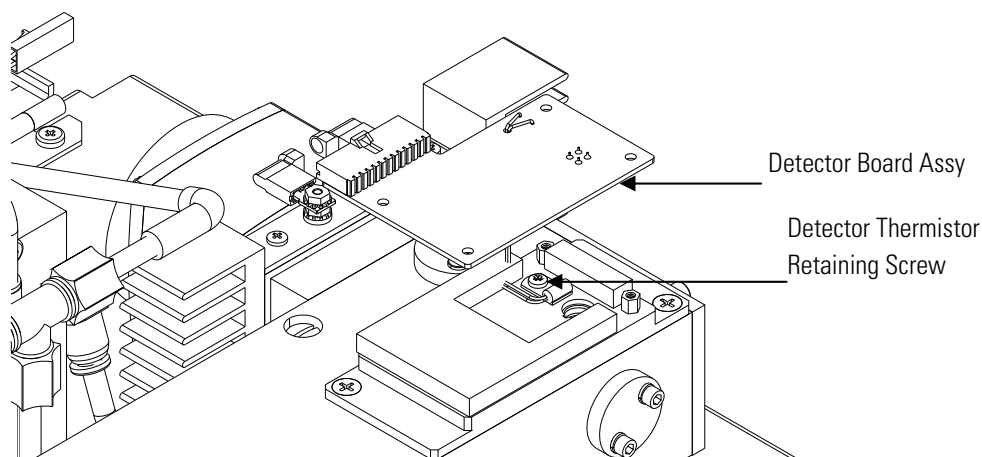






Figure 7-7. Removing the Detector Board Assembly

Preamp Board Calibration






Use the following procedure to calibrate the preamp board after replacing the detector board assembly.

Equipment Damage This adjustment should only be performed by a qualified instrument service technician. ▲

1. Let the instrument sample zero air for about 90 minutes.
2. From the Main Menu, press  to scroll to Service > press  >  to scroll to Preamp Board Calibration > and press .

The Preamp Board Cal screen appears.

Note If the Service menu is not displayed, refer to “[Accessing the Service Level](#)” on page 7-4, then return to the beginning of this step. ▲

3. At the Preamp Board Cal screen, use   to set the Max Count to 52,000 then press  to save the value.

4. Re-calibrate the instrument.

Filter Wheel Motor Replacement

Use the following procedure to replace the filter wheel motor (Figure 7–8).

Equipment Required:

- Filter wheel motor
- Flatblade screwdriver
- Allen wrenches, 5/64-inch, 5/32-inch
- Cutting pliers

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component (Figure 7–1). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.
2. Disconnect the filter wheel motor power cable from the MOT DRV connector on the measurement interface board, disconnect the IR source, the optical pickup cable, and the thermistor/cable assembly. Cut cable ties as necessary.
3. Remove the three motor retaining screws securing the filter wheel motor and wheel assembly to the optical bench (Figure 7–8). Be sure to keep the two spacers for these screws and note their location for reinstallation. Remove the motor and wheel assembly from the measurement case.
4. Remove the two remaining motor retaining screws to remove the housing. Keep the spacers for these and note their location (Figure 7–8).
5. Remove the set screw securing the filter wheel assembly to the motor shaft and remove the filter wheel assembly.

6. Separate the filter wheel motor from the source housing/window assembly by removing the two slotted fillister head screws that secure the motor to the source housing/window assembly (Figure 7–8).

7. Install the new filter wheel motor by following the previous steps in reverse.

Note When installing the filter wheel on the motor shaft, make sure that the set screw seats on the flat of the motor shaft, and then tighten the set screw. ▲

8. Perform the “Chopper Calibration” procedure that follows.

9. Calibrate the instrument. Refer to the “Calibration” chapter in this manual.

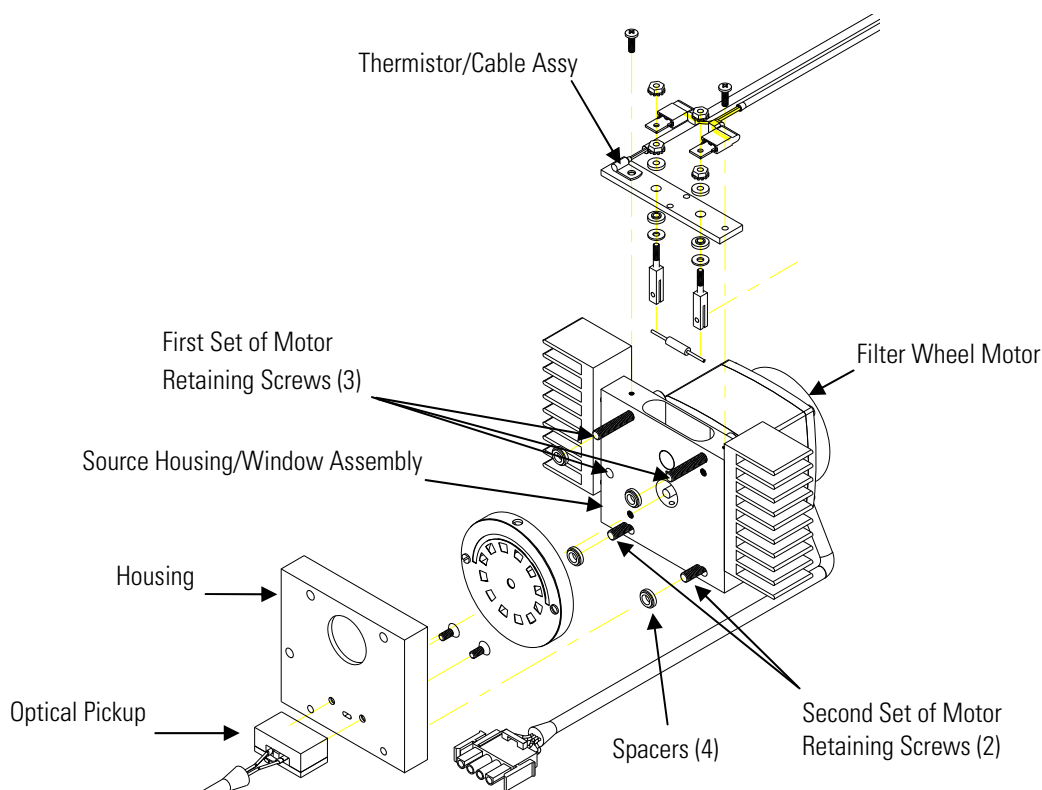


Figure 7–8. Replacing the Filter Wheel Motor

Filter Wheel Replacement

Use the following procedure to replace the filter wheel assembly. Refer to [Figure 7–8](#).

Equipment Required:

Filter wheel assembly
Flatblade screwdriver
Allen wrenches, 5/64-inch, 5/32-inch
Cutting pliers



Important Note The filter wheel replacement should only be performed at a Thermo Fisher Scientific service center so that the new wheel can be characterized. If the wheel is replaced in the field, analytical performance may not meet published specifications. Therefore, this procedure is just to remove and reinstall the same filter wheel. ▲



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component ([Figure 7–1](#)). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.
2. Disconnect the filter wheel motor power cable from the MOT DRV connector on the measurement interface board, disconnect the IR source, optical pickup cable, and the thermistor/cable assembly. Cut cable ties as necessary.
3. Remove the three motor retaining screws securing the filter wheel motor and wheel assembly to the optical bench ([Figure 7–8](#)). Be sure to keep the two spacers for these screws and note their location for reinstallation. Remove the motor and wheel assembly from the measurement case.

4. Remove the two remaining motor retaining screws to remove the housing. Keep the spacers for these and note their location (Figure 7-8).
5. Remove the set screw securing the filter wheel assembly to the motor shaft and remove the filter wheel assembly.
6. Install the new filter wheel by following the previous steps in reverse.

Note When installing the new filter wheel assembly on the motor shaft, make sure that the set screw seats on the flat of the motor shaft, and then tighten the set screw. ▲

7. Perform the “Chopper Calibration” procedure that follows.
8. Perform the “Preamp Board Calibration” procedure on page 7-16.
9. Calibrate the instrument. Refer to the “Calibration” chapter in this manual.






Chopper Calibration

Use the following procedure to adjust the peak offset to zero.

1. From the Main Menu, press  to scroll to Service > press  >  to scroll to **Adjust Peak Offset** > and press .

The Adjust Peak Offset screen appears.

Note If the Service menu is not displayed, refer to “Accessing the Service Level” on page 7-4, then return to the beginning of this step. ▲

2. Use   to change the Window Delay value so that the displayed Peak Offset value is zero. Note that pressing  causes the **Peak Offset** value to **decrease**; pressing  causes the **Peak Offset** value to **increase**.
3. Press  to save the value.

Optical Pickup Replacement

Use the following procedure to replace the optical pickup (Figure 7–8).

Equipment Required:

Optical pickup
Philips screwdriver
Allen wrench, 5/32-inch
Cutting pliers



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component (Figure 7–1). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Disconnect the filter wheel motor power cable from the MOT DRV connector on the measurement interface board, disconnect the IR source, the optical pickup cable, and the thermistor/cable assembly. Cut cable ties as necessary.
3. Remove the three motor retaining screws securing the filter wheel motor and wheel assembly to the optical bench (Figure 7–8). Be sure to keep the two spacers for these screws and note their location for reinstallation. Remove the motor and wheel assembly from the measurement case.
4. Remove the two remaining motor retaining screws to remove the housing and optical pickup. Keep the spacers for these screws and note their location (Figure 7–8).
5. Remove the two screws securing the optical pickup assembly to the housing and remove the optical pickup assembly.

6. Loosen the two screws and remove the cover plate to access the optical pickup. Loosen the screw and washer and remove the optical pickup and cable from the mounting block.
7. Install the new optical pickup assembly by following the previous steps in reverse.
8. Perform the “[Chopper Calibration](#)” procedure described previously.
9. Calibrate the instrument. Refer to the “[Calibration](#)” chapter in this manual.

IR Source Replacement

The IR source control system has been designed to operate the wire wound resistor IR source conservatively in order to increase its life. Nevertheless, the IR source does have a finite life. Since the IR source is relatively inexpensive and easily replaced, it is recommended that the IR source be replaced after one year of continuous use. This will prevent loss of data due to IR source failure. If an IR source is to be replaced on an as needed basis, it should be replaced when:

- There is no light output (as indicated by a loss of reference intensity)
- After cleaning the optics, the preamp board calibration cannot be adjusted up to 50,000 Hz

In addition, it is important to clean the window that lets the infrared light pass through to the bench, each time the IR source is replaced.

Use the following procedure to replace the IR source ([Figure 7–9](#)) and clean the source housing window.

Equipment Required:

IR source
Philips screwdriver, small
Cotton swabs
Distilled water



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component ([Figure 7–1](#)). If an antistatic wrist strap is not available, be sure to touch the instrument chassis

before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.
2. Remove the two cover screws holding the IR source cover to the source housing/window assembly and remove the IR source cover (Figure 7–9). Note that one of these screws secures the thermistor/cable.
3. Using a clean cotton swab moistened with distilled water, insert the swab into the source housing and clean the window by spinning the swab while applying gentle pressure on the window (Figure 7–10). Repeat using a dry cotton swab. Either gently blow compressed air into the housing to dry the window or allow sufficient time to air dry before installing the new IR source.
4. Loosen both clamp screws from the IR source mounting posts and remove IR source (Figure 7–9).
5. Install a new IR source by following the previous steps in reverse. Ensure that the IR source element is evenly spaced between the mounting posts. Allow 24 hours for burn in before continuing with the next step.
6. Perform the the “[Preamp Board Calibration](#)” procedure on page 7-16.
7. Recalibrate the analyzer.

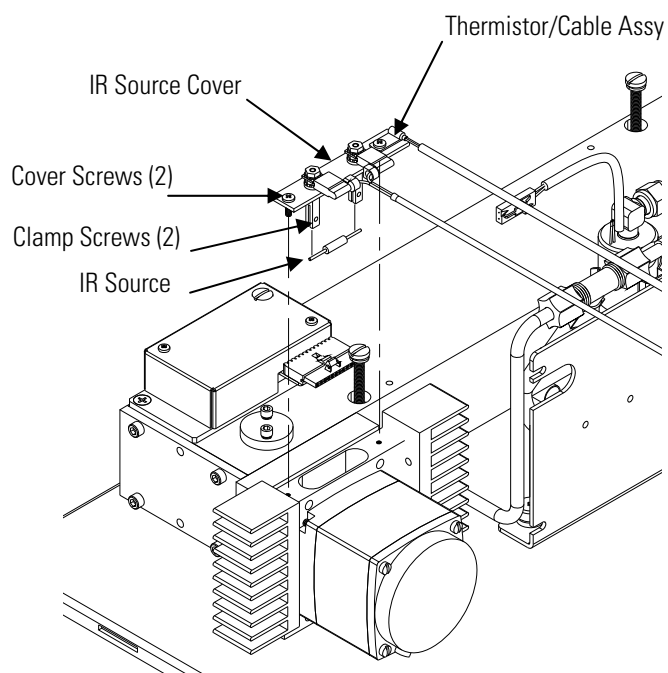


Figure 7-9. Replacing the IR Source

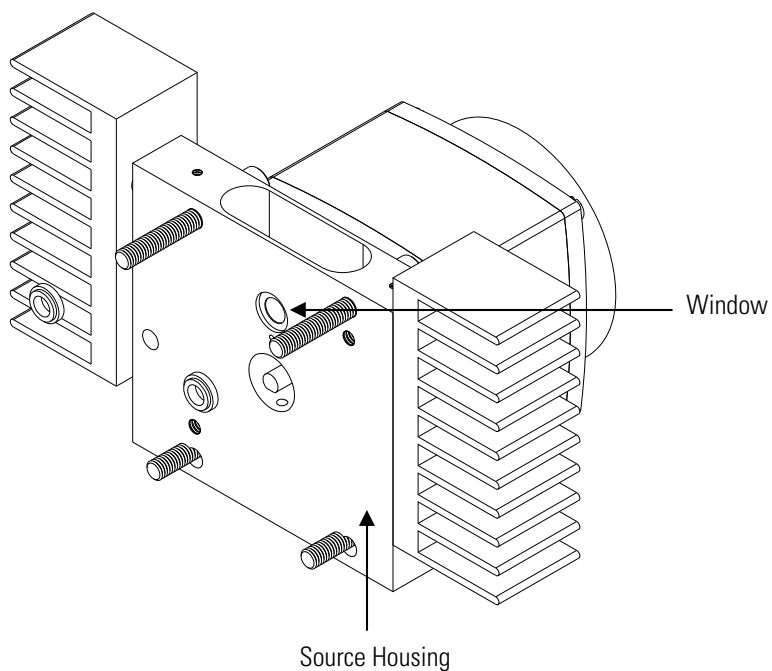


Figure 7-10. Cleaning the IR Source Window

DC Pump Replacement

Use the following procedure to replace the DC pump (Figure 7–11). To rebuild the pump, refer to the “DC Pump Rebuilding” procedure in the “Preventive Maintenance” chapter.

Equipment Required:

- DC pump
- Philips screwdriver, #2
- Cutting pliers



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component (Figure 7–1). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.
2. Disconnect the pump power connector from the DC PUMP connector on the measurement interface board. Cut cable ties as necessary.
3. Loosen the inlet and outlet tubing from the pump (and the capillary if the 60i has an O₂ sensor). Cut tubing ties as necessary.

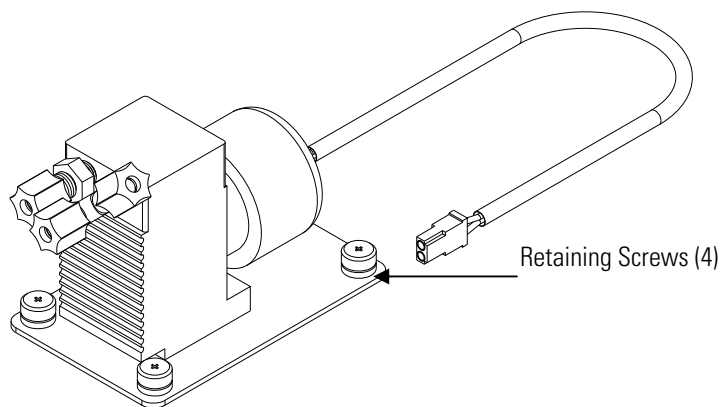


Figure 7–11. Replacing the DC Pump (pump shown is for use with O₂ sensors)

4. Using a #2 Philips screwdriver, loosen the four captive screws and lift the pump from the floorplate.
5. Install the new pump by following this procedure in reverse order.

Pressure Transducer Assembly Replacement

Use the following procedure to replace the pressure transducer assembly (Figure 7–12).

Equipment Required:

Pressure transducer assembly

Wrench, 5/16-inch

Cutting pliers



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Disconnect the soft tube from the pressure transducer assembly.
3. Disconnect the pressure transducer connector from PRES on the measurement interface board. Cut cable ties as necessary.
4. Loosen the two pressure transducer assembly retaining nuts and remove the pressure transducer assembly.

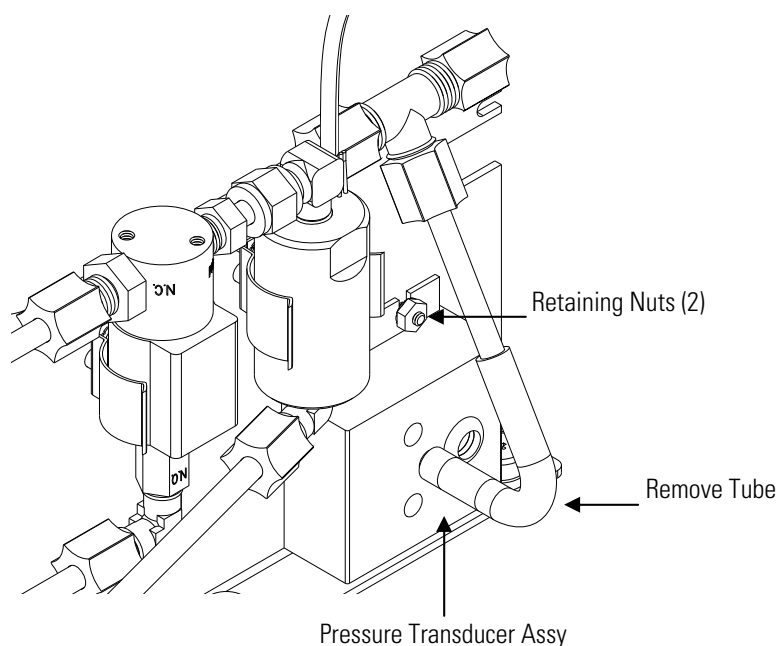


Figure 7–12. Replacing the Pressure Transducer Assembly

5. To install the pressure transducer assembly, follow the previous steps in reverse.
6. Calibrate the pressure transducer. Refer to the “[Pressure Transducer Calibration](#)” procedure that follows.

Pressure Transducer Calibration

Use the following procedure to calibrate the pressure transducer. Refer to “[Pressure Calibration](#)” on page [3-105](#) for additional information.

Notes An error in the zero setting of the pressure transducer does not introduce a measurable error in the output concentration reading. Therefore, if only a barometer is available and not a vacuum pump, adjust only the span setting. ▲

A rough check of the pressure accuracy can be made by obtaining the current barometric pressure from the local weather station or airport and comparing it to the pressure reading. However, since these pressures are usually corrected to sea level, it may be necessary to correct the reading to local pressure by subtracting 0.027 mm Hg per foot of altitude. ▲





Do not try to calibrate the pressure transducer unless the pressure is known accurately. ▲

Equipment Required:

Vacuum pump




Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲





1. Remove the cover.
2. Disconnect the tubing from the pressure transducer and connect a vacuum pump known to produce a vacuum less than 1 mm Hg.
3. From the Main Menu, press  to scroll to Service > press  >  to scroll to Pressure Calibration > and press .





The Pressure Sensor Cal screen appears.

Note If the Service menu is not displayed, refer to “[Accessing the Service Level](#)” on page 7-4, then return to the beginning of this step. ▲

4. At the Pressure Sensor Cal screen, press  to select Zero.

The Calibrate Pressure Zero screen appears.

5. Wait at least 30 seconds for the zero reading to stabilize, then press  to save the zero pressure value.
6. Slowly relieve the vacuum and disconnect the pump from the pressure transducer.
7. Press  to return to the Pressure Sensor Cal screen.
8. At the Pressure Sensor Cal screen, press   to select Span.
The Calibrate Pressure Span screen appears.

9. Wait at least 30 seconds for the ambient reading to stabilize, use  and   to enter the known barometric pressure, and press  to save the pressure value.
10. Reconnect the instrument tubing to the pressure transducer.
11. Install the cover.

3-Way Cal Solenoid/Flow Switch Replacement

Use the following procedure to replace the 3-way cal solenoid/flow switch assembly (Figure 7-13).

Equipment Required:

- 3-way cal solenoid/flow switch assembly
- Cutting pliers
- Adjustable wrench



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Disconnect the 3-way cal solenoid/flow switch assembly from the Z/S (or CAL PATH) connector and disconnect the cal flow switch cable from the CAL FLOW SW connector on the measurement interface board. Cut the cable ties as appropriate.
3. Disconnect the tubing from the Kynar fittings, then unsnap the assembly from the two spring clips on the bracket (Figure 7-13). Note the location of each tubing segment to aid in reconnection.
4. To install the 3-way cal solenoid/flow switch assembly, follow the previous steps in reverse.

Servicing

Sample Flow Switch Replacement

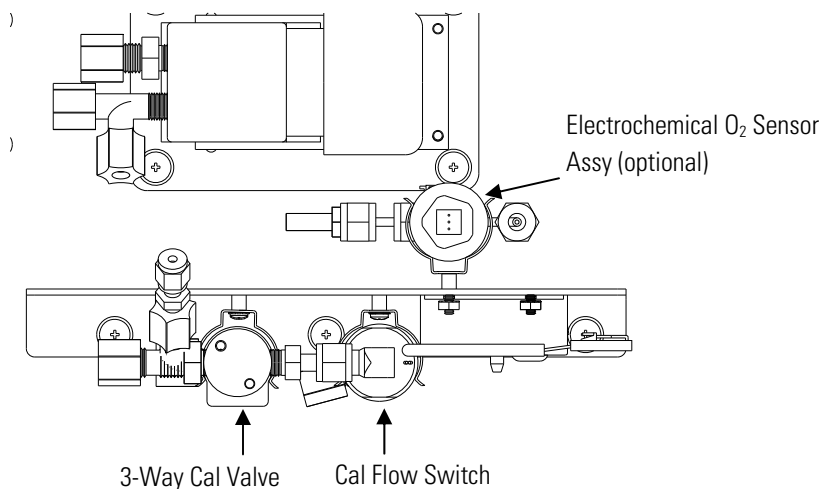


Figure 7-13. Replacing the 3-Way Cal Solenoid/Flow Switch Assembly and Electrochemical Oxygen Sensor

Sample Flow Switch Replacement

Use the following procedure to replace the sample flow switch (Figure 7-14).

Equipment Required:

Sample flow switch

Cutting pliers

Open-end wrench, 9/16-inch



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Disconnect the sample flow switch cable from the FLOW connector on the measurement interface board (Figure 7-14). Cut the sample flow switch cable ties as appropriate.

3. Disconnect the tubing on the bottom of the flow switch from the outlet of the pump, then disconnect the sample flow switch from the stainless steel fitting on the rear panel using a 9/16-inch open end wrench. Remove the assembly.
4. To install the sample flow switch, follow the previous steps in reverse.

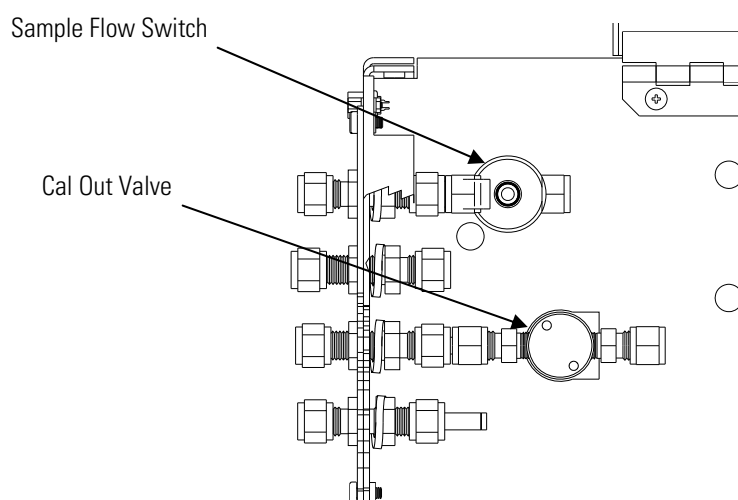


Figure 7–14. Replacing the Sample Flow Switch or the Cal Out Valve

2-Way Cal Out Solenoid Replacement

Use the following procedure to replace the 2-way cal out solenoid valve (Figure 7–14).

Equipment Required:

- 2-way cal out solenoid valve assembly
- Cutting pliers
- Open-end wrench, 9/16-inch



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.

2. Disconnect the cal out valve cable from the SAMPLE connector on the measurement interface board (Figure 7–14). Cut the cable ties as appropriate.
3. Disconnect the tubing from the cal out valve using a 9/16-inch open-end wrench, then disconnect the cal out valve from the stainless steel fitting.
4. To install the 2-way cal out solenoid valve, follow the previous steps in reverse.

Electrochemical Oxygen Sensor Replacement

Use the following procedure to replace the optional electrochemical oxygen sensor (Figure 7–13).

Equipment Required:

Electrochemical oxygen sensor



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Disconnect the electrochemical oxygen sensor cable from the top of the oxygen sensor (Figure 7–13).
3. Unscrew the electrochemical oxygen sensor and remove it from the fitting.
4. Install the new electrochemical oxygen sensor by screwing it in by hand. Do not overtighten, the O-ring seal is sufficient. Reconnect the oxygen sensor cable.
5. After the electrochemical oxygen sensor has been replaced, it must be recalibrated one time using the “Oxygen Sensor Calibration” procedure that follows. Note that this is different than the normal oxygen calibration.

Paramagnetic Oxygen Sensor Replacement

Use the following procedure to replace the optional paramagnetic oxygen sensor (Figure 7–15).

Equipment Required:

- Paramagnetic oxygen sensor assembly
- Philips screwdriver
- 2 open end wrenches, 7/16-inch



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Using the wrenches, loosen the nuts on the inlet and outlet tubes of the sensor to remove the stainless steel fittings.
3. Using the Philips screwdriver, loosen the three captive screws to remove the sensor from the floorplate.
4. Carefully lift the oxygen sensor out of the instrument and disconnect the ribbon cable. Note the orientation to facilitate reconnection.
5. Install the new oxygen sensor by following this procedure in reverse order.
6. After the oxygen sensor has been replaced, it must be recalibrated one time using the “[Oxygen Sensor Calibration](#)” procedure that follows. Note that this is different than the normal oxygen calibration.

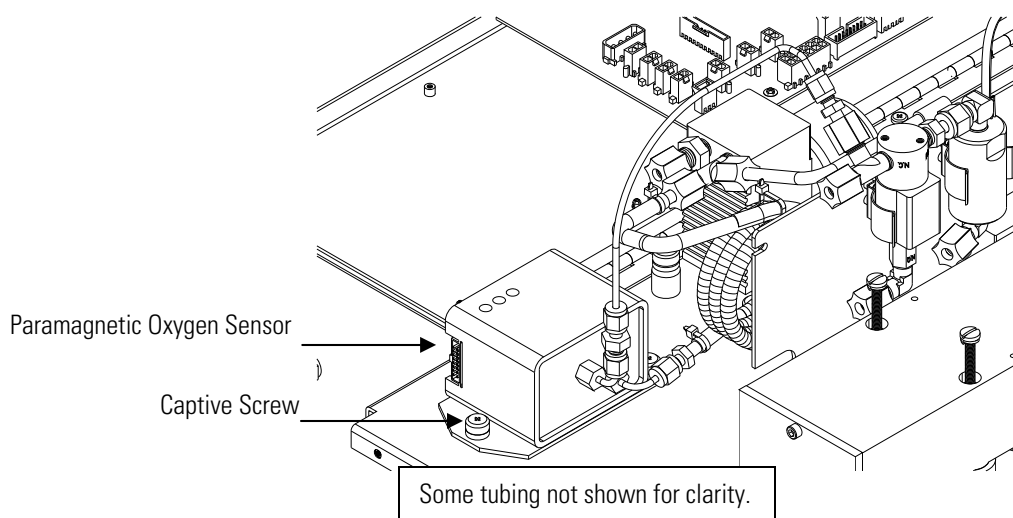


Figure 7-15. Replacing the Paramagnetic Oxygen Sensor

Oxygen Sensor Calibration

After the oxygen sensor has been replaced, this calibration procedure must be performed once. This procedure is used for calibrating both the electrochemical and paramagnetic oxygen sensors, with slight variations noted for each.

Equipment Required:

A source of UHP nitrogen to zero the sensor. (One of the other span gases that is prepared in a nitrogen balance can be used.)

Small slotted screwdriver (for paramagnetic calibration only)




Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. If calibrating the paramagnetic sensor, remove the cover.
2. Make sure the instrument is in Service mode, then go to the Service menu.
3. Provide 100% nitrogen to the sample port of the instrument. Wait at least 5 minutes for the reading to stabilize. Go to the O₂ Sensor Calibration > Zero screen to read the measurement.

4. For the **paramagnetic sensor only**, use a screwdriver to adjust the zero pot on the O₂ sensor so the measurement reads 10 mV.


For the **electrochemical sensor only**, make sure the measurement reads < 1 mV.

Press  for either sensor to save the zero calibration.

5. Provide 20.9% oxygen to the sample port of the instrument. Wait at least 5 minutes for the reading to stabilize. Make sure to use room air not zero air through a Balston air dryer because the dryer varies the O₂ content. Go to the O₂ Sensor Calibration > Span screen to read the measurement.

6. For the **paramagnetic sensor only**, use a screwdriver to adjust the coarse span and fine span pots on the O₂ sensor so the measurement reads 210 mV.

For the **electrochemical sensor only**, make sure the measurement reads > 9 mV.

Press  for either sensor to save the span calibration.

Fan Replacement

Use the following procedure to replace the fan ([Figure 7-16](#)).

Equipment Required:

Fan

Philips screwdriver



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Remove the fan guard (and filter) from the rear of the instrument by unsnapping it.
3. Disconnect the fan power cable from the fan.

4. Remove the four fan mounting screws along with nuts and washers, and remove the fan.
5. Install a new fan following the previous steps in reverse order.

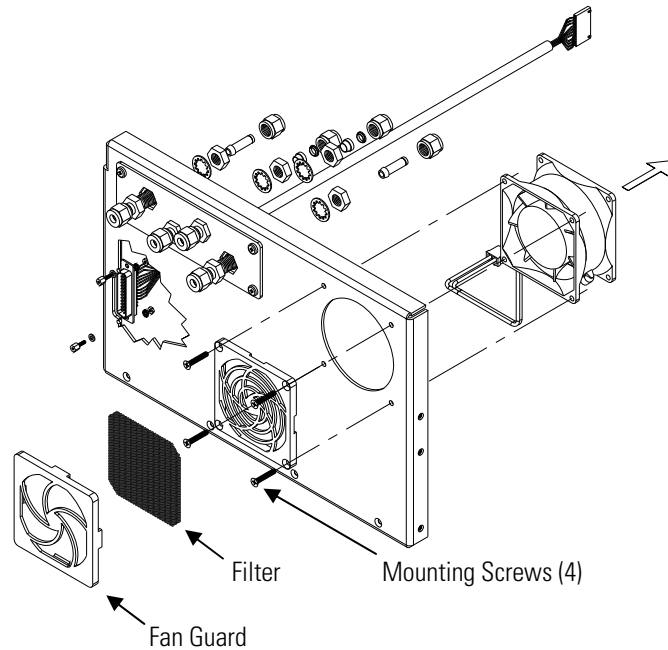


Figure 7–16. Replacing the Fan

DC Power Supply Replacement

Use the following procedure to replace the DC power supply ([Figure 7–17](#)).

Equipment Required:

DC power supply

Philips screwdriver



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component ([Figure 7–1](#)). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.

2. Disconnect all the power supply electrical connections. Note connector locations to facilitate re-connection.
3. Loosen the captive screw securing the power supply to the chassis plate and shift the power supply slightly toward the rear panel, then lift out the power supply.

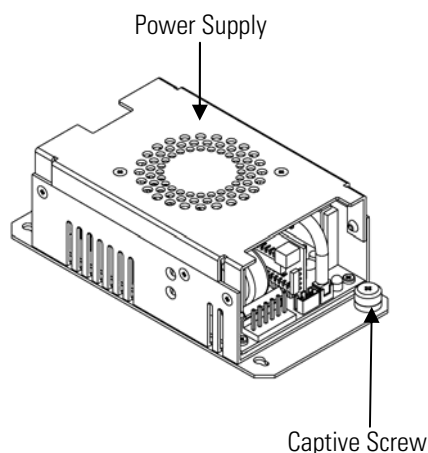


Figure 7–17. Replacing the DC Power Supply

4. Remove the four screws holding the mounting bracket to the power supply. Note orientation of the power supply on the mounting bracket to facilitate remounting.
5. To install the DC power supply, follow the previous steps in reverse.






Analog Output Testing

The analog outputs should be tested if the concentration value on the front panel display disagrees with the analog outputs. To check the analog outputs, connect a meter to an analog output channel (voltage or current) and compare the meter reading with the output value set on the Test Analog Outputs screen.

Equipment Required:

Multimeter

Use the following procedure to test the analog outputs.

1. Connect a meter to the channel to be tested. [Figure 7–18](#) shows the analog output pins and [Table 7–4](#) identifies the associated channels.
2. From the Main Menu, choose Diagnostics > **Test Analog Outputs**.
The Test Analog Outputs screen appears.
3. Press  to scroll to the desired channel corresponding to the rear panel terminal pins where the meter is connected, and press .
The Set Analog Outputs screen appears.
4. Press  to set the output to zero.
The “Output Set To” line displays Zero.
5. Check that the meter is displaying the zero value. If the meter reading differs by more than one percent of the full-scale output, the analog outputs should be adjusted. Refer to the “[Analog Output Calibration](#)” procedure that follows.
6. Press  to set the output to full scale.
The “Output Set To” line displays full scale.
7. Check that the meter is displaying a full-scale value. Note that the full-scale output may be configured to 1V, 5V, 10V or 100mV. If the meter reading differs by more than one percent of the full-scale output, the analog outputs should be adjusted. Refer to the “[Analog Output Calibration](#)” procedure that follows.
8. Press  to reset the analog outputs to normal.

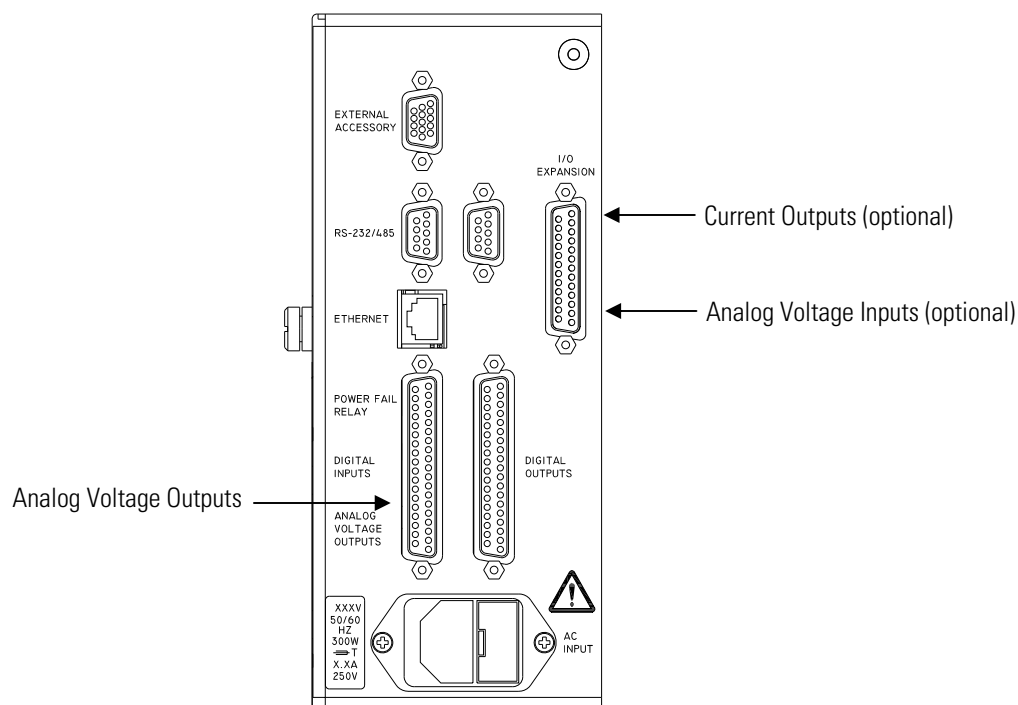


Figure 7–18. Rear Panel Analog Input and Output Pins

Note The pin numbers on the connector do not match the pin numbers on the terminal boards. Refer to [Table 2–2](#), [Table 2–3](#), and [Table 2–4](#) for information on the pin to terminal board relationship. ▲

Table 7–4. Analog Output Channels and Rear Panel Pin Connections

Voltage Channel	Pin	Current Channel	Pin
1	14	1	15
2	33	2	17
3	15	3	19
4	34	4	21
5	17	5	23
6	36	6	25
Ground	16, 18, 19, 35, 37	Current Output Return	13, 16, 18, 20, 22, 24

Table 7–5. Analog Input Channels and Rear Panel Pin Connections

Input Channel	Pin
1	1
2	2
3	3
4	5
5	6
6	7
7	9
8	10
Ground	4, 8, 11, 14

Analog Output Calibration

Use the following procedure to calibrate the analog outputs if a meter reading in the “Analog Output Testing” procedure differed by more than one percent or after replacing the optional I/O expansion board. Also refer to “[Analog Output Calibration](#)” on page 3-110.




Equipment Required:

Multimeter

1. Connect a meter to the channel to be adjusted and set to voltage or current as appropriate. [Figure 7–18](#) shows the analog output pins and [Table 7–4](#) identifies the associated channels.
2. From the Main Menu, choose Service > **Analog Out Cal.**










The Analog Output Cal screen appears.

Note If the Service menu is not displayed, refer to “[Accessing the Service Level](#)” on page 7-4, then return to the beginning of this step. ▲

3. At the Analog Output Cal menu, press  to scroll to the desired voltage channel or current channel corresponding to the rear panel terminal pin where the meter is connected, then press .
4. With the cursor at Calibrate Zero, press .

The Analog Output Cal line displays Zero.

Note When calibrating the analog output, always adjust zero first and then adjust full scale. ▲

5. Use   until the meter reads the value shown in the Set Output To line (0.0 V, or 0.0 or 4.0 mA), then press  to save the value.
6. Press  to return to the previous screen.
7. Press   to select Calibrate Full Scale.
8. Use   until the meter reads the value shown in the Set Output To line, then press  to save the value.

Analog Input Calibration

Use the following procedures to calibrate the analog inputs after replacing the optional I/O expansion board. These procedures include selecting analog input channels, calibrating them to zero volts, and then calibrating them to full scale using a known voltage source. Also refer to “[Analog Input Calibration](#)” on page 3-114.





Calibrating the Input Channels to Zero Volts

Use the following procedure to calibrate the input channels to zero volts.



1. From the Main Menu, choose Service > **Analog Input Cal.**

The Analog Input Cal screen appears.

Note If the Service menu is not displayed, refer to “[Accessing the Service Level](#)” on page 7-4, then return to the beginning of this step. ▲

2. At the Analog Input Cal screen, press  to scroll to a channel, and press .
 3. With the cursor at Calibrate Zero, press .
- The screen displays the input voltage for the selected channel.
4. Make sure that nothing is connected to the channel input pins and press  to calibrate the input voltage on the selected channel to zero volts.

The screen displays 0.00 V as the voltage setting.












5. Press  >  to return to the Analog Input Cal screen and repeat Steps 2 through 4 to calibrate other input channels to zero as necessary.
6. Continue with the “[Calibrating the Input Channels to Full Scale](#)” procedure that follows.

Calibrating the Input Channels to Full Scale

Use the following procedure to calibrate the input channels to full scale by applying a known voltage to the channels.

Equipment Required:

DC voltage source (greater than 0 volts and less than 10 volts)

1. Connect the known DC voltage source to the input channel (1-8) to be calibrated. [Figure 7-18](#) shows the analog input pins and [Table 7-5](#) identifies the associated channels.
2. From the Main Menu, choose Service > **Analog Input Cal.**
The Analog Input Cal screen displays input channels 1-8.
3. At the Analog Input Cal screen, press  to scroll to the channel selected in Step 1, and press .
4. Press  to scroll to Calibrate Full Scale, and press .
The screen displays the input voltage for the selected channel.
5. Use   and   to enter the source voltage, and press  to calibrate the input voltage for the selected channel connected to the source voltage.
6. Press  >  to return to the input channels display and repeat Steps 1-5 to calibrate other input channels to the source voltage as necessary.

Source Temperature Thermistor/Cable Assembly Replacement

Use the following procedure to replace the source temperature thermistor/cable assembly ([Figure 7–19](#)).

Equipment Required:

Thermistor/cable assembly

Phillips screwdriver



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component ([Figure 7–1](#)). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.
2. Squeeze the connector latch and pull the thermistor/cable assembly from the connector on the measurement interface board. (Note which connector it is for re-installation.)
3. Unscrew thermistor from the source housing/window assembly using the Phillips screwdriver and remove it.
4. Remove excess heat sink grease from old thermistor and coat the underside of the new thermistor.
5. Mount the new thermistor/cable assembly to the motor plate and plug the connector into the connector on the measurement interface board.
6. Perform a source temperature calibration as noted in the next section “[Source Temperature Calibration](#)”.

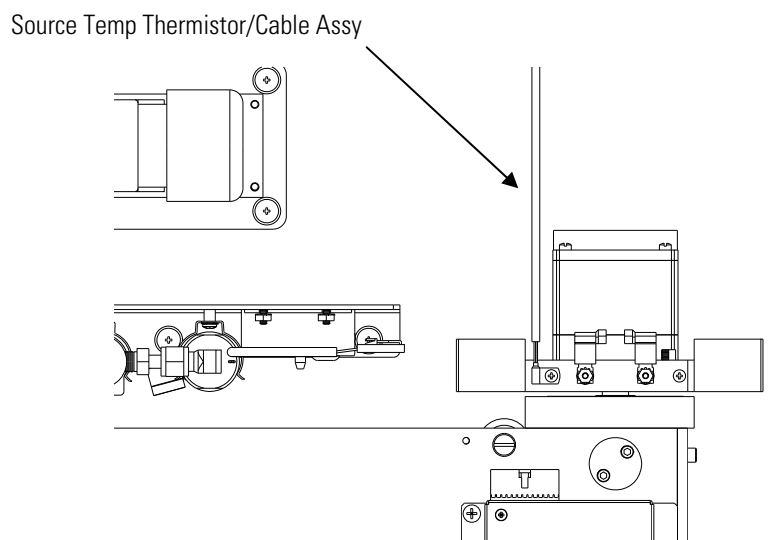


Figure 7–19. Replacing the Source Housing Thermistor Cable Assembly

Source Temperature Calibration

Use the following procedure to calibrate the thermistor that measures the temperature at the source housing.

Equipment Required:

Calibrated thermometer or 10 k Ω \pm 1% resistor



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component (Figure 7–1). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Remove the instrument cover.
2. Tape the thermometer to the thermistor, which is plugged into the measurement interface board (Figure 7–19).






Note Since the thermistors are interchangeable to an accuracy of ± 0.2 °C, and have a value of 10 k Ω at 25 °C, an alternate procedure is to connect an accurately known 10 k Ω resistor to the thermistor input connector on the measurement interface board (labelled SH Temp, AMB Temp on older models), and enter the temperature reading. ▲

A one °C change corresponds to a $\pm 5\%$ change in resistance, thus this alternative procedure can be quite accurate as a check; however, it clearly is not NIST traceable. ▲

3. From the Main Menu, choose Service > **Source Temp Calibration**.

The Calibrate Source Temp screen appears.

Note If the Service menu is not displayed, refer to “[Accessing the Service Level](#)” on page 7-4, then return to the beginning of this step. ▲

4. Wait at least 10 seconds for the reading to stabilize, use   and   to enter the known temperature, and press  to save the temperature value.

5. Install the cover.

Ambient Temperature Thermistor Assembly Replacement

Use the following procedure to replace the ambient temperature thermistor assembly (if the instrument is equipped with an internal ambient temperature thermistor).

Equipment Required:

Thermistor assembly



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component ([Figure 7-1](#)). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.
2. Squeeze the connector latch and pull the ambient thermistor assembly from the AMB TEMP connector on the measurement interface board. (Note which connector it is for re-installation.)
3. Insert the new internal thermistor assembly into the connector.

4. Perform an internal temperature calibration as noted in the next section “[Internal Temperature Calibration](#)”.

Internal Temperature Calibration

Use the following procedure to calibrate the ambient temperature thermistor for the instrument.

Equipment Required:

Calibrated thermometer or $10\text{ k}\Omega \pm 1\%$ resistor



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component ([Figure 7-1](#)). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲






1. Remove the instrument cover.
2. Tape the thermometer to the thermistor, which is plugged into the measurement interface board.

Note Since the thermistors are interchangeable to an accuracy of $\pm 0.2\text{ }^{\circ}\text{C}$, and have a value of $10\text{ k}\Omega$ at $25\text{ }^{\circ}\text{C}$, an alternate procedure is to connect an accurately known $10\text{ k}\Omega$ resistor to the thermistor input (AMB TEMP), on the measurement interface board, and enter the temperature reading. ▲

A one $^{\circ}\text{C}$ change corresponds to a $\pm 5\%$ change in resistance, thus this alternative procedure can be quite accurate as a check; however, it clearly is not NIST traceable. ▲

3. From the Main Menu, choose Service > **Internal Temp Calibration**.
The Calibrate Internal Temp screen appears.

Note If the Service menu is not displayed, refer to “[Accessing the Service Level](#)” on page 7-4, then return to the beginning of this step. ▲

4. Wait at least 10 seconds for the reading to stabilize, use   and   to enter the known temperature, and press  to save the temperature value.

5. Install the cover.

Fuse Replacement

Use the following procedure to replace the fuses.

Equipment Required:

Replacement fuses (refer to the “[Replacement Parts List](#)” in this chapter). Be sure to use the correct fuses for the appropriate voltage.

1. Turn the instrument Off and unplug the power cord.
2. Remove the fuse drawer, located on the AC power connector.
3. If either fuse is blown, replace both fuses.
4. Insert fuse drawer and re-connect power cord.

I/O Expansion Board Replacement

Use the following procedure to replace the I/O expansion board ([Figure 7–20](#)).

Equipment Required:

I/O expansion board

Nut driver, 3/16-inch



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component ([Figure 7–1](#)). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument Off, unplug the power cord, and remove the cover.
2. Unplug the I/O expansion board cable from the EXPANSION BD connector on the motherboard.
3. Remove the two standoffs holding the I/O expansion board connector to the rear panel ([Figure 7–21](#)).

4. Pop the board off of the mounting studs and remove the board.
5. To install the I/O expansion board, follow the previous steps in reverse.
6. Calibrate the analog current outputs and analog voltage inputs as defined earlier in this chapter.

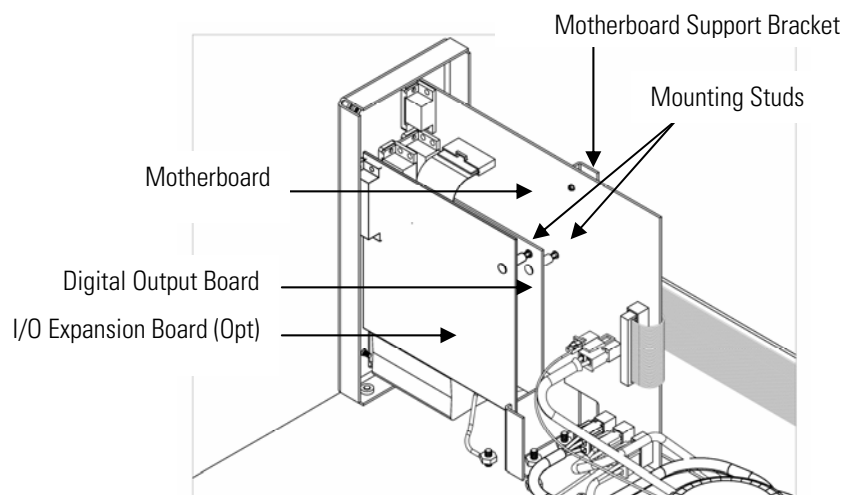


Figure 7–20. Replacing the I/O Expansion Board (Optional)

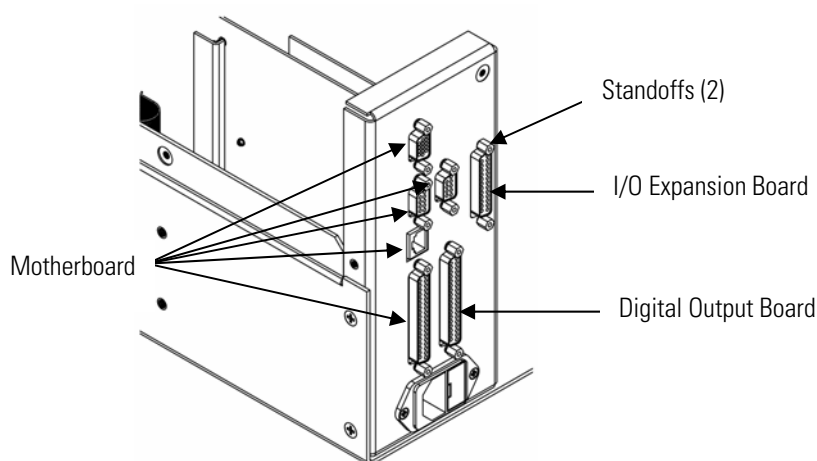


Figure 7–21. Rear Panel Board Connectors

Digital Output Board Replacement

Use the following procedure to replace the digital output board (Figure 7–19).

Equipment Required:

Digital output board

Nut driver, 3/16-inch



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Remove the I/O expansion board, if present.
3. Disconnect the digital output board ribbon cable from the motherboard.
4. Using the nut driver, remove the two standoffs securing the board to the rear panel.
5. Pop off the digital output board from the mounting studs and remove the board.
6. To install the digital output board, follow previous steps in reverse.

Motherboard Replacement

Use the following procedure to replace the motherboard (Figure 7–19).

Equipment Required:

Motherboard

Philips screwdriver

Nut driver, 3/16-inch



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must

be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Remove the I/O expansion board (optional), if used. See the “[I/O Expansion Board Replacement](#)” procedure in this chapter.
3. Remove the digital output board. See the “[Digital Output Board Replacement](#)” procedure in this chapter.
4. Unplug all connectors from the motherboard. Note connector locations to facilitate reconnection.
5. Using the nut driver, remove the standoffs securing the board to the rear panel.
6. Pop off the motherboard from motherboard support bracket, and remove the motherboard.
7. To install the motherboard, follow previous steps in reverse.
8. Calibrate the analog voltage outputs as described previously in this chapter (all ranges).

Measurement Interface Board Replacement

Use the following procedure to replace the measurement interface board ([Figure 7–22](#)).

Equipment Required:

Measurement interface board

Philips screwdriver

Small flat blade screwdriver



Important Note The wheel characterization chip on the interface board contains critical parameters that describe the analyzer’s unique hardware set and optical properties. If the interface board is replaced, the chip must be

transferred from the failed board to the new board. If the chip is lost or damaged, the entire analyzer will need to be returned to a Thermo Fisher Scientific service center to be re-tested. ▲



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Refer to “[Removing the Measurement Case Assembly and Lowering the Partition Panel](#)” in this chapter to lower the partition panel, then proceed to the next step below.
2. Unplug all connectors. Note the locations of the connectors to facilitate reconnection.

IMPORTANT Observe the orientation of the chip (U9) in the socket, and insert the small flat blade screwdriver under the chip and gently pry upwards going from one end of the chip to the other until the chip is free. ▲

3. Unscrew the two screws at the top of the measurement interface board. Pop off the measurement interface board from the two bottom mounting studs and remove the board ([Figure 7–22](#)).
4. Position the chip in the proper orientation over the socket on the new measurement interface board and apply a gentle uniform pressure to the chip until it is fully seated in the socket.
5. To install the measurement interface board, follow previous steps in reverse.
6. Re-install the measurement case. Refer to “[Removing the Measurement Case Assembly and Lowering the Partition Panel](#)” in this chapter.

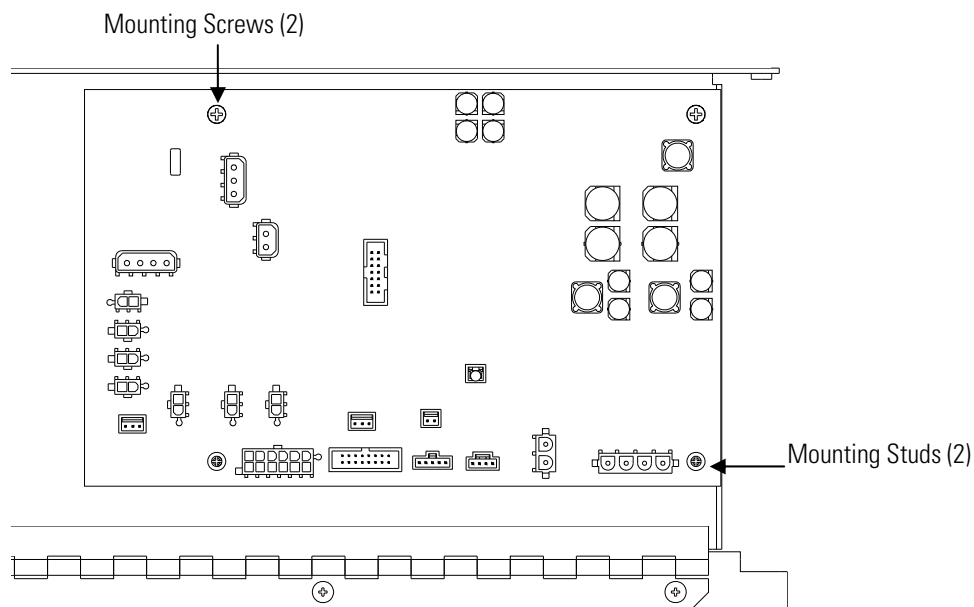


Figure 7–22. Replacing the Measurement Interface Board

Front Panel Board Replacement

Use the following procedure to replace the front panel board ([Figure 7–23](#)).

Equipment Required:

Front panel board



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Remove the three ribbon cables and the two-wire connector from the front panel board.
3. Pop off the board from the two top mounting studs and remove the board by lifting it up and off the slotted bottom support.
4. Replace the front panel board by following previous steps in reverse.

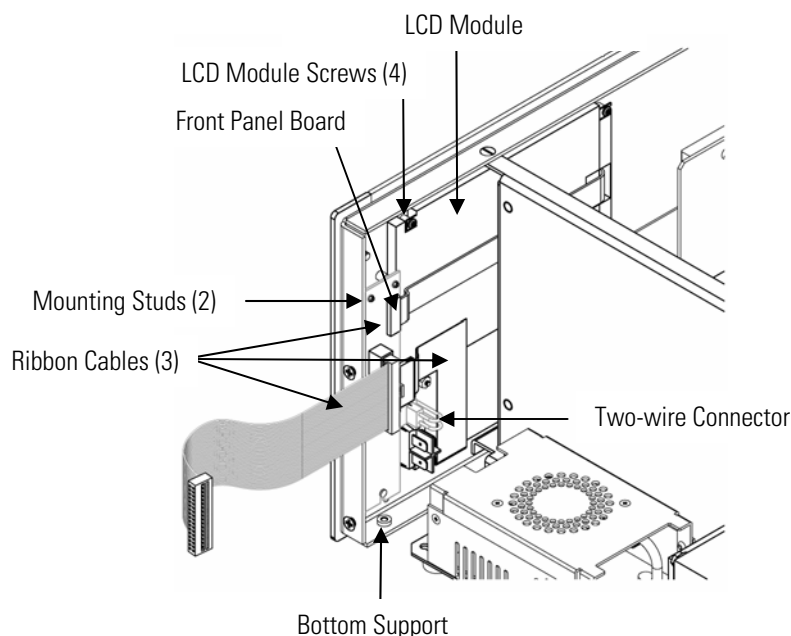


Figure 7–23. Replacing the Front Panel Board and the LCD Module

LCD Module Replacement

Use the following procedure to replace the LCD module ([Figure 7–23](#)).

Equipment Required:

LCD module

Philips screwdriver



CAUTION If the LCD panel breaks, do not let the liquid crystal contact your skin or clothes. If the liquid crystal contacts your skin or clothes, wash it off immediately using soap and water. ▲



Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

Do not remove the LCD panel or frame from the LCD module. ▲

The LCD polarizing plate is very fragile, handle it carefully. ▲

Do not wipe the LCD polarizing plate with a dry cloth, it may easily scratch the plate. ▲

Do not use alcohol, acetone, MEK or other Ketone based or aromatic solvents to clean the module. Use a soft cloth moistened with a naphtha cleaning solvent. ▲

Do not place the LCD module near organic solvents or corrosive gases. ▲

Do not shake or jolt the LCD module. ▲

1. Turn instrument Off, unplug the power cord, and remove the cover.
2. Disconnect the ribbon cable and the two-wire connector from the front panel board.
3. Remove the four screws at the corners of the LCD module.
4. Slide the LCD module out towards the center of the instrument.
5. Replace the LCD module by following previous steps in reverse.

Note The optimal contrast will change from one LCD screen to another. After replacing the LCD screen, the contrast may need to be reset. If the content on the screen is visible, select Instrument Controls > **Screen Contrast** and adjust the screen contrast. If the content on the screen is not visible, use the “set contrast” C-Link command to set screen contrast to mid range, then optimize the contrast. See the “[C-Link Protocol Commands](#)” appendix for more information on this command. ▲

Service Locations

For additional assistance, worldwide service is available from Thermo Fisher Scientific. Contact us at one of the phone numbers below for product support and technical information or visit us on the web at www.thermo.com/aqi.

Toll Free U.S. only 1-866-282-0430

U.S., Latin America, and Canada 1-508-520-0430

Europe +31 76 579 5555

China +86 10 8419 3588

Asia Pacific +91 22 27781102

Chapter 8

Component Description

This chapter describes the function and location of the hardware components, provides an overview of the firmware structure, and includes a description of the system electronics and input/output connections and functions.

- “[Hardware](#)” on page 8-1
- “[Firmware](#)” on page 8-7
- “[Electronics](#)” on page 8-8
- “[I/O Components](#)” on page 8-11

Hardware

Model 60i hardware components ([Figure 8-1](#)) include:

- Optical bench
 - Infrared source
 - Entrance mirror
 - Exit mirror
 - Field mirror
 - CaF₂ window assembly
 - Relay mirror
 - Aperture
 - Optical pickup
 - Bench Heater assembly
 - Bench Thermistor assembly
- Filter wheel assembly
 - Filter wheel
 - Chopper
 - Filter wheel/chopper motor
 - Source Housing thermistor/cable assembly

Component Description

Hardware

- Detector and pre-amplifier assembly
 - Detector
 - Pre-amplifier assembly
 - Detector thermistor
- Sample flow switch
- Electrochemical oxygen sensor (optional)
- Paramagnetic oxygen sensor (optional)
- O₂ sensor capillary
- 3-Way cal valve
- 2-Way cal out valve
- Cal flow switch
- Pressure transducer
- Capillary
- DC pump
- Fan

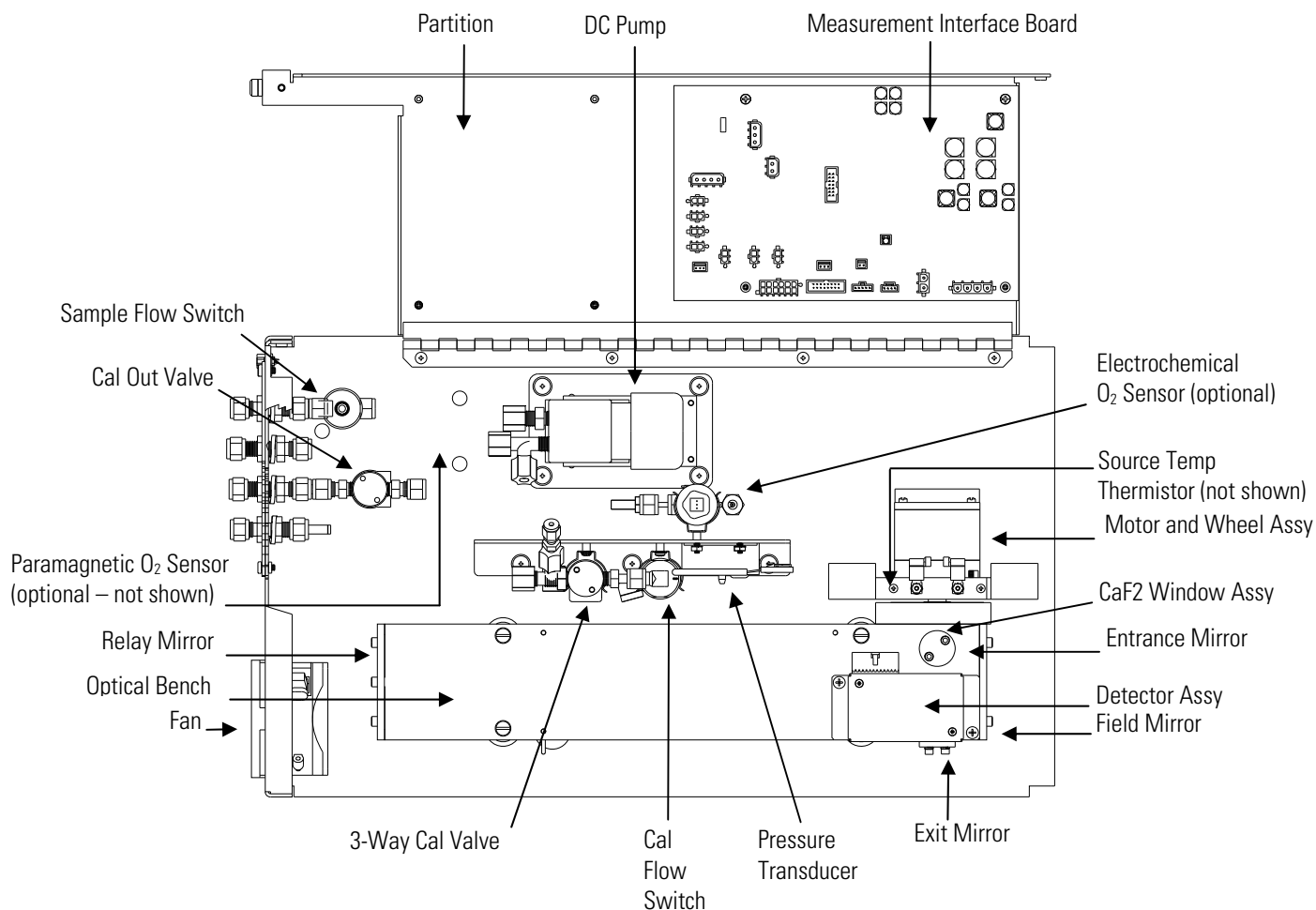


Figure 8–1. Hardware Components

Optical Bench

The optical bench is an airtight chamber that contains the sample gas. The bench includes mirrors that cause the infrared light from the infrared source to pass through the sample gas multiple times before reaching the infrared detector.

Infrared Source

The infrared source is a special wire-wound resistor operated at high temperature to create infrared radiation.

Aperture

Located adjacent to the window, the aperture allows a fixed portion of the source energy to pass through.

CaF₂ Window Assembly	Located in the side of the bench, the window allows IR energy from the source to reach the entrance mirror.
Entrance Mirror	Reflects the IR energy from the source at a 90 degree angle toward the relay mirror.
Relay Mirror	The relay mirror and the field mirror cause IR energy from the source to pass through the sample gas multiple times before it reaches the detector.
Field Mirror	See “ Relay Mirror ” described previously.
Exit Mirror	The exit mirror directs the residual IR energy to the detector.
Optical Pickup	The optical pickup detects the position of the filter wheel, provides synchronizing signals for the signal demodulation, and provides a method for checking the filter wheel/chopper motor speed.
Bench Heater Assembly	The bench heater assembly consists of four cartridge heaters that maintain the optical bench at a constant temperature.
Bench Thermistor Assembly	The bench thermistor assembly contains a thermistor that is inserted into the bench, which provides temperature feedback to the analyzer to help maintain a constant bench temperature.
Filter Wheel Assembly	The filter wheel assembly includes the filter wheel/chopper and chopper motor.

Filter Wheel/Chopper	The filter wheel contains filters that selectively pass a wavelength that the target compounds will absorb. The chopper disk rotates along with the filter wheel to periodically interrupt the radiation and create a modulated signal.
Chopper Motor	The chopper motor spins the filter wheel and chopper disk at a uniform speed.
Source Housing Thermistor/Cable Assembly	The source housing thermistor/cable assembly monitors the temperature of the infrared source, which is used to control the fan speed.
Detector and Pre-amplifier Assembly	The detector and pre-amplifier assembly includes an infrared detector, a pre-amplifier, an analog-to-digital converter, and a thermistor.
Infrared Detector	The infrared detector detects the energy of the infrared light passing through the optical bench.
Pre-amplifier Assembly	The pre-amplifier assembly amplifies the pulsating signal from the infrared detector. For detailed description, refer to “ Pre-amp Board Assembly ” on page 8-10.
Detector Thermistor	The detector thermistor measures the temperature of the detector assembly.
Sample Flow Switch	The sample flow switch is used to monitor the flow of sample through the optical bench. When sample does not flow at the proper rate, the condition triggers a low Sample Flow alarm.
Oxygen Sensor (optional)	The optional oxygen sensor is used to determine the concentration of oxygen in the sample gas. Depending on the instrument configuration, oxygen is measured using either an electrochemical cell or a paramagnetic oxygen sensor.

Electrochemical Oxygen Sensor

The optional electrochemical oxygen sensor determines the oxygen concentration by measuring the rate of an oxidation/reduction reaction that occurs in a closed cell that is exposed to the sample stream. The cell is similar to a battery in construction, and consists of an enclosure that holds two electrodes. The negatively charged cathode, which is also called the working electrode, is formed from a flat PTFE tape coated with an active catalyst. The positively charged anode, is formed from a block of lead. The entire cell is sealed from exposure to the atmosphere, and is filled with conductive electrolyte that allows transfer of ionic species between the two electrodes. The two electrodes are connected to pins that protrude from the bottom of the assembly which allow the sensor to be electrically connected to the instrument. This sensor has a limited lifetime of approximately one year under optimal usage conditions.

Paramagnetic Oxygen Sensor

Although the optional paramagnetic oxygen sensor operates on a different principal than the electrochemical sensor, it provides similar functionality. The selectivity of the paramagnetic measurement for oxygen minimizes interference from other common background gases.

The paramagnetic sensor operates on the principle that oxygen is a paramagnetic compound and is attracted to a magnetic field. Other gases that are likely to be present at a significant concentration level are diamagnetic and will be slightly repelled by or will have no significant interaction with these fields.

O₂ Sensor Capillary

The O₂ sensor capillary controls flow to either oxygen sensor.

3-Way Cal Valve and 2-Way Cal Out Valve

The 3-way cal valve directs cal gas either directly to the optical bench or back out through the cal out valve, which sends cal gas to the probe.

2-Way Cal Out Valve

The 2-way cal out valve prevents inadvertent exhaust of cal gas, and sends calibration gas to the probe when a calibration is triggered.

Cal Flow Switch

The cal flow switch is used to monitor the flow of cal gas through the instrument. When cal gas does not flow at the proper rate, the condition triggers a low Cal Flow alarm.

Pressure Transducer

The pressure transducer measures the pressure of the sample gas in the optical bench.

Capillary

The capillary and the pump control the sample gas flow rate to between 1000 and 1250 cc/min.

DC Pump

The DC pump draws the sample gas through the optical bench.

Fan

The fan provides cooling air for the instrument.

Firmware

The processor firmware tasks are organized into four areas:

- Instrument control
- Monitoring signals
- Measurement calculations
- Output communication

Instrument Control

Low-level embedded processors are used to control the various functions on the boards, such as analog and digital I/O. These processors are controlled over a serial interface with a single high-level processor that also controls the front-panel user interface. The low-level processors all run a common piece of firmware that is bundled with the high-level firmware and loaded on power-up if a different version is detected.

Each board has a specific address that is used to identify to the firmware what functions are supported on that board. This address is also used for the communications between the low-level processors and the high-level processor.

Every tenth of a second the frequency counters, analog I/O, and digital I/O are read and written to by the low-level processors. The counters are accumulated over the past second and the analog inputs are averaged over that second. The high-level processor polls the low-level processors once per second to exchange the measurement and control data.

Monitoring Signals Signals are gathered from the low-level processors once per second, and then processed by the high-level processor to produce the final measurement values. The one-second counts are accumulated and reported for the user-specified averaging time. If this averaging time is greater than ten seconds, the measurement is reported every 10 seconds. The one-second average of the other analog inputs are reported directly (no additional signal conditioning is performed by the high-level processor).

Output Communication The front panel display, serial and Ethernet data ports, and analog outputs are the means of communicating the results of the above calculations. The front panel display presents the concentrations simultaneously. The display is updated every 10 seconds.

The analog output assignments and ranges are user selectable via firmware. The analog outputs are defaulted based on the measurement range. Negative concentrations can be represented as long as they are within -5% of full scale. The zero and span values may be set by the user to any desired value.

Electronics All electronics operate from a universal switching supply, which is capable of auto-sensing the input voltage and working over the entire operating range.

Bench heaters operate on 220VAC or 110VAC, as ordered from the factory.

A front panel On/Off switch controls all power to the instrument.

Motherboard The motherboard contains the main processor, power supplies, a sub-processor, and serves as the communication hub for the instrument. The motherboard receives operator inputs from the front panel mounted function key panel and/or over I/O connections on the rear panel, and sends commands to the other boards to control the functions of the instrument and to collect measurement and diagnostic information. The motherboard outputs instrument status and measurement data to the front-panel mounted graphics display and to the rear-panel I/O. The motherboard also contains I/O circuitry and the associated connector to monitor external digital status lines and to output analog voltages that represent the measurement data. Connectors located on the motherboard include:

- External Connectors** External connectors include:
- External Accessory
 - RS-232/485 Communications (two connectors)
 - Ethernet Communications
 - I/O connector with Power Fail Relay, 16 Digital Inputs, and 6 Analog Voltage Outputs.

- Internal Connectors** Internal connectors include:
- Function key panel and Display
 - Measurement Interface Board Data
 - I/O Expansion Board Data
 - Digital Output Board
 - AC distribution

Measurement Interface Board

The measurement interface board serves as a central connection area for all measurement electronics in the instrument. It contains power supplies and interface circuitry for sensors and control devices in the measurement system. It sends status data to the motherboard and receives control signals from the motherboard.

Measurement Interface Board Connectors

- Connectors located on the measurement interface board include:
- Data communication with the motherboard
 - 24V, 120VAC, and 220VAC inputs
 - Fan and solenoid outputs
 - 120VAC or 220VAC output and thermistor input from the bench heater assembly
 - Flow and pressure sensor inputs
 - Filter wheel/chopper motor output
 - Optical pickup input
 - Pre-amp board input

- Source housing temperature thermistor
- Ambient temperature thermistor

Pre-amp Board Assembly

The pre-amp board assembly receives light passing through the sample gas and amplifies the signal from the infrared sensor. The preamplifier gain is adjusted by the main processor to bring the signal amplitude within a normal operating range. The output of the pre-amp board is fed to an analog-to-digital converter and then to the measurement interface board. Wires from the pre-amp board apply power to the infrared source. The pre-amp board assembly is mounted on top of the optical bench.

Digital Output Board

The digital output board connects to the motherboard and provides solenoid driver outputs and relay contact outputs to a connector located on the rear panel of the instrument. Ten relay contacts, normally open (with power off), are provided which are electrically isolated from each other. Eight solenoid driver outputs (open collector) are provided along with a corresponding +24VDC supply pin on the connector.

I/O Expansion Board (Optional)

The I/O expansion board connects to the motherboard and adds the capability to input external analog voltage signals and to output analog currents via a connector located on the rear panel of the instrument. It contains local power supplies, a DC/DC isolator supply, a sub-processor and analog circuits. Eight analog voltage inputs are provided with an input voltage range of 0V to 10VDC. Six current outputs are provided with a normal operating range of 0 to 20 mA. Current outputs may also be configured for a 4 to 20 mA range through the analyzer firmware.

Front Panel Connector Board

The front panel connector board interfaces between the motherboard and the front panel mounted function key panel and graphics display. It serves as a central location to tie the three connectors required for the function key panel, the graphics display control lines, and the graphics display backlight to a single ribbon cable extending back to the motherboard. This board also includes signal buffers for the graphics display control signals and a high voltage power supply for the graphics display backlight.

I/O Components

External I/O is driven from a generic bus that is capable of controlling the following devices:

- Analog output (voltage and current)
- Analog input (voltage)
- Digital output (TTL levels)
- Digital input (TTL levels)

Note The instrument has spare solenoid valve drivers and I/O support for future expansion. ▲

Analog Voltage Outputs

The standard instrument provides six analog voltage outputs. Each may be firmware configured for any one of the following ranges, while maintaining a minimum resolution of 12 bits:

- 0-100mV
- 0-1V
- 0-5V
- 0-10V

The user can calibrate each analog output zero and span point through firmware. At least 5% of full scale over and under range are also supported, but may be overridden in firmware if required.

The analog outputs may be assigned to any measurement or diagnostic channel with a user-defined range in the units of the selected parameter. The voltage outputs are independent of the current outputs.

Analog Current Outputs (Optional)

The optional I/O expansion board includes six isolated current outputs. These are firmware configured for any one of the following ranges, while maintaining a minimum resolution of 11 bits:

- 4-20 mA

The user can calibrate each analog output zero and span point through firmware. At least 5% of full scale over and under range are also supported, but may be overridden in firmware if required.

The analog outputs may be assigned to any measurement or diagnostic channel with a user-defined range in the units of the selected parameter. The current outputs are independent of the voltage outputs. The current outputs are isolated from the instrument power and ground, but they share a common return line (Isolated GND).

Analog Voltage Inputs (Optional)

Eight analog voltage inputs are used to gather measurement data from third-party devices. The user may assign a label, unit, and a conversion table (2 to 10 points). Each point in the conversion table consists of an analog input voltage value (0-10 V) and a corresponding user-defined reading value. Only two points are necessary for linear inputs, however a larger number of points may be used to approximate non-linear inputs. All voltage inputs have a resolution of 12 bits over the range of 0 to 10 volts.

Digital Relay Outputs

The instrument includes one power fail relay on the motherboard and ten digital output relays on the digital output board. These are reed relays rated for at least 500 mA @ 200VDC.

The power fail relay is Form C (both normally open and normally closed contacts). All other relays are Form A (normally open contacts) and are used to provide alarm status and mode information from the analyzer, as well as remote control to other devices, such as for controlling valves during calibration. The user may select what information is sent out from each relay and whether the active state is open or closed.

Digital Inputs

Sixteen digital inputs are available which may be programmed to signal instrument modes and special conditions.

The actual use of these inputs will vary based on analyzer configuration.

The digital inputs are TTL level compatible and are pulled up within the analyzer. The active state can be user defined in the firmware.

Serial Ports

Two serial ports allow daisy chaining so that multiple analyzers may be linked using one PC serial port.

The standard bi-directional serial interface can be configured for either RS-232 or RS-485. The serial baud rate is user selectable in the firmware for standard speeds from 1200 to 19,200 baud. The user can also set the data bits, parity, and stop bits. The following protocols are supported:

- C-Link

- Streaming Data
- MODBUS Slave

The Streaming Data protocol transmits user-selected measurement data via the serial port in real-time for capture by a serial printer, data logger, or PC.

RS-232 Connection

A null modem (crossed) cable is required when connecting the analyzer to an IBM-compatible PC. However, a straight cable (one to one) may be required when connecting the analyzer to other remote devices. As a general rule, when the connector of the host remote device is female, a straight cable is required and when the connector is male, a null modem cable is required.

Data Format:

1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 BAUD

7 or 8 data bits

1 or 2 stop bits

No, odd, or even parity

All responses are terminated with a carriage return (hex 0D)

Refer to [Table 8–1](#) for the RS-232 DB9 connector pin configuration.

Table 8–1. RS-232 DB9 Connector Pin Configuration

DB9 Pin	Function
2	RX
3	TX
7	RTS
8	CTS
5	Ground

RS-485 Connection

The instrument uses a four wire RS-485 configuration with automatic flow control (SD). Refer to [Table 8–2](#) for the RS-485 DB9 connector pin configuration.

Table 8–2. RS-485 DB9 Connector Pin Configuration

DB9 Pin	Function
2	+ receive
8	- receive
7	+ transmit
3	- transmit
5	ground

Ethernet Connection

An RJ45 connector is used for the 10Mbps Ethernet connection supporting TCP/IP communications via standard IPV4 addressing. The IP address may be configured for static addressing or dynamic addressing (set using a DHCP server). Up to three simultaneous connections are allowed per protocol.

Any serial port protocols may be accessed over Ethernet in addition to the serial port.

External Accessory Connector

This port is used to communicate with smart external devices that may be mounted hundreds of feet from the analyzer using an RS-485 electrical interface.

Chapter 9

Optional Equipment

The Model 60i is available with the following options:

- “Electrochemical Oxygen Sensor” on page 9-1
- “Paramagnetic Oxygen Sensor” on page 9-1
- “Teflon Particulate Filter” on page 9-2
- “I/O Expansion Board Assembly” on page 9-2
- “Terminal Block and Cable Kits” on page 9-2
- “Cables” on page 9-2
- “Mounting Options” on page 9-4

Electrochemical Oxygen Sensor

The optional electrochemical oxygen sensor, shown in [Figure 1–4](#), determines the oxygen concentration by measuring the rate of an oxidation/reduction reaction that occurs in a closed cell that is exposed to the sample stream. The cell is similar to a battery in construction, and consists of an enclosure that holds two electrodes. The negatively charged cathode, which is also called the working electrode, is formed from a flat PTFE tape coated with an active catalyst. The positively charged anode, is formed from a block of lead. The entire cell is sealed from exposure to the atmosphere, and is filled with conductive electrolyte that allows transfer of ionic species between the two electrodes. The two electrodes are connected to pins that protrude from the bottom of the assembly, which allow the sensor to be electrically connected to the instrument.

Paramagnetic Oxygen Sensor

The optional paramagnetic oxygen sensor provides functionality similar to that of the electrochemical sensor. However, it works on a totally different principal and should function indefinitely without replacement. In addition to the extended operating life, the paramagnetic sensor provides enhanced precision and response time.

The paramagnetic sensor operates on the principle that oxygen is a paramagnetic compound and is attracted to a magnetic field. Other gases that are likely to be present at a significant concentration level are

diamagnetic and will be slightly repelled by or will have no significant interaction with these fields.

Teflon Particulate Filter

A 5-10 micron pore size, two-inch diameter Teflon element is available for the Model 60i. This filter should be installed just prior to the SAMPLE bulkhead. When using a filter, all calibrations and span checks must be performed through the filter.

I/O Expansion Board Assembly

The I/O expansion board provides six analog current output channels (4-20 mA) and eight analog voltage inputs (0-10V). The DB25 connector on the rear panel provides the interface for these inputs and outputs.

25-Pin Terminal Board Assembly

The 25-pin terminal board assembly is included with the optional I/O expansion board. For associated part numbers, refer to “[External Device Connection Components](#)” in the “[Servicing](#)” chapter.

Terminal Block and Cable Kits

The optional terminal block and cable kits provide a convenient way to connect devices to the instrument. These kits break out the signals on the rear panel connector to individual numbered terminals.

Two types of terminal block and cable kits are available. One kit is for the DB37 connectors and can be used for either the analog output connector or the relay output connector. The other kit is for the DB25 connector and can be used for the optional I/O expansion board. For associated part numbers, refer to “[External Device Connection Components](#)” on page 7-7.

Each kit consists of:

- one six-foot cable
- one terminal block
- one snap track

Note Supporting all of the connections on units with the optional I/O expansion board requires:

- two DB37 kits
- one DB25 kit

Cables

Table 9–1 identifies the optional individual cables that are available for the instrument and Table 9–2 provides the cable color codes. For associated part numbers, refer to “External Device Connection Components” on page 7-7.

Note Table 9–2 provides the color coding for both 25-pin cables and 37-pin cables. Color codes for pins 1-25 are for 25-pin cables; color codes for pins 1-37 are for 37-pin cables. ▲

Table 9–1. Cable Options

Description	Cable Length
DB37M to open end	Six feet
DB37F to open end	Six feet
DB25M to open end	Six feet
RS-232	

Table 9–2. Color Codes for 25-Pin and 37-Pin Cables

Pin	Color	Pin	Color
1	BLACK	20	RED/BLACK
2	BROWN	21	ORANGE/BLACK
3	RED	22	YELLOW/BLACK
4	ORANGE	23	GREEN/BLACK
5	YELLOW	24	GRAY/BLACK
6	GREEN	25	PINK/BLACK
7	BLUE	End color codes for 25-pin cables continue for 37-pin cables.	
8	VIOLET	26	PINK/GREEN
9	GRAY	27	PIND/RED
19	WHITE	28	PINK/VIOLET
11	PINK	29	LIGHT BLUE
12	LIGHT GREEN	30	LIGHT BLUE/BROWN
13	BLACK/WHITE	31	LIGHT BLUE/RED
14	BROWN/WHITE	32	LIGHT BLUE/VIOLET
15	RED/WHITE	33	LIGHT BLUE/BLACK
16	ORANGE/WHITE	34	GRAY/GREEN
17	GREEN/WHITE	35	GRAY/RED

Pin	Color	Pin	Color
18	BLUE/WHITE	36	GRAY/VIOLET
19	VIOLET/WHITE	37	LIGHT GREEN/BLACK

Mounting Options

The analyzer can be installed in the configuration described in [Table 9–3](#) and shown in [Figure 9–1](#) through [Figure 9–4](#).

Table 9–3. Mounting Options

Mounting Type	Description
Bench	Positioned on bench, includes mounting feet and front panel side-trim handles.
EIA rack (top position)	Mounted in an EIA-style rack, includes mounting slides and front panel EIA-rack mounting handles.
Retrofit rack (top position)	Mounted in an EIA-style rack, includes mounting slides and front panel EIA-rack mounting handles. This configuration is intended for direct replacement of a C-series instrument in an existing rack. The rail mounting location is lower on the case and the front mounting screw slots have non-standard EIA locations.

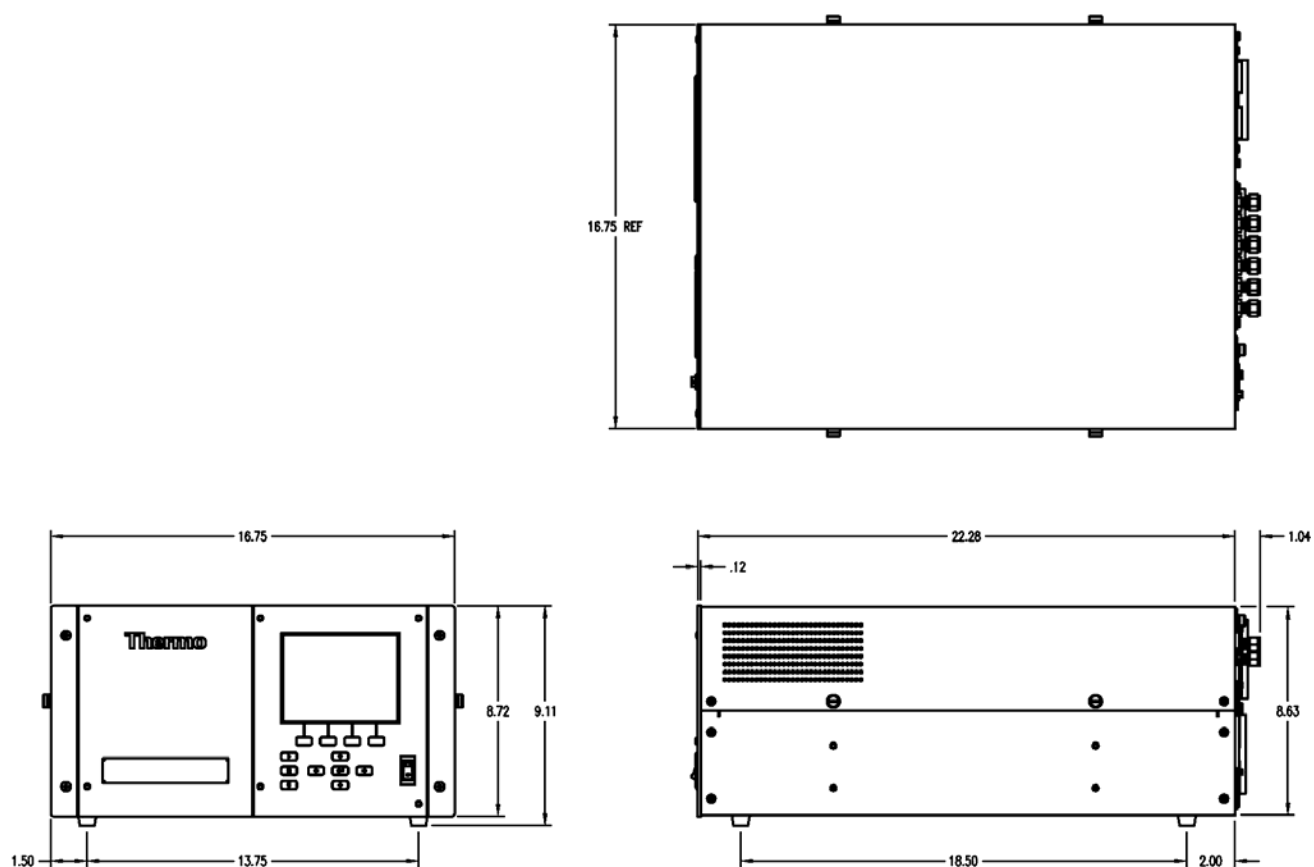


Figure 9–1. Bench Mounting

Optional Equipment
Mounting Options

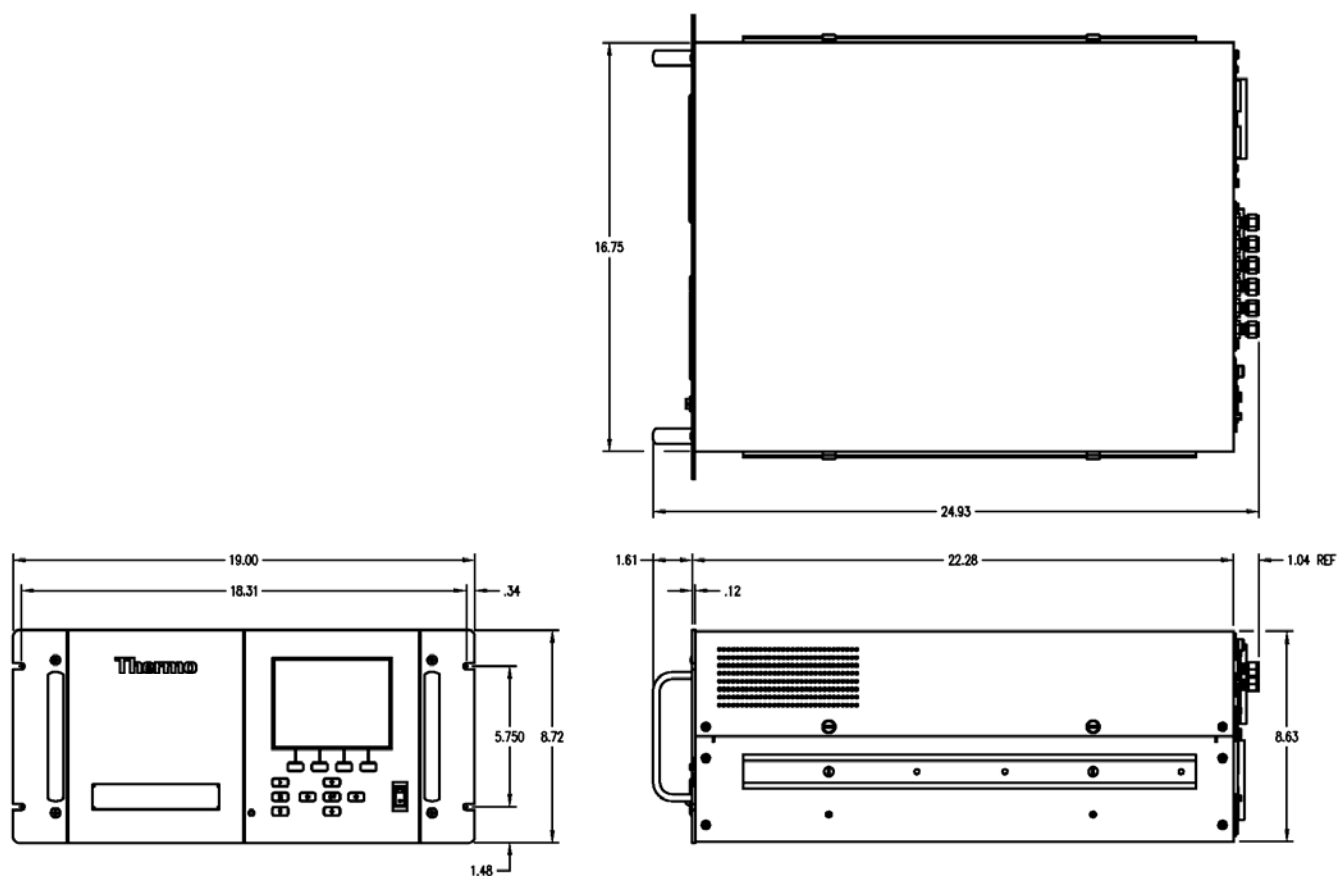


Figure 9–2. EIA Rack Mounting

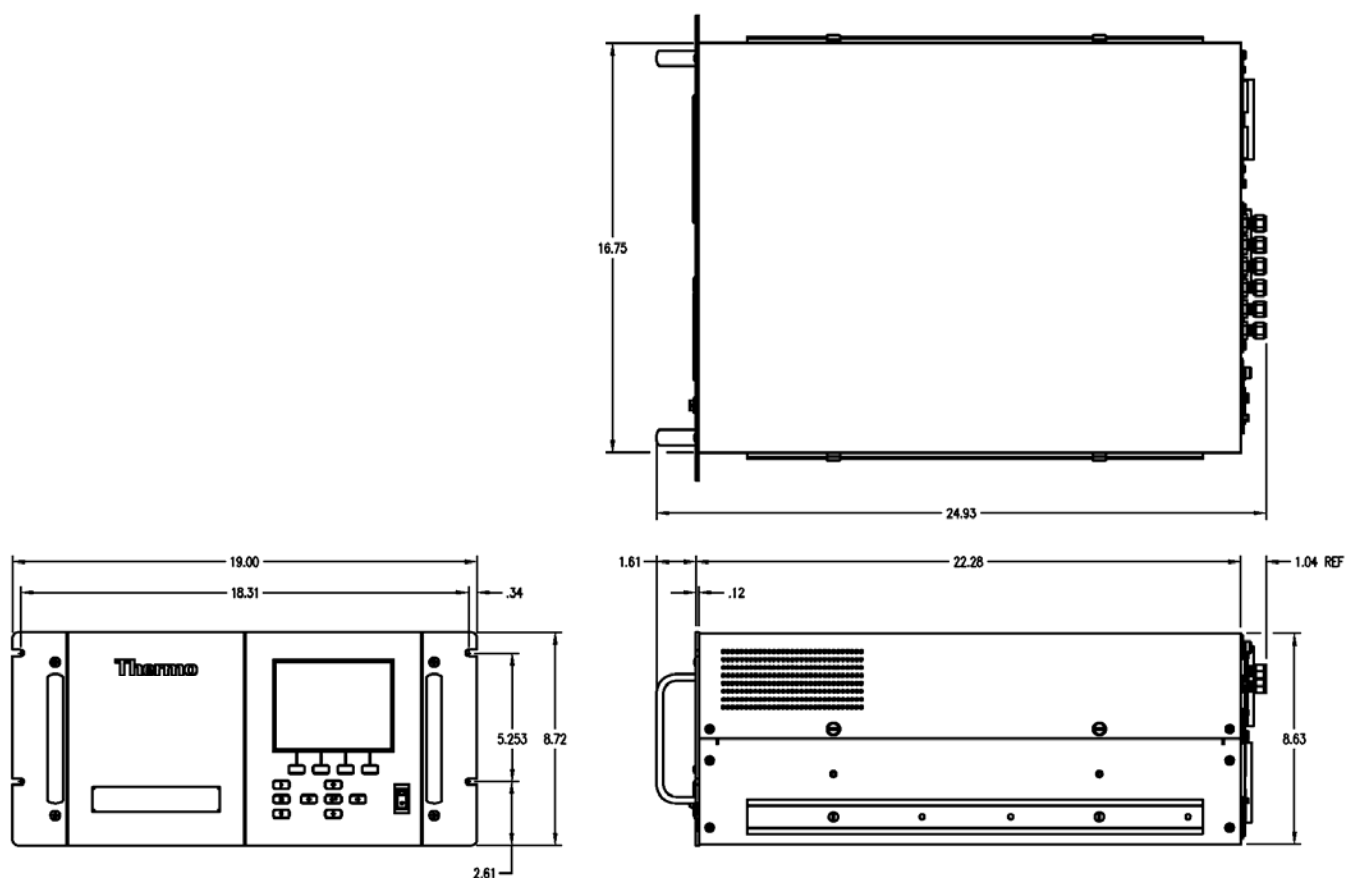


Figure 9–3. Retrofit Rack Mounting

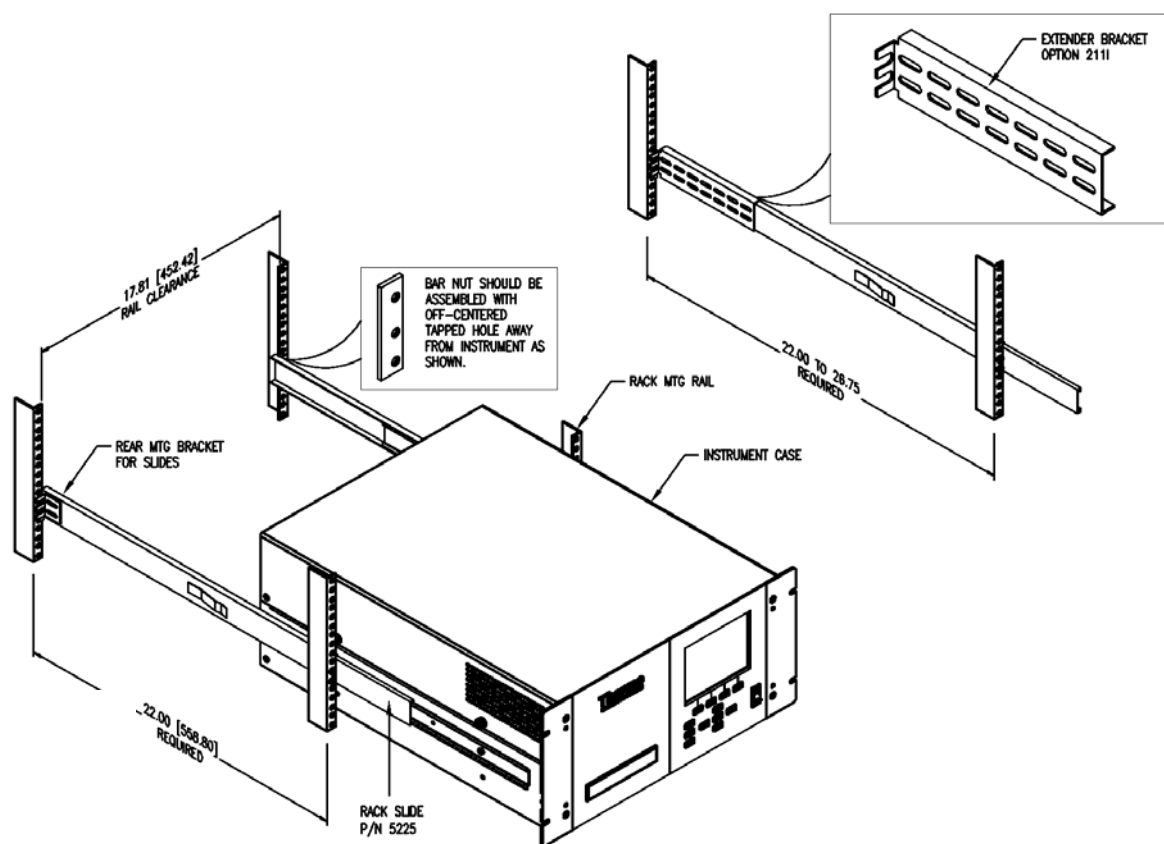


Figure 9–4. Rack Mount Option Assembly

Appendix A

Warranty

Seller warrants that the Products will operate or perform substantially in conformance with Seller's published specifications and be free from defects in material and workmanship, when subjected to normal, proper and intended usage by properly trained personnel, for the period of time set forth in the product documentation, published specifications or package inserts. If a period of time is not specified in Seller's product documentation, published specifications or package inserts, the warranty period shall be one (1) year from the date of shipment to Buyer for equipment and ninety (90) days for all other products (the "Warranty Period"). Seller agrees during the Warranty Period, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with said published specifications; provided that (a) Buyer shall promptly notify Seller in writing upon the discovery of any defect, which notice shall include the product model and serial number (if applicable) and details of the warranty claim; (b) after Seller's review, Seller will provide Buyer with service data and/or a Return Material Authorization ("RMA"), which may include biohazard decontamination procedures and other product-specific handling instructions; and (c) then, if applicable, Buyer may return the defective Products to Seller with all costs prepaid by Buyer. Replacement parts may be new or refurbished, at the election of Seller. All replaced parts shall become the property of Seller. Shipment to Buyer of repaired or replacement Products shall be made in accordance with the Delivery provisions of the Seller's Terms and Conditions of Sale. Consumables, including but not limited to lamps, fuses, batteries, bulbs and other such expendable items, are expressly excluded from the warranty under this warranty.

Notwithstanding the foregoing, Products supplied by Seller that are obtained by Seller from an original manufacturer or third party supplier are not warranted by Seller, but Seller agrees to assign to Buyer any warranty rights in such Product that Seller may have from the original manufacturer or third party supplier, to the extent such assignment is allowed by such original manufacturer or third party supplier.

In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of (i) normal wear and tear, (ii) accident, disaster or event of force majeure, (iii) misuse, fault or negligence of or by Buyer, (iv) use of the Products in a manner for which

they were not designed, (v) causes external to the Products such as, but not limited to, power failure or electrical power surges, (vi) improper storage and handling of the Products or (vii) use of the Products in combination with equipment or software not supplied by Seller. If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates. If Seller provides repair services or replacement parts that are not covered by the warranty provided in this warranty, Buyer shall pay Seller therefor at Seller's then prevailing time and materials rates. ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER'S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS.

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Appendix B

C-Link Protocol Commands

This appendix provides a description of the C-Link protocol commands that can be used to remotely control a Model 60*i* Multi-Gas Analyzer using a host device such as a PC or a datalogger. C-Link protocol may be used over RS-232, RS-485, or Ethernet. C-Link functions can be accessed over Ethernet using TCP/IP port 9880.

Streaming data is sent out the serial port or the Ethernet port on a user-defined periodic basis. Streaming data over Ethernet is only generated when a connection is made on TCP port 9881.

Up to three simultaneous connections per protocol may be made over Ethernet.

For details, see the following topics:

- “Instrument Identification Number” on page B-2
- “Commands” on page B-2
- “Measurements” on page B-10
- “Alarms” on page B-10
- “Diagnostics” on page B-15
- “Datalogging” on page B-16
- “Calibration” on page B-25
- “Keys Display” on page B-31
- “Measurement Configuration” on page B-32
- “Hardware Configuration” on page B-36
- “Communications Configuration” on page B-41
- “I/O Configuration” on page B-47
- “Record Layout Definition” on page B-57

Instrument Identification Number

Each command sent to the analyzer over the serial port must begin with the American Standard Code for Information Interchange (ASCII) symbol or byte value equivalent of the instrument's identification number plus 128.

For example, if the instrument ID is set to 60, then each command must begin with the ASCII character code 188 decimal. The analyzer ignores any command that does not begin with its instrument identification number. If the instrument ID is set to 0, then this byte is not required. For more information on changing Instrument ID, see “Instrument ID” on page 3-58.

Commands

The commands are not case sensitive. Each command must begin with the proper instrument identification number (ASCII) character. The command in the following example begins with the ASCII character code 188 decimal, which directs the command to the Model 60i, and is terminated by a carriage return “CR” (ASCII character code 13 decimal).

<ASCII 188>	T	I	M	E	<CR>
-------------	---	---	---	---	------

Many of the commands have two forms. One form reads parameter from the instrument's memory, and the other writes, or updates, a parameter. The syntax for a write command adds the word “set” in front of the command and provides an argument. Command responses are generally echoed with a data element appended.

Note If the Service Level mode is active, C-Link “set” commands are not allowed. This is to prevent parameters from being changed remotely while the unit is being serviced locally. ▲

If an incorrect command is sent, an error message is generated. The list of error responses is shown in **Table B-1**. The following example sends the incorrect command “list scr” instead of the correct command “list scr 1.”

```
Send:          list scr
Receive:       list scr bad cmd
```


Table B–1. Error Response Messages

Command Response	Description
bad cmd	Command is not recognized
too high	Supplied value is higher than the upper limit
too low	Supplied value is lower than the lower limit
invalid string	Supplied string invalid (typically because a letter was detected when the value should be numeric)
data not valid	Supplied value is not acceptable for entered command
can't, wrong settings	Command not allowed for current measurement mode
can't, mode is service	Command not allowed while instrument is in Service Level mode
feature not enabled	I/O expansion board is not detected
flags no alarm active	No measurement alarms are active

The “save” and “set save params” commands (duplicated for backward compatibility) store parameters in FLASH memory. It is important that this command be sent each time instrument parameters are changed. If changes are not saved, they will be lost in the event of a power failure.

Accessing Streaming Data

Streaming data is sent out the serial port or the Ethernet port on a user-defined periodic basis. Streaming data over Ethernet is only generated when a connection is made on TCP port 9881. Up to three simultaneous connections per protocol may be made over Ethernet.

Entering Units in PPB

When interfacing to an instrument via C-link commands, always enter the concentration values in ppb or $\mu\text{g}/\text{m}^3$ units. For example, to set a background value to 20 ppm, enter 20000 (ppb) as the value for the set background command.

Service Level Mode

If the Service Level mode is active, C-link “set” commands are not allowed. This is to prevent parameters from being changed remotely while the unit is being serviced locally.

Commands List

Table B–2 lists the C-Link protocol commands in alphabetical order. The interface will respond to the associated command strings.

Table B–2. C-Link Protocol Commands

Command	Description	Page
addr dns	Reports/sets dns address	B-41
addr gw	Reports/sets default gateway address	B-41
addr ip	Reports/sets IP address	B-41
addr nm	Reports/sets netmask address	B-42
addr ntp	Reports the IP address for the NTP time server	B-42
alarm conc max	Reports/sets the conc alarm max value	B-12
alarm conc min	Reports/sets the conc alarm min value	B-12
alarm flags	Reports 8 hexadecimal digits (or flags) that represent alarm status	B-13
alarm pressure max	Reports/sets the alarm pressure max value	B-12
alarm pressure min	Reports/sets the alarm pressure min value	B-12
alarm temp bench max	Reports/sets the sets the bench temp alarm max value	B-11
alarm temp bench min	Reports/sets the sets the bench temp alarm min value	B-11
alarm temp detector max	Reports/sets the sets the detector temp alarm max value	B-11
alarm temp detector min	Reports/sets the sets the detector temp alarm min value	B-11
alarm temp src max	Reports/sets the source temp alarm max value	B-10
alarm temp src min	Reports/sets the source temp alarm min value	B-10
alarm trig conc	Reports/sets current concentration alarm trigger sense	B-12
allow mode cmd	Reports/sets the current set allow mode command	B-45
analog iout range	Reports/sets analog current output range per channel	B-47
analog vin	Retrieves analog voltage input data per channel	B-48
analog vout range	Reports/sets analog voltage output range per channel	B-48
autocal action	Reports/sets the event number assigned for action number in autocal sequence	B-29
autocal check	Reports/sets the status of the autocal sequence check mode On/Off	B-28
autocal freq	Reports/sets the run frequency of autocal sequence	B-28

Command	Description	Page
avg time	Reports/sets the averaging time for the instrument	B-10
baud	Reports/sets current baud rate	B-42
cal single gas span	Triggers single gas span for the currently selected cylinder	B-51
cal span	Triggers span calibration based on currently selected cylinder	B-26
cal status	Reports the flags for span calculation failure	B-51
cal user zero	Triggers a zero calibration (instrument must be in zero mode)	B-52
clr lrecs	Clears away only long records that have been saved	B-16
clr records	Clears away all logging records that have been saved	B-16
clr srecs	Clears away only short records that have been saved	B-16
co co2 no no2 nox so2 o2	These commands report the current concentration of the specified gas	B-10
contrast	Reports/sets current screen contrast	B-36
copy lrec to sp	Sets/copies current lrec selection into the scratch pad	B-17
copy scr to sp	Copies the items of user screen into the first 10 entries of the scratch pad	B-40
copy sp to lrec	Sets/copies current selections in scratch pad into lrec list	B-16
copy sp to scr	Copies the first 10 non-zero items in scratch pad to user screen	B-39
copy sp to srec	Sets/copies current selections in scratch pad into srec list	B-16
copy sp to stream	Sets/copies current selections in scratch pad into stream list	B-16
copy srec to sp	Sets/copies current srec selection into the scratch pad	B-17
copy stream to sp	Sets/copies current streaming data selection into the scratch pad	B-17
data treatment lrec	Reports/sets data treatment for concentration values in long records	B-17
data treatment srec	Reports/sets data treatment for concentration values in short records	B-17
date	Reports/sets current date	B-37
default cal	Resets the user calibration settings to default values	B-26
default params	Sets parameters to default values	B-37
detector temp	Reports the detector temperature in degrees C	B-52
dhcp	Reports/sets state of use of DHCP	B-43
diag volt iob	Reports diagnostic voltage level for I/O expansion board	B-15
diag volt mb	Reports diagnostic voltage level for motherboard	B-15
diag volt mib	Reports diagnostic voltage level for measurement interface board	B-15

Command	Description	Page
dig in	Reports status of the digital inputs	B-49
din	Reports/sets digital input channel and active state	B-49
do (down)	Simulates pressing down pushbutton	B-31
dout	Reports/sets digital output channel and active state	B-49
dtoa	Reports outputs of the digital to analog converters per channel	B-50
en (enter)	Simulates pressing enter pushbutton	B-31
er	Returns a brief description of the main operating conditions in the format specified in the commands	B-19
erec	Returns a snapshot of the main operating conditions (measurements and status) in the specified format	B-22
erec format	Reports/sets erec format (ASCII or binary)	B-20
erec layout	Reports current layout of erec data	B-23
event delay	Reports/sets the delay time for the specified event	B-27
event duration	Reports/sets the duration of the specified event	B-27
event halt	Reports/sets event halt control bit used to stop current running event	B-52
event param	Reports/sets the event parameter for the specified event	B-27
event run	Triggers the selected event	B-28
event type	Reports/sets the type of event	B-26
flags	Reports 8 hexadecimal digits (or flags) that represent the status of system parameters	B-15
flow	Reports flow as OK or low	B-53
format	Reports/sets current reply termination format	B-43
gas mode	Reports the current gas mode, sample, zero ir, zero O ₂ , zero all, span mg, and span sg	B-55
he (help)	Simulates pressing help pushbutton	B-31
host name	Reports/sets host name string	B-44
instr name	Reports instrument name	B-44
instrument id	Reports/sets instrument identification	B-44
isc (iscreen)	Retrieves frame buffer data used for the display	B-31
layout ack	Disables stale layout/layout changed indicator ("*")	B-45
le (left)	Simulates pressing left pushbutton	B-31
list din	Lists current selection for digital input	B-18
list dout	Lists current selection for digital output	B-18
list lrec	Lists current selection lrec logging data	B-18

Command	Description	Page
list scr	Lists the 10 items in user screen	B-40
list sp	Lists current selection in the scratchpad list	B-18
list srec	Lists current selection srec logging data	B-18
list stream	Lists current selection streaming data output	B-18
list var aout	Reports list of analog output, index numbers, and variables	B-18
list var din	Reports list of digital input, index numbers, and variables	B-18
list var dout	Reports list of digital output, index numbers, and variables	B-18
lock action	Reports/sets the analog output lock action	B-56
lock outputs	Reports/sets the state of the C-link analog output lock	B-55
lock percent	Reports/sets the analog output lock percentage	B-55
lr	Outputs long records in the format specified in the command	B-19
lrec	Outputs long records	B-19
lrec format	Reports/sets output format for long records (ASCII or binary)	B-20
lrec layout	Reports current layout of lrec data	B-23
lrec mem size	Reports maximum number of long records that can be stored	B-21
lrec per	Reports/sets long record logging period	B-21
malloc lrec	Reports/sets memory allocation for long records	B-22
malloc srec	Reports/sets memory allocation for short records	B-22
me (menu)	Simulates pressing menu pushbutton	B-31
mp	Reports/sets the measured and actual values for the specified gasname and point	B-30
mp lin	Reports/sets linearization state.	B-30
mp points	Reports/sets the number of points in the multipoint linearization table	B-30
mp table	Lists the points in the multipoint linearization table	B-29
no of lrec	Reports/sets number of long records stored in memory	B-22
no of srec	Reports/sets number of short records stored in memory	B-22
power up mode	Reports/sets the current power up mode setting	B-46
pres	Reports the pressure	B-53
pres comp	Reports/sets pressure compensation to on off	B-53
program no	Reports analyzer program number	B-45
push	Simulates pressing a key on the front panel	B-31
range	Reports/sets the analog out range for the selected gas	B-32
relay stat	Reports/sets relay logic status to for the designated relay(s)	B-50

Command	Description	Page
ri (right)	Simulates pressing right pushbutton	B-31
ru (run)	Simulates pressing run pushbutton	B-31
sample	Sets the gas mode to Sample	B-52
save	Stores parameters in FLASH	B-38
save params	Stores parameters in FLASH	B-38
sc (screen)	C-series legacy command that reports a generic response (Use iscreen instead)	B-32
source temp	Reports the temperature at the source housing	B-52
sp field	Reports/sets item number and name in scratch pad list	B-23
span	Begins final calculations of span factors	B-26
span coef	Reports/sets span coefficient of specified gas	B-54
span conc	Reports/sets the span concentrations of gases in cylinder (1-6)	B-25
span cylinder	Reports/sets the cylinder used for spanning	B-25
sr	Reports last short record stored	B-19
srec	Reports maximum number of short records	B-19
srec format	Reports/sets output format for short records (ASCII or binary)	B-20
srec layout	Reports current layout of short record data	B-23
srec mem size	Reports maximum number of short records	B-21
srec per	Reports/sets short record logging period	B-21
stream per	Reports/sets current set time interval for streaming data	B-24
stream time	Reports/sets a time stamp to streaming data or not	B-24
sys alarm bb pres max	Reports/sets the system alarm blowback pressure maximum settings	B-54
sys alarm bb pres min	Reports/sets the system alarm blowback pressure minimum settings	B-54
sys alarm probe barrel temp max	Reports/sets the system probe barrel temp alarm max value	B-14
sys alarm probe barrel temp min	Reports/sets the system probe barrel temp alarm min value	B-14
sys alarm probe filter temp max	Reports/sets the system probe filter temp alarm max value	B-14
sys alarm probe filter temp min	Reports/sets the system probe filter temp alarm min value	B-14
sys alarm umb 1 temp max	Reports/sets the system umbilical temperature alarm max value for umbilical 1	B-54
sys alarm umb 1	Reports/sets the system umbilical temperature alarm min	B-54

Command	Description	Page
temp min	value for umbilical 1	
sys alarm umb 2 temp max	Reports/sets the system umbilical temperature alarm max value for umbilical 2	B-54
sys alarm umb 2 temp min	Reports/sets the system umbilical temperature alarm min value for umbilical 2	B-54
sys bb duration	Reports/sets the duration for system blowback	B-33
sys bb period	Reports/sets the system blowback period	B-34
sys power probe barrel	Reports/sets the status of the component power for the system probe barrel On/Off	B-34
sys power probe filter	Reports/sets the status of the component power for the system probe filter On/Off	B-34
sys power umbilical 1	Reports/sets the status of the component power for umbilical 1 On/Off	B-34
sys power umbilical 2	Reports/sets the status of the component power for umbilical 2 On/Off	B-34
sys probe barrel set temp	Reports/sets the set temperature for the system probe barrel	B-35
sys probe filter set temp	Reports/sets the set temperature for the system probe filter	B-35
sys temps	Reports probe filter, probe barrel, umbilical 1, and umbilical 2 temperatures in degrees C	B-55
sys umb 1 set temp	Reports/sets the set temperature for umbilical zone 1	B-36
sys umb 2 set temp	Reports/sets the set temperature for umbilical zone 2	B-36
temp comp	Reports/sets temperature on off	B-52
time	Reports/sets current time (24-hour time)	B-38
tz	Reports the "tz" timezone string for the NTP server	B-47
units	Reports/sets the display units for the selected gas	B-33
up	Simulates pressing up pushbutton	B-31
user scr active	Reports/sets the active state of user screen	B-39
user scr items	Reports/sets the number of items on user screen	B-39
user scr title	Reports/sets the user screen title	B-38
zero	Sets gas mode to zero	B-52
zero cyl	Reports/sets the cylinder used for zeroing	B-25

Measurements

avg time

This command reports the concentration measurement averaging time in seconds. The following example shows that the averaging time is 60 seconds.

```
Send:      avg time
Receive:   avg time 60 sec
```

set avg time *seconds*

This command sets the concentration measurement averaging time in seconds. Valid values are 10, 30, 60, 120, and 300. The following example sets the averaging time to 60 seconds.

```
Send:      set avg time 60
Receive:   set avg time 60 ok
```

co, co2, no, no2, nox, so2, o2

These commands report the current concentration of the specified gas in basic gas units. The following example reports the current O₂ concentration as 2.090E+08 ppb.

```
Send:      o2
Receive:   o2 2.090E+08 ppb
```

Alarms

alarm temp src min

alarm temp src max

These commands report the source temperature alarm minimum and maximum value current settings. The example that follows reports that the source temperature alarm minimum value is 45 °C.

```
Send:      alarm temp scr min
Receive:   alarm temp scr min 45 deg C
```

set alarm temp src min *value*

set alarm temp src max *value*

These commands set the source temperature alarm minimum and maximum values to *value*, where *value* is a floating point number representing the source temperature alarm limits. The example that follows sets the source temperature alarm maximum value to 47 °C. Alarm limit range: 8-47 °C.

```
Send:      set alarm temp src max 47
Receive:   set alarm temp src max 47 ok
```

alarm temp bench min**alarm temp bench max**

These commands report the bench temperature alarm minimum and maximum value current settings. The example that follows reports that the bench temperature alarm minimum value is 46 °C. Alarm limit range: 40-55 °C.

Send: alarm temp bench min
Receive: alarm temp bench min 46 deg C

set alarm temp bench min *value***set alarm temp bench max *value***

These commands set the bench temperature alarm minimum and maximum values to *value*, where *value* is a floating point number representing the bench temperature alarm limits. The example that follows sets the bench temperature alarm maximum value to 50 °C.

Send: set alarm temp bench max 50
Receive: set alarm temp bench max 50 ok

alarm temp detector min**alarm temp detector max**

These commands report the detector temperature alarm minimum and maximum value current settings. The example that follows reports that the detector temperature alarm minimum value is 47 °C.

Send: alarm temp detector min
Receive: alarm temp detector min 47 deg C

set alarm temp detector min *value***set alarm temp detector max *value***

These commands set the detector temperature alarm minimum and maximum values to *value*, where *value* is a floating point number representing the detector temperature alarm limits. The example that follows sets the detector temperature alarm maximum value to 49 °C.

Send: set alarm temp detector max 49
Receive: set alarm temp detector max 49 ok

alarm pressure min**alarm pressure max**

These commands report the alarm pressure minimum and maximum value current settings.

Send: alarm pressure min

Receive: alarm pressure min 400 mm Hg

set alarm pressure min *value***set alarm pressure max *value***

These commands set the alarm pressure minimum and maximum values to *value*, where *value* is a floating point number representing the alarm pressure limits. The example that follows sets the alarm pressure maximum value to 900 mm Hg. Alarm limit range: 250-1000 mm Hg.

Send: set alarm pressure max 900

Receive: set alarm pressure max 900 ok

alarm conc *gas* min**alarm conc *gas* max**

These commands report the concentration alarm minimum and maximum value current settings for *gas*, where *gas* is the selected gas. The example that follows reports that the concentration alarm minimum value for CO is 5.2 ppm.

Send: alarm conc co min

Receive: alarm conc co min 5.2 ppm

set alarm conc *gas* min *value***set alarm conc *gas* max *value***

These commands set the concentration alarm minimum and maximum values for the gas selected (*gas*) to *value*, where *value* is a floating point number representing the concentration alarm limits. The example that follows sets the concentration alarm maximum value to 20 ppm.

Send: set alarm conc co max 20

Receive: set alarm conc co max 20 ok

alarm trigger conc *gas*

This command reports the trigger mode for the selected *gas* concentration alarm trigger action for the minimum alarm, to either floor or ceiling according to **Table B-3**. The example that follows reports that the trigger mode for the CO alarm is floor.

Send: alarm trig conc co

Receive: alarm trig conc co 0

set alarm trigger conc *gas value*

These commands set the concentration alarm minimum and maximum values for the gas selected (*gas*) to *value*, where *value* is floor mode or ceiling mode according to **Table B-3**. The example that follows sets the alarm trigger for CO to floor.

Send: set alarm trig conc co 0
Receive: set alarm trig conc co 0 ok

Table B-3. Alarm Trigger Values

Value	Alarm Trigger
00	Floor
01	Ceiling

alarm flags

This command reports 8 hexadecimal digits (or flags) that represent alarm status. To decode the flags, each hexadecimal digit is converted to binary as shown in **Figure B-1**. The binary digits define the status of each parameter.

Send: alarm flags
Receive: alarm flags 00000000

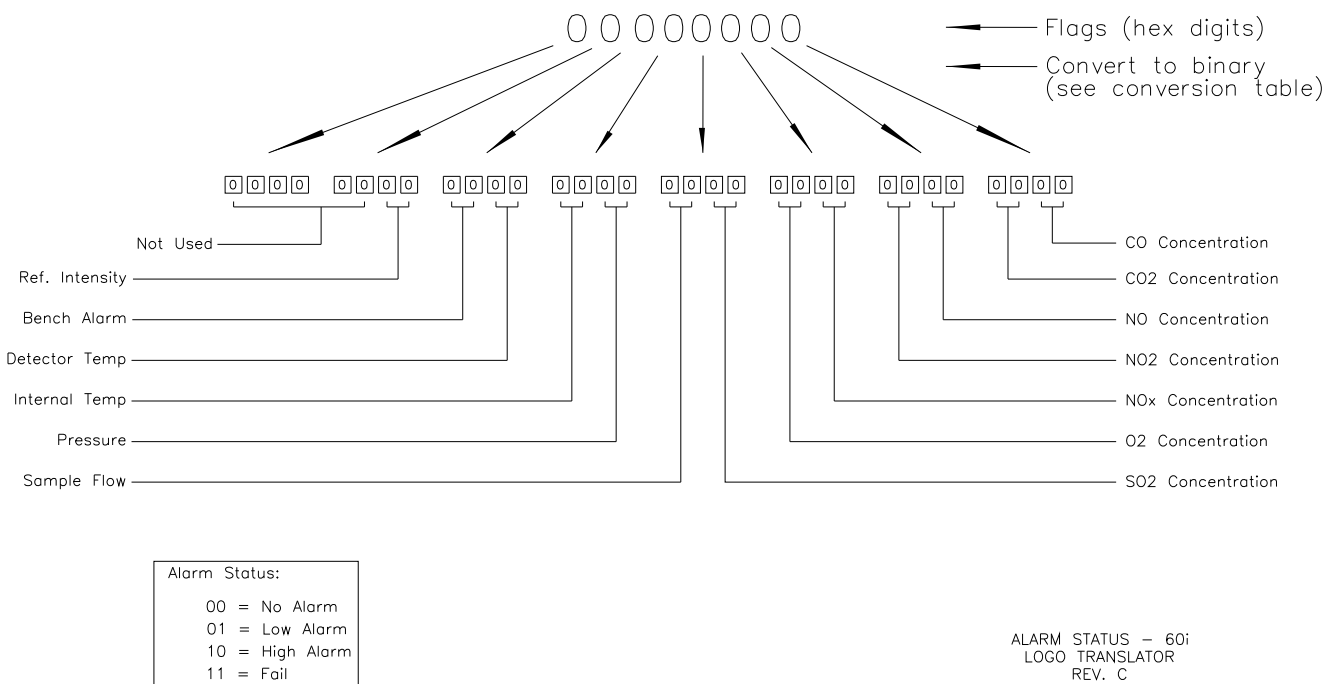


Figure B-1. Alarm Flag Status

sys alarm probe filter temp min**sys alarm probe filter temp max**

These commands report the system probe filter temperature alarm minimum and maximum value current settings. The example that follows reports that the system probe filter temperature alarm minimum value is 70 °C.

Send: sys alarm probe filter temp min

Receive: sys alarm probe filter temp min 70 deg C

set sys alarm probe filter temp min *value***set sys alarm probe filter temp max *value***

These commands set the system probe filter temperature alarm minimum and maximum values to *value*, where *value* is a floating point number representing the system probe filter temperature alarm limits. The example that follows sets the system probe filter temperature alarm maximum value to 100 °C.

Send: set sys alarm probe filter temp max 100

Receive: set sys alarm probe filter temp max 100 ok

sys alarm probe barrel temp min**sys alarm probe barrel temp max**

These commands report the system probe barrel temperature alarm minimum and maximum value current settings. The example that follows reports that the system probe barrel temperature alarm minimum value is 70 °C.

Send: sys alarm probe barrel temp min

Receive: sys alarm probe barrel temp min 70 deg C

set sys alarm probe barrel temp min *value***set sys alarm probe barrel temp max *value***

These commands set the system probe barrel temperature alarm minimum and maximum values to *value*, where *value* is a floating point number representing the system probe barrel temperature alarm limits. The example that follows sets the system probe barrel temperature alarm maximum value to 100 °C.

Send: set sys alarm probe barrel temp max 100

Receive: set sys alarm probe barrel temp max 100 ok

Diagnostics

diag volt iob

This command reports the diagnostic voltage measurements on the I/O expansion board. The sequence of voltages is: Positive 24, positive 5, positive 3.3, and negative 3.3. Each voltage value is separated by a space.

Send: diag volt iob
Receive: diag volt iob 24.1 4.9 3.2 -3.2

diag volt mb

This command reports the diagnostic voltage measurements on the motherboard. The sequence of voltages is: Positive 24, positive 15, positive 5, positive 3.3, and negative 3.3. Each voltage value is separated by a space.

Send: diag volt mb
Receive: diag volt mb 24.1 14.9 4.9 3.2 -3.2

diag volt mib

This command reports the diagnostic voltage measurements on the measurement interface board. The sequence of voltages is: Positive 24, positive 15, negative 15, positive 5, positive 3.3, positive 18 IR, positive 18 MOT, and VBIAS. Each voltage value is separated by a space.

Send: diag volt mib
Receive: diag volt mib 24.1 14.9 -14.9 4.9 3.2 17.9 17.9

flags

This command reports 8 hexadecimal digits (or flags) that represent the status mode, password lock, pressure compensation, temperature compensation, purge, check, event, blowback, calibration cylinder, and alarms. To decode the flags, each hexadecimal digit is converted to binary as shown in **Figure B-2**. The binary digits define the status of each parameter.

Send: flags
Receive: flags 40000018

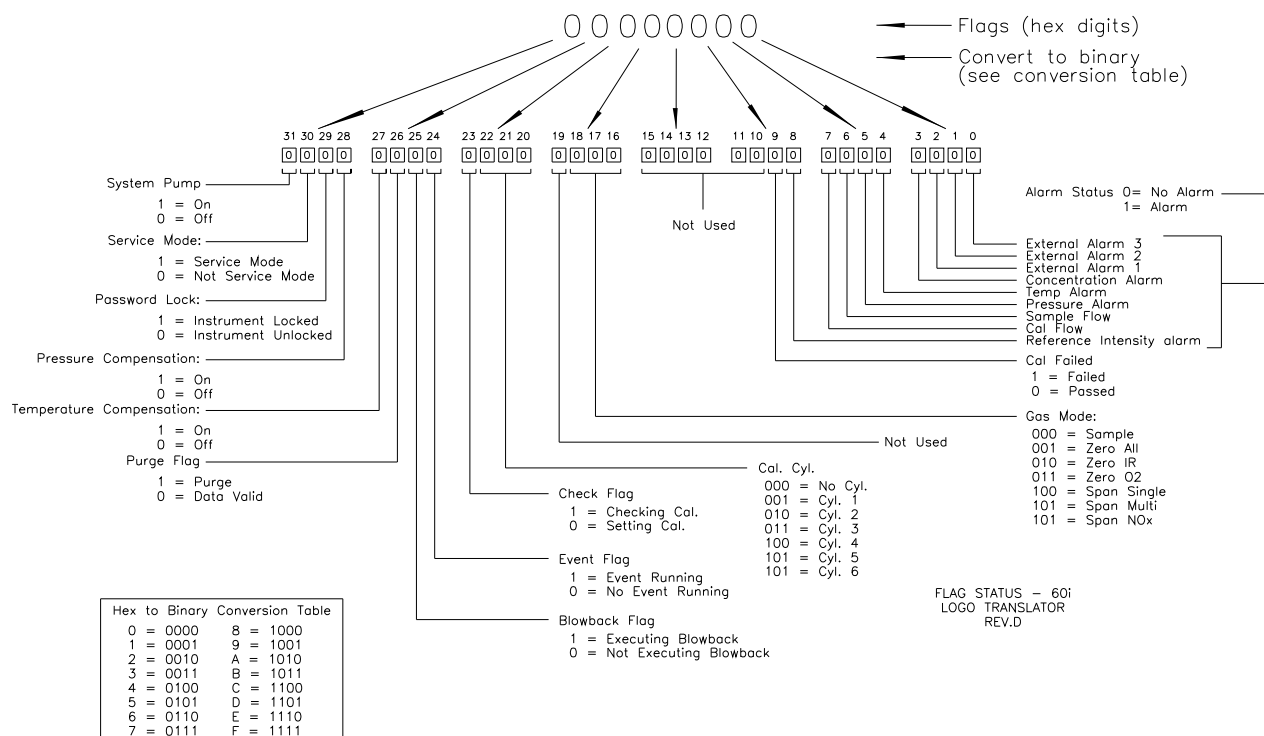


Figure B-2. Flag Status

Datalogging

clr records

clr lrecs

clr srecs

This command will clear all long and short records that have been saved.

Send: clr records

Receive: clr records ok

set clr lrecs

set clr srecs

These commands will clear only the lrecs or only the srecs that have been saved. The following example clears srecs.

Send: set clr srecs

Receive: set clr srecs ok

copy sp to lrec

copy sp to srec

copy sp to stream

These commands copy the current selections in scratch pad (sp) into the lrec, srec, or streaming data list.

The scratch pad is a temporary memory area which is used to set up lists of selections for lrec, srec, or streaming data items. The user can copy any of these lists to the scratch pad, modify individual elements in the list, then save the scratch pad back to the original list. For more information on how to edit the scratch pad, see the “sp field” command.

The following example copies the current list in scratch pad into the lrecs list.

```
Send:          set copy sp to lrec
Receive:       set copy sp to lrec ok
```

copy lrec to sp
copy srec to sp
copy stream to sp

These commands copy the current contents of the lrec, srec, or streaming data list into the scratch pad (sp). These commands are useful in easy modification of current lrec, srec, or streaming data lists.

The scratch pad is a temporary memory area which is used to set up lists of selections for lrec, srec, or streaming data items. The user can copy any of these lists to the scratch pad, modify individual elements in the list, then save the scratch pad back to the original list. For more information on how to edit the scratch pad, see the “sp field” command.

The following example copies the current list of lrecs into the scratch pad.

```
Send:          set copy lrec to sp
Receive:       set copy lrec to sp ok
```

data treatment lrec
data treatment srec

These commands report the current selection of data treatment for concentrations in the lrecs or srecs. The following example reports the data treatment for concentrations in lrec as minimum.

```
Send:          data treatment lrec
Receive:       data treatment lrec min
```

set data treatment lrec *string*
set data treatment srec *string*
string = | cur | avg | min | max |

These commands set the data treatment to current, average, minimum, or maximum for the concentrations values recorded in the lrecs or srecs. The following example sets the data treatment for concentrations in lrec as minimum.

```
Send:          set data treatment lrec min
Receive:       set data treatment lrec min ok
```

list din**list dout**

These commands report the current selection for the digital outputs in the format. Output no Index number variable name active state. The active state for digital outputs is open or closed. The active state for digital inputs is high or low.

```
Send:      list dout
Receive:   list dout
           output index variable state
           1 22 I/O BD COMM closed
           2 2  LOCAL/REMOTE open
           3 4  UNITS open
           4 19 BIAS VOLTAGE closed
           7 7  SAMPLE MODE open
           8 8  GEN MODE open
```

list lrec**list srec****list stream****list sp**

These commands report the list of current selections for lrec logging data, srec logging data, streaming data output, or the scratch pad (sp) list.

The scratch pad is a temporary memory area which is used to set up lists of selections for lrec, srec, or streaming data items. The user can copy any of these lists to the scratch pad, modify individual elements in the list, then save the scratch pad back to the original list. Refer to the “sp field” command for information on how to edit the scratch pad.

The following example shows the list for streaming data output.

```
Send:      list stream
Receive:   list stream
           field index variable
           x x time
           1 10 auxt
           2 13 pres
           3 14 smplf1
           4 15 intensity
```

list var aout**list var dout****list var din**

These commands report the list of index numbers, and the variables (associated with that index number) available for selection in the current mode for analog outputs, digital outputs, and digital inputs. The index number is used to insert the variable in a field location in a list using “set sp

field index". The following example reports the list of analog outputs, index numbers, and variables.

```
Send:      list var aout
Receive:   list var aout
           index variable
           0 none
           1 co
           5 sr
           8 intt
           9 cht
           10 aux
           13 pres
           14 smp1fl
           15 intensity
           16 speed
           28 biasv
```

er *xy*

lr *xy*

sr *xy*

x = | 0 | 1 | : Reply termination format (see "set format *format*" command)

y = | 0 | 1 | 2 | : Output format (see "set errec/lrec/srec format *format*" command)

In the following example, the command requests an lrec with no checksum, in ASCII format with text. For details on how to decode the flag fields within these records, see **Figure B-2**.

```
Send:      lr01
Receive:   lr01
           10:15 05-12-03 flags 9c040000 co 7349E+0 loco 5994E+0
           intt 33.2 cht 44.7 pres 758.9 smp1fl 1.085 speed 100.0
           biasv -115.5 intensity 1999940
```

lrec

srec

lrec *xxxx yy*

srec *xxxx yy*

lrec *aa:bb oo-pp-qq yy*

srec *aa:bb oo-pp-qq yy*

xxxx = the number of past records

yy = the number of records to return (1 to 10)

aa = hours (01 to 24)

bb = minutes (01 to 59)

oo = month (01 to 12)

pp = day (01 to 31)

qq = year

These commands output long or short records. The output format is determined by the “set lrec format” and “set srec format” commands. The logging time is determined by the “set lrec per” and “set srec per” commands.

In the following example, there are 740 long records currently stored in memory. When the command lrec 100 5 is sent, the instrument counts back 100 records from the last record collected (record 740), and then returns 5 records: 640, 641, 642, 643, and 644. For details on how to decode the flag fields within these records, see the “Flags” command and **Figure B-2**.

```
Send:          lrec 5
Receive:       lrec 100 5
              10:15 05-12-03 flags 9c040000 co 7349E+0 loco 5994E+0
              intt 33.2 cht 44.7 pres 758.9 smp1fl 1.085 speed 100.0
              biasv -115.5 intensity 1999940
              10:15 05-12-03 flags 9c040000 co 7349E+0 loco 5994E+0
              intt 33.2 cht 44.7 pres 758.9 smp1fl 1.085 speed 100.0
              biasv -115.5 intensity 1999940
              10:15 05-12-03 flags 9c040000 co 7349E+0 loco 5994E+0
              intt 33.2 cht 44.7 pres 758.9 smp1fl 1.085 speed 100.0
              biasv -115.5 intensity 1999940
              10:15 05-12-03 flags 9c040000 co 7349E+0 loco 5994E+0
              intt 33.2 cht 44.7 pres 758.9 smp1fl 1.085 speed 100.0
              biasv -115.5 intensity 1999940
              10:15 05-12-03 flags 9c040000 co 7349E+0 loco 5994E+0
              intt 33.2 cht 44.7 pres 758.9 smp1fl 1.085 speed 100.0
              biasv -115.5 intensity 1999940
```

erec format

lrec format

srec format

These commands report the output format for lrecs and srecs, and erec data in various formats such as ASCII without text, ASCII with text, or binary. The following example shows the output format for lrecs is ASCII with text, according to Table B-4.

```
Send:          lrec format
Receive:       lrec format 01
```

set erec format *format*

set lrec format *format*

set srec format *format*

These commands set the output format for lrecs and srecs, and erec data, according to Table B-4. The following example sets the lrec output format to ASCII with text.

```
Send:          set lrec format 1
Receive:       set lrec format 1 ok
```

Table B–4. Record Output Formats

Format	Output Format
0	ASCII no text
1	ASCII with text
2	Binary data

lrec mem size**srec mem size**

These commands report the number of lrecs and srecs that can be stored with the current settings and the number of blocks reserved for lrecs and srecs. The following example shows that 1075 blocks were reserved for lrecs and the maximum number of lrecs that can be stored in memory is 241979. Memory allocation can be changed using the “malloc” command.

Send: lrec mem size
Receive: lrec mem size 241979 recs, 1075 blocks

lrec per**srec per**

These commands report the lrecs and srecs logging period. The following example shows that the srec logging period is 5 minutes.

Send: srec per
Receive: srec per 5 min

set srec per *value***set lrec per *value***

value = | 1 | 5 | 15 | 30 | 60 |

These commands set the lrecs and srecs logging period to *value* in minutes. The following example sets the lrec logging period to 15 minutes.

Send: set lrec per 15
Receive: set lrec per 15 ok

no of lrec**no of srec**

These commands report the number of lrec and srecs stored memory. The following example shows that 50 lrecs have been stored in the memory.

```
Send:          no of lrec
Receive:       no of lrec 50 recs
```

malloc lrec**malloc srec**

These commands report the currently set memory allocation for lrecs and srecs in percent of total memory.

```
Send:          malloc lrec
Receive:       malloc lrec 10%
```

set malloc lrec *value***set malloc srec *value***

value = 0 to 100

These commands set the percent of memory space allocated for lrecs and srecs to *value*, where *value* is a floating-point number representing percent. The following example sets the memory allocation for lrecs to 10%.

Note Issuing these commands will clear all the logged data in memory. All the existing records should be retrieved using appropriate commands, if required. ▲

```
Send:          set malloc lrec 10
Receive:       set malloc lrec 10 ok
```

erec

This command returns a snapshot of the main operating conditions (measurements and status) at the time the command is issued. The example that follows shows a typical response.

The format is defined by the current settings of the "format" and "erec format" commands. For details on erec formatting, see "Format Specifier for Erec Layout" at the end of this appendix. For details on how to decode the flag fields within these records, see the "Flags" command.

```
Send:          erec
Receive:       erec
              09:48 04-06-05 flags 9C040510 co 0.000 4 loco -0.002
              4 s/r 0.000 los/r 0.902 biasv -112.668.500 intt 34.023
              cht 47.995 smpfl 0.000 pres 0.000 avgt1 10 avgt2 10
```

```
cobkg -0.000 cocoeff 1.000 lococoeff 1.000 corange
10000000.000 locorange 10000000.000 motor 100.000
```

erec layout

lrec layout

srec layout

These commands report the layout (string indicating the data formats) for data that is sent out in response to the erec, lrec, srec, and related commands. For details on how to interpret the strings, see “Record Layout Definition” later in this appendix.

```
Send:      lrec layout
Receive:   lrec layout %s %s %lx %f %f %f %f
           t D L ffff
           s/r pres intensity motor
```

sp field *number*

This command reports the variable *number* and name stored at index in the scratch pad list.

The scratch pad is a temporary memory area which is used to set up lists of selections for lrec, srec, or streaming data items. The user can copy any of these lists to the scratch pad, modify individual elements in the list, then save the scratch pad back to the original list.

The following example shows that field 5 in the scratch pad is set to index number 12, which is for the fuel pressure.

```
Send:      sp field 5
Receive:   sp field 5 12 fuel psi
```

set sp field *number value*

number = 1-32 for lrec and srec lists, 1-8 for streaming data lists

This command sets the scratch pad field *number* (item number in scratch pad list) to *value*, where *value* is the index number of a variable in the analog output variable list. Available variables and their corresponding index numbers may be obtained using the command “list var aout”. The “set sp field” command is used to create a list of variables which can then be transferred into the lrec, srec, or streaming data lists, using the “set copy sp to lrec”, “set copy sp to srec”, or “set copy sp to stream” commands.

```
Send:      set sp field 1 5
Receive:   set sp field 1 5 ok
```

stream per

This command reports the currently set time interval in seconds for streaming data. The following example reports the streaming period is set to 10 seconds.

Send: stream per
Receive: stream per 10 sec

set stream per *number value*

number value = | 1 | 2 | 5 | 10 | 20 | 30 | 60 | 90 | 120 | 180 | 240 | 300 |

This command sets the time interval between two consecutive streaming data strings to *number value* in seconds. The following example sets the number value to 10 seconds.

Send: set stream per 10
Receive: set stream per 10 ok

stream time

This command reports if the streaming data string will have a time stamp attached to it or not, according to **Table B–5**.

Send: stream time
Receive: stream time 0

set stream time *value*

This command enables *value*, where *value* is to attach or disable time stamp to streaming data string, according to **Table B–5**. The following example attaches a time stamp to streaming data.

Send: set stream time 1
Receive: set stream time 1 ok

Table B–5. Stream Time Values

Value	Stream Time
00	Disables time stamp to streaming data string
01	Attaches time stamp to streaming data string

Calibration

zero cyl *value*

This command reports the *value* of the cylinder used for zeroing, where *value* is either O₂, ir, or all. The following example reports that cylinder 2 is the ir zero cylinder.

Send: zero cyl ir
Receive: zero cyl ir 2

set zero cyl *value number*

This command sets the cylinder to use for zeroing *value to number*, where *value* is either O₂, ir, or all, and *number* denotes the cylinder number from 1 to 6. The following example sets cylinder 2 as the cylinder to use for zeroing ir.

Send: set zero cyl ir 2
Receive: set zero cyl ir 2 ok

span conc *number*

This command reports the span concentrations of gases in cylinder *number* where *number* is the number of the cylinder (1-6). The following example reports the span concentrations for cylinder 1.

Send: span conc 1
Receive: span conc 1
CO 20000.0000
Co2 150000.0000

set span conc *number gas value*

This command sets the concentration of *gas* in span cylinder *number* to *value*, where *gas* is the concentration of gases in the cylinder, *number* is the number of the span cylinder (1-6), and *value* is the concentration in ppb. The following example sets the CO concentration in span cylinder 1 to 20000 ppb.

Send: set span conc 1 co 20000
Receive: set span conc 1 co 20000 ok

span cylinder

This command reports the cylinder used for spanning. The following example reports that cylinder 2 is the cylinder used for spanning.

Send: span cylinder
Receive: span cylinder 2

set span cylinder *number*

This command sets the cylinder to use for spanning to *number*, where *number* is a number from 1-6. The following example sets cylinder 2 as the cylinder used for spanning.

Send: set span cylinder 2
Receive: set span cylinder 2 ok

set span

This command sets the instrument into span mode and begins calculating span factors. After running this command, wait for concentration readings to stabilize before continuing on in the span process. The following example sets the instrument into span mode and begins calculating span factors.

Send: set span
Receive: set span ok

cal span

This command triggers a span calibration based on the currently selected cylinder. To select a cylinder to be spanned, you can use the “set span cylinder” command or use digital inputs. Because this is a single gas, the cylinder should be defined as containing a single gas.

Once this is run, it may take several seconds before the values are ready to be stored, even if the command returns immediately. The following example begins final span factors calculations.

Send: set cal span
Receive: set cal span ok

set default cal

This command resets the user calibration settings to default values. This includes zero and span values, and span concentrations.

Send: set default cal
Receive: set default cal ok

event type *eventno*

This command reports the type of an event number (*eventno*). The following example reports that event 8 is a span type event.

Send: event type 8
Receive: event type 8 span

set event type *eventno type*

This command sets an event (*eventno*) to *type*, where *type* is zero, span or purge. The following example sets event 8 to span.

Send: set event type 8 span
Receive: set event type 8 span ok

event param *eventno*

This command reports the event parameter for the specified event. For events of type span, the command returns a span cylinder. For events of type zero, it returns the type of zero. The following example reports event 8 is a zero O₂.

Send: event param 8
Receive: event param 8 zero o2 ok

set event param *eventno param*

This command sets the parameter for event *eventno* to *param*. For event type of span, valid values for *param* are 1-6 and it represents the cylinder to span from. For events of type zero, valid values are 1-3, with 1 being “zero ir”, 2 being “zero O₂” and 3 being “zero all”. The following example sets event 8 to zero all.

Send: set event param 8 3
Receive: set event param 8 3 ok

event delay *eventno*

This command reports the delay time in seconds of the event specified by *eventno*. The following example reports that the delay time of event 8 is 120 seconds.

Send: event duration 8
Receive: event duration 8 120

set event delay *eventno delay*

This command sets the delay time in seconds (*delay*) of a specified event (*eventno*). The following example sets the delay time of event 8 to 120 seconds.

Send: set event delay 8 120
Receive: set event delay 8 120 ok

event duration *eventno*

This command reports the duration in seconds of the event specified by *eventno*. The following example reports that the duration of event 8 is 120 seconds.

Send: event duration 8
Receive: event duration 8 120

set event duration *eventno duration*

This command sets the duration in seconds (*duration*) of a specified event (*eventno*). The following example sets the duration of event 8 to 120 seconds.

Send: set event duration 8 120
Receive: set event duration 8 120 ok

event run *eventno*

This command will run the specified event (*eventno*). If the analyzer is not in sample mode, or another event is already running, it will report “wrong settings”. The following example will run event 8.

Send: set event run 8
Receive: set event run 8 ok

autocal check *sequence mode*

This command reports whether the autocal check *sequence* 1 or 2 is in check mode, where *mode* is On or Off. The following example reports that the autocal check 1 is not enabled (Off). The autocal check 2 command operates in the same manner as the autocal check 1 command.

Send: autocal check 1
Receive: autocal check 1 off

set autocal check *sequence mode onoff*

onoff = | on | off |

This command enables (On) or disables (Off) the autocal check for *sequence* 1 or 2. The following example enables the autocal check 1 (On).

Send: set autocal check 1 on
Receive: set autocal check 1 on ok

autocal freq *sequence*

This command reports the run frequency of autocal *sequence* 1 or 2 in seconds. The following example reports that the run frequency of autocal 1 sequence is 86400 seconds.

Send: autocal freq 1
Receive: autocal freq 1 86400

set autocal freq *sequence seconds*

This command sets the run frequency of the autocal 1 or 2 *sequence* in seconds. The following example sets the run frequency of autocal 1 sequence to 86400 seconds.

Send: set autocal freq 1 86400
Receive: set autocal freq 1 86400 ok

autocal action *sequence eventno*

This command reports which event is assigned for action number *eventno* in autocal *sequence* 1 or 2. The following example reports that the event number 8 is assigned for action number 2 in the autocal 1 sequence.

Send: autocal action 1 2
Receive: autocal action 1 2 8

set autocal action *sequence eventno event*

This command sets the action number *eventno* (1-10) to event number *event* (1-16) for autocal *sequence* 1 or 2. Omitting *event* or using the value 0 will set this *action* to “perform no event.” The following example sets event number 4 as the action number for event number 6 in the autocal 1 sequence.

Send: set autocal action 1 4 6
Receive: set autocal action 1 4 6 ok

mp table *gasname*

This command lists the points in the multipoint linearization table for the specified *gasname*, where *gasname* is the name of the selected gas (CO, CO₂, NO, NO₂, SO₂). The following example lists the points in the multipoint linearization table for CO.

Send: mp table co
Receive: mp table co

Measured	Actual
300.0	300.5
310.0	311.2
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0

mp lin *gasname*

This command reports whether the specified *gasname* is enabled for linearization or disabled, where *gasname* is the name of the selected gas (CO, CO₂, NO, NO₂, SO₂). The example that follows shows that CO is enabled for linearization.

Send: mp lin co
Receive: mp lin co enabled

set mp lin *gasname enabledisable*

enabledisable: 0 = disable, 1 = enable

This command enables/disables linearization for *gasname*, where *gasname* is the specified gas (CO, CO₂, NO, NO₂, SO₂), and *enabledisable* enables linearization (1) or disables linearization (0). The following example, sets CO to disabled (0).

Send: set mp lin co 0
Receive: set mp lin co 0 ok

mp points *gasname*

This command reports the number of points in the multipoint linearization table used for linearization for the specified *gasname*, where *gasname* is the name of the selected gas (CO, CO₂, NO, NO₂, SO₂). The following example reports that NO has four points in the linearization table.

Send: mp points NO
Receive: mp points NO 4

set mp points *gasname #ofpoints*

This command sets the number of points in the multipoint linearization table to be used for linearization for the specified *gasname*, where *gasname* is the name of the selected gas (CO, CO₂, NO, NO₂, SO₂), and *#ofpoints* is the number of points (2-10). The following example sets five points for SO₂ in the linearization table.

Send: set mp points so2 5
Receive: set mp points so2 5 ok

mp *gasname point*

This command reports the measured and actual values for the specified *gasname* and *point*, where *gasname* is specified gas (CO, CO₂, NO, NO₂, SO₂), and *point* is the specified point from the associated multipoint linearization table. The following example reports the measured and actual values for point 4 of CO.

Send: mp CO 4
Receive: mp CO 4 400.0 405.0

set mp *gasname point measured actual*

This command sets the measured and actual values for the specified *gasname* and *point*, where *gasname* is specified gas (CO, CO₂, NO, NO₂, SO₂), *point* is the specified point from the associated multipoint linearization table, *measured* is the associated measured value to input, and *actual* is the actual value to input. The following example sets the measured value for CO point 3 to 202.1 and the actual value to 200.0.

Send: set mp CO 3 202.1 200.0
Receive: set mp CO 3 202.1 200.0 ok

Keys Display

push *button*

do	help	ri	1
down	le	right	2
en	left	ru	3
enter	me	run	4
he	menu	up	

button = | do | down | en | enter | he | help | le | left | me | menu | ri | right |
ru | run | up | 1 | 2 | 3 | 4 |

These commands simulate pressing the front panel pushbuttons. The numbers represent the front panel soft keys, from left to right.

Send: push enter
Receive: push enter ok

isc

iscreen

This command retrieves the frame buffer data used for the display on the *iSeries* instrument. It is 19200 bytes in size, 2-bits per pixel, 4 pixels per byte arranged as 320 by 240 characters. The data is sent in RLE encoded form to save time in transmission. It is sent as a type '5' binary *c_link* response with no checksum.

The RLE encoding consists of a 0 followed by an 8-bit count of consecutive 0xFF bytes. The following 'c' code will expand the incoming data.

```
void      unpackDisplay ( void far* tdib, unsigned char far* rlescreen )
{
  int i,j,k;
  unsigned char far *sc4bpp, *sc2bpp, *screen, *ptr;

  ptr = screen = (unsigned char far *)malloc(19200);
  //RLE decode the screen
  for (i=0; i<19200 && (ptr - screen) < 19200; i++)
  {
    *(ptr++) = *(rlescreen + i);
```

```

if (*(rlescreen + i) == 0)
{
    unsigned char rlecount = *(unsigned char *)(rlescreen + ++i);
    while (rlecount)
    {
        *(ptr++) = 0;
        rlecount--;
    }
}
else if (*(rlescreen + i) == 0xff)
{
    unsigned char rlecount = *(unsigned char *)(rlescreen + ++i);
    while (rlecount)
    {
        *(ptr++) = 0xff;
        rlecount--;
    }
}
}
}
}

```

To convert this data into a BMP for use with windows, it needs to be turned into a 4BPP as that is the smallest windows can display. Also note that BMP files are upside down relative to this data, i.e. the top display line is the last line in the BMP.

sc

screen

This command is meant for backward compatibility on the C series. Screen information is reported using the “iscreen” command.

Send: screen
 Receive: screen
 This is an iseries instrument.
 Screen information not available.

Measurement Configuration

range *gas*

This command reports the current analog output range for the selected *gas* in ppb. Refer to **Table B–6** for a list of gas ranges.

Send: range co
 Receive: range co 150000.0000

set range *gas range*

This command sets the analog out range for *gas*, where *gas* is the selected gas, to *range*, where *range* is a floating point number representing (ppb). The following example sets the analog out range for CO (*gas*) to *value* (ppb).

Send: set range co 150000
 Receive: set range co 150000 ok

Table B–6. Gas Ranges

Gas	Range
CO	100 to 1000 ppm
CO ₂	2 to 20%
NO	100 to 1000 ppm
NO ₂	100 to 1000 ppm
O ₂	2.5 to 25%
SO ₂	200 to 2000 ppm

units *gas*

This command reports the display units for the selected *gas*. The following example reports the CO display units are ppm.

```
Send:          units co
Receive:       units co ppm
```

set units *gas value*

This command sets the display units for *gas*, where *gas* is the selected gas, to *value*, where *value* is ppm, µg/mg³, or %. The following example sets the CO display units to ppm.

```
Send:          set units co ppm
Receive:       set units co ppm ok
```

sys bb period

This command reports the system blowback period. The following example reports the system blowback period is 2 hours.

```
Send:          sys bb period
Receive:       sys bb period 2 hours
```

set sys bb period *value*

This command sets the system blowback period to *value*, where *value* is the number of seconds. The following example sets the system blowback period to 1 hour (3600 seconds).

```
Send:          set sys bb period 3600
Receive:       set sys bb period 3600 ok
```

sys bb duration

This command reports the duration for system blowback in seconds. The following example reports the system blowback duration is 10 seconds.

Send: sys bb duration
Receive: sys bb duration 10 sec

set sys bb duration *value*

This command sets the system blowback duration to *value*, where *value* is the number of seconds. The following example sets the system blowback duration to 15 seconds.

Send: set sys bb duration 15
Receive: set sys bb duration 15 ok

sys power probe barrel

This command reports the On or Off status of the component power for the system probe barrel. The following example reports the component power for the system probe barrel is On.

Send: sys power probe barrel
Receive: sys power probe barrel on

set sys power probe barrel *onoff*

onoff = | on | off |

This command turns component power for the system probe barrel On or Off. The following example turns On component power for the system probe barrel.

Send: set sys power probe barrel on
Receive: set sys power probe barrel on ok

sys power probe filter

This command reports the On or Off status of the component power for the system probe filter. The following example reports the component power for the system probe filter is On.

Send: sys power probe filter
Receive: sys power probe filter on

set sys power probe filter *onoff*

onoff = | on | off |

This command turns component power for the system probe filter On or Off. The following example turns On component power for the system probe filter.

Send: set sys power probe filter on
Receive: set sys power probe filter on ok

sys power umbilical 1

This command reports the On or Off status of the component power for umbilical 1. The following example reports the component power for the

umbilical 1 is Off. The sys power umbilical 2 command performs the same function for umbilical 2.

Send: sys power umbilical 1
Receive: sys power umbilical 1 off

set sys power umbilical 1 *onoff*

onoff = | on | off |

This command turns component power for umbilical 1 On or Off. The following example turns On component power for umbilical 1.

Send: set sys power umbilical 1 on
Receive: set sys power umbilical 1 on ok

sys probe barrel set temp

This command reports the set temperature for the system probe barrel. The following example reports the system probe barrel set temperature is 175 degrees C.

Send: sys probe barrel set temp
Receive: sys probe barrel set temp 175.000 deg C

set sys probe barrel set temp *value*

This command defines the set temperature for the system probe barrel to *value*, where *value* is a floating point number representing temperature in degrees C. The following example defines the set temperature for the system probe barrel to 175 degrees C.

Send: set sys probe barrel set temp 175
Receive: set sys probe barrel set temp 175 ok

sys probe filter set temp

This command reports the set temperature for the system probe filter. The following example reports the system probe filter set temperature is 175 degrees C.

Send: sys probe filter set temp
Receive: sys probe filter set temp 175.000 deg C

set sys probe filter set temp *value*

This command defines the set temperature for the system probe filter to *value*, where *value* is a floating point number representing temperature in degrees C. The following example defines the set temperature for the system probe filter to 175 degrees C.

Send: set sys probe filter set temp 175
Receive: set sys probe filter set temp 175 ok

Hardware
Configuration

sys umb 1 set temp
This command reports the set temperature for umbilical zone 1. The following example reports the umbilical zone 1 set temperature is 165 degrees C. The sys umb 2 set temp command performs the same function for sys umbilical 2.

Send: sys umb 1 set temp
Receive: sys umb 1 set temp 165.000 deg C

set sys umb 1 set temp *value*
This command defines the set temperature for umbilical zone 1 to *value*, where *value* is a floating point number representing temperature in degrees C. The following example defines the set temperature for umbilical zone 1 to 165 degrees C.

Send: set sys umb 1 set temp 165
Receive: set sys umb 1 set temp 165 ok

contrast
This command reports the screen's level of contrast. The following example shows the screen contrast is 50%, according to **Table B-7**.

Send: contrast
Receive: contrast 10:50%

set contrast *level*
This command sets the screen's *level* of contrast, according to **Table B-7**. The following example sets the contrast level to 50%.

Send: set contrast 10
Receive: set contrast 10 ok

Table B-7. Contrast Levels

<i>Level</i>	Contrast Level
0	0%
1	5%
2	10%
3	15%
4	20%
5	25%
6	30%
7	35%

<i>Level</i>	Contrast Level
8	40%
9	45%
10	50%
11	55%
12	60%
13	65%
14	70%
15	75%
16	80%
17	85%
18	90%
19	95%
20	100%

date

This command reports the current date. The following example reports the date as December 1, 2007.

```
Send:      date
Receive:   date 12-01-07
```

set date *mm-dd-yy*

mm = month

dd = day

yy = year

This command sets the date of the analyzer's internal clock. The following example sets the date to December 1, 2007.

```
Send:      set date 12-01-07
Receive:   set date 12-01-07 ok
```

set default params

This command sets all the parameters to their default values. This does not affect the factory-calibrated parameters.

```
Send:      set default params
Receive:   set default params ok
```

save**save params**

This command stores all current parameters in FLASH memory. It is important that each time instrument parameters are changed, that this command be sent. If changes are not saved, they will be lost in the event of a power failure. The following example saves the parameters to FLASH memory.

```
Send:          set save params
Receive:       set save params ok
```

time

This command reports the current time (24-hour time). The following example reports that the internal time is 2:15:30 pm.

```
Send:          time
Receive:       time 14:15:30
```

set time *hh:mm:ss*

hh = hours

mm = minutes

ss = seconds

This command sets the internal clock (24-hour format). The following example sets the internal time to 2:15 pm.

Note If seconds are omitted, the seconds default to 00. ▲

```
Send:          set time 14:15
Receive:       set time 14:15 ok
```

user scr title *screen*

This command reports the title for user *screen*, where *screen* is between 1 and 5 inclusive. The example that follows reports the title for user screen 2.

```
Send:          user scr title 2
Receive:       user scr title 2 CO AND CO2 CONCENTRATIONS
```

set user scr title *screen title*

This command sets the *title* for user screen *screen*, where *screen* is between 1 and 5 inclusive, and *title* is the text for the title. Title will be auto-centered in the heading and will be translated into uppercase. Title has a maximum length of 26 characters. The following example sets title for user screen 2 to CO AND CO2 CONCENTRATIONS.

```
Send:          set user scr title 2 CO AND CO2 CONCENTRATIONS
Receive:       set user scr title 2 CO AND CO2 CONCENTRATIONS ok
```

user scr items *screen*

This command reports the number of items on user *screen*, where *screen* is between 1 and 5 inclusive. The example that follows reports the number of items on user screen 2.

```
Send:          user scr items 2
Receive:       user scr items 2 2
```

set user scr items *screen number*

This command sets the *number* of items on user *screen*, where *screen* is between 1 and 5 inclusive, and *number* is the number of items between 1 and 10 inclusive. The following example sets number of items on user screen 2 to 4.

```
Send:          set user scr items 2 4
Receive:       set user scr items 2 4 ok
```

user scr active *screen*

This command reports the active state of user *screen*, where *screen* is between 1 and 5 inclusive. The example that follows reports the state of user screen 2 as active.

```
Send:          user scr active 2
Receive:       user scr active 2 active
```

set user scr active *screen state*

This command sets the active *state* of user *screen*, where *screen* is between 1 and 5 inclusive, and *screen* is active if *state* is 1, and inactive for other values. The following example sets user screen 2 to active.

```
Send:          set user scr active 2 1
Receive:       set user scr active 2 1 ok
```

copy sp to scr *screen*

This command copies the first 10 non-zero items in scratch pad to user *screen*, where *screen* is between 1 and 5 inclusive. The following example copies the first 10 non-zero items in scratch pad to user screen 2.

Send: set copy sp to scr 2
Receive: set copy sp to scr 2 ok

copy scr to sp *screen*

This command copies the items of user *screen*, where *screen* is between 1 and 5 inclusive, into the first 10 entries of the scratch pad. The following example copies items of user screen 2 into the first 10 entries of the scratch pad.

Send: set copy scr to sp 2
Receive: set copy scr to sp 2 ok

list scr *screen*

This command lists the 10 items in user *screen*, where *screen* is between 1 and 5 inclusive. All items are listed regardless of their display. The following example lists the 10 items in user screen 2.

Send: list scr 2
Receive: list scr 2 ok

field index variable

1 2 co

2 3 co2

3 4 no

4 5 no2

5 6 so2h

6 7 so2l

7 8 h2o

8 12 n20h

9 1 refl

of items: 2

title: " CO AND CO2 CONCENTRATIONS"

state: active

Communications Configuration

addr dns

This command reports the TCP/IP address for the domain name server.

Send: addr dns
Receive: addr dns 192.168.1.1

set addr dns *address*

This command sets the dns *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by “.”.

Send: set addr dns 192.168.1.1
Receive: set addr dns 192.168.1.1 ok

addr gw

This command reports the default TCP/IP gateway address.

Note This command cannot be used when DHCP is On. Refer to the DHCP command that follows for additional information. ▲

Send: addr gw
Receive: addr gw 192.168.1.1

set addr gw *address*

This command sets the default gateway *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by “.”.

Send: set addr gw 192.168.1.1
Receive: set addr gw 192.168.1.1 ok

addr ip

This command reports the IP address of the analyzer.

Note This command cannot be used when DHCP is On. Refer to the DHCP command that follows for additional information. ▲

Send: addr ip
Receive: addr ip 192.168.1.200

set addr ip *address*

This command sets the analyzer's IP *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by “.”.

```
Send:          set addr ip 192.168.1.200
Receive:       set addr ip 192.168.1.200 ok
```

addr nm

This command reports the IP netmask.

Note This command cannot be used when DHCP is On. Refer to the DHCP command that follows for additional information. ▲

```
Send:          addr nm
Receive:       addr nm 255.255.255.0
```

set addr nm *address*

This command sets the nm *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by “.”.

```
Send:          set addr nm 255.255.255.0
Receive:       set addr nm 255.255.255.0 ok
```

addr ntp

This command reports the IP address for the network time protocol server. See “Network Time Protocol Server” in the “Communication Settings” section of the “Operation” chapter for more information.

```
Send:          addr ntp
Receive:       addr ntp 10.209.43.237
```

set addr ntp *address*

This command sets the network time protocol server *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by “.”.

```
Send:          set addr ntp 10.209.43.237
Receive:       set addr ntp 10.209.43.237 ok
```

baud

This command reports the current baud rate for the serial port (RS232/RS485). The following example reports that the current baud rate

```
Send:          baud
Receive:       baud 9600
```

set baud *rate*

rate = | 1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200 |

This command sets the instrument baud rate to *rate*. The following example sets the instrument’s baud rate to 9600.

Note After the command is sent, the baud rate of the sending device must be changed to agree with the instrument. ▲

```
Send:          set baud 9600
Receive:       set baud 9600 ok
```

dhcp

This command reports the current state of use of the Dynamic Host Configuration Protocol (DHCP) as On or Off. DHCP is used to assign an IP address to the instrument automatically. The example that follows shows that DHCP is On.

```
Send:          dhcp
Receive:       dhcp on
```

set dhcp *onoff*
onoff = | on | off |

This command enables (*on*) and disables (*off*) the DHCP service. When DHCP is set to On, the instrument gets the IP address, the netmask address, and the gateway address from a DHCP server. When DHCP is set to Off, the instrument gets these addresses from system memory. The following example sets the DHCP service to On.

Note When changing the IP address, the netmask address, or the gateway address, you must cycle power to the instrument before the change takes effect. Until you cycle the power, the address assigned by the DHCP server will still be used and reported as the current address. ▲

```
Send:          set dhcp on
Receive:       set dhcp on ok
```

format

This command reports the current reply termination format. The following example shows that the reply format is 00, which means reply with no checksum, according to Table B–8.

```
Send:          format
Receive:       format 00
```

set format *format*

This command sets the reply termination *format*, where *format* is set according to **Table B–8**. The following example sets the reply termination format to checksum.

```
Send:          set format 01
Receive:       set format 01 ok
```

Table B–8. Reply Termination Formats

Format	Reply Termination
00	<CR>
01	<NL> sum xxxx <CR>

where xxxx = 4 hexadecimal digits that represent the sum of all the characters (bytes) in the message

host name

This command reports the host name string. The following example reports the host name is set to *iSeries*.

```
Send:          host name
Receive:       host name iSeries
```

set host name *string*

This command sets the host name *string*, where *string* is 1-13 alphanumeric characters. The following example sets the host name to analyzer01.

```
Send:          set host name analyzer01
Receive:       set host name analyzer01 ok
```

instr name

This command reports the instrument name. The following example reports the instrument name for the Model 60*i*.

```
Send:          instr name
Receive:       instr name
               Multigas Analyzer
               Multigas Analyzer
```

instrument id

This command reports the instrument identification (ID). The following example reports the current setting of the instrument ID.

```
Send:          instrument id
Receive:       instrument id 60
```

set instrument id *value*

This command sets the instrument ID to *value*, where *value* is an integer between 0 and 127 inclusive. The following example shows the instrument ID changed is 60.

Note Sending this command via RS-232 or RS-485 will require the host to use the new ID for subsequent commands. ▲

Send: set instrument id 60
Receive: set instrument id 60 ok

set layout ack *value*

This command disables the stale layout/layout change indicator (“*”) that is attached to each response if the erec layout has changed since the last time erec layout was requested, where *value* represents the function, according to **Table B–9**.

Send: set layout ack
Receive: set layout ack ok

Table B–9. Set Layout Ack Values

<i>Value</i>	Function
0	Do nothing (default)
1	Append “*”

program no

This command reports the analyzer’s model information and program version number, which will be dependent on the current version.

Send: program no
Receive: program no iSeries 60iTLE 01.02.12.095

allow mode cmd

This command reports the current allow mode setting: 1 = allow “set mode local” or “set mode remote” commands; 0 = ignore “set mode local” or “set mode remote” commands. The default value is 0; ignore the commands (**Table B–10**). The example that follows shows that the instrument is configured to ignore “set mode local” or “set mode remote” commands.

Send: allow mode cmd
Receive: allow mode cmd 0

set allow mode cmd *value*

This command is used to configure the instrument to *value*, where *value* is either 1 = accept or 0 = ignore the “set mode local” and “set mode remote” commands. Refer to the table that follows.

If the instrument is set to accept the commands (*value* = 1), the “set mode local” command will unlock the instrument and the keypad can be used to make changes via the front panel.

If the instrument is set to ignore the commands (*value* = 0), the instrument will respond with “ok” as if the command has been accepted and acted upon, **but will not change the instrument lock status** (this is for compatibility with systems expecting an “ok” response).

Note The instrument will always respond to the command “mode” with the status of the password lock as “mode local” or “mode remote” regardless of the above setting.▲

The example that follows sets the instrument to accept the “set mode local” or “set mode remote” commands.

Send: set allow mode cmd 1
Receive: set allow mode cmd 1 ok

Table B–10. Allow Mode Command Values

<i>Value</i>	Allow Mode Command
0	Ignore (default)
1	Accept

power up mode

This command reports the current power up mode setting, where *value*, is either 0 = local/unlocked or 1 = remote/locked. The default value is 0; power up in local/unlocked mode (**Table B–11**). The example that follows shows that the instrument is configured to power up in the remote/locked mode.

Send: power up mode
Receive: power up mode 1

set power up mode *value*

This command is used to configure the instrument to power up in the local/unlocked mode (*value* = 0) or the remote/locked mode (*value* = 1).

If the instrument is set to power up in the local/unlocked mode, the keypad can be used to make changes via the front panel. If the instrument is set to

power up in the remote/locked mode, changes can not be made from the front panel. The example that follows sets the instrument to power up in remote/locked mode.

Send: set power up mode 1
Receive: set power up mode 1 ok

Table B–11. Power Up Mode Values

<i>Value</i>	Power Up Mode Command
0	Local/Unlocked (default)
1	Remote/Locked Mode

tz

This command reports the “tz” timezone string for the NTP server. See “Network Time Protocol Server” in the “Communication Settings” section of the “Operation” chapter for more information.

Send: tz
Receive: tz EST+5EDT

set tz *string*

This command sets the timezone *string* for the instrument for use with the NTP server, where *string* is a standard timezone string. Common strings are listed in the “Timezone” screen description in the “Operation” chapter.

Send: set tz EST+5EDT
Receive: set tz EST+5EDT ok

I/O Configuration

analog iout range *channel*

This command reports the analog current output range setting for *channel*, where *channel* must be between 1 and 6, inclusive. The following example reports current output channel 4 is in the 4-20 mA range, according to Table B–12. This command responds with “feature not enabled” if the I/O expansion board is not detected.

Send: analog iout range 4
Receive: analog iout range 4 2

set analog iout range *channel range*

This command sets analog current output *channel* to the *range* where *channel* is between 1 and 6 inclusive, and *range* is set according to **Table B–12**. The following example sets current output channel 4 to the 0-20 mA range. This command responds with “feature not enabled” if the I/O expansion board is not detected.

Send: set analog iout range 4 1
Receive: set analog iout range 4 1 ok

Table B–12. Analog Current Output Range Values

Range	Output Range
1	0-20 mA
2	4-20 mA
0 [cannot be set to this, but may report]	Undefined

analog vin *channel*

This command retrieves the analog voltage input *channel* data, both the calculated value and the actual voltage. In the following example, the “calculated” value of channel 1 is 75.325 degrees F, volts are 2.796. This command responds with “feature not enabled” if the I/O expansion board is not detected.

Send: analog vin 1
Receive: analog vin 1 75.325 2.796

analog vout range *channel*

This command reports the analog voltage output *channel* range, where *channel* is between 1 and 6 inclusive, according to Table B–13.

Send: analog vout range 2
Receive: analog vout range 2 3

set analog vout range *channel range*

This command sets analog voltage output *channel* to the range, where *channel* is between 1 and 6 inclusive, and *range* is set according to Table B–13. The following example sets channel 2 to the 0-10 V range.

Send: set analog vout range 2 3
Receive: set analog vout range 2 3 ok

Table B–13. Analog Voltage Output Range Values

Range	Output Range
1	0-1 V
2	0-100 mV
3	0-10 V
4	0-5 V
0 [cannot be set to this, but may report]	Undefined

dig in

This command reports the status of the digital inputs as a 4-digit hexadecimal string with the most significant bit (MSB) being input 16.

Send: dig in
Receive: dig in 0xff7f

din channel

This command reports the action assigned to input *channel* and the corresponding active state. The following example reports input 5 to be assigned an index number 9 corresponding to action of “analog outputs to zero” with the active state being high.

Send: din 5
Receive: din 5 9 AOUTS TO ZERO high

set din channel index state

This command assigns digital input *channel* (1-16) to activate the action indicated by *index* (1-35), when the input transitions to the designated *state* (high or low). Use the “list var din” command to obtain the list of supported *index* values and corresponding actions. The following example sets the digital input channel 1 to 3 on a low-to-high transition.

Send: set din 1 3 high
Receive: set din 1 3 high ok

dout channel

This command reports the index number, output variable and the active state assigned to digital output *channel*. The following example reports output 4 to be assigned an index number 11 corresponding to action of “general alarm”.

Send: dout 4
Receive: dout 4 11 GEN ALARM open

set dout channel index state

This command assigns digital output *channel* to be assigned to the action associated with *index*, and assigns it an active state of *state* (open or closed). Use the “list var dout” command to obtain the list of supported index values and corresponding state. The following example sets the digital output channel 4 to state 11.

Send: set dout 4 11 open
Receive: set dout 4 11 open ok

dtoa channel

This reports the outputs of the 6 or 12 Digital to Analog converters, according to Table B–14. The following example shows that the D/A #1 is 97.7% full scale.

```
Send:      dtoa 1
Receive:   dtoa 1 97.7%
```

Note All channel ranges are user definable. If any customization has been made to the analog output configuration, the default selections may not apply. ▲

Table B–14. Default Output Assignment

D to A	Function	Single Range	Dual Range	Auto Range
1	Voltage Output	CO	Low CO	CO
2	Voltage Output	CO	High CO	Range Status
3	Voltage Output	Not Used	Not Used	Not Used
4	Voltage Output	Not Used	Not Used	Not Used
5	Voltage Output	Not Used	Not Used	Not Used
6	Voltage Output	Not Used	Not Used	Not Used
7	Current Output	CO	Low CO	CO
8	Current Output	CO	High CO	Range Status
9	Current Output	Not Used	Not Used	Not Used
10	Current Output	Not Used	Not Used	Not Used
11	Current Output	Not Used	Not Used	Not Used
12	Current Output	Not Used	Not Used	Not Used

relay stat

This command reports the current relay logic normally “open” or normally “closed,” if all the relays are set to same state, that is all open or all closed. The following example shows that the status when all the relays logic is set to normally “open”.

```
Send:      relay stat
Receive:   relay stat open
```


Note If individual relays have been assigned different logic then the response would be a 4-digit hexadecimal string with the least significant byte (LSB) being relay no 1. ▲

For example:

Receive: relay stat 0x0001 (indicates relay no 1 is set to normally open logic, all others are normally closed)
Receive: relay stat 0x0005 (indicates relay no 1 and 3 are set to be normally open logic, all others are normally closed)

set relay open
set relay open *value*
set relay closed
set relay closed *value*

These commands set the relay logic to normally open or closed for relay number *value*, where *value* is the relay between 1 and 16. The following example sets the relay no 1 logic to normally open.

Note If the command is sent without an appended relay number, then all the relays are assigned the set logic of normally open/closed. ▲

Send: set relay open 1
Receive: set relay open 1 ok

set cal single gas span

This command triggers a single gas span for the currently selected cylinder. To select a cylinder to be spanned, you can use the “set span cylinder” command or use digital inputs. Because this is a single gas, the cylinder should be defined as containing a single gas.

Send: set cal single gas span
Receive: set cal single gas span ok

cal status

This command reports the flags for span calculation failure. The value reported is a one byte (8-bit) number represented as two hex digits. A bit is set to 1 for “fail,” and 0 for “pass.”

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UNUSED	O ₂	UNUSED	NO ₂	NO	SO ₂	CO ₂	CO

Send: cal status
Receive: cal status 02

cal user zero

This command stores the current absorbances as zero.

Send: cal user zero
Receive: cal user zero ok

sample

This command sets the gas mode to sample.

Send: set sample
Receive: set sample ok

zero

This command sets the gas mode to zero.

Send: set zero
Receive: set zero ok

detector temp

This command reports the detector temperature in degrees C.

Send: detector temp
Receive: detector temp 47.0 deg C

source temp

This command reports the temperature at the source housing in degrees C.

Send: source temp
Receive: source temp 56.5 deg C

temp comp

This command reports the current setting for temperature compensation. The example that follows shows that the temperature compensation is set to Off (no temperature compensation).

Send: temp comp
Receive: temp comp off

set temp comp *onoff*

This command sets the temperature compensation to *onoff*, where *On* is temperature compensation On, and *Off* is temperature compensation Off.

Send: set temp comp on
Receive: set temp comp on ok

event halt

This command reports the status of the event halt control bit. When the event halt bit is reported as 1, it indicates that the currently running event

or sequence has been stopped. The following example reports that the currently running event or sequence has been stopped.

```
Send:          event halt
Receive:       event halt 1
```

set event halt

This command stops the currently running event or sequence by setting the event halt control bit. This control bit is reset to 0 after the event is halted.

```
Send:          set event halt
Receive:       set event halt ok
```

flow

This command reports the status of the flow switch as OK or flow low.

```
Send:          flow
Receive:       flow ok
```

pres comp

This command reports the current setting for pressure compensation. The example that follows shows that the pressure compensation is set to Off (no pressure compensation).

```
Send:          pres comp
Receive:       pres comp off
```

set pres comp *onoff*

This command sets the pressure compensation to *onoff*, where *On* is pressure compensation On, and *Off* is pressure compensation Off.

```
Send:          set pres comp on
Receive:       set pres comp on ok
```

pres

This command reports the bench pressure in mm Hg. The first pressure shown is the pressure value being used in instrument calculations. The second pressure shown is the actual pressure reading being measured.

```
Send:          pres
Receive:       pres 738.8 mm Hg, actual 738.8
```

span coef *gas*

This command reports the span coefficient for the selected *gas*. The following example reports the span coefficient for CO is 1.012.

Send: span coef co
Receive: span coef co 1.012

set span coef *gas*

This command sets the span coefficient for the selected *gas*. The following example reports the span coefficient for NO is set to 1.023.

Send: set span coef no 1.023
Receive: set span coef no 1.023 ok

sys alarm bb pres min**sys alarm bb pres max**

These commands report the system alarm blowback pressure minimum and maximum value current settings.

Send: sys alarm blowback pressure min
Receive: sys alarm blowback pressure min 30 psi.

set sys alarm bb pres min *value***set sys alarm bb pres max *value***

These commands set the system alarm blowback pressure minimum and maximum values to *value*, where *value* is a floating point number representing the alarm pressure limits. The example that follows sets the system alarm blowback pressure maximum value to 80 psi. Alarm limit range is 30-85 psi.

Send: set sys alarm blowback pressure max 80
Receive: set sys alarm blowback pressure max 80 ok

sys alarm umb 1 temp min**sys alarm umb 1 temp max**

These commands report the system umbilical temperature alarm minimum and maximum value current settings for umbilical 1 in degrees C. The sys alarm umb 2 temp command functions in the same manner.

Send: sys alarm umb 1 temp min
Receive: sys alarm umb 1 temp min 160 deg C

set sys alarm umb 1 temp min *value***set sys alarm umb 1 temp max *value***

These commands set the system umbilical temperature alarm minimum and maximum values to *value*, where *value* is a floating point number

representing the alarm temperature limits. The set sys alarm umb 2 temp command functions in the same manner. The example that follows sets the sys alarm umb 1 temp maximum value to 170 degrees C.

```
Send:      set sys alarm umb 1 temp max 170
Receive:   set sys alarm umb 1 temp max 170 ok
```

sys temps

This command reports probe filter, probe barrel, umbilical 1, and umbilical 2 temperatures in degrees C.

```
Send:      sys temps
Receive:   sys temps 125.1 130.2 127.3 127.2
```

gas mode

This command reports the current gas mode, sample, zero ir, zero O₂, zero all, span mg, and span sg.

```
Send:      gas mode
Receive:   gas mode sample
```

lock outputs

This command reports the state of the C-link analog output lock. When the lock is On, the analog outputs will hold their values as designated by the analog out lock type (lock action command). The following example reports the concentration output lock is Off.

```
Send:      lock outputs
Receive:   lock outputs off
```

set lock outputs *onoff*

onoff = | on | off |

This command sets the C-link analog output lock *onoff*, where *On* sets the output lock On, and *Off* sets the output lock Off. The following example sets the concentration output lock to On.

```
Send:      set lock outputs on
Receive:   set lock outputs on ok
```

lock percent

This command reports the percent of output range that the analog outputs will lock to if locking is active and the action is set to “lock to percentage”.

The following example reports that the percent of output range that the analog outputs will lock to is 100 percent.

```
Send:      lock percent
Receive:   lock percent 100
```

set lock percent *value*

value = -5 to 105

This command sets the analog output lock percentage to an integer *value*, where *value* is the percent of the output range that the analog outputs will lock to if locking is active. Limits are from -5 to 105, in percent of range. For example, if the user sends the command "set lock percent 105" then when the analog outputs are locked, they will be locked at 10.5 volts if the outputs are set to the 0-10 volt range. The following example sets the lock percent to 100 percent.

Send: set lock percent 100
Receive: set lock percent 100 ok

lock action

This command reports the analog output lock action, where 1 = No locking action, 2 = lock to current analog output value (holds at value previous to lock), or 3 = lock to percentage (where percentage is the value set by the "lock percent" command or screen. The following example reports that the analog output lock action (2) is set to lock to current analog output value.

Send: lock action
Receive: lock action 2

set lock action *value*

value = 1, 2, or 3

This command sets the analog output lock action to *value*, where *value* is 1 = No locking action, 2 = lock to current analog output value (holds at value previous to lock), or 3 = lock to percentage (where percentage is the value set by the "lock percent" command or screen. The following example sets the analog output lock action (3) to lock to *percentage* (where *percentage* is the value set by the "lock percent" command or screen).

Send: set lock action 3
Receive: set lock action 3 ok

Record Layout Definition

The erec, lrec, and srec layouts contain the following:

- A format specifier for parsing ASCII responses
- A format specifier for parsing binary responses

In addition to these, the erec layout contains:

- A format specifier for producing the front panel display screens

Values are read using either the ASCII or binary format specifiers and converted to uniform internal representations (32-bit floats or 32-bit integers). These values are converted into text for display on the screen using the format specifier for the front panel display. Normally, the specifier used to parse a particular datum from the input stream will be strongly related to the specifier used to display it (such as, all of the floating point inputs will be displayed with an 'f' output specifier, and all of the integer inputs will be displayed with a 'd' specifier).

Format Specifier for ASCII Responses

The first line of the layout response is the scanf-like parameter list for parsing the fields from an ASCII erec response. Parameters are separated by spaces and the line is terminated by a “\n” (the normal line separator character). Valid fields are:

- %s - parse a string
- %d - parse a decimal number
- %ld - parse a long (32-bit) decimal number
- %f - parse a floating point number
- %x - parse a hexadecimal number
- %lx - parse a long (32-bit) hex number
- %* - ignore the field

Note Signed versus unsigned for the integer values does not matter; it is handled automatically. ▲

Format Specifier for Binary Responses

The second line of the layout response is the binary parameter list for parsing the fields from a binary response. Parameters **MUST** be separated by spaces, and the line is terminated by a '\n'. Valid fields are:

- t - parse a time specifier (2 bytes)
- D - parse a date specifier (3 bytes)
- i - ignore one 8-bit character (1 byte)
- e - parse a 24-bit floating point number (3 bytes: n/x)
- E - parse a 24-bit floating point number (3 bytes: N/x)

f - parse a 32-bit floating point number (4 bytes)
 c - parse an 8-bit signed number (1 byte)
 C - parse an 8-bit unsigned number (1 byte)
 n - parse a 16-bit signed number (2 bytes)
 N - parse a 16-bit unsigned number (2 bytes)
 m - parse a 24-bit signed number (3 bytes)
 M - parse a 24-bit unsigned number (3 bytes)
 l - parse a 32-bit signed number (4 bytes)
 L - parse a 32-bit unsigned number (4 bytes)

There is an optional single digit *d* which may follow any of the numeric fields, which indicates that after the field has been parsed out, the resulting value is to be divided by 10^d . Thus the 16-bit field 0xFFC6 would be interpreted with the format specifier 'n3' as the number -0.058.

Format Specifier for Erec Layout

The subsequent lines in the erec layout response describe the appearance of the full panel. The full instrument panel as it appears on the screen has two columns of lines. Each line is composed of three major components: (1) a text field, (2) a value field, and (3) a button. None of these three components is required. The text field contains statically displayed text.

The value field displays values which are parsed out of the response to a erec command. It also displays, though background changes, alarm status. The button, when pressed, triggers input from either a dialog box or a selection list. There are five kinds of buttons, B, I, L, T, and N.

Each line in the layout string corresponds to one line on the display. The layout string describes each of the three major fields as well as translation mechanisms and corresponding commands.

Text The first field in the layout string is the text. It is delimited by a ':'. The string up to the first ':' will be read and inserted in the text field of the line.

Value String This is followed by a possible string enclosed in quotes that is used to place a string into the value field.

Value Source The value source, which is the item (or word) number in the DATA/EREC response, appears next. This is followed by an optional bitfield designator. The datum identified by the value source can be printed as a string 's', hexadecimal 'x', decimal 'd', floating point 'f', or binary 'b' number.

Typically, bitfield extractions are only done for decimal or hexadecimal numbers.

Floating-point numbers can be followed with an optional precision specifier which will be used as an argument to printf's %f format (for example, a field of '4' would be translated into the printf command of '%.3f'). Alternately, the special character '*' can precede the precision specifier; this causes an indirection on the precision specifier (which now becomes a field number).

This is useful when formatting, for example, numbers which have varying precision depending on the mode of the instrument.

Binary numbers can also have an optional precision specifier which is used to determine how many bits to print. For example, the specifier 'b4' will print the lowest four bits of the parsed number.

There are serious restrictions on where an 's' field may appear: currently sources 1 and 2 must be 's', and no others may be 's'.

Alarm Information

The value source is followed by optional alarm information, indicated by a commercial at sign '@' with a source indicator and a starting bit indicator. All alarm information is presumed to be two bits long (low and high). The bitfield extraction is performed on the integer part of the source. Typical alarm information would appear as '@6.4'.

Translation Table

Then, there appears an optional translation table within braces '{}'. This is a string of words separated by spaces. An example translation table would be '{Code_0 Code_1 Code_2 Code_3}'. The value, once extracted, is used as a zero-based index into the translation table to determine the string to display.

Selection Table

Then there appears an optional selection table within parentheses '(...)'. This is a string of numbers separated by spaces '(0 1)'. The selection table lists the translation table entries which the user may select from when setting the parameter. This is not necessarily the same as the entries which may be displayed.

Button Designator

Then there appears an optional button designator. This will be one of 'B', 'T', 'L', 'T', or 'N'.

B—Indicates a button which pops up an input dialog prompting the user for a new value using the designated input format. The input format is specified from the 'B' through the subsequent semicolon.

I—Indicates a button which pops up a selection list with input translation. That is, the values read are translated before they are compared to the selection list options.

L—Indicates a button which pops up a selection list without any translation. The output value is the number of the selected option.

T—Indicates a button which pops up a selection list with output translation. The number of the option selected is used as an index into the translation table to generate an output string.

N—Indicates a button which only sends the subsequent command to the instrument. No user-prompting happens.

The following string through an optional '|' or the end of the line is the command which is to be sent to the instrument upon the completion of the button selection. The command string should normally contain print-style formatting to include the user input. If a '|' is present, it indicates a command which is sent to the instrument upon successful completion of the button command to update the value field.

Examples

Some examples ('\n' is the C syntax for an end-of-line character):

```
'Concentrations\n'
```

This is a single text-only line.

```
'\n'
```

This is a single blank line.

```
' NO:3s\n'
```

This is a line which appears slightly indented. The text field is 'NO', the value is taken from the third element of the data response, and interpreted as a string.

```
' NO:18sBd.ddd;set no coef %s\n'
```

This is a line which also appears slightly indented. The next field is also 'NO', but the value is taken from the eighteenth element of the data response, again interpreted as a string. A button appears on this line which, when pressed, pops up an input dialog which will state "Please enter a new value for NO using a d.ddd format." The string entered by the user is used to construct the output command. If the user enters, for example, '1.234', the constructed command will be 'set no coef 1.234'.

```
' NO:21f{Code_0 Code_1 Code_2 Code_3 Code_4 Code_5 Code_6
Code_7 Code_8 Code_9 Code_10 Code_11}Lset range no %d\n'
```

This is a line which appears slightly indented, the title is again 'NO', and the value is the twenty-first element of the data response, interpreted as a floating-point number. There is a no-translation button which creates a selection list of twelve "Code nn" options. The number of the user selection is used to create the output command.

```
'Mode:6.12-13x{local remote service service}(0 1)Tset mode
%s\n'
```

This is a line which has a title of 'Mode' and value taken from the sixth field of the data response. There is a bitfield extraction of bits 12 through 13 from the source (the value type is not important here because the value is being translated to an output string). Once the bits have been extracted, they are shifted down to the bit-zero position. Thus, the possible values of this example will be 0 through 3. The translation list shows the words which correspond to each input value, the zero index value appearing first (0 -> local, 1 -> remote, etc.). The selection list shows that only the first two values, in this case, are to be shown to the user when the button is pressed. The 'T' button indicates full translation, input code to string, and user selection number to output string.

```
'\xC'
```

This is a line that starts a new column (the \xC or ^L).

```
' Comp:6.11x{off on}Tset temp comp %s\n'
```

This shows that the bitfield end (the second part of a bitfield specification) is optional. The bitfield will be one bit long, starting in this case at the eleventh bit.

```
'Background:7f*8Bd.ddd;set o3 bkg %s\n'
```

This shows the use of indirect precision specifiers for floating point displays. The background value is taken from the 7th element, and the precision specifier is taken from the 8th. If the asterisk were not present, it would indicate instead that 8 digits after the decimal point should be displayed.

Appendix C

MODBUS Protocol

This appendix provides a description of the MODBUS Protocol Interface and is supported both over RS-232/485 (RTU protocol) as well as TCP/IP over Ethernet.

The MODBUS Commands that are implemented are explained in detail in this document. The MODBUS protocol support for the *i*Series enables the user to perform the functions of reading the various concentrations and other analog values or variables, read the status of the digital outputs of the instrument, and to trigger or simulate the activation of a digital input to the instrument. This is achieved by using the supported MODBUS commands listed that follows.

For details of the Model 60*i* MODBUS Protocol specification, see the following topics:

- “Serial Communication Parameters” on page C-2
- “TCP Communication Parameters” on page C-2
- “Application Data Unit Definition” on page C-2
- “Function Codes” on page C-3
- “MODBUS Addresses Supported” on page C-9

Additional information on the MODBUS protocol can be obtained at <http://www.modbus.org>. References are from MODBUS Application Protocol Specification V1.1a MODBUS-IDA June 4, 2004.

Serial Communication Parameters

The following are the communication parameters that are used to configure the serial port of the *i*Series to support MODBUS RTU protocol.

Number of Data bits	: 7 or 8
Number of Stop bits	: 1 or 2
Parity	: None, Odd, or Even
Data rate	: 1200 to 115200 Baud (9600 is default)

TCP Communication Parameters

*i*Series Instruments support the MODBUS/TCP protocol. The register definition is the same as for the serial interface. Up to three simultaneous connections are supported over Ethernet.

TCP connection port for MODBUS: 502

Application Data Unit Definition

Here are the MODBUS ADU (Application Data Unit) formats over serial and TCP/IP:

Serial:	Slave Address	Function Code	Data	Error Check
TCP/IP:	MBAP Header	Function Code	Data	

Slave Address

The MODBUS slave address is a single byte in length. This is the same as the instrument ID used for C-Link commands and can be between 1 and 127 decimal (i.e. 0x01 hex to 0x7F hex). This address is only used for MODBUS RTU over serial connections.

Note Device ID ‘0’ used for broadcast MODBUS commands, is not supported. Device IDs 128 through 247 (i.e. 0x80 hex to 0xF7 hex) are not supported because of limitations imposed by C-Link. ▲

MBAP Header

In MODBUS over TCP/IP, a MODBUS Application Protocol Header (MBAP) is used to identify the message. This header consists of the following components:

Transaction Identifier	2 Bytes	0x0000 to 0xFFFF (Passed back in response)
Protocol Identifier	2 Bytes	0x00 (MODBUS protocol)
Length	2 Bytes	0x0000 to 0xFFFF (Number of following bytes)
Unit Identifier	1 Byte	0x00 to 0xFF (Passed back in response)

A Slave address is not required in MODBUS over TCP/IP because the higher-level protocols include device addressing. The unit identifier is not used by the instrument.

Function Code The function code is a single byte in length. The following function codes are supported by the instrument:

Read Coils	:	0x01
Read Inputs	:	0x02
Read Holding Registers	:	0x03
Read Input Registers	:	0x04
Force (Write) Single Coil	:	0x05
Read Exception Status	:	0x07

If a function code is received that is not in this list, and invalid function exception is returned.

Data The data field varies depending on the function. For more description of these data fields, see “Function Codes” that follows.

Error Check In MODBUS over Serial an error check is included in the message. This is not necessary in MODBUS over TCP/IP because the higher-level protocols ensure error-free transmission. The error check is a two-byte (16-bit) CRC value.

Function Codes This section describes the various function codes that are supported by the Model 60i.

**(0x01/0x02) Read Coils /
Read Inputs**

Read Coils/Inputs reads the status of the digital outputs (relays) in the instrument. Issuing either of these function codes will generate the same response.

These requests specify the starting address, i.e. the address of the first output specified, and the number of outputs. The outputs are addressed starting at zero. Therefore, outputs numbered 1–16 are addressed as 0–15.

The outputs in the response message are packed as one per bit of the data field. Status is indicated as 1 = Active (on) and 0 = Inactive (off). The LSB of the first data byte contains the output addressed in the query. The other outputs follow toward the high order end of this byte, and from low order to high order in subsequent bytes. If the returned output quantity is not a multiple of eight, the remaining bits in the final data byte will be padded

with zeros (toward the high order end of the byte). The Byte Count field specifies the quantity of complete bytes of data.

Note The values reported may not reflect the state of the actual relays in the instrument, as the user may program these outputs for either active closed or open. ▲

Request

Function code	1 Byte	0x01 or 0x02
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Quantity of outputs	2 Bytes	1 to maximum allowed by instrument
Unit Identifier	1 Byte	0x00 to 0xFF (Passed back in response)

Response

Function code	1 Byte	0x01 or 0x02
Byte count	1 Byte	N (N = Quantity of Outputs / 8, if the remainder not equal to zero, then N=N+1)
Output Status	n Byte	N = N or N+1

Error Response

Function code	1 Byte	0x01 or 0x02
Exception code	1 Byte	01=Illegal Function, 02=Illegal Address, 03=Illegal Data, 04=Slave Device Failure

Here is an example of a request and response to read outputs 2–15:

Request

<i>Field Name</i>	<i>(Hex)</i>
Function	0x01
Starting Address Hi	0x00
Starting Address Lo	0x02
Quantity of Outputs Hi	0x00
Quantity of Outputs Lo	0x0D

Response

<i>Field Name</i>	<i>(Hex)</i>
Function	0x01
Byte Count	0x03
Output Status 2–10	0xCD
Output Status 11–15	0x0A

The status of outputs 2–10 is shown as the byte value 0xCD, or binary 1100 1101. Output 10 is the MSB of this byte, and output 2 is the LSB. By convention, bits within a byte are shown with the MSB to the left, and the LSB to the right. Thus the outputs in the first byte are ‘10 through 2’, from left to right. In the last data byte, the status of outputs 15–11 is shown as the byte value 0x0A, or binary 0000 1010. Output 15 is in the fifth bit position from the left, and output 11 is the LSB of this byte. The four remaining high order bits are zero filled.

**(0x03/0x04) Read Holding
Registers / Read Input Registers**

Read holding/input registers reads the measurement data from the instrument. Issuing either of these function codes will generate the same response. These functions read the contents of one or more contiguous registers.

These registers are 16 bits each and are organized as shown below. All of the values are reported as 32-bit IEEE standard 754 floating point format. This uses 2 sequential registers, least significant 16 bits first.

Registers marked with an asterisk (*) are 32-bit unsigned integers or have to be interpreted as 32-bit unsigned integers.

The request specifies the starting register address and the number of registers. Registers are addressed starting at zero. Therefore registers numbered 1–16 are addressed as 0–15. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

The status of outputs 2–10 is shown as the byte value 0xCD, or binary 1100 1101. Output 10 is the MSB of this byte, and output 2 is the LSB. By convention, bits within a byte are shown with the MSB to the left, and the LSB to the right. Thus, the outputs in the first byte are ‘10 through 2’, from left to right. In the last data byte, the status of outputs 15–11 is shown as the byte value 0x0A, or binary 0000 1010. Output 15 is in the fifth bit position from the left, and output 11 is the LSB of this byte. The four remaining high order bits are zero filled.

The request specifies the starting register address and the number of registers. Registers are addressed starting at zero. Therefore, registers

numbered 1–16 are addressed as 0–15. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Request

Function code	1 Byte	0x03 or 0x04
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Quantity of Registers	2 Bytes	1 to maximum allowed by instrument

Response

Function code	1 Byte	0x03 or 0x04
Byte count	1 Byte	2 x N (N = quantity of registers)
Register value	N* x 2 Bytes	N = N or N+1

Error Response

Function code	1 Byte	Function code + 0x80
Exception code	1 Byte	01=Illegal Function, 02=Illegal Address, 03=Illegal Data, 04=Slave Device Failure

Here is an example of a request and response to read registers 10–13:

Request

<i>Field Name</i>	<i>(Hex)</i>
Function	0x03
Starting Address Hi	0x00
Starting Address Lo	0x09
No. of Registers Hi	0x00
No. of Registers Lo	0x04

Response

<i>Field Name</i>	<i>(Hex)</i>
Function	0x03
Byte Count	0x06

Register value Hi (10)	0x02
Register value Lo (10)	0x2B
Register value Hi (11)	0x00
Register value Lo (11)	0x00
Register value Hi (12)	0x00
Register value Lo (12)	0x64
Register value Hi (13)	0x00
Register value Lo (13)	0x64

The contents of register 10 are shown as the two byte values of 0x02 0x2B. Then contents of registers 11–13 are 0x00 0x00, 0x00 0x64 and 0x00 0x64 respectively.

(0x05) Force (Write) Single Coil

The force (write) single coil function simulates the activation of the digital inputs in the instrument, which triggers the respective action.

This function code is used to set a single action to either On or Off. The request specifies the address of the action to be forced. Actions are addressed starting at zero. Therefore, action number 1 is addressed as 0. The requested On/Off state is specified by a constant in the request data field. A value of 0xFF00 requests the action to be On. A value of 0x0000 requests it to be Off. All other values are illegal and will not affect the output. The normal response is an echo of the request, returned after the state has been written.

Note This function will not work if the instrument is in Service Level mode. ▲

Request

Function code	1 Byte	0x05
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Output Value	2 Bytes	0x0000 or 0xFF00

Response

Function code	1 Byte	0x05
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Output Value	2 Bytes	0x0000 or 0xFF00

Error Response

Function code	1 Byte	Function code + 0x80
Exception code	1 Byte	01=Illegal Function, 02=Illegal Address, 03=Illegal Data, 04=Slave Device Failure

Here is an example of a request to write Coil 5 On:

Request

<i>Field Name</i>	<i>(Hex)</i>
Function	05
Output Address Hi	00
Output Address Lo	05
Output Value Hi	FF
Output Value Lo	00

Response

<i>Field Name</i>	<i>(Hex)</i>
Function	05
Output Address Hi	00
Output Address Lo	05
Output Value Hi	FF
Output Value Lo	00

MODBUS Addresses Supported

Table C–1 through **Table C–3** list the MODBUS addresses supported for the Model 60*i*.

IMPORTANT NOTE The addresses in the following tables are Protocol Data Unit (PDU) addresses. Verify the coil number on your MODBUS master to ensure that it matches the coil number on the instrument. ▲

Note Coil status 1 indicates active state. ▲

Table C–1. Read Coils for 60*i*

Coil Number	Status
0	NONE
1	LOCAL/REMOTE
2	SERVICE
3	SAMPLE MODE
4	ZERO MODE
5	SPAN MODE
6	CYLINDER 1 ACTIVE
7	CYLINDER 2 ACTIVE
8	CYLINDER 3 ACTIVE
9	CYLINDER 4 ACTIVE
10	CYLINDER 5 ACTIVE
11	CYLINDER 6 ACTIVE
12	BLOWBACK
13	PURGE
14	CHECK CAL
15	EVENT RUNNING
16	GENERAL ALARM
17	CONC MAX CO ALARM
18	CONC MIN CO ALARM
19	CONC MAX CO2 ALARM
20	CONC MIN CO2 ALARM
21	CONC MAX NO ALARM

MODBUS Protocol

MODBUS Addresses Supported

Coil Number	Status
22	CONC MIN NO ALARM
23	CONC MAX NO2 ALARM
24	CONC MIN NO2 ALARM
25	CONC MAX NOX ALARM
26	CONC MIN NOX ALARM
27	CONC MAX O2 ALARM
28	CONC MIN O2 ALARM
29	CONC MAX SO2 ALARM
30	CONC MIN SO2 ALARM
31	INT TEMP ALARM
32	BENCH TEMP ALARM
33	DETECTOR TEMP ALARM
34	UMB Z1 TEMP ALARM (system only)
35	UMB Z2 TEMP ALARM (system only)
36	PROBE FILTER TEMP ALARM (system only)
37	PRESSURE ALARM
38	SAMPLE FLOW ALARM
39	CAL FLOW ALARM
40	DEWPOINT ALARM
41	REF INTENSITY ALARM
42	MB STATUS ALARM
43	MIB STATUS ALARM
44	I/O BOARD STATUS ALARM
45	DETECTOR BOARD STATUS ALARM
46	MODEL 62i STATUS ALARM
47	EXTERNAL ALARM 1 ALARM
48	EXTERNAL ALARM 2 ALARM
49	EXTERNAL ALARM 3 ALARM
50	"NO" DILUTION
51	"NO" OZONATOR
52	CAL THROUGH SYSTEM
53	PROBE BARREL TEMP ALARM (system only)
54	CAL FAILED

In addition to the coils in **Table C–1**, the coils in **Table C–3** are also available to be read.

IMPORTANT NOTE The addresses in the following tables are Protocol Data Unit (PDU) addresses. Verify the register number on your MODBUS master to ensure that it matches the register number on the instrument. ▲

Note For additional information on how to read registers and interpret the data, refer to the “(0x03/0x04) Read Holding Registers / Read Input Registers” section in this appendix. ▲

Table C–2. Read Registers for 60i

Register Number	Variable
0	NONE
1&2	NONE
3&4	NONE
5&6	NONE
7&8	NONE
9&10	CO CONCENTRATION
11&12	NO CONCENTRATION
13&14	NONE
15&16	CO2 CONCENTRATION
17&18	NONE
19&20	NONE
21&22	NONE
23&24	NONE
25&26	NOX CONCENTRATION
27&28	O2 CONCENTRATION
29&30	SO2 CONCENTRATION
31&32	NO2 CONCENTRATION
33&34	ANALOG IN 1
35&36	ANALOG IN 2
37&38	ANALOG IN 3
39&40	ANALOG IN 4
41&42	ANALOG IN 5

MODBUS Protocol

MODBUS Addresses Supported

Register Number	Variable
43&44	ANALOG IN 6
45&46	ANALOG IN 7
47&48	ANALOG IN 8
49&50	BENCH PRESSURE
51&52	SOURCE TEMPERATURE
53&54	BENCH TEMPERATURE
55&56	DETECTOR TEMPERATURE
57&58	CHANNEL 2 ABSORBANCE
59&60	CHANNEL 3 ABSORBANCE
61&62	CHANNEL 4 ABSORBANCE
63&64	CHANNEL 5 ABSORBANCE
65&66	CHANNEL 6 ABSORBANCE
67&68	CHANNEL 7 ABSORBANCE
69&70	CHANNEL 8 ABSORBANCE
71&72	CHANNEL 9 ABSORBANCE
73&74	CHANNEL 10 ABSORBANCE
75&76	CHANNEL 11 ABSORBANCE
77&78	CHANNEL 12 ABSORBANCE
79&80	CO (contents current selected cyl)
81&82	CO2 (contents current selected cyl)
83&84	NO (contents current selected cyl)
85&86	NO2 (contents current selected cyl)
87&88	SO2 (contents current selected cyl)
89&90	O2 (contents current selected cyl)
91&92	NONE
93&94*	EXTERNAL ALARMS
95&96	REFERENCE INTENSITY
97&98	NONE
99&100*	ALARM FLAGS (C-link)
101&102	DEW POINT
103&104	BLOWBACK PRESSURE (system only)
105&106	PROBE FILTER TEMP (system only)
107&108	PROBE BARREL TEMP (system only)
109&110	CHILLER TEMP (system only)

Register Number	Variable
111&112	UMBILICAL ZONE 1 TEMP (system only)
113&114	UMBILICAL ZONE 2 TEMP (system only)
115&116*	CAL STATUS
117&118*	FLAGS (C-link)

Registers marked with an asterisk () are 32-bit unsigned integers or have to be interpreted as 32-bit unsigned integers.

IMPORTANT NOTE The addresses in the following tables are Protocol Data Unit (PDU) addresses. Verify the coil number on your MODBUS master to ensure that it matches the coil number on the instrument. ▲

Note Writing 1 to the coil number shown in the following table will initiate the “action triggered” listed in the table. This state must be held for at least 1 second to ensure the instrument detects the change and triggers the appropriate action. For example, to trigger AOUTS to zero, write 1 to coil 101. To see the state of coil 101, issue a read coil 101. ▲

Note The coils within each coil group in the following table are mutually exclusive and will not be triggered if there is a conflict. Before you assert (1) one coil in a group, make sure the other coils in the group are de-asserted (0).

In addition to the coils in **Table C–3**, the coils in **Table C–1** are also available to be read.

Table C–3. Write Coils for 60i

Coil Number	Action Triggered	Coil Group
100	NONE	
101	SET AOUTS TO ZERO	
102	SET AOUTS TO FS	
103	SELECT CYLINDER 1	CYLINDER
104	SELECT CYLINDER 2	CYLINDER
105	SELECT CYLINDER 3	CYLINDER
106	SELECT CYLINDER 4	CYLINDER
107	SELECT CYLINDER 5	CYLINDER
108	SELECT CYLINDER 6	CYLINDER
109	RUN EVENT 1	EVENT
110	RUN EVENT 2	EVENT

Coil Number	Action Triggered	Coil Group
111	RUN EVENT 3	EVENT
112	RUN EVENT 4	EVENT
113	RUN EVENT 5	EVENT
114	RUN EVENT 6	EVENT
115	RUN EVENT 7	EVENT
116	RUN EVENT 8	EVENT
117	RUN EVENT 9	EVENT
118	RUN EVENT 10	EVENT
119	RUN EVENT 11	EVENT
120	RUN EVENT 12	EVENT
121	RUN EVENT 13	EVENT
122	RUN EVENT 14	EVENT
123	RUN EVENT 15	EVENT
124	RUN EVENT 16	EVENT
125	INITIATE PURGE	EVENT
126	ACTIVATE CHECK CAL	
127	TRIGGER EXTERNAL ALARM 1	
128	TRIGGER EXTERNAL ALARM 2	
129	TRIGGER EXTERNAL ALARM 3	
130	TRIGGER BLOWBACK	
131	TRIGGER WATER SLIP ALARM	
132	HALT EVENTS/SEQUENCE/AUTOCAL	
133	RUN SEQUENCE 1	EVENT
134	RUN SEQUENCE 2	EVENT
135	SPAN MODE	CALIBRATION
136	ZERO IR MODE	CALIBRATION
137	ZERO O2 MODE	CALIBRATION
138	SPAN NOX MODE	CALIBRATION
139	OZONATOR	CALIBRATION
140	STORE CAL	CALIBRATION
141	STORE 1	CALIBRATION
142	STORE 2	CALIBRATION
143	COMPUTE NO2 SPAN	CALIBRATION
144	SPAN O2	CALIBRATION

Coil Number	Action Triggered	Coil Group
145	SAVE CALS	SAVES TO FILE

Appendix D

Geysitech (Bayern-Hessen) Protocol

This appendix provides a description of the Geysitech (Bayern-Hessen or BH) Protocol Interface and is supported both over RS-232/485 as well as TCP/IP over Ethernet.

The Geysitech commands that are implemented are explained in detail in this document. The Geysitech protocol support for the *iSeries* enables the user to perform the functions of reading the various concentrations and to trigger the instrument to be in sample/zero/span mode if valid for that instrument. This is achieved by using the supported Geysitech commands that follow.

Up to three simultaneous connections are supported over Ethernet.

For details of the Model 60*i* Geysitech Protocol specification, see the following topics:

“Serial Communication Parameters” on page D-1

“TCP Communication Parameters” on page D-2

“Instrument Address” on page D-2

“Abbreviations Used” on page D-2

“Basic Command Structure” on page D-2

“Block Checksum” on page D-3

“Geysitech Commands” on page D-3

Serial Communication Parameters

The following are the communication parameters that are used to configure the serial port of the *iSeries* to support Geysitech protocol.

Number of Data bits	: 7 or 8
Number of Stop bits	: 1 or 2
Parity	: None, Odd, or Even
Data rate	: 1200 to 115200 Baud (9600 is default)

TCP Communication Parameters

iSeries instruments support the Geysitech protocol over TCP/IP. The register definition is the same as for the serial interface. Up to three simultaneous connections are supported over Ethernet.

TCP connection port for Geysitech: 9882

Instrument Address

The Geysitech instrument address has a value between 0 and 127 and is represented by a 3 digit ASCII number with leading zeros or leading spaces if required (e.g. instrument address of 1 is represented as 001 or <SP><SP>1).

The instrument address is the same as the Instrument ID used for C-Link and MODBUS commands. This can be set via the front panel.

The instrument address is represented by <address> in the examples throughout this document.

Note Device IDs 128 through 247 are not supported because of limitations imposed by the C-Link protocol. ▲

Abbreviations Used

The following is a list of abbreviations used in this document:

<CR> is abbreviation for Carriage Return (ASCII code 0x0D)

<STX> is abbreviation for Start of Text (ASCII code 0x02)

<ETX> is abbreviation for End of Text (ASCII code 0x03)

<SP> is abbreviation for space (ASCII code 0x20)

Basic Command Structure

The following is the basic structure of a Geysitech command:

<STX>Command text<ETX><BCC>

OR

<STX>Command text<CR>

Each command is framed by control characters, <STX> at the start and terminated with either <ETX> or <CR>.

If a command is terminated with <ETX>, then two additional characters <BCC> is attached after <ETX>. This is the block checksum.

Block Check Characters <BCC> may be added to the command to prevent processing invalid commands.

Block Checksum Characters <BCC>

The Block Checksum Characters are calculated beginning with a seed value of 00000000, binary (0x00), and bitwise exclusive ORing with each of the characters of the command string (or response) including the framing characters <STX> and <ETX>. The checksum works as an error check. The command terminator determines the presence or absence of <BCC>.

If a command is terminated by <ETX> then the next two characters are the checksum, if the command is terminated with <CR> no checksum is attached.

The block checksum is represented by two characters, which represent a 2 digit hex number (1byte) (e.g. 1 byte 0xAB hex checksum will be represented by the two characters 'A' & 'B').

The checksum is referred to as <BCC> throughout this document.

Geysitech Commands

The following commands are supported by the Geysitech protocol:

- Instrument Control Command (ST)
- Data Sampling/Data Query Command (DA)

Instrument Control Command (ST)

There are three control commands supported by the Geysitech protocol.

This <control command> is a single letter, which triggers an action in the instrument. These commands are active only when Service Level mode is inactive and the zero/span option is present.

Command 'N' switches the instrument gas mode to Zero mode.

Command 'K' switches the instrument gas mode to Span mode.

Command 'M' switches the instrument gas mode to Sample mode.

The following are the different acceptable formats of the ST command:

<STX>ST<address><control command><ETX><BCC>

OR

<STX>ST<address><control command><CR>

OR

<STX>ST<address><SP><control command><CR>

OR

<STX>ST<address><SP><control command><ETX><BCC>

The <address> is optional, which means it can be left out completely. The <address>, if present, must match the Instrument Address. Additional space can be present after the <address>.

If the received command does not satisfy the above formats, or if the <address> does not match the Instrument Address, the command is ignored.

This is a sample command to switch the instrument to zero mode, instrument address 5:

<STX>ST005<SP>N<CR>

Data Sampling/Data Query Command (DA)

This command initiates a data transfer from the instrument. The instrument responds with measurement data, which depends on the range mode and is listed in “Measurements reported in response to DA command” that follows.

The command structure for a data query command is as follows:

<STX>DA<address><ETX><BCC>

The <address> is optional, which means it can be left out completely. The <address>, if present, must match the Instrument Address. Additional space can be present after the <address>.

If the <address> is left out, then no space is allowed in the query string.

A command with no address is also a valid command.

The following are the different acceptable formats of the DA command with Instrument Address 5:

<STX>DA<CR>

<STX>DA005<CR>

<STX>DA<SP><SP>5<ETX><BCC>

<STX>DA<ETX><BCC>

The data query string is valid and will be answered with data transmission only if the command starts with <STX>, which is followed by the characters DA, and the <address> (if present) matches the Instrument Address, and the command is terminated with either <CR> with no checksum or <ETX>, followed by the correct checksum <BCC>.

Sample Data Reply String in response to Data Query Command (DA):

In response to a valid data query command, the instrument responds in the following format:

```
<STX>MD02<SP><address><SP><measured  
value1><SP><status><SP><SFKT><SP><address+1><SP><measured  
value2><SP><status><SP><SFKT><ETX><BCC>
```

The response uses the same command terminators as used by the received command, i.e. if the received command was terminated with a <CR> then the response is terminated with <CR>, and if the command was terminated with a <ETX><BCC>, then the response is terminated with <ETX> and the computed checksum <BCC>.

The 02 after the MD indicates that two measurements are present in the reply string, 03 for three measurements and so on. This will also determine the length of the reply string.

<address> is the Instrument Address. Each subsequent measurement attached to the response will have the <address + X>, where X keeps incrementing by 1 for each measurement included.

<measured value> is the concentration value in currently selected gas units, represented as exponential representation with 4 characters mantissa and 2 characters exponent, each with sign.

Mantissa: sign and 4 digits. The decimal point is assumed to be after the first digit and is not transmitted.

Exponent: sign and 2 digits.

Example:

-5384000.0 is represented as -5384+06

+0.04567 is represented as +4567-02

<status>: is formed by < operating status > and < error status > and separated by a space, i.e.:

```
<operating status><SP><error status>
```

Each of the two (<operating status> and <error status>) are formed by two characters, each representing a 2 digit hex number which is one byte (8 Bits) operation status and one byte (8 Bits) error status.

These two bytes contain the information about the main operating conditions of the instrument at that instant. For details on how to interpret the status bytes, refer to **Table D-1** and **Table D-2** that follow.

<SFKT>: is the space provided for future use for special function. It currently contains a string of ten 0's, i.e. <0000000000>.

The Geysitech serial number defaults to zero. To set the Geysitech serial number select Main Menu > Instrument Controls > Communication Settings > **Geysitech Serial No.**

Example of response to DA command from an instrument with Geysitech serial number set to 000. The Geysitech serial number is **bold** in the example.

Geysitech Protocol with transmission of three concentrations (Instrument ID is 1, Operation Status is 03, Error Status is 04):

Data Query String: <STX>DA<CR>

Reply String:

```
<STX>MD03<SP>001<SP>+2578+01<SP>03 <SP>04<SP>0000000000 <SP>002 <SP>
      ↑           ↑                               ↑
      Address   First Concentration(E-format)=25.78      Address+1

+5681+00<SP>03<SP>04<SP>0000000000<SP>003<SP>+1175+01<SP>03<SP>04<SP>
      ↑                               ↑           ↑
      Second Concentration = 5.681      Address+2   Third Concentration=11.75

0000000000<SP><CR>
```

Example of response to DA command from an instrument with Geysitech serial number set to 123.

Data Query String: <STX>DA<CR>

Reply String:

```
<STX>MD03<SP>001<SP>+2578+01<SP>03 <SP>04<SP>1230000000 <SP>002 <SP>
      ↑           ↑                               ↑
      Address   First Concentration(E-format)=25.78      Address+1

+5681+00<SP>03<SP>04<SP>1230000000<SP>003<SP>+1175+01<SP>03<SP>04<SP>
      ↑                               ↑           ↑
      Second Concentration = 5.681      Address+2   Third Concentration=11.75

1230000000<SP><CR>
```

Measurements reported in response to DA command

The following measurements reported (if all gases measurable) in response to DA command for the Model 60*i* include:

- CO
- CO₂
- NO

- NO2
- NOX
- SO2
- O2

Operating and Error Status

See **Table D–1** for operating status and **Table D–2** for error status for the Model 60*i*.

Table D–1. Operating Status for Model 60*i*

	D7	D6	D5	D4		D3	D2	D1	D0
→ Bit	8	7	6	5		4	3	2	1
→ Hex-value	80	40	20	10		08	04	02	01
	MSB					LSB			
Operating status:									
Local/Remote/Service (bit 0 = service on, bit 1 = pass lock on)	0	0	0	0		0	0	0	1
Zero IR	0	0	0	0		0	0	1	0
Zero O2	0	0	0	0		0	1	0	0
Span Single	0	0	0	0		1	0	0	0
Span Multi	0	0	0	1		0	0	0	0
Cal Cylinder (binary encoded, 000 = no cylinder, 001 = first ... 110 = sixth)	0	0	1	0		0	0	0	0
	0	1	0	0		0	0	0	0
	1	0	0	0		0	0	0	0

Table D–2. Error Status for Model 60*i*

	D7	D6	D5	D4		D3	D2	D1	D0
→ Bit	8	7	6	5		4	3	2	1
→ Hex-value	80	40	20	10		08	04	02	01
	MSB					LSB			
Error status:									
Concentration Alarms	0	0	0	0		0	0	0	1
Temperature Alarms	0	0	0	0		0	0	1	0
Board Alarms	0	0	0	0		0	1	0	0

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	D7	D6	D5	D4		D3	D2	D1	D0
Pressure Alarm	0	0	0	0		1	0	0	0
Intensity Alarm	0	0	0	1		0	0	0	0
Dewpoint Alarm	0	0	1	0		0	0	0	0
Flow Alarm	0	1	0	0		0	0	0	0
Not used	1	0	0	0		0	0	0	0

Appendix E

Interfacing a DCS/PLC with the Model 60i Multi-Gas Analyzer

Establishing communications between the Model 60i Multi-Gas Analyzer and a DCS/PLC involves making the physical connections between devices and using an appropriate method/application to establish data communications.

Introduction

Typical communications functions provided by the 60i include:

- Checking data values
- Reading system and alarm status
- Triggering events
- Calibrating the analyzer

The 60i provides several methods for establishing data communication with a DCS/PLC including:

- MODBUS protocol
- C-Link commands
- Analog output connections
- Digital I/O connections

Connecting a DCS/PLC to the Model 60i

You can connect to the 60i via Ethernet or Serial communications (RS-232/485). Refer to **Figure E-1** and the “Installation” chapter. For C-link over Ethernet use port 9880. For MODBUS use port 502. Each port supports up to three connections.

The optional terminal block shown in **Figure E-1** provides a convenient way to connect devices to the instrument. It is used to break out the signals on the rear panel connector to individual numbered terminals. For additional information, refer to “Terminal Block and Cable Kits” on page 9-2.

Interfacing a DCS/PLC with the Model 60i Multi-Gas Analyzer

Connecting a DCS/PLC to the Model 60i

Note Consult with a network engineer or system administrator for information about making the appropriate Ethernet connection for your application. ▲

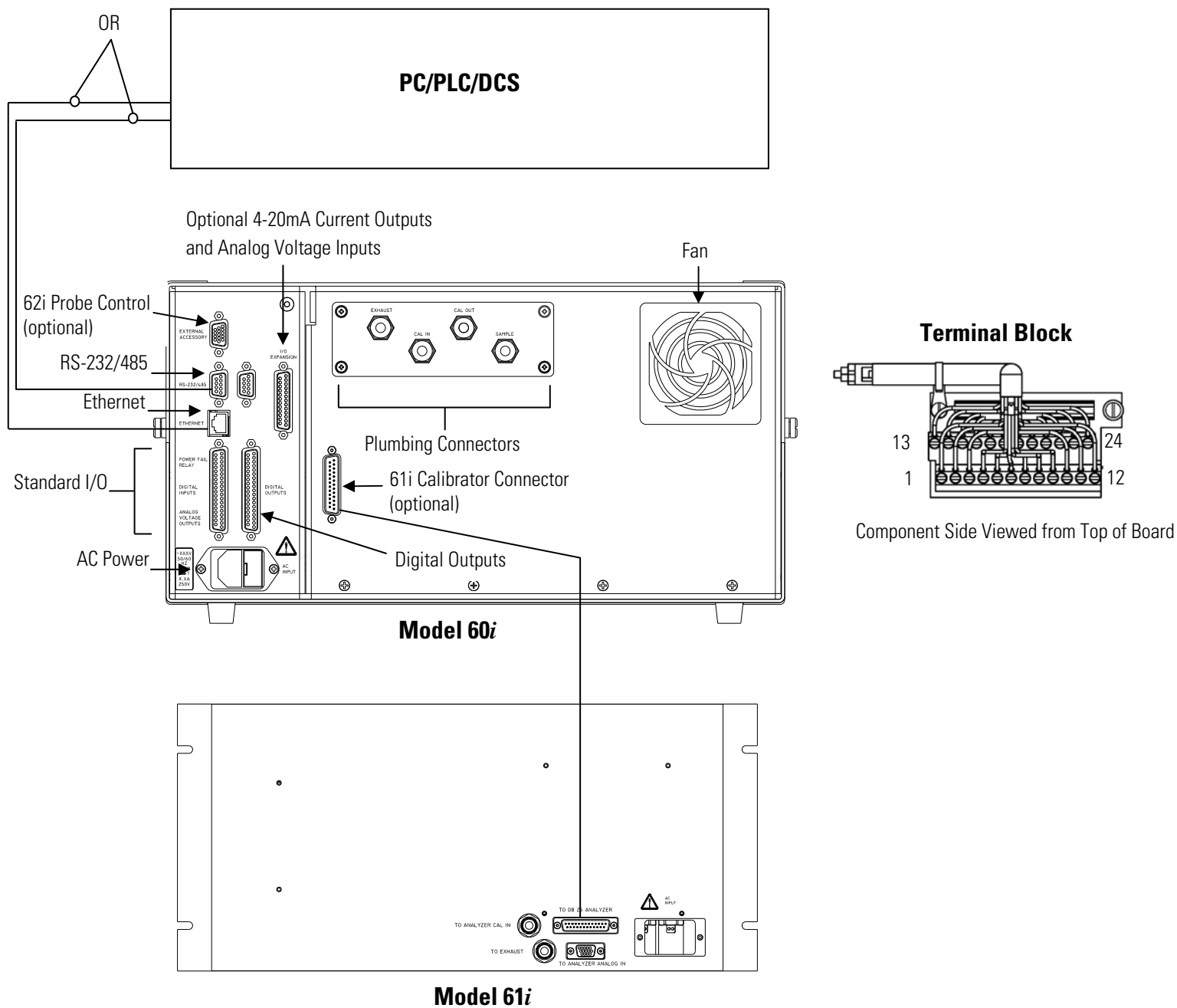


Figure E-1. Rear Panel Connectors

Establishing Communications

This section provides information on the methods available for retrieving system data, accessing system status conditions, initiating system events, and calibrating the analyzer.

Check Readings

The 60i provides several methods for retrieving system data including:

- MODBUS read register
- C-Link commands
- Analog output connections

Refer to **Table E-1** for the default analog output assignments, associated rear panel pinouts, and the MODBUS and C-link methods for retrieving data. Refer to **Figure E-2** to locate the pins on the rear panel connector.

Note For purposes of this example, analog output 1 was configured to provide CO concentration data, however you must configure your analog outputs for your particular application. For analog output configuration information Refer to “Analog Output Configuration (Select Channel)” on page 3-74. ▲

Table E-1. Retrieving System Data via MODBUS, C-Link, or Analog Outputs

Analog Outputs		Description	MODBUS Read Register	C-Link Command
No.	Rear Panel			
1	Pin 14	CO concentration	9&10	CO
2	Pin 33	NO concentration	11&12	NO
3	Pin 15	NO ₂ concentration	29&30	NO ₂
4	Pin 34	CO ₂ concentration	15&16	CO ₂
5	Pin 17	O ₂ concentration	27&28	O ₂
6	Pin 36	SO ₂ concentration	31&32	SO ₂

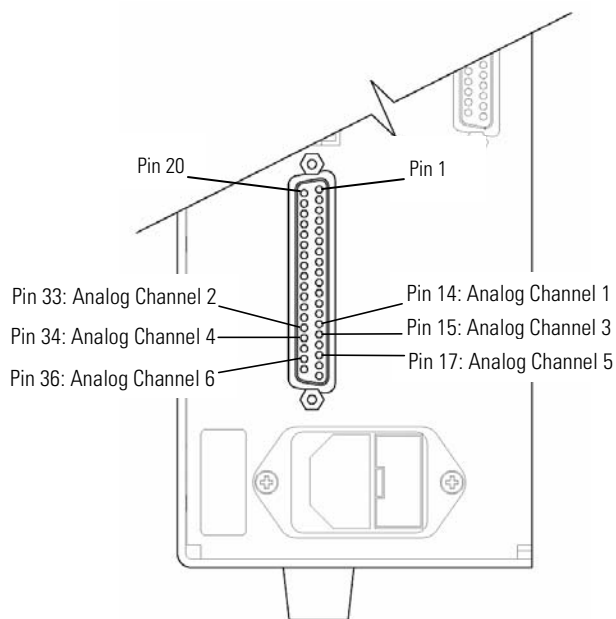


Figure E-2. Analog Voltage Outputs - Rear Panel Pinouts

Read Status

The 60i allows the user to access system status conditions via:

- MODBUS read coils
- C-link flags
- Digital output connections and configurations

Refer to **Table E-2** for the digital output assignments, associated rear panel pinouts, and the MODBUS and C-link methods for accessing system status. Refer to **Figure E-3** to locate the pins on the rear panel connector.

Note For purposes of this example, digital output 1 was configured to provide sample mode status information, however you must configure your digital outputs for your particular application. ▲

Table E–2. Accessing System Status via MODBUS, C-Link, or Digital Outputs

Digital Outputs		Description	MODBUS Read Coil	C-Link Command
No.	Rear Panel			
1	Pin 1	Sample mode	3	dout 1
2	Pin 2	Zero mode	4	dout 2
3	Pin 3	Span mode	5	dout 3
4	Pin 4	Cylinder 1	6	dout 4
5	Pin 5	Cylinder 2	7	dout 5
6	Pin 6	Cylinder 3	8	dout 6
7	Pin 7	Cylinder 4	9	dout 7
8	Pin 8	Cylinder 5	10	dout 8
9	Pin 9	Cylinder 6	11	dout 9
10	Pin 10	Event running	15	dout 10
11	*	General alarm	16	*
12	*	Blowback	12	*

*Only 10 digital outputs are available.

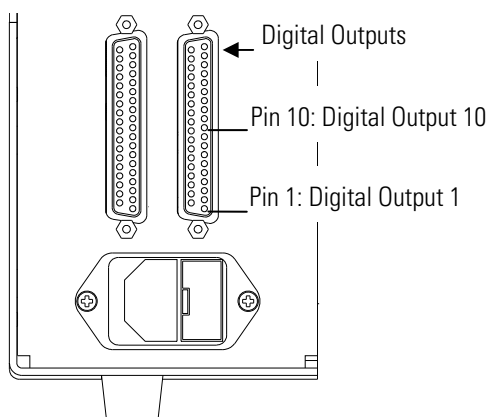


Figure E–3. Digital Outputs - Rear Panel Pinouts

Trigger Events

The 60i allows the user to initiate system events by any of the following methods:

- MODBUS write coils
- C-link commands
- Digital input activate connections

Refer to **Table E-3** for the digital input assignments, associated rear panel pinouts, and the MODBUS and C-link methods for initiating system events. Refer to **Figure E-4** to locate the pin on the rear panel connector.

Note For purposes of this example, **Table E-3** and **Figure E-4** show only some of the available 16 digital inputs. ▲

Note For purposes of this example, digital input 1 was configured to trigger Event 1 (Zero all IR channels), however you must configure your digital inputs to trigger events for your particular application. ▲

Table E-3. Triggering Events via MODBUS, C-Link, or Digital Inputs

Digital Inputs		Description	MODBUS	C-Link
No.	Rear Panel		Write Coil	Command
1	Pin 3	Event 1 (Zero all IR channels)	109	event run 1
2	Pin 4	Event 2 (Span CO ₂ , O ₂ Cyl 2)	110	event run 2
3	Pin 23	Event 3 (Span CO, SO ₂ , NO Cyl 3)	111	event run 3
4	Pin 24	Event 4 (Zero O ₂ Cyl 4)	112	event run 4
5	Pin 6	Event 5 (Span SO ₂)	113	event run 5
6	Pin 25	Event 6 (Span NO ₂)	114	event run 6
7	Pin 7	Event 7 (Span NO)	115	event run 7
8	Pin 8	Event 8 (Zero all IR channels)	116	event run 8
9	Pin 27	Event 9 (Initiate purge)	117	event run 9
10	Pin 9	Purge	125	purge on/off
11	*	Halt events	132	event halt
12	*	Run sequence 1	133	seq run 1
13	*	Run sequence 2	134	seq run 2

*Not all 16 available digital inputs are shown in this example.

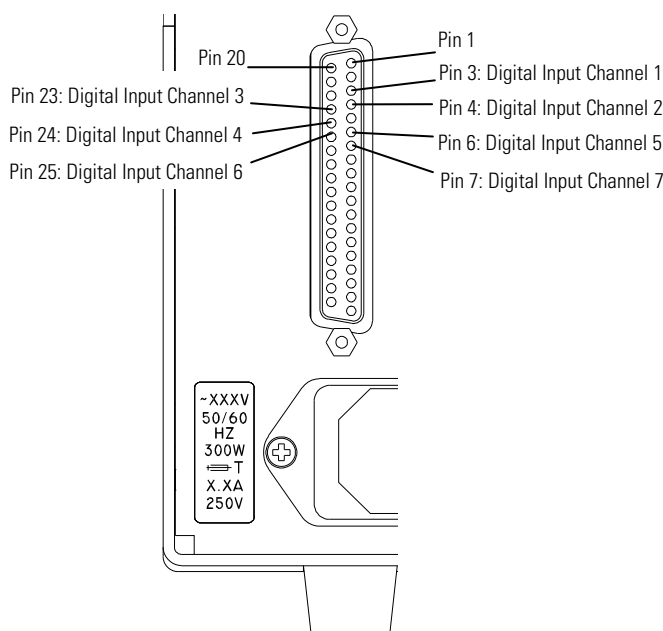


Figure E-4. Digital Inputs – Rear Panel Pinouts

Calibration

The 60i allows the user to perform a multigas span, a single gas span, and to zero the analyzer. Refer to this section **Table E-3** for an example of how calibration events are triggered.

Figure E-5 and **Figure E-6** show examples of I/O status during manual calibration and output status during autocal.

Figure E-5 shows that the digital inputs are used to trigger three events as well as flag instrument data as invalid after the calibration has completed (purge). The event trigger digital inputs will request that the instrument runs the corresponding event on the rising edge of the input. If the instrument is in a state that allows events to run, it will begin immediately.

The purge output not only mirrors the purge input, but it is also asserted during the delay portion of events to indicate that the current readings match neither the sample gas nor the calibration gas.

The cylinder outputs are asserted when the instrument is requesting gas from the corresponding cylinder. Whether the Model 61i is used, or a custom system, these outputs indicate which cylinder should be flowing at what times.

The event running output is asserted whenever an event is processing. This can be relied upon for synchronization between the instrument and any external system regarding event timing.

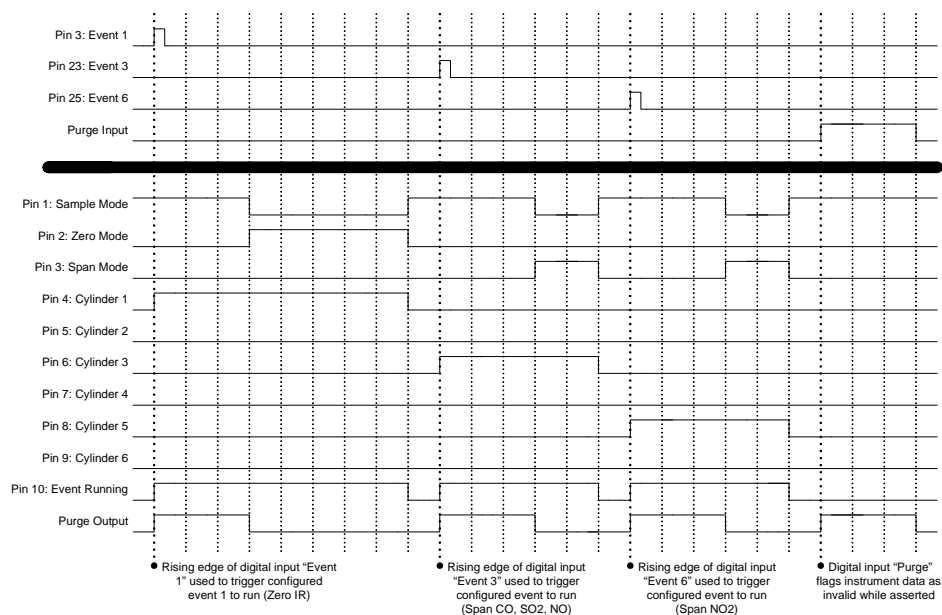


Figure E-5. Example of I/O Status During Manual Calibration

Figure E-6 shows the state of the outputs during an automatic calibration. Functionally, the outputs are identical to a manually triggered calibration, though the Event Running output will continuously be asserted through the whole sequence.

To synchronize an external system with the analyzer's internal clocks for calibration, the Purge output can be used to mark the start of an event's delay portion (also the overall start of the event), while the sample mode output going low can be used to mark the transition from the delay time to the duration. When the instrument returns to sample mode, this signifies either the start of a new event (depending on the state of the purge output) or the completion of the last event.

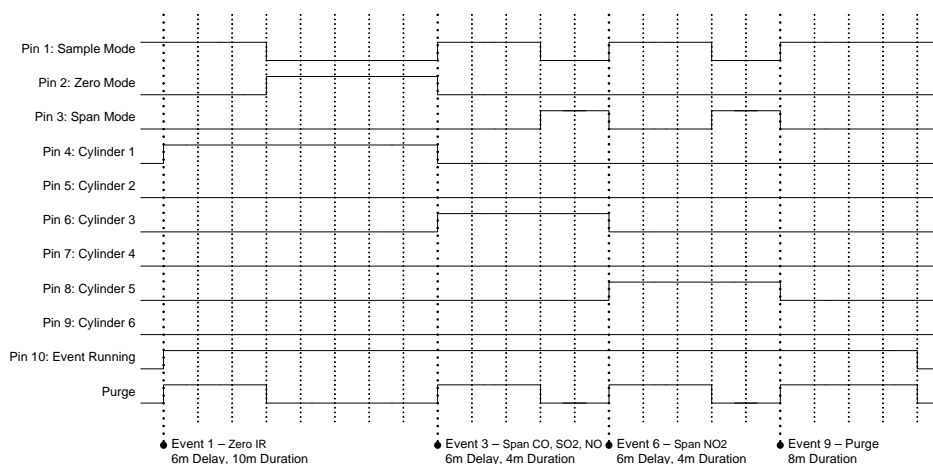


Figure E-6. Example of Output Status During Autocal