Model 51*i*

Instruction Manual
Total Hydrocarbon Analyzer
Part Number 103960-00
26Mar2012

CE

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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 51*i* analyzer. 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, setup, and startup 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 "System 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 and 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 and is supported both over RS-232/485 as well as TCP/IP over Ethernet.

Safety

Review the following safety information carefully before using the analyzer. This manual provides specific information on how to operate the analyzer, however, 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 bypass (or sample gas exhaust) contains all of the pollutants of the original sample. Depending on the application, the bypass could be flammable, explosive, or highly toxic. If the sample stream is potentially hazardous, the bypass should be routed back to the source or to an appropriate vent. ▲
		During normal operation, the FID exhaust contains non-flammable components, mostly air and water vapor. However, under failure conditions, the FID exhaust could contain explosive levels of hydrogen. ▲

Alert	Description
	The Model 51*i* is supplied with a three-wire grounded power cord. Under no circumstances should this grounding system be defeated. ▲
	Pressures are set at the factory and should not be arbitrarily changed. ▲
	The service procedures in this manual are restricted to qualified service personnel only. ▲
	If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲
⚠ **CAUTION**	Gas fittings on the rear panel or inside the oven are very hot. ▲
	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. ▲
	Due to the possibility of residual fuel in the detector, keep your face away from the FID. The ignitor pulse is clearly visible from a distance when the thermocouple has been removed. ▲
	Avoid contact with the heated oven components. Allow the oven to cool to room temperature before handling oven componenets. A small fan directed into the oven will speed cooling. ▲
⚠ **Equipment Damage**	Do not attempt to lift the analyzer by the cover or other external fittings. ▲
	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. ▲
	Disconnect the serial cable before changing the RS-232 and RS-485 selection to prevent damage to any equipment that the analyzer is currently connected to. ▲
	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. ▲

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

Service is available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information.

866-282-0430 Toll Free

508-520-0430 International

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Chapter 1
Introduction

The Model 51*i* Total Hydrocarbon (THC) Analyzer combines proven Flame Ionization Detector (FID) technology, easy to use menu-driven firmware, and advanced diagnostics to offer unsurpassed flexibility and reliability. The Model 51*i* is available in Low Temperature and High Temperature versions, and has the following features:

- 320 x 240 graphics display

- Menu-driven firmware

- Temperature controlled detector oven and sampling system

- Automatic ranging

- Multiple user-defined analog outputs

- Analog input options

- Reporting of alarm conditions

- Flame-out detection and automatic re-ignition

- User-programmable report generation

- User-selectable digital input/output capabilities

- Standard communications features include RS-232/485 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:

- "Operating Principle of the Flame Ionization Detector" on page 1-2

- "Operating Principle of the Sampling and Flow Controls" on page 1-3

- "Specifications" on page 1-5

Thermo Fisher Scientific is pleased to supply this total hydrocarbon 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 Chapter 7, "Servicing".

Operating Principle of the Flame Ionization Detector

The Model 51*i* uses a flame ionization detector, or FID, to measure organic gases and vapors. Flame ionization is a well-known technology that has been used in laboratories and industry for many years. Flame ionization detectors are highly efficient; they provide a wide linear range and sensitive detection of organic compounds.

An FID operates by ionizing organic compounds in the sample stream using the energy of a hydrogen flame. The hydrogen flame oxidizes organic compounds to generate carbon dioxide and water. In the process, ions are formed in an electrical field that is generated between a polarized jet where the hydrogen flame burns, and a cylindrical collector electrode, which surrounds the jet, as shown in Figure 1–1.

The sample gas is mixed with the hydrogen inside the FID at the base of the jet. An external source of air provides the necessary oxygen for the combustion of fuel at the jet.
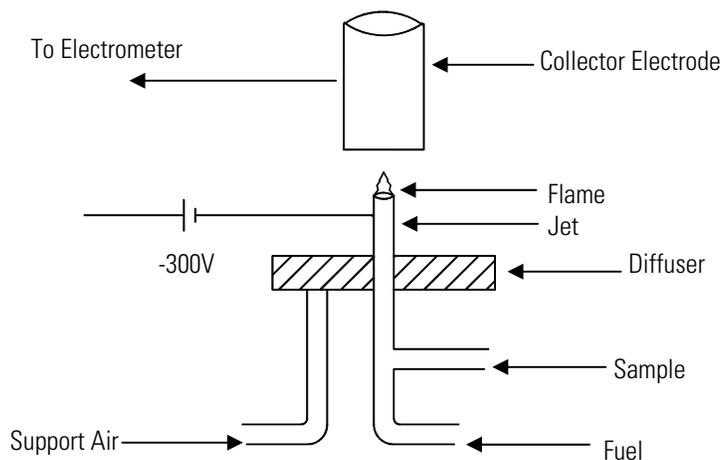
Figure 1–1. Model 51*i* FID Schematic

Due to the voltage difference between the jet and collector, negatively charged ions formed in the flame migrate to the collector. When the ions arrive at the collector, a small ion current is created. This current, which can be as small as $1x10^{-12}$ amps, is proportional to the concentration of carbon atoms in the sample.

Unlike some other ionization detectors, the FID responds to almost all organic compounds, including methane. Because the signal is produced primarily by the ions formed during the oxidation of carbon-hydrogen bonds, the strength of the response is directly related to the molar concentration of the organic compound and the number of carbon atoms per molecule.

The current signal generated at the FID's collector electrode is carried through a shielded cable that runs to an electrometer and amplifier circuit that is located inside the instrument on the front of the detector oven. The electrometer circuit converts the current to a voltage that is amplified and then digitized by a voltage to frequency (V/F) converter. The frequency output can range from a few hundred Hz up to a maximum of approximately 400,000 Hz. The instrument's amplifier design includes three ranges, or gain-settings, that function under processor control and are switched on the basis of the V/F output. This allows the instrument to measure total hydrocarbon (THC) concentrations ranging from less than 0.1 ppmc to over 40,000 ppmc without input from the operator.

Real-time hydrocarbon concentrations are calculated from the digitized signal by applying a calibration factor. This factor is automatically calculated during calibration by comparing the FID signal produced while sampling high purity zero-air to that produced by a span gas containing a known quantity of hydrocarbon. Once the hydrocarbon concentration has been determined, it is displayed on the front panel and made available over the analog outputs and the serial or Ethernet connection.

Operating Principle of the Sampling and Flow Controls

The Model 51*i* sampling and gas flow system is shown in Figure 1–2. The fuel and air that support the FID flame are provided from pressurized supplies that are connected to the instrument's rear panel. The sample is drawn into the instrument using an internal vacuum pump that pulls sample through 1/4-inch outside diameter (OD) sample line.

The instrument air enters through the rear panel bulkhead, as shown in Figure 1–2. Inside the instrument, the air line splits, with one branch running to an electronic pressure controller that supplies the FID. Flow through this line is controlled by the combination of the pressure controller and a flow restrictor that is mounted in the base of the detector. The second branch supplies make-up air for controlling the sample pressure. The flow rate of make-up air is also controlled by an electronic pressure controller, which automatically adjusts in response to changes in pressure in

the sample line. The manual pressure regulator protects the electronic pressure controller from overpressurization.
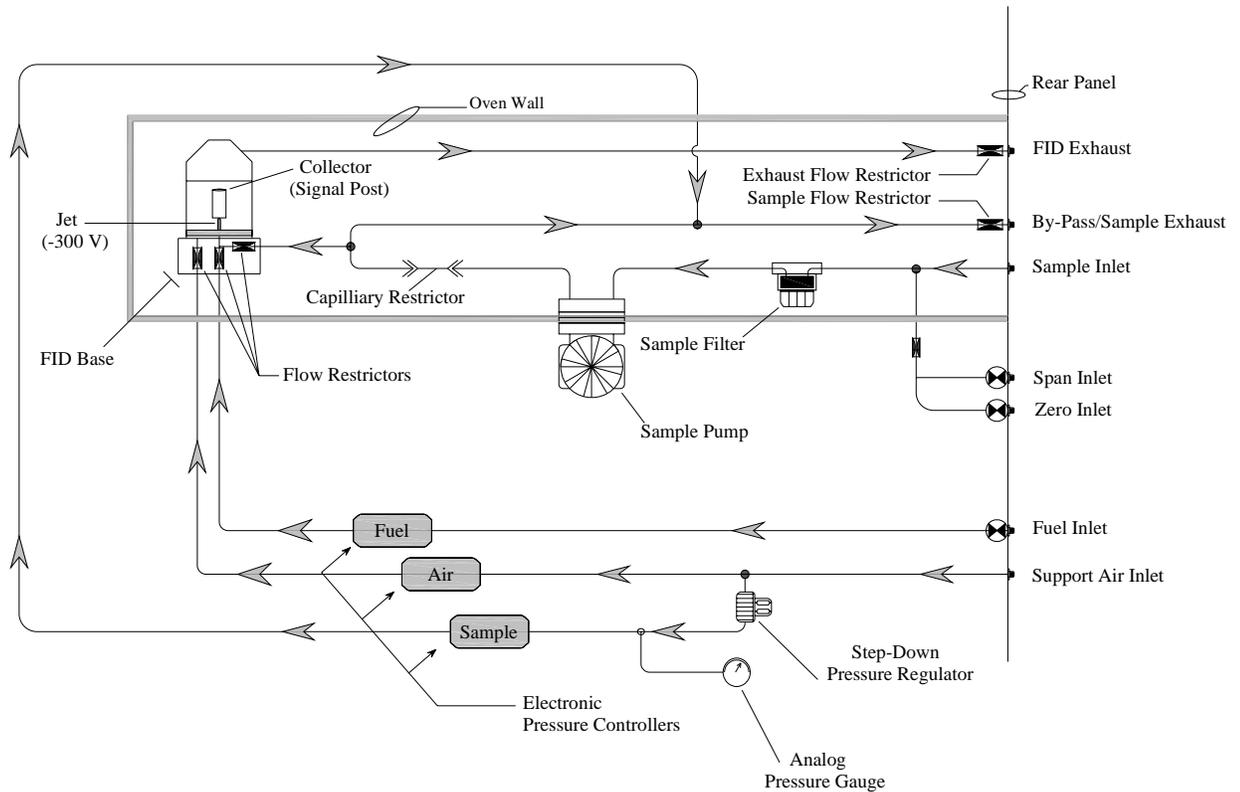
Figure 1–2. Model 51*i* Gas Flow System

Fuel entering the instrument at the rear panel passes through a 2-way solenoid valve that acts as a safety shut-off in case of a flame out or other malfunction. From the shut-off valve, the fuel flows to an electronic pressure controller. In conjunction with a flow restrictor installed in the detector base, the pressure controller regulates the flow of fuel.

Sample is drawn into the unit by an internal vacuum pump. The sample moves from the inlet bulkhead, through a sintered metal filter element, and then into the vacuum side of the pump. The pump exhaust flows through a capillary restrictor to a "tee" fitting. One branch of the tee leads to the detector base and the other branch leads to the sample bypass. Make-up air mixes with the sample at the bypass port to create a back-pressure that controls the flow rate of sample into the FID.

Specifications

Table 1–1 lists the specifications for the Model 51*i*.

Table 1–1. Model 51*i* Specifications

Preset ranges	1, 10, 100, 1000, 5000, 10000 ppmc
Custom ranges	1 to 10000 ppmc
Ambient operation temperature	15–35 °C
Storage temperature range	0–45 °C
Power requirements	100 VAC @ 50/60 Hz
	115 VAC @ 50/60 Hz
	220–240 VAC @ 50/60 Hz
	420 Watts
Physical dimensions	16.75″ (W) X 8.62″ (H) X 23″ (D)
Weight	Approximately 50 lbs.

Detector	
Type	Flame Ionization
Minimum detectable limit	0.05 ppm carbon (independent of gas)
Ignitor	Processor controlled electronic glow plug
Flame out safety	Solenoid shuts off fuel on flame out
Noise	Less than 0.025 ppmc (10 second averaging)
Drift	Less than 0.50 ppm in 24 hours
Repeatability	2% of reading or ±0.1 ppm (whichever is larger)
Accuracy	2% of reading or ±0.1 ppm (whichever is larger) (concentrations from 10 to 150% of span)
Range	0 to 10,000 ppm carbon
Auto ranging	Automatically adjusts front panel reading over the instrument's entire operating range
Oven temperature	User adjustable 100 to 125 °C (LT Model)
	User adjustable 125 to 200 °C (HT Model)
Response time	90% of final reading within 15 seconds (signal averaging set to 1 second)

Sample	
Sampling rate	0.75 to 1.5 LPM nominal
Detector flow rate	Approximately 10 to 20 milliliters per minute

Remote Operation	
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 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 10 Mbs Ethernet connection, static or dynamic TCP/IP addressing, up to 3 simultaneous connections per protocol

Support Gases	
Combustion air	Approximately 150 to 300 milliliters per minute required (see test sheet for exact flow settings) Total consumption approximately 1.0 LPM.
Fuel	Approximately 10 to 35 milliliters per minute hydrogen or 50 to 120 milliliter per minute hydrogen/helium mix (see test sheet for exact flow settings)
Calibration gases	Hydrocarbon free "zero" air or nitrogen and span mixture of methane, propane, or hexane in air or nitrogen balance. Exact span composition varies with the application. Approximately 2 liters required per calibration cycle.

Chapter 2
Installation

Installation of the Model 51*i* includes lifting the instrument, unpacking and inspection, connecting sample, zero, span, and exhaust lines, and attaching the analog and/or digital outputs to a recording device. The installation should always be followed by instrument calibration as described in the "Calibration" chapter of this manual.

This chapter provides the following recommendations and procedures for installing the instrument:

- "Lifting" on page 2-1
- "Unpacking and Inspection" on page 2-1
- "Connecting Support Gases" on page 2-2
- "Connecting External Devices" on page 2-7
- "Startup" on page 2-12

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 other external fittings. ▲

Unpacking and Inspection

The Model 51*i* is shipped complete in one container. If there is obvious damage to the shipping container when the instrument is received, notify the carrier immediately and hold for inspection. The carrier is responsible for any damage incurred during shipment.

Use the following procedure to unpack and inspect the instrument.

1. Remove the instrument from its shipping container and set it on a table or bench that allows easy access to both the front and rear.

2. Remove the cover to expose the internal components.

3. Remove the packing material in the analyzer (Figure 2–1).

Units without Optional I/O Board

Units with Optional I/O Board
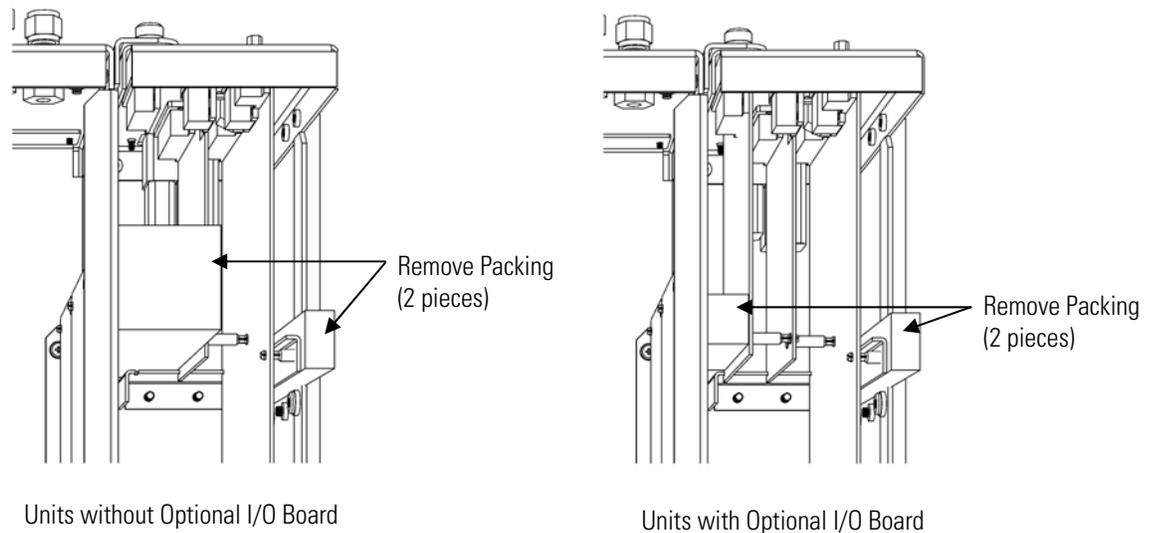
Figure 2–1. Remove the Packing Material

4. Check for possible damage during shipment.

5. Check that all connectors and circuit boards are firmly attached. (Except for the connector for the spare ignitor, which is taped to the floor plate.)

6. Re-install the cover.

7. Remove any protective plastic material from the case exterior.

Connecting Support Gases

The Model 51*i* requires fuel gas (hydrogen or hydrogen/helium mix), combustion air, zero air, and span gas. Figure 2–2 shows the input ports for these gases. All connections are designed for 1/4-inch outside diameter (OD) lines. Fittings are supplied for making good leak-tight connections. High quality single or dual stage regulators should control all gas pressures. To the extent possible, high quality, high purity support gases, regulators, and Teflon or metal lines should be used.

(Note Zero and span bulkheads are only present if the internal calibration valve option is installed.) ▲
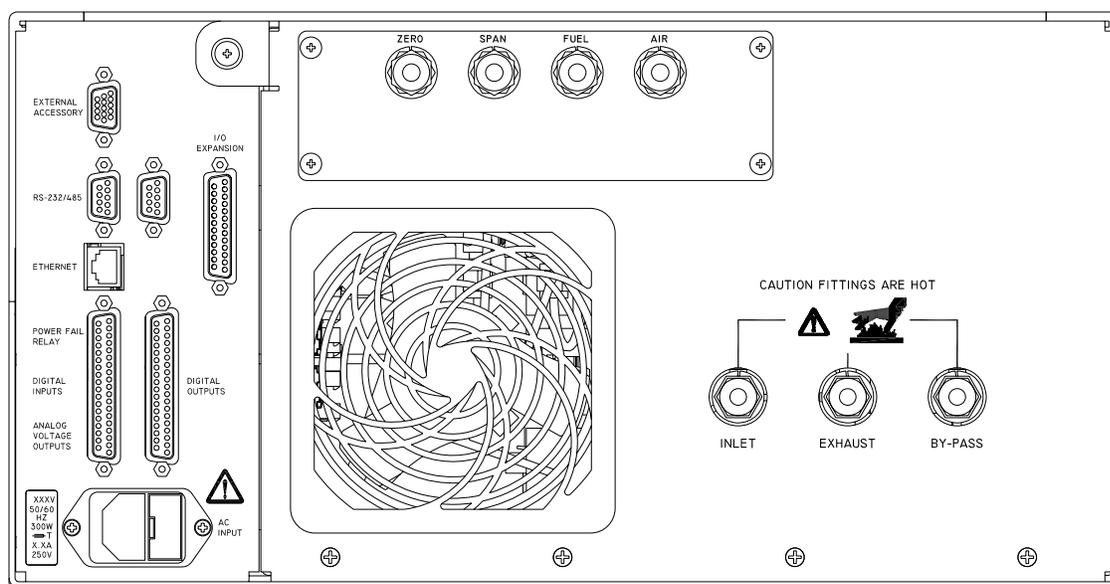
Figure 2–2. Model 51*i* Rear Panel

Flow of the fuel gas, combustion air, and sample gas are controlled by electronic pressure controllers and regulators within the Model 51*i*. The internal pressure controllers and regulators are adjusted at the factory to provide proper flow rates. Typical controller settings and consumption rates are given below. Normally, the instrument hardware maintains factory set flow rates automatically. However, should adjustment become necessary, refer to the "Servicing" chapter for the procedure for adjusting gas flows.

Note Combustion air continues to flow if the Model 51*i* is turned off. If the instrument is shut down for an extended period of time, the combustion air should therefore be disconnected or turned off at the cylinder. Although fuel flow and calibration gases are automatically stopped by the internal solenoids when the instrument power is shut off, it is recommended that the cylinders be turned off whenever the instrument is shut down for an extended period. ▲

Fuel   The 51*i* requires either pure hydrogen or mixed helium/hydrogen fuel (60%/40%) for operation. In accordance with U.S. EPA recommendations on monitoring combustion sources, the HT version of the instrument is optimized for operation with mixed fuel. The unit can also be operated

with pure hydrogen, but the flows will need to be re-optimized and the performance may not meet published specifications. The LT version of the instrument, which is not intended for use in combustion source monitoring applications, is optimized for pure hydrogen fuel and cannot be run with mixed fuel.

When purchasing fuel cylinders, the gas purity or grade is a significant consideration. For ambient or trace level measurements, high purity fuel is required. For many applications, use of a hydrogen generator should be considered. For source monitoring operations with the HT version of the instrument, cylinders can be purchased from a specialty gas supplier, and are usually marketed as "FID fuel".

When the fuel gas is hydrogen, the cylinder regulator should be set to 45 to 50 psig. Consumption of the fuel is approximately 25 ml per minute. When the fuel gas is a hydrogen/helium mixture, the cylinder regulator should be set to 45 to 50 psig and consumption will be approximately 100 to 130 ml per minute.

Combustion Air

The 51*i* requires a pressurized source of combustion air to support the FID flame and also to provide back-pressure that is used to control and stabilize the sample flow into the detector. Air can be supplied from cylinders or can be generated on-site. In either case, the combustion air should be dry and particle free to prevent contamination of the analyzer. As with the fuel, the hydrocarbon content will impact the analyzer's performance and for ambient or trace level monitoring, high purity, THC free air will be required. For additional discussion of air quality, see Chapter 4, "Calibration" in this manual.

The combustion air cylinder regulator should be set to 45 to 50 psig. Consumption is approximately 250 to 350 ml per minute.

Calibration Gases

If the internal zero and span valves will be used, the zero air and span gas cylinder regulators should be set to 10 psig. The cylinder pressure controls the calibration gas flow rate, so it might be necessary to adjust the cylinder pressures. For more information, refer to Chapter 4, "Calibration".

Sample Line Connection

The sample line is connected to the sample port (inlet) on the Model 51*i* with 1/4-inch OD tubing. The sample line can be up to 200 feet without significantly compromising the sample flow rate. If the sample is drawn from a source that operates under strong negative pressure, or if the sample line is more than 200 feet long, an external pump should be considered. However, if an external pump is used, the additional positive pressure should not be used to force the sample into the instrument. Figure 2–3

illustrates the atmospheric dump bypass plumbing required when an external pump is used.
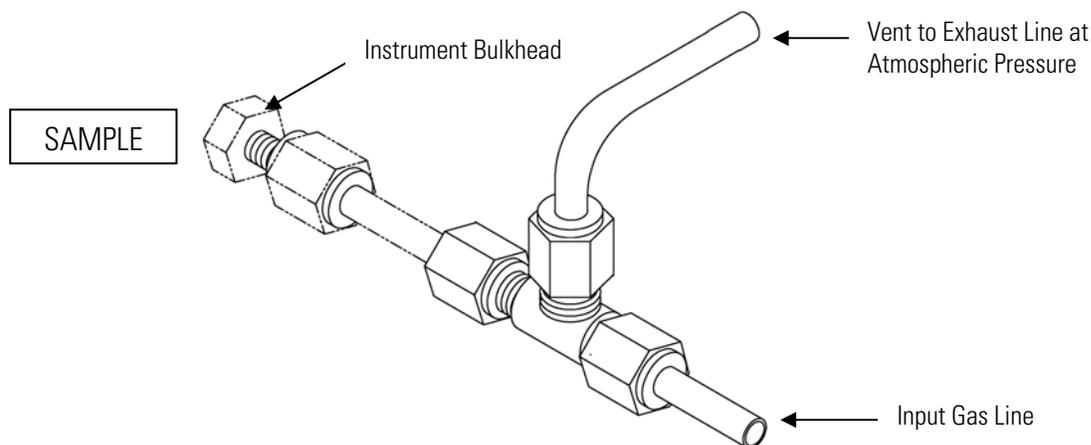
Figure 2–3. Atmospheric Dump Bypass Plumbing

Note This arrangement is required only if sample is delivered to the analyzer under positive pressure. ▲

Venting the Bypass

The 51*i* pump draws significantly more sample than is needed by the detector. The excess sample gas is vented from the instrument through a bypass port located on the rear panel.

For most applications, it is not necessary to connect the bypass to a vent or scrubber. However, if the Model 51*i* is located in an enclosure, or if hazardous samples are being monitored, it may be necessary to run the bypass exhaust back to the source or to a vent to avoid build-up of hazardous sample gases inside an enclosed space or in the work area. If exhaust lines or scrubbers are added, care should be taken to limit the build-up of back-pressure. If long exhaust lines are needed, increasing the vent tube diameter will help prevent excessive back-pressure.

WARNING The bypass (or sample gas exhaust) contains all of the pollutants of the original sample. Depending on the application, the bypass could be flammable, explosive, or highly toxic. If the sample stream is potentially hazardous, the bypass should be routed back to the source or to an appropriate vent. ▲

Venting the FID Exhaust

If the analyzer is running in an open rack or an area with normal ventilation, the FID exhaust can be left open and does not need to be vented. This is the preferred configuration. However, if the analyzer must be mounted in a small enclosure without ventilation, the FID exhaust port should be connected to a vent line that runs to an exhaust system. This is so hydrogen cannot accumulate and create an explosion hazard in the event of a failure. If an exhaust line is used, the operator should be aware that it may make flame ignition more difficult. Use of a large diameter line may be helpful if this becomes a problem.

Gas exiting the detector vent contains water vapor formed by hydrogen combustion. Any exit line connected to the detector vent must be slanted down to prevent condensed water from collecting in the tubing.

⚠ **WARNING** During normal operation, the FID exhaust contains non-flammable components, mostly air and water vapor. However, under failure conditions, the FID exhaust could contain explosive levels of hydrogen. ▲

⚠ **CAUTION** Gas fittings on the rear panel or inside the oven are very hot. ▲

Power Connection

The only electrical connection needed for start-up of the Model 51*i* is the power cord, which plugs into a recepticle on the rear panel (Figure 2–2). Before the power cord is connected, be sure that the front panel power switch is off.

⚠ **WARNING** The Model 51*i* is supplied with a three-wire grounded power cord. Under no circumstances should this grounding system be defeated. ▲

For detailed information about connecting to the instrument, refer to:

"Connecting External Devices" on page 2-7

"Instrument Controls Menu" on page 3-19

"I/O Configuration" on page 3-39

"Connector Pin Descriptions" on page 6-10

"Terminal Block and Cable Kits" on page 9-1

For detailed information about troubleshooting a connection, refer to "Analog Output Testing" on page 7-29.

Connecting External Devices

Several components are available for connecting external devices to *i*Series instruments.

These connection options include:

● Individual terminal board PCB assemblies (standard)

● Terminal block and cable kits (optional)

● Individual cables (optional)

For detailed information on the optional connection components, refer to the "Optional Equipment" chapter. For associated part numbers, refer to "External Device Connection Components" on page 7-7.

Terminal Board PCB Assemblies

The terminal board PCB assemblies are circuit boards with a D-Sub connector on one side and a series of screw terminals on the other side. These assemblies provide a convenient mechanism for connecting wires from a data system to the analyzer's I/O connectors.

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

● I/O terminal board PCB assembly, 37 pin (standard)

● D/O terminal board PCB assembly, 37 pin (standard)

● 25-pin terminal board PCB assembly, (included with optional I/O expansion board)

I/O Terminal Board

Figure 2–4 shows the recommended method for attaching the cable (customer supplied) to the terminal board using the included tie-down and spacer. Table 2–1 identifies the connector pins and associated signals.

Note Not all of the I/O available in the instrument is brought out on the supplied terminal board. If more I/O is desired, an alternative means of connection is required. See optional "Terminal Block and Cable Kits". ▲

See Detail "A"

See Detail "B"

Component Side Viewed from Top of Board

Detail "A"

Detail "B"

Assembled Connector
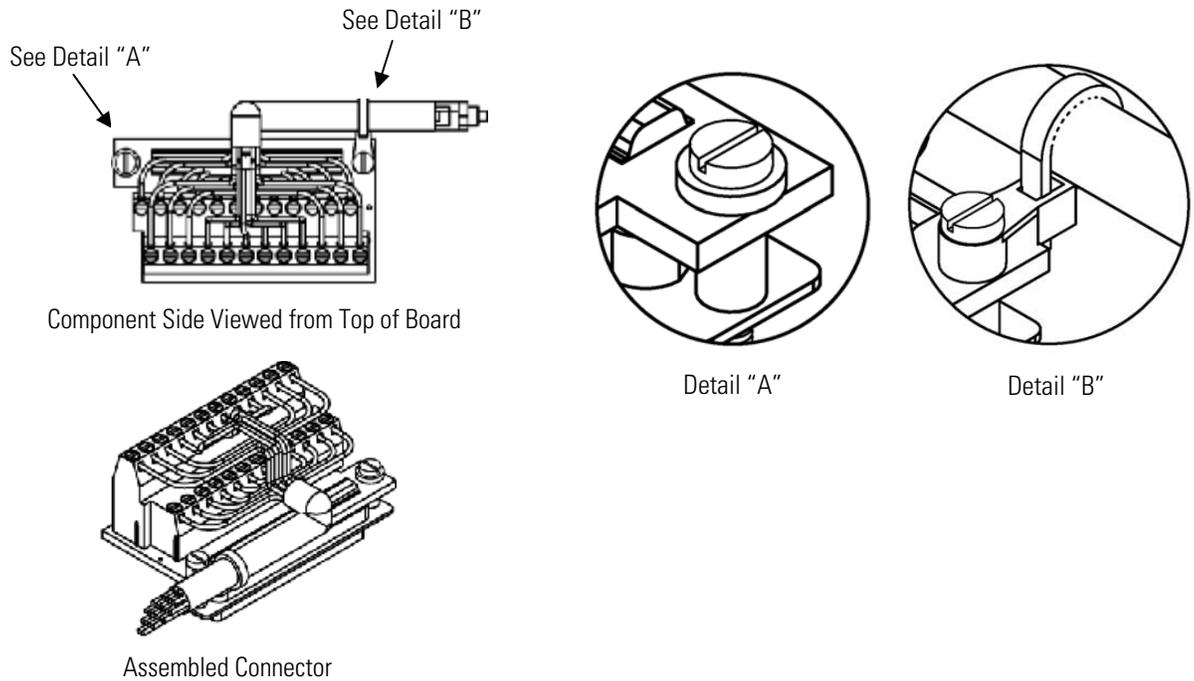
Figure 2–4. I/O Terminal Board Views

Table 2–1. I/O Terminal Board Pin Descriptions

Screw	Signal Description	Screw	Signal Description
1	Analog1	13	Power_Fail_NC
2	Analog ground	14	Power_Fail_COM
3	Analog2	15	Power_Fail_NO
4	Analog ground	16	TTL_Input1
5	Analog3	17	TTL_Input2
6	Analog ground	18	TTL_Input3
7	Analog4	19	TTL_Input4
8	Analog ground	20	Digital ground
9	Analog5	21	TTL_Input5
10	Analog ground	22	TTL_Input6
11	Analog6	23	TTL_Input7
12	Analog ground	24	Digital ground

The analog outputs are arranged on the rear panel connector as shown in
Figure 2–5. See Table 2–2 for channels and pin connections.
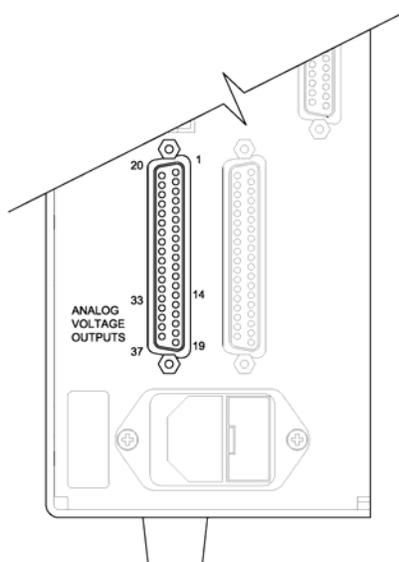
Figure 2–5. Pin-Out of Rear Panel Connector

Table 2–2. Default Analog Outputs

Channel	Connector Pin	I/O Terminal Pin	Description
1	14	1	THC Analog Output
2	33	3	THC Analog Output
3	15	5	None
4	34	7	None
5	17	9	None
6	36	11	None
Ground	16, 18, 19, 35, 37	2, 4, 6, 8, 10, 12	Signal Ground

Note All channels are user definable. If any customization has been made
to the analog output configuration, the default selections may not apply. ▲

D/O Terminal Board   Figure 2–6 shows the recommended method for attaching the cable
(customer supplied) to the terminal board using the included tie-down and
spacer. Table 2–3 identifies the connector pins and associated signals.

See Detail "A"

See Detail "B"

Component Side Viewed from Top of Board

Detail "A"

Detail "B"

Assembled Connector
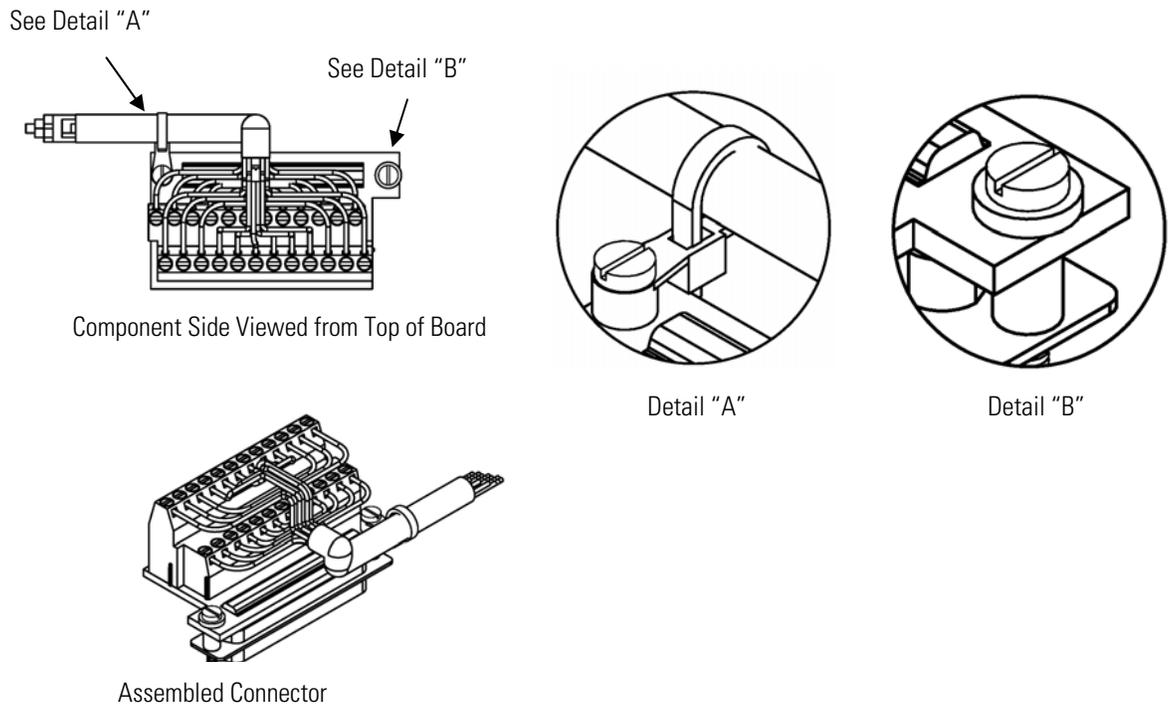
Figure 2–6. D/O Terminal Board Views

Table 2–3. D/O Terminal Board Pin Descriptions

Screw	Signal Description	Screw	Signal Description
1	Relay1_ContactA	13	Relay7_ContactA
2	Relay1_ContactB	14	Relay7_ContactB
3	Relay2_ContactA	15	Relay8_ContactA
4	Relay2_ContactB	16	Relay8_ContactB
5	Relay3_ContactA	17	Relay9_ContactA
6	Relay3_ContactB	18	Relay9_ContactB
7	Relay4_ContactA	19	Relay10_ContactA
8	Relay4_ContactB	20	Relay10_ContactB
9	Relay5_ContactA	21	(not used)
10	Relay5_ContactB	22	+24V
11	Relay6_ContactA	23	(not used)
12	Relay6_ContactB	24	+24V

25-Pin Terminal Board

The 25-pin terminal board is included with the optional I/O Expansion Board. Figure 2–7 shows the recommended method for attaching the cable (customer supplied) to the terminal board using the included tie-down and spacer. Table 2–4 identifies the connector pins and associated signals.

See Detail "A"

See Detail "B"

Component Side Viewed from Top of Board

Detail "A"   Detail "B"

Assembled Connector
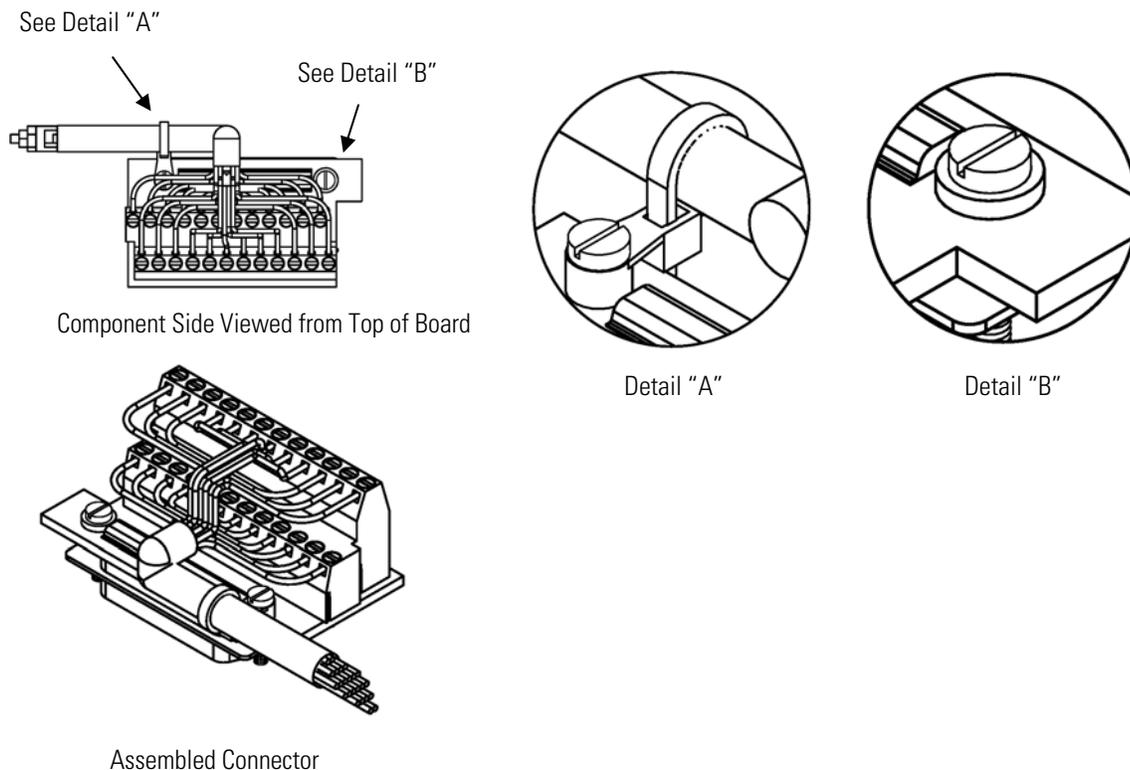
Figure 2–7. 25-Pin Terminal Board Views

Table 2–4. 25-Pin Terminal Board Pin Descriptions

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

Startup

Once the electrical and gas connections are complete, the instrument can be turned on and the Power-Up screen appears.

Following the Power-Up screen, a message briefly appears indicating either a Cold Start, Warm Start, or Hot Start. The "Cold Start" message appears if the oven is at ambient temperature when the instrument is turned on. The "Warm Start" message appears if the instrument has been off for a relatively short period of time and the oven is greater than 75% of the oven set temperature. The "Hot Start" message appears if the instrument has been off for a very short period of time and the oven is within 5 degrees of the oven set temperature.

After the initial diagnostics, the "Warming Up" message appears until the oven set temperature is reached and the pump turns on. The "Stabilizing" screen then appears and remains on until the oven stabilizes (5 minutes for a warm start, 30 minutes for a cold start, and no stabilization period for a hot start). When the oven stabilizes, the fuel solenoid opens, the flame lights, and the Run screen appears.

If the 51*i* fails to light after the ignition sequence, it will pause for 15 minutes and then re-enter the ignition cycle. If it still fails to light after four full ignition cycles, the unit will attempt re-ignition once every 24 hours. The "Cannot Ignite" alarm will be active during this time. If you want to leave the instrument power on, but you do not want the auto-ignition sequence to trigger, the unit should be set to Idle Mode, as described in the "Calibration" chapter.

If necessary, the warm up and stabilization periods can be bypassed by going into the menu system and manually lighting the flame from the "FID Status" screen. However, this should be avoided since full temperature stabilization is needed to achieve optimal performance.

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   The 320 x 240 graphics liquid-crystal display (LCD) shows the sample concentrations, instrument parameters, instrument controls, help, 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.
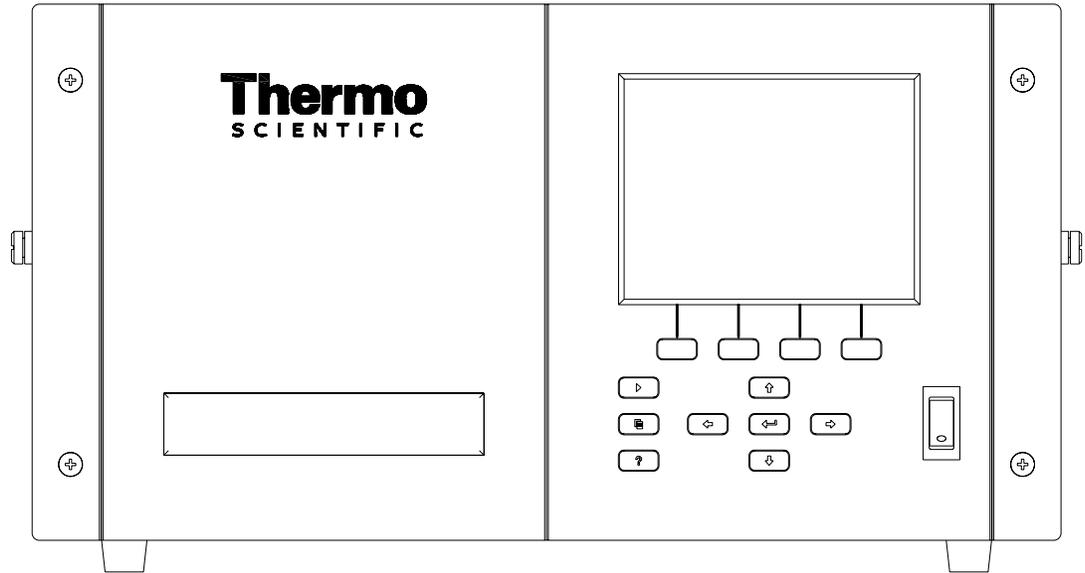
Figure 3–1. Front Panel Display

 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.
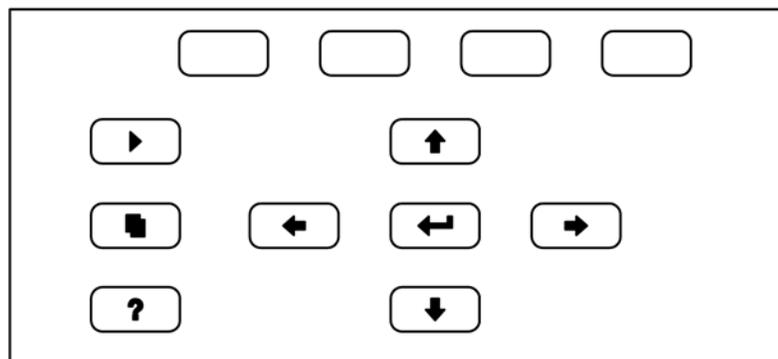
Figure 3–2. Front Panel Pushbuttons

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" below.
▶ = Run	The ▶ is used to display the Run screen. The Run screen normally displays the current THC concentration.
■ = Menu	The ■ is used to display the Main Menu when in the Run screen, or 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 function of the soft keys is to 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 Not all menu items may be assigned to soft keys. If a particular menu or screen item cannot be assigned, the key assignment 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
     ABCDEFGHIJKLMN   BKSP
     OPQRSTUVWXYZ     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 ⟶

```
ABCDEFGHIJKLMN   BKSP       abcdefghijklmn   BKSP
OPQRSTUVWXYZ     PAGE       opqrstuvwxyz     PAGE
0123456789 ./-   SAVE       0123456789 ./-   SAVE

RANGE   AVG   DIAGS ALARM   RANGE   AVG   DIAGS ALARM
```
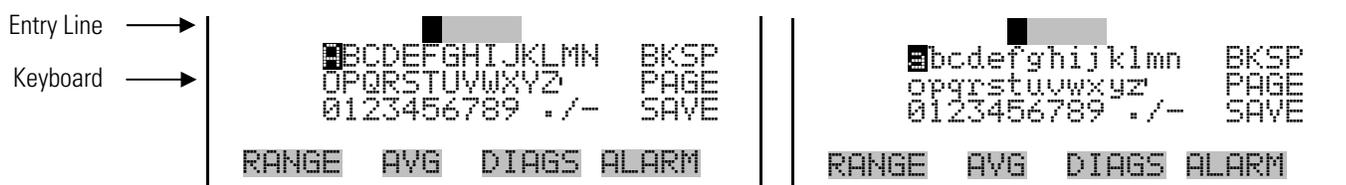
Firmware Overview

The Model 51*i* utilizes the menu-driven firmware as illustrated by the flowchart in Figure 3–3. 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. This screen provides the current total hydrocarbon (THC) concentration 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.
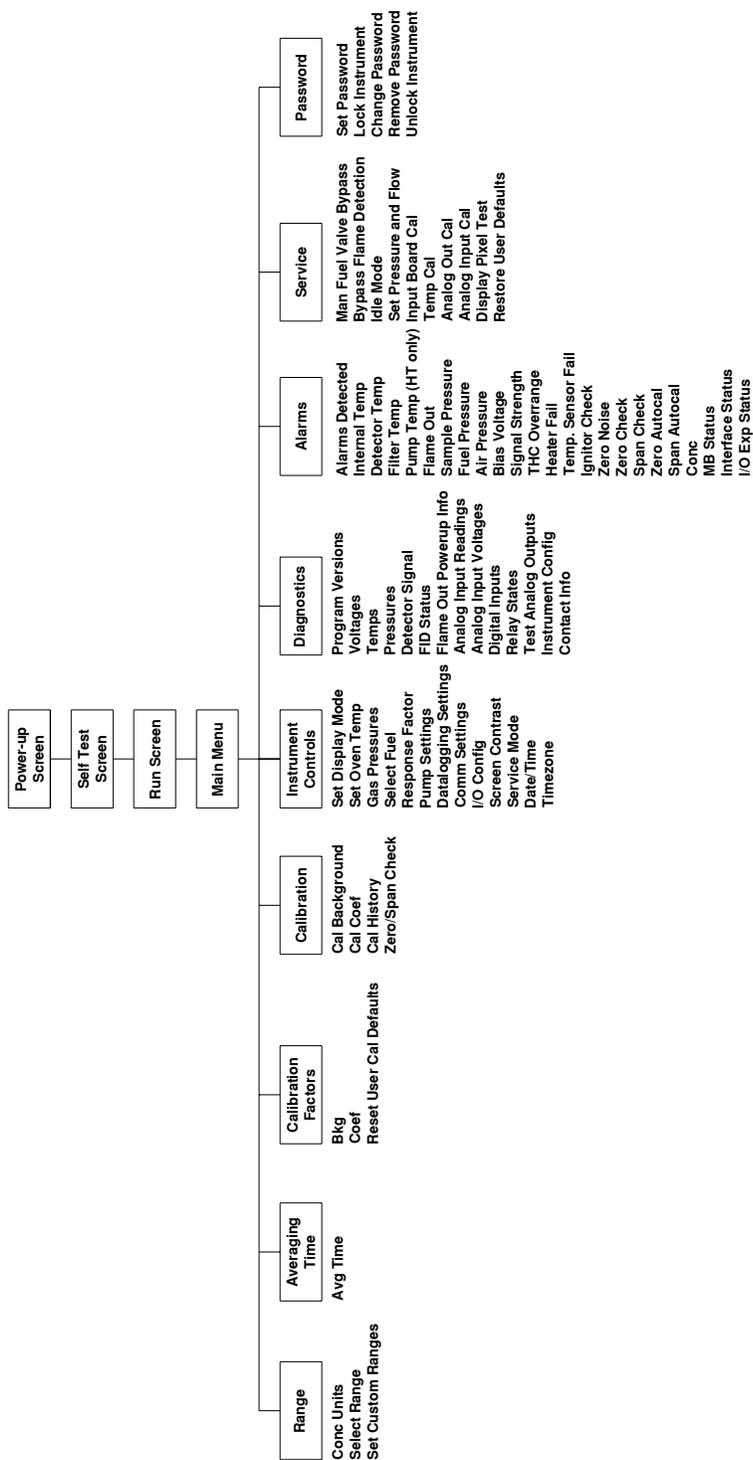
Figure 3–3. Flowchart of Menu-Driven Firmware

Power-Up Screen

The Power-Up screen is displayed when power is applied to the Model 51*i*. 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 THC readings and statistics. The status bar displays the time, the password (lock) icon, service (wrench) icon, alarm (bell) icon, and optional zero/span sample solenoid valve status, if installed.

Status Bar Icons

The password (lock) icon indicates that no parameter changes can be made from the front panel.

The alarm (bell) icon indicates that an alarm is active.

The service (wrench) icon indicates that the instrument is in the service mode.

The first line, labeled "THC" displays the current THC reading. The line labeled "AVG" displays the average THC measurement during the current report period. The lines labeled "HI" and "LO", respectively, display the highest and lowest THC readings that have occurred during the current report period. The report period is tied to the function of the analyzer's built-in datalogger. Adjustment of the logging period is discussed later in this chapter under Datalogging Settings. If the report period is set to zero, these lines indicate the average, lowest and highest readings since the current run screen was displayed. Pressing ⬛➡ to reset the statistics also clears the AVG, HI, and LO readings and restarts the calculation. The title bar indicates current flame status and operating mode. The status bar displays the current time (24-hour format), alarm, service, and password.

The word "SAMPLE" on the left of the status bar indicates the analyzer has the zero/span valve option and is in "SAMPLE" mode. Other modes appear in the same area of the display as "ZERO" or "SPAN". For more information about the optional solenoid valves, see Chapter 9, "Optional Equipment".
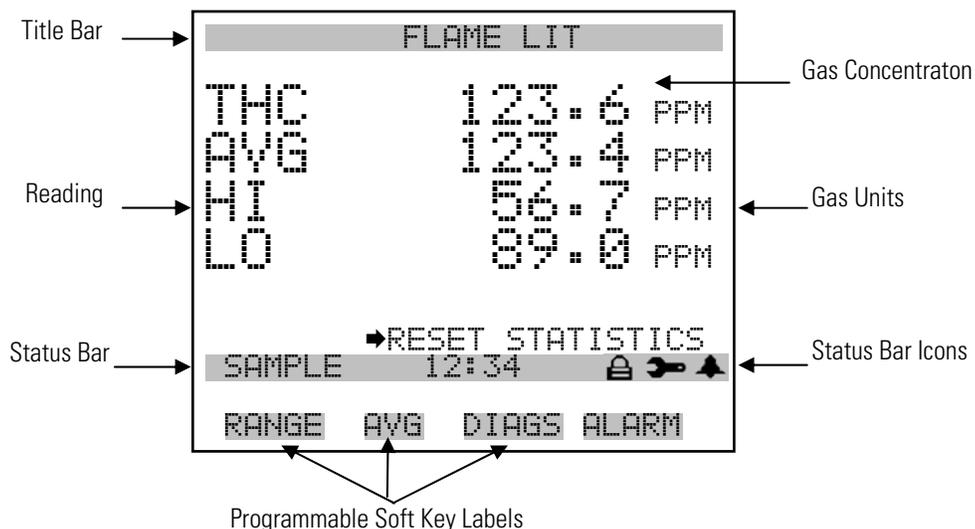
Main Menu

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 mode. For more information on the service mode, see "Service Mode" later in this chapter.

● 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.
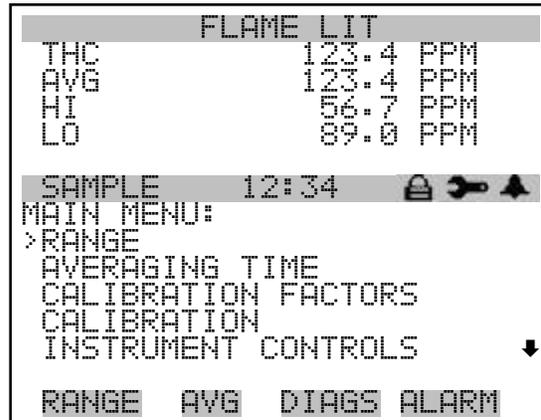
```
           FLAME LIT
THC             123.4 PPM
AVG             123.4 PPM
HI               56.7 PPM
LO               89.0 PPM

SAMPLE      12:34      🔒 🔧 🔔
MAIN MENU:
>RANGE
 AVERAGING TIME
 CALIBRATION FACTORS
 CALIBRATION
 INSTRUMENT CONTROLS       ⬇

 RANGE   AVG   DIAGS ALARM

       DIAGNOSTICS
       ALARMS
       SERVICE
       PASSWORD
```

Range Menu

The Range menu allows the operator to select the gas units, standard ranges, and to set the custom ranges.

● In the Main Menu, choose **Range**

```
RANGE:
>CONC UNITS              PPM
 SELECT RANGE          50000
 SET CUSTOM RANGES



 RANGE    AVG    DIAGS ALARM
```
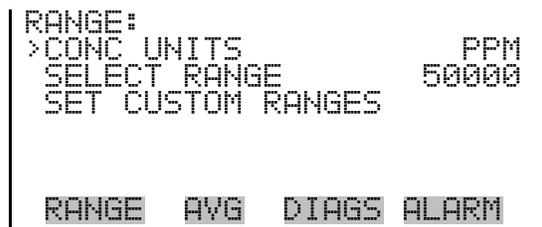
Concentration Units

The Concentration Units screen defines how the THC concentration is expressed. Gas units of parts per billion (ppb), parts per million (ppm), parts per million carbon (ppmc), micrograms per cubic meter (μg/m^3), milligrams per cubic meter (mg/m^3), or percent are available. It should be understood that the concentration unit is only a label. Therefore, the instrument operates independently of the type of unit selected; the unit selection does not affect the instrument's measurement procedure.

When switching the selected units, the instrument's analog ranges all default to the highest range. For example, when switching from mg/m³ to ppm, all the ranges default to 50000 ppm. Therefore, whenever you change units, you should also check the range settings.

Note If the units change, the instrument should be re-calibrated. A display warning will appear. ▲

The Model 51*i* cannot convert between the various units of concentration. Therefore, the unit selected must match the units used to express the concentration of the span gas. It is especially important to understand that when measuring gases and vapors, the common units of ppb, ppm, and ppmc are based on volume of contaminant per volume of sample gas. A gas containing 100 ppm of methane would contain 100 liters of methane per 1,000,000 liters of gas. In contrast, concentrations expressed in mg/m³ and μg/m³ are based on the mass of contaminant per unit volume of sample gas. Therefore, conversion between units of ppm and mg/m³ requires knowledge of the specific hydrocarbon present in the sample. ▲

● In the Main Menu, choose Range > **Conc Units**.

```
CONC UNITS:
 CURRENTLY:           PPM
    SET TO:           PPM

 ↑↓ CHANGE VALUE    ← SAVE

 RANGE   AVG   DIAGS ALARM
```

```
CONC UNITS:
 CURRENTLY:           PPM
    SET TO:        UG/M3 ?
WARNING! RECALIBRATE AFTER
  CHANGING UNIT SETTING!
 ↑↓ CHANGE VALUE    ← SAVE

 RANGE   AVG   DIAGS ALARM
```
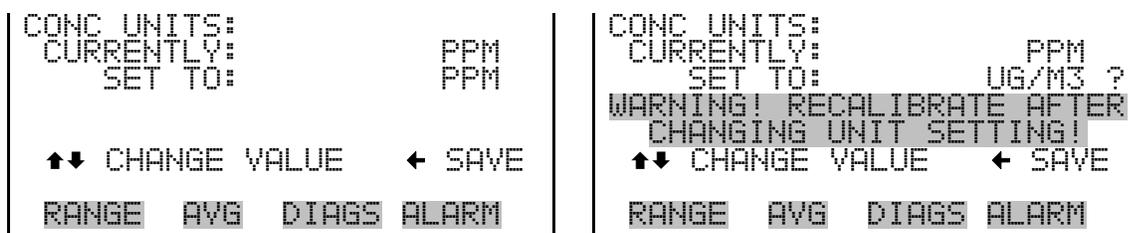
Select Range

The Select Range screen defines the concentration range of the analog outputs. For example, selecting a THC range of 0–100 ppm sets the analog output to concentrations between 0 and 100 ppm. Available ranges include: 1, 10, 100, 1000, 5000, 10000 and 50000 (.01, .1, .5, 1 and 5 if in percent).

C1, C2, and C3 are custom ranges. For more information about custom ranges, see "Set Custom Ranges" below.

The display shows the current THC range. The next line of the display is used to change the range.

● In the Main Menu, choose Range > **Select Range**.

```
RANGE:
 CURRENTLY:              10
     SET TO:            100 ?

              ↑↓  CHANGE VALUE
               ↵  SAVE VALUE

  RANGE   AVG   DIAGS ALARM
```
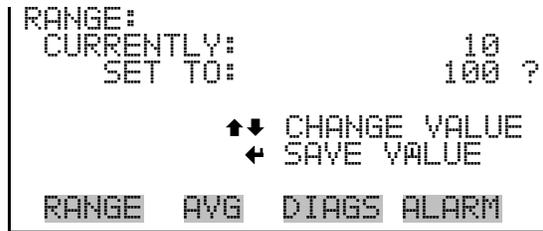
The analog outputs are arranged on the rear panel connector as shown in Figure 3–4. See Table 3–2 for channels and pin connections.
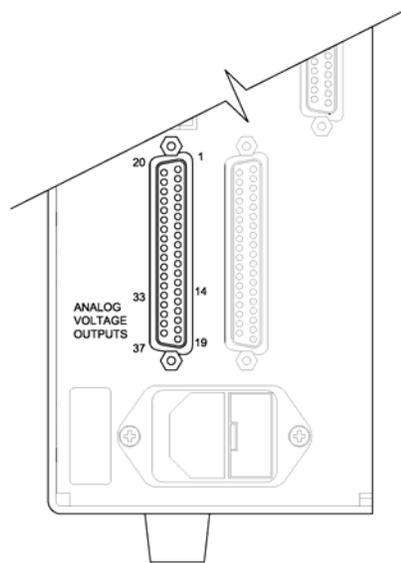
Figure 3–4. Pin-Out of Rear Panel Connector

Table 3–2. Default Analog Outputs

Channel	Connector Pin	I/O Terminal Pin	Description
1	14	1	THC Analog Output
2	33	3	THC Analog Output
3	15	5	None
4	34	7	None
5	17	9	None
6	36	11	None
Ground	16, 18, 19, 35, 37	2, 4, 6, 8, 10, 12	Signal Ground

Note All channels are user definable. If any customization has been made to the analog output configuration, the default selections may not apply. ▲

Set Custom Ranges   The Set Custom Ranges menu lists three custom ranges, which are user-defined. Any value between 1 and 50000 can be specified as a range.

●   In the Main Menu, choose Range > **Set Custom Ranges**.

```
CUSTOM RANGES:
>CUSTOM RANGE 1        55.6
 CUSTOM RANGE 2        75.0
 CUSTOM RANGE 3       125.0


 RANGE   AVG   DIAGS ALARM
```

Custom Ranges   The Custom Ranges screen is used to define the custom ranges.

The display shows the current custom range. The next line of the display is used to set the range. For more information about selecting ranges, see "Select Range" above.

●   In the Main Menu, choose Range > Set Custom Ranges > **Custom Range 1, 2,** or **3**.

```
CUSTOM RANGE 1:
 CURRENTLY:            55.6
    SET TO:       000055.7 ?

              ◆▶ MOVE CURSOR
 ▲▼ CHANGE VALUE    ◀ SAVE
 RANGE   AVG   DIAGS ALARM
```

Averaging Time   The Averaging Time screen allows the user to change the averaging time, which is the time period (1 to 300 seconds) over which the THC measurements are averaged. The THC measurement shown on the front panel display is updated every second. 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 10 seconds, the THC reading shown on the display at any given time is the average concentration over the last 10 seconds.

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 hydrocarbon concentration. The following averaging times are available: 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, 240, and 300 seconds.

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

```
AVERAGING TIME:
 CURRENTLY:       30 SEC
    SET TO:       10 SEC ?

          ↑↓ CHANGE VALUE
           ↵ SAVE VALUE

RANGE   AVG   DIAGS ALARM
```

Calibration Factors Menu

The Calibration Factors menu displays the calibration factors, which are used to correct the THC concentration readings that the instrument generates using its own internal calibration data.

Normally, the calibration factors are calculated automatically using the functions described in "Calibration Menu" later in this chapter. However, the calibration factors can also be set manually using the functions in this menu.

● In the Main Menu, choose **Calibration Factors**.

```
CALIBRATION FACTORS:
>BKG (ZERO)          0.00
 COEF (SPAN)         1.000
 RESET USER CAL DEFAULTS



RANGE    AVG   DIAGS ALARM
```

Background

The Background screen is used to perform a manual adjustment of the instrument's zero reading. Before performing a manual zero adjustment, allow the analyzer to sample zero air until stable readings are obtained.

The display shows the current THC reading. The next line of the display shows the THC background correction that will be stored in memory. The THC background correction is a value, expressed in the current gas units, that is subtracted from the detector signal to produce the THC reading of zero.

In the following example, the analyzer displays 5.2 ppm of THC while sampling zero air. A background correction of 0.0 ppm means that 0 ppm is being subtracted from the THC reading being displayed. Therefore, the

background correction must be increased to 5.2 ppm in order for the THC reading to be at 0 ppm. That is, a THC reading of 5.2 ppm minus a THC background reading of 5.2 ppm gives the corrected THC reading of 0 ppm.

To set the THC reading in the following example to zero, use ⬆ to increment the THC background correction to 5.2 ppm. As the THC background correction is increased, the THC concentration is decreased. Note that at this point, pressing ⬆ and ⬇ have no effect on the analog outputs or the stored THC background correction of 0.0 ppm. A question mark following the THC background correction indicates that these are proposed changes as opposed to implemented changes. To escape this screen without saving any changes, press ■ to return to the Calibration Factors menu or ▶ to return to the Run screen. Press ↵ to actually set the THC reading to 0 ppm and store the new background correction of 5.2 ppm. Then the question mark prompt beside the THC reading disappears.

● In the Main Menu, choose Calibration Factors **> Bkg**.

```
BACKGROUND:
         THC:        5.2
  SET BKG TO:        0.00 ?

         ⬆⬇ INC/DEC
          ↵ SAVE VALUE

 RANGE    AVG   DIAGS ALARM
```
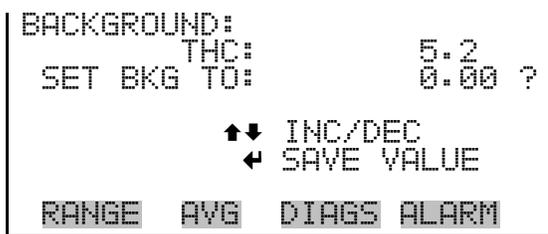
Coefficient

The Coefficient screen allows the span coefficient to be manually changed while sampling span gas of known concentration.

The display shows the current THC reading. The next line of the display shows the THC span coefficient that is stored in memory and is being used to correct the THC concentration. Notice that as the span coefficient value is changed, the current THC concentration reading on the above line also changes. However, no actual changes are made to the value stored in memory until ↵ is pressed. Only proposed changes, as indicated by a question mark prompt, are displayed until ↵ is pressed.

Note The screen will show "SPAN CONC NOT VALID" if the coefficient change causes the concentration to be either higher than the selected range or less than or equal to zero. ▲

● In the Main Menu, choose Calibration Factors > **Coef**.

```
COEFFICIENT:
        THC:            51.4
  SET COEF TO:         1.000 ?

                  ▲▼ INC/DEC
                   ↵ SAVE VALUE

  RANGE   AVG   DIAGS ALARM
```
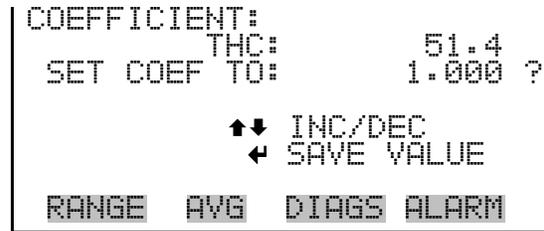
Reset User Calibration Defaults

The Reset User Calibration Defaults screen allows the user to reset the calibration factors to factory defaults.

● In the Main Menu, choose Calibration Factors > **Reset User Cal 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
```
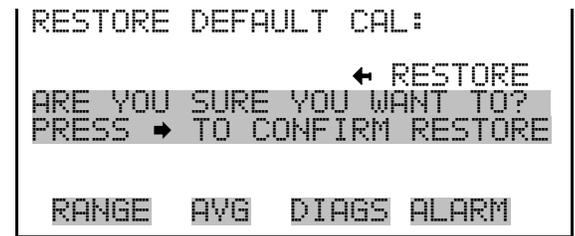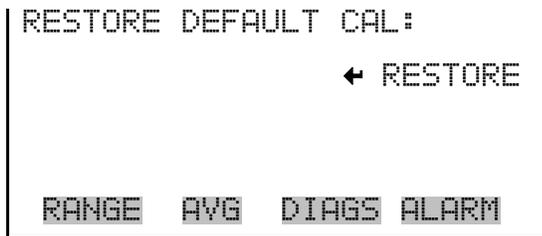
Calibration Menu

The Calibration menu is used to automatically set the zero background and the span coefficient. The zero/span check menu item is visible only if the zero/span valve option is installed.

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

```
CALIBRATION:
>CAL BACKGROUND (ZERO)
 CAL COEF (SPAN)
 CALIBRATION HISTORY
 ZERO/SPAN CHECK


  RANGE   AVG   DIAGS ALARM
```

Calibrate Background

The Calibrate Background screen is used to adjust the instrument zero, or background. Before making an adjustment, be sure the analyzer samples zero air until the reading stabilizes. The display shows the current THC reading and the current background value. Press ↵ to set the THC reading to zero.

It is important to note the averaging time when calibrating. In general, the longer the averaging time, the more accurate the calibration will be. For most applications, the 30-second averaging time is adequate. For more information about calibration, see Chapter 4, "Calibration".

● In the Main Menu, choose Calibration > **Cal Background**.

```
THC BACKGROUND:
       THC:           1.2
  CURRENTLY:          0.00 ?

              ↵ SET THC TO ZERO


 RANGE   AVG   DIAGS ALARM
```

Calibrate Coefficient

The Calibrate Coefficient screen is used to adjust the THC reading while sampling span gas of known concentration. Before making an adjustment, be sure the analyzer samples span gas until the reading stabilizes.

The display shows the current THC reading. The next line of the display is where the span gas concentration is entered. Press ↵ to save the new calibration coefficient.

It is important to note the averaging time when calibrating. In general, the longer the averaging time, the more accurate the calibration will be. For most applications, the 30-second averaging time will be adequate. For more information about calibration, see Chapter 4, "Calibration".

● In the Main Menu, choose Calibration > **Cal Coef**.

```
CALIBRATE THC:
       THC:          25.5
  SPAN CONC:     0001.00▮ ?

            ↔ MOVE CURSOR
   ↕ CHANGE VALUE    ↵ SAVE
 RANGE   AVG   DIAGS ALARM
```

Calibration History

The Calibration History screen is a list of diagnostic data from the 5 most recent calibrations. This includes: date and time of calibration, the type of calibration activity, the signal intensity produced by the zero and/or span gas and the other diagnostic information. The possible calibration types include zero adjust, span adjust, manual calibration, and automatic calibration. For detailed calibration procedures and reports, refer to Chapter 4, "Calibration".

Note If a calibration fails or produces a fault condition, it is noted in the Calibration History and the unit will continue to operate using the last valid calibration. ▲

● In the Main Menu, choose Calibration > **Calibration History**.

```
CALIBRATION HISTORY:
>1      15AUG2006 22:57:06
 2      14AUG2006 22:57:06
 3      13AUG2006 22:57:06
 4      12AUG2006 22:57:06
 5      11AUG2006 22:57:06
 RANGE   AVG   DIAGS ALARM
```

```
CALIBRATION HISTORY:
>TIME     15AUG2006 22:57
 TYPE              MANUAL
 STATUS              GOOD
 SPAN/ZERO           ZERO
 BACKGROUND SIGNAL   4066 ↓
 RANGE   AVG   DIAGS ALARM
```

```
SPAN SIGNAL      292,180
SPAN CONC         300.00
SPAN COEF          1.000
SIGNAL NOISE     9.185690
SIGNAL SLOPE    25.413500
```

Zero/Span Check

The Zero/Span Check menu is available only if the zero/span valve option is installed. It is used to program the instrument to perform fully automated zero and span checks or adjustments.

● In the Main Menu, choose Calibration > **Zero/Span Check**.

```
ZERO/SPAN CHECK:
>NEXT TIME 01Jan06 12:00
 PERIOD HR            24
 TOTAL DURATION HR   1.5
 ZERO DURATION MIN    30
 SPAN DURATION MIN    30 ↓
 RANGE   AVG   DIAGS ALARM
```

```
PURGE DURATION MIN    30
ZERO/SPAN AVG SEC     60
ZERO CAL RESET        ON
SPAN CAL RESET       OFF
ZERO/SPAN RATIO        1
```

Next Time   The Next Time screen is used to view and set the initial date and time (24-hour format) of the zero/span check. Once the initial zero/span check is performed, the date and time of the next zero/span check is calculated and displayed.

● In the Main Menu, choose Calibration > Zero/Span Check > **Next Time**.

```
NEXT DATE AND TIME:
 19 MAR 2007  12:34
 PRESS ← TO EDIT



 RANGE   AVG   DIAGS ALARM
```

```
NEXT DATE AND TIME:
 19 MAR 2007  12:34 ?
 SETTING:  DAYS
          → SET MONTHS
        ↑↓ CHANGE VALUE
          ← SAVE VALUE
 RANGE   AVG   DIAGS ALARM
```
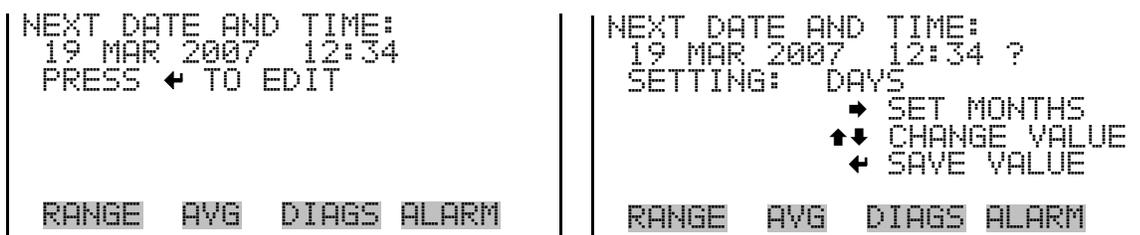
Period Hours   The Period Hours screen defines the period or interval between zero/span checks. Periods between 0 and 999 hours are acceptable. To turn the zero/span check off, set the period to 0.

● In the Main Menu, choose Calibration > Zero/Span Check > **Period HR**.

```
ZERO/SPAN PERIOD:
 CURRENTLY:      024 HRS
    SET TO:      02█ HRS ?

          ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ← SAVE
 RANGE    AVG   DIAGS ALARM
```
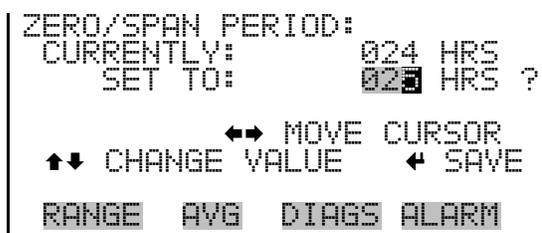
Total Duration Hour   The Total Duration Hour line is the sum of the zero, span, and purge duration minutes, and is for viewing only.

Zero/Span/Purge Duration Minutes   The Zero Duration Minutes screen defines how long zero air is sampled by the instrument. The Span and Purge Duration Minutes screens look and function the same way as the zero duration screen. The span duration screen is used to set how long the span gas is sampled by the instrument. The purge duration screen is used to set how long the purge period will be after doing a zero or span check. This gives the instrument time to flush

out the zero and span gas before any meaningful data is taken. Logged data is flagged as taken during a purge to show that the data is suspect. Durations between 0 and 99 minutes are acceptable. Each time a zero/span check occurs the zero check is done first, followed by the span check. To perform just a zero check, set the span duration to 0 (off). The same applies to perform just a span check.

● In the Main Menu, choose Calibration > Zero/Span Check > **Zero, Span** or **Purge Duration Min**.

```
ZERO DURATION:
  CURRENTLY:        30 MIN
     SET TO:        31 MIN ?

                 ◆➤ MOVE CURSOR
  ▲▼ CHANGE VALUE     ◆ SAVE

  RANGE   AVG   DIAGS ALARM
```

Zero/Span Averaging Time

The Zero/Span Averaging Time screen allows the user to set the zero/span averaging time. The zero/span averaging time is used by the analyzer only when performing an automatic zero or span check or adjustment. The analyzer's averaging time is used for all other functions. The following averaging times are available: 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, 240, and 300 seconds.

● In the Main Menu, choose Calibration > Zero/Span Check > **Zero/Span Avg Sec**.

```
ZERO/SPAN AVERAGING TIME:
  CURRENTLY:        60 SEC
     SET TO:        90 SEC ?

               ▲▼ CHANGE VALUE
                ◆ SAVE VALUE

  RANGE   AVG   DIAGS ALARM
```

Zero/Span Calibration Reset

Zero and Span Calibration Reset are toggle items that change between yes or no when selected, and are displayed only if Auto Calibration is set to YES in the Instrument Configuration screen in the Diagnostics menu.

If the zero calibration reset line is set to yes, then not only is a zero check done, but a zero adjustment is made. If the span calibration reset line is set to yes, then not only is a span check done, but a span adjustment is made. (This is how to set up a scheduled, recurring auto calibration.)

Zero/Span Ratio   The Zero/Span Ratio screen is used to set the ratio of zero checks to span checks. For example, if this value is set to 1, a span check will follow every zero check. If this value is set to 3, there will be three zero checks between each span check. This value may be set from 1 to 10, with 1 as default.

● In the Main Menu, choose Calibration > Zero/Span Check > **Zero/Span Ratio**.

```
ZERO/SPAN RATIO:
 CURRENTLY:          1:1
     SET TO:         2:1 ?

             ↑↓ CHANGE VALUE
             ↵  SAVE VALUE

 RANGE   AVG   DIAGS ALARM
```

Instrument Controls Menu

The Instrument Controls menu contains a number of items that may be selected to control various 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:
>SET DISPLAY MODE
 SET OVEN TEMPERATURE
 GAS PRESSURES
 SELECT FUEL
 RESPONSE FACTOR              ↓

 RANGE   AVG   DIAGS ALARM
```

```
PUMP SETTINGS
DATALOGGING SETTINGS
COMMUNICATION SETTINGS
I/O CONFIGURATION
SCREEN CONTRAST
SERVICE MODE
DATE/TIME
TIMEZONE
```

Set Display Mode   The Set Display Mode screen is used to set the run screen display mode to either Statistics or Normal. Statistics mode displays the current THC reading, as well as the average, high, and low concentration readings. Normal mode displays only the current THC reading.

● In the Main Menu, choose Instrument Controls > **Set Display Mode**.

```
DISPLAY MODE:
  CURRENTLY:     STATISTICS
     SET TO:        NORMAL ?

              ↵ TOGGLE VALUE


  RANGE   AVG   DIAGS ALARM
```

Set Oven Temperature

The Set Oven Temperature screen is used to adjust the detector oven temperature setting. Temperature ranges are 100–125 °C for the LT Model and 125–200 °C for the HT Model.

● In the Main Menu, choose Instrument Controls > **Set Oven Temperature**.

```
SET OVEN TEMPERATURE:
  CURRENTLY:        175 °C
     SET TO:        180 °C ?

            ↑↓ INC/DEC
             ↵ SAVE VALUE
  RANGE   AVG   DIAGS ALARM
```

Gas Pressures

The Gas Pressures menu is used to view and adjust the set pressures for the sample, air, hydrogen, and mixed fuel. (Note that pressures for both hydrogen and mixed fuel can be entered. See the next section on how to select which fuel is to be used.) Two pressures are specified for each gas. One is used during flame ignition (ignite), and the other is used during normal operation (run). Acceptable pressure ranges are 0–15 psi for the sample and 0–50 for the air and fuels.

WARNING Pressures are set at the factory and should not be arbitrarily changed. ▲

● In the Main Menu, choose Instrument Controls > **Gas Pressures**.

```
SET PRESSURES:
>SAMPLE RUN        6.8 psi
 SAMPLE IGNITE     3.0 psi
 AIR RUN          20.5 psi
 AIR IGNITE       18.5 psi
 H2 FUEL RUN       6.5 psi  ↓

 RANGE   AVG   DIAGS ALARM
```

```
 H2 FUEL IGNITE 18.5 psi
 MIX FUEL RUN   25.0 psi
 MIX FUEL IGNITE25.0 psi
```

The following example sets the SAMPLE RUN pressure to 6.9 psi. All of the other set pressure screens function the same way.

```
SET PRESSURE:       SAMPLE
 CURRENTLY:       6.8 psi
     SET TO:      6.9 psi ?

            ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE
 RANGE   AVG   DIAGS ALARM
```

Select Fuel

The Select Fuel screen is used to select the fuel type, either hydrogen or mixed, so that the corresponding pressures set in the gas pressures screen will be utilized.

● In the Main Menu, choose Instrument Controls > **Select Fuel**.

```
SELECT FUEL:
 CURRENTLY:       HYDROGEN
     SET TO:         MIXED?

            ↑↓ INC/DEC
             ↵ SAVE VALUE
 RANGE   AVG   DIAGS ALARM
```

Response Factor

The Response Factor screen allows the user to define a multiplier that is automatically applied to the THC measurement before the concentration is displayed on the front panel. It can be used to compensate for differences in the FID's sensitivity to the calibration gas and the actual sample.

For example, if the 51*i* is calibrated with propane and then used to monitor hexane, the ppm based THC readings will indicate a concentration approximately double the actual value. This occurs because the FID response depends on both the concentration of the hydrocarbon and the

number of carbon atoms in the individual molecules. Hexane (C_6H_{14}) has twice as many carbon atoms per molecule as propane (C_3H_8), and therefore produces approximately double the signal. If a response factor of 0.5 is applied, the hexane concentration would then read correctly.

If the composition of the sample gas is known, the response factor can be determined and programmed into the analyzer. Once programmed, the 51*i* automatically compensates for the difference in molecular structure by applying the response factor before the data is displayed.

In most cases, the exact sample composition is unknown or variable. In those cases, the response factor should be set to 1.0, which has no effect on the THC reading.

● In the Main Menu, choose Instrument Controls > **Response Factor**.

```
RESPONSE FACTOR:
  CURRENTLY:      001.000
     SET TO:      001.000 ?

            ←→ MOVE CURSOR
  ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE    AVG   DIAGS ALARM
```

Pump Settings

The Pump Settings screen is used to change the operating state of the pump. Settings include: Always On, Always Off, and Off Until Warm (where the pump remains off until the oven reaches the set temperature).

Note The pump setting should usually be "Off Until Warm". This prevents condensation from occurring in the pump head at start-up. ▲

● In the Main Menu, choose Instrument Controls > **Pump Settings**.

```
PUMP SETTINGS:
  CURRENTLY:OFF UNTIL WARM
     SET TO:     ALWAYS ON

            ↑↓ CHANGE VALUE
             ↵ SAVE VALUE

 RANGE    AVG   DIAGS ALARM
```

Datalogging Settings

The *i*Series instruments include a built-in datalogging capability as a standard feature. The operator is allowed to create two different types of records, which for historical reasons, are named lrecs and srecs. 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 function independent of each other. So, for example, an srec containing just the current THC level could be generated every 5 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, THC concentration and error flags, the analyzer can store data once each minute for 4 months (>190,000 total records).

The Datalogging Settings menu allows the user flexibility in how data is stored and recorded.

● 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 the log record type 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 the number of records or by date and time. Note that both types of records cannot be viewed at the same time, only the selected record type.

● 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
```

Number of Records

The Number of Records screen is used to select the number of records to view, ending with the most recent. It also shows the total number of records that have been logged for the selected record type.

```
SET # BACK FROM CURRENT:
                  0000009
TOTAL LRECS:           20
               ↔  MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE
RANGE   AVG   DIAGS ALARM
```

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

```
time    date     flags
10:01 01/20/07  8105151
10:02 01/20/07  8105151
10:03 01/20/07  8105151
10:04 01/20/07  8105151
 ↑↓ PGUP/DN   ↔ PAN L/R
RANGE   AVG   DIAGS ALARM
```

Date and Time

The Date and Time screen is used to set a start date and time for which to view logged data. For example, if "20 Jan 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 "20 Jan 2007 10:01".

```
DATE AND TIME:
 20 JAN 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 01/20/07  8105151
10:02 01/20/07  8105151
10:03 01/20/07  8105151
10:04 01/20/07  8105151
  ↑↓ 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 only (not both srecs and lrecs).

● 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 submenu displays a list of 32 record fields to use to configure the data to be logged. When a field is selected, a submenu list appears of the items to choose from to assign to those fields. Item types are Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board is installed). These record fields comprise a temporary list of items for the selected record type that must be committed via the

datalogging menu before the changes will apply. Note that committing any changes to this list will erase all currently logged data for the selected record type only, as the format of the stored data is changed.

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

```
LREC FIELDS:
>FIELD 1              THC
 FIELD 2          THC_AVG
 FIELD 3         THC_HIGH
 FIELD 4          THC_LOW
 FIELD 5         DET_TEMP  ↓

 RANGE   AVG   DIAGS ALARM
```

Choose Field Data   The Choose Field Data submenu displays a list of the types of data that can be logged for the current field. Choices are Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board is installed).

● In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > **Field 1–32**.

```
DATA IN SREC FIELD   1:
>CONCENTRATIONS
 OTHER MEASUREMENTS
 ANALOG INPUTS



 RANGE    AVG   DIAGS ALARM
```

Concentrations   The Concentrations screen allows the user to assign one of the concentrations to the selected record field. The selected item is shown by "<--" after it. Note that at this point, pressing ⏎ indicates that these are proposed changes as opposed to implemented changes. To change the selected record format and erase record log file data, see "Commit Content" below.

● In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > select Field > **Concentrations**.

```
CONCENTRATIONS:
>NONE
 THC                              <--
 AVG THC
 HI THC
 LO THC

 RANGE   AVG   DIAGS ALARM
```

Other Measurements The Other Measurements screen allows the user to assign one of the other available measurement types to the selected record field. The selected item is shown by "<--" after it. Pump temperature is only available in the HT Model. Note that at this point, pressing ⏎ indicates that these are proposed changes as opposed to implemented changes. To change the selected record format and erase record log file data, see "Commit Content" below.

● In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > select Field > **Other Measurements**.
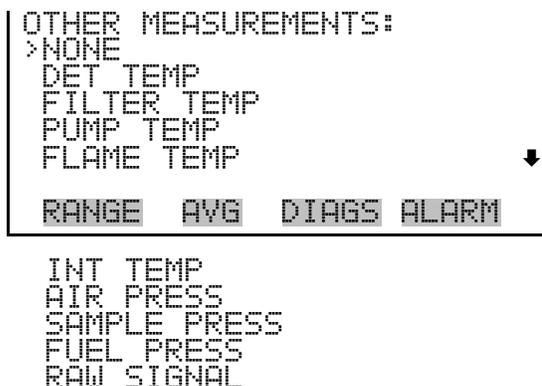
```
OTHER MEASUREMENTS:
>NONE
 DET TEMP
 FILTER TEMP
 PUMP TEMP
 FLAME TEMP                        ↓

 RANGE   AVG   DIAGS ALARM
```
```
 INT TEMP
 AIR PRESS
 SAMPLE PRESS
 FUEL PRESS
 RAW SIGNAL
```

Analog Inputs The Analog Inputs screen allows the user to assign an analog input signal (none or analog inputs 1–8) to the selected record field. The selected item is shown by "<--" after it. Note that at this point, pressing ⏎ indicates that these are proposed changes as opposed to implemented changes. To change the selected record format and erase record log file data, see "Commit Content" below.

● In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > select Field > **Analog Inputs**.

```
    ANALOG INPUTS:
   >NONE
    ANALOG IN 1
    ANALOG IN 2
    ANALOG IN 3
    ANALOG IN 4                    ↓

    RANGE   AVG   DIAGS ALARM
```

Commit Content   The Commit Content screen is used to save any changes that have been
made to any of the record fields for the selected record type. Saving changes
will erase record log file data for that record type. If no changes have been
made "NO CHANGES TO RECORD LIST!" will appear. For more
information about selecting the content of logged data fields, see "Select
Content" above.

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

```
CHANGE LREC DATA AND
ERASE LREC LOG FILE DATA?
                ↵ COMMIT



  RANGE    AVG   DIAGS ALARM
```

```
CHANGE LREC DATA AND
ERASE LREC LOG FILE DATA?
                ↵ COMMIT
ARE YOU SURE YOU WANT TO?
PRESS ➡ TO CONFIRM ERASURE

  RANGE    AVG   DIAGS ALARM
```

Reset to Default Content   The Reset to Default Content screen is used to reset all of the datalogging
record field items to default values for the selected record type. For more
information about selecting the content of logged data fields, see "Select
Content" above.

● 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 deals with datalogging configuration 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


 RANGE   AVG   DIAGS ALARM
```

Logging Period Min   The Logging Period Min screen is used to select the logging period in minutes for the selected record format (srec or lrec). List of choices include: 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:       OFF 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 may be used by the selected record type (lrecs or srecs). Percentages between 0 and 100% are available in increments of 10. Changing this value results in log erasure for both types of records, and changing the percent allocated to one record type will automatically change the other.

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

```
SET PERCENT LRECS:              SET PERCENT LRECS:
 CURRENTLY:          50%         CURRENTLY:          50%
    SET TO:          60% ?          SET TO:          60% ?
                                THIS WILL ERASE ALL LOGS!
                                PRESS ➡ TO CONFIRM CHANGE
 ♦↓ CHANGE VALUE   ↵ SAVE

 RANGE   AVG   DIAGS ALARM       RANGE   AVG   DIAGS ALARM
```

Data Treatment   The Data Treatment screen is used to select the data type for the selected record type: 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 measurement. All other data points log the current value at the end of the interval.

Note This feature is found in all *i*Series instruments, but it is recommended that the data type be set to ONLY the current value (cur). The 51*i* already has a means of logging average, minimum, or maximum concentrations. (See "Datalogging Settings/Select Content" earlier in this chapter. ▲

● 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
```

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
 COMMUNICATION PROTOCOL
 STREAMING DATA CONFIG
 TCP/IP SETTINGS

 RANGE   AVG   DIAGS ALARM
```

Serial Settings   The Serial Setting submenu 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/RS-485 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:        19200 ?

         ↑↓ CHANGE VALUE
          ↵ SAVE VALUE
 RANGE   AVG   DIAGS ALARM
```

Data Bits   The Data Bits screen is used to set the number of serial data bits to either 7 or 8 (default).

● 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 to None (default), Even, or Odd.

● 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 set the number of stop bits for the serial port to 1 (default) or 2.

● 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 analyzer. ▲

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

```
RS-232/RS-485 SELECTION:        RS-232/RS-485 SELECTION:
     ** WARNING **               CURRENTLY:        RS-232
 DISCONNECT THE SERIAL              SET TO:        RS-485 ?
 CABLES BEFORE CHANGING         MAKE SURE THAT THE CABLE
    THE SELECTION!              IS OFF: PRESS ➜ TO CONFIRM
                ↵ TO CONTINUE                 ↵ TOGGLE VALUE

 RANGE   AVG   DIAGS ALARM       RANGE   AVG   DIAGS ALARM
```

Instrument ID

The Instrument ID screen allows the operator to edit the instrument ID number. 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 instruments of the same model are connected to one computer. Valid instrument ID numbers are from 0 to 127. The Model 51*i* has a default instrument ID of 51. For more information about the instrument ID, see Appendix B "C-Link Protocol" or Appendix C "MODBUS Protocol".

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

```
INSTRUMENT ID:
 CURRENTLY:              51
    SET TO:              52 ?

               ↑↓ CHANGE VALUE
               ↵ SAVE VALUE

 RANGE   AVG   DIAGS ALARM
```

Communication Protocol

The Communication Protocol screen is used to change the protocol for serial communications. Possible choices include: C-Link, MODBUS, Geysitech, and Streaming Data.

● 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 allow for configuration
of the 8 streaming data output items, streaming interval, current data
format, and current timestamp setting. The Choose Stream Data submenu
displays a list of the analog output signal group choices to choose from.
Choices are Concentrations, Other Measurements, and Analog Inputs (if
the I/O expansion board option is installed).

● 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         AVG THC ↓

 RANGE   AVG   DIAGS ALARM
```

Streaming Data Interval   The Streaming Data Interval screen is used to adjust how frequently a new
record will be generated. 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
```

Note Add Labels, Prepend Timestamp, and Add Flags are toggle items that
change between yes or no when selected. ▲

Choose Stream Data   The Choose Stream Data screen displays a list of the types of data that can be sent via streaming data. Choices are Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board is installed).

● In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > **Item 1–8**.

```
CHOOSE STREAM DATA:
>CONCENTRATIONS
 OTHER MEASUREMENTS
 ANALOG INPUTS


 RANGE   AVG   DIAGS ALARM
```

Concentrations   The Concentrations screen allows the user to assign one of the concentrations to the selected streaming data item. The currently selected item is shown by "<--" after it. Once an item is selected, pressing (↵) will save the selected streaming data item.

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

```
CONCENTRATIONS:
>NONE
 THC                       <--
 AVG THC
 HI THC
 LO THC
 RANGE   AVG   DIAGS ALARM
```

Other Measurements   The Other Measurements screen allows the user to assign one of the other available measurement types to the selected streaming data item. The currently selected item is shown by "<--" after it. Once an item is selected, pressing (↵) will save the selected streaming data item. Pump temperature is only available in the HT Model.

● In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > select Item > **Other Measurements**.

```
OTHER MEASUREMENTS:
>NONE
 DET TEMP
 FILTER TEMP
 PUMP TEMP
 FLAME TEMP                    ↓

 RANGE   AVG   DIAGS ALARM
```

```
 INT TEMP
 AIR PRESS
 SAMPLE PRESS
 FUEL PRESS
 RAW SIGNAL
```

Analog Inputs   The Analog Inputs screen allows the user to assign an analog input signal
(none or analog inputs 1–8) to the selected streaming data item. The
currently selected item is shown by "<--" after it. Once an item is selected,
pressing ⏎ will save the selected streaming data item.

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

```
ANALOG INPUTS:
>NONE
 ANALOG IN 1
 ANALOG IN 2
 ANALOG IN 3
 ANALOG IN 4                   ↓

 RANGE   AVG   DIAGS ALARM
```

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     10.209.40.155
 NETMASK     255.265.252.0
 GATEWAY      10.209.42.1
 HOST NAME        ISERIES↓

 RANGE   AVG   DIAGS ALARM
```

```
 NTP SVR      10.209.43.237
```

Use DHCP

The Use DHCP screen is used to specify whether to use Dynamic Host Configuration Protocol (DHCP) or not. When DHCP is enabled, the network dynamically provides an IP address for the instrument.

● 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 SETTABE IF DHCP IS ON". For more information on DHCP, see "Use DHCP" above.

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

```
IP ADDRESS:
 CURRENT: 10.209.40.155
  SET TO: 10.209.40.155 ■
          ←→ 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 SETTABE IF

DHCP IS ON". For more information on DHCP, see "Use DHCP" above.

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

```
NETMASK:
 CURRENT: 255.255.252.0
 SET TO: 255.255.252.0
         ←→ 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 SETTABE IF DHCP IS ON". For more information on DHCP, see "Use DHCP" above. 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: 10.209.42.1
 SET TO: 10.209.42.1
         ←→ 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
         ISERIES          ?
      ABCDEFGHIJKLMN   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: 10.209.43.237
  SET TO: 10.209.43.237
            ←→ 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. The analog input configuration is displayed only if the I/O expansion board option 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 10 digital output relays available, and allows the user to select the logic state and instrument parameter for the relay selected.

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

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

```
OUTPUT RELAY SETTINGS:
>1    NOP        ZERO MODE
 2    NOP        SPAN MODE
 3    NOP       PURGE MODE
 4    NOP        GEN ALARM
 5    NOP       FUEL PRESS  ↓

 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.

● 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. A submenu lists signal types of either alarms or non-alarm to choose from.

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

```
CHOOSE SIGNAL TYPE:
>ALARMS
 NON-ALARM



 RANGE    AVG   DIAGS  ALARM
```

Alarms   The Alarms screen allows the user to select an alarm status for the selected relay output. The currently selected item is shown by "<--" after it. Pump temperature is only available in the HT Model. The I/O board status alarm is only present if the I/O expansion board is installed. Zero and Span Check Cal are only present if the automated zero/span check is enabled.

See the Alarms Menu section later in this chapter for more information on alarm items.

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

```
┌─────────────────────────────────────┐
│ ALARM STATUS ITEMS:                  │
│>NONE                                 │
│ GEN ALARM                      <──   │
│ CONC ALARM                           │
│ CONC MAX                             │
│ CONC MIN                        ↓    │
│                                      │
│ RANGE   AVG   DIAGS ALARM            │
└─────────────────────────────────────┘
     INT TEMP
     DET TEMP
     FILT TEMP
     PUMP TEMP
     AIR PRESS
     SAMP PRESS
     FUEL PRESS
     FLAME OUT
     SIGNAL STR
     OVER RANGE
     HEATER FAIL
     SENSOR FAIL
     ZERO NOISE
     ZERO CHK/CAL
     SPAN CHK/CAL
     BIAS VOLTAGE
     MB STATUS
     MIB STATUS
     I/O BD STATUS
```

Non-Alarm   The Non-Alarm screen allows the user to select a non-alarm status for the selected relay output. The currently selected item is shown by "<--" after it. The zero, span, and sample modes are only present if the zero/span valve option is installed.

● 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
 ZERO MODE
 SPAN MODE                    ↓

 RANGE   AVG   DIAGS ALARM
```

```
 SAMPLE MODE
 PURGE MODE
 IDLE MODE
```

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 parameter for the relay selected.

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. (See optional Terminal Block and Cable Kits.) ▲

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

```
DIGITAL INPUT SETTINGS:
>1   NOP       ZERO MODE
 2   NOP       SPAN MODE
 3   NOP   SET BACKGROUND
 4   NOP    SET IDLE MODE
 5   NOP      CAL TO SPAN ↓
 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.

● Press ⏎ to toggle and set the logic state to normally open or normally closed.

```
DIGITAL INPUT SETUP:
>LOGIC STATE          OPEN
 INSTRUMENT ACTION



  RANGE   AVG   DIAGS ALARM
```

Instrument Action   The Instrument Action submenu allows the user to choose the instrument action that is assigned to the selected digital input. The zero and span modes are only present if the zero/span valve option is installed.

● In the Main Menu, choose Instrument Controls > I/O Configuration > Digital Input Settings > select Relay > **Instrument Action**.

```
CHOOSE ACTION:
>NONE
 ZERO MODE
 SPAN MODE
 SET BACKGROUND        <--
 SET IDLE MODE           ↓
  RANGE   AVG   DIAGS ALARM

 CAL TO SPAN
 AOUTS TO ZERO
 AOUTS TO FS
```

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).

● 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
```

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 adjust for the selected output channel. Configuration choices include selecting range, setting minimum/maximum values, and choosing the signal to output.

● 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   AVG   DIAGS ALARM
```

Select Range

The Select Range screen is used to select the hardware range for the selected analog output channel. Possible ranges for the voltage outputs are: 0-100 mV, 0-1, 0-5, and 0-10 V. Possible ranges for the current outputs are: 0-20 mA and 4-20 mA.

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

```
SELECT OUTPUT RANGE:
 SELECTED OUTPUT:    V ALL
 CURRENTLY:        0-10V
     SET TO:      0-100mV ?

 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE   AVG   DIAGS ALARM
```

Minimum and Maximum Value

The 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 3–3 for a list of choices. Pump temperature is only available in the HT Model. The minimum and maximum output 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:   V ALL
 CURRENTLY:        N/A %
     SET TO:     0000.0 % ?

 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE   AVG   DIAGS ALARM
```

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

Output	Zero (0)% Value	Full-Scale 100% Value
THC	Zero (0)	Range Setting
AVG THC	Zero (0)	Range Setting
HI THC	Zero (0)	Range Setting
LO THC	Zero (0)	Range Setting
Detector Temp	User-set alarm min value	User-set alarm max value
Filter Temp	User-set alarm min value	User-set alarm max value
Pump Temp	User-set alarm min value	User-set alarm max value
Flame Temp	150 °C min	300 °C max
Internal Temp	User-set alarm min value	User-set alarm max value
Air Pressure	User-set alarm min value	User-set alarm max value

Output	Zero (0)% Value	Full-Scale 100% Value
Sample Pressure	User-set alarm min value	User-set alarm max value
Fuel Pressure	User-set alarm min value	User-set alarm max value
Raw Signal	User-set alarm min value	User-set alarm max value
Everything Else	0 Units	10 Units

Choose Signal to Output

The Choose Signal to Output screen displays a list of the analog output signal choices. Choices are grouped into three categories: Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board option is installed). This allows the user to select the output signal that will be assigned to each analog channel. The Concentrations screen is shown below. See Table 3–4 below 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



 RANGE   AVG   DIAGS ALARM
```

```
CHOOSE SIGNAL -    CONC
 SELECTED OUTPUT:    V1
 CURRENTLY: THC
   SET TO: AVG THC     ?

 ↑↓ CHANGE VALUE   ↵ SAVE

 RANGE   AVG   DIAGS ALARM
```
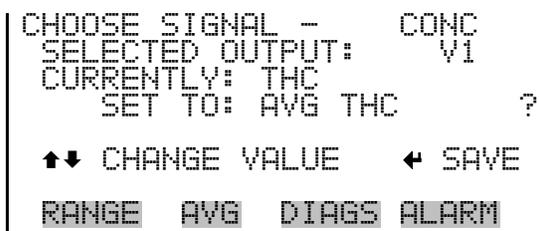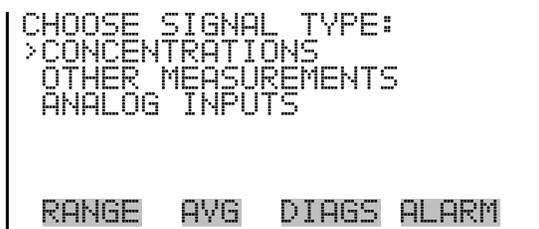
Table 3–4. Signal Type Group Choices

Concentrations	Other Measurements	Analog Inputs
None	None	None
THC	Detector Temp	Analog Input 1 (if I/O Exapnsion board installed)
AVG THC	Filter Temp	Analog Input 2 (if I/O Exapnsion board installed)
HI THC	Pump Temp	Analog Input 3 (if I/O Exapnsion board installed)

Concentrations	Other Measurements	Analog Inputs
LO THC	Flame Temp	Analog Input 4 (if I/O Exapnsion board installed)
	Internal Temp	Analog Input 5 (if I/O Exapnsion board installed)
	Air Pressure	Analog Input 6 (if I/O Exapnsion board installed)
	Sample Pressure	Analog Input 7 (if I/O Exapnsion board installed)
	Fuel Pressure	Analog Input 8 (if I/O Exapnsion board installed)
	Raw Signal	

Analog Input Configuration

The Analog Input Configuration menu displays a list of the 8 analog input channels available for configuration. This screen is only displayed if the I/O expansion board option is installed. Configuration includes entering the Descriptor, Units, Decimal Places, choice of 1–10 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            IN7↓

 RANGE   AVG   DIAGS ALARM
```

```
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
     ABCDEFGHIJKLMN   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
            V
     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 ?

            ↑↓ CHANGE VALUE
             ↵ 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. Each point in the table consists of an analog input voltage value (0–10.5 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 ?

          ↑↓ CHANGE VALUE
           ↵ SAVE VALUE
 RANGE    AVG   DIAGS ALARM
```

Table Points

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 10.50. 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:       00.0█

          ◆➡ MOVE CURSOR
  ◆➡ CHANGE VALUE   ↵ SAVE

 RANGE   AVG   DIAGS ALARM
```
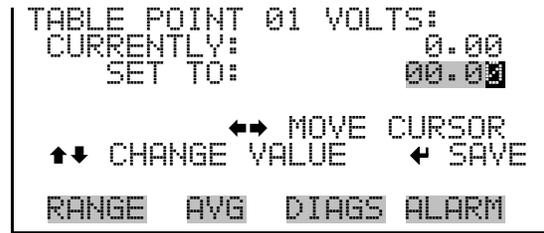
User Value

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 99999999. 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:      00000.0█

          ◆➡ MOVE CURSOR
  ◆➡ CHANGE VALUE   ↵ SAVE
 RANGE   AVG   DIAGS ALARM
```
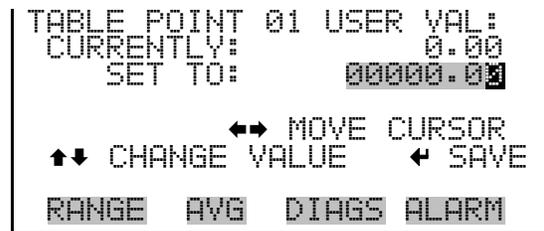
Screen Contrast

The Screen Contrast screen is used to change the contrast of the display. Intensities 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.

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

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

Note 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 Appendix B, "C-Link Protocol Commands" 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
```
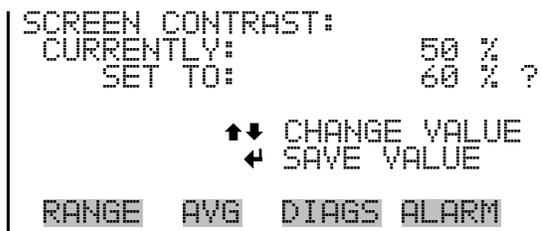
Service Mode

The Service Mode screen is used to turn the service mode on or off. Turning service mode "ON" locks out any remote actions and allows access to parameters and functions that are useful when making adjustments or diagnosing the Model 51*i*. The service (wrench) icon on the status bar is shown when service mode is on. For more information about the service mode, see "Service Menu" later in this chapter.

Note The service mode should be turned off when finished, as it prevents remote operation. ▲

● In the Main Menu, choose Instrument Controls > **Service Mode**.

```
SERVICE MODE:
 CURRENTLY:             OFF
    SET TO:             ON ?


                ↵ TOGGLE 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:
 19 MAR 2005  12:34:56
PRESS ← TO EDIT



RANGE   AVG   DIAGS ALARM
```

```
DATE AND TIME:
 19 MAR 2005  12:34:56    ?
SETTING: DAYS
            → SET MONTHS
           ↑↓ CHANGE VALUE
            ← SAVE VALUE
RANGE   AVG   DIAGS ALARM
```

Timezone

The Timezone screen is used to set the timezone for the Network Time Protocol (NTP) 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 the C-LINK "tz" 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: EST (GMT+5)   ?

         ↑↓ CHANGE VALUE
          ← SAVE VALUE
RANGE   AVG   DIAGS ALARM
```

Diagnostics Menu

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

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

```
DIAGNOSTICS:
>PROGRAM VERSIONS
 VOLTAGES
 TEMPERATURES
 PRESSURES
 DETECTOR SIGNAL              ↓

 RANGE   AVG   DIAGS ALARM
```

```
 FID STATUS
 FLAME OUT POWERUP INFO
 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 (51*i*HT or 51*i*LT) and the program version numbers.

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

```
PROGRAM VERSIONS:
  PRODUCT:   MODEL 51iHT
  VERSION:  00.04.62.088
 FIRMWARE:       10.09.65



 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 only displayed if the I/O expansion board option is installed.

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

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



 RANGE    AVG   DIAGS ALARM
```

Motherboard Voltages

The Motherboard 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         5.0 V
  15.0 SUPPLY        15.0 V
  24.0 SUPPLY        24.1 V
  -3.3 SUPPLY        -3.3 V

 RANGE    AVG   DIAGS ALARM
```

Interface Board Voltages

The Interface Board 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        24.0 V
 -15.0 SUPPLY       -15.0 V ↓

 RANGE    AVG   DIAGS ALARM
```

```
 BIAS SUPPLY       -300.0 V
```

I/O Board Voltages

The I/O Board screen (read only) is used to display the voltage readings on the I/O expansion board. This menu is only displayed if the I/O expansion board option 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    AVG   DIAGS ALARM
```

Temperatures   The Temperatures screen (read only) displays the detector base temperature, filter temperature, pump temperature (only in Model 51*i* HT), flame temperature, and internal temperature. The internal temperature is the air temperature measured by a sensor located on the measurement interface board.

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

```
TEMPERATURES:
 DETECTOR BASE    199.5  °C
 FILTER           199.8  °C
 PUMP             200.0  °C
 FLAME            225.1  °C
 INTERNAL          34.6  °C

 RANGE   AVG   DIAGS ALARM
```

Pressures   The Pressures screen (read only) displays the sample pressure, fuel pressure, and air pressure readings.

● In the Main Menu, choose Diagnostics > **Pressures**.

```
PRESSURES:
 SAMPLE             5.6 psi
 FUEL              28.0 psi
 AIR               19.7 psi


 RANGE   AVG   DIAGS ALARM
```

Detector Signal   The Detector Signal screen (read only) displays the current adjusted detector signal in Hertz.

● In the Main Menu, choose Diagnostics > **Detector Signal**.

```
DETECTOR SIGNAL:

 SIGNAL:          4244 Hz



 RANGE   AVG   DIAGS ALARM
```

FID Status   The FID Status screen displays information about the current state of the detector and allows the user to initiate ignition. STATUS specifies the current FID status. Possible messages are error, flame out, pressure wait, igniting, checking, or lit. COUNTS specifies the current unadjusted detector signal in Hertz and can range from 0 to 500,000. FLAME specifies the current flame temperature. A flame temperature higher than the FID base temperature indicates that the flame is currently lit. DET BASE specifies the current FID base temperature.

If the FID flame is out, pressing ⬚➡ will trigger the ignition sequence.

● In the Main Menu, choose Diagnostics > **FID Status**.

```
FID STATUS:
    STATUS:          IGNITING
    COUNTS:             6168
     FLAME:          191.0 °C
 DET BASE:           200.0 °C
          ➡ TO BEGIN INGITION

 RANGE   AVG   DIAGS ALARM
```

Flame Out Power-Up Information   The Flame Out Power-Up Information screen (read only) displays the number of flame-outs since the last power-up and the date and time of the last power-up.

● In the Main Menu, choose Diagnostics > **Flame Out Powerup Info**.

```
FLAME AND POWER STATS:
 LAST POWER ON:
        15AUG2006 22:57:06
 FLAMEOUTS:
                           1


 RANGE   AVG   DIAGS ALARM
```

Analog Input Readings   The Analog Input Readings screen (read only) displays the 8 user-scaled analog readings (if the I/O expansion board option is installed).

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

```
ANALOG INPUT READINGS:
>THC              10.2 PPM
 SO2              18.2 PPB
 CO2               250 PPM
 FL1             20.42 LPM
 IO5               0.0  V↓

 RANGE   AVG   DIAGS ALARM
```

Analog Input Voltages

The Analog Input Voltages screen (read only) displays the 8 raw analog 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 (see "Digital Input Settings" earlier in this chapter). This will dictate whether the input is brought to high (1) or to ground (0) to call for an action.

● 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
```

Relay States

The Relay States screen displays the state of the 10 digital 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 and set the relay state to open or closed for the selected digital output.

```
RELAY STATES:
>OUTPUT 1                    0
 OUTPUT 2                    0
 OUTPUT 3                    0
 OUTPUT 4                    1
 OUTPUT 5                    1↓

 RANGE    AVG    DIAGS ALARM
```

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, 6 voltage channels, and 6 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
```

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, zero sets the analog outputs to 0 volts, 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 information on the hardware configuration of the instrument.

Note If the analyzer is in service mode, pressing [↵] will toggle the selected item between yes and no. Zero/span valves needs to be set to ON in order to do zero and span checks, and auto calibration needs to be set to ON in order to do zero and span calibration resets. ▲

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

```
INSTRUMENT CONFIGURATION:
>I/O EXPANSION BOARD    YES
 ZERO/SPAN VALVES       YES
 AUTO CALIBRATION        NO


 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:

 CALL CENTER: 508-520-0430

 WEB:        WWW.THERMO.COM

 RANGE   AVG   DIAGS ALARM
```

Alarms Menu

The Alarms menu displays a list of items that are monitored by the analyzer. 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". The total number of alarms detected is displayed at the top of the menu to indicate how many alarms have occurred.

To see the actual reading of an item and its minimum and maximum limits, move the cursor to the item and press [↵].

Items displayed are determined by the options installed. The Pump Temperature is present only in the HT Model. The Zero/Span Check and

Auto Calibration alarms are visible only if the zero/span check or auto calibration options are enabled. Flame Out, THC Overrange, Heater Fail, Temperature Sensor Fail, and Ignitor Check are display only. The Motherboard Status, Interface Status, and I/O Expansion Status (if the I/O expansion board is installed) indicate that the power supplies are working and the connections are successful. There are no setting screens for these alarms.

If any alarms are active, the alarm (bell) icon is displayed on the right side of the status bar.

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

```
 ALARMS:
  ALARMS DETECTED        3
 >INTERNAL TEMP         OK
  DETECTOR TEMP         OK
  FILTER TEMP           OK
  PUMP TEMP             OK↓

  RANGE   AVG   DIAGS ALARM
```

```
  FLAME OUT           FAIL
  SAMPLE PRESSURE       OK
  FUEL PRESSURE         OK
  AIR PRESSURE        HIGH
  BIAS VOLTAGE          OK
  SIGNAL STRENGTH      LOW
  THC OVERRANGE         OK
  HEATER FAIL           OK
  TEMP SENSOR FAIL      OK
  IGNITOR CHECK         OK
  ZERO NOISE            OK
  ZERO CHECK            OK
  SPAN CHECK            OK
  ZERO AUTOCAL          OK
  SPAN AUTOCAL          OK
  CONCENTRATION         OK
  MOTHERBOARD STATUS    OK
  INTERFACE STATUS      OK
  I/O EXP STATUS        OK
```

Internal Temperature   The Internal Temperature screen displays the current internal temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 8 to 47 °C. If the internal temperature reading 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 > **Internal Temp**.

```
INTERNAL TEMPERATURE:
 ACTUAL            28.6 °C
>MIN               15.0 °C
 MAX               45.0 °C


 RANGE   AVG   DIAGS ALARM
```

Min and Max Internal Temperature Limits

The Minimum Internal Temperature alarm limit screen is used to change the minimum internal temperature alarm limit. The minimum and maximum internal temperature screens function the same way.

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

```
INTERNAL TEMPERATURE:
 ACTUAL MIN:      15.0 °C
 SET MIN TO:      16.0 °C ?

          ↑↓ INC/DEC
           ↵ SAVE VALUE
 RANGE   AVG   DIAGS ALARM
```

Detector Temperature

The Detector Temperature screen displays the current detector temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 115 to 210 °C. If the detector temperature reading 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 > **Detector Temp**.

```
DETECTOR TEMPERATURE:
 ACTUAL           197.6 °C
>MIN              165.0 °C
 MAX              185.0 °C


 RANGE   AVG   DIAGS ALARM
```

Min and Max Detector Temperature Limits

The Minimum Detector Temperature alarm limit screen is used to change the minimum detector temperature alarm limit. The minimum and maximum detector temperature screens function the same way.

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

```
DETECTOR TEMPERATURE:
 ACTUAL MIN:     165.0 °C
 SET MIN TO:     175.0 °C ?

            ↑↓ INC/DEC
            ↵ SAVE VALUE

 RANGE   AVG   DIAGS ALARM
```

Filter Temperature

The Filter Temperature screen displays the current filter temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 115 to 210 °C. If the filter temperature reading 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 > **Filter Temp**.

```
FILTER TEMPERATURE:
 ACTUAL          197.6 °C
>MIN             165.0 °C
 MAX             185.0 °C



 RANGE   AVG   DIAGS ALARM
```

Min and Max Filter Temperature Limits

The Minimum Filter Temperature alarm limit screen is used to change the minimum filter temperature alarm limit. The minimum and maximum filter temperature screens function the same way.

● In the Main Menu, choose Alarms > Filter Temp > **Min** or **Max**.

```
FILTER TEMPERATURE:
 ACTUAL MIN      165.0 °C
 SET MIN TO:     170.0 °C ?

            ↑↓ INC/DEC
            ↵ SAVE VALUE
 RANGE   AVG   DIAGS ALARM
```

Pump Temperature

The Pump Temperature screen displays the current pump temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 115 to 210 °C. If the pump temperature reading 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 > **Pump Temp**.

```
┌─────────────────────────────────────┐
│ PUMP TEMPERATURE:                    │
│  ACTUAL           197.6 °C           │
│ >MIN              165.0 °C           │
│  MAX              185.0 °C           │
│                                      │
│                                      │
│  RANGE   AVG   DIAGS ALARM           │
└─────────────────────────────────────┘
```

Min and Max Pump Temperature Limits

The Minimum Pump Temperature alarm limit screen is used to change the minimum pump temperature alarm limit. The minimum and maximum pump temperature screens function the same way.

● In the Main Menu, choose Alarms > Pump Temp > **Min** or **Max**.

```
┌─────────────────────────────────────┐
│ PUMP TEMPERATURE:                    │
│  ACTUAL MIN       165.0 °C           │
│  SET MIN TO:      170.0 °C ?         │
│                                      │
│            ↑↓ INC/DEC                │
│             ↵ SAVE VALUE             │
│  RANGE   AVG   DIAGS ALARM           │
└─────────────────────────────────────┘
```

Sample Pressure

The Sample Pressure screen displays the current sample pressure reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 0 to 15 psi. If the sample pressure reading 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 > **Sample Pressure**.

```
┌─────────────────────────────────────┐
│ SAMPLE PRESSURE:                     │
│  ACTUAL            5.9 psi           │
│ >MIN               0.0 psi           │
│  MAX              15.0 psi           │
│                                      │
│                                      │
│  RANGE   AVG   DIAGS ALARM           │
└─────────────────────────────────────┘
```

Min and Max Sample Pressure Limits

The Minimum Sample Pressure alarm limit screen is used to change the minimum sample pressure alarm limit. The minimum and maximum sample pressure screens function the same way.

● In the Main Menu, choose Alarms > Sample Pressure > **Min** or **Max**.

```
SAMPLE PRESSURE:
 ACTUAL MIN:      0.0 psi
 SET MIN TO:      3.0 psi ?

          ↑↓  INC/DEC
          ↵  SAVE VALUE

 RANGE   AVG   DIAGS ALARM
```

Fuel Pressure

The Fuel Pressure screen displays the current fuel pressure reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 0 to 50 psi. If the fuel pressure reading 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 > **Fuel Pressure**.

```
FUEL PRESSURE:
 ACTUAL           5.3 psi
>MIN              0.0 psi
 MAX             50.0 psi



 RANGE   AVG   DIAGS ALARM
```

Min and Max Fuel Pressure Limits

The Minimum Fuel Pressure alarm limit screen is used to change the minimum fuel pressure alarm limit. The minimum and maximum fuel pressure screens function the same way.

● In the Main Menu, choose Alarms > Fuel Pressure > **Min** or **Max**.

```
FUEL PRESSURE:
 ACTUAL MIN:      0.0 psi
 SET MIN TO:      2.5 psi ?

          ↑↓  INC/DEC
          ↵  SAVE VALUE

 RANGE   AVG   DIAGS ALARM
```

Air Pressure

The Air Pressure screen displays the current air pressure reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 0.0 to 50.0 psi. If the air pressure reading 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 > **Air Pressure**.

```
AIR PRESSURE:
 ACTUAL           19.2 psi
>MIN               0.0 psi
 MAX              50.0 psi


 RANGE   AVG   DIAGS ALARM
```

Min and Max Air Pressure Limits

The Minimum Air Pressure alarm limit screen is used to change the minimum air pressure alarm limit. The minimum and maximum air pressure screens function the same way.

● In the Main Menu, choose Alarms > Air Pressure > **Min** or **Max**.

```
AIR PRESSURE:
 ACTUAL MIN:       0.0 psi
 SET MIN TO:       5.0 psi ?

          ↑↓  INC/DEC
           ↵  SAVE VALUE
 RANGE    AVG   DIAGS ALARM
```

Bias Voltage

The Bias Voltage screen displays the current bias voltage reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from -325 to -275 V. If the bias voltage reading 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 > **Bias Voltage**.

```
BIAS VOLTAGE:
 ACTUAL            -302.0 V
>MIN               -325.0 V
 MAX               -275.0 V


 RANGE   AVG   DIAGS ALARM
```

Min and Max Bias Voltage Limits

The Minimum Bias Voltage alarm limit screen is used to change the minimum bias voltage alarm limit. The minimum and maximum bias voltage screens function the same way.

● In the Main Menu, choose Alarms > Bias Voltage > **Min** or **Max**.

```
BIAS VOLTAGE:
 ACTUAL MIN:    -325 V
 SET MIN TO:    -320 V      ?

            ↑↓ INC/DEC
             ↵ SAVE VALUE
 RANGE   AVG   DIAGS ALARM
```

Signal Strength

The Signal Strength screen displays the signal strength reading taken during the most recent calibration and sets the minimum and maximum alarm limits. Acceptable alarm limits range from .001 to 100.000. If the signal strength calculated during a calibration 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 > **Signal Strength**.

```
SIGNAL STRENGTH:
 ACTUAL             1.000
>MIN                0.001
 MAX              100.000


 RANGE   AVG   DIAGS ALARM
```

Min and Max Signal Strength Limits

The Minimum Signal Strength alarm limit screen is used to change the minimum signal strength alarm limit. The minimum and maximum signal strength screens function the same way.

● In the Main Menu, choose Alarms > Signal Strength > **Min** or **Max**.

```
 ┌─────────────────────────────────┐
 │ SIGNAL STRENGTH:                │
 │  ACTUAL MIN:       .001         │
 │  SET MIN TO:      0.101    ?    │
 │                                 │
 │            ↑↓ INC/DEC           │
 │            ↵  SAVE VALUE        │
 │                                 │
 │  RANGE   AVG   DIAGS  ALARM     │
 └─────────────────────────────────┘
```
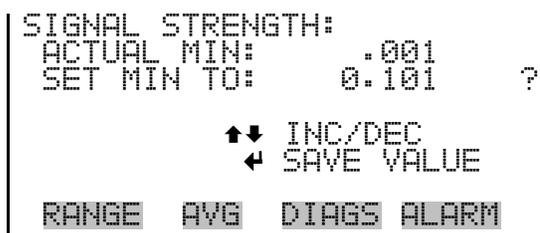
Zero Noise

The Zero Noise screen displays the zero noise measured during the most recent calibration and sets the minimum and maximum alarm limits. Acceptable alarm limits range from .001 to 100.000. If calibration produces a zero noise reading that 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 > **Zero Noise**.

```
 ┌─────────────────────────────────┐
 │ ZERO NOISE:                     │
 │  ACTUAL            0.050        │
 │ >MIN               0.001        │
 │  MAX             100.000        │
 │                                 │
 │                                 │
 │  RANGE   AVG   DIAGS  ALARM     │
 └─────────────────────────────────┘
```
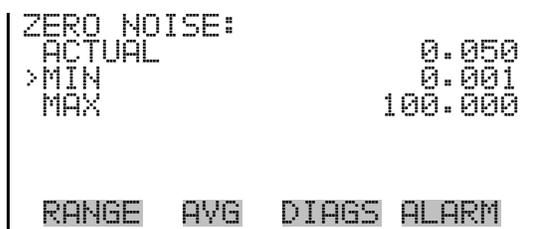
Min and Max Zero Noise Limits

The Minimum Zero Noise alarm limit screen is used to change the minimum zero noise alarm limit. The minimum and maximum zero noise screens function the same way.

● In the Main Menu, choose Alarms > Zero Noise > **Min** or **Max**.

```
 ┌─────────────────────────────────┐
 │ ZERO NOISE:                     │
 │  ACTUAL MIN:      0.001         │
 │  SET MIN TO:      0.101    ?    │
 │                                 │
 │            ↑↓ INC/DEC           │
 │            ↵  SAVE VALUE        │
 │  RANGE   AVG   DIAGS  ALARM     │
 └─────────────────────────────────┘
```
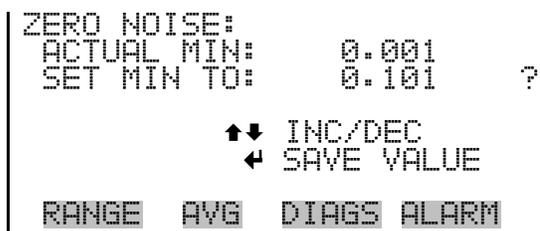
Zero and Span Check

The Zero and Span Check screens allow the user to view the status of the most recent zero/span checks and set the maximum check offset. (The maximum check offset is in the same units that were used during calibration.) An alarm will be triggered if a zero or span check indicates

drift that exceeds the offset value. The zero and span check screens are
visible only if the zero/span check option is enabled and function the same
way.

● In the Main Menu, choose Alarms > **Zero** or **Span Check**.

```
ZERO CHECK:
     ALARM:            OK
   RESPONSE:          0.0
>MAX OFFSET          10.0


  RANGE   AVG   DIAGS ALARM
```

Max Zero and Span Check Offset

The Max Zero and Span Check Offset screens are used to change the
maximum check offsets. The maximum zero and span offset screens
function the same way.

● In the Main Menu, choose Alarms > Zero or Span Check > **Max Offset**.

```
MAX ZERO CHECK OFFSET:
  CURRENTLY:        10.0
    SET TO:      00011.00 ?

             ←→ MOVE CURSOR
  ↑↓ CHANGE VALUE    ← SAVE
  RANGE   AVG   DIAGS ALARM
```

Zero and Span Auto Calibration

The Zero and Span Auto Calibration screens (read only) allow the user to
view the status of the most recent automatic zero or span calibration. The
zero and span auto calibration screens are visible only if the auto calibration
option is enabled and the zero or span cal reset function is enabled.

● In the Main Menu, choose Alarms > **Zero** or **Span Autocal**.

```
ZERO AUTO CALIBRATION:
     ALARM:            OK
   RESPONSE:          5.00



  RANGE   AVG   DIAGS ALARM
```

Concentration

The Concentration screen displays the current instrument reading (THC concentration) and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 0 to 50000 (.01, .1, .5, 1 and 5 if in percent). 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**.

```
CONCENTRATION:
 ACTUAL              3.57
>MIN               100.0
 MAX             50000.0
 MIN TRIGGER     CEILING

 RANGE   AVG  DIAGS ALARM
```

Min and Max Concentration Limits

The Minimum Concentration alarm limit screen is used to change the minimum concentration alarm limit. The minimum and maximum concentration alarm limit screens function the same way.

● In the Main Menu, choose Alarms > Concentration > **Min** or **Max**.

```
CONCENTRATION:
 ACTUAL MIN:         0.0
 SET MIN TO:    00010.00 ?

              ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ← SAVE
 RANGE   AVG  DIAGS ALARM
```

Min Trigger

The Minimum Trigger screen allows the user to view and set the minimum 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).

● In the Main Menu, choose Alarms > Concentration > **Min Trigger**.

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


  ↵ TOGGLE AND SAVE VALUE

RANGE   AVG   DIAGS ALARM
```

Service Menu

The Service menu appears only when the instrument is in the service 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 mode, choose Instrument Controls > **Service Mode** in the Main Menu.

Advanced diagnostic functions are included in the service mode. Meaningful data should not be collected when the instrument is in the service mode.

● In the Main Menu, choose **Service**.

```
SERVICE:
>MANUAL FUEL VALVE BYPASS
 BYPASS FLAME DETECTION
 IDLE MODE
 SET PRESSURE AND FLOW
 INPUT BOARD CALIBRATION  ↓

RANGE   AVG   DIAGS ALARM
```

```
 TEMPERATURE CALIBRATION
 ANALOG OUT CAL
 ANALOG INPUT CAL
 DISPLAY PIXEL TEST
 RESTORE USER DEFAULTS
```

Manual Fuel Valve Bypass

The Manual Fuel Valve Bypass screen allows the user to open the fuel valve manually, overriding automatic operation. Manual operation will terminate after five minutes for safety purposes. Toggle Solenoid appears only if Bypass is ON.

Note This adjustment should only be performed by an instrument service technician. ▲

● In the Main Menu, choose Service > **Manual Fuel Valve Bypass**.

```
MANUAL FUEL VALVE BYPASS:
  BYPASS:                   ON
  VALVE:                    OFF

            ◄─► TOGGLE BYPASS
            ▲▼ TOGGLE SOLENOID

 RANGE   AVG   DIAGS ALARM
```
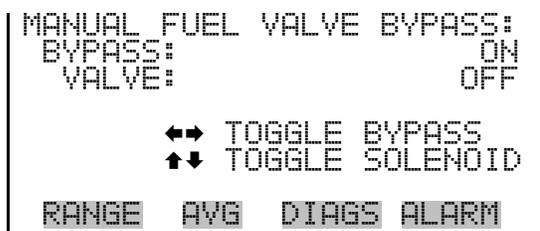
Bypass Flame Detection

The Bypass Flame Detection screen allows the user to bypass the flame detection routines, overriding automatic operation. When ON, the analyzer will act as if the flame is lit in all respects whether it is or not, and when turned OFF, the analyzer will go to FLAME OUT condition and go through the ignition sequence unless the flame is still lit.

● In the Main Menu, choose Service > **Bypass Flame Detection**.

```
BYPASS FLAME DETECTION:
  CURRENTLY               OFF
     SET TO:              ON ?

            ◄ TOGGLE VALUE


 RANGE   AVG   DIAGS ALARM
```

Instrument Idle Mode

The Instrument Idle Mode screen is used to turn off the pump and the hydrogen, which extinguishes the flame, but leaves the heaters running so the instrument stays at temperature. Turning idle mode back to OFF will re-start pump and initiate the flame ignition sequence.

● In the Main Menu, choose Service > **Idle Mode**.

```
INSTRUMENT IDLE MODE:
  CURRENTLY               OFF
     SET TO:              ON ?

            ◄ TOGGLE VALUE


 RANGE   AVG   DIAGS ALARM
```
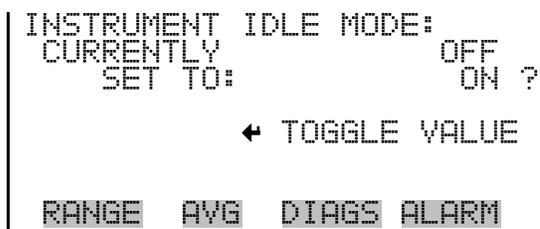
Set Pressure and Flow

The Set Pressure and Flow screen is similar to the Gas Pressures screen in the Instrument Control menu, in that it is used to view and adjust the set pressures for the sample, air, hydrogen, and mixed fuel. Again, two pressures are specified for each gas, one for igniting the flame and the other

for running the analyzer in normal operation. Acceptable pressure ranges are 0–15 psi for the sample and 0–50 psi for the air and fuels.

Unlike the Gas Pressures screen, this screen does not allow pressures to be adjusted while the flame is still lit. This is because when a pressure is selected for adjustment, the firmware shuts off all other gases. This makes it easy to measure the selected gas flow from the exhaust bulkhead on the rear panel.

Regarding setting the fuel pressures, it is important to note whether hydrogen or mixed fuel is the selected fuel, and adjust those pressures accordingly. When adjusting any of the fuel pressures, it is not necessary to manually turn on the fuel solenoid. The analyzer will do it automatically when a fuel pressure is selected.

The Set Pressures screen shows the current set point for each gas. Once one of the pressures is selected for adjustment, the Target Flow/Set Pressure screen is displayed. At this point, a 0–500 cc/min flow meter should be connected to the exhaust bulkhead on the rear panel. (Caution, the fittings are hot.) The analyzer cannot measure the flow rate, but this screen displays a target flow that should be achieved by adjusting the set pressure. Note that the analyzer temporarily shuts off the pump unless the sample run or ignite pressure is being adjusted, so that the flow rates can be measured correctly.

Once target flow have been achieved for the sample, air, and fuel, refer to "Optimizing the Gas Flows" in the Servicing chapter.

WARNING Pressures are set at the factory and should not be arbitrarily changed. ▲

Note This adjustment should only be performed by an instrument service technician. ▲

Note The Model 51*i* must be stabilized at the set temperature in order for the gas flows to be set properly. ▲

● In the Main Menu, choose Service > **Set Pressure and Flow**.

```
SET PRESSURES:
>SAMPLE RUN        6.8 psi
 SAMPLE IGNITE     3.0 psi
 AIR RUN          20.5 psi
 AIR IGNITE       18.5 psi
 H2 FUEL RUN       6.5 psi  ↓

  RANGE   AVG   DIAGS ALARM
```

```
H2 FUEL IGNITE 18.5 psi
MIX FUEL RUN    25.0 psi
MIX FUEL IGNITE25.0 psi
```

The following example sets the AIR RUN target flow and set pressure adjustment.

```
SET:            RUN AIR
TARGET FLOW: 250.0 ml/min
    SET PSI:  20.5 psi

          ↑↓ CHANGE VALUE
           ↵ SAVE

  RANGE   AVG   DIAGS ALARM
```

Input Board Calibration

The Input Board Calibration menu is used to initiate a calibration of the input board A/D stages.

Note This adjustment should only be performed by an instrument service technician. ▲

● In the Main Menu, choose Service > **Input Board Calibration**.

```
INPUT BOARD CALIBRATION:
>MANUAL INPUT CAL
 AUTOMATIC INPUT CAL
 INPUT FREQUENCY DISP



  RANGE   AVG   DIAGS ALARM
```

Manual Input Calibration

The Manual Input Calibration screen is used to do a manual calibration of the input board A/D stages per the following procedure:

Note The flame must not be lit when performing an input board calibration. ▲

1. In the Main Menu, choose Service > Input Board Calibration > **Manual Input Cal**.

2. Press ⏎ to leave warning screen.

3. Make a note of the frequency at gain of 1.

4. Use ⬅ and ➡ to change the gain from 1 to 100.

5. Use ⬆ and ⬇ to increment or decrement the D/A counts so the frequency at gain 100 matches or is slightly above the frequency at gain 1 (within 50 counts).

6. Press ⏎ to save new input board calibration.

```
INPUT BOARD CALIBRATION:
        ↵ TO CALIBRATE
     ** WARNING **
THIS ACTION MAY REQUIRE
  RECALIBRATION OF THE
ENTIRE MEASUREMENT SYSTEM!

 RANGE   AVG   DIAGS ALARM
```

```
GAIN 1   - MANUAL:
    FREQ =   4500
    D/A =    N/A  ?

↔ CHG GAIN    ↕ INC/DEC
         ↵ SAVE VALUES

 RANGE   AVG   DIAGS ALARM
```

Automatic Input Calibration The Automatic Input Calibration screen is used to do an automatic calibration of the input board A/D stages. A message will be displayed after the optimum setting has been determined.

Note The flame must not be lit when performing an input board calibration. ▲

● In the Main Menu, choose Service > Input Board Calibration > **Automatic Input Cal**.

● Press ⏎ to leave warning screen and begin automatic calibration.

```
INPUT BOARD CALIBRATION:        INPUT BOARD CALIBRATION:
          ↵ TO CALIBRATE             ** IN PROGRESS **
      ** WARNING **             D/A    =   2047
 THIS ACTION MAY REQUIRE        TARGET =      0
   RECALIBRATION OF THE         FREQ   =      0        0
ENTIRE MEASUREMENT SYSTEM!      ZERO   =      0 CNT =  1

 RANGE   AVG   DIAGS ALARM       RANGE   AVG   DIAGS ALARM
```

Input Frequency Display

The Input Frequency Display screen is used to manually adjust the input board gain. This may be used as a troubleshooting tool to ensure that the input board is working properly. The gain setting and test mode are reset upon exiting this screen. (That is, no changes are saved.) Note that this screen can be used while the flame is still lit, and is mainly for diagnostic purposes.

● In the Main Menu, choose Service > Input Board Calibration > **Input Frequency Disp**.

● Press ⊡ to leave warning screen.

● Use ⊡ and ⊡ to toggle the test signal (between ON and OFF).

● Use ⊡ and ⊡ to change the gain between 1, 10 and 100.

```
INPUT BOARD CALIBRATION:        INPUT GAIN TEST:
          ↵ TO CALIBRATE           GAIN = 1
      ** WARNING **                TEST = OFF
CONCENTRATION CALCULATION          FREQ = 5000
    IS HALTED INSIDE           ↔ CHG GAIN ↕ TEST MODE
      THIS SCREEN!
 RANGE   AVG   DIAGS ALARM       RANGE   AVG   DIAGS ALARM
```

Temperature Calibration

The Temperature Calibration screen allows the user to view and set the ambient temperature sensor offset, which basically adjusts the temperature sensor so that it reads correctly. 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 > **Temperature Calibration**.

```
CALIBRATE AMBIENT TEMP:
 CURRENTLY:      32.3 C
     SET TO:    032.█ °C ?

            ←→ MOVE CURSOR
   ↑↓ CHANGE VALUE   ↵ SAVE

    RANGE   AVG  DIAGS ALARM
```
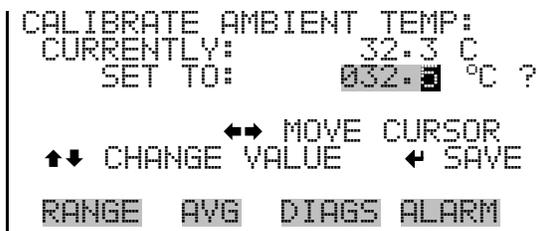
Analog Output Calibration

The Analog Output Calibration menu provides access to the 6 voltage channels and 6 current channels for calibration. Current channels are visible only if 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 Out Cal**.

```
ANALOG OUTPUT CAL:
>VOLTAGE CHANNEL 1
 VOLTAGE CHANNEL 2
 VOLTAGE CHANNEL 3
 VOLTAGE CHANNEL 4
 VOLTAGE CHANNEL 5            ↓

 RANGE   AVG   DIAGS ALARM
```

```
ANALOG OUTPUT CAL:
>CALIBRATE ZERO
 CALIBRATE FULL SCALE



 RANGE   AVG   DIAGS ALARM
```

Analog Output Calibrate Zero

The Analog Output Calibrate Zero screen allows the user to calibrate the zero state of the selected analog output. The operator must connect a volt meter to the output and adjust the output until it reads 0.0 V on the meter for a voltage channel, or either 0 or 4 mA for a current channel (depending on the selected range). See the "set output to:" field on the display.

● 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 allows the user to calibrate the full-scale state of the selected analog output. The operator must connect a volt meter to the output and adjust the output until the meter 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:            3397
 ← SAVE VALUE   ↑↓ INC/DEC
SET OUTPUT TO:        10 V

  RANGE   AVG   DIAGS ALARM
```

Analog Input Calibration

The Analog Input Calibration menu is used to calibrate the 8 analog input channels at both zero and full-scale. The Analog Input Calibration menu is visible 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
```

```
ANALOG INPUT CAL:
>CALIBRATE ZERO
 CALIBRATE FULL SCALE




 RANGE   AVG   DIAGS ALARM
```

Analog Input Calibrate Zero

The Analog Input Calibrate Zero screen allows the user to calibrate the zero state of the selected analog input.

● In the Main Menu, choose Service > Analog Input Cal > select Channel > **Calibrate Zero**.

```
ANALOG INPUT CAL:   ZERO
DISCONNECT SELECTED INPUT!
 SELECTED INPUT:   INPUT 1
 CURRENTLY:        0.04 V

  ↵ CALIBRATE INPUT TO ZERO

 RANGE   AVG   DIAGS ALARM
```

Analog Input Calibrate Full-Scale

The Analog Input Calibrate Full-Scale screen allows the user 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**. (Hook up a voltage source of 10 V to the analog input channel.)

```
ANALOG INPUT CAL:    SPAN
PROVIDE VOLTAGE TO INPUT!
 SELECTED INPUT:   INPUT 1
 CURRENTLY:        9.84 V
     SET TO:      10.0█ V
   ↵ CALIBRATE TO 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   AVG   DIAGS ALARM
```
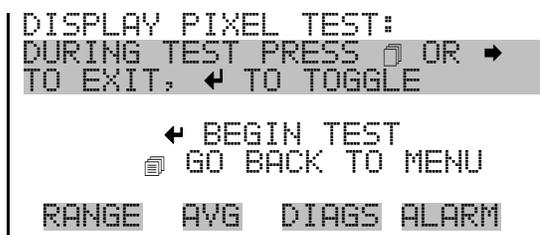
Restore User Defaults

The Restore User Defaults screen is used to reset the user calibration and configuration values to factory defaults.

● In the Main Menu, choose Service > **Restore User Defaults**.

```
RESTORE USER DEFAULTS:

              ↵ RESTORE




  RANGE   AVG   DIAGS ALARM
```

```
RESTORE USER DEFAULTS:

              ↵ RESTORE
ARE YOU SURE YOU WANT TO?
PRESS ➡ TO CONFIRM RESTORE


  RANGE   AVG   DIAGS ALARM
```
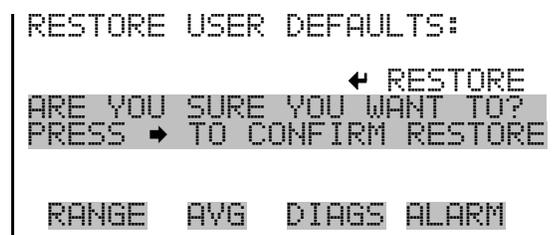
Password Menu

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
```
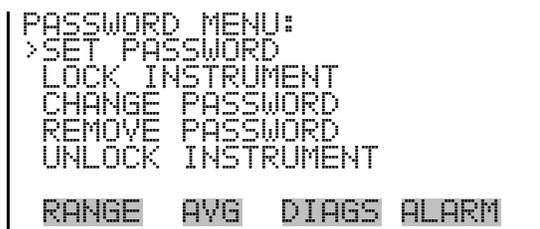
Set Password

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:
       ▮

   ▮BCDEFGHIJKLMN  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 is locked via the front panel using Password > **Lock Instrument**, the instrument reports being in Remote mode. In this mode, the front panel is "locked", where data can be viewed, settings 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 settings 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 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 NEW PASSWORD:
       ■
  ■BCDEFGHIJKLMN   BKSP
  OPQRSTUVWXYZ     PAGE
  0123456789 ./-   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**

```
REMOVE PASSWORD:
      PRESSING ENTER WILL
  REMOVE CURRENT PASSWORD
     AND DISABLE LOCKING
        ← REMOVE PASSWORD

  RANGE   AVG   DIAGS ALARM
```

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**

```
ENTER THE PASSWORD:
       ■
  ■BCDEFGHIJKLMN   BKSP
  OPQRSTUVWXYZ     PAGE
  0123456789 ./-   SAVE
  RANGE   AVG   DIAGS ALARM
```

Chapter 4
Calibration

The Model 51*i* is a quantitative instrument that can accurately measure hydrocarbons at a wide range of concentrations. However, as with all electronic instruments, the accuracy of the measurements depends on proper calibration.

In general terms, calibration is the process that establishes the relationship between the detector's output signal and the concentration of hydrocarbons in the sample stream. When hydrocarbons enter the instrument detector, a hydrogen/air flame ionizes the molecules. This ionization process causes an electrical current to flow between two electrodes located in the detector. The magnitude of the current flow can be measured and is directly related to the concentration of organic compounds in the sample. Calibration establishes the relationship between the electrical current, measured in pico-amps, and the hydrocarbon concentration, which is usually measured in parts per million (ppm) by volume.

Because signal intensity can be affected by operating parameters such as the flow rate of the sample, the type of fuel being used or the detector temperature, a permanent calibration cannot be established and the instrument must be calibrated on a routine basis. Calibration is best achieved using gas mixtures that are similar to the unknown sample being measured and should be conducted under conditions that are similar to the actual operating conditions.

The FID, or flame ionization detector, used in the Model 51*i* is linear over the instrument's entire measurement range. Therefore, the instrument can be calibrated using a simple two-point procedure. First, the sample inlet is flooded with hydrocarbon free "zero" air and the detector's background or "zero" signal is recorded. Then the inlet is flooded with span gas containing a known concentration of hydrocarbons and the detector signal is again recorded. A calibration factor can then be calculated based on the FID's response to zero air and to a known concentration of hydrocarbons.

When the instrument is switched to the normal "Run" mode, the calibration factor is used to convert FID signal strength back into a hydrocarbon concentration for display on the front panel.

The following sections discuss the calibration process and procedures for calibrating the instrument:

- "Frequency of Calibration" on page 4-2

- "Selecting Calibration Gases" on page 4-2

- "Connecting Calibration Gases" on page 4-5

- "Calibration Menus" on page 4-7

- "Manual Calibration Procedure" on page 4-7

Frequency of Calibration

Each instrument is calibrated and tested for accuracy at the factory. The calibration and accuracy tests are run using methane or propane standards at concentrations ranging from 10 to 50,000 ppmc. A copy of the test results is included in the instrument packet.

Although data from the factory calibration test is stored in memory, the operator must calibrate the instrument prior to initial use. As a general rule, a new instrument should also be re-calibrated once each day. As the operator gains experience with the instrument, the frequency of calibration may be adjusted as needed.

In addition to daily calibration, it is also recommended that the standard operating procedures should include an on-going quality control plan that allows the frequency of calibration to be modified depending on historical calibration and/or zero and span check data. A quality control program is essential to ascertain the accuracy and reliability of the air quality data collected. The data compiled for such a program might include items such as dates of calibration, atmospheric conditions, control settings and other pertinent data. The *Quality Assurance Handbook for Air Pollution Measurement Systems*, published by the U.S. EPA, Research Triangle Park, NC, 27711, can be consulted for detailed quality assurance guidelines.

Selecting Calibration Gases

The following information is used to select the calibration gas used, the response factors and choice of concentration units.

Zero Gas

In order to establish the FID background signal, the instrument must be "zeroed" using a gas that contains little or no hydrocarbon. Typically, the zero gas will be either air or nitrogen. Because the oxygen present in air can affect the FID signal, the zero gas should be selected to match the expected composition of the actual sample and therefore depends on the application.

For applications, such as ambient monitoring, that involve measurement of hydrocarbons in air, the best zero gas is hydrocarbon free air. For applications that involve monitoring combustion sources that contain less than about 10% oxygen, the best zero gas is hydrocarbon free nitrogen.

In selecting a zero gas, the operator should also consider the gas quality, that is, the level of hydrocarbon contamination that will be considered acceptable. Ultra-High Purity (UHP) zero gases with THC content of less than 10 ppb are available from specialty gas suppliers and would be most appropriate for ambient air monitoring, or for other applications that involve measuring low ppm levels of hydrocarbons.

High quality zero air, containing less than 10 ppb of total hydrocarbons, can also be generated on-site using a catalytic oxidation system. Thermo Fisher Scientific's in-house laboratories routinely use zero air generated by commercial zero air generators, such as the Thermo Fisher Scientific Model 1160, that combine compression, chemical scrubbing and reaction into one self-contained device. In these systems, ambient air that has been compressed is dried by passage through a heatless air dryer or membrane drier and is then sent through a series of chemical reactors and/or scrubbers. Normally, the scrubbers include indicating silica gel or Drierite to remove traces of water, Purafil®, activated charcoal, and a fine (5 micron) particulate filter.

If a zero air generator of this type will be used, the operator should be aware that optimal performance might not be achieved until the generator has been run for 24 to 48 hours. This occurs because the impurities can desorb from the chemical reactors during the initial operation. However, after 24 to 48 hours of continuous operation, impurity levels will generally fall and stabilize below detection limits for trace level analyzers. When using this type of zero air source, it is critical to always maintain some minimal flow through the system. If flow is interrupted, even for a short period, a reconditioning time of up to 24 hours may be required.

One advantage of using an on-site generator is that the system that supplies zero air can also be used to provide the FID support air. Use of a high quality zero air generator may also provide other advantages, including reduced FID noise levels and reduced operating cost. Be aware, however, that non-catalytic systems using activated charcoal or molecular sieve scrubbers do not remove methane, and will not generate good quality zero gas.

For applications that involve taking measurements at high concentrations, less expensive zero gas cylinders with THC levels certified as less than 1 ppm are often adequate. This grade of zero air is readily available from gas suppliers at somewhat reduced cost and should be adequate for many source-monitoring applications.

Span Gas Composition

The instrument can be spanned with virtually any stable mixture of a hydrocarbon in an inert balance gas. In most cases, the instrument will be calibrated with methane in air when used for ambient monitoring and with propane in air or propane in nitrogen when used for source applications.

The choice of hydrocarbon is usually based on factors such as availability or regulatory considerations, and the balance gas should be selected to match the zero gas.

For those applications that involve measurement of a known specific hydrocarbon, the best span gas is a mixture that contains that specific compound. For example, if the instrument is used for measuring toluene emissions from a printing operation, a span gas containing toluene will produce the most accurate results.

When selecting a span gas, the operator must be aware that the detector response varies depending on the specific compound being sampled. Therefore, if the instrument is calibrated with propane, the ppm readings displayed on the front panel will not be the same as if the instrument were calibrated with methane.

Selecting Span Gas Concentration

As described in the previous section, the instrument is normally calibrated with a gas mixture containing methane or propane in air. The span gas concentration should be similar to the concentration expected in the actual sample. As a general rule of thumb, a span concentration that is about 80% of the maximum expected in the sample will provide good results.

The instrument is expected to maintain accuracy that is within 2% of the span value when sample concentrations range from 10 to 120% of the span concentration. Readings taken outside that range are usually still accurate, but might be considered suspect until confirmed by a re-calibration within that range, or by checking against a known standard.

Span gases are available in a wide range of concentrations. However, to maintain good span gas stability, the cylinder concentration should generally be above 1.0 ppm. If calibration with lower concentrations is required, dilution is advised. The possibility of stability problems at extremely low concentrations should also be discussed with the gas supplier.

Response Factors and Choice of Concentration Units

The signal generated by an FID is dependent on both the hydrocarbon concentration and on the type of hydrocarbon being sampled. For simple hydrocarbons, the signal strength is almost directly dependent on the number of carbon atoms in the molecule. For example, if the instrument is calibrated with propane (C_3H_8) and then used to measure hexane (C_6H_{14}), the ppm readings will be approximately double the true concentration. For substituted hydrocarbons, which contain elements other than carbon and hydrogen, the signal strength will usually be somewhat reduced. For example, methanol (CH_3OH) produces as signal that is about 30% weaker than that produced by methane (CH_4).

For applications involving measurement of a well-defined sample stream, the instrument reading can be adjusted to provide a true concentration reading through the use of a response factor. A response factor is simply a multiplier that adjusts the instrument reading according to an experimentally determined relationship between the calibration gas and the compound being sampled. If a response factor is used, it should be entered under "Response Factor" in the "Instrument Controls" menu, and it will automatically be applied to the instrument reading. For example, if a response factor of three is entered, all hydrocarbon readings are multiplied by three before they are displayed.

In some industries that use FIDs, the issue of varying signal strength is addressed by expressing concentrations in parts per million carbon (ppmc) rather than in ppm. The concentration in ppmc is defined as the concentration in ppm multiplied by the number of carbon atoms per molecule. Since FID response nearly follows carbon number, expressing concentrations in terms of ppmc automatically adjusts the instrument reading for differences in response. To follow the example cited above, 100 ppm of propane would equal 300 ppmc, while 100 ppm of hexane, which produces double the FID response, would be equal to 600 ppmc.

Note In the case of methane, the concentration in terms of ppmc is equal to the concentration in ppm. Therefore, in some industries it has become standard practice to calibrate with methane and then report the concentrations as "methane equivalents". ▲

Connecting Calibration Gases

For source monitoring applications, the calibration gases should be introduced to the sample inlet at the probe. For ambient monitoring applications, the calibration gases can be introduced through the sample inlet, or if the instrument is equipped with internal zero and span valves, the gases can be connected directly to the zero and span ports on the rear panel.

Whichever configuration is selected, the calibration gases must enter the sampling system at a controlled flow rate to avoid over-pressurization. For example, if span gas is introduced directly into the sample inlet from a pressurized cylinder, an atmospheric pressure dump or bypass must also be included to prevent pressurizing the sample inlet.

If the calibration gases are introduced using the internal zero and span valves and plumbing, the gas pressures must be properly adjusted to provide just enough flow to meet the demand generated by the pump, but without over-pressurization of the sampling system. A suggested pressure adjustment procedure is outlined below.

1. Make sure that the pump is running, then remove the sample line from the sample port.

2. Set the zero gas pressure regulator to 5 psi.

3. From the Run screen, press ⟨ ▶ ⟩ until the word "zero" appears at the left end of the status bar.

   This opens the zero air solenoid. With the solenoid open, excess zero air flows out of the sample port.

4. Connect a small flow meter to the sample port and adjust the cylinder regulator pressure until an excess flow of 200 to 400 cc per minute is measured at the sample port.

5. Once the zero cylinder is adjusted, set the span cylinder to the same pressure and switch to span mode by pressing ⟨ ▶ ⟩ until the word "span" appears on the status bar. Be sure that there is an excess flow of 200 to 400 cc per minute. Consumption of calibration gas is approximately 2 liters per calibration.
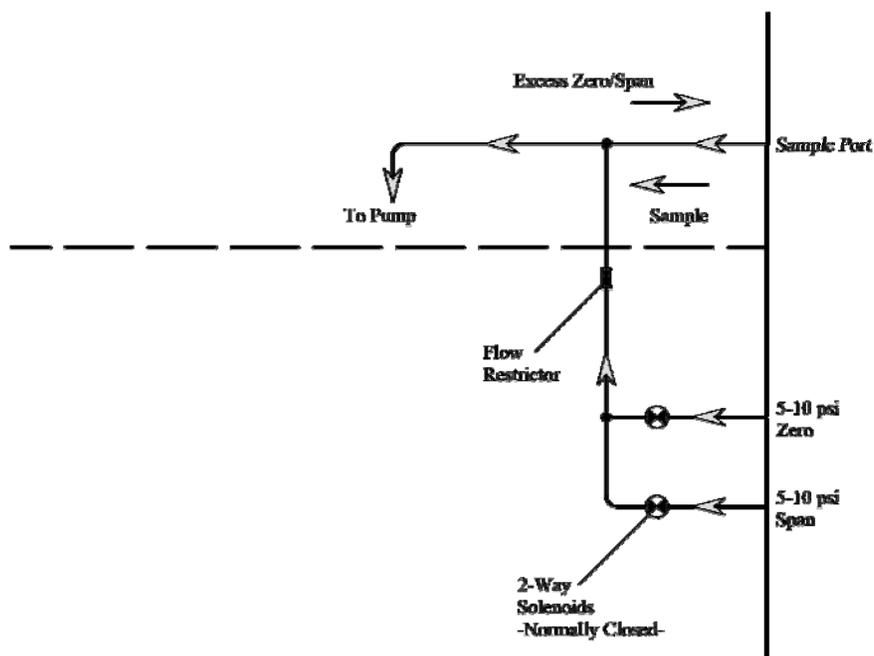
Figure 4–1. Internal Zero/Span Valve Schematic

Calibration Menus

The instrument's Main Menu contains two sub-menus that are directly related to calibration. The first, titled "Calibration Factors", provides direct access to the zero offset and span coefficients that the firmware uses to convert the raw detector signal to a concentration value. These parameters may be viewed, adjusted or reset to default values through this menu. The ability to view and manually adjust these parameters may be useful for troubleshooting. However, the commands available in this menu generally should not be utilized during routine calibration and operation.

The second sub-menu, titled "Calibration", provides access to the controls that are used for routine calibration, including microprocessor-based adjustments to the zero and span. The "Calibration" menu also provides access to a sub-menu called "Zero/Span Check", which provides a system for programming the analyzer to perform automatic calibration checks and/or adjustments.

Manual Calibration Procedure

Note The manual calibration procedure described here assumes that the calibration gases will be introduced through the analyzer's SAMPLE port. If the internal ZERO and SPAN valves are being used, be sure to open the appropriate valve using the (➡) pushbutton as indicated on the analyzer screen. If the internal zero and span valves are installed, but are not being used at this time, **DO NOT** switch the instrument to zero or span mode, since that will open the internal valves and allow ambient air to leak into the system. ▲

The first step in calibration is to determine the magnitude of the signal that the detector outputs when there are no organic compounds present in the sample stream. This signal, which is referred to as the background or zero signal, originates from organic contaminants in the support gases or instrument gas handling systems, from leakage currents in the detector, from thermionic emissions at the jet, from electrical noise in the amplifiers, and from other random sources. Once the background signal has been measured, it is saved in the instrument memory as the "zero-offset". During routine measurement, the zero-offset is subtracted from the detector signal, leaving only that portion of the signal that can be attributed to organic compounds in the sample.

After the zero offset has been established, span gas containing a known concentration of propane or methane is introduced. The instrument calculates an estimated concentration by subtracting the zero offset from the span signal and multiplying that difference by a fixed constant that is hard-coded into the analyzer's embedded program. This constant is established experimentally at the factory and is an expression of detector sensitivity for a typical instrument of this design. To complete the

calibration, a span coefficient, or correction factor, that will bring the instrument reading in-line with the actual span gas concentration must be determined. This coefficient is a multiplier that can be applied to the estimated concentration reading. A span coefficient that is less than 1.00 would suggest that the instrument signal is slightly stronger than expected and a span coefficient that is greater than 1.00 would suggest a signal that is weaker than expected for a given span gas concentration. Typically, the span coefficient will range from 0.2 to 5.0, but numbers outside that range are also acceptable.

When considering the span coefficient, the operator should be aware that analytical performance is dependent on the signal to noise ratio, not just signal strength. Even though a span coefficient of greater than 1.00 suggests that the sensitivity may be less than average, it does not necessarily indicate sub-standard analytical performance. While the absolute value of the span coefficient is not tremendously important, a span coefficient that changes significantly over time may suggest that service is required.

Once the zero signal and the span coefficient have been determined, a given detector signal can be converted to a concentration reading using the following formula:

$$\text{Concentration} = (\text{Detector\_Signal} - \text{Zero\_Offset}) \times (\text{Calibration\_Factor}) \times (\text{Span Coefficient})$$

As noted earlier, the relationship between detector signal and concentration has been demonstrated to be linear over a wide range. Therefore, measurement of the zero signal and the detector signal at one span point is sufficient to allow measurements taken at concentrations ranging from 20 to 120% of the span point to be accurate to within 2% of the span value. Measurements taken at concentrations outside those limits will typically be sufficiently accurate for most applications, but may not meet some of the more demanding regulatory requirements.

Note When adjusting the analyzer zero or span, the averaging time should be set to a value of 30 seconds or higher. ▲

Background/Zero Adjust

Use the following procedure to adjust the instrument zero offset.

1. From the Main Menu, choose **Calibration**.

2. If necessary, move the cursor to Cal Background and press ⏎.

3. Press ➡ to open the zero valve, or introduce the zero gas through the sample port.

4. Allow the instrument to stabilize for at least 5 minutes or until the reading does not appear to be changing.

5. Press ⏎ and the processor will automatically adjust the zero-offset value to produce an instrument reading of 0.00.

6. Press ◼ to return to the Calibration menu.

Span Adjust   Use the following procedure to adjust the instrument span coefficient.

1. From the Main Menu, choose **Calibration**.

2. Move the cursor to Cal Coefficient and press ⏎ .

3. If the span concentration does not match the concentration you are using, edit the value as needed.

4. Press ➡ to open the span valve, or introduce span gas through the sample port.

5. Allow the instrument to stabilize for at least 5 minutes or until the reading does not appear to be changing.

6. Press ⏎ and the processor will automatically adjust the span coefficient to give the instrument reading that was entered in Step 3.

7. Press ◼ to return to the Calibration menu.

Fully Automated Zero and Span Checks and Adjustments   In addition to the calibration procedures described above, the Model 51*i* can also be programmed to either check or adjust the analyzer calibration on a routine basis. However, to implement this function, the internal calibration valves must be in-use, or the external zero and span gas supply system must be capable of turning the gas flows on and off by a signal from the analyzer's I/O system.

For additional information about automated zero and span checks, refer to "Zero/Span Check" on page 3-16.

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, the components should be inspected frequently until an appropriate maintenance schedule is determined.

This chapter includes the following preventive maintenance information:

● "Safety Precautions" on page 5-1

● "Cleaning the Outside Case" on page 5-2

● "Visual Inspection and Cleaning" on page 5-2

● "Fan Filter Inspection and Cleaning" on page 5-2

● "Internal Sample Filter Cleaning" on page 5-3

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. For more information about appropriate safety precautions, see the "Servicing" chapter. ▲

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. ▲

Visual Inspection and Cleaning

The instrument should be inspected occasionally for obvious visible defects, such as loose connectors, loose fittings, cracked or clogged Teflon lines, and excessive dust or dirt accumulation. Dust and dirt can accumulate in the instrument and can cause overheating or component failure. Dirt on the components prevents efficient heat dissipation and may provide conducting paths for electricity. The best way to clean the inside of the instrument is to first carefully vacuum all accessible areas and then blow away the remaining dust with low pressure compressed air. Use a soft paint brush or cloth to remove stubborn dirt.

Fan Filter Inspection and Cleaning

Use the following procedure to inspect and clean the fan filter (Figure 5–1).

1. Remove the fan guard from the fan by unsnapping it. (No tools are required.) DO NOT remove the four mounting screws.

2. Flush the filter with warm water and let dry (a clean, oil-free air purge will help the drying process) or gently blow the filter clean with compressed air.

3. Re-install the filter and fan guard.

⚠ **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. For more information about appropriate safety precautions, see the "Servicing" chapter. ▲
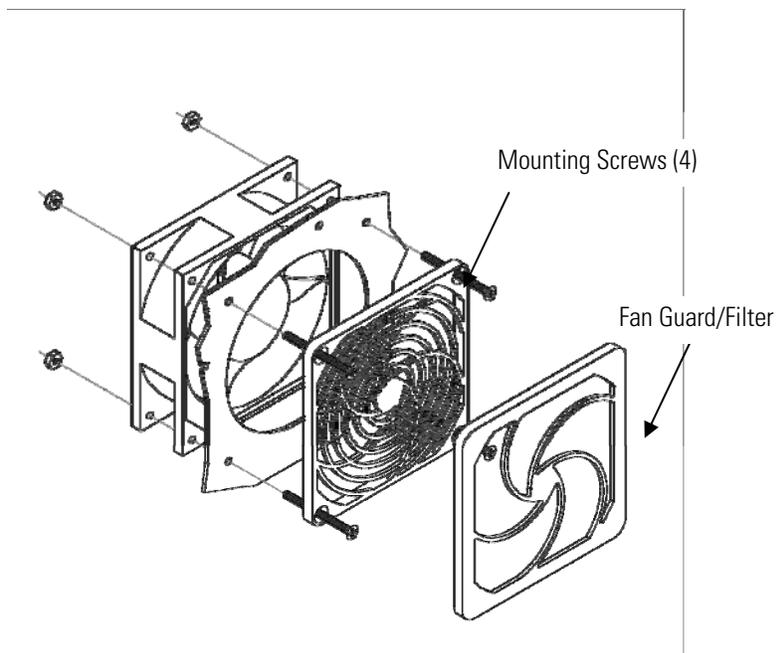
Figure 5–1. Inspecting and Cleaning the Fan Filters

Internal Sample Filter Cleaning

This section provides the requirements and instructions for cleaning the internal sample filter element in the Model 51*i*.

Use the following procedure to remove and clean the internal sample filter element.

Equipment Required:

Wrench, 1-inch

Long Philips head screwdriver

Teflon pipe thread tape

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. For more information about appropriate safety precautions, see the "Servicing" chapter. ▲

1. Shut off the main power and remove the instrument cover. Using the Philips head screwdriver, loosen the eight thumb screws, remove the oven cover and allow the internal components to cool.

2. Using the 1-inch wrench, remove the filter assembly cap nut (Figure 5–2).

Note This nut may be very difficult to move. Be careful not to bend any of the 1/8-inch tubing attached to the filter assembly while undoing the cap nut. ▲

3. Remove the filter element from the assembly base. Gently dislodge the element from the base with a screwdriver if necessary.

4. Using a clean air supply or other clean compressed gas, gently blow any dust or particles out of the base. Do not lose the aluminum o-ring in the base.

5. Using a clean air supply or other clean compressed gas, blow any dust or particular out of the filter element.

   Note that if the filter cannot be cleaned adequately with air, it may be cleaned with methanol or acetone in an appropriate ultrasonic bath, provided it is sufficiently rinsed and dried before it is installed in the instrument. Otherwise, the filter should be replaced (See Chapter 7, "Servicing").

6. Install the cleaned filter element back into the base.

Note Be sure to install the filter element with the open end of the cup facing down into the base and that it is seated flat. ▲

7. Wrap the filter housing threads with Teflon tape, then replace the cap nut and tighten with the wrench. If Teflon tape is not used, the cap nut may become difficult to remove.

8. Re-install the oven cover and the instrument cover.
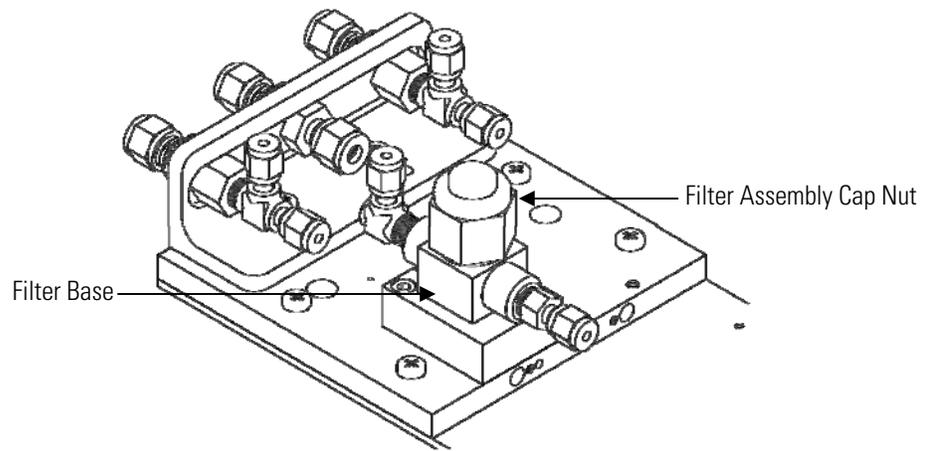
Figure 5–2. Cleaning the Internal Filter Element

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.

For additional fault location information refer to the "Preventive Maintenance" chapter in this manual.

The service 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. See "Service Locations" on page 6-22 for contact information. 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 6-22

Safety Precautions

Read the safety precautions in the Preface and "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, or other information describing the

analyzer's current state. Table 6–1 is a list of the analyzer's diagnostics and the expected range of values for each variable.

Table 6–1. Model 51*i* Firmware Diagnostic Information

Flame Temperature	Hydrogen fuel: 165 to 240 °C
	40% Hydrogen/Helium fuel: 200 to 400 °C
Oven Temperature (Base, Pump or Filter)	LT: 120 to 135 °C
	HT: ± 5° of Set Point
Sample Pressure	± 0.5 psi of Set Point
Fuel Pressure	15 to 50 psi ± 1.0 psi of Set Point
Air Pressure	15 to 50 psi ± 1.0 psi of Set Point
+5 Volt Supply	4.7 to 5.3 Volts
+15 Volt Supply	14 to 16 Volts
-15 Volt Supply	-15.7 to -14.2 Volts
+12 Volt Supply	11.2 to 12.8 Volts
Bias	-261 to -339 Volts

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. See "Alarms Menu" in the "Operation" chapter for detailed information.

Table 6–2. Troubleshooting - General Guide

Malfunction	Possible Cause	Action
Does not start up (the display backlight is off and nothing is on the display)	No power	Check the line to confirm that power is available and that it matches the voltage and frequency configuration of the instrument.
	Main fuse is blown or missing	Unplug the power cord to the analyzer, open the fuse drawer on the back panel, and check fuses visually or with a multimeter.
	Bad switch or wiring connection	Unplug the power cord to the analyzer, disconnect the switch on the front panel and check operation with a multimeter.

Malfunction	Possible Cause	Action
	DC power supply failure	Check the green LED on the back edge of the power supply. If the LED is off, the supply has failed. Check 24 V output using a multimeter.
	DC power distribution failure	Check surface mount LEDs labeled "24V PWR" on the motherboard, interface board. If lit, power is OK.
	Display failure	If possible, check instrument function through RS-232 or Ethernet.
		Call Thermo Fisher Scientific Service Department.
Front panel display functions but pump, heaters, and/or fan do not operate correctly	Wrong voltage configuration	Verify instrument configuration and power label and compare to local power.
Flame will not light	Gas flows need adjustment	Check support gas pressures at the cylinder and instrument front panel against factory test sheet, and adjust as necessary.
		Check gas flow rates at FID exhaust and compare to suggested values.
		Adjust fuel pressure up by 2 psi and/or air pressure down by 2 psi.
	Ignitor circuit failure	Check ignitor voltage at test point 2 (TP2) of measurement interface board during ignition cycle. Should be approximately 2.3 V.
	Ignitor failure	Plug in the installed spare ignitor, or replace ignitor(s) if necessary.
	Oven not fully heated	Check the flame temperature while the flame is out. If flame temperature is below detector temperature by more than 10 degrees, wait for full stabilization.
	Sensor failure	Check oven and flame temperatures reported under Diagnostics menu. Check temperatures and FID signal reported on flame status screen (Diagnostic menu).
Low or no signal from FID	Flame out or low	Check status screen for current flame temperature and signal.
		Check air and fuel pressure.
		Check sample pressure reading in Diagnostics menu.
		Hold mirror or chrome tool against the FID exhaust port and check for steam, which indicates flame is lit.
	Signal cable is loose	Check BNC connectors at both ends.

Malfunction	Possible Cause	Action
	Signal post short to ground	Turn off power, and disconnect signal cable. Check for "open" circuit between center post and ground, and also between center post and bias voltage supply. If they are not open, there may be a short.
Pump does not run	Pump switched off in firmware	Check pump settings under Instrument Controls menu.
	Oven temperature too low	The pump will not run until the detector oven temperature approaches the oven temperature set point (200 °C for Model HT, 125 °C for Model LT, nominal).
	Pump overheated	Remove the instrument cover. Under the Instrument Controls menu, shut the pump off. Wait 30 minutes and try to restart pump.
	Pump bearing failure	Shut off the main power and try to rotate the pump fan by hand. Jamming or excess noise indicates possible bearing failure.
		Call Thermo Fisher Scientific Service Department.
Reduced response or no response to span gas	System failure	Check alarm screens and diagnostic voltage screens to localize fault.
	Bias voltage has failed	Check voltage diagnostic screen and test point on measurement interface board.
	No gas reaching the analyzer	Check flow and pressure readings on the diagnostics screens.
	Span cylinder empty	Check the source pressure.
	Calibration system failure	Check zero/span solenoids or other hardware to be sure that span gas is being delivered correctly.
	Ruptured pump diaphragm	Check flow rate at the sample bulkhead. If low flow, rebuild pump head.
	Faulty FID or input board.	Use input board test mode and verify signal on each range to isolate fault to either FID or input board. Replace faulty component. If problem still exists, check signal cables and replace measurement interface board.
No response to sample gas	Flame not lit	Check flame out alarm status, check fuel.
	Analyzer not calibrated	Recalibrate.
	No gas reaching the analyzer	Check the response to a known span gas.

Malfunction	Possible Cause	Action
	Ruptured pump diaphragm	Check flow rate at the sample bulkhead. If low flow, rebuild pump head.
	Faulty FID or input board	Use input board test mode and verify signal on each range to isolate fault to either FID or input board. Replace faulty component. If problem still exists, check signal cables and replace measurement interface board.
	Analyzer not calibrated or calibrated improperly	Check that the calibration factors are within their proper limits.
Zero or Span will not stabilize.	Flow rate of the calibration gas is inadequate, or too high	Check bypass or atmospheric pressure vent to verify that the zero air system is providing more flow than the instrument is drawing, but not pressurizing the inlet.
	Instrument is not drawing in span gas	Check pressure readings on the Diagnostics screen.
	Averaging time is not set correctly	Check the averaging time in Main Menu. If too high, the unit will be slow to stabilize. If too low, the signal may appear noisy.
Calibration Drift	Line voltage fluctuations	Check to see if line voltage is within specifications.
	Unstable span source	Replace source gases.
	Back-pressure sample control has failed	Check pressure on Diagnostic screen.
Excessive Noise	Defective input board or BNC connection	Identify defective component and replace.
	Noise pick-up by recorder or data logger	Check analog output cable shielding and grounding. Try to localize source of noise by comparing analog signal to data collected through RS-232 or Ethernet.
Non-linear response	Leak in sample probe line	Check for variable dilution.
	Leak within the analyzer	Check for loose fittings in analyzer.
	Problem with input board range switching	Go to Input Board Test screen (Service menu) and step through each range while the instrument samples a known stable source of gas.

Malfunction	Possible Cause	Action
		Stay on the Input Board Test screen, and while holding instrument on the lowest gain, step the calibrator through gas levels.
Excessive response time	Slow averaging time chosen	Check the averaging time screen.
	Leak within the analyzer	Check for loose fittings in analyzer.
Analog signal doesn't match expected value	Firmware has not been configured	Verify that the selected analog output has been properly configured to match the data system and that the outputs have been calibrated.
	Analog output goes above full-scale or below zero	By default, a 5% over and under range on the analog outputs is provided. If this is not desirable due to system restrictions, it may be turned off in the Instrument Controls > IO Configuration > Analog Output Config screens.
	Recorder is loading down output	Verify that the recorder or data logger input impedance meets minimum requirements.
	Analog outputs are not calibrated	Run test of analog outputs under Diagnostics menu

Table 6–3. Troubleshooting - Alarm Messages

Alarm Message	Possible Cause	Action
Alarm - Internal Temp	Fan stopped	Replace fan if not operating properly.
	Fan filter is dirty	Clean or replace foam filter, refer to "Preventive Maintenance" chapter in this manual.
	Sensor failed	Check 10K thermistor on measurement interface board, replace if bad.
Alarm - Detector Temp	Failed heater or sensor	Check temperatures in diagnostic screen. Check heaters for open or short circuits. Check thermocouples for open or short circuits.
Alarm - Filter Temp	Failed heater or sensor	Check temperatures in diagnostic screen. Check heaters for open or short circuits. Check thermocouples for open or short circuits.
Alarm - Pump Temp	Failed heater or sensor	Check temperatures in diagnostic screen. Check heaters for open or short circuits. Check thermocouples for open or short circuits.
Alarm - Flame Out	Gas supply failure	Check gas pressures.
Alarm - Sample Pressure	Pressure high or low	Check the pump for a tear in the diaphragm, replace with pump repair kit if necessary. Refer to the "Preventive Maintenance" chapter.

Alarm Message	Possible Cause	Action
		Check air sources.
		Check plumbing for leaks.
		Check electrical cabling between pressure sensor and measurement interface board.
Alarm - Fuel Pressure	Pressure low	Check gas sources.
		Check plumbing for leaks.
		Check electrical cabling between pressure sensor and measurement interface board.
Alarm - Air Pressure	Pressure low	Check gas sources.
		Check plumbing for leaks.
		Check electrical cabling between pressure sensor and measurement interface board.
Alarm - Bias Voltage	Circuit failure	Check voltages in Diagnostics
Alarm - Signal Strength	Bad calibration	Check calibration history.
Alarm - THC Over Range	THC concentration too high	No action required.
		Not an instrument fault.
Alarm - Heater Fail		Check heaters. Refer to "General Electrical Testing" in the Servicing chapter.
Alarm - Temp Sensor Fail		Check temperature sensors. Refer to "General Electrical Testing" in the Servicing chapter.
Alarm - Ignitor Check	Ignitor has failed	Plug in the installed spare ignitor, or replace the ignitor(s).
Alarm - Zero Noise Alarm - Span Noise	Bad calibration	Check calibration system and calibration history.
Alarm - Zero Check Alarm - Span Check	Instrument out of calibration	Re-calibrate instrument.
Alarm - Zero Autocal Alarm - Span Autocal	Instrument out of calibration	Check gas supply. Perform manual calibration.
Alarm - Concentration	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, be sure the min trigger is set as desired.
Alarm - Motherboard Status Alarm - Interface Status Alarm - I/O Exp Status	Internal cables not connected properly Board is defective	Check that all internal cables are connected properly. Re-cycle AC power to analyzer. If still alarming, change board.

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.
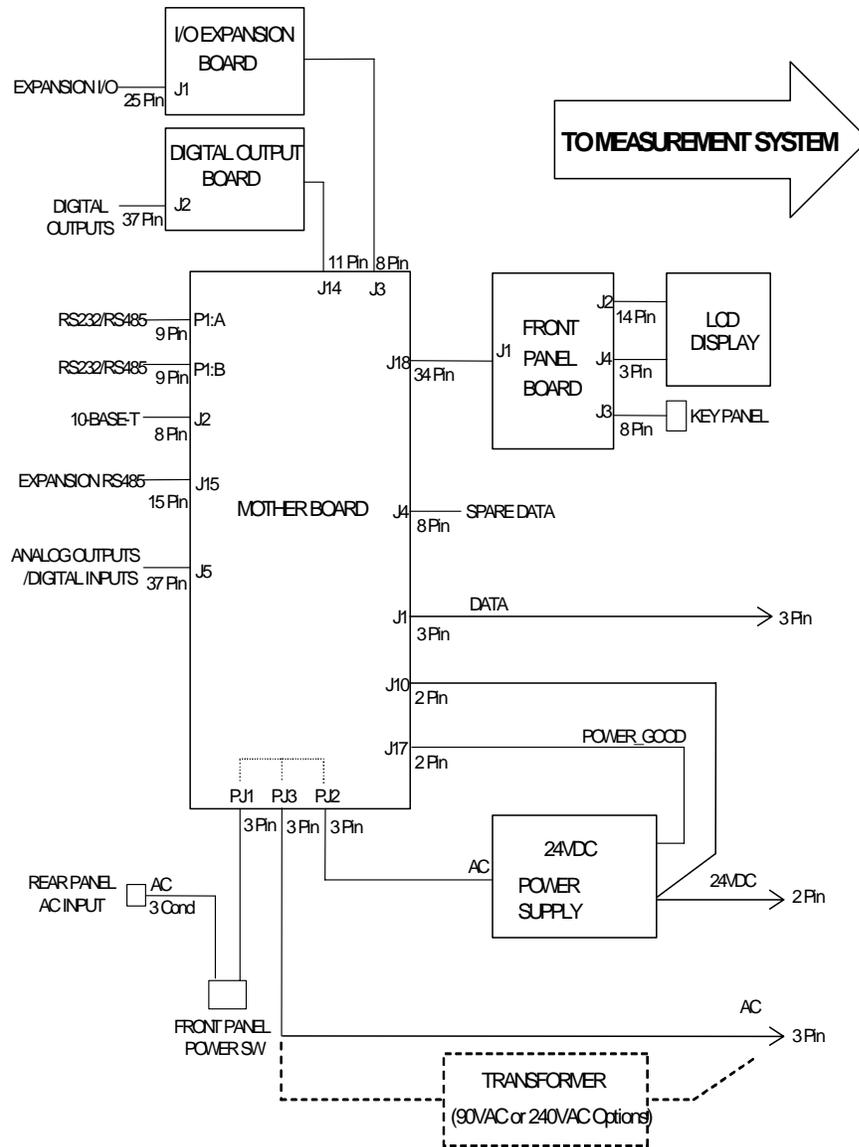
Figure 6–1. Board-Level Connection Diagram - Common Electronics
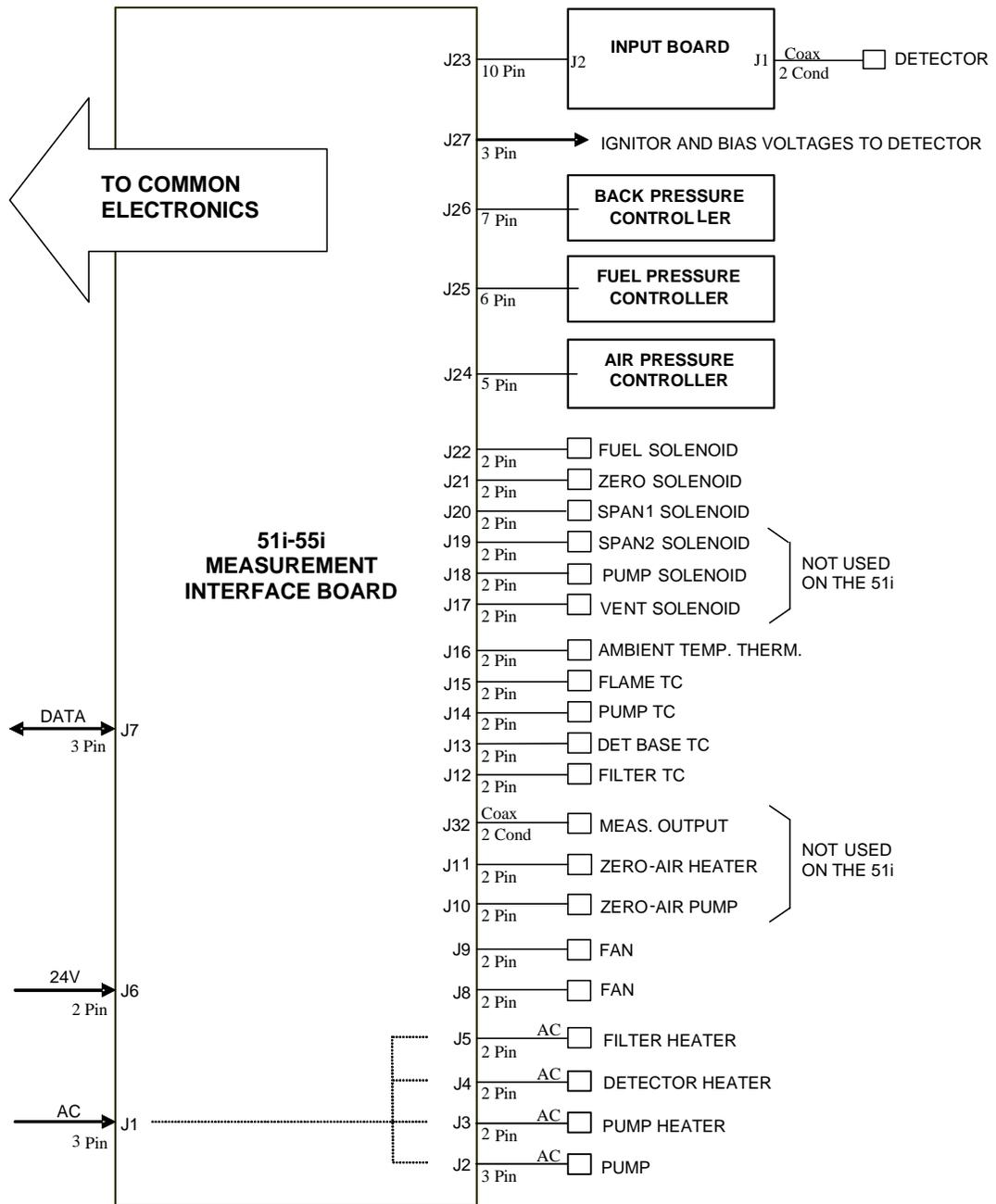
Figure 6–2. Board-Level Connection Diagram - Measurement System

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

Connector Label	Reference Designator	Pin	Signal Description
SPARE DATA	J4	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	+RS485 to Spare Board
		8	-RS485 to Spare Board
I/O	J5	1	Power Fail Relay N.C. Contact
		2	Ground
		3	TTL Input 1
		4	TTL Input 2
		5	Ground
		6	TTL Input 5
		7	TTL Input 7
		8	TTL Input 8
		9	TTL Input 10
		10	Ground
		11	TTL Input 13
		12	TTL Input 15
		13	Ground
		14	Analog Voltage Output 1
		15	Analog Voltage Output 3
		16	Ground
		17	Analog Voltage Output 5
		18	Ground
		19	Ground
		20	Power Fail Relay COM
		21	Power Fail Relay N.O. Contact
		22	Ground
		23	TTL Input 3
		24	TTL Input 4
		25	TTL Input 6
		26	Ground

Connector Label	Reference Designator	Pin	Signal Description
		27	TTL Input 9
		28	TTL Input 11
		29	TTL Input 12
		30	TTL Input 14
		31	TTL Input 16
		32	Ground
		33	Analog Voltage Output 2
		34	Analog Voltage Output 4
		35	Ground
		36	Analog Voltage Output 6
		37	Ground
SER EN	J7	1	Serial Enable Jumper
		2	+3.3V
24V IN	J10	1	+24V
		2	Ground
DIGITAL OUTPUT	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

Connector Label	Reference Designator	Pin	Signal Description
		9	NC
		10	NC
		11	+24V
		12	+24V
		13	+24V
		14	+24V
		15	+24V
24 MONITOR	J17	1	24V Power Monitor
		2	Ground
FRONT PANEL BD	J18	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

Connector Label	Reference Designator	Pin	Signal Description
		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
RS232/RS485:A	P1:A	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
RS232/RS485:B	P1:B	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

Connector Label	Reference Designator	Pin	Signal Description
AC INTF BD	PJ3	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground

Table 6–5. Measurement Interface Board Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
AC IN	J1	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground
AC PUMP	J2	1	AC-HOT
		2	AC-NEUT Switched
		3	AC-Ground
P/C HTR	J3	1	Pump/Column Heater AC Control
		2	AC-HOT
DET HTR	J4	1	Detector Heater AC Control
		2	AC-HOT
FLT HTR	J5	1	Filter Heater AC Control
		2	AC-HOT
24V IN	J6	1	+24V
		2	Ground
DATA	J7	1	Ground
		2	+RS485 from Motherboard
		3	-RS485 from Motherboard
FAN	J8	1	+24V (Fused)
		2	Ground
FAN	J9	1	+24V (Fused)
		2	Ground
Z A PMP	J10	1	+24V
		2	Ground
Z A HTR	J11	1	+24V
		2	Ground
FILTER TC	J12	1	Filter TC+

Connector Label	Reference Designator	Pin	Signal Description
		2	Filter TC-
DET BASE TC	J13	1	Detector Base TC+
		2	Detector Base TC-
PMP/COL TC	J14	1	Pump/Column TC+
		2	Pump/Column TC-
FLAME TC	J15	1	Flame TC+
		2	Flame TC-
AMB TEMP	J16	1	Ambient Temperature Thermistor
		2	Ground
VENT	J17	1	+24V
		2	Vent Solenoid Control
PUMP	J18	1	+24V
		2	Pump Solenoid Control
SPAN2/CAL	J19	1	+24V
		2	Span2/Cal Solenoid Control
SPAN1/INJ	J20	1	+24V
		2	Span1/Inject Solenoid Control
ZERO/BF	J21	1	+24V
		2	Zero/Back Flush Solenoid Control
FUEL	J22	1	+24V
		2	Fuel Solenoid Control
INPUT BD	J23	1	+15V
		2	Ground
		3	-15V
		4	+5V
		5	Ground
		6	Measurement Frequency Output
		7	Amplifier Zero Adjust Voltage
		8	SPI Output
		9	SPI Clock
		10	SPI Board Select
AIR CNTRL	J24	1	+24V
		2	Ground
		3	No Connection

Connector Label	Reference Designator	Pin	Signal Description
		4	Air Pressure In
		5	Air Pressure Control
FUEL CNTRL	J25	1	+24V
		2	Ground
		3	No Connection
		4	Fuel Pressure In
		5	Fuel Pressure Control
		6	No Connection
BP/CARR CNTRL	J26	1	+24V
		2	Ground
		3	No Connection
		4	Back Press./Carrier Press. In
		5	Back Press./Carrier Press. Control
		6	No Connection
		7	No Connection
IGN/BIAS	J27	1	Ignite Voltage
		2	Ground
		3	Bias Voltage
MEAS OUT	J32	1	Measurement Output
		2	Ground

Table 6–6. Front Panel Board Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
MOTHER BOARD	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

Connector Label	Reference Designator	Pin	Signal Description
		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
		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

Connector Label	Reference Designator	Pin	Signal Description
		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
LCD BACKLIGHT	J4	1	+5V Supply
		2	NC
		3	Ground

Table 6–7. 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

Connector Label	Reference Designator	Pin	Signal Description
		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
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	+RS485 to Motherboard
		8	-RS485 to Motherboard

Table 6–8. 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

Connector Label	Reference Designator	Pin	Signal Description
		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
		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

Connector Label	Reference Designator	Pin	Signal Description
		32	+24V
		33	+24V
		34	+24V
		35	+24V
		36	+24V
		37	+24V

Table 6–9. Input Board Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
PMT IN	J1	1	PMT Input
		2	Ground
INTF BD	J2	1	+15V
		2	Ground
		3	-15V
		4	+5V
		5	Ground
		6	Measurement Frequency Output
		7	Amplifier Zero Adjust Voltage
		8	SPI Input
		9	SPI Clock
		10	SPI Board Select

Service Locations

For additional assistance, Thermo Fisher Scientific has service available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information.

866-282-0430 Toll Free

508-520-0430 International

Chapter 7

Servicing

This chapter explains how to replace the Model 51*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 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" at the end of this chapter.

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 Mode" 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 7-10

● "Pump Replacement" on page 7-11

● "Pump Rebuilding (Heated Head Version)" on page 7-13

● "Pump Rebuilding (Low Temp Version)" on page 7-19

● "Fan/Filter Replacement" on page 7-24

● "Input Board Replacement" on page 7-25

● "Input Board Calibration" on page 7-27

● "DC Power Supply Replacement" on page 7-28

● "Analog Output Testing" on page 7-29

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 Due to the possibility of residual fuel in the detector, keep your face away from the FID. The ignitor pulse is clearly visible from a distance when the thermocouple has been removed. ▲

Avoid contact with the heated oven components. Allow the oven to cool to room temperature before handling oven components. A small fan directed into the oven will speed cooling. ▲

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 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. ▲
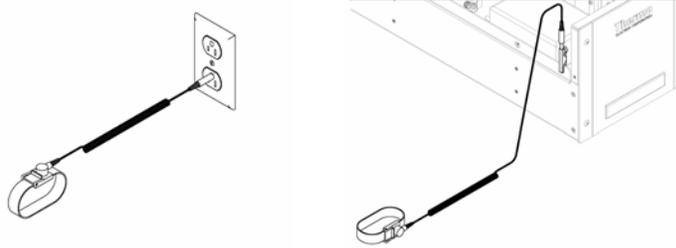
Figure 7–1. Properly Grounded Antistatic Wrist Strap

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 Mode

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 Mode**.

   The Service Mode screen appears.

2. Press ⏎ to toggle the Service Mode to ON.

3. Press ▪ > ▪ to return to the Main Menu.

4. Return to the procedure.

Replacement Parts List

Table 7-1 lists the replacement parts for both the Model 51*i* High Temperature and the Model 51*i* Low Temperature major subassemblies. Refer to Figure 7-2 and Figure 7-3 to identify the component location.

Table 7–1. Model 51*i* Replacement Parts

Part Number	Description
100480-00	Front Panel Pushbutton Board
101491-23	Processor Board (51*i* HT)
101491-24	Processor Board (51*i* LT)
100533-00	Motherboard
100539-00	Digital Output Board
100542-00	I/O Expansion Board (optional)
102340-00	Front Panel Connector Board
102496-00	Front Panel LCD Display
103812-00	Transformer, Step-Down, 220-240 VAC (optional)
101863-00	Transformer, Step-Up, 100 VAC (optional)
103002-00	Measurement Interface Board
101167-00	Input Board Assembly
103762-00	Solenoid Valve
103933-00	Pump Assembly (Low Temperature Version)
112286-00	Pump Assembly (Heated Head Version)
108002-00	Pump Repair Kit—New Technology Pump (Low Temperature Version)
108091-00	Pump Repair Kit—New Technology Pump (Heated Head Version)
8606	Pump Repair Kit (Low Temperature Version)
18070	Pump Repair Kit (Heated Head Version)
101055-00	AC Receptacle Assembly
101681-00	Power Supply Assembly, 24 VDC, with Base Plate and Screws
103803-00	Fan Assembly, 24 VDC
4070	Fan Filter[*]
105198-00	Fuse, 250 VAC, 6.25 Amp, SlowBlow (for 100 and 110 VAC models)[*]
103894-00	Fuse, 250 VAC, 3.15 Amp, SlowBlow (for 220-240 VAC models)[*]
101688-00	Ambient Temperature Connector with Thermistor
12190	Filter Inlet Element, 0.5 micron
12188	Aluminum Gasket

Part Number	Description
105567-00	Ignitor/Cable Assembly
10981	Ignitor (without wire and connector attached, requires soldering)
11032	O-ring, FID Flame Sensor (006 red silicone)
103581-00	Flame Sensor Thermocouple Assembly
105151-00	Detector O-ring Kit (three each of 14814, 14816, 11032, 16013, qty 6 of 6646)
105152-00	Detector Rebuild Kit (one each of 104158-00, 104155-00, 103770-00, 14816, 16013, 14814, 11032, qty 2 of 6646)
103952-01	Pressure Controller, Air
103952-02	Pressure Controller, Fuel
103952-03	Pressure Controller, Back Pressure
104872-00	Pressure Regulator
101055-00	Main AC Receptacle Assembly
103687-00	Detector Pogo Assembly
104139-00	Sample Frit Fitting
104151-00	Exhaust Frit Bulkhead Fitting
105554-01	Bypass Orifice Bulkhead, .016 (51*i* HT)
105554-02	Bypass Orifice Bulkhead, .018 (51*i* LT)

*Expendable item, not covered by warranty

Cable List

Table 7–2 lists the Model 51*i* High Temperature and the Model 51*i* Low Temperature cables. See the "Troubleshooting" chapter for associated connection diagrams and board connector pin descriptions.

Table 7–2. Model 51*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	115 VAC Supply to Measurement Interface Board
101048-00	RS-485/Data
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

Part Number	Description
101033-00	AC from Receptacle
101377-00	AC to Power Switch
104631-00	Signal Ribbon
103905-00	Heater Power
103682-00	Detector Signal Cable

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)
103084-00	Terminal Board PCB Assembly, DB25M (optional) Included with optional I/O Expansion Board in all instruments.
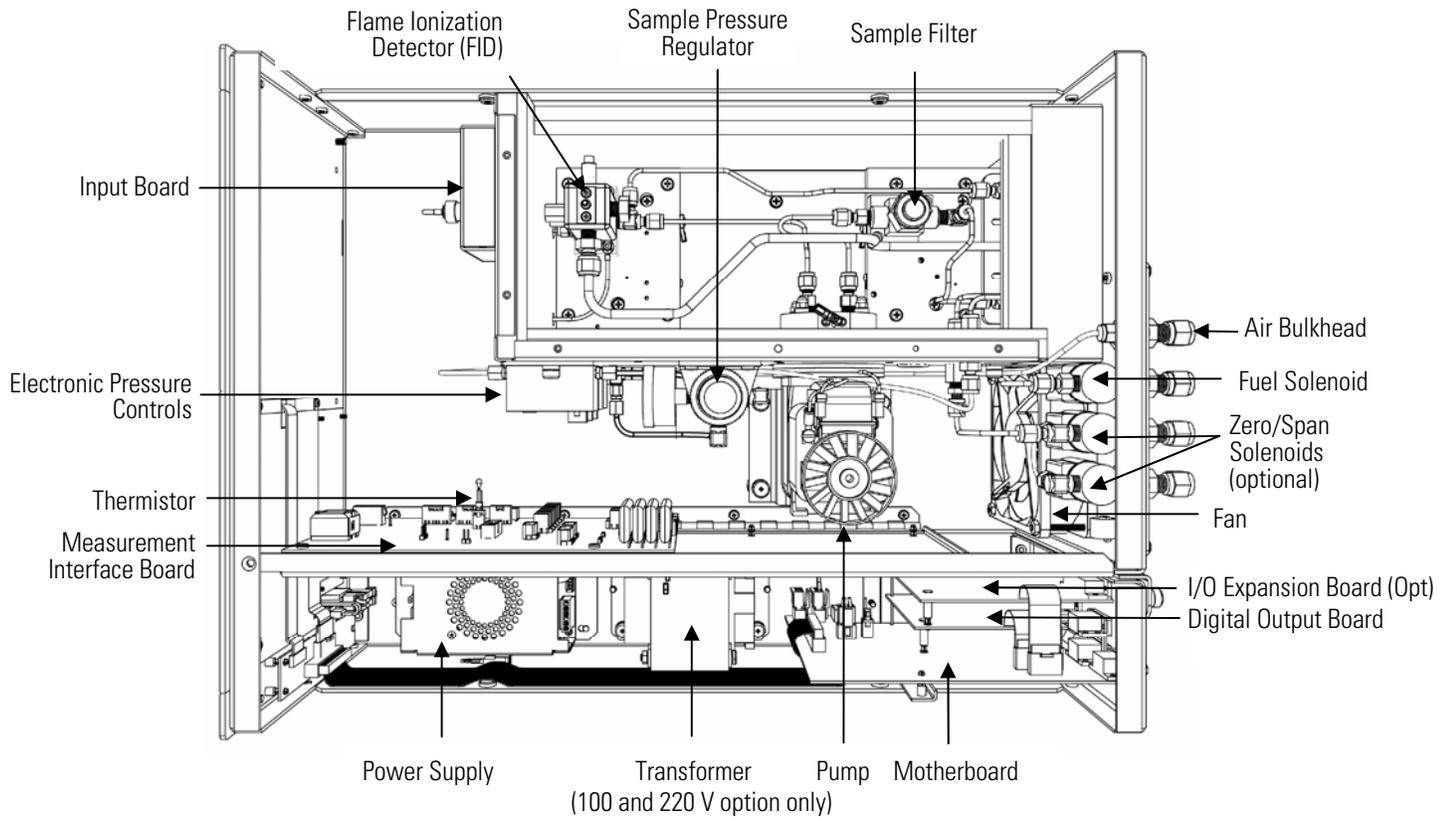
Figure 7–2. Model 51*i* Component Layout (High Temperature)
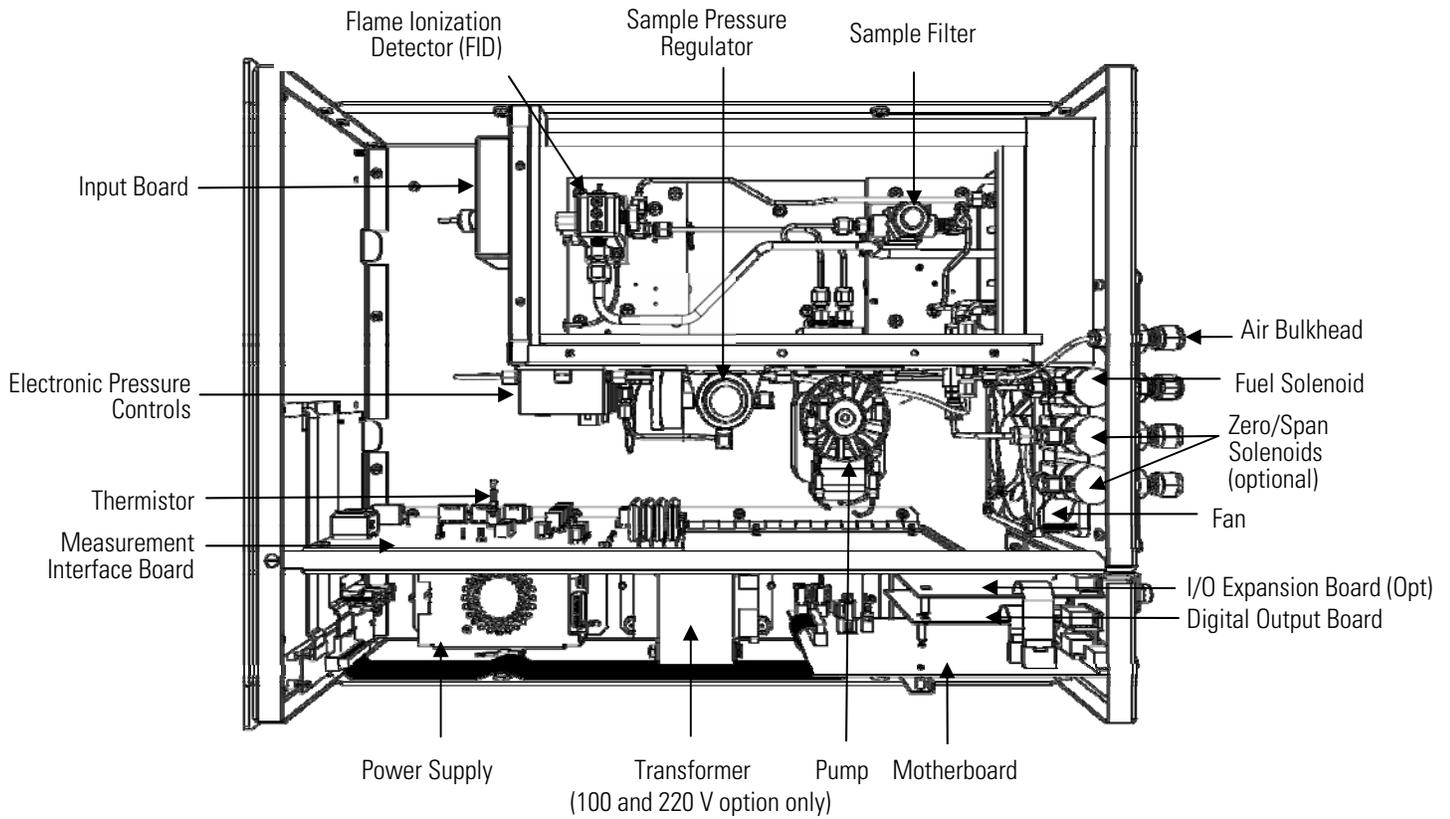
Figure 7–3. Model 51*i* Component Layout (Low Temperature)

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 7–4).

REMOVE SCREWS

Pass Through Connectors

Remove Screw

SLIDE CASE ASSEMBLY OUT

Loosen Captive Screw

Partition Panel

Remove Screws

Remove Screw

LOWER PANEL

Remove Hidden Screw
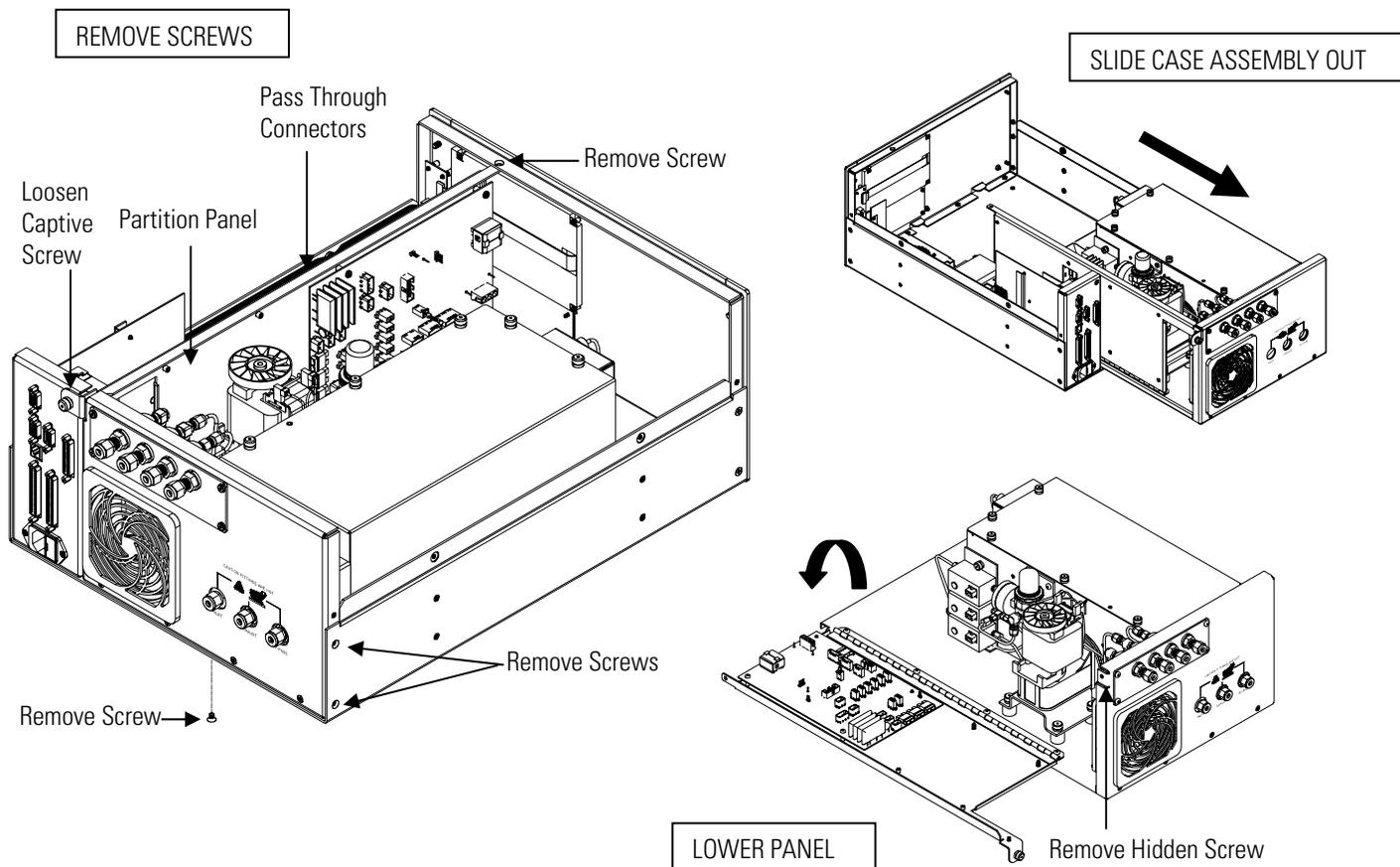
Figure 7–4. Removing the Measurement Case Assembly and Lowering the Partition Panel (High Temperature shown)

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. ▲

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.

Pump Replacement

Use the following procedure to replace the pump (Figure 7–5 and Figure 7–6).

Equipment Required:

> 120 V pump
>
> Wrench, 7/16-inch (2 required)
>
> Teflon tape, 1/4-inch
>
> 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. ▲

1. Allow the detector oven to cool to room temperature. Disconnect the pump power cable from the measurement interface board.

2. Remove the detector oven cover.

3. Remove the heater and temperature sensor (HT only).

4. Remove both the inlet and exhaust line from the pump and remove the pump and mounting bracket from the measurement case assembly.

5. Remove the two connectors from the pump tabs.

6. Remove the pump from its mounting bracket.

7. Remove the inlet and exhaust fitting from the pump head.

8. Remove the remaining Teflon tape from fitting threads.

9. Install the new pump by following the previous steps in reverse.

Inlet   Pump Bracket Mounting Screws (4)

Heater Cartridge
Temperature Sensor
Exhaust

Pump Mounting Screws (4)
(back side of bracket)
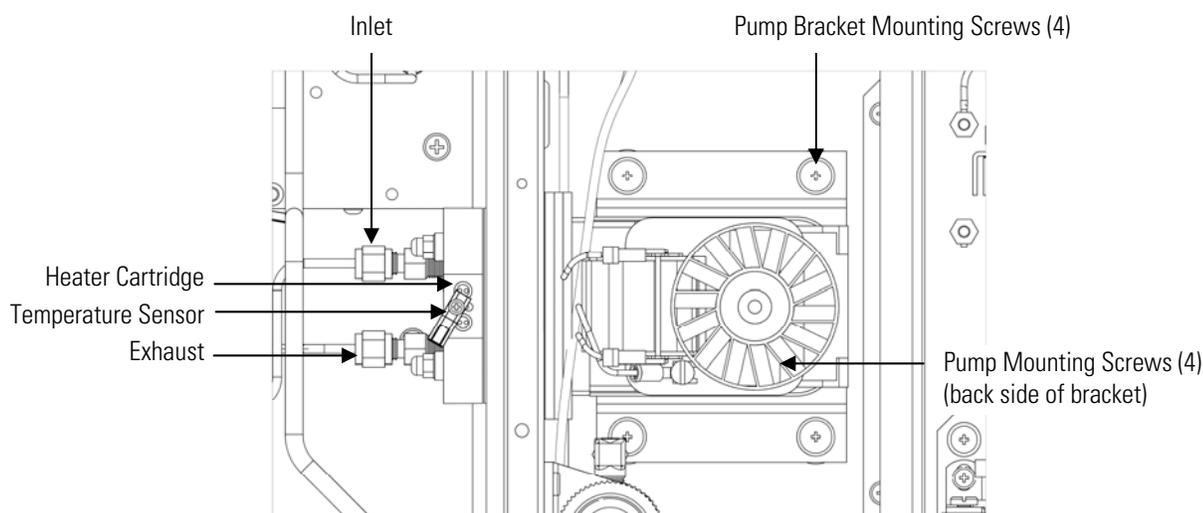
Figure 7–5. Replacing the Pump (High Temperature)

Inlet

Pump Bracket Mounting Screws (4)

Pump Mounting Screws (4)

Exhaust
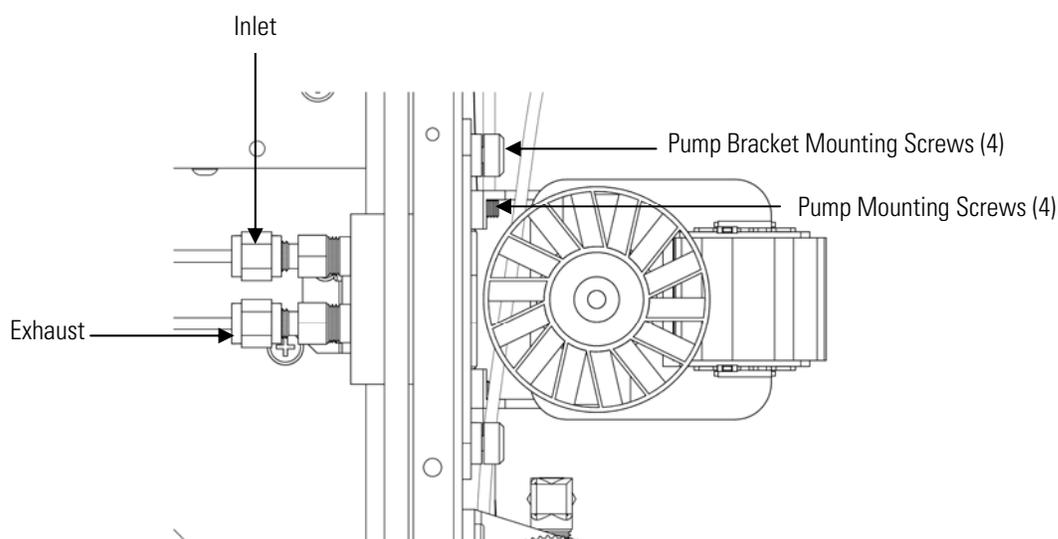
Figure 7–6. Replacing the Pump (Low Temperature)

Pump Rebuilding (Heated Head Version)

For the new technology pump (repair kit part number 108091-00), use the following procedure to rebuild the pump (Figure 7–7, provided by KNF). The new technology pump will have the repair kit part number on its label. If no repair kit part number is listed, refer to the procedure for the older model pump following this procedure.

Equipment Required:

Pump repair kit (heated head version)

Marking pencil or Sharpie marker

Nut driver, 7 mm

Needle-nose pliers

Spanner wrench

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. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover. Make a sketch of the position of any tubes and fittings for ease of re-assembly later.

2. Remove the pump assembly from the analyzer as described in "Pump Replacement".

3. Mark the position of the pump head plate, intermediate plate, and compressor housing relative to each other by drawing a line on the edges with a pencil or marker to ensure proper re-assembly.

4. Remove the expanded metal compressor housing cover to gain access to the inside of the compressor housing. Remove the four screws and then remove the cover. Re-use any gasketing. Remove any debris that may have accumulated in the bottom of the compressor housing.

5. Remove the four cap nuts with spring washers and remove the head plate. Remove the flapper valves and O-rings from the intermediate plate. Note the position of the flappers relative to the inlet and outlet valve ports on the head plate and intermediate plate.

6. Remove the intermediate plate.

7. Check that all parts are free from dirt and clean as necessary. Take care to not scratch the parts.

8. Unscrew the clamping disk using a spanner wrench. Lift the clamping disc, diaphragms, connection rod disc, and shim rings from the pump.

Remember that the quantity and thickness of shim rings will vary from pump to pump. If repairing multiple pumps, take care not to mix parts.

9. Place the new diaphragms with the connection rod disc and shim rings on the clamping disc stud. Position the assembly onto the four threaded rods mounted into the pump compressor housing. Take care that the shim rings do not fall off the stud.

10. Carefully screw the clamping disc stud into the connecting rod extension. Tighten the clamping disc taking care to maintain alignment of the diaphragms on the four threaded rods.

Note Misalignment of the diaphragm can prevent proper start-up and will severely reduce the service life of the replacement diaphragms. ▲

11. Place the clean intermediate plate onto the compressor housing using the reference mark made earlier to ensure the correct orientation. Recalling the position of the flappers noted during disassembly, place the new flapper valves and O-rings on top of the intermediate plate.

12. Place the clean head plate on top of the intermediate plate using the reference mark made earlier to ensure the correct orientation. Install the four cap nuts and spring washers according to the spring washer assembly diagram in Figure 7–7. Tighten the cap nuts in a diagonal pattern to a torque of approximately 4 inch-lbs taking care that the spring washers are fully engaged, but not overly compressed.

Note Correctly tightened spring washers will maintain proper sealing pressure on the diaphragm across the operating temperature range of the pump. ▲

13. Rotate the fan by hand to confirm that the pump turns freely.

14. Replace the compressor housing cover and gasket. Install the 4 cover screws. Do not over-tighten.

15. Re-install the pump assembly by reversing the removal sequence used earlier and verify that all fittings and electrical connections are secure.

16. Power-up the instrument and, if necessary, go to the Pump Settings screen in the Instrument Controls menu and turn the pump on. (From

the Main Menu, choose Instrument Controls > **Pump Settings**.) Listen closely for a "knocking" sound that would indicate that the clamping disk is hitting the intermediate plate. If you do hear a knocking sound, equally loosen the four head nuts until the sound just disappears. Make sure that the cap nuts and spring washers are properly engaged.

17. Allow the instrument to come up to full operating temperature then check for knocking, as described in the previous step. Verify that the pump is working correctly by checking the flow rate at the sample inlet bulkhead and the sample pressure reported in the Diagnostic menu. (The pump should draw at least 700 cc per minute of sample.)
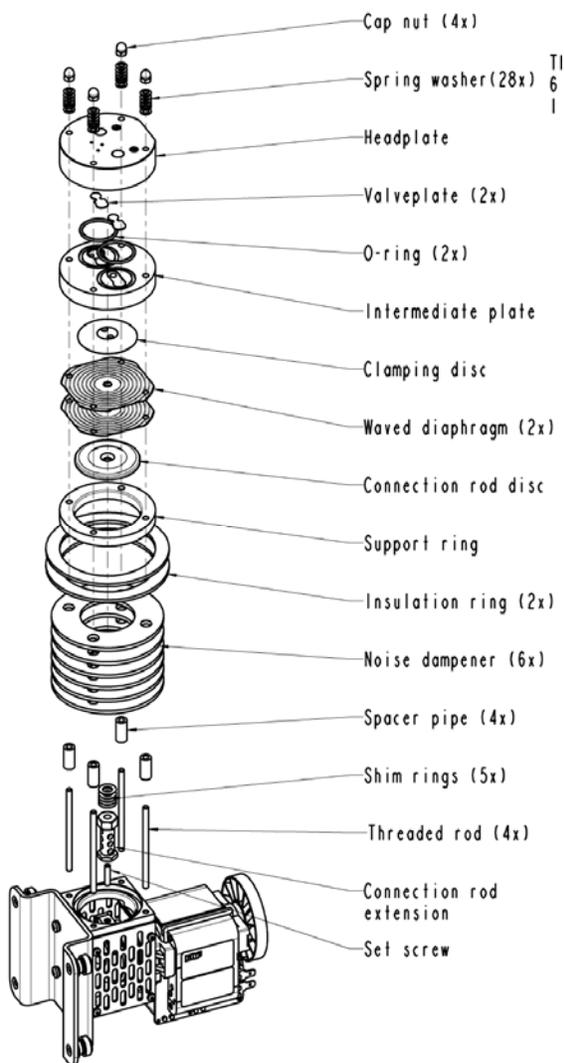
Figure 7–7. Rebuilding the Pump—New Technology (Heated Head Version)

For older models (repair kit part number 18070), use the following procedure to replace the heated head pump diaphragm and valve plate for the Model 51*i* HT only (Figure 7–8, provided by KNF). During normal use, the diaphragm and valve plate are the only parts of the pump that need to be replaced.

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Remove the pump assembly from the analyzer as described in "Pump Replacement".

3. For ease of re-assembly, mark the relative positions of the head plate (A), intermediate plate (B), and the spacer ring (C) with a line using the pencil or Sharpie type marker.

4. Undo the 4 head nuts and flat washers (D) and the 6 cup washers (L) from the studs, and lift off the head plate (A), valve plate (E) and intermediate plate (B).

5. If necessary, lightly clean the valve seat area of the head plate (A) and intermediate plate (B) of any deposits with fine steel wool.

6. Unscrew the clamping disk (G) by inserting needle-nose pliers into the two holes and turning it counter-clockwise. Remove the clamping disk, the two diaphragms (H), the connecting rod disk, and any shim disks (P) present on top of the hex piece. Be sure to note the number and position of the shims so that they can be replaced correctly when you re-assemble the pump.

7. Turn the counterweight or the motor fan by hand until the connecting rod (K) is at mid-stroke and centered, and place the shim disk or disks (P) on top of the hex piece. Place the connecting rod disk in its cavity in the spacer ring, place two new diaphragms (H) over the spacer ring (C), lining up the screw holes as you re-assemble. Note that if one side of the diaphragm is brown, that side should be facing down.

8. Place the threaded boss of the clamping disk (G) through the holes in the two new diaphragms (H), the connecting rod disk and shim disks (P), and thread it into the hex piece. Tighten the clamping disk using the needle-nose pliers until snug, but do not over-tighten.

9. Place the intermediate plate (B) over the diaphragm using the marks that were made in Step 2 to line up the parts.

10. Place the new valve plate (E) on top of the intermediate plate (B), orienting the valve flaps with the holes. If the valve plate has one side that is brown, that side should be down.

11. Place the head plate (A) on top of the valve plate (E), again using the marks made in step 2 to line up the components.

12. Be sure that all components are centered. Position 6 cup washers (L) over each stud, oriented as shown in the diagram, then place the flat washers on the studs. Tighten the 4 head nuts (D) in a crisscross pattern to a snug fit, but do not over-tighten.

13. If you are replacing the fittings on the head plate, remove any old Teflon tape and carefully apply two layers of new tape to the fitting threads. Do not substitute any other type of tape, and be sure that the Teflon does not extend below the threads, as excess tape may tear off and become lodged in the pump valves.

14. Turn the motor fan or counterweight by hand to be sure that the pump runs freely.

15. Re-install the pump assembly by reversing the removal sequence used earlier and verify that all fittings and electrical connections are secure.

16. Power-up the instrument and, if necessary, go to the Pump Settings screen in the Instrument Controls menu and turn the pump on. (From the Main Menu, choose Instrument Controls > **Pump Settings**.) Listen closely for a "knocking" sound that would indicate that the clamping disk is hitting the intermediate plate. If you do hear a knocking sound, equally loosen the four head nuts until the sound just disappears.

17. Allow the instrument to come up to full operating temperature then check for knocking, as described in the previous step. Verify that the pump is working correctly by checking the flow rate at the sample inlet bulkhead and the sample pressure reported in the Diagnostics menu. (The pump should draw at least 700 cc per minute of sample.)
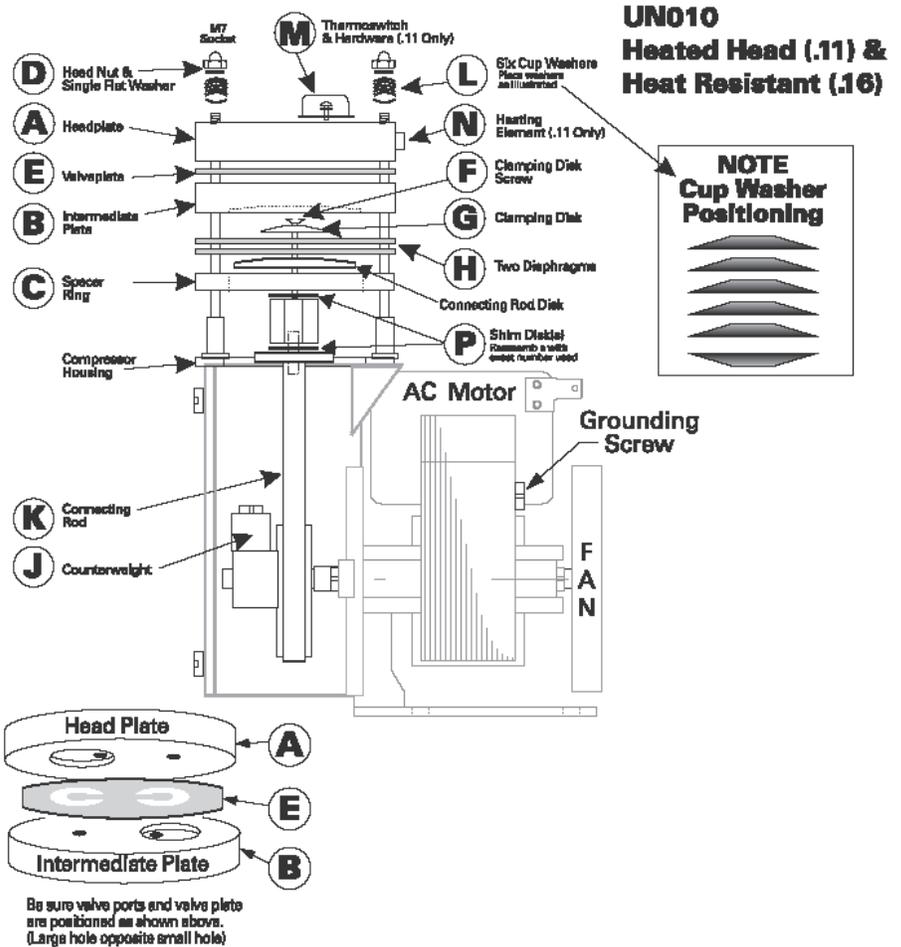
Figure 7–8. Rebuilding the Pump (Heated Head Version)

Pump Rebuilding (Low Temp Version)

For the new technology pump (repair kit part number 108002-00), use the following procedure to rebuild the pump (Figure 7–9, provided by KNF). The new technology pump will have the repair kit part number on its label. If no repair kit part number is listed, refer to the procedure for the older model pump following this procedure.

Equipment Required:

   Pump repair kit (low temp version)

   Marking pencil or Sharpie marker

   Nut driver, 7 mm

   Needle-nose 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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover. Mark a sketch of the position of any tubes and fittings for ease of re-assembly later.

2. Remove the pump assembly from the analyzer as described in "Pump Replacement".

3. Mark the position of the pump top plate, bottom plate and compressor housing relative to each other by drawing a line on the edges with a pencil or marker to ensure proper re-assembly.

4. The aluminum compressor housing cover must be removed to gain access to the inside of the compressor housing. Remove the four screws and then remove the cover. Re-use any gasketing. Remove any debris that may have accumulated in the bottom of the compressor housing.

5. Remove the four top plate screws and remove the top plate. Note the positioning of the flapper valve relative to the valve ports on the top plate and bottom plate. Lift off the flapper valve.

6. Remove the bottom plate.

7. Check that all parts are free from dirt and clean as necessary. DO NOT scratch the parts.

8. Rotate the fan so that the diaphragm is positioned at the top dead center. This will help unseat the edge of the diaphragm. If required, push up from underneath the diaphragm or use a **non-metallic** tool to pry up the diaphragm from the housing groove. Do not scratch the head components. Unscrew the old diaphragm by turning it counterclockwise using both hands. Lift up and grip the edges of the diaphragm at 10 and 4 o'clock. High intial force may be required to break the diaphragm loose. **DO NOT use tools!**

Note Take care not to lose the shim rings positioned between the diaphragm and connecting rod, as the same shim rings must be used during re-assembly. ▲

While unscrewing the diaphragm with one hand, use your other hand to secure the support cap and shim ring(s) onto the diaphragm stud. Lift the diaphragm, support cup and shim ring(s) from the pump. The compressor housing cover must be removed to gain access to and secure the support cup and shim ring(s) onto the stud. Note that the quantity and thickness of shim ring(s) will vary from pump to pump. Parts removed must be replaced exactly as found. If repairing multiple pumps, take care not to mix parts.

9. Place the parts removed in the previous step onto the threaded stud of the new diaphragm. Carefully screw the new diaphragm into the connecting rod. Secure the support cup and small parts onto the diaphragm stud using a technique similar to that used during removal. It is helpful to hold the connecting rod at a slight angle until the threads are started. Spin the diaphragm on until it is snug. Lift and grip the edges of the diaphragm at 7 and 2 o'clock and tighten firmly using both hands. DO NOT use tools!

Note If the pump is loose and not mounted, position and hold the pump with the motor shaft vertical when starting the threaded diaphragm stud into the connecting rod. This helps to prevent the small parts from falling off the stud. ▲

10. Turn the fan until the diaphragm is flat across (mid-point of the stroke). With the diaphragm centered over the compressor housing, firmly seat the diaphragm edge into the compressor housing groove.

11. Place the clean bottom plate onto the compressor housing using the reference mark made earlier to ensure the correct orientation. Then place the new flapper valve on top of the intermediate plate.

12. Place the clean top plate on top of the bottom plate using the reference mark made earlier to ensure the correct orientation. Tighten the four top plate screws snugly in a diagonal pattern and then tighten to a maximum torque of 6-7 inch-lbs. Turn the fan by hand to confirm that the pump turns freely.

13. Replace the compressor housing cover and gasket. Install the four cover screws. Do not over-tighten.

14. Re-install the pump assembly by reversing the removal sequence used earlier and verify that all fittings and electrical connections are secure.

15. Power-up the instrument and turn the pump on. Allow the instrument to come up to full operating temperature. Verify that the pump is working correctly by checking the flow rate at the sample inlet bulkhead (the pump should draw at least 700 cc per minute of sample) and checking to see that the sample pressure reported in the Diagnostic menu is close to the set pressure.
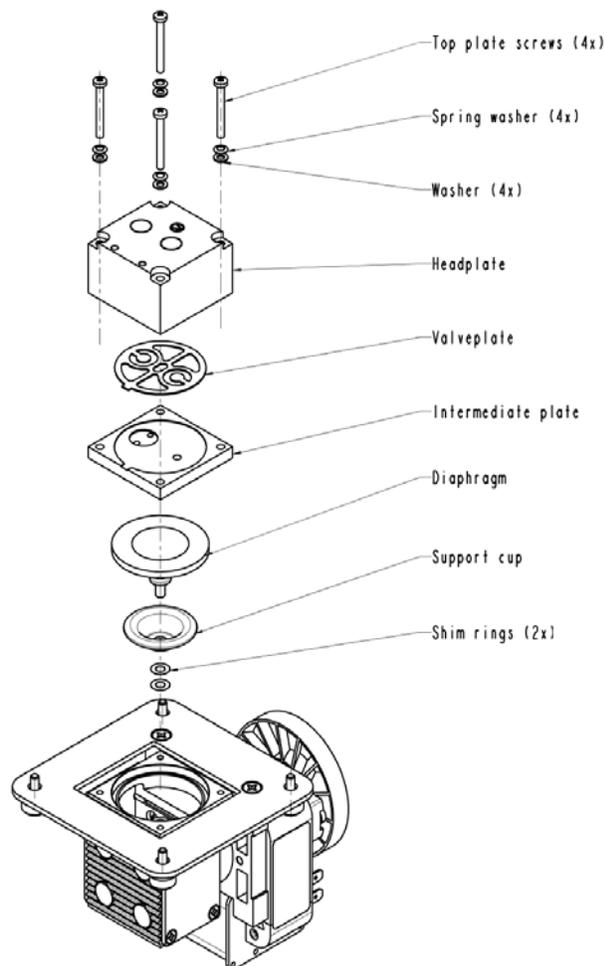
Figure 7–9. Rebuilding the Pump—New Technology (Low Temp Version)

For older models (repair kit part number 8606), use the following procedure to replace the low temperature pump diaphragm and valve plate for the Model 51*i* LT only (Figure 7–10). During normal use, the diaphragm and valve plate are the only parts of the pump that need to be replaced.

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Remove the pump assembly from the analyzer as described in "Pump Replacement".

3. For ease of re-assembly, mark the relative positions of the head plate and bottom plate with a line using the pencil or Sharpie type marker.

4. Remove the four screws from the top plate, and remove the top plate, flapper valve, and the bottom plate.

5. Remove the screw securing the clamping disk and the diaphragm to the piston, and remove the diaphragm.

6. Assemble the pump with the new flapper valve and diaphragm by following the previous steps in reverse; make sure the Teflon (white) side of the diaphragm is facing up and that the flapper valves cover the holes of the top and bottom plate. Do not over tighten the screws.

7. If you are replacing the fittings on the top plate, remove any old Teflon tape and carefully apply two layers of new tape to the fitting threads. Do not substitute any other type of tape, and be sure that the Teflon does not extend below the threads, as excess tape may tear off and become lodged in the pump valves.

8. Turn the motor fan or counterweight by hand to be sure that the pump runs freely.

9. Re-install the pump assembly by reversing the removal sequence used earlier and verify that all fittings and electrical connections are secure.
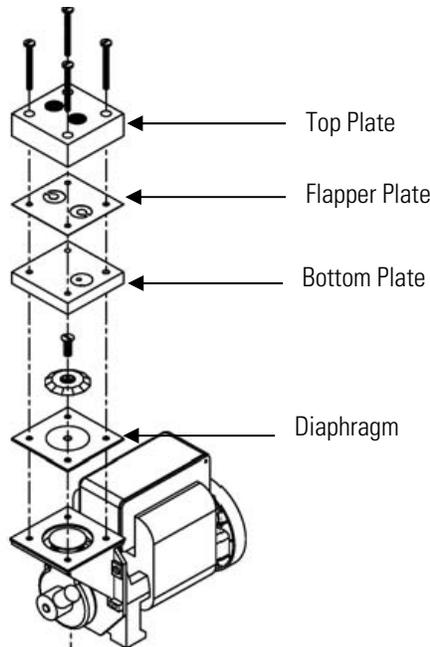
Figure 7–10. Rebuilding the Pump (Low Temp Version)

10. Power-up the instrument and turn the pump on. Allow the instrument to come up to full operating temperature. Verify that the pump is working correctly by checking the flow rate at the sample inlet bulkhead (the pump should draw at least 700 cc per minute of sample) and checking to see that the sample pressure reported in the Diagnostic menu is close to the set pressure.

Fan/Filter Replacement

Use the following procedure to replace the fan and the fan filter (Figure 7–11).

Equipment Required:

Fan

Fan filter

Philips screwdriver

Cable cutter (for tie-wrap removal)

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. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Remove the fan guard and filter from the fan by unsnapping it.

3. If the fan is not being replaced, install the new filter, and snap it back into place, and skip the remaining steps.

4. Disconnect the fan power cable from the measurement interface board. Do not lose the four nuts.

5. Remove the four fan mounting screws and remove the fan.

6. Install a new fan following the previous steps in reverse.
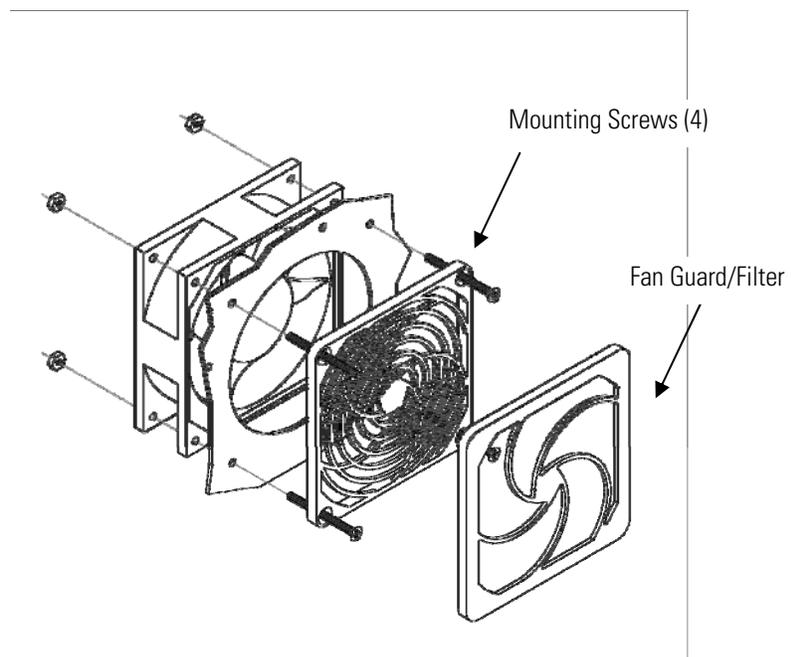
Figure 7–11. Replacing the Fan

Input Board Replacement

Use the following procedure to replace the input board (Figure 7–12).

Equipment Required:

Input board

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. ▲

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. Disconnect the coaxial cable with BNC connector and the ribbon cable.

3. Loosen the two screws holding the input box to the oven assembly and lift the input box off the screws.
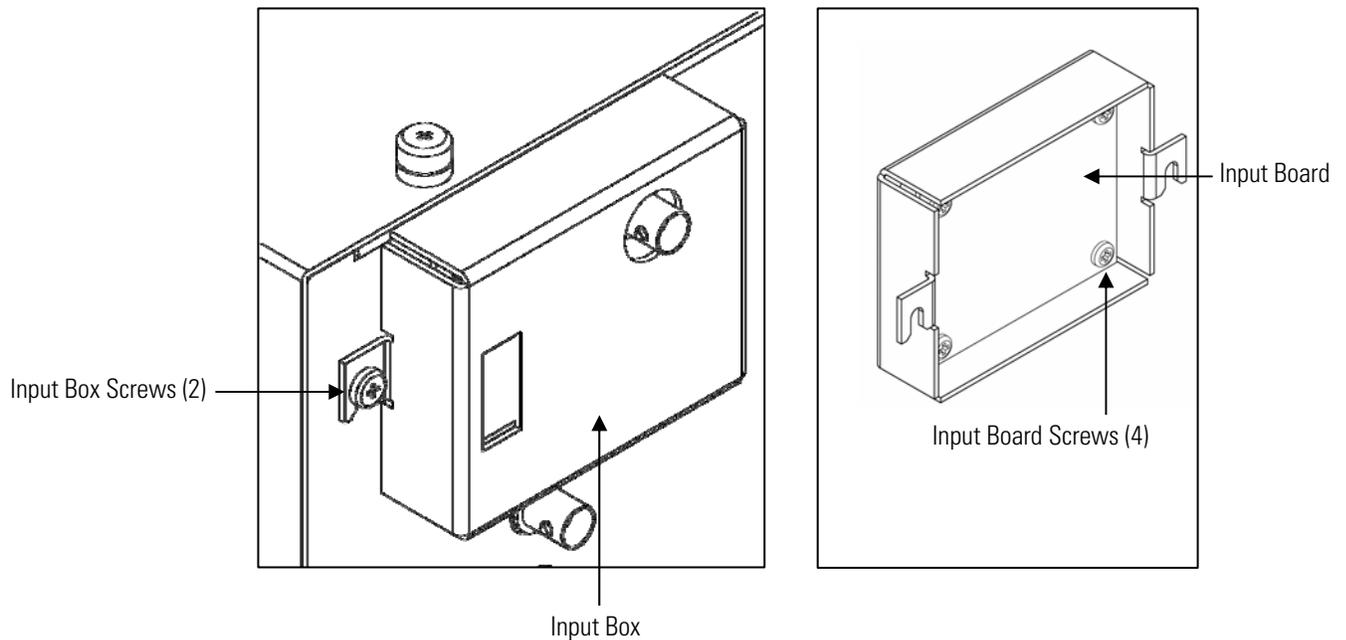
Figure 7–12. Replacing the Input Board

4. Remove the four screws holding the input board to the input box.

5. Install the input board by following the previous steps in reverse.

6. Re-install the measurement case assembly. Refer to "Removing the Measurement Case Assembly and Lowering the Partition Panel" in this chapter.

7. Perform an input board calibration. See the "Input Board Calibration" procedure that follows.

Input Board Calibration

After replacing the input board, use the following procedure to calibrate the input board.

⚠️

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

Note The flame must not be lit when performing an input board calibration. ▲

1. From the Main Menu, choose Service > **Input Board Calibration**.

   The Input Board Calibration screen appears.

Note If Service Mode is not displayed, refer to "Accessing the Service Mode" on page 7-4 , then return to the beginning of this step. ▲

2. At the Input Board Calibration screen, choose Automatic Input Cal, which automatically calibrates the input board and stores the D/A value. If preferred, the user may choose the Manual Input Cal function and use the following procedure to perform the calibration.

3. The screen displays the frequency at GAIN 1. Make a note of the FREQ value displayed, then press ⬅ or ➡ to change the GAIN to 100.

4. At the GAIN 100 screen, use ⬆ ⬇ to increment or decrement the D/A counts until the FREQ value matches or is slightly above (within 50 counts) the value noted in the previous step.

5. Press ⬅ to store the value.

   The screen flashes **Calculating - Please Wait!** and **Done - Values Saved!** messages.

DC Power Supply Replacement

Use the following procedure to replace the DC power supply (Figure 7–13).

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. ▲

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.

Power Supply

Retaining Screws (4)

BOTTOM VIEW

Captive Screw
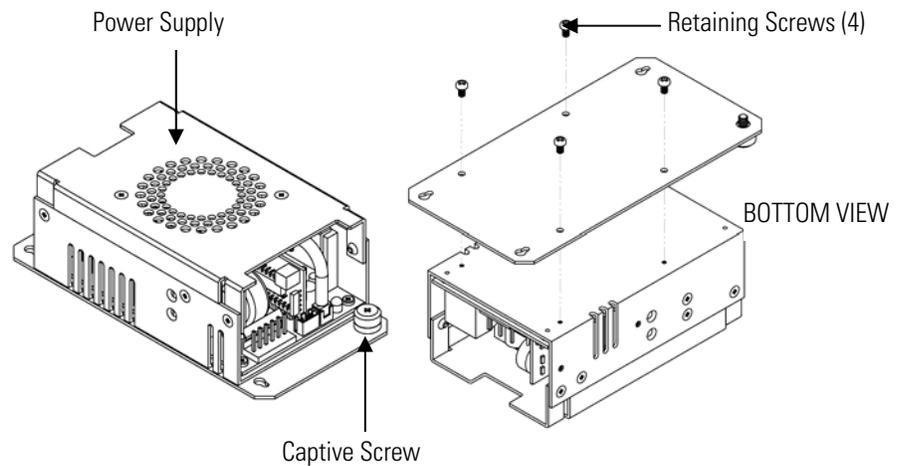
Figure 7–13. Replacing the DC Power Supply

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 7–14 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. 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.
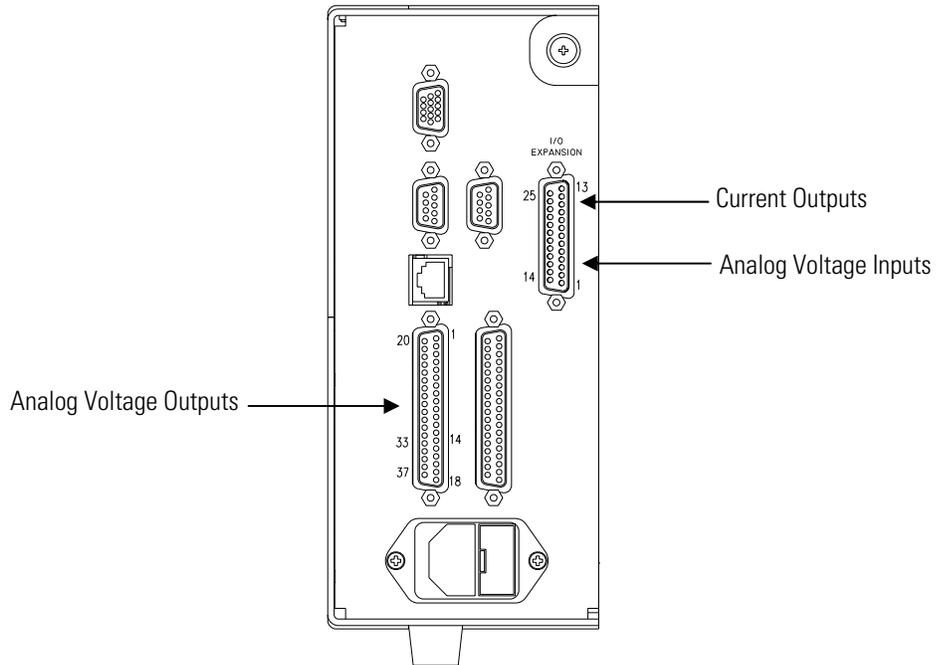
Figure 7–14. Rear Panel Analog Input and Output Pins

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.

Equipment Required:

Multimeter

1. Connect a meter to the channel to be adjusted and set to voltage or current as appropriate. Figure 7–14 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 Service Mode is not displayed, refer to "Accessing the Service Mode" 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 calibrate zero first and then calibrate 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.

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 Service Mode is not displayed, refer to "Accessing the Service Mode" 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 7–14 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 3-5 to calibrate other input channels to the source voltage as necessary.

Thermistor Replacement

Use the following procedure to replace the ambient temperature thermistor (Figure 7–15).

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. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Squeeze the thermistor latch and pull the thermistor assembly from the AMB TEMP connector on the measurement interface board.

3. Snap the new thermistor assembly into the AMB TEMP connector.
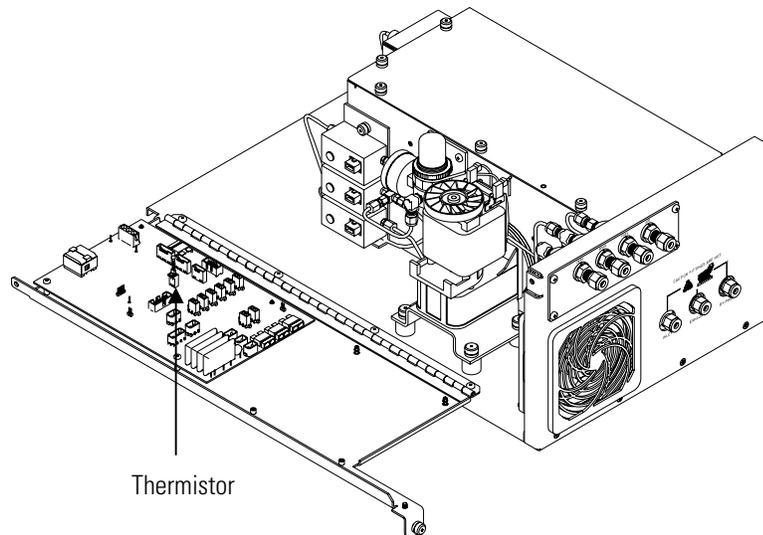
Thermistor

Figure 7–15. Replacing the Thermistor

Ambient Temperature Calibration

Use the following procedure to calibrate the ambient internal temperature for the instrument.

Equipment Required:

Calibrated thermometer or 10 K ±1% Resistor

⚠️ **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. ▲

⚠️ **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. ▲

1. Remove the instrument cover.

2. Tape the thermometer to the thermistor, which is plugged into the measurement interface board (Figure 7–15).

Note Since the thermistors are interchangeable to an accuracy of ±0.2 °C, and have a value of 10 K ohms at 25 °C, an alternate procedure is to connect an accurately known 10 K resistor to the thermistor input (AMB TEMP) on the measurement interface board, and enter the temperature reading. ▲

A 1 °C change corresponds to a ±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 > **Temperature Calibration**.

   The Calibrate Ambient Temp screen appears.

Note If Service Mode is not displayed, refer to "Accessing the Service Mode" on page 7-4 , then return to the beginning of this step. ▲

4. Wait at least 10 seconds for the ambient reading to stabilize, use
   [←] [→] and [↑] [↓] to enter the known temperature, and
   press [↵] to save the temperature value.

5. Install the cover.

Pressure Controller Replacement

Use the following procedure to replace the support gas pressure controllers (Figure 7–16).

Equipment Required:

Replacement pressure controller (air, fuel, or back pressure)

Philips screwdriver

Wrench, open end, 1/4-inch

Wrench, open end, 5/16-inch

Wrench, open end, 3/8-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. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Disconnect the RJ-45 cables from all three pressure controllers. Note the location of the connectors to facilitate re-connection.

3. Disconnect the tubing supporting all three controllers. Note the location of the tubing to facilitate re-connection.

4. Loosen the captive screw holding the controller bracket to the oven wall and remove the controller assembly.

5. Remove the screws from the back of the controller(s) to be replaced and remove the controller(s).

6. Remove the fittings from the discarded controller(s) and install them in the new controller in the same manner.

7. To install the new controller(s), follow the previous steps in reverse. Make sure all fo the fittings on the controller assembly are tight.
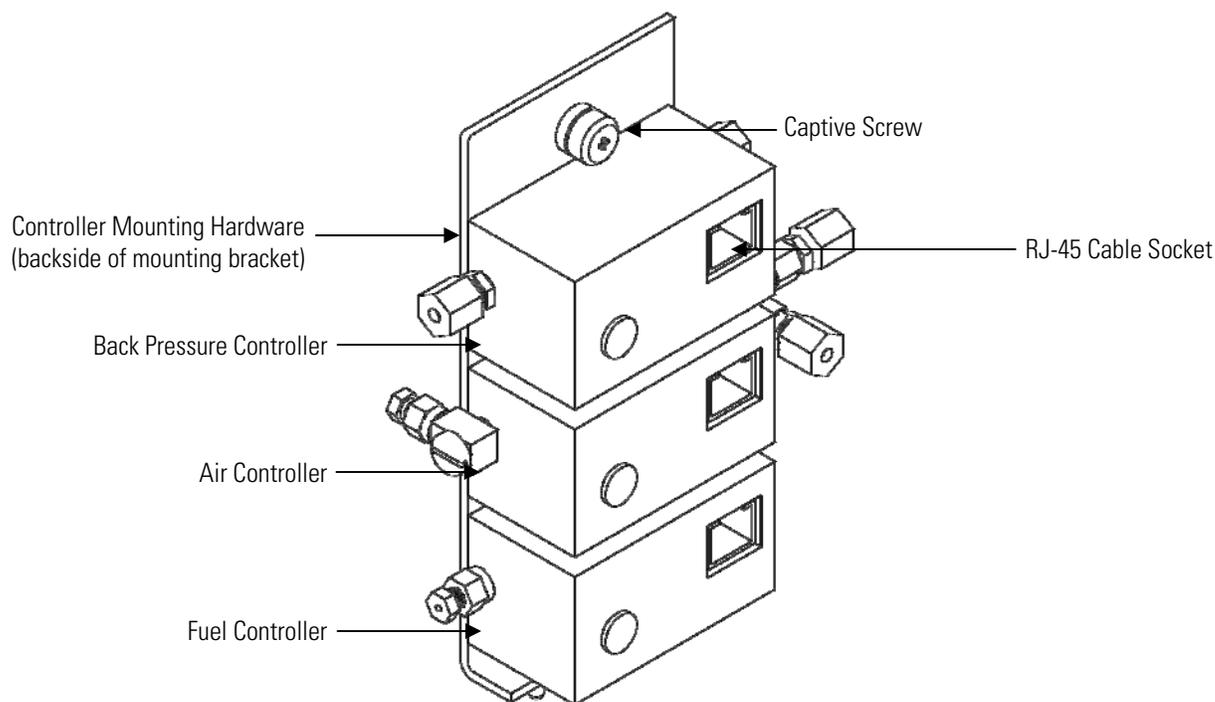
Figure 7–16. Replacing the Pressure Controllers

Pressure Regulator Replacement

Use the following procedure to replace the pressure regulator (Figure 7–17).

Equipment Required:

    Wrench, open end, 7/16-inch

    Philips screwdriver

    Adjustable pliers (wide jaw)

    Hex wrench set

    Teflon pipe thread tape

⚠️ **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. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Shut down the instrument combustion air supply and remove the inlet and outlet tube fittings from the pressure regulator. Note the location of each tube to facilitate re-connection.

3. Remove the pressure gauge and clean any remaining pipe tape from the gauge threads.

4. Using the adjustable pliers, remove the regulator panel nut that is securing the regulator to the mounting bracket. (Removing the regulator mounting bracket may simplify the removal of the panel nut.)

5. Remove the inlet and outlet fittings from the body of the regulator and clean any remaining pipe tape from the fitting threads. Note the location and orientation of the fittings prior to removal to facilitate re-installation.

6. Remove the socket head plug located in the rear side outlet port and clean any remaining pipe tape from the plug threads.

7. To install the new regulator, follow the previous steps in reverse. Replace the pipe thread tape on all fittings before installing.
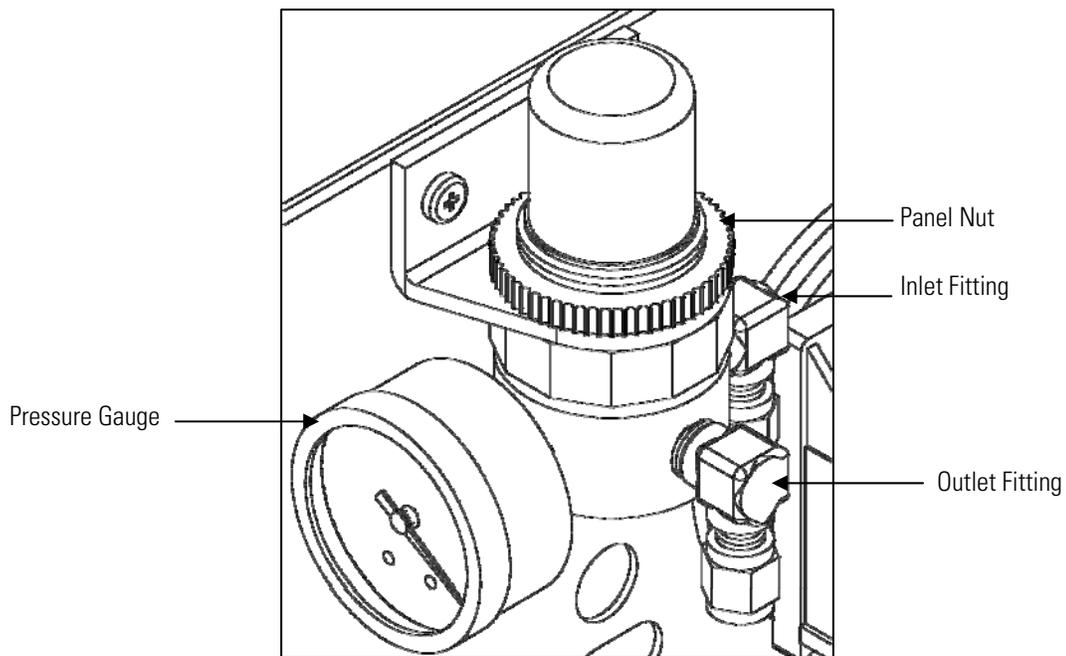
Figure 7–17. Replacing the Pressure Regulator

Hydrogen/Zero/Span Solenoid Valve Replacement

Use the following procedure to replace the hydrogen, zero, or span solenoid valve.

Equipment Required:

    2-Way solenoid valve assembly

    Wrench, 1/2-inch

    Wrench, 9/16-inch

    Wrench, 5/8-inch

    Wrench, 7/16-inch

    Teflon pipe thread tape

1. Disconnect the solenoid at its connector.

2. Remove the attached tubing from the solenoid valve.

3. Remove the solenoid valve assembly from the back panel and remove the fittings from the valve body. Note the orientation of the fittings before removing them from the solenoid valve.

4. Remove and replace the old Teflon pipe thread tape from the fittings.

5. To install the new solenoid valve, follow the previous steps in reverse.

Testing and Replacing the Ignitor

The FID flame is lit by applying a controlled voltage to an ignitor that screws into the side of the detector housing. The ignitor contains a small coil of wire that produces a red-hot ignition source when electric current flows through it. Over time, the ignitor can fail due to normal wear or due to exposure to corrosive atmospheres. The Model 51*i* comes with a spare ingitor already installed, which would just need to be plugged into the connector in place of the failed ignitor.

Equipment Required:

    Replacement ignitor/cable assembly

    Multimeter

    Philips screwdriver

    Wrench, 5/16-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. ▲

Use the following procedure to test the ignitor.

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Unplug connector 27 labeled IGN/BIAS from the measurement interface board.

3. Measure the resistance between instrument ground and pin 1 (first tan wire). An ignitor that is functioning properly should have a resistance of about 2 to 10 ohms.

Note The ignitor should be replaced if the resistance is outside this window. ▲

4. If the spare ignitor is still in working order, simply disconnect the damaged ignitor from the pink connector coming from pin 1 of J27 and plug in the spare.

Use the following procedure to replace the ignitor (Figure 7–18). If neither ignitor is in working order, it is recommended that both be replaced.

5. Locate the ignitor power cable and disconnect the pink connector coming from pin 1 of J27 of the measurement interface board.

6. Remove the oven cover to access the detector and locate the ignitor(s) screwed into the side of the detector housing.

7. Using the 5/16-inch wrench, unscrew the ignitor(s) from the detector.

8. Install the new ignitor(s) into the detector, being sure to include the copper ring that acts as a gasket between the plug and the detector housing.

9. Re-connect the ignitor power cable to the pink connector going to pin 1 of J27 on the measurement interface board.

10. Shut the instrument fuel supply off at the source. Disconnect the fuel line from the back of the instrument, and be sure the IGN/BIAS connector is re-installed on the measurement interface board.

11. Before installing the oven cover, test the new ignitor(s). To do this, loosen the two screws on the top of the detector and lift the flame sensor thermocouple straight out of the detector top.

12. Re-install the power cord, turn the main power ON and wait for the Run screen to appear.

13. From the Main Menu, choose Diagnostics > **FID Status**.

    The FID Status screen appears.

Note Since the fuel is off, the flame should not light, but the ignitor pulsing should be clearly visible through the hole in the top of the detector. ▲

CAUTION Due to the possibility of residual fuel in the detector, keep your face away from the FID. The ignitor pulse is clearly visible from a distance when the thermocouple has been removed. ▲

14. If the ignitor is pulsing correctly, shut the instrument power OFF, replace the flame sensor thermocouple, and re-install the oven cover. Tape the connector of the spare ignitor (if replaced) to the floor plate.

Note If the replacement ignitor does not appear to be functioning, please call the service center for further instruction. ▲

Checking the Detector Bias Voltage

For the FID to operate correctly, a bias of approximately -280 to -300 volts is applied to the detector jet. If the bias fails, the FID produces weak signals, excessive drift, high noise, poor sensitivity, or poor reproducibility. The voltage is supplied by circuitry located on the measurement interface board.

Use the following procedure to check the detector bias voltage.

Equipment Required:

Multimeter

Wrench, open end, 7/16-inch

Note Before testing the bias voltage with a voltmeter, it should be checked with the built-in diagnostics described in Chapter 3, "Operation". ▲

1. Locate TP3 next to the IGN/BIAS connector, J27 on the measurement interface board. Connect a multimeter between TP3 and ground.

Note The voltage should be between -260 and -320 volts. If the reading is outside the range, then the power supply might have failed and will need to be replaced. If the reading is within range, continue with step 2. ▲

2. To test the connection between the bias power supply and the FID, turn the main power OFF and remove the IGN/BIAS connector, J27 from the measurement interface board.

3. Connect the multimeter between the bias pin 3 in the connector and instrument ground and check that it shows an open circuit. Any indication of continuity shows a short in the wire or at the detector.

4. To test the interconnect cable, disconnect the BNC connection at the bias pogo and check the continuity between the BNC center pin and pin 3 of J27 plug. The reading should indicate continuity.

5. To test the bias pogo, disconnect instrument power, open the oven, and allow cooling. Once cooled, remove the bias pogo from the detector housing using a 7/16-inch wrench. It may be necessary to remove the signal pogo to gain access to the bias pogo. Once the bias pogo is removed, check for continuity between the BNC center socket and the tip of the plunger. The reading should indicate continuity.

Removing the Detector

The FID detector can be removed from the instrument as a single unit. It might be easier to service after removing the whole detector, and in some circumstances, it is necessary (see Figure 7–18).

Use the following procedure to remove the detector.

Equipment Required:

Philips screwdriver

Hex wrench set

Wrench, open end, 5/16-inch

Wrench, open end, 7/16-inch

Wrench, open end, 9/16-inch

Wrench, open end, 1/2-inch

⚠ **CAUTION** Avoid contact with the heated oven components. Allow the oven to cool to room temperature before handling oven components. A small fan directed into the oven will speed cooling. ▲

⚠ **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. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Remove the oven cover and allow the internal components to cool.

3. Shut off all support gases.

4. Loosen the two screws on the flame thermocouple retainer located on the top of the detector and pull the flame sensor out of the detector.

Note Gently rock the sensor if needed to dislodge the o-ring seal. ▲

5. Disconnect the BNC coax signal connection to the signal pogo.

6. Disconnect the BNC bias cable from the bias pogo.

7. Disconnect the ignitor power cable (pink connector), located outside the oven.

8. Using the 9/16-inch wrench, disconnect the exhaust vent line from the top of the detector.

Note The stainless steel vent tube can be gently flexed if necessary to remove it from the fitting. ▲

9. Pull the ignitor power cable and spare ignitor power cable through the grommet on the side wall of the oven.

10. Using an Allen wrench, remove the four screws holding the upper detector base to the lower detector base.

11. Disconnect the ignitor grounding wire from the detector base.

12. Lift the detector assembly straight up about 1/4-inch and slide it off to the side.

13. Continue with the rebuild procedure in this chapter.

14. Once the detector unit is re-assembled, it can be re-installed using the previous steps in reverse.
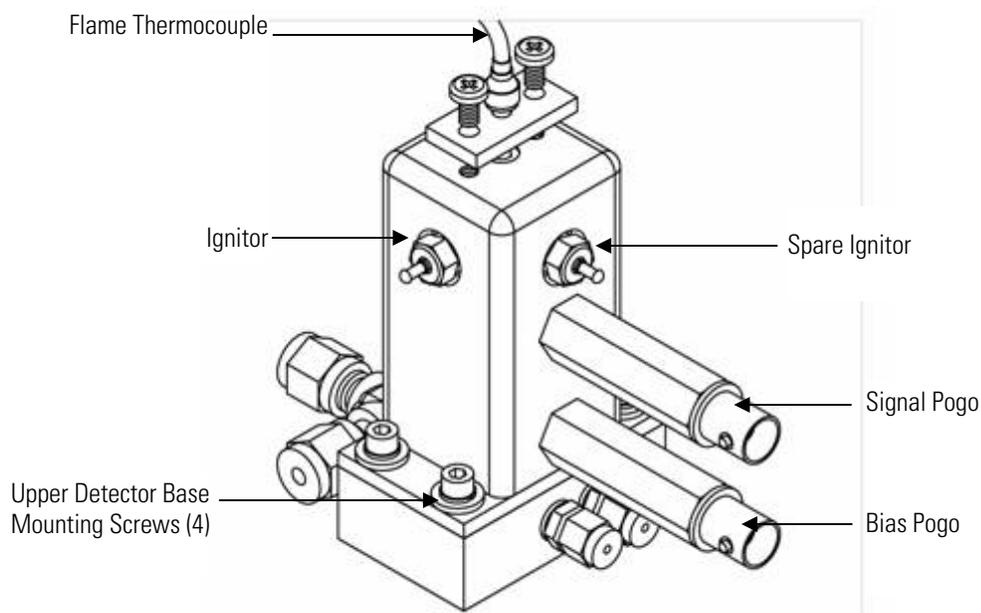
Figure 7–18. Removing the Detector

Detector Rebuilding

This section provides the equipment and instructions for rebuilding the detector assembly as shown in Figure 7–19. A part number and drawing reference for the detector assembly is provided in Table 7–6. It is necessary to remove the detector from the instrument as a complete unit before service. Refer to the "Removing the Detector" procedure in this chapter.

The detector rebuild kit contains one set of high temperature o-rings (six o-rings per set: 4 in the detector and 2 below the detector) and three Teflon

insulators. Each time the detector is opened, the o-rings should be replaced. Teflon insulators should last for at least two years of normal operation. In most cases, metal parts of the detector do not need to be replaced and can be cleaned and re-used.

Use the following procedure for rebuilding the detector.

Equipment Required:

Detector rebuild kit

Philips screwdriver

Needle-nose piers

Hex wrench set

Wrench, 5/16-inch

Wrench, 7/16-inch

Wrench, 1/2-inch

Wrench, 9/16-inch

Screw starter, long handled flat blade (optional but very useful)

Pick for removing o-rings, angled, fine-pointed (optional)

Clean cloth or paper towels (lint free)

Clean beaker or other vessel

Laboratory detergent (such as Alconox)

Clean solvent such as Methanol or Acetone

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. ▲

1. Remove the detector assembly from the lower detector base (see "Removing the Detector" earlier in this chapter) and remove the signal and bias pogo assemblies.

Note If there is a short to ground in either pogo assembly, recheck the continuity measurement of these assemblies while they are removed and contact the service center. ▲

2. Remove the four flat head screws securing the upper detector plate to the bottom of the detector.

3. Carefully remove the internal parts of the detector and place them on the clean towels. The upper detector insulator and o-ring (see diagram) might be lightly adhered into the top of the detector; use the pick or screwdriver to gently dislodge and remove them.

4. Remove the two screws holding the thermocouple retainer to the detector cover and place the retainer and screws aside. The thermocouple o-ring might also be adhered to the retainer, so again use the pick or screwdriver to remove it.

5. Using the pick, carefully remove the two o-rings from the lower detector base mounted to the oven heater plate.

Note Be careful not to get any rubber crumbs caught in the two small holes in the base (one is in the center of the central depression, one is on the concentric ring). If rubber crumbs do get into these holes, gas flows to the FID will be blocked. ▲

6. If necessary, blow clean compressed air through each of the two gas feed lines to remove o-ring debris from the base plate holes.

7. Once the o-rings have been removed, the parts should be cleaned before reassembly. Use these steps to clean the parts:

   a. First, deposits on the tip of the jet plate and inner bore of the collector can be removed with a fine emery cloth.

   b. Place the detector cover, upper detector base, all three Teflon pieces, the flat and wavy washers, the collector assembly, and the jet plate into the beaker and immerse in detergent solution. If possible, ultrasonic agitation is recommended for five to ten minutes, otherwise just stir vigorously.

   c. Rinse all the parts with large amounts of clean water, and set the Teflon pieces aside on a clean towel to dry. Rinse ONLY the metal with acetone or methanol.

   d. If the detector base has been cleaned, blow out any remaining liquid from the gas feed lines with clean compressed air or nitrogen. Always apply pressure to the fitting end of the tube rather than the holes in the base.

   e. If possible, dry all the pieces in an oven at 175 °C for an hour and allow them to cool before reassembling. Allow the pieces to dry overnight if no oven is available.

8. Place the wavy washer, flat washer and o-ring into the detector cover. The o-ring will hold the other pieces in place.

9. Place new o-rings into the two channels on the lower detector base. Place a new o-ring onto the bottom of the jet plate, around the jet tube and one onto the upper detector base.

10. Re-assemble the remaining internal parts of the detector onto the upper base.

11. Carefully place the detector cover over the stack of pieces. Be certain to orient the detector cover properly on the upper detector base. Otherwise the FID air holes will not line up and no FID air will flow.

12. Screw the upper detector base onto the detector cover.

13. Screw the signal and bias pogo assemblies back into the detector cover.

14. Feed the signal and bias pogo assemblies through the oven wall clearance holes and position the detector over the base.

15. Screw the detector assembly down to the lower base, remembering to re-connect the ignitor ground wire with one of the screws.

16. Place a new o-ring into the hole on top of the detector, and replace the thermocouple retainer loosely.

17. Insert the flame sensor thermocouple and tighten the two screws until snug. Rotate the sensor while inserting it through the o-ring to avoid cutting the rubber.

18. Re-install the ignitor, if necessary, and re-connect the ignitor power cable. Re-connect the bias and signal cables to the correct locations.

19. Re-connect the exhaust vent tube to the detector.

Note Following an FID rebuild, the instrument requires a burn-in time of 48 to 72 hours. The instrument can be used during burn-in, but requires more frequent calibration. ▲

CABLE NOT SHOWN
FOR CLARITY
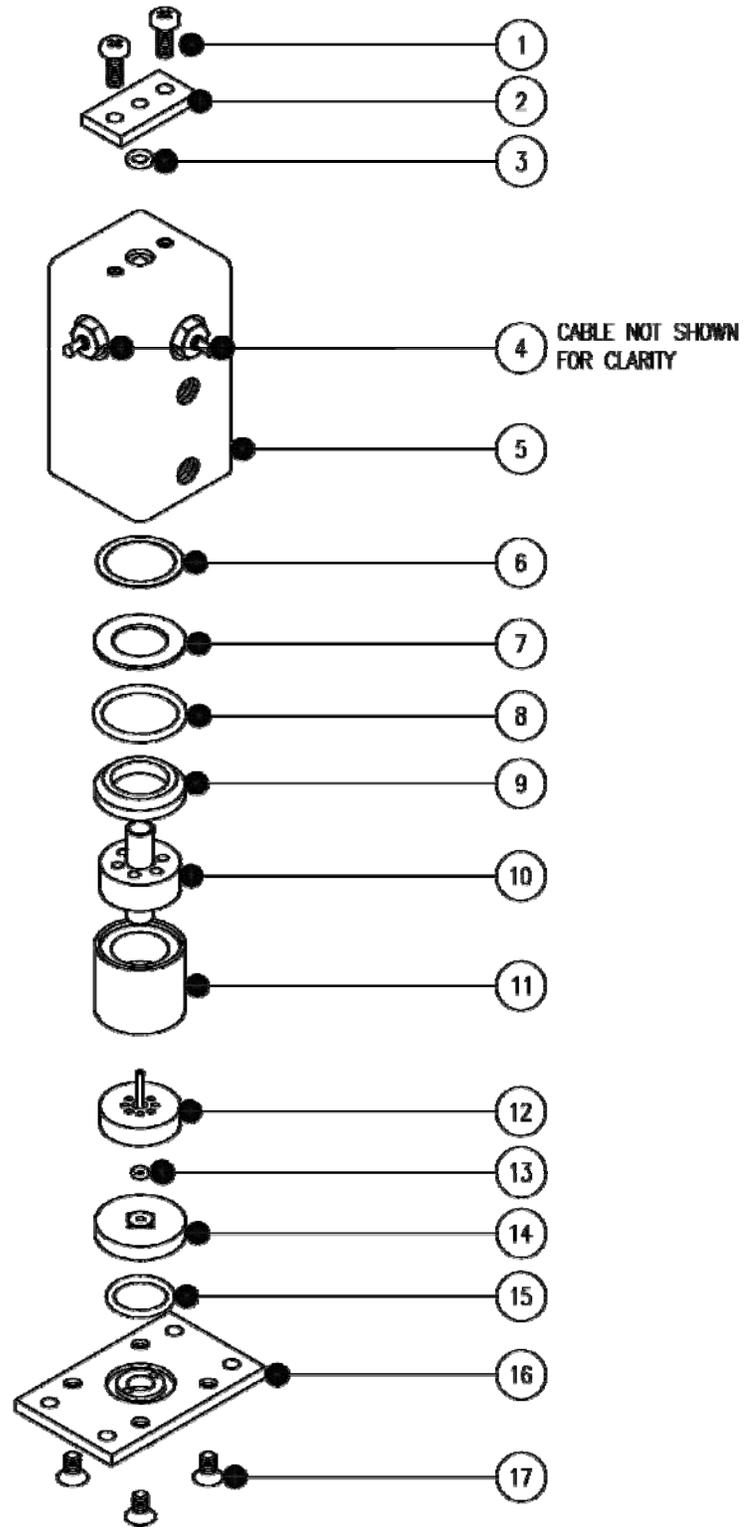
Figure 7–19. Rebuilding the Detector

Table 7–6. Part Number and Drawing Reference for Detector Assembly

Item	Description	Drawing No.	Part No.	Qty.
1	Screw 6-32 x 3/8" pan ph sems ss		102188-00	2
2	Retainer Thermocouple	78P518	14861	1
3	O-ring (2-006) Red Silicone		11032	1
4	Ignitor/Cable Assembly	105567-00	105567-00	2
5	Detector Cover	103689-00	103689-00	1
6	Wavy Washer	104165-00	104065-00	1
7	Flat Washer	104166-00	104166-00	1
8	O-ring (2-018) Viton		16013	1
9	Upper Detector Insulator	104155-00	104155-00	1
10	Collector, FID	104156-00	104156-00	1
11	Spacer	103770-00	103770-00	1
12	Jet, Plate Assembly	103773-00	103773-00	1
13	O-ring (2-003) Viton		14816	1
14	Base Insulator	104158-00	104158-00	1
15	O-ring (2-014) Viton		6646	1
16	Upper Detector Base	104159-00	104159-00	1
17	Screw 6-32 x 1/4" ph flat head screw ss		103198-00	4

Internal Sample Filter Replacement

Use the following procedure to replace the internal filter element and aluminum o-ring.

Equipment Required:

Wrench, 1-inch

Long Philips head screwdriver

Replacement filter element

Replacement aluminum gasket

Teflon pipe thread tape

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. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Use the Philips head screwdriver to loosen the eight thumb screws, if necessary, and remove the oven cover and allow the internal components to cool.

3. Using the 1-inch wrench, remove the filter assembly cap nut (see Figure 5–2).

Note This nut may be difficult to move. Be careful not to bend any of the 1/8-inch tubing attached to the filter assembly while undoing the cap nut. ▲

4. Remove the old filter element and gasket from the assembly base and gently dislodge the element from the base with a screwdriver if necessary.

5. Using a clean air supply or other clean compressed gas, blow any dust or particles out of the base.

6. Install the new filter element and gasket into the base.

Note Be sure to install the filter element with the open end of the cup facing down into the base and that it is seated flat. ▲

7. Wrap the filter housing threads with Teflon tape, then replace the cap nut and tighten with the wrench. If Teflon tape is not used, the cap nut may become difficult to remove.

8. Re-install the oven cover and the instrument cover.

General Electrical Testing

This section provides the equipment requirements and instructions for testing the instrument heating system and temperature sensors.

Equipment Required:

Electrical temperature gauge (type K thermocouple)

Multimeter

Philips screwdriver

Hex wrench set

⚠ **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. ▲

Use the following procedure to test the heating system.

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Disconnect J3, J4, and J5 located on the measurement interface board, noting their location in order to facilitate re-connection. Measure the heater resistance using the multimeter. Acceptable resistance readings are listed in the following schedule in Table 7–7.

Table 7–7. Acceptable Heater Resistance Readings

Description	Resistance Reading	Tolerance
Pump Heater (P/C)	280 ohm	±10 ohm
Detector Heater (DET)	140 ohm	±10 ohm
Filter Heater (FLT)	140 ohm	±10 ohm

3. If there is a short circuit to ground in the heater circuits on the measurement interface board, there will be continuity between any pin in any of the three connectors and ground. Test with the multimeter between ground and each pin. If the circuit shows anything other than open, contact the service center for further instructions.

Use the following procedure to test the temperature sensors.

4. Turn the instrument OFF, unplug the power cord, and remove the cover. Prior to removing any connectors, note their location in order to facilitate re-connection.

Note The instrument needs to cool completely (to ambient temperature) prior to testing the temperature sensors. ▲

5. **Flame Thermocouple**: Disconnect the flame thermocouple from the measurement interface board (J15). Connect the flame thermocouple to the electronic temperature gauge. The measurement value should be equivalent to the current ambient temperature ±5 °C.

6. **Filter Base Thermocouple**: Disconnect the filter thermocouple from the measurement interface board (J12). Connect the filter base thermocouple to the electronic temperature gauge. The measurement value should be equivalent to the current ambient temperature ±5 °C.

7. **Detector Base Thermocouple**: Disconnect the detector base thermocouple from the measurement interface board (J13). Connect the detector base thermocouple to the electronic temperature gauge. The measurement value should be equivalent to the current ambient temperature ±5 °C.

8. **Pump (PMP/COL) Thermocouple**: Disconnect the pump thermocouple from the measurement interface board (J14). Connect the pump thermocouple to the electronic temperature gauge. The measurement value should be equivalent to the current ambient temperature ±5 °C.

Adjusting Critical Gas Flows

This section provides the necessary procedural steps to adjust all critical gas flows, essential for proper instrument operation with either hydrogen fuel (H_2) or mixed fuel (H_2/He) supplies.

Equipment Required:

0-500 cc/min Flow meter, accurate to ±2.0%

WARNING Pressures are set at the factory and should not be arbitrarily changed. ▲

Note This adjustment should only be performed by an instrument service technician. ▲

Preliminary Set-Up

Perform the following preliminary set-up procedure before adjusting for hydrogen fuel (H_2) or adjusting for mixed fuel (H_2/He) fuel.

1. Before proceeding, ensure that the instrument is in "FLAME OUT" and the oven temperatures are at the prescribed set points and fully equilibrated.

2. Remove the instrument cover and disconnect the IGN/BIAS supply cable at J27 located on the measurement interface board.

3. Connect a source of clean dry air to the instrument's air bulkhead on the rear panel and set the supply pressure to 60 psi.

4. Connect a flow meter to the FID exhaust located on the rear panel.

5. Make sure the instrument is in Service Mode. Refer to "Accessing the Service Mode" in this chapter, if necessary.

Adjusting For Hydrogen Fuel

Use the following procedure to adjust the gas flows for hydrogen fuel. This includes:

● Set the Fuel Pressure

● Set the Sample Pressure

● Set the Combustion Air Pressure

Set the Fuel Pressure

1. Connect hydrogen and air to the instrument's fuel bulkhead fitting and air bulkhead fitting, respectively, on the rear panel and set both supply pressures to 60 psi.

2. Turn off any calibration gas supplies entering the instrument and relieve the pressure. Make sure the manual air pressure regulator that is mounted to the oven is set to approximately 20 psi.

3. From the Main Menu, choose Instrument Controls > Select Fuel > **Hydrogen**.

4. From the Main Menu, choose Service > **Set Pressure and Flow**. For more information, see "Set Pressure and Flow" in Chapter 3, Operation.

5. From the Set Pressure and Flow screen, choose **H2 Fuel Run**. Set the pressure to create a fuel flow of **25 cc/min** and save. Repeat this adjustment, if necessary, until the correct flow rate is verified from the flow meter attached to the FID exhaust port.

6. Return to the Set Pressure and Flow screen, choose **H2 Fuel Ignite**. Set the pressure to create a fuel flow of **30 cc/min** and save. Repeat this adjustment, if necessary, until the correct flow rate is verified from the flow meter attached to the FID exhaust port. Record the stored pressure value.

Set the Sample Pressure

1. Return to the Set Pressure and Flow screen, choose **Sample Run**. Set the pressure to create a sample air flow of **15 cc/min** and save. Repeat this adjustment, if necessary, until the correct flow rate is verified from the flow meter attached to the FID exhaust port.

2. Return to the Set Pressure and Flow screen, choose **Sample Ignite**. Set the pressure to create a sample air flow of **20 cc/min** and save. Repeat this adjustment, if necessary, until the correct flow rate is verified from the flow meter attached to the FID exhaust port. Record the stored pressure value.

Set the Combustion Air Pressure

1. Return to the Set Pressure and Flow screen, choose **Air Run**. Set the pressure to create an air flow of **180 cc/min** and save. Repeat this adjustment, if necessary, until the correct flow rate is verified from the flow meter attached to the FID exhaust port.

2. Return to the Set Pressure and Flow screen, choose **Air Ignite**. Set the pressure to create an air flow of **175 cc/min** and save. Repeat this adjustment, if necessary, until the correct flow rate is verified from the flow meter attached to the FID exhaust port. Record the stored pressure value.

3. Re-connect the IGN/BIAS supply cable at J27 located on the measurement interface board.

4. Remove the flow meter from the FID exhaust port.

5. Proceed to the following section "Optimizing the Gas Flows".

Adjusting For Mixed Fuel (H$_2$/He)

Use the following procedure to adjust the gas flows for mixed fuel (H$_2$/He). This includes:

● Set the Fuel Pressure

● Set the Sample Pressure

● Set the Combustion Air Pressure

Set the Fuel Pressure

1. Connect mixed fuel (H$_2$/He) and air to the instrument's fuel bulkhead fitting and air bulkhead fitting, respectively, on the rear panel and set the supply pressures to 60 psi.

2. Turn off any calibration gas supplies entering the instrument and relieve the pressure. Make sure the manual air pressure regulator that is mounted to the oven is set to approximately 20 psi.

3. From the Main Menu, choose Instrument Controls > Select Fuel > **Mixed**.

4. From the Main Menu, choose Service > **Set Pressure and Flow**. For more information, see "Set Pressure and Flow" in Chapter 3, Operation.

5. From the Main Menu, choose Instrument Controls > Gas Pressures > **Mixed Fuel Run**. Set the pressure to create a fuel flow of **125 cc/min** and save. Repeat this adjustment, if necessary, until the correct flow rate is verified from the flow meter attached to the FID exhaust port.

6. Return to the Set Pressure and Flow screen, choose **Mixed Fuel Ignite**. Set the pressure to create a fuel flow of **110 cc/min** and save. Repeat this adjustment, if necessary, until the correct flow rate is verified from the flow meter attached to the FID exhaust port. Record the stored pressure value.

Set the Sample Pressure.

1. Return to the Set Pressure and Flow screen, choose **Sample Run**. Set the pressure to create a sample air flow of **15 cc/min** and save. Repeat this adjustment, if necessary, until the correct flow rate is verified from the flow meter attached to the FID exhaust port.

2. Return to the Set Pressure and Flow screen, choose **Sample Ignite**. Set the pressure equal to the setting entered in the Sample Run screen from the previous step. Record the stored pressure value.

Set the Combustion Air Pressure.

1. Return to the Set Pressure and Flow sceen, choose **Air Run**. Set the pressure to create an air flow of **230 cc/min** and save. Repeat this adjustment, if necessary, until the correct flow rate is verified from the flow meter attached to the FID exhaust port.

2. Return to the Set Pressure and Flow screen, choose **Air Ignite**. Set the pressure to create an air flow of **225 cc/min** and save. Repeat this adjustment, if necessary, until the correct flow rate is verified from the flow meter attached to the FID exhaust port. Record the stored pressure value.

3. Re-connect the IGN/BIAS supply cable at J27 located on the measurement interface board.

4. Remove the flow meter from the FID exhaust port.

5. Proceed to the following section "Optimizing the Gas Flows".

Optimizing the Gas Flows

Once all input pressures are at their respective set points, use the following procedure to optimize the gas flows.

1. From the Main Menu, choose Diagnostics > **FID Status.** Press (➡) to initiate the ignition sequence. The ignition sequence will make many attempts to light the FID before displaying FLAME OUT. If at any time during the ignition sequence the display status bar reads FLAME LIT, the ignition was successful, go to step 2. If ignition fails, verify that all gas flows are still at the levels set in the previous steps. If so, refer to Chapter 6, Troublshooting.

2. Once the instrument has been successfully lit and the detector has thermally stabilized, introduce a known concentration of span gas into the sample port at atmospheric pressure. A suggested concentration would be 100 ppm methane in air.

3. From the Main Menu, choose Instrument Controls > Gas Pressures > and the appropriate (H_2 or MIXED) **Fuel Run**. At the Set Pressure screen, increase the pressure by 0.5 psi increments beginning from the initial stored value. Observe the THC concentration reading at the top of the front panel display. Notice an increase in the reported concentration level which directly corresponds to an increase in signal strength. As the fuel pressure is increased, the concentration readings will increase along a curve to reach a peak value then begin to decay toward zero with any additional increases in pressure. The fuel pressure will be considered optimized when the concentration reading reaches the peak level. Adjust the pressure up through the peak value and then reduce back to the peak value. Record the peak pressure value and go to step 4.

4. From the Main Menu, choose Instrument Controls > Gas Pressures > **Air Run**. At the Set Pressure screen, increase the pressure by 0.5 psi increments beginning from the initial stored value. Observe the THC concentration reading at the top of the front panel display. Notice an increase in the reported concentration level which directly corresponds

to an increase in signal strength. As the air pressure is increased, the concentration readings will increase along a curve to reach a plateau where any additional increase in pressure will result in a negligible increase in concentration. The air pressure pressure is optimized when this plateau is reached.

5. Re-calibrate the instrument prior to recording any permanent data. Once the calibration is complete, there should be no need to repeat this procedure. All new pressure settings should be recorded for future reference.

With the setting of the air and fuel complete, all of the instrument gas flows are considered optimized. If any changes are made to the sample flow, the fuel and air setting may need to be re-optimized to maintain the correct fuel to sample ratio.

Fuse Replacement

Use the following procedure to replace the fuse.

Equipment Required:

Replacement fuses (refer to the "Replacement Parts List" in this chapter).

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 (Optional) Replacement

Use the following procedure to replace the optional 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. ▲

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.
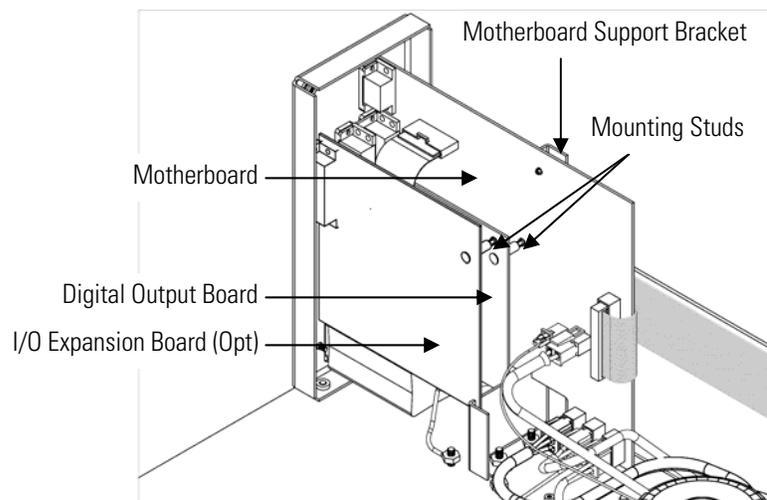
Figure 7–20. Replacing the I/O Expansion Board (Optional)
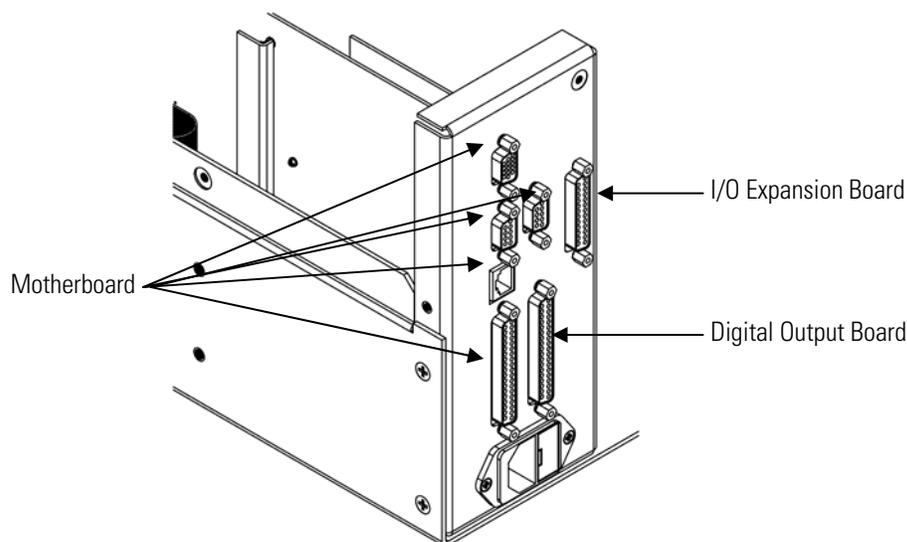
Figure 7–21. Rear Panel Board Connectors

Digital Output Board Replacement

Use the following procedure to replace the digital output board (Figure 7–20).

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 grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the 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 (Optional) Replacement" procedure in this chapter.

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 (Figure 7–21).

5. Pop the digital output board off of the mounting studs and remove the board.

6. To install the digital output board, follow the previous steps in reverse.

Motherboard Replacement

Use the following procedure to replace the motherboard (Figure 7–20).

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 grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the 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 (Optional) 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 re-connection.

5. Using the nut driver, remove the eight standoffs securing the board to the rear panel (Figure 7–21).

6. Pop the motherboard off of the support bracket, and remove the motherboard.

7. To install the motherboard, follow the previous steps in reverse.

8. Calibrate the analog voltage outputs as defined earlier 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

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. ▲

1. Lower the partition panel, then proceed to the next step below. Refer to "Removing the Measurement Case Assembly and Lowering the Partition Panel" in this chapter.

2. Unplug all connectors from the measurement interface board. Note the locations of the connectors to facilitate re-connection.

3. Unscrew the two screws at the top of the measurement interface board. Pop the measurement interface board off of the two bottom mounting studs and remove the board.

4. To install the measurement interface board, follow the previous steps in reverse.

5. Re-install the measurement case assembly.

6. Calibrate the input board and the ambient temperature sensor as defined earlier in this chapter, and re-calibrate the unit with zero air and span gas.

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 grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the 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 the board off of 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 the previous steps in reverse.
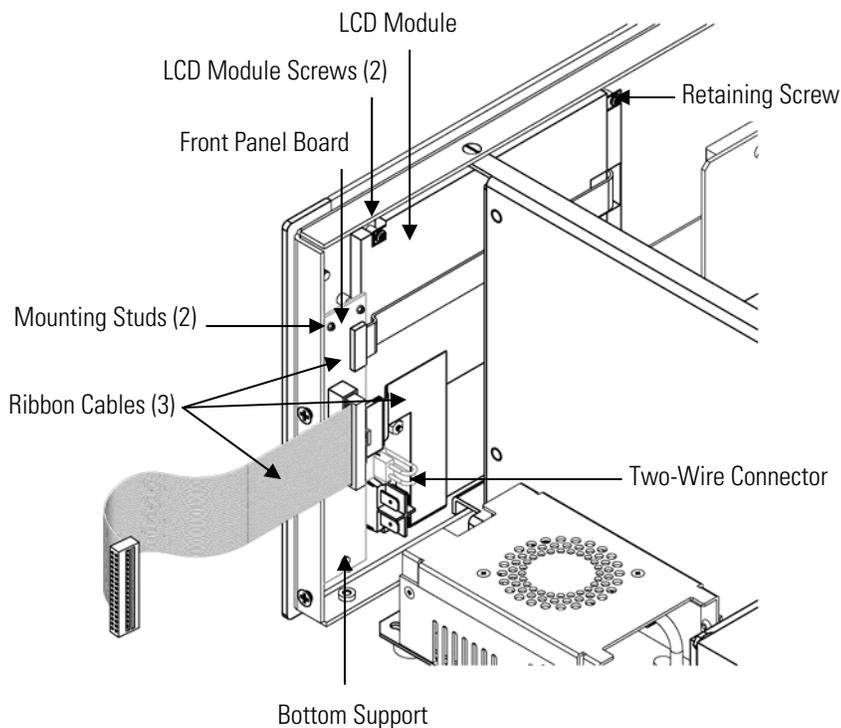
Figure 7–23. Replacing the Front Panel Board and the LCD Module

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 grounded antistatic wrist strap must be worn while handling any internal component. ▲

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. ▲

1. Turn the 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 the 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 10" C-Link command to set screen constrast 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, Thermo Fisher Scientific has service available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information.

866-282-0430 Toll Free

508-520-0430 International

Chapter 8
System Description

This chapter 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 and functions as follows:

- "Hardware" on page 8-1
- "Firmware" on page 8-5
- "Electronics" on page 8-6
- "I/O Components" on page 8-9

Hardware

Model 51*i* hardware components (Figure 8-1) include:

- Flame Ionization Detector (FID)
- Sample Filter
- Internal Pump
- Sample Pressure Regulator
- Electronic Pressure Controllers
- Fuel Shutoff Solenoid
- Zero/Span Solenoids
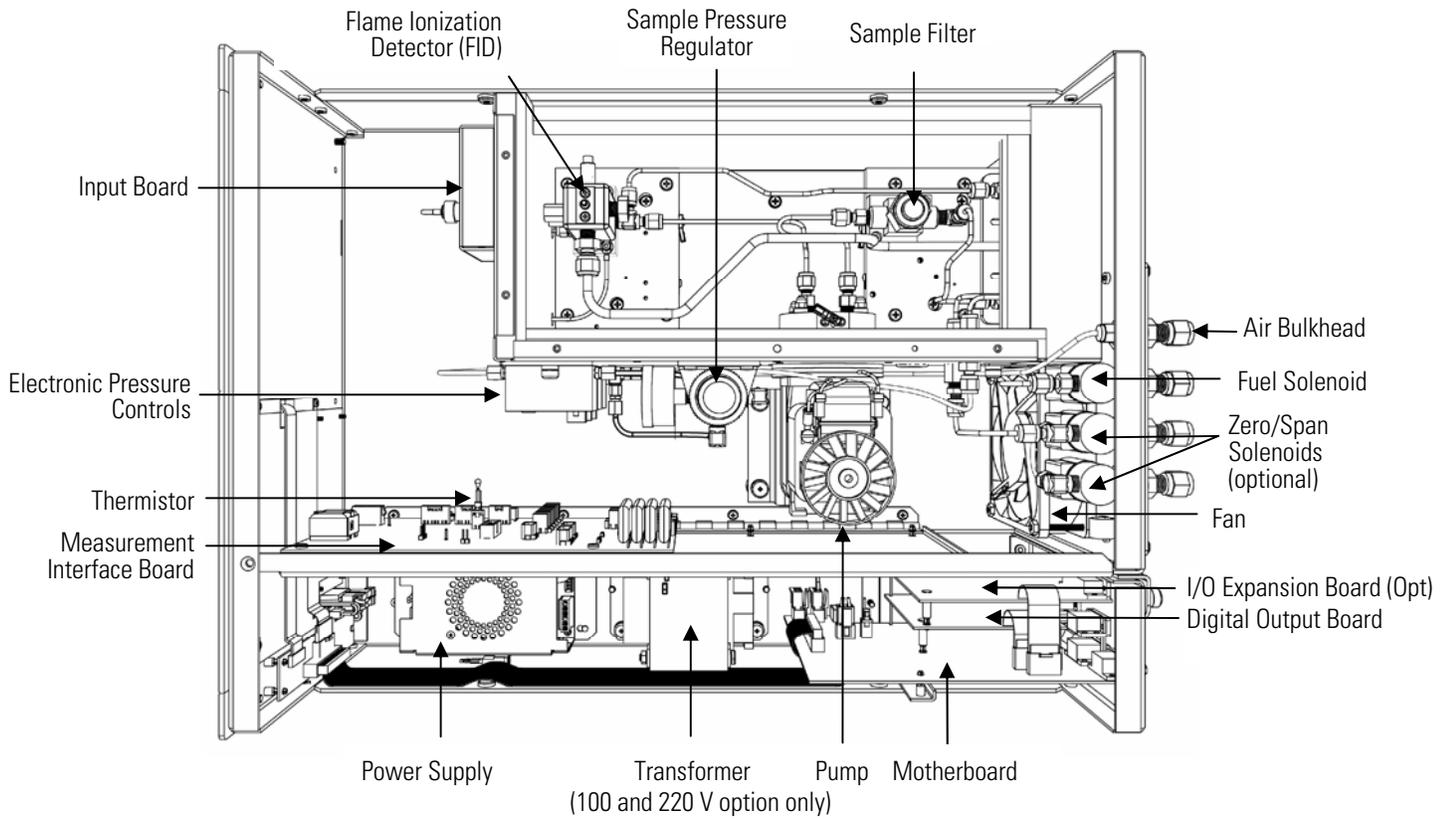
Figure 8–1. Hardware Components (High Temperature)
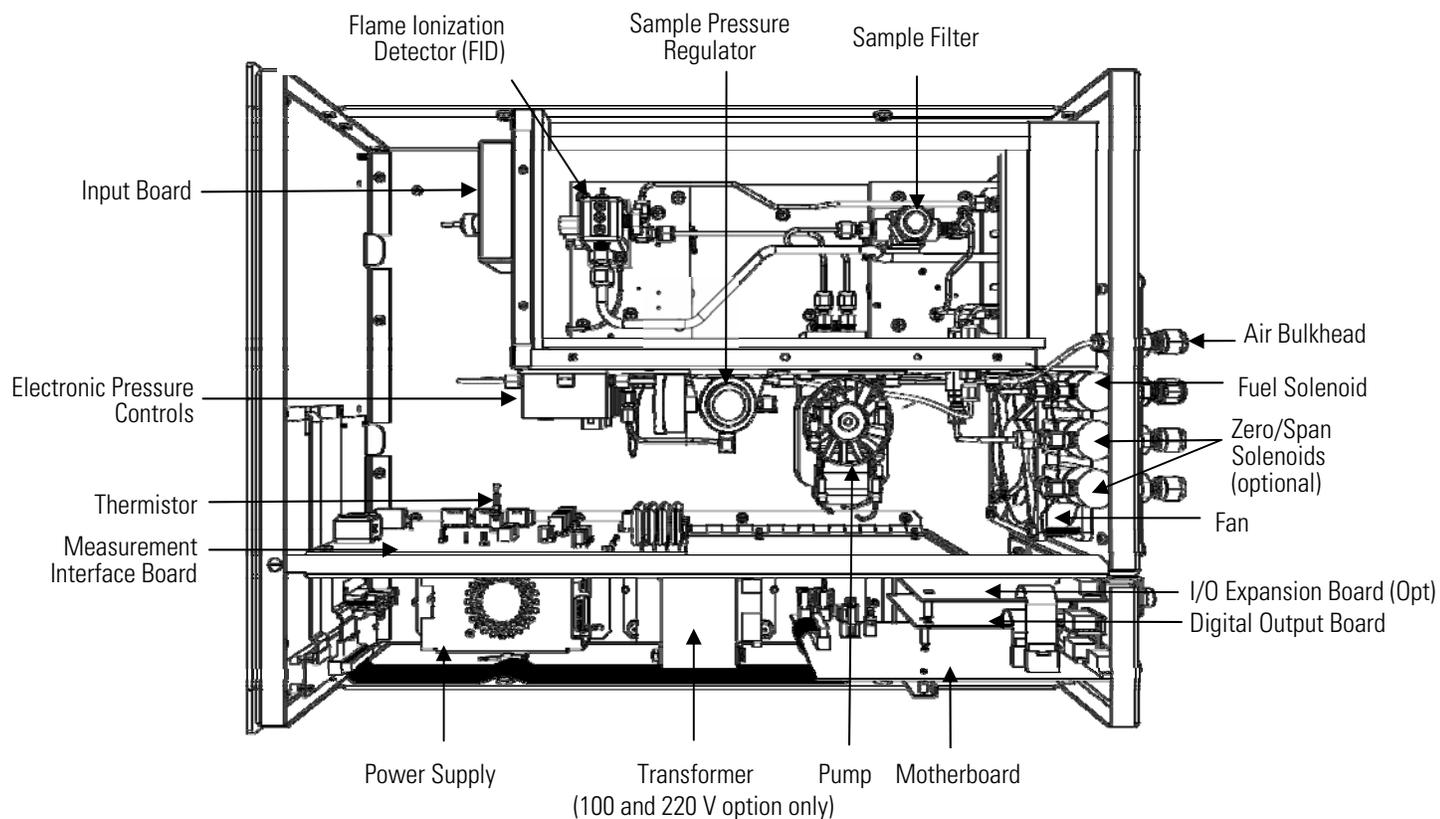
Figure 8–2. Hardware Components (Low Temperature)

Flame Ionization Detector (FID)

The Flame Ionization Detector (FID) quantifies the hydrocarbon concentration by measuring the current that flows between two electrodes when organic compounds are burned in a hydrogen/air flame.

Sample Filter

The in-line sample filter is located just upstream of the pump and protects the pump and flow restrictors from particulate matter in the sample stream. The filter assembly contains a cup-shaped sintered metal element that can be cleaned or replaced by the user. The standard element is rated for removal of particulate down to 2 microns. Additional external filtering is strongly recommended for applications that involve high levels of fine particulate, such as monitoring of cement kilns.

Internal Pump

The internal pump draws sample into the analyzer and into the oven through the sample inlet port. The sample is delivered to the FID under positive pressure. The internal pump has a nominal flow rate of approximately 0.8 liters per minute and has adequate head pressure to draw sample through 100 feet of 1/4-inch OD sample line. The pump head is heated in the HT version of the analyzer.

Sample Pressure Regulator

The sample pressure regulator is used to step down the incoming pressure of the combustion air so that the air source can be used to feed the sample back-pressure controller. The sample back-pressure controller is the electronic pressure controller that is used to stabilize the sample pressure at the FID inlet. The sample pressure regulator is adjusted at the factory to provide 18 to 22 psi inlet pressure to the electronic controller.

Electronic Pressure Controllers

The analyzer utilizes electronic pressure controllers and fixed flow restrictors to control the flow rate of fuel, combustion air and sample going to the FID. The electronic pressure controllers utilize pressure sensors and temperature compensated electronic proportional valves in a closed loop control system to provide a fixed gas pressure to flow restrictors located in the base of the FID.

The pressure controller assembly consists of three closed loop pressure controllers, (one) 0-15 psi, and (two) 0-50 psi controllers, pressurizing thermally stable restrictors to provide smooth consistent gas flow to the FID. Each controller is individually adjustable from the front panel, allowing the user to set the pressure control values and receive readings corresponding to the actual regulated output pressures. The overall pressure control scheme used by the analyzer allows the controllers to regulate both

the ignition and running pressure settings. These pressure settings provide separate discrete control of all gas flow rates used in both of the FID's operating modes (ignite and run).

Fuel Shutoff Solenoid

The fuel solenoid is a safety valve that is used to shut off the fuel supply whenever the FID flame is not lit. The valve is a two-way, normally closed, 24-volt DC solenoid.

Zero/Span Solenoids

The zero and span solenoid valves can be used to control the flow of zero air and span gas during calibration or calibration checks. See Chapter 4, "Calibration", for a complete description of the zero and span plumbing and operation.

Firmware

The 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 and heater control. 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 communication 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 accumulated counts representing the THC concentrations are accumulated and reported for the user-specified averaging time. If this averaging time is greater than ten seconds, the measurement is still reported every 10 seconds. The one-second average of the other analog inputs, such as oven temperature, 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 THC concentrations. The display is updated every 1-10 seconds, depending on the averaging time.

The analog output ranges are user selectable via the 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 full-scale 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 specified operating ranges of 100 to 240 VAC.

The internal pump and heaters all operate on 110 VAC. An optional, internal transformer is required if operating on the 210-250 VAC or 90-110 VAC ranges.

An on/off switch controls all power to the analyzer and is accessible on the front panel.

Motherboard

The motherboard contains the main processor, power supplies, and a sub-processor, and serves as the communication hub for the instrument. The motherboard receives operator inputs from the front panel function keys and/or over I/O connections on the rear panel. The motherboard 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 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 Accessory (to external converter)

● 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:

● Function Key Panel and Display

● Measurement Interface Board

● I/O Expansion Board

● 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

● 24 V and 120 VAC power supply inputs

● Solenoid outputs

● 120 VAC output for the pump and fan

● 120 VAC outputs for the oven heaters

● Pressure controller communication links

● Thermocouple sensor inputs

● Ambient temperature sensor

● FID high voltage bias supply

● Measurement input board

Input Board

The input board is located in an aluminum housing mounted on the front of the detector oven. The board receives the FID signal through a BNC cable that runs from the FID, and scales it by a factor of approximately 1, 10, or 100. The board includes a high impedance input with a multistage amplifier and a voltage to frequency converter that is used to digitize the signal. The digitized signal is sent to the interface board through a ribbon cable, which also carries power for the input board and the control signals that are used to set the amplifier gain.

The input board includes a test signal that can be activated under firmware control. The test signal is injected at the first stage of the input board in parallel with the FID input. This allows the input board and the connection to the processor system to be tested without using the FID.

Digital Output Board

The digital output board connects to the motherboard and provides 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.

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 0 to 10 VDC. Six current outputs are provided with a selectable operating range of either 0 to 20 mA or 4 to 20 mA.

Front Panel Connector Board

The front panel connector board interfaces between the motherboard and the 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 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:

● 0-100 mV

● 0-1 V

● 0-5 V

● 0-10 V

The user can calibrate each analog output zero and span point through the firmware. At least 5% of full-scale over and under range are also supported, but may be overridden in the 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:

● 0-20 mA

● 4-20 mA

The user can calibrate each analog output zero and span point through the firmware. At least 5% of full-scale over and under range are also supported, but may be overridden in the 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)

The optional I/O expansion board includes eight analog voltage inputs. These inputs are used to gather measurement data from third-party devices such as meteorological equipment. 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 (0-10.5 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 @ 200 VDC.

The power fail relay is Form C (both normally opened and normally closed contacts). All other relays are Form A (normally opened 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 opened or closed.

Digital Inputs

Sixteen digital inputs are available, which may be programmed to signal instrument modes and special conditions including:

● Zero Mode (opens zero solenoid)

● Span Mode (opens span solenoid)

● Set Background (sets zero)

● Cal to span (sets span coefficient)

● Analog outputs to zero

● Analog outputs to full-scale

● Set Idle Mode

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 115200 baud. The user can also set the data bits, parity, and stop bits. The following protocols are supported:

● C-Link

● Modbus Slave

● Geysitech (Bayern-Hessen)

● Streaming Data

The Streaming Data protocol transmits user-selected measurement data via the serial port in real-time for capture by a serial printer, datalogger, 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 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 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 10Mbs 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).

Any serial port protocols may be accessed over Ethernet in addition to the serial port. Up to three simultaneous connections are allowed per protocol.

External Accessory Connector

The external accessory connector is not used in the Model 51*i* analyzer.

This port is used in other models 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 51*i* is available with the following options:

- "Internal Zero/Span Valves" on page 9-1
- "I/O Expansion Board Assembly" on page 9-1
- "25 Pin Terminal Board Assembly" on page 9-1
- "Terminal Block and Cable Kits" on page 9-1
- "Cables" on page 9-2
- "Mounting Options" on page 9-3

Internal Zero/Span Valves

With the zero/span assembly option, a source of span gas is connected to the SPAN port and a source of zero air is connected to the ZERO port. Zero and span gas should be supplied at approximately 5 to 10 psi. (See Chapter 4, "Calibration" for details.)

For more information, refer to the "Installation" chapter, the "Calibration" chapter, and the "Operation" chapter.

I/O Expansion Board Assembly

The I/O expansion board provides six analog current output channels (0-20 mA or 4-20 mA) and eight analog voltage inputs (0-10 V). 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. Refer to "Terminal Board PCB Assemblies" in the "Installation" chapter for information on attaching the cable to the connector board. For associated part numbers, refer to 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	PINK/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
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	Mounted in an EIA-style rack, includes mounting slides and front panel EIA-rack mounting handles.
Retrofit rack	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.
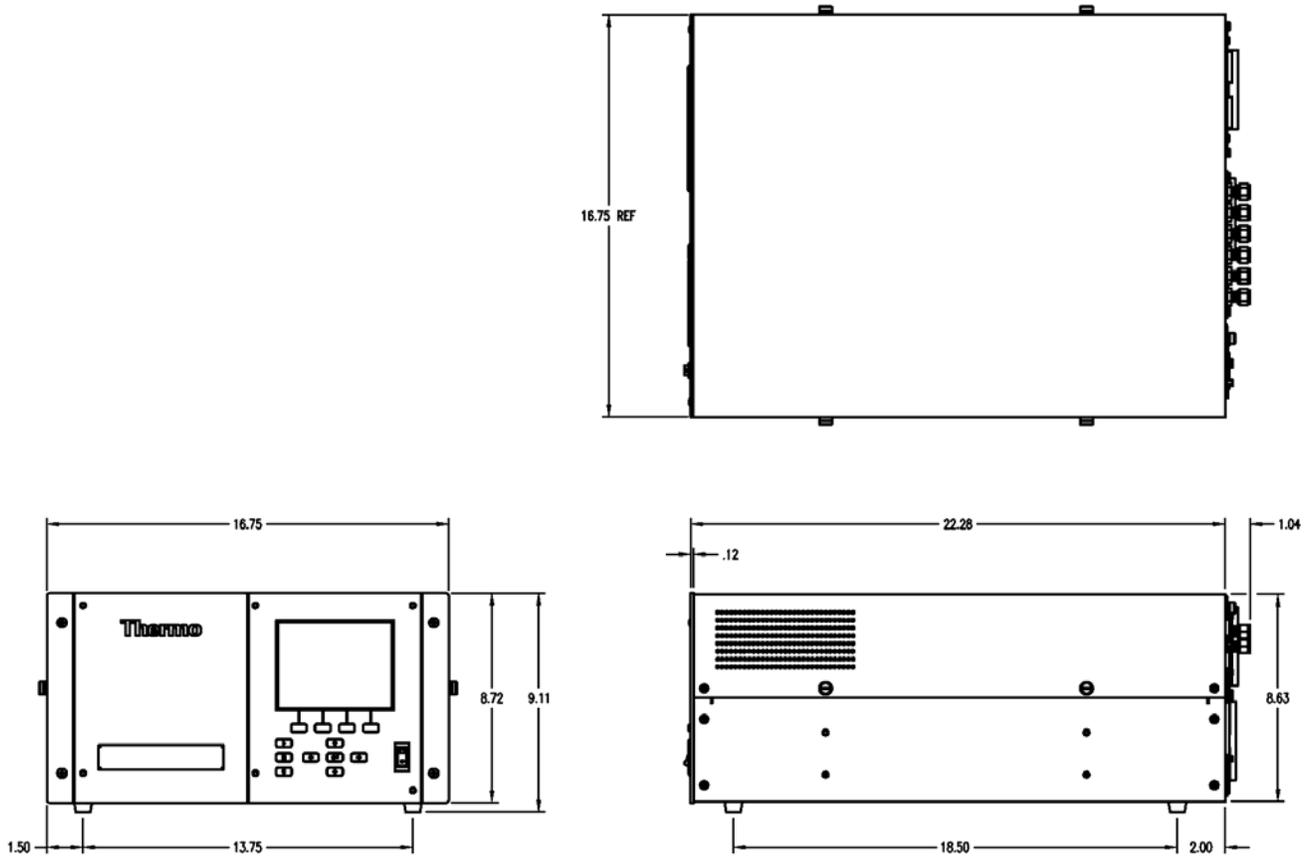
Figure 9–1. Bench Mounting
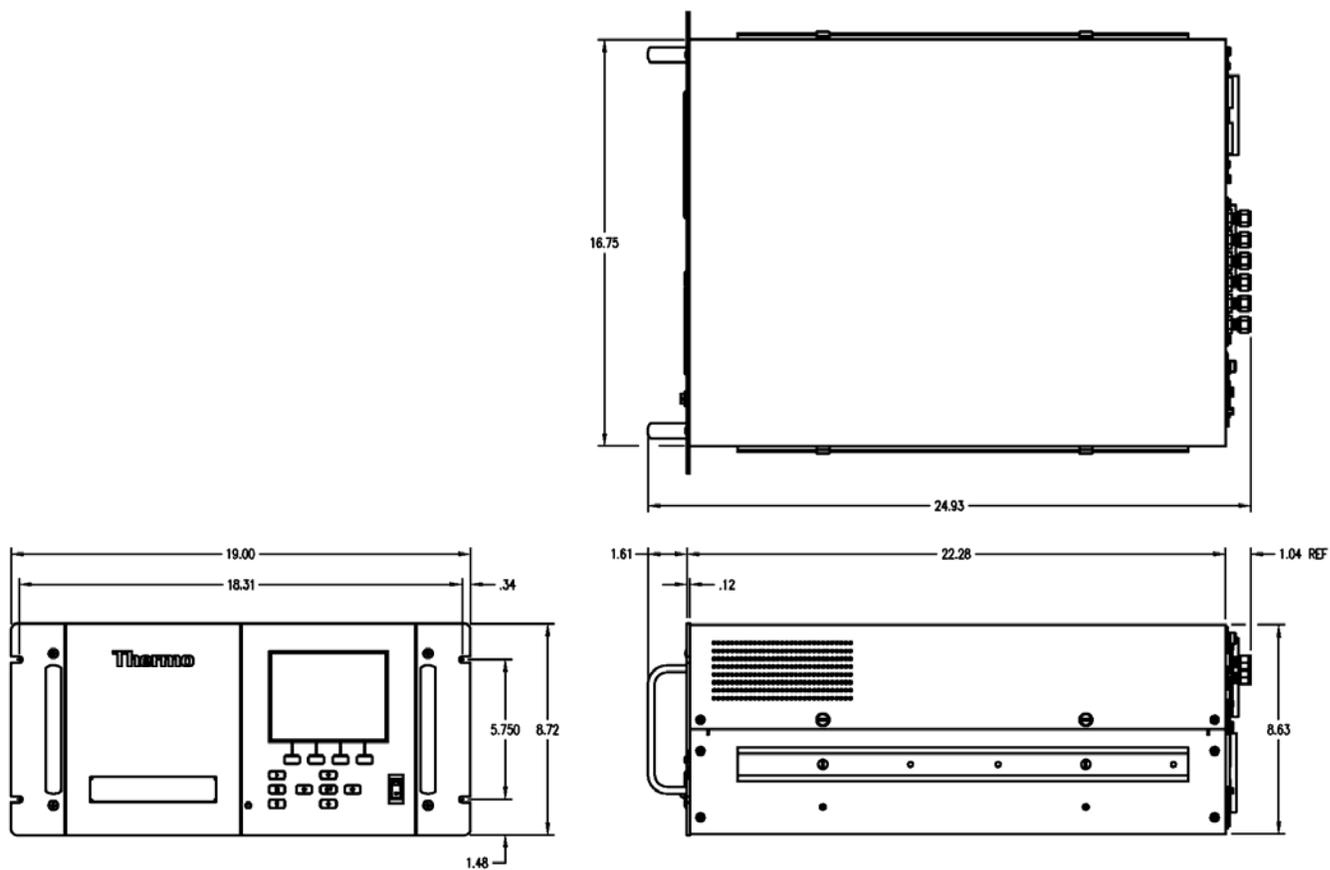
Figure 9–2. EIA Rack Mounting
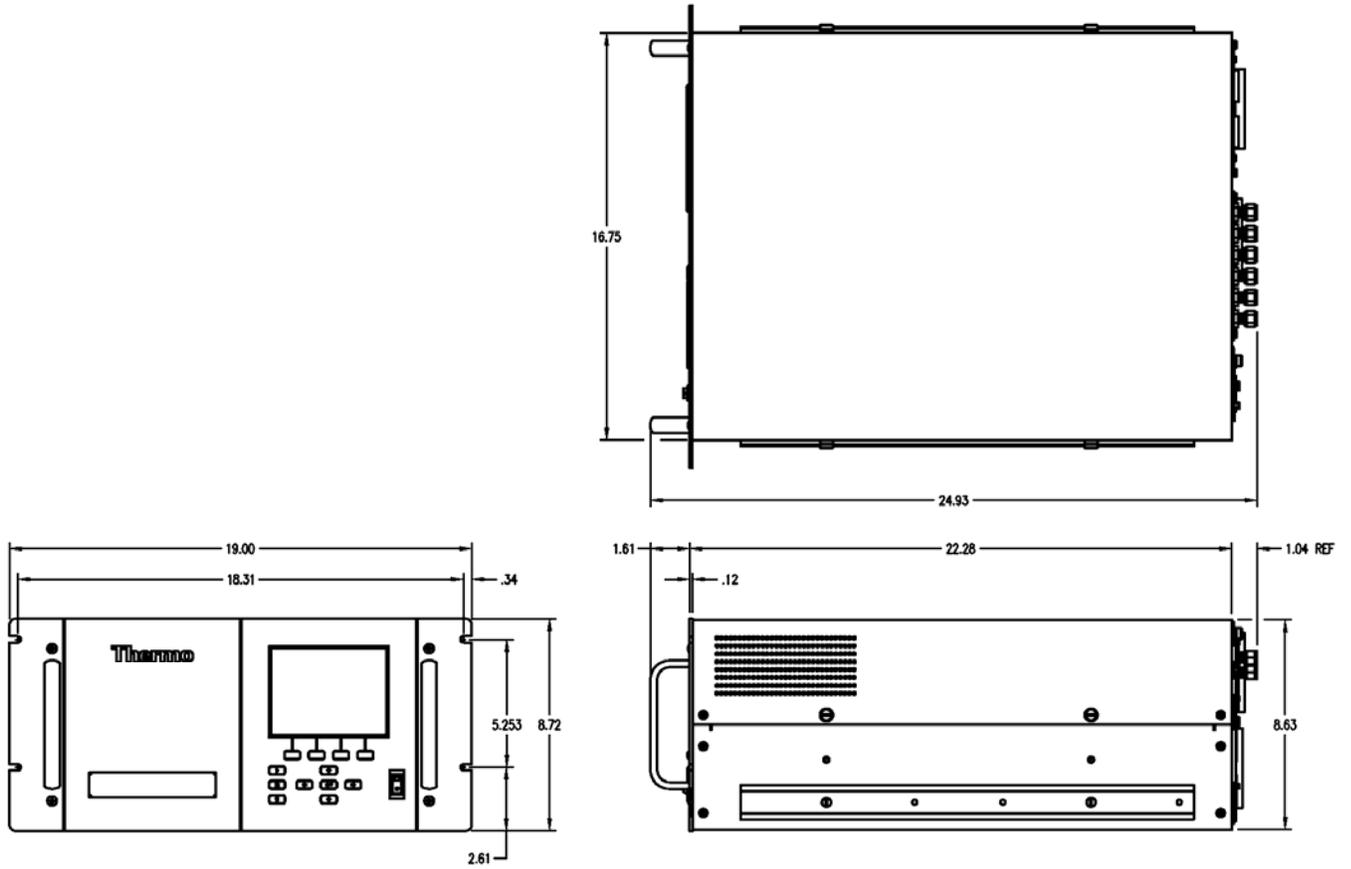
Figure 9–3. Retrofit Rack Mounting
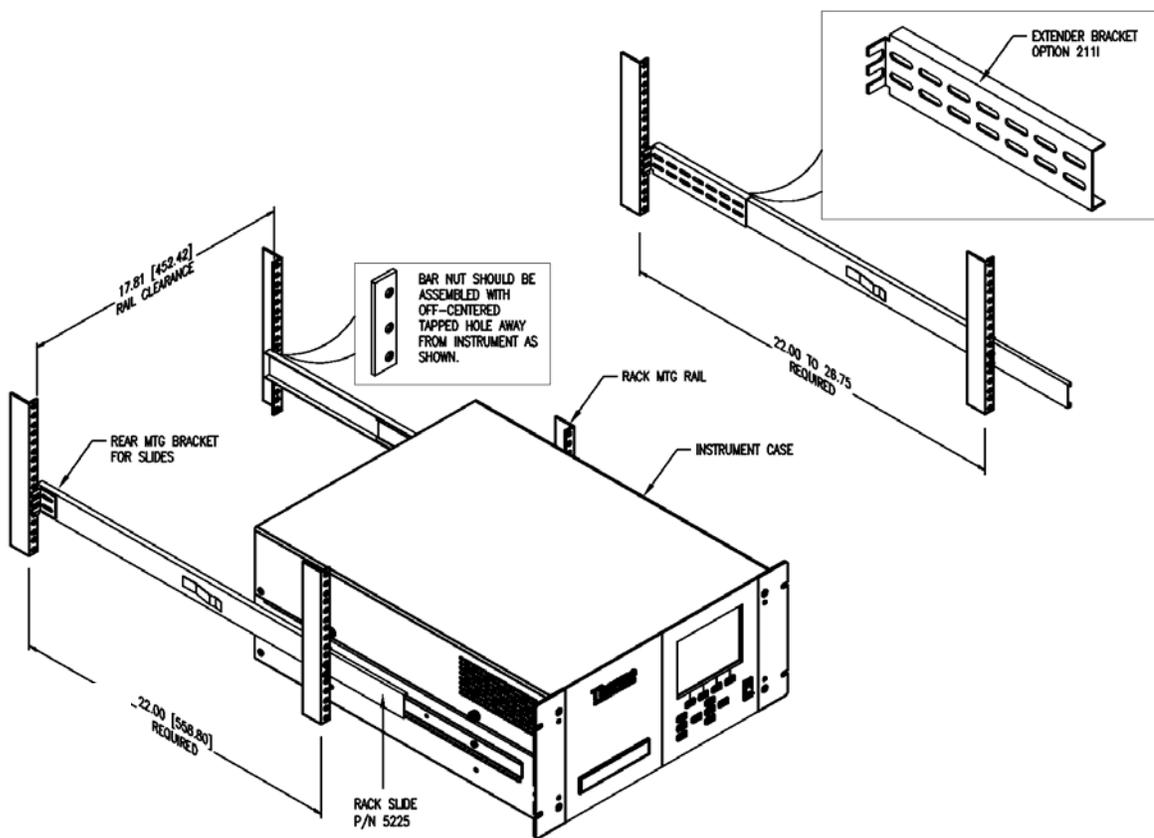
Figure 9–4. Rack Mount Option Assembly

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 51*i* 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 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

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 to the instrument's identification number plus 128.

For example, if the instrument ID is set to 51, then each command must begin with the ACSII character code 179 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 Chapter 3, "Operation".

Commands

The analyzer must be in the remote mode in order to change instrument parameters remotely. However, the command "set mode remote" can be sent to the analyzer to put it in the remote mode. Report commands (commands that don't begin with "set") can be issued either in the remote or local mode. For information on changing modes, see Chapter 3, "Operation".

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 179 decimal, which directs the command to the Model 51*i*, and is terminated by a carriage return "CR" (ASCII character code 13 decimal).

<ASCII 179>	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 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 "set unit ppm" instead of the correct command "set gas unit ppm."

```
Send:        set unit ppm
Receive:     set unit ppm 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 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.

Commands List

Table B–2 lists the 51*i* C-Link protocol commands. The interface will respond to the command strings outlined below.

Table B–2. C-Link Protocol Commands

Command	Description	Page
addr dns	Reports/sets domain name server address for Ethernet port	B-37
addr gw	Reports/sets default gateway address for Ethernet port	B-37
addr ip	Reports/sets IP address for Ethernet port	B-38
addr nm	Reports/sets netmask address for Ethernet port	B-38
addr ntp	Reports/sets IP address for network time protocol server	B-38
air control pressure	Reports/sets current air control pressure	B-32
air pressure	Reports current air pressure	B-10
alarm bias voltage max	Reports/sets bias voltage alarm maximum value	B-11
alarm bias voltage min	Reports/sets bias voltage alarm minimum value	B-11
alarm conc max	Reports/sets current THC concentration alarm maximum value	B-12
alarm conc min	Reports/sets current THC concentration alarm minimum value	B-12

Command	Description	Page
alarm detector temp max	Reports/sets detector temperature alarm maximum value	B-12
alarm detector temp min	Reports/sets detector temperature alarm minimum value	B-12
alarm filter temp max	Reports/sets filter temperature alarm maximum value	B-13
alarm filter temp min	Reports/sets filter temperature alarm minimum value	B-13
alarm flame temp max	Reports/sets flame temperature alarm maximum value	B-13
alarm flame temp min	Reports/sets flame temperature alarm minimum value	B-13
alarm internal temp max	Reports/sets internal temperature alarm maximum value	B-13
alarm internal temp min	Reports/sets internal temperature alarm minimum value	B-13
alarm level max	Reports/sets current THC concentration alarm maximum value	B-12
alarm pressure air max	Reports/sets air pressure alarm maximum value	B-14
alarm pressure air min	Reports/sets air pressure alarm minimum value	B-14
alarm pressure fuel max	Reports/sets fuel pressure alarm maximum value	B-14
alarm pressure fuel min	Reports/sets fuel pressure alarm minimum value	B-14
alarm pressure sample max	Reports/sets sample pressure alarm maximum value	B-15
alarm pressure sample min	Reports/sets sample pressure alarm minimum value	B-15
alarm pump temp max	Reports/sets pump temperature alarm maximum value	B-15
alarm pump temp min	Reports/sets pump temperature alarm minimum value	B-15
alarm signal max	Reports/sets signal strength alarm maximum value	B-16
alarm signal min	Reports/sets signal strength alarm minimum value	B-16
alarm span noise max	Reports/sets span noise alarm maximum value	B-16
alarm span noise min	Reports/sets span noise alarm minimum value	B-16

Command	Description	Page
alarm trig conc	Reports/sets current concentration alarm trigger sense	B-16
alarm zero noise max	Reports/sets zero noise alarm maximum value	B-17
alarm zero noise min	Reports/sets zero noise alarm minimum value	B-17
allow mode cmd	Reports/sets whether "set mode" locks instrument front panel	B-41
analog iout range	Reports/sets analog current output range per channel	B-44
analog vin	Retrieves analog voltage input data per channel	B-45
analog vout range	Reports/sets analog voltage output range per channel	B-45
avg time	Reports/sets averaging time	B-9
avg value	Reports current THC average concentration	B-11
base temp	Reports temperature at the detector base	B-10
baud	Reports/sets current baud rate	B-39
bias voltage	Reports current bias supply voltage	B-17
cal thc bkg	Sets THC background	B-27
cal thc coef	Sets THC coefficient	B-27
calibrate	Sets THC coefficient	B-27
clr lrecs	Clears away only lrecs that have been saved	B-18
clr records	Clears away all logging records that have been saved	B-18
clr srecs	Clears away only srecs that have been saved	B-18
contrast	Reports/sets current screen contrast	B-34
copy lrec to sp	Sets/copies current lrec selection into the scratch pad	B-25
copy sp to lrec	Sets/copies current selections in scratch pad into lrec list	B-24
copy sp to srec	Sets/copies current selections in scratch pad into srec list	B-24
copy sp to stream	Sets/copies current selections in scratch pad into stream list	B-24
copy srec to sp	Sets/copies current srec selection into the scratch pad	B-25
copy stream to sp	Sets/copies current streaming data selection into the scratch pad	B-25
custom	Reports/sets defined custom range concentration	B-30
data treatment lrec	Reports/sets data treatment for concentration values in lrecs	B-19
data treatment srec	Reports/sets data treatment for concentration values in srecs	B-19
date	Reports/sets current date	B-35
default params	Sets parameters to default values	B-35

Command	Description	Page
dhcp	Reports/sets state of use of Dynamic Host Configuration Protocol (DHCP)	B-39
diag volt iob	Reports diagnostic voltage levels for I/O expansion board	B-18
diag volt mb	Reports diagnostic voltage levels for motherboard	B-17
diag volt mib	Reports diagnostic voltage levels for measurement interface board	B-18
dig in	Reports status of the digital inputs	B-45
din	Reports/sets digital input channel and active state	B-46
display mode	Reports/sets current display mode	B-31
do (down)	Simulates pressing down pushbutton	B-28
dout	Reports/sets digital output channel and active state	B-46
dtoa	Reports outputs of the digital to analog converters per channel	B-46
en (enter)	Simulates pressing enter pushbutton	B-28
er	Returns a brief description of the main operating conditions in the format specified in the commands	B-20
erec	Returns a snapshot of the main operating conditions (measurements and status) in the specified format	B-20
erec format	Reports/sets erec format	B-22
erec layout	Reports current layout of erec data	B-23
filter temp	Reports temperature at the sample filter	B-10
flags	Reports current active measurement status flags in plain ASCII text	B-18
flame temp	Reports FID flame temperature	B-10
flow pressure	Reports current sample flow pressure	B-10
format	Reports/sets current reply termination format	B-40
frequency	Reports raw FID signal	B-11
fuel control pressure	Reports/sets current fuel control pressure	B-33
fuel pressure	Reports current fuel pressure	B-10
fuel type	Reports/sets current fuel type	B-35
gas mode	Reports current mode of sample, zero, or span	B-31
gas unit	Reports/sets current gas units	B-32
he (help)	Simulates pressing help pushbutton	B-28
high value	Reports current high THC concentration	B-11
host name	Reports/sets host name string	B-40

Command	Description	Page
idle	Reports/sets instrument in idle mode	B-36
ignite	Sets to attempt to light the FID flame	B-36
instr name	Reports instrument name	B-40
instrument id	Reports/sets instrument id	B-41
internal temp	Reports current internal instrument temperature	B-11
isc (iscreen)	Retrieves framebuffer data used for the display	B-29
layout ack	Disables stale layout/layout changed indicator ('*')	B-43
le (left)	Simulates pressing left pushbutton	B-28
list din	Lists current selection for digital inputs	B-19
list dout	Lists current selection for digital outputs	B-19
list lrec	Lists current selection lrec logging data	B-19
list sp	Lists current selection in the scratchpad list	B-19
list srec	Lists current selection srec logging data	B-19
list stream	Lists current selection streaming data output	B-19
list var aout	Reports list of analog output, index numbers, and variables	B-47
list var din	Reports list of digital input, index numbers, and variables	B-47
list var dout	Reports list of digital output, index numbers, and variables	B-47
low value	Reports current low THC concentration	B-11
lr	Reports the last lrec stored	B-20
lrec	Reports maximum number of lrecs	B-21
lrec format	Reports/sets output format for lrecs (ASCII or binary)	B-22
lrec layout	Reports current layout of lrec data	B-23
lrec mem size	Reports maximum number of lrecs that can be stored	B-23
lrec per	Reports/sets lrec logging period	B-23
malloc lrec	Reports/sets memory allocation for lrecs	B-24
malloc srec	Reports/sets memory allocation for srecs	B-24
me (menu)	Simulates pressing menu pushbutton	B-28
mode	Reports/sets operating mode as local or remote	B-41
no of lrec	Reports/sets number of lrecs stored in memory	B-24
no or srec	Reports/sets number of srecs stored in memory	B-24
oven temp	Reports/sets the setpoint for the detector oven	B-11
power up mode	Reports/sets the power up mode as local or remote	B-42
pressure	Reports current sample pressure	B-10
program no	Reports analyzer program number	B-43

Command	Description	Page
pump	Reports the status of the pump	B-36
pump off always	Sets the pump always off	B-36
pump on always	Sets the pump always on	B-36
pump on when hot	Turns the pump on when hot	B-36
pump temp	Reports temperature of the sample pump	B-11
push	Simulates pressing a key on the front panel	B-28
range	Reports/sets current THC range	B-30
relay stat	Reports/sets relay logic status for the designated relay(s)	B-48
response factor	Reports/sets the response factor	B-32
ri (right)	Simulates pressing right pushbutton	B-28
ru (run)	Simulates pressing run pushbutton	B-28
sample	Sets zero/span valves to sample mode	B-31
sample control pressure	Reports/sets current sample control pressure	B-33
sample pressure	Reports current sample pressure	B-10
save	Stores parameters in FLASH	B-36
save params	Stores parameters in FLASH	B-36
sc (screen)	C-series legacy command that reports a generic response (Use iscreen instead)	B-29
sp field	Reports/sets item number and name in scratch pad list	B-25
span	Sets zero/span valves to span mode	B-32
span calibrate	Sets THC coefficient	B-27
span conc	Reports/sets span gas concentration	B-28
sr	Reports the last srec stored	B-20
srec	Reports maximum number of srecs	B-21
srec format	Reports/sets output format for srecs (ASCII or binary)	B-22
srec layout	Reports current layout of srec data	B-23
srec mem size	Reports maximum number of srecs that can be stored	B-23
srec per	Reports/sets srec logging period	B-23
stream per	Reports/sets current time interval for streaming data	B-26
stream time	Reports/sets a time stamp to streaming data or not	B-26
thc	Reports current THC concentration	B-11
thc bkg	Reports/sets current THC background	B-27
thc coef	Reports/sets current THC coefficient	B-27

Command	Description	Page
time	Reports/sets current time (24-hour format)	B-37
tz	Reports/sets the timezone string for the network time protocol server	B-44
up	Simulates pressing up pushbutton	B-28
value	Reports current THC concentration	B-11
zero	Sets zero/span valves to zero mode	B-31
zero calibrate	Sets THC background	B-27

Measurements

avg time

This command reports the concentration measurement averaging time, in seconds. The following example shows that the averaging time is 300 seconds, according to Table B–3.

```
Send:        avg time
Receive:     avg time 11:300 sec
```

set avg time *selection*

This command sets the concentration measurement averaging time, in seconds, according to Table B–3. The following example sets the averaging time to 120 seconds.

```
Send:        set avg time 8
Receive:     set avg time 8 ok
```

Table B–3. Averaging Times

Selection	Averaging Time
0	1 seconds
1	2
2	5
3	10
4	20
5	30
6	60
7	90
8	120
9	180
10	240
11	300

air pressure
This command reports the current air pressure measurement, in PSI. The following example reports that the air pressure is 19.7 psi.

```
Send:        air pressure
Receive:     air pressure 19.7 psi
```

fuel pressure
This command reports the current fuel pressure measurement, in PSI. The following example reports that the fuel pressure is 28.0 psi.

```
Send:        fuel pressure
Receive:     fuel pressure 28.0 psi
```

pressure
flow pressure
sample pressure
These commands report the current sample flow pressure measurement, in PSI. The following example reports that the sample pressure measurement is 5.6 psi.

```
Send:        sample pressure
Receive:     sample pressure  5.6 psi
```

base temp
This command reports the current detector base temperature, in degrees C. The following example reports that the current detector base temperature is 199.5 °C.

```
Send:        base temp
Receive:     base temp 199.5 deg C
```

filter temp
This command reports the current sample filter temperature, in degrees C. The following example reports that the current filter temperature is 199.8 °C.

```
Send:        filter temp
Receive:     filter temp 199.8 deg C
```

flame temp
This command reports the current FID flame temperature, in degrees C. The following example reports that the current flame temperature is 221.0 °C.

```
Send:        flame temp
Receive:     flame temp 221.0 deg C
```

frequency
This command reports the average raw FID signal, in Hz. The following example reports that the frequency is 56749 Hz.

```
Send:          frequency
Receive:       frequency 56749 Hz
```

internal temp
This command reports the current internal instrument temperature. The following example reports that the internal temperature is 27.2 °C.

```
Send:          internal temp
Receive:       internal temp 027.2 deg C
```

oven temp
This command reports the setpoint for the detector oven temperature, in degrees C. The following example reports that the detector oven temperature is 200.0 °C.

```
Send:          oven temp
Receive:       oven temp 200.0 deg C
```

pump temp
This command reports the pump temperature, in degrees C (only in the Model 51*i* HT). The following example reports that the pump temperature is 200.0 °C.

```
Send:          pump temp
Receive:       pump temp 200.0 deg C
```

thc
value
avg value
high value
low value
These commands report the measured THC, AVG THC, HI THC, and LO THC concentrations. The following example shows that the THC concentration is 40 ppb.

```
Send:          thc
Receive:       thc 4.000E+01 ppb
```

Alarms

alarm bias voltage min
alarm bias voltage max
These commands report the current bias voltage alarm minimum and maximum value settings. The following example reports that the bias voltage alarm minimum value is -325.

```
Send:         alarm bias voltage min
Receive:      alarm bias voltage min -325 V
```

set alarm bias voltage min *value*
set alarm bias voltage max *value*
These commands set the bias voltage alarm minimum and maximum
values to *value*, where *value* is a floating-point number representing the bias
voltage alarm limits. The following example sets the bias voltage alarm
maximum value to -275.

```
Send:         set alarm bias voltage max -275
Receive:      set alarm bias voltage max -275 ok
```

alarm conc min
alarm conc max
alarm level max
These commands report the current THC concentration alarm minimum
and maximum values settings. The following example reports that the
THC concentration minimum is 100 ppb.

```
Send:         alarm conc min
Receive:      alarm conc min 100.000 ppb
```

set alarm conc min *value*
set alarm conc max *value*
set alarm level max *value*
These commands set the THC concentration alarm minimum and
maximum values to *value*, where *value* is a floating-point representation of
the concentration alarm limits. Values must be in the units that are
currently set for use. The following example sets the THC concentration
alarm maximum value to 5000.

```
Send:         set alarm conc max 5000
Receive:      set alarm conc max 5000 ok
```

alarm detector temp min
alarm detector temp max
These commands report the current detector temperature alarm minimum
and maximum value settings. The following example reports that the
detector temperature alarm minimum value is 115.0 °C.

```
Send:         alarm detector temp min
Receive:      alarm detector temp min 115.0 deg C
```

set alarm detector temp min *value*
set alarm detector temp 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 in degrees C. The following example sets the detector temperature alarm maximum value to 210 °C.

```
Send:          set alarm detector temp max 210
Receive:       set alarm detector temp max 210 ok
```

alarm filter temp min
alarm filter temp max
These commands report the current filter temperature alarm minimum and maximum value settings. The following example reports that the filter temperature alarm minimum value is 115.0 °C.

```
Send:          alarm filter temp min
Receive:       alarm filter temp min 115.0 deg C
```

set alarm filter temp min *value*
set alarm filter temp max *value*
These commands set the filter temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing the filter temperature alarm limits in degrees C. The following example sets the filter temperature alarm maximum value to 210 °C.

```
Send:          set alarm filter temp max 210
Receive:       set alarm filter temp max 210 ok
```

alarm flame temp min
alarm flame temp max
These commands report the current flame temperature alarm minimum and maximum value settings. The following example reports that the flame temperature alarm minimum value is 210.0 °C.

```
Send:          alarm flame temp min
Receive:       alarm flame temp min 210.0 deg C
```

set alarm flame temp min *value*
set alarm flame temp max *value*
These commands set the flame temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing the flame temperature alarm limits in degrees C. The following example sets the flame temperature alarm maximum value to 300 °C.

```
Send:          set alarm flame temp max 300
Receive:       set alarm flame temp max 300 ok
```

alarm internal temp min
alarm internal temp max

These commands report the current internal temperature alarm minimum and maximum value settings. The following example reports that the internal temperature alarm minimum value is 15.0 °C.

```
Send:        alarm internal temp min
Receive:     alarm internal temp min 15.0 deg C
```

set alarm internal temp min *value*
set alarm internal temp max *value*
These commands set the internal temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing the internal temperature alarm limits in degrees C. The following example sets the internal temperature alarm maximum value to 45 °C.

```
Send:        set alarm internal temp max 45
Receive:     set alarm internal temp max 45 ok
```

alarm pressure air min
alarm pressure air max
These commands report the current air pressure alarm minimum and maximum value settings. The following example reports that the air pressure alarm minimum value is 3.0 psi.

```
Send:        alarm pressure air min
Receive:     alarm pressure air min 3.0 psi
```

set alarm pressure air min *value*
set alarm pressure air max *value*
These commands set the air pressure alarm minimum and maximum values to *value*, where *value* is a floating-point number representing the air pressure alarm limits in pounds per square inch. The following example sets the air pressure alarm maximum value to 32 psi.

```
Send:        set alarm pressure air max 32
Receive:     set alarm pressure air max 32 ok
```

alarm pressure fuel min
alarm pressure fuel max
These commands report the current fuel pressure alarm minimum and maximum value settings. The following example reports that the fuel pressure alarm minimum value is 5.3 psi.

```
Send:        alarm pressure fuel min
Receive:     alarm pressure fuel min 5.3 psi
```

set alarm pressure fuel min *value*
set alarm pressure fuel max *value*

These commands set the fuel pressure alarm minimum and maximum
values to *value*, where *value* is a floating-point number representing the fuel
pressure alarm limits in pounds per square inch. The following example sets
the fuel pressure alarm maximum value to 30 psi.

```
Send:        set alarm pressure fuel max 30
Receive:     set alarm pressure fuel max 30 ok
```

alarm pressure sample min
alarm pressure sample max
These commands report the current sample pressure alarm minimum and
maximum value settings. The following example reports that the sample
pressure alarm minimum value is 5 psi.

```
Send:        alarm pressure sample min
Receive:     alarm pressure sample min 5.0 psi
```

set alarm pressure sample min *value*
set alarm pressure sample max *value*
These commands set the sample pressure alarm minimum and maximum
values to *value*, where *value* is a floating-point number representing the
sample pressure alarm limits in pounds per square inch. The following
example sets the sample pressure alarm maximum value to 10 psi.

```
Send:        set alarm pressure sample max 10
Receive:     set alarm pressure sample max 10 ok
```

alarm pump temp min
alarm pump temp max
These commands report the current pump temperature alarm minimum
and maximum value settings. The following example reports that the pump
temperature alarm minimum value is 135.0 °C.

```
Send:        alarm pump temp min
Receive:     alarm pump temp min 135.0 deg C
```

set alarm pump temp min *value*
set alarm pump temp max *value*
These commands set the pump temperature alarm minimum and
maximum values to *value*, where *value* is a floating-point number
representing the pump temperature alarm limits in degrees C. The
following example sets the pump temperature alarm maximum value to
210 °C.

```
Send:        set alarm pump temp max 210
Receive:     set alarm pump temp max 210 ok
```

alarm signal min
alarm signal max
These commands report the current signal strength alarm minimum and maximum value settings. The following example reports that the signal strength alarm minimum value is .001.

```
Send:        alarm signal min
Receive:     alarm signal min  0.001
```

set alarm signal min *value*
set alarm signal max *value*
These commands set the signal strength alarm minimum and maximum values to *value*, where *value* is a floating-point number representing the signal strength alarm limits. The following example sets the signal strength alarm maximum value to 100.

```
Send:        set alarm signal max 100
Receive:     set alarm signal max 100 ok
```

alarm span noise min
alarm span noise max
These commands report the current span noise alarm minimum and maximum value settings. The following example reports that the span noise alarm minimum value is .001.

```
Send:        alarm span noise min
Receive:     alarm span noise min  0.001
```

set alarm span noise min *value*
set alarm span noise max *value*
These commands set the span noise alarm minimum and maximum values to *value*, where *value* is a floating-point number representing the span noise alarm limits. The following example sets the span noise alarm maximum value to 100.

```
Send:        set alarm span noise max 100
Receive:     set alarm span noise max 100 ok
```

alarm trig conc
This command reports the current THC concentration alarm trigger action for the minimum alarm, to either floor or ceiling. The following example shows the THC concentration minimum alarm trigger to ceiling, according at Table B–4.

```
Send:        alarm trig conc
Receive:     alarm trig conc 1
```

set alarm trig conc *value*
This command sets the THC concentration alarm minimum *value*, where
value is set to either floor or ceiling, according to Table B–4. The following
example sets the THC concentration minimum alarm trigger to ceiling.

```
Send:          set alarm trig conc 1
Receive:       set alarm trig conc 1 ok
```

Table B–4. Alarm Trigger Values

Value	**Alarm Trigger**
00	Floor
01	Ceiling

alarm zero noise min
alarm zero noise max
These commands report the current zero noise alarm minimum and
maximum value settings. The following example reports that the zero noise
alarm minimum value is .001.

```
Send:          alarm zero noise min
Receive:       alarm zero noise min  0.001
```

set alarm zero noise min *value*
set alarm zero noise max *value*
These commands set the zero noise alarm minimum and maximum values
to *value*, where *value* is a floating-point number representing the zero noise
alarm limits. The following example sets the zero noise alarm maximum
value to 100.

```
Send:          set alarm zero noise max 100
Receive:       set alarm zero noise max 100 ok
```

Diagnostics

bias voltage
This command reports the current bias supply voltage. The following
example reports that the bias voltage is -302.3 volts.

```
Send:          bias voltage
Receive:       bias voltage -302.3 V
```

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 23.90 14.89 4.94 3.27 -3.16
```

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, and positive 15. Each
voltage value is separated by a space.

```
Send:          diag volt mib
Receive:       diag volt mib 23.96 14.98 -15.05 4.96 3.27 14.97
```

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 23.96 4.96 3.27 -3.16
```

flags
This command reports all of the currently active measurement status flags
in plain ASCII text. If no measurement alarms are active, the response is
"flags no alarm active". If any alarms are active, they are reported as follows:

```
Send:          flags
Receive:       flags
               Bad cal
               Can not light
               Cal mode
               High conc alarm
               Overrange
               Idle Mode
               High det base temp
               Low det base temp
               High filter temp
               Low filter temp
               High pump temp (Model 51iHT)
               Low pump temp (Model 51iHT)
               High flame temp
               Low flame temp
```

Datalogging

clr records
This command will clear all lrecs and srecs 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
```

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 concentration 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 inputs or 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 3 ZERO MODE open
                2 4 SPAN MODE open
                3 6 PURGE MODE open
                4 8 GEN ALARM open
                5 19 FUEL PRESS 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 1 THC
                2 5 Det_Temp
                3 8 Flame_Temp
                4 10 Air_PSI
                5 11 Sample_PSI
                6 12 Fuel_PSI
```

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 erec/lrec/srec format *format*" command)

These commands report the last lrecs or srecs stored or the erec data record. 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-1.

```
Send:          lr01
Receive:       lr01
               09:15 01-04-07  flags 8530000 THC -0.004 THC_Avg 0.030
               THC_High 4.098 THC_Low -1.479 Det_Temp 124.957
               Filt_Temp 124.725 Flame_Temp 199.879 Int_Temp 027.200
               Air_PSI 18.872 Sample_PSI 4.792 Fuel_PSI 19.008
```

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 the "Record Layout Definition" section 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
             10:05 01-04-07 flags 8530000 THC 3.137 THC_Avg 0.551
             THC_High 4.098 THC_Low -1.479  4 avgtime 10 Sample_PSI
             4.800 airpres 18.940 Fuel_PSI 19.008 Int_Temp 027.200
             Flame_Temp 188.703 ovenset 125 Det_Temp 124.908
             Filt_Temp 124.823
```

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 23)

bb = minutes (01 to 59)

oo = month (01 to 12)

pp = day (01 to 31)

qq = year

These commands output lrecs or srecs and erec data. 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, assume there are 740 lrecs 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 Figure B–1.

```
Send:        lrec 100 5
Receive:     lrec 100 5
             08:30 01-03-07  flags 8530000 THC 0.189 THC_Avg 0.126
             THC_High 1.119 THC_Low -2.889 Det_Temp 124.884
             Filt_Temp 125.067 Flame_Temp 200.077 Int_Temp 027.200
             Air_PSI 14.427 Sample_PSI 2.064 Fuel_PSI 25.326
             08:45 01-03-07  flags 8530000 THC 0.182 THC_Avg 0.126
             THC_High 1.119 THC_Low -2.889 Det_Temp 124.847
             Filt_Temp 124.957 Flame_Temp 200.077 Int_Temp 027.200
             Air_PSI 14.441 Sample_PSI 2.059 Fuel_PSI 25.326
             09:00 01-03-07  flags 8530000 THC 0.225 THC_Avg 0.127
             THC_High 1.119 THC_Low -2.889 Det_Temp 125.250
             Filt_Temp 125.031 Flame_Temp 200.077 Int_Temp 027.200
             Air_PSI 14.441 Sample_PSI 2.059 Fuel_PSI 25.326
             09:15 01-03-07  flags 8530000 THC 3.185 THC_Avg 0.139
             THC_High 3.257 THC_Low -2.889 Det_Temp 125.165
```

```
Filt_Temp 125.128 Flame_Temp 199.978 Int_Temp 027.200
Air_PSI 14.427 Sample_PSI 2.059 Fuel_PSI 25.312
09:30 01-03-07  flags 8530000 THC 3.279 THC_Avg 0.179
THC_High 3.647 THC_Low -2.889 Det_Temp 125.275
Filt_Temp 125.128 Flame_Temp 199.978 Int_Temp 027.200
Air_PSI 14.427 Sample_PSI 2.059 Fuel_PSI 25.3
```
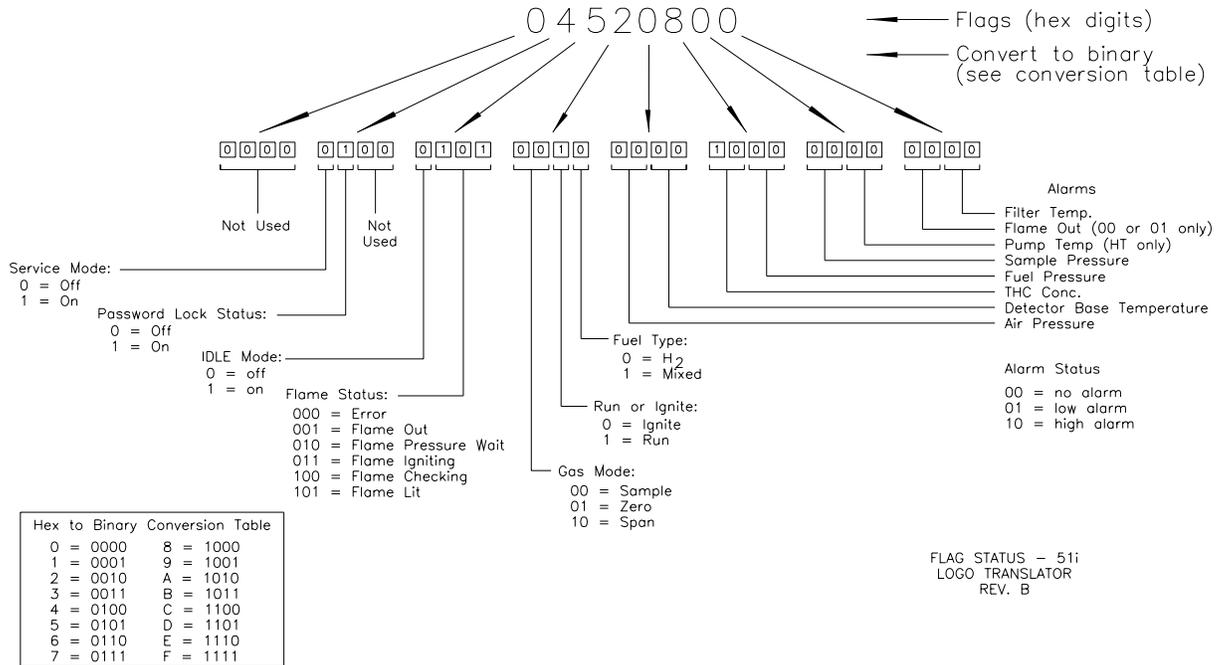

Figure B–1. Flags Field

lrec format
srec format
erec 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–5.

```
Send:        lrec format
Receive:     lrec format 01
```

set lrec format *format*
set srec format *format*
set erec format *format*

These commands set the output format for lrecs and srecs, and erec data, according to Table B–5. 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–5. Record Output Formats

Format	**Output Format**
0	ASCII no text
1	ASCII with text
2	Binary data

lrec layout
srec layout
erec layout
These commands report the layout (string indicating the data formats) for data that is sent out in response to the lrec, srec, erec, 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 %f %f %f %f %f %f %f
             t D L fffffffffff
             flags THC THC_Avg THC_Hgh THC_Low Det_Temp Filt_Temp
             Flame_Temp Int_Temp Air_PSI Sample_PSI Fuel_PSI
```

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 lrec per *value*
set srec 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 sreco 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
```

set copy sp to lrec
set copy sp to srec
set 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
```

set copy lrec to sp
set copy srec to sp
set 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
```

sp field *number*
This command reports the variable *number* and name stored at the 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 current 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
```

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–6. The following example reports that the streaming data shall not include a time stamp.

```
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–6. The following example attaches a time stamp to streaming data.

```
Send:          set stream time 0
Receive:       set stream time 0 ok
```

Table B–6. Stream Time Values

Value	**Stream Time**
0	Attaches time stamp to streaming data string
1	Disables time stamp to streaming data string

Calibration

set cal thc bkg
set zero calibrate
These commands will set the THC background. The following example shows a successful auto-calibration of the THC background.

Note Zero air must be provided to the instrument prior to issuing any of these commands. ▲

```
Send:        set cal thc bkg
Receive:     set cal thc bkg ok
```

set cal thc coef
set span calibrate
set calibrate
These commands will set THC coefficient based on THC span gas concentration. The following example shows a successful auto-calibration of the THC coefficient.

Note Span gas must be provided to the instrument prior to issuing any of these commands. ▲

```
Send:        set cal thc coef
Receive:     set cal thc coef ok
```

thc bkg
This command reports the current THC background. The following example reports that the THC background is 0.5 ppb.

```
Send:        thc bkg
Receive:     thc bkg 0.5 ppb
```

set thc bkg *value*
This command is used to set the THC background to a user-defined *value*, where *value* is a floating-point representation of the background in the currently selected units. The following example sets the THC background to 0.5 ppb.

```
Send:        set thc bkg 0.5
Receive:     set thc bkg 0.5 ok
```

thc coef
This command reports the current THC coefficient. The following example reports that the THC coefficient is 1.000.

```
Send:          thc coef
Receive:       thc coef 1.000
```

set thc coef *value*
This command sets the THC coefficient to a user-defined *value*, where *value* is a floating-point representation of the coefficient. The following example sets the THC coefficient to 1.005.

```
Send:          set thc coef 1.005
Receive:       set thc coef 1.005 ok
```

span conc
This command reports the THC span gas concentration used to auto-calibrate the THC coefficient. The following example reports that the THC calibration gas concentration is 40.0 ppb.

```
Send:          span conc
Receive:       span conc 4.000E+01 ppb
```

set span conc *value*
This command sets the THC span gas concentration used by the auto-calibration routine to *value*, where *value* is a floating-point representation of the gas concentration in the currently selected units. The gas units are the same as those chosen by the user in the Range menu. The following example sets the THC calibration gas concentration to 100.0 ppb.

```
Send:          set span conc 100.0
Receive:       set span conc 100.0 ok
```

Keys/Display

push *button*

do	**ri**
down	**right**
en	**ru**
enter	**run**
he	**up**
help	**1**
le	**2**
left	**3**
me	**4**
menu	

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

These commands retrieve the framebuffer data used for the display on the *i*Series 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 saved as a 4-bit-per-pixel gray-scale image. 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

These commands are meant for backward compatibility with the C series. Screen information is instead reported using the "iscreen" command above.

```
Send:       screen
Receive:    screen This is an ISeries instrument.
            Screen information not available.
```

Measurement Configuration

range
This command reports the current THC range. The following example reports that the THC full-scale range is set to 100 ppb, according to Table B–7.

```
Send:         range
Receive:      range 2: 1.000E+02 ppb
```

set range *selection*
This command sets the THC full-scale range, according to Table B–7. The following example sets the THC full-scale range to 20,000 ppb.

```
Send:         set range 5
Receive:      set range 5 ok
```

Table B–7. Ranges

Selection	Range (ppm, ppb, ug/m3, mgm3, ppmc)	Range (%)
0	1	.01
1	10	.1
2	100	.5
3	1,000	1
4	10,000	5
5	20,000	
6	50,000	
7	C1	
8	C2	
9	C3	

custom *range*
range = │ 1 │ 2 │ 3 │

This command reports the user-defined value of custom *range* 1, 2, or 3. The following example reports that custom range 1 is defined to 5.50 ppb.

```
Send:         custom 1
Receive:      custom 1 5.500E+00 ppb
```

set custom *range* **range** *value*
set custom 1 *value*
set custom 2 *value*
set custom 3 *value*

These commands are used to set the maximum concentration for any of the three custom *ranges* 1, 2, or 3 to range *value*, where *value* is a floating-point number representing concentration in the currently selected units. The following example sets the custom 1 range to 55.5 ppb.

```
Send:          set custom 1 range 55.5
Receive:       set custom 1 range 55.5 ok
```

display mode
This command reports the current display mode as either normal or statistics. The following example reports that the display mode is statistics.

```
Send:          display mode
Receive:       display mode statistics
```

set display mode *mode*
mode = | normal | statistics |

This command sets the display mode to either normal or statistics. The following example sets the display mode to normal.

```
Send:          set display mode normal
Receive:       set display mode normal ok
```

gas mode
This command reports the current state of the zero/span valves gas mode as sample, zero, or span. The following example reports that the gas mode is sample.

```
Send:          gas mode
Receive:       gas mode sample
```

set sample
This command sets the zero/span valves to the sample mode. The following example sets the instrument to sample mode, that is, the instrument is reading sample gas.

```
Send:          set sample
Receive:       set sample ok
```

set zero
This command sets the zero/span valves to the zero mode. The following example sets the instrument to zero mode, that is, the instrument is reading zero gas.

```
Send:          set zero
Receive:       set zero ok
```

set span

This command sets the zero/span valves to the span mode. The following example sets the instrument to span mode, that is, the instrument is reading span gas.

```
Send:       set span
Receive:    set span ok
```

gas unit

This command reports the current gas units (ppm, ppb, µg/m³, mg/m³, %, or ppmc). The following example reports that the gas units are set to ppb.

```
Send:       gas unit
Receive:    gas unit ppb
```

set gas unit *unit*

unit = | ppm | ppb | µg/m³ | mg/m³ | % | ppmc |

These commands set the gas units to ppm, ppb, µg/m³, mg/m³, %, or ppmc. The following example sets the gas units to mg/m³.

```
Send:       set gas unit mg/m3
Receive:    set gas unit mg/m3 ok
```

response factor

This command reports the current response factor, that is, the multiplier set for the THC measurement before the concentration is displayed. The following example shows the response factor is 1.000.

```
Send:       response factor
Receive:    response factor   1.000
```

set response factor *value*

This command sets the response factor to *value*, where *value* is a floating-point number representing the response factor. The following example sets the response factor to 5.

```
Send:       set response factor 5
Receive:    set response factor 5 ok
```

Hardware Configuration

air control pressure

This command reports the current air control pressure according to Table B–8. The following example shows that for hydrogen fuel during ignition, the air control pressure is set to 17 psi.

```
Send:       air control pressure 0 1
Receive:    air control pressure 0 1 17.000
```

set air control pressure *fuel status value*
This command sets the air control pressure according to Table B–8. The following example sets the air control pressure for mixed fuel during the run mode to *value*, where *value* is a floating-point number representing the air control pressure in PSI. The following example sets the air control pressure to 15 psi.

```
Send:          set air control pressure 1 0 15.000
Receive:       set air control pressure 1 0 15.000 ok
```

Table B–8. Fuel and Status Values

Fuel	Type	*Status*	Set
0	Hydrogen	0	Run
1	Mixed	1	Ignite

fuel control pressure
This command reports the current fuel control pressure according to Table B–8. The following example shows that for mixed fuel during ignition, the fuel control pressure is set to 15 psi.

```
Send:          fuel control pressure 1 1
Receive:       fuel control pressure 1 1 15.000
```

set fuel control pressure *fuel status value*
This command sets the fuel control pressure according to Table B–8. The following example sets the fuel control pressure for mixed fuel during the run mode to *value*, where *value* is a floating-point number representing the fuel control pressure in PSI. The following example sets the fuel control pressure to 15 psi.

```
Send:          set fuel control pressure 1 0 15.000
Receive:       set fuel control pressure 1 0 15.000 ok
```

sample control pressure
This command reports the current sample control pressure according to Table B–8. The following example shows that for mixed fuel during ignition, the sample control pressure is set to 5 psi.

```
Send:          sample control pressure 1 1
Receive:       sample control pressure 1 1 5.000
```

set sample control pressure *fuel status value*
This command sets the sample control pressure according to Table B–8. The following example sets the sample control pressure for mixed fuel during the run mode to *value*, where *value* is a floating-point number

representing the sample control pressure in PSI. The following example sets the sample control pressure to 5 psi.

```
Send:          set sample control pressure 1 0 5.000
Receive:       set sample control pressure 1 0 5.000 ok
```

contrast
This command reports the screen's level of contrast. The following example shows the screen contrast is 50%, according to Table B–9.

```
Send:          contrast
Receive:       contrast 5: 50%
```

set contrast *level*
This command sets the screen's *level* of contrast, according to Table B–9. The following example sets the contrast level to 50%.

```
Send:          set contrast 5
Receive:       set contrast 5 ok
```

Table B–9. Contrast Levels

Level	**Contrast Level**
0	0%
1	5%
2	10%
3	15%
4	20%
5	25%
6	30%
7	35%
8	40%
9	45%
10	50%
11	55%
12	60%
13	65%
14	70%
15	75%
16	80%
17	85%

Level	Contrast Level
18	90%
19	95%
20	100%

date
This command reports the current date. The following example reports the date as December 1, 2006.

```
Send:       date
Receive:    date 12-01-06
```

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, 2006.

```
Send:       set date 12-01-06
Receive:    set date 12-01-06 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
```

fuel type
This command reports the current fuel type. The following example shows that the current fuel type is hydrogen.

```
Send:       fuel type
Receive:    fuel type hydrogen
```

set fuel type *value*
This command sets the fuel type to *value*, where *value* is either hydrogen or mixed. The following example sets the fuel type to mixed.

```
Send:       set fuel type mixed
Receive:    set fuel type mixed ok
```

idle

This command reports whether the instrument idle is on or off. The following example shows that the instrument idle is on.

```
Send:        idle
Receive:     idle on
```

set idle *onoff*
onoff = | on | off |

This command sets the instrument idle to *on* or *off*. The following example turns the instrument idle off.

```
Send:        set idle off
Receive:     set idle off ok
```

set ignite

This command will set the instrument to attempt to light the FID flame. The FID diagnostic screen is brought up when this command is issued.

```
Send:        set ignite
Receive:     set ignite ok
```

pump

This command reports the status of the pump. The following example reports that the pump is always on.

```
Send:        pump
Receive:     pump pump on always
```

set pump off always
set pump on always
set pump on when hot

These commands set the pump to always off, always on, or on when hot. The following example sets the pump to turn on when hot.

```
Send:        set pump on when hot
Receive:     set pump on when hot ok
```

save

set save params

These commands store 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 format). 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
```

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 domain name server *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.

```
Send:        addr gw
Receive:     addr gw 10.209.42.1
```

set addr gw *address*
This command sets the default gateway *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by ".".

Note This command cannot be used when DHCP is on. Refer to the DHCP command that follows for additional information. ▲

```
Send:          set addr gw 10.209.42.1
Receive:       set addr gw 10.209.42.1 ok
```

addr ip
This command reports the IP address of the analyzer.

```
Send:          addr ip
Receive:       addr ip 10.209.40.155
```

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 ".".

Note This command cannot be used when DHCP is on. Refer to the DHCP command that follows for additional information. ▲

```
Send:          set addr ip 10.209.40.155
Receive:       set addr ip 10.209.40.155 ok
```

addr nm
This command reports the IP netmask.

```
Send:          addr nm
Receive:       addr nm 255.255.252.0
```

set addr nm *address*
This command sets the netmask *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by ".".

Note This command cannot be used when DHCP is on. Refer to the DHCP command that follows for additional information. ▲

```
Send:          set addr nm 255.255.252.0
Receive:       set addr nm 255.255.252.0 ok
```

addr ntp
This command reports the IP address for the network time protocol server.

```
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 is 9600 baud.

```
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 following example 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 If DHCP is changed from on to off and then the IP address, the netmask address, or the gateway address is changed, 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–10.

```
Send:          format
Receive:       format 00
```

set format *format*

This command sets the reply termination *format*, where *format* is set according to Table B–10. The following example sets the reply termination format to checksum.

```
Send:          set format 01
Receive:       set format 01 ok
```

Table B–10. 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 *i*Series.

```
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 51*i*.

```
Send:          instr name
Receive:       instr name
               Total Hydrocarbon Analyzer
               THC 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 51
```

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 to 52.

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 52
Receive:       set instrument id 52 ok
```

mode

This command reports what operating mode the instrument is in: local, service, or remote. The following example shows that the instrument is in the remote mode.

```
Send:          mode
Receive:       mode remote
```

set mode local
set mode remote

These commands set the instrument to local or remote mode. The following example sets the instrument to the local mode.

```
Send:          set mode local
Receive:       set mode local ok
```

allow mode cmd

This command reports the current allow mode setting: 1 = allow "set mode local" and "set mode remote" commands; 0 = ignore "set mode local" or "set mode remote"commands, according to Table B–11. The default value is 0; ignore the commands. The following example 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, according to Table B–11.

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 it will not change the instrument lock status** (this is for compatibility with systems expecting and "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 following example sets the instrument to accept the "set mode local" and "set mode remote" commands.

```
Send:          set allow mode cmd 1
Receive:       set allow mode cmd 1 ok
```

Table B–11. Allow Mode Command Values

Value	**Allow Mode Command**
0	Ignore (default)
1	Accept

power up mode
This command reports the current power up mode setting to either 0 = local/unlocked or 1 = remote/locked, according to Table B–12. The default value is 0; power up in local/unlocked mode. The following example shows that the instrument is configured to power up in the remote/unlocked 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), according to Table B–12.

If the instrument is set to power up in the local/remote 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 following example 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–12. Power up Mode Values

Value	**Power up Mode**
0	Local/Unlocked Mode (default)
1	Remote/Locked Mode

program no
This command reports the analyzer's model information and program version number.

```
Send:        program no
Receive:     program no iSeries 51iLT 01.00.01.074
```

set layout ack
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, according to Table B–13.

```
Send:        set layout ack
Receive:     set layout ack ok
```

Table B–13. Set Layout Ack Values

Value	**Function**
0	Do nothing (default)
1	Append "*"

tz
This command reports the "tz" timezone string for the NTP server. See "Network Time Protocol Server" in the "Communications 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 Chapter 3.

```
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–14. 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–14. 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–14. 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 V
```

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–15. The following example reports that analog voltage output channel 2 is set to 3 (0-10 V).

```
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–15. 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–15. 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 the digital input *channel* and the index number of 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 command reports the outputs of the 6 or 12 Digital to Analog converters, according to Table B–16. The following example shows that the D/A #1 is 97.7% full-scale.

```
Send:          dtoa 1
Receive:       dtoa 1 97.7%
```

Note If the instrument is in a mode which does not provide a particular output, and that output is selected, the value will be 0.0. ▲

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–16. Default Analog Output Channel Assignments

D to A	Function	Parameter
1	Voltage Output	THC
2	Voltage Output	THC
3	Voltage Output	Not Assigned
4	Voltage Output	Not Assigned
5	Voltage Output	Not Assigned
6	Voltage Output	Not Assigned
7	Current Output	THC
8	Current Output	THC
9	Current Output	Not Assigned
10	Current Output	Not Assigned
11	Current Output	Not Assigned
12	Current Output	Not Assigned

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 THC
              2 THC_Avg
              3 THC_High
              4 THC_Low
              5 Det_Temp
              6 Filt_Temp
```

```
 8 Flame_Temp
 9 Int_Temp
10 Air_PSI
11 Sample_PSI
12 Fuel_PSI
13 Raw Hz
```

relay stat

This command reports the current relay logic as 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 of 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
```

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', 'I', '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 measurement values, read the status of the digital outputs of the analyzer, and to trigger or simulate the activation of a digital input to the instrument. This is achieved by using the supported MODBUS parameters listed below.

Up to three simultaneous connections are supported over Ethernet.

For details of the Model 51*i* MODBUS Protocol specification, see the following topics:

- "Serial Communication Parameters" on page C-1

- "TCP Communication Parameters" on page C-2

- "Application Data Unit Definition" on page C-2

- "Function Codes" on page C-3

- "MODBUS Parameters Supported" on page C-8

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	:	0x06

If a function code is received that is not in this list, an invalid function exception is returned.

Data

The data field varies depending on the function. For more description of these data fields, see "Function Codes" below.

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 51*i*.

(0x01/0x02) Read Coils/Read Inputs

Read Coils/Inputs read 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 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*
Output Status	N Byte	N = N or N+1

*N = Quantity of Outputs / 8, if the remainder not equal to zero, then N=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

Field Name	(Hex)
Function	0x01
Starting Address Hi	0x00
Starting Address Lo	0x02
Quantity of Outputs Hi	0x00
Quantity of Outputs Lo	0x0D

Response

Field Name	(Hex)
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.

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*
Register Value	N* x 2 Bytes	N = N or N+1

*N = Quantity of Registers

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

Field Name	(Hex)
Function	0x03
Starting Address Hi	0x00
Starting Address Lo	0x09
No. of Registers Hi	0x00
No. of Registers Lo	0x04

Response

Field Name	(Hex)
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 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

Field Name	(Hex)
Function	05
Output Address Hi	00
Output Address Lo	05
Output Value Hi	FF
Output Value Lo	00

Response

Field Name	(Hex)
Function	05
Output Address Hi	00
Output Address Lo	05
Output Value Hi	FF
Output Value Lo	00

MODBUS Parameters Supported

Table C–1 through Table C–3 lists the MODBUS addresses supported for the Model 51*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 51*i*

Coil Number	Status
0	INVALID
1	LOCAL/REMOTE
2	SERVICE
3	ZERO MODE
4	SPAN MODE
5	SAMPLE MODE

Coil Number	Status
6	PURGE MODE
7	IDLE MODE
8	GEN ALARM
9	CONC ALARM
10	CONC MAX ALARM
11	CONC MIN ALARM
12	INTERNAL TEMP ALARM
13	DETECTOR TEMP ALARM
14	FILTER TEMP ALARM
15	PUMP TEMP ALARM
16	FLAME TEMP ALARM
17	AIR PRESSURE ALARM
18	SAMPLE PRESSURE ALARM
19	FUEL PRESSURE ALARM
20	FLAME OUT ALARM
21	SIGNAL STRENGTH ALARM
22	OVER RANGE ALARM
23	HEATER FAIL ALARM
24	SENSOR FAIL ALARM
25	ZERO NOISE ALARM
26	SPAN NOISE ALARM
27	ZERO CHECK/CAL ALARM
28	SPAN CHECK/CAL ALARM
29	BIAS VOLTAGE ALARM
30	INTERFACE BD STATUS ALARM
31	I/O EXP BD STATUS ALARM
32	EXTERNAL CONVERTER BD STATUS

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 51*i*

Register Number	Variable
0	INVALID
1 & 2	THC
3 & 4	AVG THC
5 & 6	HI THC
7 & 8	LO THC
9 & 10	DETECTOR TEMP
11 & 12	FILTER TEMP
13 & 14	PUMP TEMP
15 & 16	FLAME TEMP
17 & 18	INTERNAL TEMP
19 & 20	AIR PRESSURE
21 & 22	SAMPLE PRESSURE
23 & 24	FUEL PRESSURE
25 & 26	RAW SIGNAL
27 & 28	ANALOG IN 1
29 & 30	ANALOG IN 2
31 & 32	ANALOG IN 3
33 & 34	ANALOG IN 4
35 & 36	ANALOG IN 5
37 & 38	ANALOG IN 6
39 & 40	ANALOG IN 7
41 & 42	ANALOG IN 8

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. ▲

Note The coils within each coil group in the following table are mutually exclusive and will not be triggered if there is conflict. Before you assert (1) one coil in a group, make sure the other coils in the group are de-asserted (0). ▲

Table C–3. Write Coils for 51*i*

Coil Number	Action Triggered
100	INVALID
101	ZERO MODE
102	SPAN MODE
103	SET BACKGROUND
104	SET IDLE MODE
105	CAL TO LO SPAN
106	AOUTS TO ZERO
107	AOUTS TO FS
107	AOUTS TO FS

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 *i*Series 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 listed below.

Up to three simultaneous connections are supported over Ethernet.

For details of the Model 51*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 *i*Series 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

*i*Series 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 Checksum 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 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" below.

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 below.

<SFKT>: is the space provided for future use for special function. It currently contains a string of ten 0's, i.e. <0000000000>.

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>`

The attached concentrations are in the selected gas units. The measurements that are attached to the response, if not valid in a particular mode, will report a value of 0.0.

Measurements reported in response to DA command

The following 4 measurements reported in response to DA command for the Model 51i include:

- THC
- Average THC
- Low THC
- High THC

Operating and Error Status

See Table D–1 for operating status and Table D–2 for error status for the Model 51i.

Table D–1. Operating Status for Model 51*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:									
Service Mode (On)	0	0	0	0		0	0	0	1
Maintenance (Local)	0	0	0	0		0	0	1	0
Zero Gas (On)	0	0	0	0		0	1	0	0
Span Gas (On)	0	0	0	0		1	0	0	0
Pump On	0	0	0	1		0	0	0	0
Not Used	0	0	1	0		0	0	0	0
Not Used	0	1	0	0		0	0	0	0
Not Used	1	0	0	0		0	0	0	0

Table D–2. Error Status for Model 51*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:									
Internal Temperature Alarm	0	0	0	0		0	0	0	1
Flame Out Alarm	0	0	0	0		0	0	1	0
Detector OR Filter OR Pump Temp Alarm	0	0	0	0		0	1	0	0
Bias Voltage Alarm	0	0	0	0		1	0	0	0
Pressure Alarm (All 3 pressures)	0	0	0	1		0	0	0	0
Heater Fail Alarm	0	0	1	0		0	0	0	0
Temp Sensor Fail Alarm	0	1	0	0		0	0	0	0
Conc Alarm	1	0	0	0		0	0	0	0