Model 55*i*

Instruction Manual
Direct Methane, Non-Methane
Hydrocarbon Analyzer
Part Number 103962-00
2Aug2012

CE

Thermo
SCIENTIFIC

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 55*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.

● Appendix E "AK Protocol Commands" provides a description of the AK protocol commands that can be used to remotely control an analyzer using a host device such as a PC or datalogger.

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 Model 55*i* is supplied with a three-wire grounded power cord. Under no circumstances should this grounding system be defeated. ▲
		If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲

Alert	Description
	The service procedures in this manual are restricted to qualified service representatives. ▲
⚠ **CAUTION**	During operation, the sample intake, sample bypass, and FID exhaust bulkheads are extremely hot. Use caution when working with a hot instrument. ▲
	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 apply power to the Model 55*i* until all other installation procedures have been completed. An incorrect start-up sequence could damage the instrument. ▲
	Do not attempt to lift the analyzer by the cover or other external fittings. ▲
	Heating the column oven while the carrier gas is not flowing may damage the column. ▲
	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. ▲
	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 use solvents or other cleaning products to clean the outside case. ▲
	Do not disassemble the valve unless the system malfunction is definitely isolated to the valve: perform all other system checks first. If disassembly is required, make certain, the instructions that follow are carefully observed. ▲
	Any contact between the interior of the valve body and the metal of the rotor or any tool is likely to cause damage. ▲
	Do not remove the LCD panel or frame from the LCD module. ▲

Alert	Description
	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 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 or visit us on the web at www.thermo.com/aqi.

1-866-282-0430 Toll Free

1-508-520-0430 International

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Chapter 1
Introduction

The Model 55*i* Direct Methane, Non-Methane Hydrocarbon Analyzer is a back-flush gas chromatography (GC) system designed for automated measurement of methane and non-methane hydrocarbons. Unlike instruments that measure only methane and total hydrocarbons, the back-flush GC method provides a direct measurement of non-methane concentrations. This allows accurate and precise measurement of low levels of non-methane hydrocarbons (NMHC), even in the presence of methane at much higher concentrations.

The Model 55*i* has the following features:

● 320 x 240 graphics display

● Menu-driven firmware

● Temperature controlled detector oven and sampling system

● 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), AK, streaming data, and NTP (Network Time Protocol) protocols. Simultaneous connections from different locations over Ethernet.

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

● "Principle of Operation" on page 1-2

● "Specifications" on page 1-7

Thermo Fisher Scientific is pleased to supply this direct methane, non-methane 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".

Principle of Operation

The Model 55*i*'s measurement of methane and non-methane hydrocarbons is based on the well developed science of gas chromatography and utilizes a proprietary column system developed specifically for this application. Gas chromatography is a proven analytical tool that was initially developed in the 1950's and is now the most widely applied separation technique in analytical laboratories. A detailed discussion of chromatographic theory goes beyond the scope of this manual, and is not necessary for operation of the analyzer. However, a basic understanding of chromatographic principals may be helpful for instrument setup and troubleshooting. For initial installation and operation, the user should become familiar with the sampling system, the gas flow patterns, the analog signal outputs, and the hydrocarbon detection and measurement methods described in this chapter. For those who are interested in a more complete description of the chromatographic process, a detailed explanation can be found in most textbooks on analytical instrumentation.

The Model 55*i* is an automated batch analyzer which repeatedly collects and analyzes small amounts of the sample stream drawn in by the pump. Central to the instrument's operation is an eight port, two position, rotary valve which is used to introduce the gas sample into the analyzer and to control the flow of gases through the chromatographic column.

As shown in Figure 1–1, the rotary valve is designed in a circular configuration with the eight ports, or connection points, spaced equally around the periphery of the valve body. Internally, the valve includes a cone shaped "rotor" at the hub, which has a set of 4 channels or grooves cut in the surface. Each channel connects two adjacent ports. The rotor can be shifted to either of two positions to provide two different gas flow configurations. For example, port number two can be connected to either port number one or port number three, while port number three can be connected to port number two or port number four.
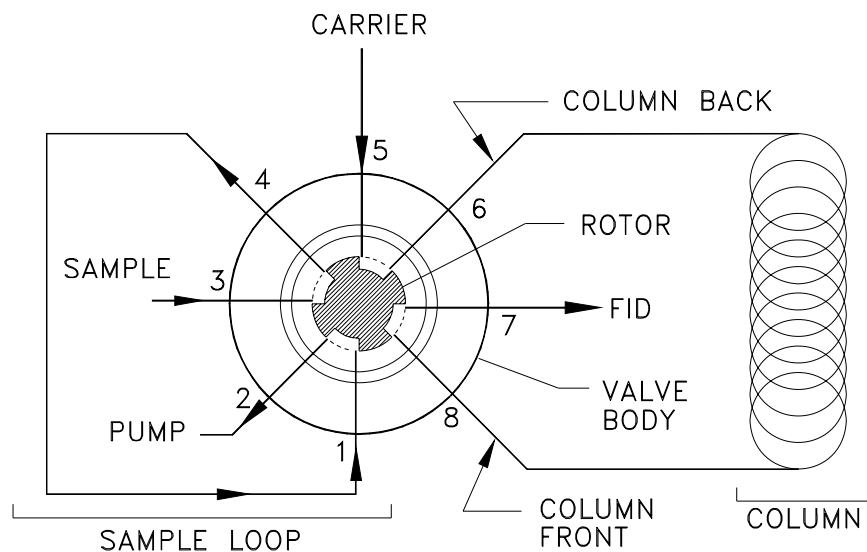
Figure 1–1. Rotary Valve Configuration

In the Model 55*i*, the two valve positions are referred to as *inject* and *backflush* and they provide the following connection, according to Table 1–1:

Table 1–1. Inject and Backflush Connections

Inject			Backflush		
Carrier Inlet (5)	→	Sample Loop (4)	Carrier Inlet (5)	→	Column-back (6)
Sample Loop (1)	→	Column-front (8)	Column-front (8)	→	FID (7)
Column-back (6)	→	FID (7)	Pump Vacuum (2)	→	Sample Loop (1)
Pump Vacuum (2)	→	Sample Inlet (3)	Sample Loop (4)	→	Sample Inlet (3)

Between analyses, or while running in the stand-by mode, the rotary valve is left in the backflush position. In this position, sample gas is continuously pulled through the sampling loop, which is simply a coil of empty tubing. This flow configuration is illustrated in Figure 1–2. To start the analysis, the rotary valve is switched to the inject position, as shown in Figure 1–2. This action connects the carrier inlet to the sample loop and introduces the gas sample that was in the loop into a flowing stream of inert "carrier gas".

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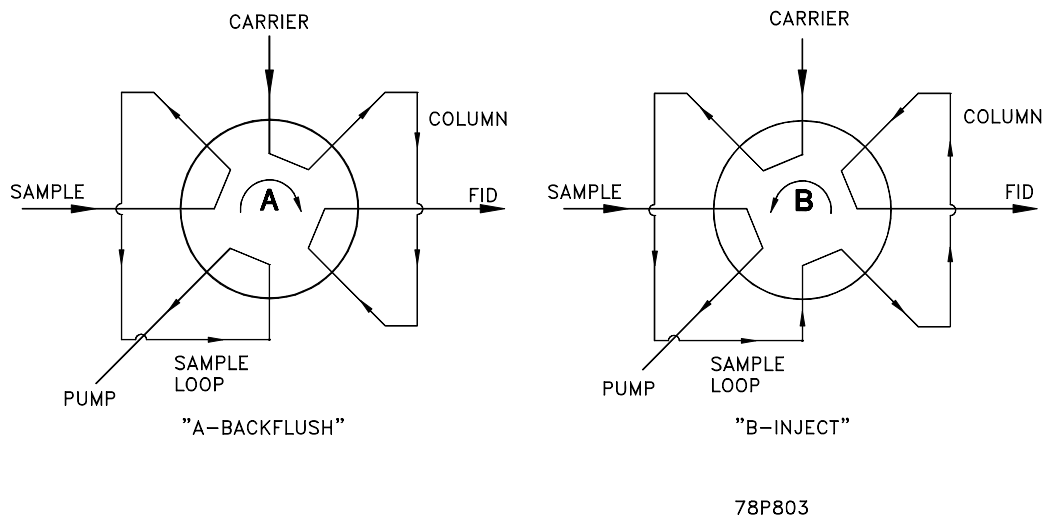
Figure 1–2. 8-Port Rotary Valve, Backflush and Inject Positions

The carrier gas sweeps the sample from the loop and into the front, or inject end, of the separation column. It should be noted that the column is physically located in a separate oven that is run at 65 °C. As the sample is carried down the column, the various components move at different speeds, as determined by their physical and chemical properties. Due to its low molecular weight and high volatility, methane moves faster than other organic compounds and is the first to emerge from the opposite end of the column. Upon leaving the column, the methane flows back through the rotary valve and then to the flame ionization detector, or FID. The methane is measured by the FID and its signal is converted into a concentration by comparison with the signal produced by a calibration gas. The FID used in the instrument is similar to those seen in many laboratory instruments and uses a hydrogen flame to ionize organic molecules in the carrier gas. This is an established method that is sensitive and reliable for measurement of most organic compounds.

Once the methane peak has been detected, the rotary valve is automatically returned to the original backflush position, as shown in Figure 1–1. Note that at this point the direction of carrier gas flow through the column has reversed, and that the sample loop has been switched out of the carrier stream and back into the sampling system. With the reversal of carrier flow in the column, the non-methane hydrocarbons are "back-flushed" out and carried to the FID for measurement. As the NMHCs reach the FID, they create a signal that is proportional to the total NMHC concentration and can be converted to a ppm reading by comparison with the signal generated by a known standard.

If the FID signal is continuously monitored with a chart recorder or data acquisition system, the output will create a chromatogram showing one peak for methane and a second peak that represents the combined non-methane hydrocarbons. A typical chromatogram obtained from the analysis of a standard mixture containing 2 ppm each of methane and propane is shown in Figure 1–3.

In this case, the methane peak reaches a maximum approximately 17 seconds after injection, and is preceded by a smaller peak that represents oxygen. The 17-second elapsed time between injection and the top of the methane peak is referred to as the methane retention time (C1-Rt) and is critical for proper operation of the instrument.

Note The retention time varies with the specific model and configuration of the analyzer. Please see the factory test report to determine the correct retention time for your analyzer. ▲

The non-methane peak, as shown in Figure 1–3, will generally be lower and wider than the methane peak, and it can have varying retention times depending on operating conditions and composition of the sample.

In the automatic, or continuous, operating mode, the instrument initiates the next analysis by injecting another sample as soon as the non-methane measurement is complete. The time required for analysis of one sample is about 70 seconds. However, if rapid analysis times are not required, the instrument cycle time can be slowed by specifying an extended Sampling Time in the Instrument Controls menu.

For applications with limited sample volume, such as those involving sample collection in Tedlar or Teflon bags, the instrument may be set to "Single Analysis" mode. In this mode, the analyzer completes one analysis and then pauses for operator input.
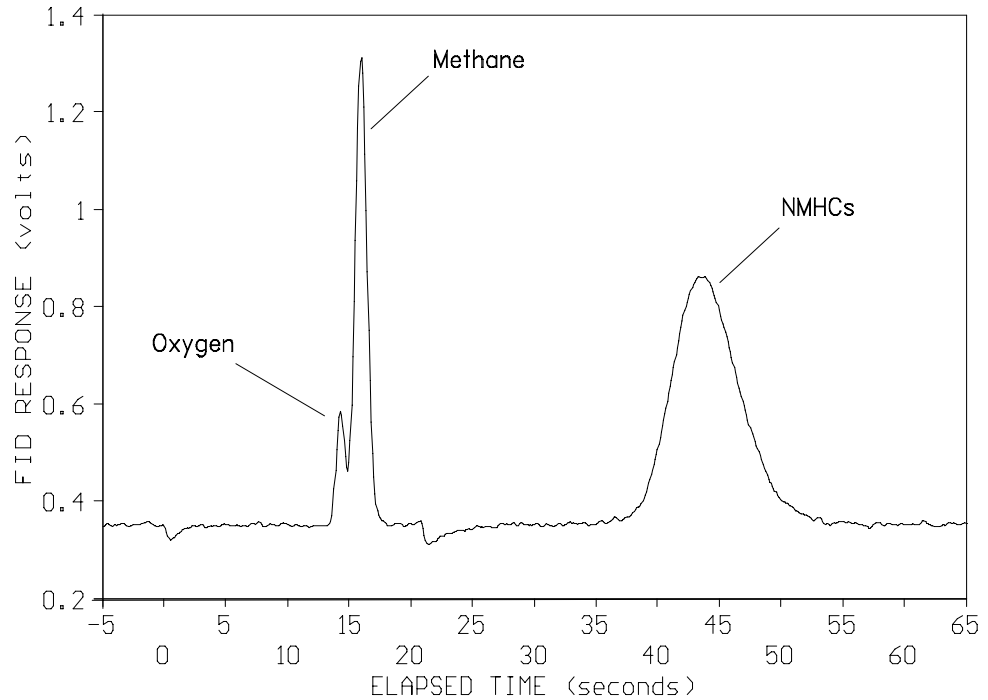
Figure 1–3. Typical Model 55*i* Span Gas Chromatogram

The Model 55*i* is calibrated using a mixture of methane and non-methane hydrocarbons which simulates the actual sample. In most applications, propane is a good choice for the non-methane component. Instrument calibration may be initiated manually or may be performed automatically at user specified intervals. Calibration is achieved by flooding the sample inlet with span gas. Methane concentrations are measured using peak height, measured from baseline references taken before and after the oxygen and methane elute from the column. Due to the variability in peak shapes and retention times, NMHCs are quantified based on peak area rather than height. Because the instrument takes several references during each analysis, a separate zero gas is not usually required for calibration. Note however, that the instrument does provide the option of running zero chromatograms if required.

Methane and non-methane hydrocarbon concentrations are reported on the front panel digital display as methane (CH_4) and non-methane (NM), respectively. Concentration units are the same as those used in calibration, and may be set to display parts per million (ppm) or parts per million carbon (ppmc). The front panel display also includes the time the sample was injected, the instrument operating mode, and various status messages.

Separate analog outputs on the rear panel indicate the results of the most recent methane and non-methane analysis. A dedicated analog output provides a continuous indication of the FID signal (the chromatogram).

Other rear panel connections allow for remote operation of the unit, either by dedicated control lines or with a bi-directional RS-232/Ethernet computer link.

Performance specifications and a description of important instrument parameters are listed on the following pages. A plumbing schematic is presented in Figure 1–4.
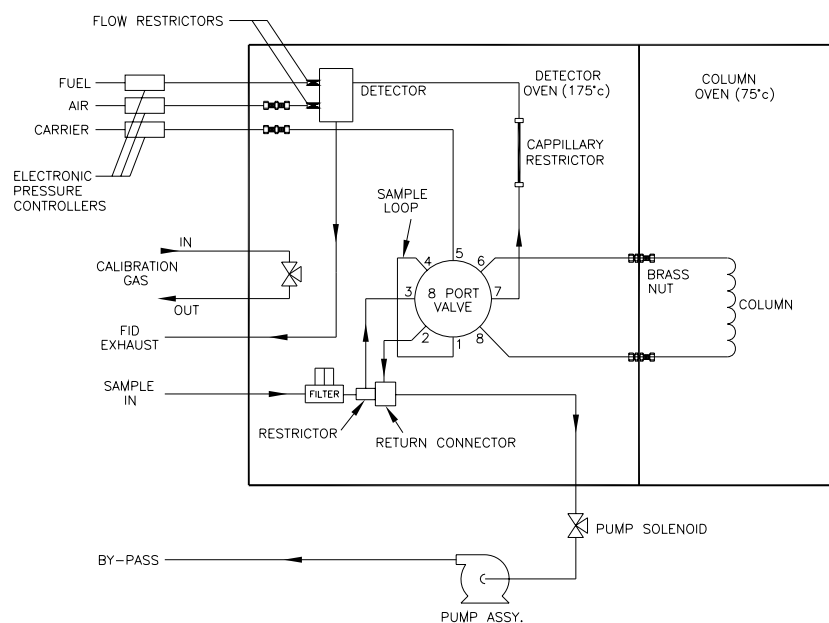
Figure 1–4. Model 55*i* Flow Schematic

Specifications

Table 1–2 lists the specifications for the Model 55*i*.

Table 1–2. Model 55*i* Specifications

Measurement ranges (CH4 and NMHC set independently)	0–5/50/500 ppm
	0–10/100/1000 ppm
	0–20/200/2000 ppm
	0–50/500/5000 ppm
Limit of detection	50 ppb
Analysis time	Approximately 70 seconds
Accuracy	±1% of range
Repeatability	±2% of measured value or 50 ppb (whichever is larger)
Drift (without auto calibration)	±2% of span over 24 hours
Ambient operating temperature	15–35 °C

Sample temperature	Ambient to 80 °C (standard), higher temperatures optional
Sample flow rate	0.5 liter/minute minimum
Power requirements	100 VAC @ 50/60 Hz 115 VAC @ 50/60 Hz 220–240 VAC @ 50/60 Hz 420 Watts
Support gases	HC free air (275–350 cc/min) N_2 carrier (35–70 cc/min) H_2 fuel (25–50 cc/min) or mixed fuel (100–150 cc/min) Span mix (2-liter/calibration)
Physical dimensions	16.75" (W) X 8.62" (H) X 23" (D)
Weight	Approximately 50 lbs.
Analog outputs	6 voltage outputs; 0–100 mV, 1, 5, 10 V (user selectable), 5% of full-scale over/under range (user selectable), 12 bit resolution, measurement output user selectable per channel
Digital outputs	1 power fail relay Form C, 10 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), AK, 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

Note: All NMHC specifications are based on propane.

Chapter 2
Installation

Installation of the Model 55*i* includes unpacking and inspection, connecting sample, zero and span lines, attaching the analog and/or digital outputs to a recording device, and connecting any control or status lines that will be used. The startup section includes instructions for initial powerup of of the Model 55*i* and for adjustment of basic operating parameters, such as gas pressures. The installation should always be followed by instrument calibration as described in the "Calibration" chapter of this manual.

⚠ **Equipment Damage** Do not apply power to the Model 55*i* until all other installation procedures have been completed. An incorrect start-up sequence could damage the instrument. ▲

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

- "Lifting" on page 2-1
- "Unpacking and Inspection" on page 2-2
- "Selecting Hardware and Support Gases" on page 2-3
- "Connecting Support Gases" on page 2-8
- "Connecting External Devices" on page 2-13
- "Startup" on page 2-18
- "Column Conditioning and Initial Burn-In" on page 2-19
- "Running Test Chromatograms" on page 2-19

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 55*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.

Note Save all packing material. If it is ever necessary to ship the instrument for service, the original packing material should be re-used. It is especially important to cap all fittings and to wrap the instrument in plastic before shipment to avoid contamination of the gas lines with packing foam. ▲

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 instrument from the plastic bag and remove the caps or plugs that cover the gas fittings on the rear panel.

3. Remove the cover to expose the internal components.

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

Units without Optional I/O Board

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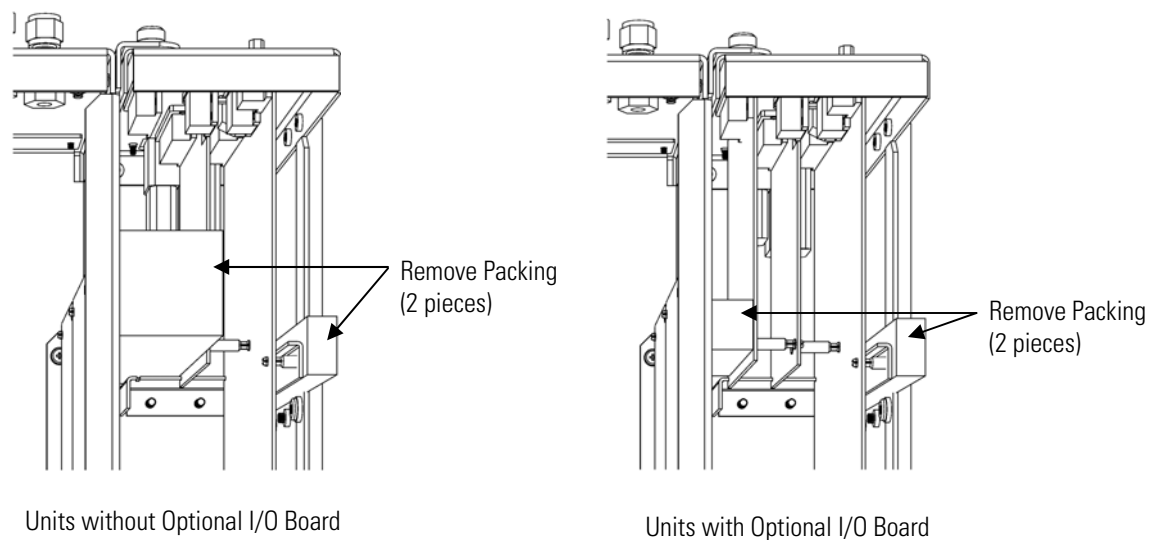
Figure 2–1. Remove the Packing Material

5. Check for possible damage during shipment.

6. Check that all connectors and circuit boards are firmly attached.

7. Re-install the cover.

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

Selecting Hardware and Support Gases

The Model 55*i* requires a number of support gases and some external plumbing for operation. It is important that support gases, regulators, gas lines, gas scrubbers, and fittings are carefully selected to provide the cleanest possible support gases to the instrument. Use of inappropriate gas supplies or hardware will have an adverse affect on performance and can contaminate the instrument with oils or other organic compounds. Appropriate hardware and gases can be obtained from chromatography suppliers and from specialty gas vendors.

The most important consideration in selecting support gases and hardware is the purity of the carrier gas. Low quality carrier gas produces an erratic baseline, can elevate non-methane readings, and contaminate the chromatographic column. Fuel or air contaminated with hydrocarbons can also affect performance by increasing the FID background signal, which can interfere with detection of low-level hydrocarbons.

Gas Pressure Regulators

All gas cylinders should be fit with high quality one or two stage regulators with stainless steel diaphragms. These regulators are available from scientific and specialty gas suppliers and are usually sold as *high purity* regulators.

Carrier gas, fuel, combustion air, and actuator air must be delivered to the Model 55*i* at controlled pressures, which range between 40 and 80 psi as stated below:

- Combustion Air: 40 - 80 psi
- Fuel:
  - (hydrogen)   40 - 60 psi
  - (hydrogen/helium)   70 - 80 psi
- Carrier: 40 - 60 psi
- Actuator Air: 40 - 45 psi

Note Do not use general purpose, industrial, or welding regulators that usually have a rubber or polymeric diaphragm. Polymeric diaphragms tend to give off organic compounds that will interfere with the instrument operation. ▲

Plumbing Lines and Fittings

All support gases are connected to the rear panel of the instrument using 1/4-inch OD tubing and compression fittings (see Figure 2–1). To avoid potential leaks that could result from mixing of different fitting types, use the hardware supplied with the instrument.

If additional fittings are required, contact the service department for recommendations on selecting the correct materials. Choice of gas lines should be given careful consideration. While lines made of plastic materials such as Teflon, are easy to handle, they can give off organic vapors and are sometimes permeable to permanent gases. For best performance, the use of pre-cleaned, GC grade copper or steel is recommended. In most cases, pre-cleaned copper tubing purchased from a GC supply house is recommended. If other materials are used, the lines should be kept as short as possible.
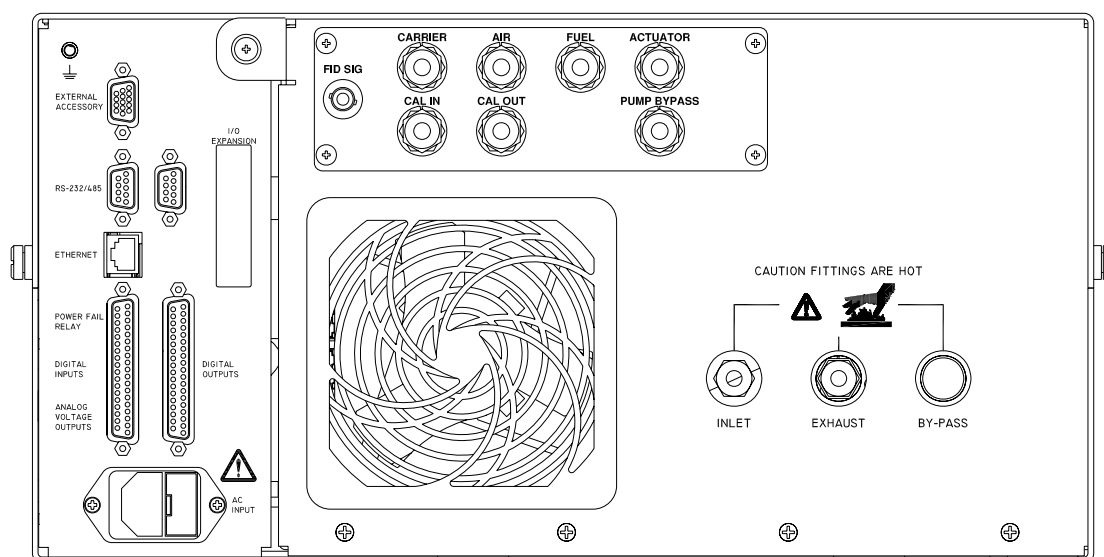
Figure 2–2. Model 55*i* Rear Panel

Gas Scrubbers

Gas scrubbers that remove traces of oxygen, hydrocarbons, and water vapor from the support air and fuel are available from chromatography suppliers. If the highest-grade support gases are used, scrubbers are generally not needed. However, if mid or low grade air and fuel is used, scrubbers may improve performance of the analyzer. Scrubbers are especially helpful if the instrument is being operated with breathing quality air or with *house* air from a compressor.

Note If hydrocarbon scrubbers containing charcoal or molecular sieve are installed, these devices do not remove methane, which is the most common hydrocarbon contaminant. In addition, scrubbers must be replaced or refilled on a regular basis to maintain performance. Failure to provide routine maintenance will result in loss of scrubber performance, and in some cases, can cause increased levels of contamination in the support gases. Because the carrier gas must be ultra-high purity grade, the addition of scrubbers to the carrier line will not usually improve performance, and in some cases can even introduce problems. ▲

Combustion Air

A continuous supply of air is required to support the FID flame. To provide enough air for operation of the FID, the air pressure coming into the instrument must be set between 40 and 80 psi, and the system must be able to supply at least 400 milliliters per minute of flow.

Compressed air is available in several grades, or quality levels, with higher grades being more expensive. The grade of the support air will have some effect on performance, especially when measuring low concentrations of hydrocarbons. For applications involving hydrocarbon measurements below 1 or 2 ppm, *ultra zero* or *ultra high purity* air containing less than 0.1 ppm of total hydrocarbons is the best choice.

Ultra zero grade air is available in cylinders from scientific gas suppliers, or can be obtained from a zero air generator, such as the Thermo Scientific's Model 1160.

For less critical applications, involving measurement of hydrocarbons at concentrations of about 2 ppm or higher, zero air with up to 1 ppm hydrocarbons can be run through charcoal or molecular sieve scrubbers, and used as FID support air.

Compressed air from an industrial house air system can also be used, but will require an oil trap, a particulate filter, a water scrubber, and a hydrocarbon scrubber. These filters and traps will ensure that no harmful contaminants reach the instrument.

Actuator Air

To operate the rotary valve actuator, the actuator air pressure coming into the instrument must be set between 40 and 45 psi, and the system must be able to supply at least 2 liters per minute of flow. Air pressures in excess of 45 psi can reduce the service life of the valve actuator and pressures lower than 40 psi may cause erratic performance. The same air source that supplies the combustion air can be used for the actuator air, as long as the pressure is between 40 and 45 psi. Alternatively, less expensive air grades can be used to drive the valve.

FID Fuel

The Model 55*i* FID operates most efficiently with high purity hydrogen fuel. However, pre-mixed helium/hydrogen fuel can also be used. The air purity considerations discussed earlier can also apply to the fuel.

For critical applications, ultra high purity hydrogen is available with purity levels of 99.999 percent or better. For less demanding applications, pre-purified or zero grade fuels with total hydrocarbon content of less than 0.5 ppm will be adequate. A good quality hydrogen generator is also an excellent source of FID fuel.

If the instrument operates with a mixed helium/hydrogen fuel, the ratio should be 40% hydrogen and 60% helium. This is a standard mixture available from most scientific gas suppliers and is sold as FID fuel with a total hydrocarbon content of less than 0.5 ppm.

Note Operation with mixed fuel requires approximately 2.5 times higher fuel flow than hydrogen. A special mixed fuel flow restrictor that provides adequate flow is available from Thermo Fisher Scientific. For further information regarding operation with mixed fuels, contact the service department. ▲

Carrier Gas

In addition to air and fuel for the FID, the instrument also requires a supply of carrier gas to sweep the sample through the column.

Of the three gases used by the instrument, the purity of the carrier gas is the most important consideration. Low-grade carrier gases will produce an unstable baseline, elevated NMHC readings, and can eventually contaminate the column. For most applications, ultra-high-purity (UHP) nitrogen (99.999%) is the best carrier gas. For laboratory installations, use of boil-off from a liquid nitrogen cylinder is also a good choice.

Calibration Gas

The Model 55*i* requires a calibration, or span gas, mixture containing known concentrations of methane and a non-methane hydrocarbon. For most applications, the non-methane hydrocarbon should be propane, and the gas mixture should be prepared in hydrocarbon free air. Calibration mixtures of methane and propane in air are readily available from scientific gas suppliers, and will remain stable for at least several months. The concentrations of methane and propane in the calibration gas should be about 80% of the concentrations expected in the sample. However, the methane concentration should not be less than 2 ppm and the propane concentration should not be less than 1 ppm.

If calibration at less than 2 ppm methane is required for very small concentrations, an alternate calibration gas must be used. The instrument is set to measure and interpret the highest peak as the methane concentration. Since ambient air is 2 ppm methane, a calibration gas standard with a balance of nitrogen is required.

Various grades or qualities of span gas are available. However, it should be noted that the accuracy of the Model 55*i* measurement can be no better than the accuracy of the calibration standard. For most applications a calibration gas that has been analyzed with an accuracy of ±2% will be sufficient.

If the sample being monitored is known to contain specific hydrocarbons other than methane and propane, a custom span gas containing those same components can often be obtained. In most cases, a custom mixture that is similar to the gas stream being monitored will provide the most accurate calibration. However, custom mixtures are more expensive and may be less stable. Information concerning custom calibration gases can be obtained from scientific gas suppliers.

As a GC based system, the Model 55*i* automatically resets the baseline during each analysis, thus a separate zero gas is not essential for calibration.

If required by regulations or the specific application, a "zero chromatogram" can be run to establish an instrument baseline that will then be subtracted from subsequent analytical cycles. If a zero chromatogram will be used, the zero air mut be ultra-zero grade with total hydrocarbons of less than 0.1 ppm.

Connecting Support Gases

Air, fuel, and carrier gas are connected to the rear panel bulkheads using 1/4 -inch OD line and the compression fittings supplied with the instrument (see Figure 2–1).

Note There are two air inlets on the rear panel. The AIR inlet supplies the FID and the ACTUATOR inlet supplies the rotary valve actuator. In cases where the high purity air supply is limited, the rotary valve actuator may be driven by a lower grade air supply or dedicated compressor. ▲

Sample Inlet

Connect the sample line to the bulkhead fitting labeled SAMPLE INLET using the 1/4-inch compression fitting that is provided. If the sample is expected to contain particulate material, a filter should be included in the sample line to protect the rotary valve.

The sample should be presented to the instrument at a stable pressure near normal atmospheric levels. The instrument's internal pump can work against a vacuum of about 10-inches of water and will draw sample through at least 100-feet of 1/4-inch OD sample line. If sample is being drawn from a source that operates under strong negative pressure, an external pump should be considered. For further information, contact the service department.

If the inlet is connected to a source that operates above atmospheric pressure, or if an external pump will be used, the sampling line must be vented to avoid pressurizing the inlet. In some cases, it may be preferable to shut off or remove the internal pump and add a bypass. Figure 2–3 illustrates the atmospheric dump bypass plumbing required when an external pump is used.

Fluctuations of sample inlet pressures may cause problems with repeatability and accuracy of hydrocarbon measurements. If the inlet pressure is expected to fluctuate, an external pump may be added, or in some cases a backpressure regulator can be included in the sampling system. In addition, if the sample is being drawn from a high temperature source, a heated sample line is required, and the bulkhead connection must be wrapped with insulation to avoid formation of a cold spot.

⚠ **CAUTION** During operation, the sample intake, sample bypass, and FID exhaust bulkheads are extremely hot. Use caution when working with a hot instrument. ▲
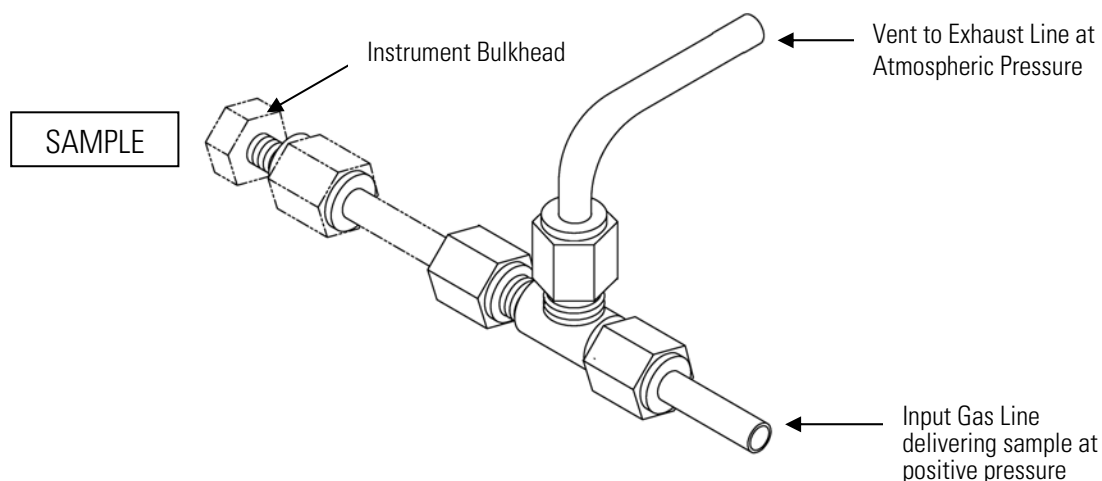
Figure 2–3. Atmospheric Dump Bypass Plumbing

Span Gas Connections

Span gas must be introduced to the instrument through the sample inlet. The internal span control valve allows the instrument micro-processor to turn the span gas on and off, but it does not connect the span gas to the sampling system.

If the internal span valve will be used, connect the span gas cylinder to the port labeled CALIBRATION GAS IN and adjust the cylinder pressure to 10 to 15 psi. Internally, the CALIBRATION GAS IN port is connected to the CALIBRATION GAS OUT port through a two-way solenoid valve and a flow restrictor. The CALIBRATION GAS OUT port must be connected to the sample probe or sample line outside the instrument using a "tee" fitting and check valve, or some other similar arrangement.

As a general rule, the span gas should be introduced in a manner that simulates the sample inlet as closely as possible. For example, if a long sample line is being used, the span gas should be introduced at the end of the sample line near the probe rather than close to the instrument.

Note During the initial calibration, the flow rate of the span gas must be monitored and the pressure regulator adjusted to provide slightly more flow than the instrument pump normally draws in. ▲

Some examples of acceptable sampling arrangements are presented in Figure 2–4 and Figure 2–5. If you are unsure about the correct configuration for your installation, contact the service department for recommendations.
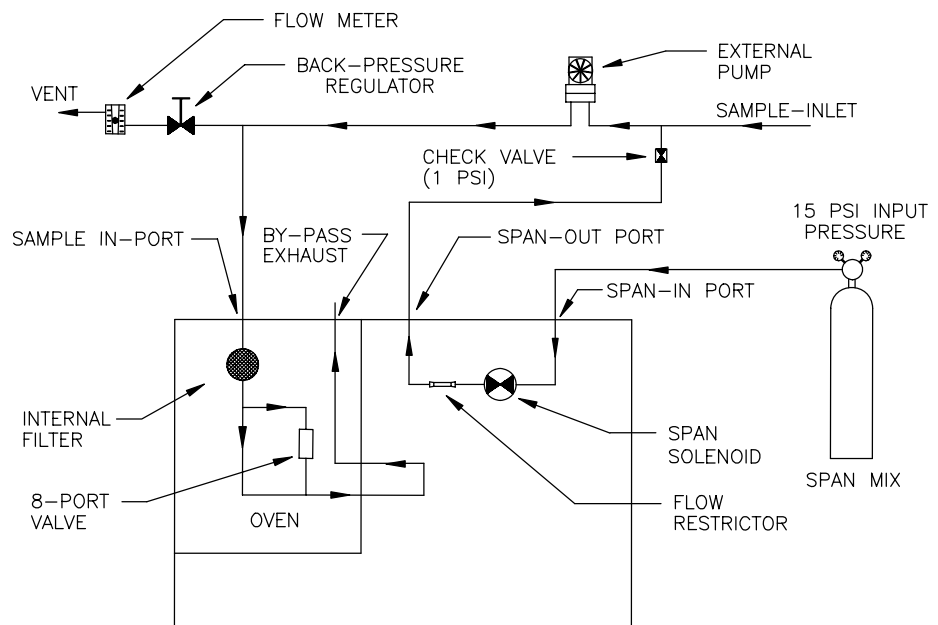
78P806

Figure 2–4. Suggested Sample and Span Connections with External Pump
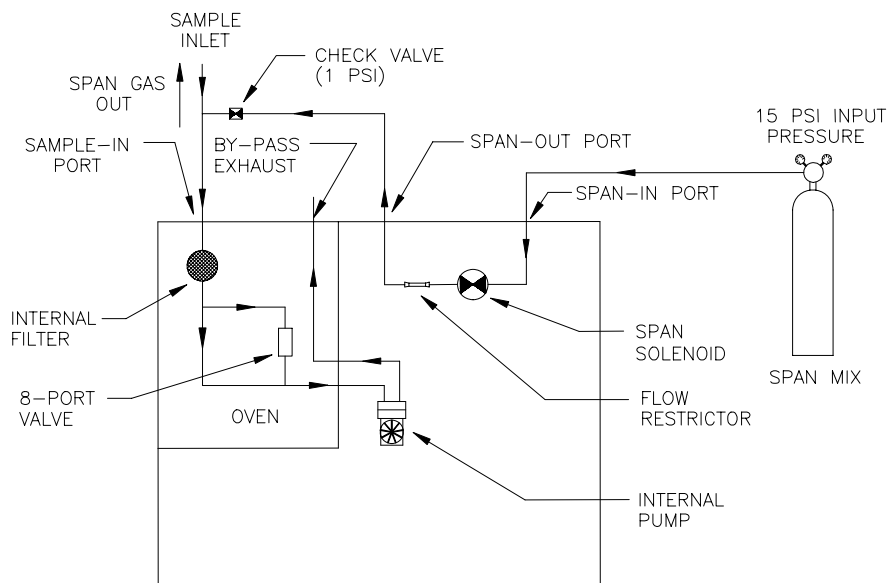
78P806

Figure 2–5. Suggested Sample and Span Connections with Internal Pump

Sample ByPass and FID Exhaust

The FID exhaust and bypass exhaust are located in the lower-right corner of the rear panel next to the sample inlet. On some models there may be a second bypass exhaust located in the lower left corner of the rear panel. In this case, only one of the two bypass exhausts will be in use.

The FID exhaust gas is composed primarily of air and water vapor with some products of combustion. If the instrument is located in a room with reasonable ventilation, the FID exhaust can usually be left open to the atmosphere without creating a hazard. However, if the instrument is located in a small confined space, such as a closed cabinet, it is preferable to run an exhaust line outside or to a ventilation system. If an exhaust line is used, it should be as short as possible and the diameter should be as large as possible to prevent pressurizing the FID. Since the FID flame produces steam, any exhaust line that is used must be configured to slope down away from the instrument to drain off condensation.

Excess sample flows out one of the ports labeled BYPASS at a rate of up to one liter per minute. If the sample stream contains potentially hazardous materials, the bypass should be connected to a ventilation system. Otherwise, the bypass may be left open. If an exhaust line is connected to the bypass, the connection should be as short as possible and should open

at near-atmospheric pressure. Do not connect the sample by-pass and the FID exhaust port to the same line, or to a strong vacuum, such as another pump.

When designing your installation, be aware that changes in the bypass pressure can affect the pump sampling rate and may also affect the accuracy of the analysis. Because of the importance of sample pressure, and because air is mixed with the sample by the pump solenoid, the bypass should not be used to supply sample to another instrument without consulting the service department.

Power Connection

The only electrical connection needed for start-up of the Model 55*i* is the power cord, which plugs into a receptacle 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 55*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 2-13

"Instrument Controls Menu" on page 3-18

"I/O Configuration" on page 3-38

"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 7-16.

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. This assembly provides 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 2–6 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 "B"

See Detail "A"

Component Side Viewed from Top of Board

Detail "A"   Detail "B"

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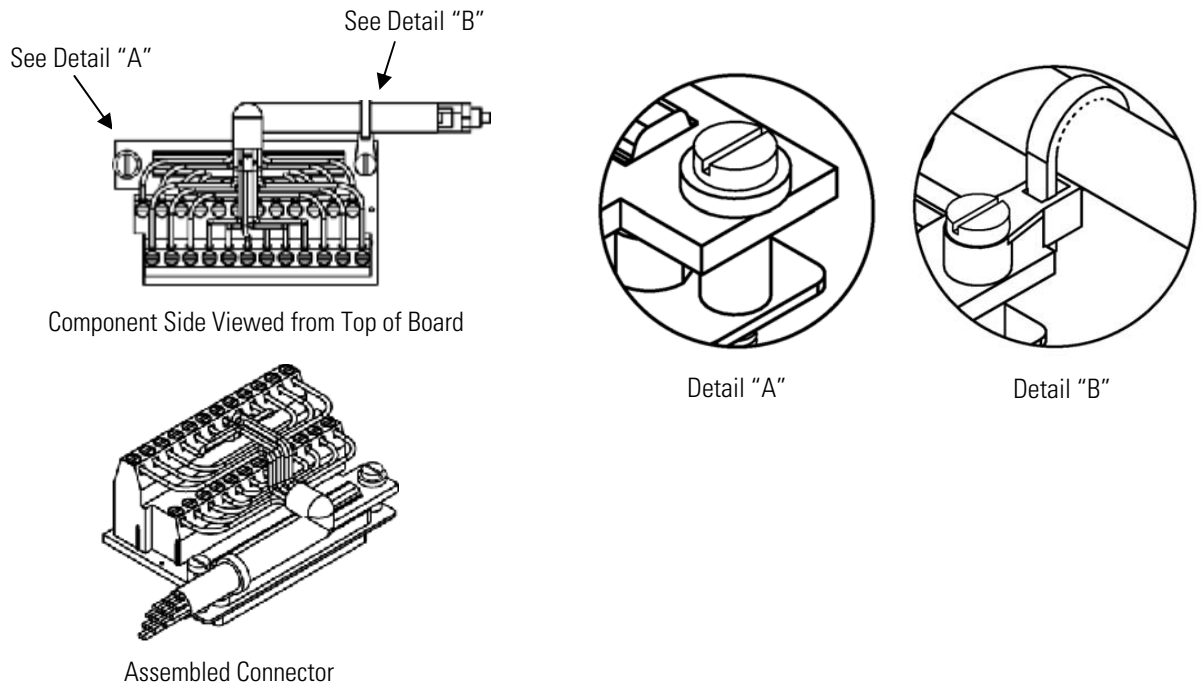
Figure 2–6. I/O Terminal Board Views

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 2–7. See Table 2–2 for channels and pin connections.
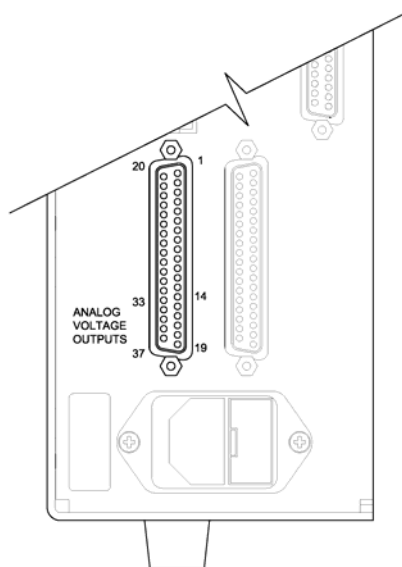
Figure 2–7. Pin-Out of Rear Panel Connector

Table 2–2. Default Analog Outputs

Channel	Connector Pin	I/O Terminal Pin	Description
1	14	1	FID Signal
2	33	3	Methane
3	15	5	NMHC
4	34	7	THC
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 2–8 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
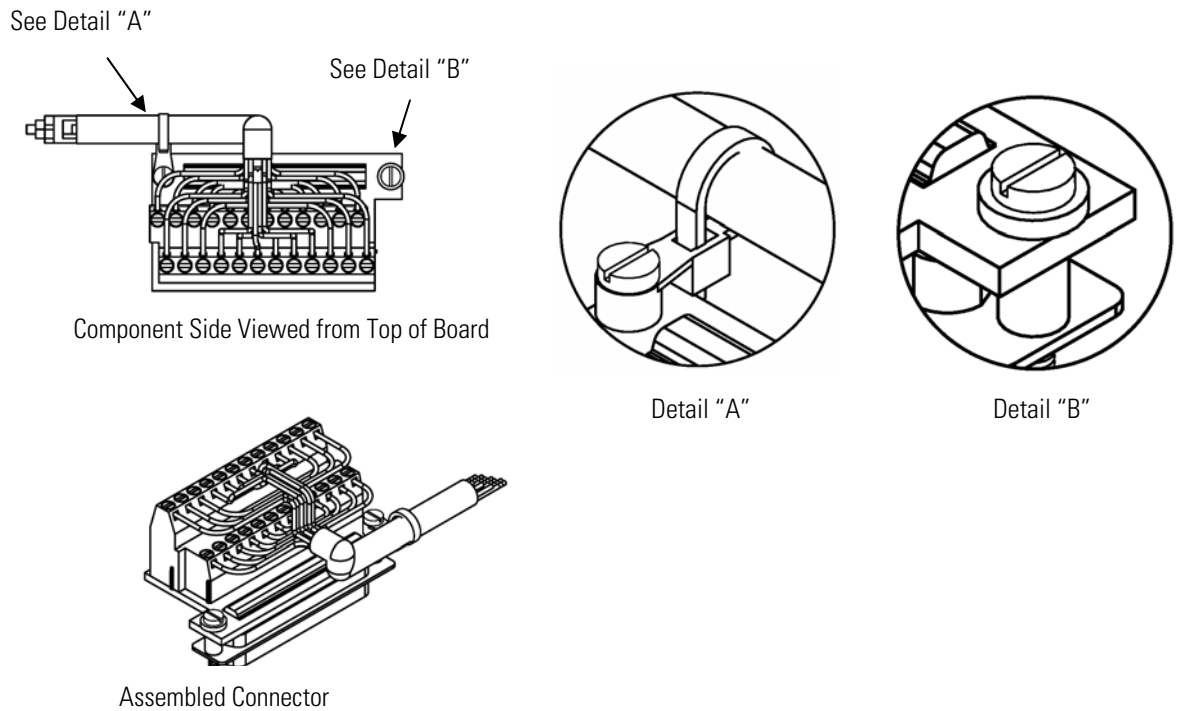
Figure 2–8. D/O Terminal Board Views

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 2–9 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
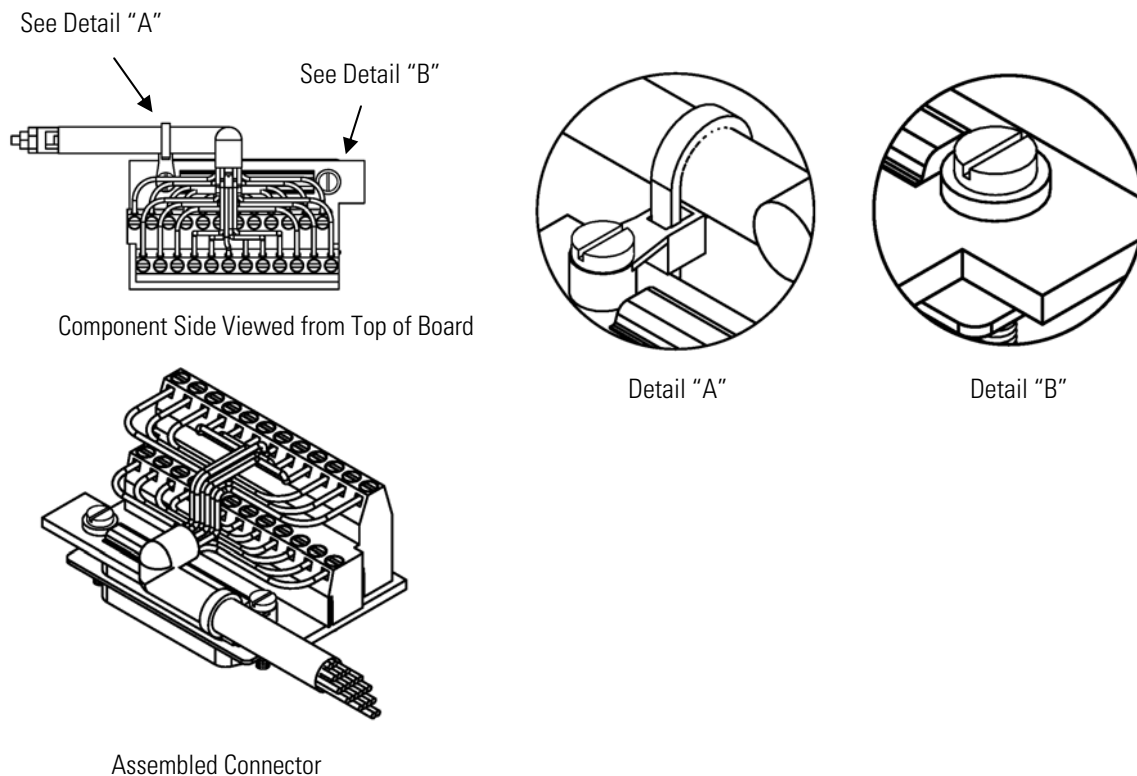
Figure 2–9. 25-Pin Terminal Board Views

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

Instrument start-up should be performed in the order specified below. It is especially important not to turn on the power and heat the ovens until after the carrier gas has been connected and turned on.

⚠

Equipment Damage Heating the column oven while the carrier gas is not flowing may damage the column. ▲

1. Turn on all gas cylinders and adjust cylinder regulators to the following pressures.

   - Fuel:
      - Hydrogen   60 psi
      - Helium-Hydrogen Mix   80 psi
   - Combustion Air: 80 psi
   - Actuator Air: 45 psi
   - Carrier Gas: 60 psi
   - Span Gas: 15 psi

2. Slightly loosen each fitting at the rear of the instrument for about 30 seconds to bleed off air trapped in the lines and scrubbers, and then re-tighten the fittings.

3. Turn on the main power switch and note whether any error messages are reported. After a brief diagnostic test, the instrument will enter the "Warm-Up" mode. The instrument will require about 90 minutes to warm up to full operating temperature.

Note The fuel pressure will read zero during warm-up because the fuel solenoid is automatically closed. The solenoid may be opened using a screen in the Service menu. ▲

4. When the instrument has stabilized at the correct operating temperature, the fuel solenoid will automatically open and the instrument will attempt to light the FID. If ignition fails, the fuel will be shut off, and the front screen will prompt the user to press ⏎ to try again. During the ignition cycle, check the fuel pressure, and if necessary, adjust to match the value shown on the factory test sheet.

5. If the pump is currently off, turn it on using the pump settings on/off screen in the Instrument Controls menu, and then press ⬛▶ to start automatic analyses using the factory entered parameters and calibration.

6. If the instrument fails to start, or if the FID fails to light, refer to the "Troubleshooting" chapter and the "Servicing" chapter in this manual.

Column Conditioning and Initial Burn-In

Although all Model 55*i* analyzers are optimized and run for at least two days at the factory before shipment, most units require a short burn-in period after installation. The simplest procedure for achieving stable operation is to follow the startup procedures described above and then run the built-in column conditioning routine. The column conditioning routine automatically raises the oven temperatures for a period of 8 hours, which then helps condition the column and clean out any accumulated hydrocarbons.

Use the following procedure to initiate a column conditioning cycle.

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

Note If Service Mode is not displayed, refer to "Accessing the Service Mode" on page 7-4. ▲

2. At the Service menu, press ⬛⬇ to scroll down to Condition Column, then press ⬛↵.

3. Press ⬛➡ to begin column conditioning.

The instrument will now raise the oven temperatures and start a timer. After eight hours, the instrument will return to normal operating temperatures.

Running Test Chromatograms

Following installation and burn-in, it is advisable to obtain a series of test chromatograms to ensure that the instrument is operating correctly. In order to obtain chromatograms, it is necessary to connect a chart recorder or data acquisition system the BNC connector on the rear panel of the instrument (FID signal).

For initial tests, the chart recorder's input range should be set to about half of the instrument's output range. That is, if the Model 55*i* outputs are set to the default range of 0-10 volts, the chart recorder should be set for a fullscale deflection at 5 volts. The chart speed should be high enough so that the shape of each chromatographic peak is clearly defined. In most

cases, a speed of 5 to 10 inches per minute will provide good results. If a computer based data acquisition system will be used rather than a chart recorder, the sampling rate should be set to at least 10 Hz.

Test chromatograms should include a blank, a zero air analysis, and a span mix. A set of sample chromatograms is shown in Figure 2–10, and procedures for obtaining each type of chromatogram are presented below.

Ideally, all test chromatograms should look similar, except for the presence or absence of peaks for methane, NMHCs, and oxygen. Although spikes occurring at the time of injection and backflush are normal, the baseline should recover within five seconds and should otherwise appear flat and relatively noise free. In the case that test chromatograms do not appear similar to the examples shown here, see the "Troubleshooting" chapter in this manual.

Blank

A blank chromatogram consists of an injection and backflush of instrument carrier gas. This can be achieved by disconnecting the sample line from the back of the analyzer, turning off the pump and then running a series of five or more analysis cycles. During the initial two or three cycles, the instrument will probably report a non-zero value for methane and non-methane hydrocarbons, and the chromatograms will show peaks for air, methane and non-methane hydrocarbons. However, after a few cycles, the instrument readings should drop to zero. At that point, the chromatograms should appear flat, other than the pressure pulses caused by the valve switching.

Zero Air

Although zero air is not required for calibration, a test chromatogram made with hydrocarbon-free zero air may be useful for evaluation of instrument performance. In order to obtain a zero chromatogram, attach a source of hydrocarbon free air to the sample inlet and, with the pump on, run a series of five to seven analysis cycles. Be sure to include a vent, or atmospheric pressure dump, in the sampling system to prevent pressurizing the inlet. After two to three analysis cycles, the methane and non-methane readings should drop to 0.00 ppm and the associated peaks should disappear from the chromatogram. As illustrated in Figure 2–10, the chromatogram will show one small peak, representing oxygen that was not present in the blank chromatogram. Also, it should be noted that many zero air sources do not completely remove methane and it is not unusual for the zero air chromatogram to show a small peak at the normal location of methane.

Span The final test chromatogram should be run with a calibration mixture containing methane and a non-methane hydrocarbon, in air. For most applications a mixture containing approximately 2 ppm each of methane and propane will provide a good test gas. As with the zero test, the gas mixture for the span test gas should be introduced through the sample inlet, and a vent should be included to avoid pressurizing the system.
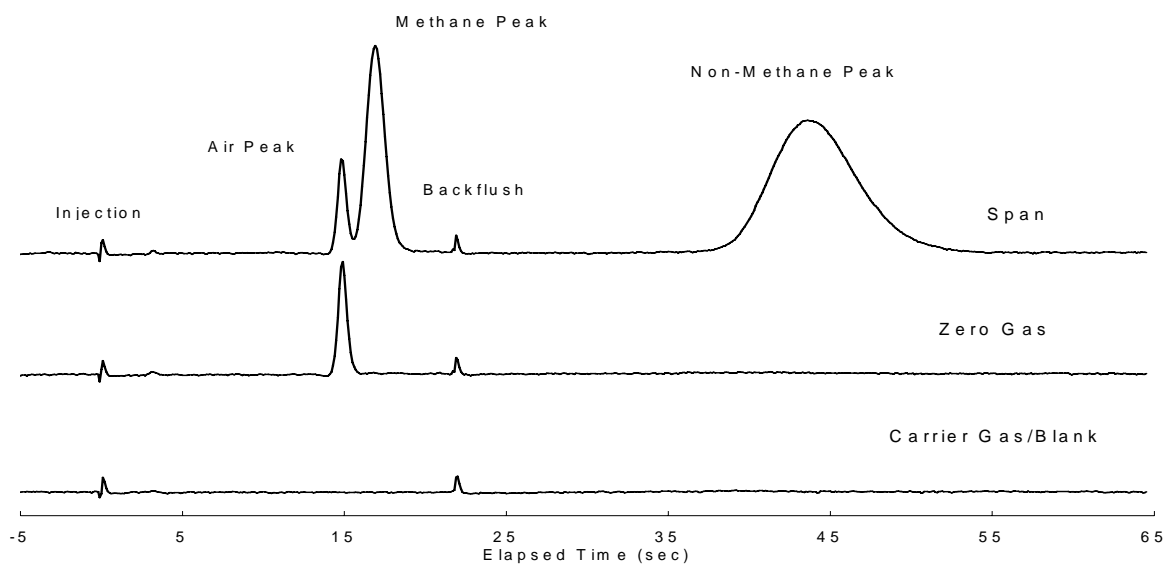
Figure 2–10. Test Chromatograms

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.
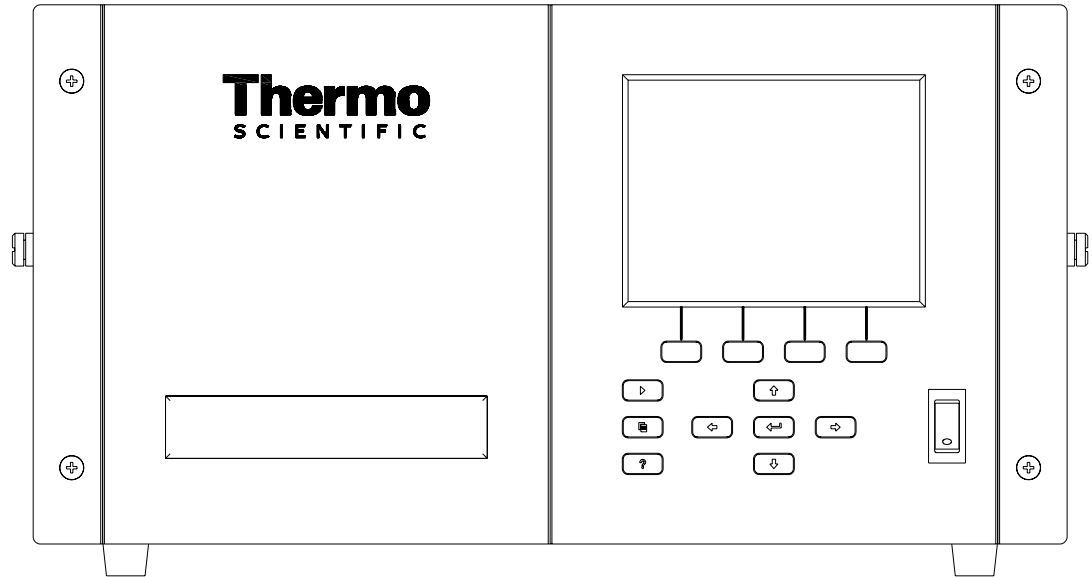
Figure 3–1. Front Panel Display

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.
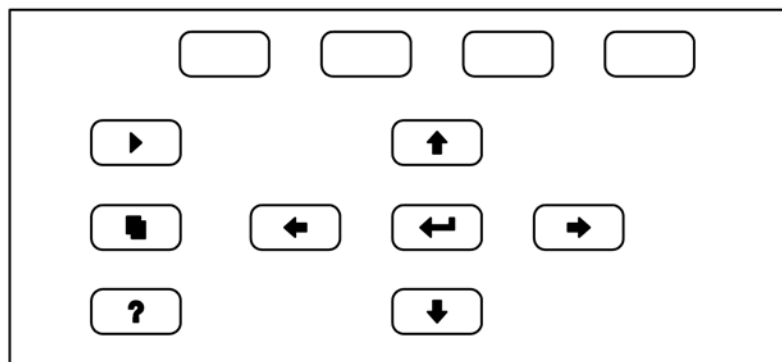
Figure 3–2. Front Panel Pushbuttons

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 measurement of methane and non-methane organics.
■ = 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 desired 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
            ▓ANGE
 █BCDEFGHIJKLMN   BKSP
 OPQRSTUVWXYZ     PAGE
 0123456789_./-   SAVE

 RANGE INST   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 ⟶

```
 █BCDEFGHIJKLMN   BKSP          █bcdefghijklmn   BKSP
 OPQRSTUVWXYZ     PAGE          opqrstuvwxyz     PAGE
 0123456789_./-   SAVE          0123456789_./-   SAVE

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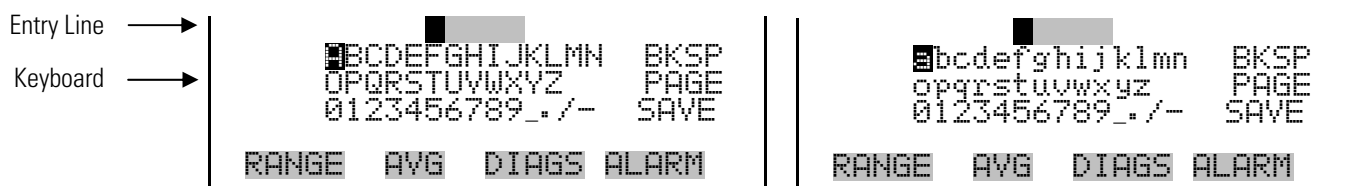
Firmware Overview

The Model 55*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 measurement of methane and non-methane organics 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.
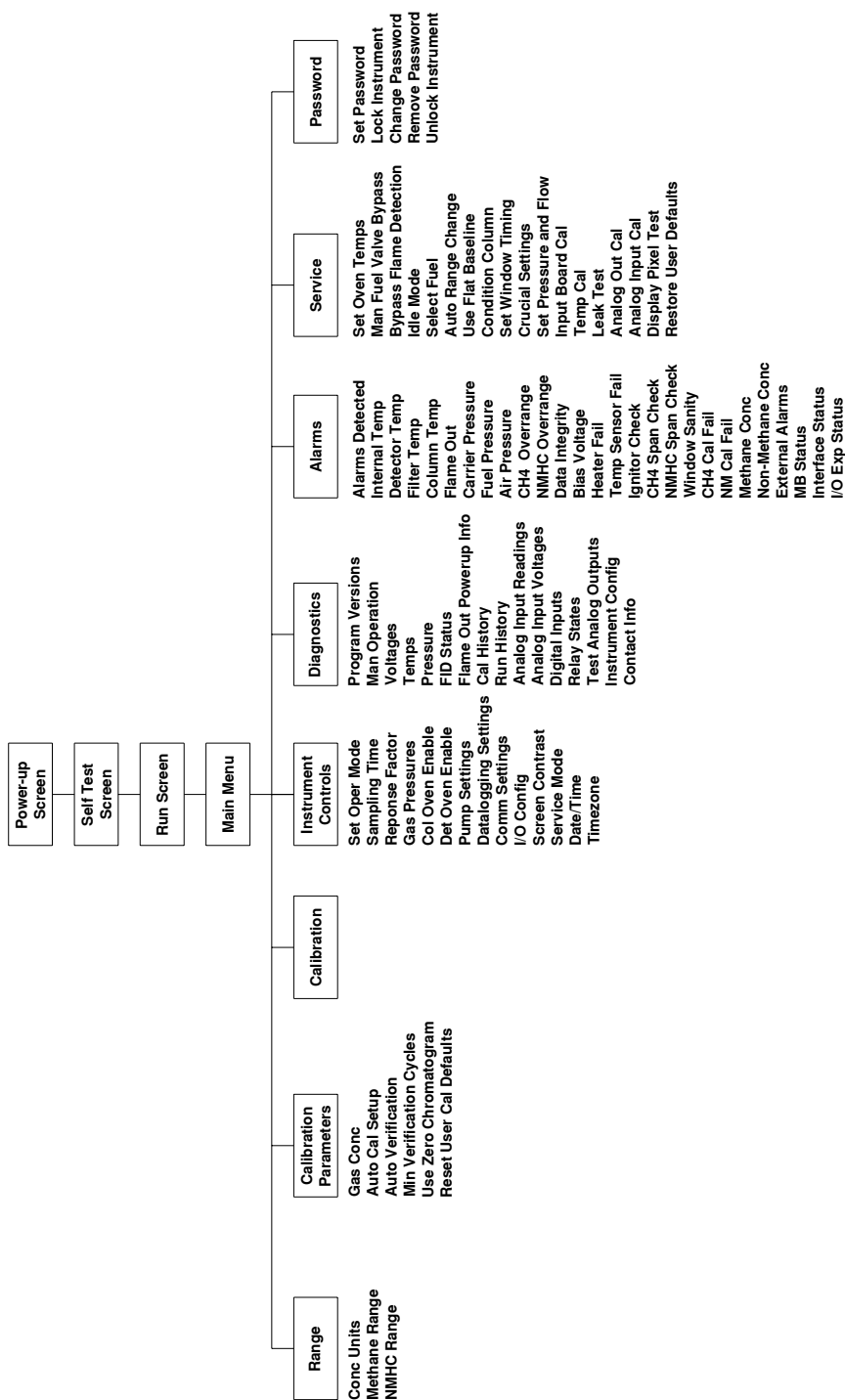
Figure 3–3. Flowchart of Menu-Driven Firmware

Power-Up Screen   The Power-Up screen is displayed when power is applied to the Model 55*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 methane and non-methane concentrations. 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 title bar on the top of the screen indicates the current status of the instrument and operating mode. During power-up, the title bar displays "HOT START", "WARM START", or "COLD START". After 15 seconds, the title bar will change to "WARMING UP".

During normal operation, the title bar displays the measurement mode as "AUTO RUN MODE", "SINGLE RUN MODE", or "**IDLE MODE**".

If the column conditioning function is started, then the title bar displays "**CONDITIONING COLUMN!**" for the duration of the conditioning. If the flame detection has been bypassed, then the title bar displays "FLAME DETECTION BYPASSED" instead of the run mode.

The first line on the run screen, labeled "CH4" displays the current methane reading. The second line labeled "NM" displays the current non-methane reading. If the unit is configured, or programmed, for continuous operation, a run screen similar to that shown below will appear on the front display. Pressing [←] will cancel a run.

The INJ TIME field shows what time the sample was injected for the current data being displayed on the run screen.

The left side of the message field displays the current measurement run state: "SAMPLING", "INJECT", "BACKFLUSH", "PROCESSING", "DONE", "CANCELED", or "PURGE". The right side of the message field displays the FID status: "FLAME OUT", "PRESSURE WAIT", "IGNITING", "CHECING" or "LIT".

The word "SAMPLE" on the left of the status bar indicates the analyzer is performing a "SAMPLE" run. Other run types appear in the same area of the display as "ZERO", or "SPAN".

The status bar also displays the current time (24-hour format), the valve position ("BF" or "INJ"), password, service, and alarm icons.

Title Bar — AUTO RUN MODE

CH₄ 123.6 ppm — Gas Concentraton

NM 123.4 ppm — Gas Units

Messages — INJ TIME: 14:59 / BACKFLUSH FLAME OUT

PRESS ← TO CANCEL RUN

Status Bar — SAMPLE 12:34 BF 🔒 🔧 🔔 — Status Bar Icons

RANGE INST DIAGS ALARM

Programmable Soft Key Labels
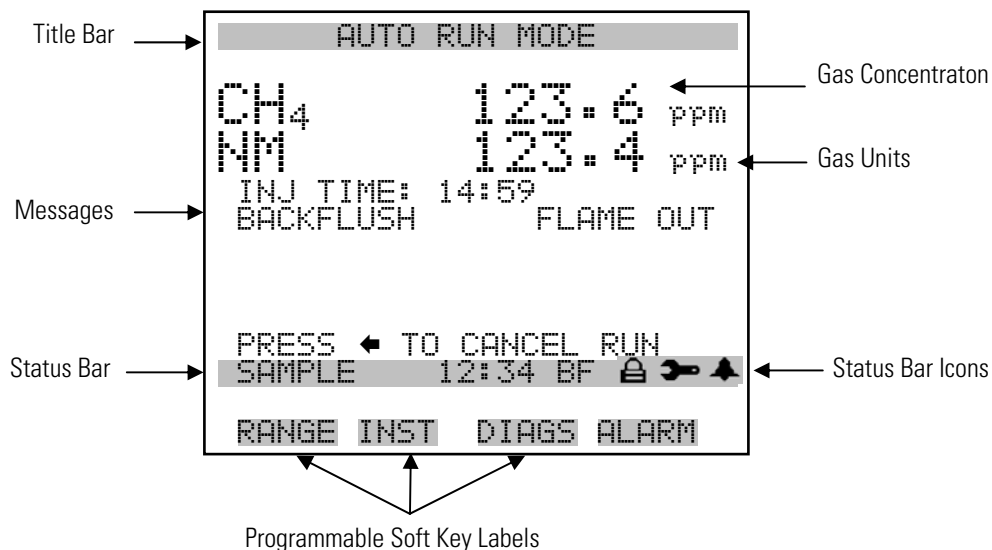
Main Menu

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.

```
        AUTO RUN MODE
CH4              123.6 ppm
NM               123.4 ppm
INJ TIME:
BACKFLUSH           FLAME OUT

SAMPLE       12:34    🔒 🔧 🔔
MAIN MENU:
>RANGE
 CALIBRATION PARAMETERS
 CALIBRATION
 INSTRUMENT CONTROLS
 DIAGNOSTICS                  ⬇

RANGE INST   DIAGS ALARM
```
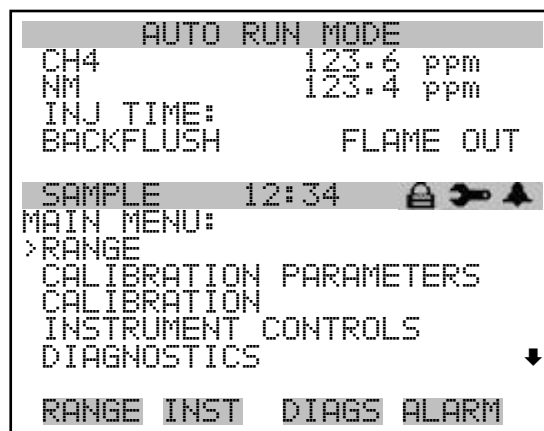
```
 ALARMS
 SERVICE
 PASSWORD
```

Range Menu

The Range menu allows the operator to select the gas units and ranges for both methane and non-methane. Depending on the loop size chosen, the instrument has a distinct set of three preset range values available. See **Table 3–2** for the range values. For more information on loop size, see "Instrument Configuration" on page 3-61.

● In the Main Menu, choose **Range**

```
RANGE:
>CONC UNITS              ppm
 METHANE RANGE          2000
 NMHC RANGE             2000


  RANGE INST   DIAGS ALARM
```
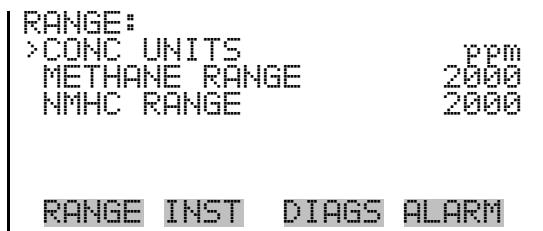
Table 3–2. Loop Size Range Values

Loop Size	Low Range Concentration	Medium Range Concentration	High Range Concentration
Trace Concentration	5	50	500
Low Concentration	10	100	1000
Medium Concentration	20	200	2000
High Concentration	50	500	5000

Concentration Units

The Concentration Units screen defines how the methane and non-methane concentration are expressed. Gas units of parts per billion (ppb), parts per million (ppm), parts per million carbon (ppmc), micrograms per cubic meter (µg/m³), milligrams per cubic meter (mg/m³), 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 200000 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 55*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/m^3 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 INST  DIAGS ALARM
```

```
CONC UNITS:
  CURRENTLY:           ppm
     SET TO:       μg/m3 ?
WARNING! RECALIBRATE AFTER
  CHANGING UNIT SETTING!
⬆⬇ CHANGE VALUE     ↵ SAVE

RANGE INST  DIAGS ALARM
```

Methane Range

The Methane Range screen defines the concentration range of the analog outputs. For example, selecting a methane range of 0–200 ppm sets the analog output to concentrations between 0 and 200 ppm. Available ranges include: 0–20, 0–200, and 0–2000 with a medium sample loop.

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

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

```
METHANE RANGE:
  CURRENTLY:            20
     SET TO:          200 ?

       ⬆⬇ CHANGE VALUE
       ↵ SAVE VALUE

RANGE INST  DIAGS ALARM
```

Non-Methane Range

The Non-Methane Range screen defines the concentration range of the analog outputs. For example, selecting a non-methane range of 0–200 ppm sets the analog output to concentrations between 0 and 200 ppm. Available ranges include: 0–20, 0–200, and 0–2000 with a medium sample loop.

The display shows the current non-methane range. The next line of the display is used to change the range.

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

```
NON-METHANE RANGE:
  CURRENTLY:            20
    SET TO:           200 ?

              ↑↓ CHANGE VALUE
               ↵ SAVE VALUE

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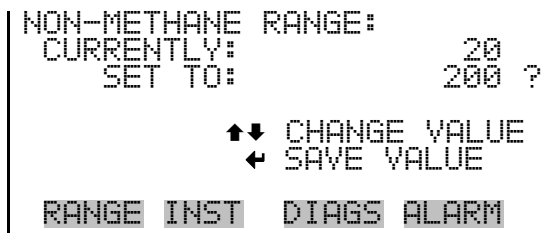
The analog outputs are arranged on the rear panel connector as shown in Figure 3–4. See Table 3–3 for channels and pin connections.
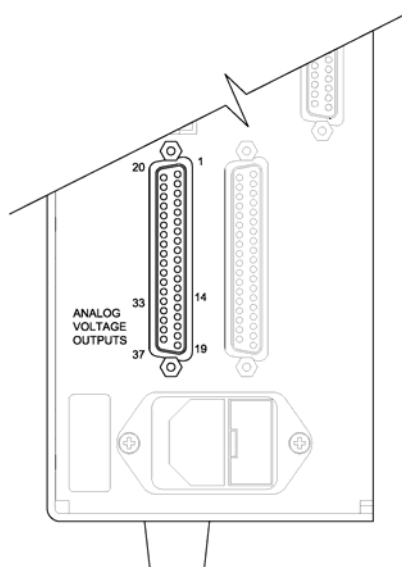
Figure 3–4. Pin-Out of Rear Panel Connector

Table 3–3. Default Analog Outputs

Channel	Connector Pin	I/O Terminal Pin	Description
1	14	1	Raw Signal
2	33	3	Methane
3	15	5	NMHC
4	34	7	THC
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. ▲

Calibration Parameters Menu

The Calibration Parameters menu is used to adjust operating parameters that relate to instrument calibration. Once the calibration method has been established, the actual calibration procedure can be triggered automatically.

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

```
CALIBRATION PARAMETERS:
>GAS CONCENTRATIONS
 AUTO CALIBRATION SETUP
 AUTO VERIFICATION
 MIN VERIFICATION CYCLES
 USE ZERO CHROMATOGRAM      ↓

 RANGE INST   DIAGS ALARM
```

```
RESET USER CAL DEFAULTS
```

Gas Concentrations

The Gas Concentrations menu allows the user to set the calibration gas concentrations for methane and non-methane. The screens below show the gas concentrations for single-span gas mode and three-span gas mode (low, mid, and hi). For more information on number of span gases, see "Instrument Configuration" on page 3-61.

● In the Main Menu, choose Calibration Parameters > **Gas Concentrations**.

```
GAS CONCENTRATIONS:
>CH4                   2.00
 NMHC                  5.00



 RANGE INST   DIAGS ALARM
```

```
GAS CONCENTRATIONS:
>LOW CH4               2.00
 MID CH4               2.00
 HI CH4                2.00
 LOW NMHC              5.00
 MID NMHC              5.00↓
 RANGE   AVG   DIAGS ALARM
```

```
HI NMHC                5.00
```

Methane Calibration Gas Concentration

The Methane Calibration Gas Concentration screen is used to enter the one methane calibration gas concentration in 1-span-gas mode OR the selected low, middle, or high concentration in 3-span-gas mode.

The display shows the current methane calibration gas concentration in single span gas mode. The next line of the display is where the span gas

concentration is entered. Press ⟨ ↵ ⟩ to save the new methane calibration gas concentration.

● In the Main Menu, choose Calibration Parameters > Gas Concentrations > **CH4**.

```
METHANE CAL GAS CONC:
 CURRENTLY:          2.00
    SET TO:      00002.07 ?

           ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  INST   DIAGS  ALARM
```
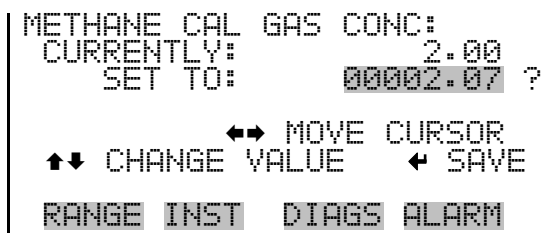
Non-Methane Calibration Gas Concentration

The Non-Methane Calibration Gas Concentration screen is used to enter the one non-methane calibration gas concentration in 1-span-gas mode OR the selected low, mid, or hi concentration in 3-span-gas mode.

The display shows the current non-methane calibration gas concentration in single span gas mode. The next line of the display is where the span gas concentration is entered. Press ⟨ ↵ ⟩ to save the new non-methane calibration gas concentration.

● In the Main Menu, choose Calibration Parameters > Gas Concentrations > **NMHC**.

```
NON-METHANE CAL GAS CONC:
 CURRENTLY:          5.00
    SET TO:      00005.07 ?

           ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  INST   DIAGS  ALARM
```
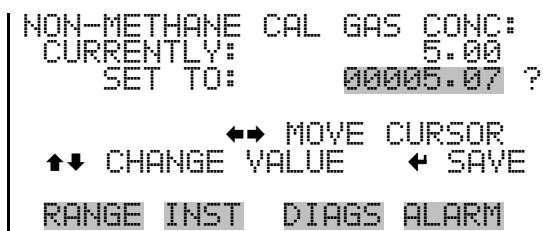
Auto Calibration Setup

The Auto Calibration Setup menu is used for setting the automatic calibration/check options.

● In the Main Menu, choose Calibration Parameters > **Auto Calibration Setup**.

```
AUTO CALIBRATION SETUP:
>CAL MODE              OFF
 SETTINGS
 CAL RESET             NO



 RANGE INST  DIAGS ALARM
```

Calibration Mode The Calibration Mode screen is used to switch between the various auto-calibration modes. The list of choices include: Off (no automatic calibration or check will be performed), By Run (define number of normal runs between calibrations), or By Time (calibrations performed after a specified duration starting at a specified time).

● In the Main Menu, choose Calibration Parameters > Auto Calibration Setup > **Cal Mode**.

```
AUTO CALIBRATION MODE:
 CURRENTLY:           OFF
    SET TO:      BY TIME?

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

Settings The Settings submenu is used for setting the auto calibration/check parameters. Number of runs is only present if calibration mode is BY RUN or OFF. Initial time and period are only present if calibration mode is BY TIME or OFF.

● In the Main Menu, choose Calibration Parameters > Auto Calibration Setup > **Settings**.

```
AUTO CALIBRATION SETTINGS:
>NUMBER OF RUNS        10
 INITIAL TIME
 PERIOD                0



 RANGE INST  DIAGS ALARM
```

Number of Runs The Number of Runs screen is used to adjust the number of runs between auto-calibration actions, and is displayed only if calibration mode is set to BY RUN or OFF. This can be set to any value between 2 and 999.

● In the Main Menu, choose Calibration Parameters > Auto Calibration Setup > Settings > **Number of Runs**.

```
NUMBER OF RUNS:
 CURRENTLY:        10 RUNS
    SET TO:       01█ RUNS?

              ◄► MOVE CURSOR
  ▲▼ CHANGE VALUE    ◄┘ SAVE
   RANGE INST  DIAGS ALARM
```

Initial Time   The Initial Time screen is used to adjust the number of runs between auto-calibration actions, and is displayed only if calibration mode is set to BY TIME or OFF. The user can set the initial time and date, and the analyzer will run at every "period" interval thereafter. The screen initially displays the next time that an auto-calibration event will occur.

● In the Main Menu, choose Calibration Parameters > Auto Calibration Setup > Settings > **Initial Time**.

```
NEXT DATE AND TIME:
 19 MAR 2005  12:34
PRESS ◄┘ TO EDIT



   RANGE INST  DIAGS ALARM
```

```
NEXT DATE AND TIME:
 19 MAR 2005  12:34 ?
SETTING: DAYS
          ➡ SET MONTHS
         ▲▼ CHANGE VALUE
          ◄┘ SAVE VALUE
   RANGE INST  DIAGS ALARM
```

Period   The Period screen is used to adjust the number of hours between auto-calibration actions. This may be set from 0 to 99 hours inclusive. If the period is set to 0, the calibration will only be run a single time.

● In the Main Menu, choose Calibration Parameters > Auto Calibration Setup > Settings > **Period**.

```
PERIOD:
 CURRENTLY:        10 HRS
    SET TO:       1█ HRS ?

              ◄► MOVE CURSOR
  ▲▼ CHANGE VALUE    ◄┘ SAVE
   RANGE INST  DIAGS ALARM
```

Calibration Reset   The Calibration Reset screen is used to switch between "auto-calibration" OR "auto-check" modes, and may be set to either YES or NO. If it is set to YES, an auto-calibration will be performed. If it is set to NO, an auto-check will be performed.

● In the Main Menu, choose Calibration Parameters > Auto Calibration Setup > **Cal Reset**.

```
CALIBRATION RESET:
 CURRENTLY:            NO
    SET TO:           YES ?

              ← TOGGLE VALUE


 RANGE INST   DIAGS ALARM
```

Auto Verification   The Auto Verification screen allows the user to set the automatic vreification mode on or off. If it is set to on, each calibration will involve at least two analysis cycles. Data collected during consecutive cycles will be compared to determine calibration repeatability. If auto-verification is set to off, calibration will be based on a single analysis cycle, and will not be checked. In most cases, the auto verification should be set to on.

● In the Main Menu, choose Calibration Parameters > **Auto Verification**.

```
AUTO VERIFICATION:
 CURRENTLY:           OFF
    SET TO:           ON ?

              ← TOGGLE VALUE


 RANGE INST   DIAGS ALARM
```

Min Verification Cycles   The Verification Cycles screen allows the user to adjust the minimum number of verification cycles used when auto verification is on. Values are between 2 (default) and 5.

● In the Main Menu, choose Calibration Parameters > **Min Verification Cycles**.
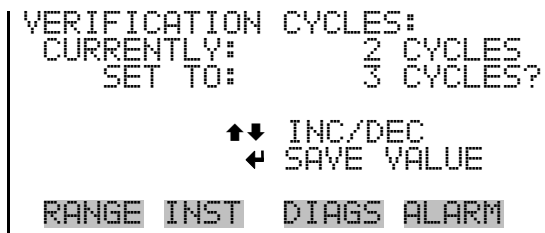
```
VERIFICATION CYCLES:
 CURRENTLY:        2 CYCLES
      SET TO:      3 CYCLES?

              ♦♦ INC/DEC
              ↵  SAVE VALUE

  RANGE INST  DIAGS ALARM
```

Use Zero Chromatogram

The Use Zero Chromatogram screen allows the user to choose whether to use a previously stored zero chromatogram for baseline correction or not.

Note The screen will show "ZERO CHROM DATA IS INVALID" if set to YES and the data is not OK. ▲

● In the Main Menu, choose Calibration Parameters > **Use Zero Chromatogram**.

```
USE ZERO CHROMATOGRAM:
 CURRENTLY:            YES
      SET TO:          NO ?

              ↵ TOGGLE VALUE

  RANGE INST  DIAGS ALARM
```

Reset User Calibration Defaults

The Reset User Calibration Defaults screen allows the user to reset the calibration factors, response factor, calibration error limits, and auto-calibration parameters to factory defaults. This function also clears the zero chromatogram data and invalidates the zero chromatogram (the user will have to take a new zero chromatogram to continue to use this feature).

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

```
RESTORE DEFAULT CAL:

              ↵ RESTORE




  RANGE INST  DIAGS ALARM
```

```
RESTORE DEFAULT CAL:

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


  RANGE INST  DIAGS ALARM
```
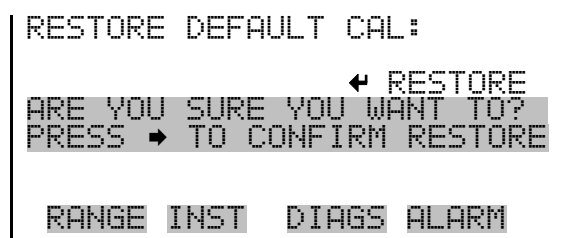
Calibration The Manual Calibration screen is used to manually initiate calibration or calibration check on the instrument. If calibration can not be performed, the instrument will respond with "NOT ABLE TO START CAL NOW!"

Note The screen will show "ZERO CHROM DATA IS INVALID" if use zero chromatogram is ON and the data is not OK. ▲

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

```
MANUAL CALIBRATION:
 PRESS KEY TO BEGIN:
        ➡ CALIBRATION
        ⬅ CALIBRATION CHECK
        ⬇ DO ZERO CHROM.


RANGE INST   DIAGS ALARM
```

Instrument Controls Menu The Instrument Controls menu contains a number of items that may be used 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 OPERATION MODE
 SAMPLING TIME
 RESPONSE FACTOR
 GAS PRESSURES
 COLUMN OVEN ENABLE        ⬇

RANGE INST   DIAGS ALARM
```

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

Set Operation Mode

The Set Operation Mode screen allows the user to choose between continuous and single run mode. Continuous mode is the usual setting and allows the instrument to run automatically. In single run mode, the instrument pauses after each analysis and waits until the RUN button is pressed before starting another measurement cycle. The single mode is useful for measurement samples collected in bags or other containers.

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

```
OPERATING MODE:
 CURRENTLY:      CONTINUOUS
     SET TO:         SINGLE

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

Sampling Time

The Sampling Time screen allows the user to adjust the instrument sampling time, which is a pause that occurs just before injection. In single run mode, the sampling time counts down from the time the RUN button is pressed until the time of sample injection. In continuous mode, the sampling time is added at the start of the measurement cycle. The sampling time can range from 4 (default) to 999 seconds.

● In the Main Menu, choose Instrument Controls > **Sampling Time**.

```
SAMPLING TIME:
 CURRENTLY:          4 SEC
     SET TO:       00█ SEC?

              ↔ MOVE CURSOR
  ↑↓ CHANGE VALUE    ↵ SAVE
   RANGE  INST   DIAGS ALARM
```

Response Factor

The Response Factor screen allows the user to set a multiplier that is then automatically applied to the NMHC measurement before it is displayed or sent to the analog output. The response factor can be used to compensate for any difference in detector response between the actual sample and the span gas. Limits are 0.0001 to 1000.0. For most applications, the response factor should be set to 1.0 (default), which has no effect on the NMHC reading.

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

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

              ←→ MOVE CURSOR
   ↑↓ CHANGE VALUE    ← SAVE

  RANGE  INST   DIAGS ALARM
```

Gas Pressures

The Gas Pressures menu is used to view and adjust the set pressures for the carrier, 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 5–50 psi, refer to the customer data sheet for initial settings.

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

```
SET PRESSURES:
>CARRIER RUN    32.0 psi
 CARRIER IGNITE 32.0 psi
 AIR RUN        23.9 psi
 AIR IGNITE     16.4 psi
 H2 FUEL RUN     9.8 psi  ↓

  RANGE  INST   DIAGS ALARM
```

```
 H2 FUEL IGNITE  9.5 psi
 MIX FUEL RUN   22.4 psi
 MIX FUEL IGNITE22.4 psi
```

The following example sets the CARRIER RUN pressure to 32.9 psi. All of the other set pressure screens function the same way.

```
SET PRESSURE:     CARRIER
 CURRENTLY:      32.0 psi
     SET TO:     32.9 psi ?

              ←→ MOVE CURSOR
   ↑↓ CHANGE VALUE    ← SAVE

  RANGE  INST   DIAGS ALARM
```

Column Oven Enable

The Column Oven Enable screen is used to turn the column oven heater on or off.

Note This setting is NOT saved on power cycle, it is always reverted to ON on power-up. ▲

● In the Main Menu, choose Instrument Controls > **Column Oven Enable**.

```
COLUMN OVEN:
  CURRENTLY:        ENABLED
     SET TO:       DISABLED ?

                ↵ TOGGLE VALUE


 RANGE INST   DIAGS ALARM
```

Detector Oven Enable

The Detector Oven Enable screen is used to turn the detector oven heater on or off.

Note This setting is NOT saved on power cycle, it is always reverted to ON on power-up. ▲

● In the Main Menu, choose Instrument Controls > **Detector Oven Enable**.

```
DETECTOR OVEN:
  CURRENTLY:        ENABLED
     SET TO:       DISABLED ?

                ↵ TOGGLE VALUE


 RANGE INST   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  INST   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 NMHC 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, NMHC 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  INST    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  INST    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  INST    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:
                   0000003
TOTAL LRECS:            20

              ←→ MOVE CURSOR
   ↑↓ CHANGE VALUE    ← SAVE

   RANGE INST  DIAGS ALARM
```

The Record Display screen (read only) displays the selected records. Use the UP and DOWN arrow keys to scroll through the records and the LEFT and RIGHT arrow keys to view the data items for each record.

```
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 INST  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 INST  DIAGS ALARM
```

The Record Display screen (read only) displays the selected records. Use the UP and DOWN arrow keys to scroll through the records and the LEFT and RIGHT arrow keys to view the data items for each record.

```
 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 INST  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). This will only erase the logged data, it will not reset the selected content.

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

```
ERASE LREC LOG FILE DATA?
                 ↵ ERASE




RANGE INST  DIAGS ALARM
```

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


RANGE INST  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          CH4
 FIELD 2          NMHC
 FIELD 3          DET_TEMP
 FIELD 4          COL_TEMP
 FIELD 5          FLAME ⬇
RANGE INST  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 INST   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
 METHANE                    <--
 NMHC
 THC


 RANGE INST   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. 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
 COLUMN TEMP
 FLAME TEMP                        ↓

 RANGE  INST   DIAGS  ALARM
```

```
 INT TEMP
 AIR PRES
 CARRIER PRES
 FUEL PRES
 RAW SIGNAL
 FLAME STATUS
 CH4 PK HT
 CH4 PK RT
 CH4 BASELINE
 CH4 LOD
 NM PK HT
 NM PK AREA
 NM BASE ST
 NM BASE END
 NM LOD
 NM START IDX
 NM END IDX
 NM MAX SLOPE
 NM MIN SLOPE
 NM DATA PTS
 EXT ALARMS
```

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. Note: the optional I/O Expansion Board must be installed to use analog outputs.

● 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  INST   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  INST   DIAGS  ALARM
```

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


 RANGE  INST   DIAGS  ALARM
```

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

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


 RANGE  INST   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:
>MEMORY ALLOCATION %   50




  RANGE INST   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:
 CURRENTLY:          50%
    SET TO:          60% ?


 ⬆⬇ CHANGE VALUE    ← SAVE
 RANGE INST   DIAGS ALARM
```

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

 RANGE INST   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 INST   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 INST  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 INST  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 INST  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  INST   DIAGS  ALARM
```
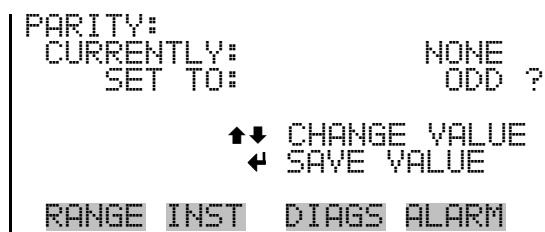
Stop Bits   The Stop Bits screen is used to set the number of stop bits for the serial port to 1 (default) or 2.

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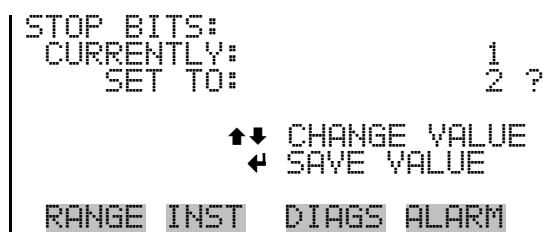
RS-232/RS-485 Selection   The RS-232/RS-485 Selection screen allows the user to choose between the RS-232 or RS-485 specification for serial communication.

⚠ **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 INST  DIAGS ALARM           RANGE INST  DIAGS ALARM
```
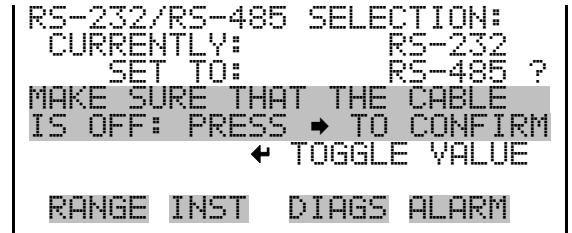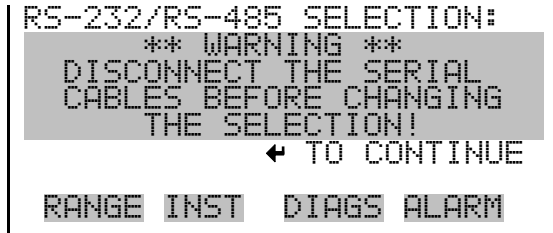
Instrument ID   The Instrument ID screen allows the operator to edit the instrument ID number. The ID is used to identify the instrument when using the C-Link or MODBUS protocols to control the instrument or collect data. It may be necessary to edit the ID number if two or more instruments of the same model are connected to one computer. Valid instrument ID numbers are from 0 to 127. The Model 55*i* has a default instrument ID of 55. 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:              55
   SET TO:               56 ?

             ▲▼ CHANGE VALUE
              ↵ SAVE VALUE

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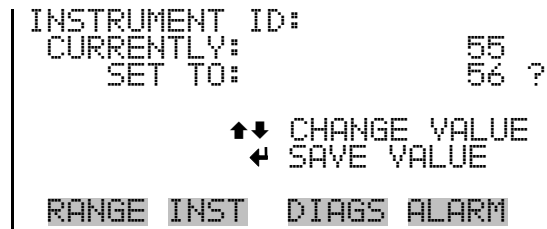
Communication Protocol   The Communication Protocol screen is used to change the protocol for serial communications. Possible choices include: C-Link, MODBUS, Geysitech, AK, and Streaming Data.

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

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

             ▲▼ CHANGE VALUE
              ↵ SAVE VALUE

 RANGE INST  DIAGS ALARM
```
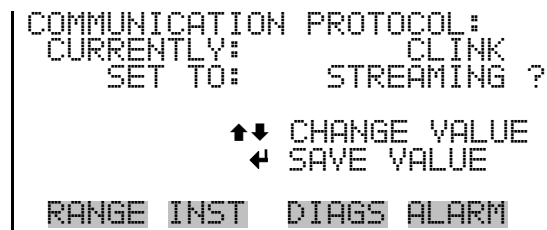
Streaming Data Configuration

The Streaming Data Configuration menu is used to allow for configuration of the 8 streaming data output items, current streaming interval, data format, timestamp, flags, and raw data streaming settings. 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
 STREAM RAW DATA       NO  ↓

 RANGE INST   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 INST   DIAGS ALARM
```

Note Add Labels, Prepend Timestamp, Add Flags, and Sream Raw Data 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 INST  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
 METHANE                    <--
 NMHC
 THC


 RANGE INST  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.

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

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

 RANGE INST   DIAGS ALARM
```

```
 INT TEMP
 AIR PRES
 CARRIER PRES
 FUEL PRES
 RAW SIGNAL
 FLAME STATUS
 CH4 PK HT
 CH4 PK RT
 CH4 BASELINE
 CH4 LOD
 NM PK HT
 NM PK AREA
 NM BASE ST
 NM BASE END
 NM LOD
 NM START IDX
 NM END IDX
 NM MAX SLOPE
 NM MIN SLOPE
 NM DATA PTS
 EXT ALARMS
```

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 INST   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     255.255.252.0
 GATEWAY       10.209.42.1
 HOST NAME        ISERIES↓

 RANGE INST   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 INST   DIAGS ALARM
```

IP Address   The IP Address screen is used to edit the IP address. The IP address can only be changed when DHCP is off. If DHCP is on, the instrument will respond with "NOT SETTABLE IF DHCP IS ON". For more information on DHCP, see "Use DHCP" 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 INST   DIAGS ALARM
```

Netmask The Netmask screen is used to edit the netmask. The netmask is used to determine the subnet on which the instrument can directly communicate to other devices. The netmask can only be changed when DHCP is off. If DHCP is on, the instrument will respond with "NOT SETTABLE IF DHCP IS ON". For more information on DHCP, see "Use DHCP" 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  INST   DIAGS ALARM
```

Default Gateway The Default Gateway screen is used to edit the gateway address. The default gateway can only be changed when DHCP is off. If DHCP is on, the instrument will respond with "NOT SETTABLE IF DHCP IS ON". For more information on DHCP, see "Use DHCP" 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  INST   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 INST  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 INST  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 INST  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        SPAN MODE
 2    NOP     CH4 CONC MAX
 3    NOP    CH4 OVERRANGE
 4    NOP        ZERO MODE
 5    NOP           INJECT  ⬇
 RANGE INST   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 INST   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 INST   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. The I/O board status alarm is only present if the I/O expansion board is installed. 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
 CH4 CONC MAX
 CH4 CONC MIN
 NM CONC MAX                        ↓

 RANGE INST   DIAGS ALARM
```

```
 NM CONC MIN
 INT TEMP
 DET TEMP
 FILT TEMP
 COLUMN TEMP
 AIR PRESS
 CARRIER PRESS
 FUEL PRESS
 FLAME OUT
 CH4 OVERRANGE
 NM OVERRANGE
 CAL FAILURE
 HEATER FAIL
 SENSOR FAIL
 BIAS VOLTAGE
 DATA INTEG
 CH4 SPAN CHK
 NM SPAN CHK
 WINDOW SANE
 MB STATUS
 MIB STATUS
 I/O BD STATUS
 EXT ALARM 1
 EXT ALARM 2
 EXT ALARM 3
```

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
 CAL MODE
 CAL CHK MODE                    ↓

 RANGE INST   DIAGS ALARM
```

```
 RUN MODE
 IDLE MODE
 INJECT
 ZERO MODE
 SPAN 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 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".) ▲

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

```
DIGITAL INPUT SETTINGS:
>1   NOP          START RUN
 2   NOP          START CAL
 3   NOP      START CAL CHK
 4   NOP               STOP
 5   NOP             INJECT ↓

 RANGE INST   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 INST   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
 START RUN              <--
 START CAL
 START CAL CHK
 STOP                     ↓

 RANGE INST   DIAGS ALARM
```

```
 INJECT
 BACKFLUSH
 SET IDLE MODE
 AOUTS TO ZERO
 AOUTS TO FS
 EXT ALARM 1
 EXT ALARM 2
 EXT ALARM 3
```

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 INST  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 INST   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 INST   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 INST   DIAGS ALARM
```

Set Minimum and   The Set Minimum and Maximum Value screens are used to edit the zero
Maximum Value   (0%) and full-scale (100%) values, respectively, in percentages for the selected analog output channel. See Table 3–4 for a list of choices. 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 INST   DIAGS ALARM
```

Table 3–4. Analog Output Zero to Full-Scale

Output	Zero (0)% Value	Full-Scale 100% Value
CH4	Zero (0)	Range Setting
NMHC		
THC	Zero (0)	(CH4 range + NMHC Range)
Detector Temp	User-set alarm min value	User-set alarm max value
Filter Temp		
Column Temp		
Internal Temp		
Air Pressure		
Carrier Pressure		
Fuel Pressure		
Flame Temp	210 °C	300 °C
Raw Signal	0	30,000,000 Hz
Flame Status	Recommend user not to change the settings for this output	
CH4 Peak Height	0	30,000,000 Hz
CH4 Peak Retention Time	0	100 sec
CH4 Baseline	0	30,000,000
CH4 LOD		
NMHC Peak Height		
NMHC Peak Area	0	3,000,000,000
NMHC Baseline Start	0	30,000,000
NMHC Baseline End		
NMHC LOD		
NMHC Start Index	0	100 sec
NMHC End Index		
NMHC Max Slope	0	100
NMHC Min Slope	0	-100
NMHC Data Points	0	100
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 3–5 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 INST   DIAGS ALARM
```

```
CHOOSE SIGNAL -    CONC
 SELECTED OUTPUT:    V1
 CURRENTLY: RAW SIGNAL
    SET TO: METHANE     ?

 ♠♦ CHANGE VALUE   ← SAVE

 RANGE INST   DIAGS ALARM
```

Table 3–5. Signal Type Group Choices

Concentrations	Other Measurements	Analog Inputs
None	None	None
METHANE	Detector Temperature	Analog Input 1 (if the I/O expansion board is installed)
NMHC	Filter Temperature	Analog Input 2 (if the I/O expansion board is installed)
THC	Column Temperature	Analog Input 3 (if the I/O expansion board is installed)
	Flame Temperature	Analog Input 4 (if the I/O expansion board is installed)
	Internal Temperature	Analog Input 5 (if the I/O expansion board is installed)
	Air Pressure	Analog Input 6 (if the I/O expansion board is installed)

Concentrations	Other Measurements	Analog Inputs
	Carrier Pressure	Analog Input 7 (if the I/O expansion board is installed)
	Fuel Pressure	Analog Input 8 (if the I/O expansion board is installed)
	Raw Signal	
	Flame Status	
	CH4 Peak Height	
	CH4 Peak Retention Time	
	CH4 Baseline	
	CH4 LOD	
	NMHC Peak Height	
	NMHC Peak Area	
	NMHC Base Start	
	NMHC Base End	
	NMHC LOD	
	NMHC Start Index	
	NMHC End Index	
	NMHC Maximum Slope	
	NMHC Minimum Slope	
	NMHC Data Points	
	External Alarms	

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            IN5↓

 RANGE INST   DIAGS ALARM
```

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

 RANGE INST   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 INST   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

     ABCDEFGHIJKLMN  BKSP
     OPQRSTUVWXYZ    PAGE
     0123456789_./-  SAVE

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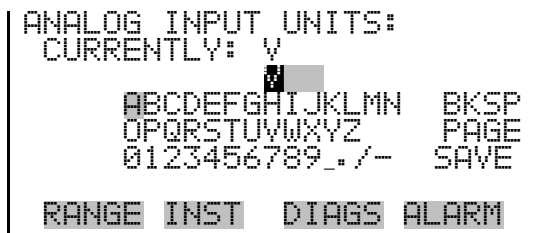
Decimal Places   The Decimal Places screen allows the user to select how many digits are displayed to the right of the decimal point, from 0 to 6, with a default of 2.

● 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 INST   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 INST   DIAGS ALARM
```
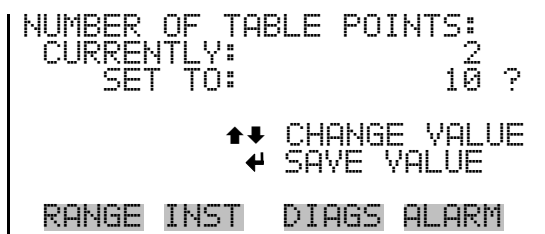
Table Points   The Table Points submenu allows the user to set up an individual table point.

● 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 INST  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 INST  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 INST   DIAGS ALARM
```
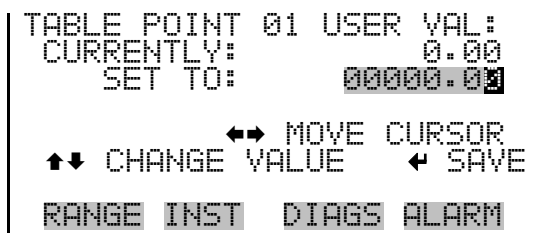
Screen Contrast

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 INST   DIAGS ALARM
```
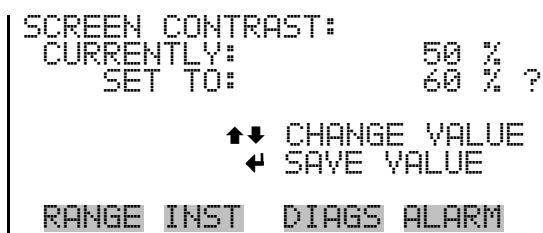
Service Mode

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 55*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 INST   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 INST   DIAGS ALARM
```

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

Diagnostics Menu

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

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

```
DIAGNOSTICS:
>PROGRAM VERSIONS
 MANUAL OPERATION
 VOLTAGES
 TEMPERATURES
 PRESSURE                  ↓

RANGE INST   DIAGS ALARM
```

```
FID STATUS
FLAME OUT/POWERUP INFO
CALIBRATION HISTORY
RUN HISTORY
ANALOG INPUT READINGS
ANALOG INPUT VOLTAGES
DIGITAL INPUTS
RELAY STATES
TEST ANALOG OUTPUTS
INSTRUMENT CONFIGURATION
CONTACT INFORMATION
```

Program Versions

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

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

```
PROGRAM VERSIONS:
   PRODUCT:    MODEL 55i
   VERSION:  01.00.00.129
   FIRMWARE:     11.02.99



RANGE  INST   DIAGS ALARM
```

Manual Operation

The Manual Operation screen allows the user to manually view and change the valve position to either inject or backflush.

● In the Main Menu, choose Diagnostics > **Manual Operation**.

```
MANUAL OPERATION:
 CURRENTLY:     BACKFLUSH

            ↵ OPERATE VALUE

RANGE  INST   DIAGS ALARM
```

Voltages

The Voltages menu displays the current diagnostic voltage readings. These screens enable 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  INST   DIAGS ALARM
```

Motherboard Voltages

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

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

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

  RANGE INST   DIAGS ALARM
```

Interface Board Voltages

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

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

```
INTERFACE BOARD VOLTAGES:
>  3.3 SUPPLY          3.3 V
   5.0 SUPPLY          5.0 V
  15.0 SUPPLY         15.0 V
  24.0 SUPPLY         24.0 V
 -15.0 SUPPLY        -15.0 V ▼

  RANGE INST   DIAGS ALARM
```

```
BIAS SUPPLY        -300.0 V
```

I/O Board Voltages

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

Temperatures

The Temperatures screen (read only) displays the detector oven temperature, filter temperature, column oven temperature, 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 OVEN      199.5  °C
 FILTER             199.8  °C
 COLUMN OVEN        200.0  °C
 FLAME              225.1  °C
 INTERNAL            34.6  °C

RANGE  INST   DIAGS ALARM
```

Pressure

The Pressure screen (read only) displays the carrier pressure, fuel pressure, and air pressure readings. The readings will show "LOW" if the measured value falls below the range of the pressure controller. If this happens, check the appropriate supply plumbing.

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

```
PRESSURES:
 CARRIER            25.6  psi
 FUEL               28.0  psi
 AIR                19.7  psi



RANGE  INST   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  INST   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
 DET OVEN AT START: 199.5
 COL OVEN AT START: 200.0

 RANGE INST   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 Diagnostics > **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 INST   DIAGS ALARM
```

```
CALIBRATION HISTORY:
>TIME      15AUG2006 22:57
 TYPE              MANUAL
 STATUS              GOOD
 CHECK/ADJUST      ADJUST
 CH4 SPAN CONC       4066  ↓

 RANGE INST  DIAGS ALARM
```

```
CH4 SP RATIO  1.842e-03
CH4 RT          300.00
CH4 PK IDX        1.000
CH4 PK HT      9.185690
NM SPAN CONC  25.413500
NM SP RATIO   1.132e-04
NM PEAK AREA     53377
```

Run History

The Run 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 Diagnostics > **Run History**.

```
RUN 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 INST  DIAGS ALARM
```

```
RUN HISTORY:
>TIME      15AUG2006 22:57
 CH4 PK HT          MANUAL
 CH4 RT               GOOD
 CH4 BASELINE         ZERO
 CH4 LOD               818 ↓

 RANGE  INST   DIAGS ALARM
```

```
 CH4 SD                272
 CH4 CONC             9.02
 NM PK HT             2354
 NM PEAK AREA            0
 NM CONC              3.02
 NM BASE START       12157
 NM BASE END         11350
 NM LOD               7780
 NM START IDX           11
 NM END IDX             88
 NM MAX SLOPE          134
 NM MIN SLOPE          -96
 NM PT COUNT             0
```

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:
>CH4            10.2 ppm
 THC            18.2 ppb
 CO2             250 ppm
 IN4             0.0   V
 IN5             0.0   V↓

 RANGE  INST   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  INST   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 INST   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 STATE:
>OUTPUT 1                0
 OUTPUT 2                0
 OUTPUT 3                0
 OUTPUT 4                1
 OUTPUT 5                1↓
 RANGE INST   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 INST  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 INST  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 setting for the selected item. Auto calibration needs to be set to YES in order to do zero and span calibration resets. The instrument must be power-cycled after making a change to the instrument configuration for the new configuration to become fully active. ▲

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

```
INSTRUMENT CONFIGURATION:
>I/O EXPANSION BOARD   YES
 LOOP SIZE        MED CONC
 NUMBER OF SPAN GASES    1
 AUTO CALIBRATION       NO


 RANGE INST  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 INST  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. Flame Out, CH_4/NMHC Overrange, Data Integrity, Heater Fail, Temperature Sensor Fail, Window Sanity, and CH_4/NM Cal Fail are display only. The External Alarms menu is displayed only if assigned as a digital input. 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        2
>INTERNAL TEMP         OK
 DETECTOR TEMP         OK
 FILTER TEMP           OK
 COLUMN TEMP           OK↓

 RANGE  INST   DIAGS ALARM
```

```
 FLAME OUT            FAIL
 CARRIER PRESSURE       OK
 FUEL PRESSURE          OK
 AIR PRESSURE         HIGH
 CH4 OVERRANGE          OK
 NMHC OVERRANGE         OK
 DATA INTEGRITY         OK
 BIAS VOLTAGE           OK
 HEATER FAIL            OK
 TEMP SENSOR FAIL       OK
 CH4 SPAN CHECK         OK
 NMHC SPAN CHECK        OK
 WINDOW SANITY          OK
 CH4 CAL FAIL           OK
 NM CAL FAIL            OK
 METHANE CONC           OK
 NON-METHANE CONC       OK
 EXTERNAL ALARMS        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  INST   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 INST   DIAGS ALARM
```
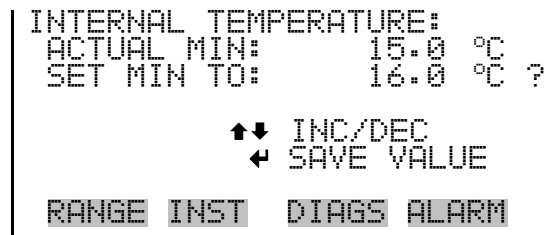
Detector Temperature

The Detector Temperature screen displays the current detector temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 95 to 205 °C. These values should be set relatively tightly around the set point as defined in the Service > Set Oven Temperatures > Detector Oven screen. 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         177.6 °C
>MIN            170.0 °C
 MAX            180.0 °C



 RANGE INST   DIAGS ALARM
```
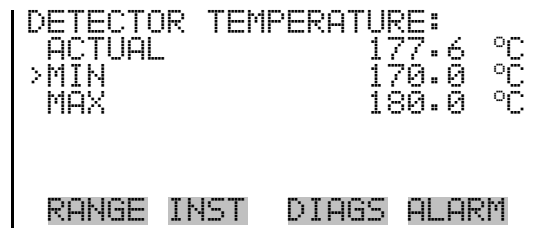
Min and Max Detector Temperature Limits

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:     170.0 °C
 SET MIN TO:     175.0 °C ?

            ↑↓ INC/DEC
             ↵ SAVE VALUE

 RANGE INST   DIAGS ALARM
```
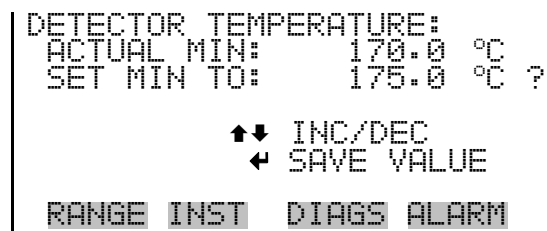
Filter Temperature

The Filter Temperature screen displays the current filter temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits

range from 95 to 205 °C. These values should be set relatively tightly around the set point as defined in the Service > Set Oven Temperatures > Detector Oven screen. 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           177.6  °C
>MIN              170.0  °C
 MAX              180.0  °C


 RANGE INST   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       170.0  °C
 SET MIN TO:      175.0  °C ?

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

Column Temperature

The Column Temperature screen displays the current column oven temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 45 to 155 °C. These values should be set relatively tightly around the set point as defined in the Service > Set Oven Temperatures > Column Oven screen. If the column 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 > **Column Temp**.

```
COLUMN TEMPERATURE:
 ACTUAL           67.6 °C
>MIN              65.0 °C
 MAX              75.0 °C


 RANGE  INST   DIAGS  ALARM
```

Min and Max Column Temperature Limits

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

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

```
COLUMN TEMPERATURE:
 ACTUAL MIN       65.0 °C
 SET MIN TO:      70.0 °C ?

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

Carrier Pressure

The Carrier Pressure screen displays the current carrier pressure reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 5 to 50.0 psi. Typically these alarm limits are set to 5.0 and 10.0 psi. If the carrier 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 > **Carrier Pressure**.

```
CARRIER PRESSURE:
 ACTUAL            5.9 psi
>MIN               5.0 psi
 MAX              10.0 psi


 RANGE  INST   DIAGS  ALARM
```

Min and Max Carrier Pressure Limits

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

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

```
CARRIER PRESSURE:
 ACTUAL MIN:       5.0 psi
 SET MIN TO:       5.5 psi ?

              ↑↓ INC/DEC
              ↵ SAVE VALUE

  RANGE INST  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 5 to 50.0 psi. Typically these alarm limits are set to 8.0 and 22.0 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          12.3 psi
>MIN              8.0 psi
 MAX             22.0 psi



  RANGE INST  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:       8.0 psi
 SET MIN TO:       8.5 psi ?

              ↑↓ INC/DEC
              ↵ SAVE VALUE
  RANGE INST  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 5 to 50.0 psi. Typically these alarm limits are set to 8.0 and 22.0 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             8.0 psi
 MAX            22.0 psi


 RANGE  INST   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:     8.0 psi
 SET MIN TO:     8.5 psi ?

               ↑↓ INC/DEC
                ↵ SAVE VALUE
 RANGE  INST   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. Typically these alarm limits are set to -310 and -290 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           -310.0 V
 MAX           -290.0 V


 RANGE  INST   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:   -310 V
 SET MIN TO:   -305 V      ?

           ↑↓  INC/DEC
            ↵  SAVE VALUE

 RANGE INST  DIAGS ALARM
```

Methane Span Check

The Methane Span Check screen allows the user to view the status of the most recent methane span check and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 75 to 125.0 percent. Typically these alarm limits are set to 97.0 and 103.0 percent. If the methane span check 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 > **CH4 Span Check**.

```
CH4 SPAN CHECK:
 ACTUAL            99.0 %
>MIN               97.0 %
 MAX              103.0 %


 RANGE INST  DIAGS ALARM
```

Min and Max Methane Span Check

The Minimum Methane Span Check alarm limit screen is used to change the minimum methane span check alarm limit. The minimum and maximum methane span check screens function the same way.

● In the Main Menu, choose Alarms > CH4 Span Check > **Min** or **Max**.

```
CH4 CAL CHECK RESULT:
 ACTUAL MIN:     97.0 %
 SET MIN TO:     97.5 %    ?

            ↑↓ INC/DEC
            ↵ SAVE VALUE

 RANGE INST  DIAGS ALARM
```

Non-Methane Span Check

The Non-Methane Span Check screen allows the user to view the status of the most recent non-methane span check and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 75 to 125.0 percent. Typically these alarm limits are set to 97.0 and 103.0 percent. If the non-methane 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 > **NMHC Span Check**.

```
NMHC SPAN CHECK:
 ACTUAL            99.0 %
>MIN               97.0 %
 MAX              103.0 %



 RANGE INST   DIAGS ALARM
```

Min and Max Methane Span Check

The Minimum Non-Methane Methane Span Check alarm limit screen is used to change the minimum non-methane span check alarm limit. The minimum and maximum non-methane span check screens function the same way.

● In the Main Menu, choose Alarms > NMHC Span Check > **Min** or **Max**.

```
NMHC CAL CHECK RESULT:
 ACTUAL MIN:     97.0 %
 SET MIN TO:     97.5 %    ?

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

Methane Concentration

The Methane Concentration screen displays the current instrument reading (CH$_4$ concentration) and sets the minimum and maximum alarm limits.

Acceptable alarm limits range from 0 to the highest range value for the installed sample loop. 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 > **Methane Conc**.

```
METHANE CONCENTRATION:
 ACTUAL            3.57
>MIN               2000
 MAX             200000
 MIN TRIGGER    CEILING


 RANGE INST   DIAGS ALARM
```

Min and Max Methane Concentration Limits

The Minimum Methane Concentration alarm limit screen is used to change the minimum CH_4 concentration alarm limit. The minimum and maximum methane concentration alarm limit screens function the same way.

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

```
METHANE CONCENTRATION:
 ACTUAL MIN:        0.0
 SET MIN TO:    00000.00 ?

          ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE   ↵ SAVE

 RANGE INST   DIAGS ALARM
```

Min Trigger

The Minimum Trigger screen allows the user to view and set the minimum CH_4 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 > Methane Conc > **Min Trigger**.

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


    ↵ TOGGLE AND SAVE VALUE

 RANGE INST  DIAGS ALARM
```

Non-Methane Concentration

The Non-Methane Concentration screen displays the current instrument reading (NMHC concentration) and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 0 to the highest range value for the installed sample loop. 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 > **Non-Methane Conc**.

```
 NMHC CONCENTRATION:
  ACTUAL           3.57
 >MIN             100.0
  MAX          200000.0
  MIN TRIGGER    CEILING


 RANGE INST  DIAGS ALARM
```

Min and Max Non-Methane Concentration Limits

The Minimum Non-Methane Concentration alarm limit screen is used to change the minimum NMHC concentration alarm limit. The minimum and maximum non-methane concentration alarm limit screens function the same way.

● In the Main Menu, choose Alarms > Non-Methane Conc > **Min** or **Max**.

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

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

Min Trigger

The Minimum Trigger screen allows the user to view and set the minimum NMHC 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 > Non-Methane Conc > **Min Trigger**.

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


  ↵ TOGGLE AND SAVE VALUE

RANGE INST   DIAGS ALARM
```

External Alarms

The External Alarms menu is used to display the external alarm status for alarm 1, 2, and 3 only if the external alarm is assigned as a digital input. External alarms can be assigned to digital inputs using the Instruments Controls > I/O Configuration > Digital Input Settings menu. External alarms can also be logged, streamed, or output as a digital output by choosing "EXT ALARMS" from the Other Measurements list.

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

```
ALARMS:
  EXTERNAL ALARM 1      OK
  EXTERNAL ALARM 2      OK
  EXTERNAL ALARM 3      OK



RANGE INST   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:
>SET OVEN TEMPERATURES
 MANUAL FUEL VALVE BYPASS
 BYPASS FLAME DETECTION
 IDLE MODE
 SELECT FUEL              ↓

 RANGE INST  DIAGS ALARM
```

```
 AUTO RANGE CHANGE
 USE FLAT BASELINE
 CONDITION COLUMN
 SET WINDOW TIMING
 CRUCIAL SETTINGS
 SET PRESSURE AND FLOW
 INPUT BOARD CALIBRATION
 TEMPERATURE CALIBRATION
 LEAK TEST
 ANALOG OUT CAL
 ANALOG INPUT CAL
 DISPLAY PIXEL TEST
 RESTORE USER DEFAULTS
```

Set Oven Temperatures

The Set Oven Temperatures menu allows the user to adjust the set points for the detector and column heaters.

● In the Main Menu, choose Service > **Set Oven Temperatures**.

```
SET OVEN TEMPERATURES:
>DETECTOR OVEN   175.0 °C
 COLUMN OVEN      75.0 °C

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

Detector Oven Temperature

The Set Detector Oven Temperature screen allows the user to set the detector oven temperature. The permitted range for the detector oven is 100 to 200 °C, with a default of 175 °C.

Note Temperatures are set at the factory and should not be arbitrarily changed. ▲

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

● In the Main Menu, choose Service > Set Oven Temperatures >
  Detector Oven.

```
SET DETECTOR VOEN TEMP:
 CURRENTLY:      175.0 °C
     SET TO:     190.0 °C ?

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

Column Oven Temperature

The Set Column Oven Temperature screen allows the user to set the oven temperature. The permitted range for the column oven is 50 to 150 °C, with a default of 75 °C.

Note Temperatures are set at the factory and should not be arbitrarily changed. ▲

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

● In the Main Menu, choose Service > Set Oven Temperatures >
  Column Oven.

```
SET COLUMN OVEN TEMP:
 CURRENTLY:       75 °C
     SET TO:      76 °C ?

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

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 INST   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 INST   DIAGS ALARM             │
└─────────────────────────────────────┘
```

Idle Mode

The 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 INST   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?

              ← TOGGLE VALUE


 RANGE  INST   DIAGS ALARM
```

Auto Range Change

The Auto Range Change screen allows the user to choose whether the instrument will automatically attempt to change ranges if a run is out of range. The auto range change feature only works if the unit is also in "continuous operation mode".

● In the Main Menu, choose Service > **Auto Range Change**.

```
AUTO RANGE CHANGE MODE:
 CURRENTLY             OFF
     SET TO:            ON ?

              ← TOGGLE VALUE


 RANGE  INST   DIAGS ALARM
```

Use Flat Baseline

The Use Flat Baseline screen allows the user to choose whether the instrument will use its normal nm baseline algorithm or just extrapolate backwards from the end of the NMHC window.

● In the Main Menu, choose Service > **Use Flat Baseline**.

```
USE FLAT BASELINE:
 CURRENTLY             OFF
     SET TO:            ON ?

              ← TOGGLE VALUE


 RANGE  INST   DIAGS ALARM
```

Condition Column

The Condition Column screen is used to manually initiate a column conditioning cycle. This option is useful for cleaning a new column or an older column that shows signs of contamination. The column conditioning routine is also useful as a "burn-in" procedure following initial installation

of the 55*i*, or after a prolonged shut-down. During a column conditioning cycle, the valve will shift to the backflush position and the column oven base temperature will rise to 125 °C. The unit will then cycle the valve once each hour and will hold the high temperature for eight hours. After conditioning is complete, the unit will automatically set the column oven temperature back to the normal value. Although it is best to run the conditioning routine for the full eight hours, the cycle can be aborted at any time by pressing ⬅. If column conditioning can not be performed, the instrument will respond with "PLEASE WAIT UNTIL READY".

● In the Main Menu, choose Service > **Condition Column**.

```
CONDITION COLUMN:
     PRESS ➡ TO BEGIN
     PRESS ⬅ TO ABORT


        CONDITIONING!

RANGE INST   DIAGS ALARM
```

Set Window Timing

The Set Windows Timing menu is used to set the timing parameters that control injection, backflush, and data acquisition. These parameters are initially set at the factory and should not require adjustment.

● In the Main Menu, choose Service > **Set Window Timing**.

```
SET WINDOW TIMING:
>METHANE START        8.0
 METHANE END         16.0
 BACKFLUSH           18.0
 NMHC START          20.0
 NMHC END            52.0
RANGE INST   DIAGS ALARM
```

Methane Start/End

The Methane Start and Methane End screens are used to set the time at which the methane window starts and ends. In order for the methane concentration to be measured correctly, the methane and oxygen peaks must both fall within this window. If the window value has changed since the previous zero run, the instrument will respond with "ZERO CHROM DATA IS INVALID". The methane start and end screens function the same way.

Note Changing these values could severely affect the operation of the instrument. If adjustment becomes necessary, please contact the service center for further information. ▲

● In the Main Menu, choose Service > Set Window Timing > **Methane Start** or **Methane End**.

```
SET WINDOW TIME: CH4 START
 CURRENTLY:       8.0 SEC
    SET TO:       8.0 SEC

               ←→ MOVE CURSOR
  ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE INST   DIAGS ALARM
```

Backflush   The Backflush screen is used to change the time at which the rotary valve switches between inject and backflush modes. Backflush must occur after the methane peak has completely returned to baseline, but should not be delayed any longer than necessary. If the window value has changed since the previous zero run, the instrument will respond with "ZERO CHROM DATA IS INVALID".

Note Changing this value could severely affect the operation of the instrument. If adjustment becomes necessary, please contact the service center for further information. ▲

● In the Main Menu, choose Service > Set Window Timing > **Backflush**.

```
SET WINDOW TIME: BACKFLUSH
 CURRENTLY:      18.0 SEC
    SET TO:      18.0 SEC

               ←→ MOVE CURSOR
  ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE INST   DIAGS ALARM
```

NMHC Start/End   The NMHC Start and NMHC End screens are used to set the time at which the NMHC window starts and ends. Data is collected only while the window is open. If the window value has changed since the previous zero run, the instrument will respond with "ZERO CHROM DATA IS INVALID". The NMHC start and end screens function the same way.

Note Changing these values could severely affect the operation of the instrument. If adjustment becomes necessary, please contact the service center for further information. ▲

● In the Main Menu, choose Service > Set Window Timing > **NMHC Start** or **NMHC End**.

```
SET WINDOW TIME:   NM START
 CURRENTLY:        20.0 SEC
     SET TO:       20.█ SEC

           ←→ MOVE CURSOR
  ↑↓ CHANGE VALUE    ← SAVE

 RANGE INST   DIAGS ALARM
```

Crucial Settings

The Crucial Settings menu is used to adjust software parameters that control the integration method and calibration of some hardware. These parameters are initially set at the factory and should not require adjustment. If adjustment becomes necessary, please contact the service center for guidance.

● In the Main Menu, choose Service > **Crucial Settings**.

```
CRUCIAL SETTINGS:
>SLOPE THRESHOLD
 METHANE CAL ERROR
 NMHC CAL ERROR
 GAIN FACTORS
 CALIBRATION FACTORS

 RANGE INST   DIAGS ALARM
```

Slope Threshold

The Slope Threshold screen is used during measurement of the NMHC peak primarily to discriminate between small NMHC peaks and signals caused by random noise. During data analysis, a maximum and minimum slope value is calculated for each candidate peak. If the values fall below the slope thresholds set in the software, the signal is disregarded.

Correct slope threshold settings are determined at the factory by running a series of blank chromatograms and recording the maximum and minimum slope values reported in the diagnostic menu. The slope thresholds are then adjusted to a value slightly higher than the values observed while running blanks. If the slope thresholds are set too high, the instruments ability to detect small peaks will be impaired. Conversely, slope threshold values that

are set too low, may result in erroneously high readings and/or poor repeatability

● In the Main Menu, choose Service > Crucial Settings > **Slope Threshold**.

```
SLOPE THRESHOLD:
>MINIMUM            0.03
 MAXIMUM            0.03


 RANGE INST   DIAGS ALARM
```

Min and Max Slope Threshold

The Minimum Slope Threshold screen is used to change the slope threshold minimum value. The minimum and maximum slope threshold screens function the same way.

● In the Main Menu, choose Service > Crucial Settings > Slope Threshold > **Minimum** or **Maximum**.

```
SLOPE THRESHOLD MINIMUM:
 CURRENTLY:         0.03
    SET TO:        00.03 ?

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

Methane Calibration Error

The Methane Calibration Error screen is used in determining whether a given calibration is valid. At the end of each calibration, the methane calibration factor is calculated as the ratio of span gas concentration divided by peak height. If the methane calibration factor falls within the limits defined by this menu entry, the calibration is considered valid. Otherwise the calibration is rejected and the appropriate cal fail alarm is triggered.

● In the Main Menu, choose Service > Crucial Settings > **Methane Cal Error**.

```
METHANE CAL ERROR:
>MINIMUM          0.0000100
 MAXIMUM         50.0000000




   RANGE INST   DIAGS ALARM
```

Min and Max Methane Calibration Error

The Minimum Methane Calibration Error screen is used to change the CH₄ calibration error minimum value. The minimum and maximum methane calibration error screens function the same way.

● In the Main Menu, choose Service > Crucial Settings > Methane Calibration Error > **Minimum** or **Maximum**.

```
CH4 CAL ERROR MINIMUM:
 CURRENTLY:       0.000010
    SET TO:      00.00001█ ?

            ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ← SAVE

   RANGE INST   DIAGS ALARM
```

Non-Methane Calibration Error

The Non-Methane Calibration Error screen is used in determining whether a given calibration is valid. At the end of each calibration, the NMHC calibration factor is calculated as the ratio of span gas concentration divided by peak height. If the NMHC calibration factor falls within the limits defined by this menu entry, the calibration is considered valid. Otherwise the calibration is rejected and the service alarm is triggered.

● In the Main Menu, choose Service > Crucial Settings > **Non-Methane Cal Error**.

```
NON-METHANE CAL ERROR:
>MINIMUM          0.0000010
 MAXIMUM         50.0000000




   RANGE INST   DIAGS ALARM
```

Min and Max Methane Calibration Error

The Minimum Non-Methane Calibration Error screen is used to change the NMHC calibration error minimum value. The minimum and maximum non-methane calibration error screens function the same way.

● In the Main Menu, choose Service > Crucial Settings > Non-Methane
Calibration Error > **Minimum** or **Maximum**.

```
NMHC CAL ERROR MINIMUM:
 CURRENTLY:       0.000050
    SET TO:    00.000051 ?

             ←→ MOVE CURSOR
  ↑↓ CHANGE VALUE   ↵ SAVE

 RANGE INST   DIAGS ALARM
```

Gain Factors   The Gain Factors menu is used to set the gain factors used to compensate
for changes in the instrument measuremenet range. That is, they reflect the
difference in amplifier gain between the low, mid and high measurement
ranges. Gain factors are set at the factory and should not require
adjustment unless the input board is repaired or replaced.

● In the Main Menu, choose Service > Crucial Settings > **Gain Factors**.

```
SET GAIN FACTORS:
>MID RANGE          10.000
 HIGH RANGE        100.000




 RANGE INST   DIAGS ALARM
```

Mid Range Gain Factor   The Mid Range Gain Factor screen is used to enter the mid-range gain
factor. This is the multiplication factor between the low and mid gain
settings on the input board.

● In the Main Menu, choose Service > Crucial Settings > Gain Factors >
Mid Range.

```
MID RANGE GAIN FACTOR:
 CURRENTLY:         10.000
    SET TO:    000009.95 ?

             ←→ MOVE CURSOR
  ↑↓ CHANGE VALUE   ↵ SAVE

 RANGE INST   DIAGS ALARM
```

High Range Gain Factor

The High Range Gain Factor screen is used to enter the high-range gain factor. This is the multiplication factor between the low and high gain settings on the input board.

● In the Main Menu, choose Service > Crucial Settings < Gain Factors > **High Range**.

```
HIGH RANGE GAIN FACTOR:
 CURRENTLY:      100.000
    SET TO:   000098.747 ?

             ←→ MOVE CURSOR
  ↑↓ CHANGE VALUE    ← SAVE

  RANGE INST   DIAGS ALARM
```

Calibration Factors

The Calibration Factors menu is used to automatically adjust the calibration factor for CH_4 and NMHC during each calibration cycle. As described earlier, the CH_4 calibration factor is calculated as the ratio of the span gas concentration divided by CH_4 peak height, and the NMHC cal factor is calculated as the NMHC span concentration divided by the NMHC peak area. The Crucial Settings menu allows the calibration factors to manually adjust. This procedure may be useful as a short-term solution to operating the instrument when proper calibration gases are not available.

The screens below show the calibration factors for single-span gas mode and three-span gas mode (low, mid, and hi). For more information on number of span gases, see "Instrument Configuration" on page 3-61.

● In the Main Menu, choose Service > Crucial Settings > **Calibration Factors**.

```
ADJUST CAL FACTORS:
>CH4          2.0000000e+00
 NMHC         5.0000000e+00




  RANGE INST   DIAGS ALARM
```

```
ADJUST CAL FACTORS:
>LOW CH4      2.0000000e+00
 MID CH4      2.0000000e+00
 HI CH4       2.0000000e+00
 LOW NMHC     5.0000000e+00
 MID NMHC     5.0000000e+00↓

  RANGE   AVG  DIAGS ALARM
```

```
 HI NMHC      5.0000000e+00
```

Methane Calibration Factor

The Methane Calibration Factor screen is used to enter the methane calibration factor.

● In the Main Menu, choose Service > Calibration Factors > **CH4**.

```
METHANE CAL FACTOR:
  CURRENTLY:      1.0000000
    SET TO:     01.000000▮?

              ◄► MOVE CURSOR
  ▲▼ CHANGE VALUE    ↵ SAVE

  RANGE INST   DIAGS ALARM
```

Non-Methane Calibration Factor

The Non-Methane Calibration Factor screen is used to enter the non-methane calibration factor.

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

```
NON-METHANE CAL FACTOR:
  CURRENTLY:      1.0000000
    SET TO:     01.000000▮?

              ◄► MOVE CURSOR
  ▲▼ CHANGE VALUE    ↵ SAVE

  RANGE INST   DIAGS ALARM
```

Set Pressure and Flow

The Set Pressure and Flow menu 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 carrier, 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 5–50 psi.

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 carrier, air, and fuel, refer to "Optimizing the Gas Flows" in the Servicing chapter.

Note 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 55*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:
>CARRIER RUN      32.0 psi
 CARRIER IGNITE 32.0 psi
 AIR RUN          23.9 psi
 AIR IGNITE       16.4 psi
 H2 FUEL RUN       9.8 psi  ↓

 RANGE INST   DIAGS ALARM
```

```
 H2 FUEL IGNITE  9.5 psi
 MIX FUEL RUN    22.4 psi
 MIX FUEL IGNITE 22.4 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:  20.6 psi   ?

              ↑↓ CHANGE VALUE
              ↵ SAVE

  RANGE INST   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 INST   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:        GAIN 1   - MANUAL:
        ↵ TO CALIBRATE              FREQ =    4500
     ** WARNING **                   D/A =     N/A  ?
 THIS ACTION MAY REQUIRE
   RECALIBRATION OF THE         ↔ CHG GAIN   ↕ INC/DEC
ENTIRE MEASUREMENT SYSTEM!               ↵ SAVE VALUES

 RANGE INST  DIAGS ALARM         RANGE INST  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 INST  DIAGS ALARM         RANGE INST  DIAGS ALARM
```

Input Frequency Display   The Input Frequency Display screen is used to manually adjust the input board gain settings. 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). The test signal allows the input board and measurement interface board circuitry to be tested independent of the FID hardware.

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

```
INPUT BOARD CALIBRATION:          INPUT BOARD TEST:
       ↵ TO CALIBRATE                GAIN = 1
    ** WARNING **                    TEST = OFF
CONCENTRATION CALCULATION            FREQ = 5000
    IS HALTED INSIDE             ←→ CHG GAIN ↑↓ TEST MODE
       THIS SCREEN!

 RANGE INST  DIAGS ALARM           RANGE INST  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:       22.3 °C
    SET TO:      022.▊ °C ?

             ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE     ↵ SAVE

 RANGE  INST   DIAGS ALARM
```

Leak Test

The Leak Test screen is used to set the analyzer into leak test configuration, opening valves and controllers to facilitate the test. To conduct a leak test, the detector assembly must be replaced with a blanking plate. Pressurized zero air must be plumbed to the calibration inlet (if present) or the sample inlet, carrier inlet, FID fuel inlet, and FID air inlet ports. The air supply pressure should be set to 10 psig and the readings on the screen should be

recorded, then the air should be cut off using a pinch off valve and new readings should be recorded after on minute. None of the pressures should drop by more than 1.0 psig over this one minute interval.

Note The flame must not be lit when performing a leak test. ▲

● In the Main Menu, choose Service > **Leak Test**.

● Press ⟦ ➡ ⟧ to leave warning screen and start test.

```
LEAK TEST:
  * FLAME MUST BE OUT! *
  CONFIGURE ANALYZER FOR
       LEAK TESTING
  THEN PRESS ➡ TO BEGIN
           ➡ TO START TEST

  RANGE INST  DIAGS ALARM
```

```
LEAK TEST:
CARRIER: =          25.6 psi
   FUEL: =          28.0 psi
    AIR: =          19.7 psi
                  🗐 TO EXIT

  RANGE INST  DIAGS ALARM
```
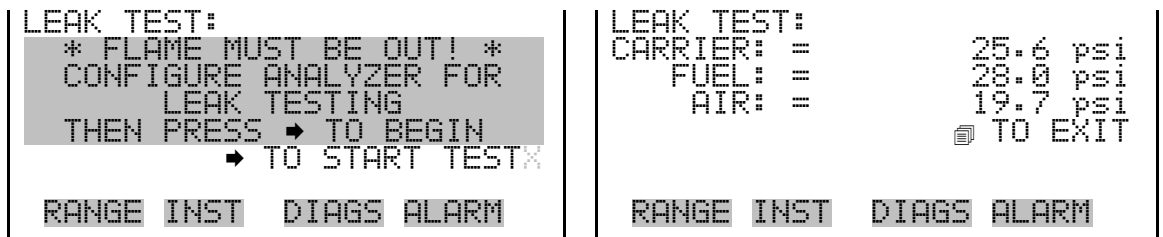
Analog Output Calibration

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 option 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 INST  DIAGS ALARM
```
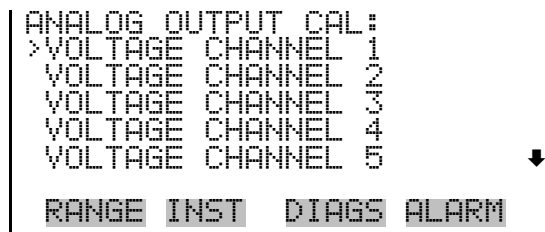
```
 ANALOG OUTPUT CAL:
>CALIBRATE ZERO
 CALIBRATE FULL SCALE



 RANGE INST   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 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 INST   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 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 INST   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 INST   DIAGS ALARM
```

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




 RANGE INST   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. Connect the selected analog input channel to ground to calibrate the input to zero.

● 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 INST   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. Connect the selected analog input channel to a 10 Volt voltage source.

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

```
ANALOG INPUT CAL:    SPAN
PROVIDE VOLTAGE TO INPUT!
 SELECTED INPUT:    INPUT 1
CURRENTLY:           9.84 V
    SET TO:         10.05 V
    ↵ CALIBRATE TO VALUE

RANGE INST   DIAGS ALARM
```
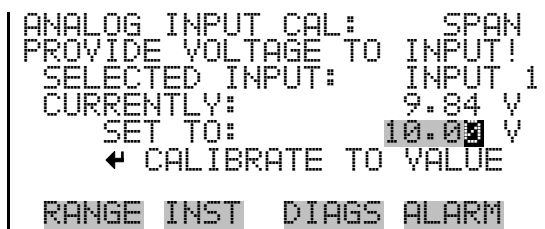
Display Pixel Test

The Display Pixel Test screen is used to test the LCD display, by toggling between all pixels on and all pixels off to ensure that they are functioning properly.

● In the Main Menu, choose Service > **Display Pixel Test**.

```
DISPLAY PIXEL TEST:
DURING TEST PRESS ⬚ OR ➡
TO EXIT, ↵ TO TOGGLE

       ↵ BEGIN TEST
    ⬚ GO BACK TO MENU
RANGE INST   DIAGS ALARM
```
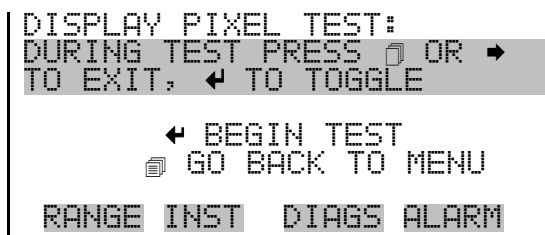
Restore User Defaults

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 USER DEFAULTS:
              ↵ RESTORE                            ↵ RESTORE
                                     ARE YOU SURE YOU WANT TO?
                                     PRESS  ➜ TO CONFIRM RESTORE


  RANGE INST  DIAGS ALARM             RANGE INST  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 INST  DIAGS ALARM
```
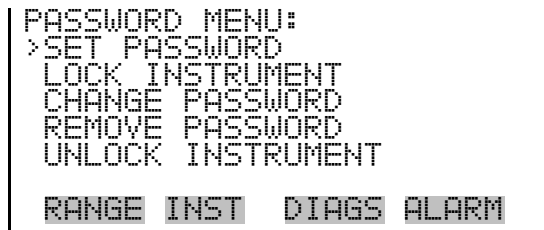
Set Password

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 INST  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 INST  DIAGS ALARM
```

Lock/Unlock and   If the instrument is locked via the front panel using Password > **Lock
Local/Remote Operation   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 INST  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 INST   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 INST   DIAGS ALARM
```

Chapter 4
Calibration

The Model 55*i* is a quantitative instrument that can make accurate measurements of methane and other organic gases and vapors at concentrations up to 5000 ppm. However, as with all electronic instruments, the accuracy of the measurements depends on proper calibration.

In general terms, calibration, also called standardization, is the process that establishes the relationship between the detector's output signal and the parameter the operator is attempting to measure. When organic compounds in the carrier gas stream enter the instrument's detector, organic molecules are ionized by the hydrogen/air flame. 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 allows the electrical current, measured in pico-amps, to be related to a gas or vapor concentration, which is usually expressed in parts per million (ppm) by volume.

Because signal intensity can be affected by operating parameters such as fuel type, fuel flow or 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 ideally should be conducted under conditions that are similar to the actual operating conditions.

While multi-point calibration is usually the most precise method, the model 55*i*, like most field instruments, relies on a simpler two-point calibration that utilizes a zero and a span. The calibration is performed by flooding the sample inlet with a span mix containing known concentrations of methane and NMHC prepared in hydrocarbon free air. The instrument injects a sample of the span gas and runs a complete chromatogram. During the analysis, a series of background, or "zero" readings are taken at times when no hydrocarbons are expected to elute from the column. The FID's response to the known concentrations of methane and non-methane hydrocarbons is also recorded, and calibration factors that relate concentration to FID response are calculated.

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

Frequency of Calibration

Each instrument is calibrated and tested for accuracy at the factory. The calibration and accuracy tests are run using mixed methane and propane standards at concentrations ranging from 2.0 to 2000 ppm. 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 Mixture

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

Span Gas Composition

For applications involving measurement of a known compound, the best calibration standard is a mixture that contains that specific compound. For example, if the Model 55*i* will be used for measuring toluene emissions from a printing operation, a calibration mixture containing methane and toluene will produce the most accurate results. Although span gases that have similar composition to the actual sample will provide the most accurate calibration, this may not be practical. In these cases, the span gas can be selected on the basis of other factors, such as availability or cost. For most applications, calibration with a mixture of methane and propane in air is most practical.

In selecting a calibration gas, the operator must also be aware that the detector response varies depending on the specific compound being sampled. Therefore, if the non-methane channel is calibrated with propane and then used to measure other compounds, the instrument readings will not be a direct measure of concentration in ppm. For example, if the instrument is calibrated with propane and then used to measure hexane, the ppm readings will be approximately double the true concentration. This problem can be addressed by expressing concentrations in ppmc rather than ppm, or through the use of a response factor.

The concentration in ppmc is calculated by multiplying the concentration in ppm by the number of carbon atoms per molecule in the span gas. For example, 3 ppm of propane, which is composed of three carbon atoms, is equivalent to 9 ppmc. Use of ppmc rather than ppm, is preferred for some applications where the total number of carbon atoms is considered to be an important issue or in situations where the operator would prefer to report all results in "methane equivalents".

A response factor is 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 will be used, it can be entered under the Instrument Controls menu, and will be automatically applied to the instrument reading.

Note The response factor is only applied to the non-methane concentration. ▲

Selecting Span Gas Concentrations

As described above, the instrument is normally calibrated with a single gas mixture containing methane and a non-methane hydrocarbon in air. The span gas concentrations should be similar to the concentrations expected in the actual sample. For example, a good span gas for use in a typical ambient air application would contain about 2 ppm of methane, and 1 to 2 ppm of propane in air. For other applications, the methane and NMHC concentrations should be adjusted as needed. However, to avoid possible interference from oxygen, the methane span concentration should never be less than about 1.5 ppm.

NMHC concentrations may be as low as needed. But, to maintain good calibration repeatability, the concentration should generally be above 0.5 ppm. The possibility of stability problems at extremely low concentrations should also be discussed with the gas supplier. In some cases it may be appropriate to use nitrogen, rather than air, as the balance gas if this will improve the gas stability.

Because the instrument's response is linear, a simple two-point calibration will provide good accuracy and repeatability for measurements taken

throughout the measurement range. As a general rule, the instrument will be accurate to within 2% at sample concentrations ranging from 20% to 120% of the span concentration. Readings taken outside that range are usually accurate, but may be considered suspect until confirmed by re-calibration.

Connecting the Calibration Gas

Calibration gas is introduced through the sample inlet. If the calibration gas is run through the analyzer Span-In and Span-Out ports, the instrument will control when the span gas is turned on and off. However, the calibration gas must still be connected to the sample line external to the instrument.

To the extent possible, calibration gas should be introduced to the sample inlet in a manner that simulates the introduction of actual sample. That is, if the installation includes a long sample line and a probe, the span gas should be introduced at the probe, not at the back of the instrument.

If a span gas cylinder is connected directly to the instrument, an atmospheric pressure dump, or by-pass must also be included to prevent pressurizing the sample inlet. A simple vent system is shown in Figure 2–3.

Some examples of acceptable configurations for the span gas and sampling systems are shown in Chapter 2, "Installation". These figures illustrate two important factors which must be considered when presenting span gas to the Model 55*i*:

● If using the internal pump, calibration gases **must not** be forced into the instrument at elevated pressure.

● When using a direct connection to a span cylinder, there must be an excess flow so that the span gas will not be diluted by ambient air or sample.

Calibration Menus

The instrument's Main Menu contains two sub-menus that are directly related to calibration. These are the "Calibration Parameters" menu and the "Calibration" screen. The first step in setting up the software is to specify a calibration method by entering the correct values for items listed under the Calibration Parameters menu. Once the calibration method has been established, the actual calibration procedure can be triggered automatically, or manually using the commands listed under the Calibration screen.

Calibration Parameters

The Calibration Parameters menu includes several items that control the calibration routine. This list includes entries that specify the span gas concentrations, enable or disable automatic calibration features, and

control whether calibrations should be based on one or more analysis cycles. An explanation of each calibration parameter includes:

Gas Concentrations

This entry is used to edit the span gas concentrations for the methane and non-methane channels. Concentrations may be entered in parts per million by volume (ppm), or in parts per million carbon (ppmc).

Concentration values are edited using the arrow keys. The cursor is moved using the left and right arrows and the highlighted digit is incremented or decremented using the up and down arrow keys. The decimal point may be moved by locating the cursor in the desired position and then using the arrow keys to change the digit to one less than 0, or to 1 more than 9. Once the display has been adjusted, press [⏎] to lock in the new value.

If a mixed span gas containing both methane and a non-methane hydrocarbon is not available, a value of zero may be entered for one channel. In that case, the channel set to 0.0 will not be adjusted during subsequent calibrations.

The instrument may be configured for one span gas or three via the DIAGNOSTICS > INSTRUMENT CONFIGURATION menu. If three span gases are configured, it is the user's responsibility to provide the correct span gas to the span or sample port of the instrument at the proper time.

Auto Calibration Setup

The Auto Calibration Setup option allows the user to determine whether the instrument will perform automatic calibrations and how they will be scheduled. The options for automatic calibration mode are: OFF, which disables automatic calibration feature, BY RUN, which allow the user to specify the number of analytical cycles between calibrations, and BY TIME, which allows the user to specify a time of day when the instrument will start performing automatic calibrations, and the time period between these automatic calibrations, in hours. These options are mutually exclusive, that is, setting auto calibration by number of runs turns off auto calibration by time.

The options for Cal Reset are: NO, which performs only calibration checks at the specified period, or YES, which updates the calibration parameters to re-calibrate the analyzer at the specified period. The Auto Calibration Check feature (Cal Reset = NO) is intended to be used under regulations which require frequent span checks or drift tests, but which do not allow automatic re-calibration. When an automatic calibration check is running, the calibration solenoid is opened to flood the sample inlet with span gas and a full analysis is performed. However, the instrument calibration is not adjusted. The automatic calibration check option allows the user to

determine whether the instrument will perform automatic tests of the current calibration and how they will be scheduled.

To change the current setting, press $\boxed{\uparrow}$ or $\boxed{\downarrow}$ until the desired option appears, and then press $\boxed{\hookleftarrow}$. For more information on automatic calibration setup, see Chapter 3, "Operation".

Auto Verification

Auto Verification allows the user to improve confidence in the calibration procedure by automatically running a span check immediately after each calibration. Auto verification may be set to ON or OFF by pressing $\boxed{\hookleftarrow}$. When set to ON, a span check is run immediately after the calibration cycle. If the span check indicates a difference of greater than 2.0 %, the calibration is automatically repeated. The Model 55*i* will make up to five attempts to achieve a repeatable calibration. If Auto Verification is set to OFF, no span check will be run and the calibration will be based on a single analysis cycle.

If the span concentration is too low, it will be difficult to achieve 2% repeatability due to the limited resolution available. In that case, the calibration will be considered valid if the difference between two consecutive readings is less than 0.02 ppm.

Auto verification can avoid many common calibration errors and should usually be left ON. For example, an installation that uses a long sample line and introduces span gas at the end of the sample probe may require two or three analysis cycles to achieve a stable concentration of span gas. In this case, the automatic verification would prevent the instrument from accepting an invalid calibration caused by inadequate flushing of the sample lines.

Minimum Verification Cycles

The Minimum Verification Cycles screen allows the user to adjust the minimum number of verification cycles used when auto verification is ON. Values are between 2 (default) and 5.

Use Zero Chromatogram

The Use Zero Chromatogram screen allows the user to choose whether to use a previously stored zero chromatogram for baseline correction or not. For additional discussion of this feature, see "Zero Chromatogram" in this chapter.

Reset User Cal Defaults

The Reset User Cal Default screen allows the user to reset calibration settings to default values.

Calibration

The calibration screen presents three commands. These allow the operator to initiate a manual calibration, a manual calibration check, or to do a zero chromatogram. Each procedure is described below.

Calibration

Selecting Manual Calibration will trigger a calibration cycle. The span solenoid will open to allow the calibration mixture to flow into the sample line. The instrument will pause for 30 seconds, then inject a span gas and measure the methane and non-methane peaks. Calibration factors, which relate peak size to gas concentration, will be calculated using the span gas values that were entered in the Calibration Parameters menu. If the auto verification option is set to ON, the span solenoid will stay open, and the calibration cycle will be repeated. The calibration cycle will continue to repeat until two consecutive calibrations agree to within ±2%. If 2% repeatability is not achieved within the user-specified minimum number of verification cycles, a fault alarm will be triggered, and the instrument will continue to operate using the last valid calibration.

Calibration Check

The Manual Calibration Check option allows the operator to check the repeatability or validity of the current calibration, without making any adjustments. When manual check is selected, the span solenoid opens and floods the sample line with span gas. A reading is then taken and compared to the original span reading that is stored in memory. Results of the calibration check are available in the "CH4 Span Check" and "NMHC Span Check" from the Alarms menu. Any error, or difference between the two readings, is displayed as percent error. It should be understood that the calibration check function does not alter the instrument calibration. It serves only as a convenient method of checking instrument drift, or for evaluating possible calibration errors.

Do Zero Chromatogram

Do Zero Chromatogram triggers a run which will be stored as the new zero chromatogram. The user must be sure that no air or sample is injected for this run. For additional discussion, see "Zero Chromatogram" in this chapter.

Manual Calibration Procedure

Use the following procedure to initiate a calibration.

1. From the Main Menu, choose **Calibration Parameters**. Enter the span gas concentrations for the methane and non-methane channels.

2. Press [■] to return to the Calibration Parameters menu and choose **Auto Calibration Setup** to select Cal Reset option as described earlier.

3. Press [■] to return to the Calibration Parameters menu and choose **Auto Verification** to set the auto verification option to ON or OFF as described earlier. For most applications, this option should be set to ON.

4. Press [■] to return to the Calibration Parameters menu and choose **Min Verification Cycles** to set the minimum number of calibration runs that will be performed (if auto verification option is set to ON). For most applications the default value of 2 provides adequate performance.

5. Press [■] twice to return to the Main Menu and choose **Calibration.**

6. Be sure that the span gas cylinder is turned on, and if you are using the instrument's internal calibration solenoid to control the gas flow, adjust the cylinder regulator pressure to about 15 psi.

7. From the Calibration screen, press [→] to initiate the calibration.

Note The message "NOT ABLE TO START CAL NOW!" is displayed if the flame is not lit or the analyzer is in the middle of a run or in column conditioning mode. ▲

8. During the initial calibration, check to be sure that the span gas flow rate is sufficient to flood the sampling line and prevent ambient air or sample from being pulled into the instrument from the atmospheric dump.

The span solenoid will open and allow span gas to enter the sample line. The instrument will pause for 20 seconds plus the sampling time to flush the sample line, and then inject a sample of span gas onto the analytical column. Following injection, the instrument will run a complete analysis of the span gas and record the detector response for the methane and non methane components. Calibration factors relating detector response to the sample concentrations will be determined and stored in memory. If Auto Verification is set to ON, the instrument will check the repeatability of the calibration. If the verification test shows that the methane and NMHC readings were stable to within 2%, the calibration solenoid will close and the new calibration will be complete.

If the verification indicates instability of greater than 2%, the amount of drift, expressed as a percent of the span concentration, will be displayed and another sample of span gas will be injected. The instrument will repeat the calibration up to five times, or until the verification test is passed.

Once the calibration cycle is complete, the new calibration factors are compared to calibration factors stored to memory. If the factors fall within the expected or acceptable range, the calibration is considered valid and the new calibration factors will go into affect. If the calibration factors fall outside the expected range, the calibration will be rejected, an alarm will be triggered, and the instrument will continue operation using the last valid calibration factors.

If the cycle was initiated automatically, the instrument will pause for 30 seconds to flush any residual span gas out of the sampling system. Otherwise, it will return to the Main Menu.

Following calibration, the calibration factors and other diagnostic information can be viewed by selecting Diagnostics from the Main Menu > **Calibration History**. Also, if automatic calibration or calibration checks have been requested, the counter will reset to zero following a manual calibration if the automatic calibration or calibration check is set to BY RUN.

Zero Chromatogram

The user has the option to store a zero chromatogram run in the instrument. Subsequent calibration and sample runs will have this zero run subtracted out before calculation of concentration if the Use Zero Chromatogram is turned ON. This feature can help resolve methane and non-methane peaks if the instrument baseline is less than ideal. Stored zero chromatogram data will become invalid if the user changes the window timing parameters in the Service menu. If the data bcomes invalid, it will not be used for baseline correction regardless of the user setting. Invalid data warnings will be shown in the Calibration screen and in the Use Zero Chromatogram screen.

Performing a Zero Chromatogram

Before storing a zero chromatogram, the user should ensure that no air or sample remains in the sampling system.

Use the following procedure to perform a zero chromatogram.

1. Disconnect the sample line from the instrument sample inlet.

2. Turn the pump OFF. From the main menu, choose Instrument Controls > **Pump Settings.** Select **Always Off**, and press [↵].

3. Set the instrument to single run mode. From the main menu, choose Instrument Controls > **Set Operation Mode.** Select **Single**, and press ⏎.

4. Press ▶ to return to the Run screen.

5. Run at least three analysis cycles. If possible, use the FID SIG analog output or other means (streamed raw data **or** "dump run current" C-Link command) to observe the baseline of the run. Continue running cycles until the obtained signal trace is consistent.

6. Run a zero chromatogram. Press ■ to return to the Main Menu and choose **Calibration.** From the Calibration screen, press ⬇. This will perform an analysis cycle and store the baseline data into the instrument for subtraction from subsequent analyses. No concentrations are calculated for this run.

7. Press ■ to return to the Main Menu and choose Calibration Parameters > **Use Zero Chromatogram.** Press ⏎ toggle value to **Yes** to subtract the acquired zero chromatogram data from all analyses.

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
- "Pump Rebuilding" on page 5-5

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. ▲
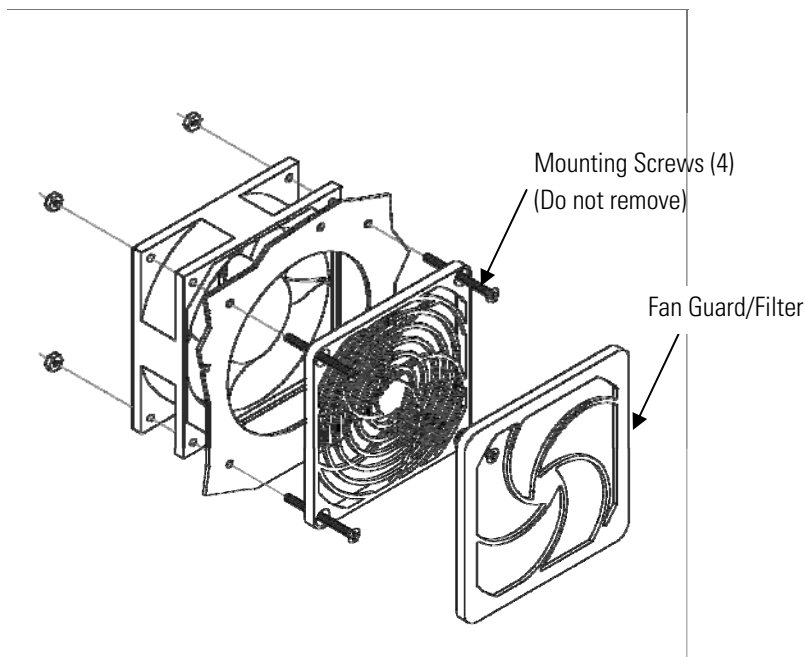
Figure 5–1. Inspecting and Cleaning the Fan Filters

Internal Sample Filter Cleaning

This section provides the requirements and instructions for cleaning the internal sample filter element in the Model 55*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 seal-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 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.
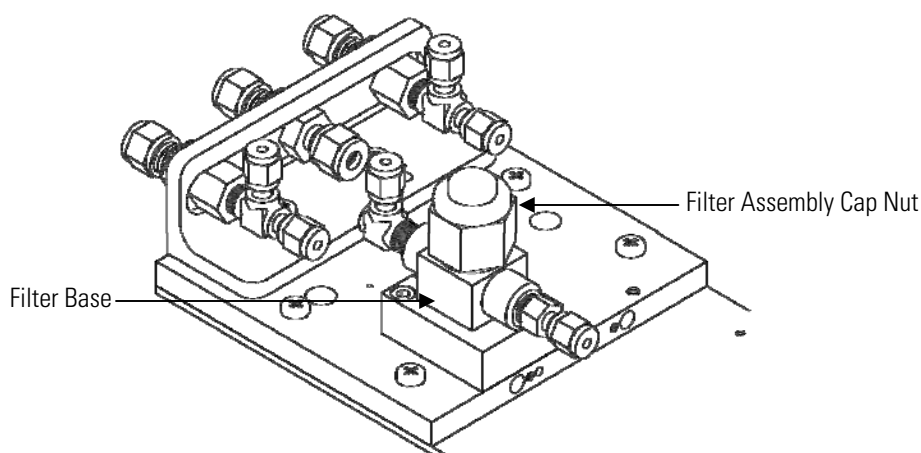
Figure 5–2. Cleaning the Internal Filter Element

Pump Rebuilding

For the new technology pump (repair kit part number 108002-00), use the following procedure to rebuild the pump (Figure 5–3). 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. To replace the pump, see "Pump Replacement" in the "Servicing" chapter.

Equipment Required:

Pump repair kit

Allen wrench, 3mm

Screwdriver, Philips

Screwdriver, slotted

Wrench, 9/16-inch

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

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

2. Loosen the fittings and remove both lines going to the pump.

3. Loosen the four screws holding the pump plate to the flow of the instrument. Unplug the pump power connector from the measurement interface board and remove the pump assembly from the instrument.

4. Remove the four screws from the compressor housing cover and remove the cover.

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

6. Turn the fan until the diaphragm is positioned at the top dead center. Unscrew the old diaphragm by turning it counterclockwise using both hands. While unscrewing the diaphragm with one hand, use the other hand to secure the support cup and shim rings onto the diaphragm stud. Lift the diaphragm, support cup and shim rings from the pump.

Note DO NOT use tools. Take care not to lose any shim rings positioned between the diaphragm support cup and connecting rod, as the exact number of shim rings must be used during re-assembly. ▲

7. Replace the support cup, and shim rings onto the threaded stud of the new diaphragm. Carefully screw the new diaphragm into the connecting rod. Spin the diaphragm on until it is snug.

Note DO NOT use tools. ▲

8. Turn the fan until the diaphragm is flat across. With the diaphragm centered over the compressor housing, firmly seat the diaphragm edge into the compressor housing groove.

9. Replace the bottom plate onto the compressor housing, the new flapper valve on top of the intermediate plate, and the top plate on top of the bottom plate.

10. Tighten the four top plate screws to a maximum torque of 6-7 inch-lbs. Turn the fan by hand to confirm that the pump turns freely.

11. Replace the compressor housing cover and gasket. Install the four cover screws, making sure not to over tighten.

12. Check that the flow from the pump exhaust is 1 LPM with the pump inlet open to the air.

Top Plate screws (4x)

Top Plate

Flapper Valve

Bottom Plate

Diaphragm

Support Cup

Shim Rings

Cover Screws (4x)

Compressor Housing Cover
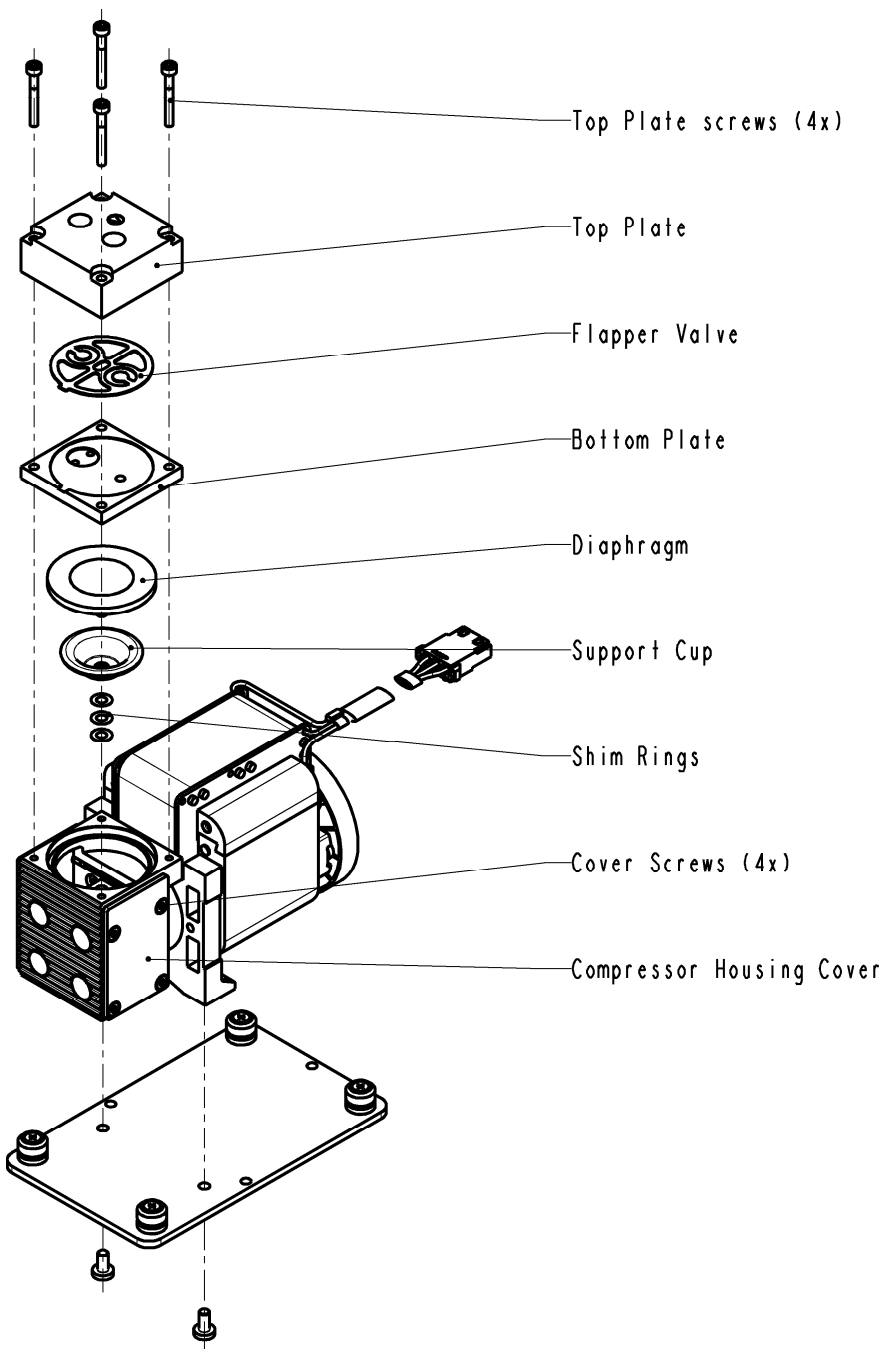
Figure 5–3. Rebuilding the Pump (New Technology)

For older models (repair kit part number 8606), use the following procedure to rebuild the pump (Figure 5–4). To replace the pump, see "Pump Replacement" in the "Servicing" chapter.

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

2. Loosen the fittings and remove both lines going to the pump.

3. Loosen the four screws holding the pump plate to the floor of the instrument. Unplug the pump power connector from the measurement interface board and remove the pump assembly from the instrument.

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

5. Remove the clamping disc (with the needle-nose pliers) holding the diaphragm and Teflon protection wafer onto the clamping rod. Remove both diaphragm and Teflon wafer.

6. Assemble the pump by following the above procedure in reverse, making sure not to over tighten clamping disc, and to have the Teflon side of the diaphragm facing up and that the flapper valves cover the holes of the top and bottom plate.

7. Check that the flow from the pump exhaust is 1 LPM with the pump inlet open to the air.
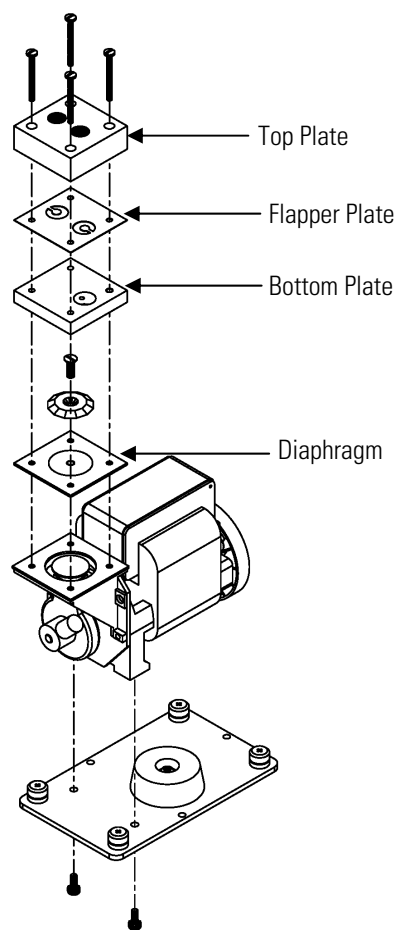
Figure 5–4. Rebuilding the Pump

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 6-29 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 6-2

● "Troubleshooting Guides" on page 6-2

● "Board-Level Connection Diagrams" on page 6-8

● "Connector Pin Descriptions" on page 6-10

● "Performance Problems" on page 6-22

● "Service Locations" on page 6-29

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. Typical oven temperatures and support gas pressures for an instrument that is operating correctly are shown in Table 6–1. In most cases, the values can vary some without causing problems. Information available in the Model 55*i* Diagnostic menu is generally related to performance issues, and is discussed in the appropriate section.

Table 6–1. Model 55*i* Firmware Diagnostic Information

Oven Temperatures	
Detector Oven	170 to 180 °C
Filter	170 to 180 °C
Column Oven	70 to 85 °C
Flame	225 to 350 °C
Internal	Ambient + 7 °C
Support Gas Pressures	
Air	50 to 60 psi
Fuel	50 to 60 psi (Hydrogen)
	50 to 60 psi (Mixed Helium/Hydrogen)
Carrier (Nitrogen)	50 to 60 psi

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 6–10 provides possible problems that follow the sample chromatogram and help narrow down the problem to one instrument area.

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.

Malfunction	Possible Cause	Action
	Main fuses are 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.
	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.
		Verify 120 VAC power cable is attached to J1 (AC IN) on measurement interface board and the motherboard.
		Verify 24 V power cable is attached to J6 (24V IN) on measurement interface board and the power supply.
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 power supply test point during ignition cycle.
	Ignitor failure	Move ignitor supply lead to alternate ignitor. Replace bad ignitor 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 5 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.
	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	Depending on the pump setting, the pump will not run until the detector oven temperature approaches the oven temperature set point (175 °C).
	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.
	Vacuum lock	Shut off power and rotate the pump fan by hand. Re-apply power and allow time for the oven temperature to return to operating temperature. Pump should start.
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 FID	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.
Incorrect or no response to sample gas	Flame not lit	Check flame out alarm status, check fuel.
	Analyzer not calibrated	Re-calibrate.
	No gas reaching the analyzer	Check the response to a known span gas.
	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 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.
	Window timing is improperly set	Check the window timing in the Service menu.
Span Drift	Line voltage fluctuations	Check to see if line voltage is within specifications.
	Unstable span source	Verify span source pressure is stable, if not, replace source gases.
	Pressure carrier gas is unstable	Check pressure in Diagnostic screen.
	Fuel and/or air supply pressure unstable	Check pressure in 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.
	Unstable bias voltage	Check bias voltage in Diagnostic screen.
Non-linear response	Leak in sample line	Check for sample dilution.
	Leak within the analyzer	Check for loose fittings in analyzer.
	Problem with input board range switching	Extinguish the flame (turn off fuel supply). Go to Input Frequency Disp. Test screen (Service menu) and step through each range with the test voltage on.
		Gain 1 freq = 5750 – 7500
		Gain 10 freq = 30000 – 35000
		Gain 100 freq = 275000 – 300000
Excessive response time	Leak within the analyzer	Check for loose fittings in analyzer.
	Carrier gas pressure too low	Check carrier pressure.
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.
Alarm - Filter Temp		Check heaters for open or short circuits.
Alarm - Column Temp		Check thermocouples for open or short circuits.
Alarm - Flame Out	Gas supply failure	Check gas pressures.
Alarm - Carrier Pressure	Pressure is outside alarm window	Check gas supply pressure.
		Check plumbing for leaks.
Alarm - Fuel Pressure		Verify pressure controller output pressure is present (Diagnostic menu).
Alarm - Air Pressure		
Alarm - CH4 Overrange	Sample conc exceeds range	Increase CH4 range setting.
Alarm - NMHC Overrange	Sample conc exceeds range	Increase NMHC range setting.
Alarm - Data Integrity	Run Data error(s)	Call Thermo Fisher Scientific Service Department.
Alarm - Bias Voltage	Circuit failure	Check voltages in Diagnostics.
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 - CH4 Span Check	Span value exceeds offset	Re-calibrate or shift offset.
Alarm - NMHC Span Check		
Alarm - Window Sanity	Window timing incorrect	In Service Mode modify window timing.
Alarm - CH4 Cal Fail	Cal value outside cal error window	Verify correct cal error settings in Serivce menu Crucial Settings screen.
Alarm - NM Cal Fail		
Alarm - Methane Conc	Sample conc beyond alarm window	Review alarm data screen for legitimate failure.
Alarm - Non-Methane Conc		
Alarm - External Alarms	External alarm input active	Check externally connected device.
Alarm - Motherboard Status	Internal cables not connected properly	Check that all internal cables are connected properly. Re-cycle AC power to analyzer. If still alarming, change board.
Alarm - Interface Status	Board improperly seated	Turn power off and re-seat board.
Alarm - I/O Exp Status	Board is defective	Replace 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.
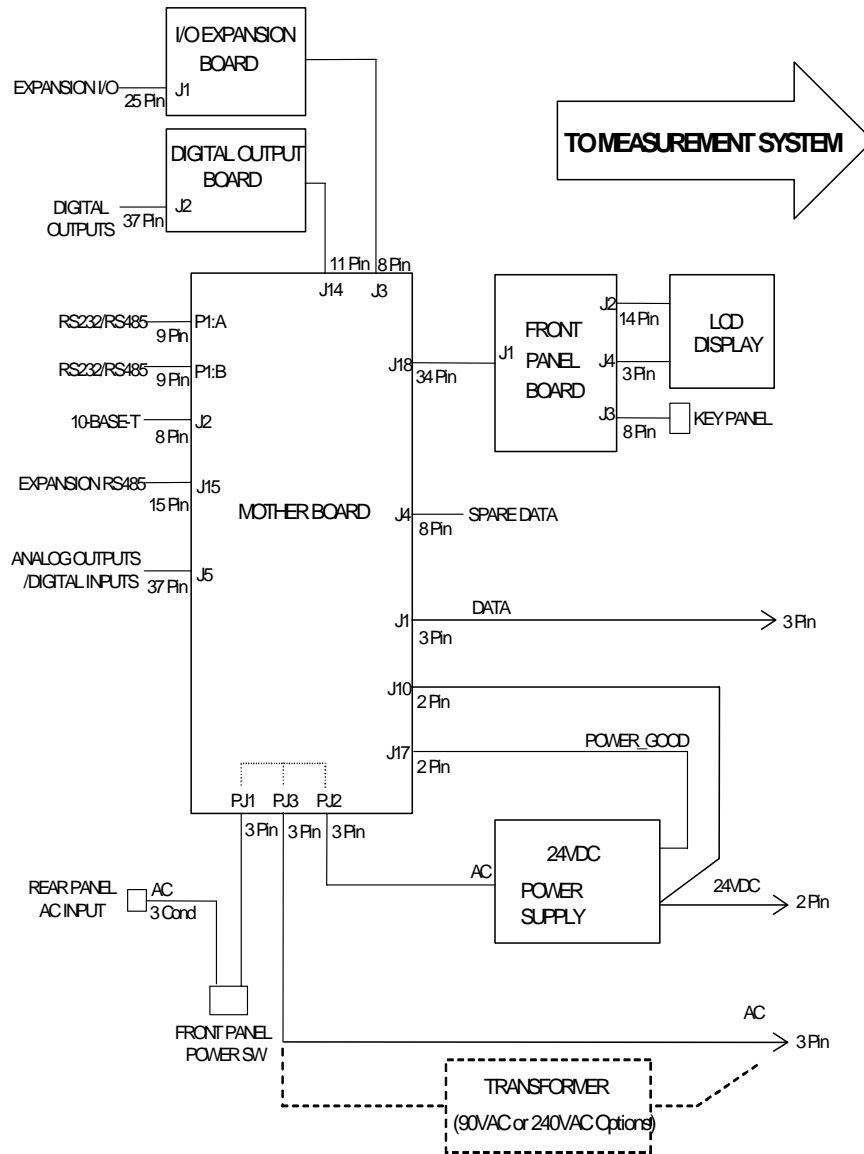
Figure 6–1. Board-Level Connection Diagram - Common Electronics
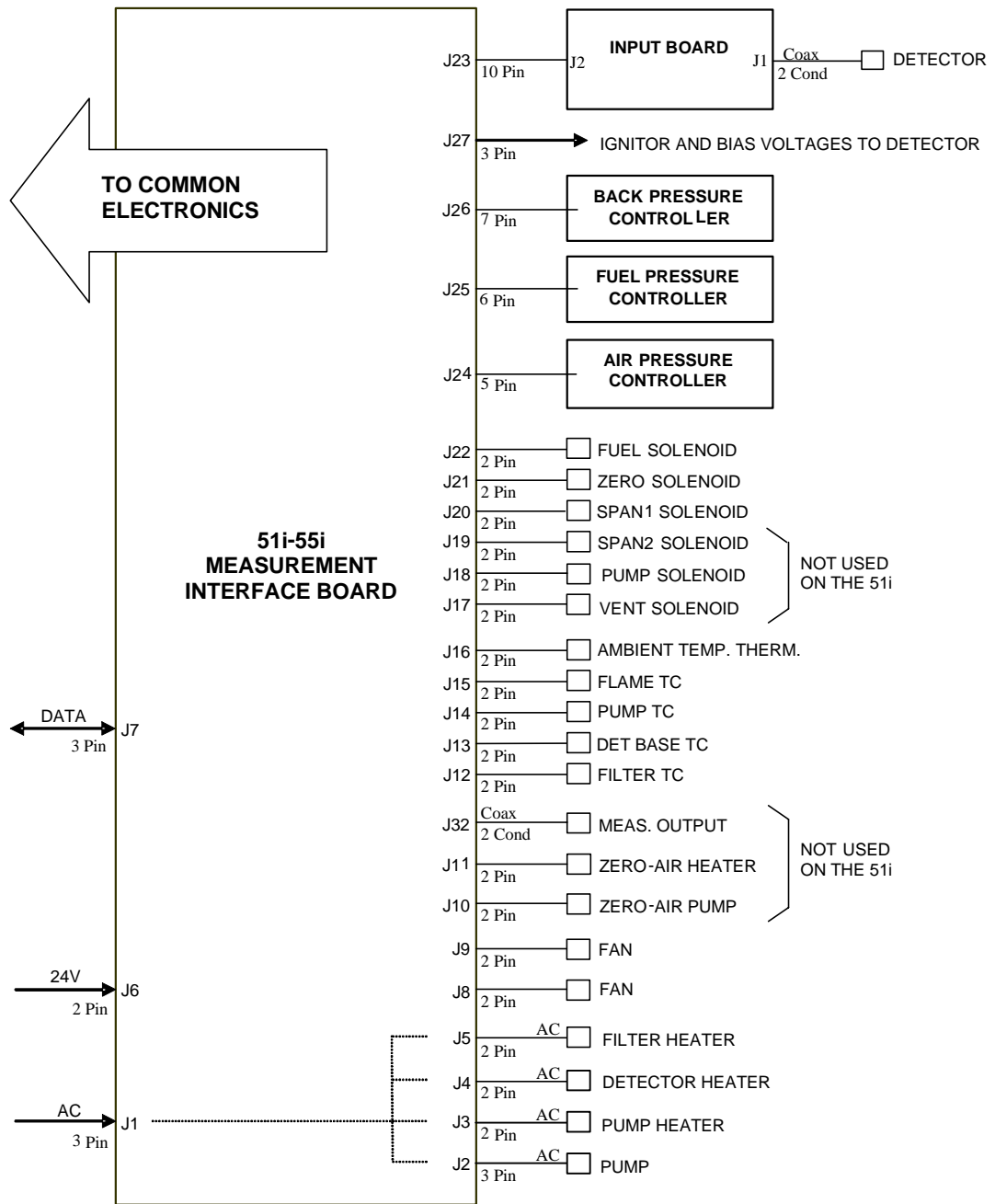
Figure 6–2. Board-Level Connection Diagram - Measurement System

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.

"Motherboard Connector Pin Descriptions" on page 6-10

"Measurement Interface Board Connector Pin Descriptions" on page 6-15

"Front Panel Board Connector Pin Descriptions" on page 6-17

"I/O Expansion Board (Optional) Connector Pin Descriptions" on page 6-19

"Digital Output Board Connector Pin Descriptions" on page 6-20

"Input Board Connector Pin Descriptions" on page 6-22

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
		25	Keypad Col 2 Select

Connector Label	Reference Designator	Pin	Signal Description
		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
AC INTF BD	PJ3	1	AC-HOT

Connector Label	Reference Designator	Pin	Signal Description
		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+
		2	Filter TC-

Connector Label	Reference Designator	Pin	Signal Description
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
		4	Air Pressure In

Connector Label	Reference Designator	Pin	Signal Description
		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
		10	LD5 – LCD Signal

Connector Label	Reference Designator	Pin	Signal Description
		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
		10	+5V

Connector Label	Reference Designator	Pin	Signal Description
		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
		14	Ground

Connector Label	Reference Designator	Pin	Signal Description
		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
		10	SPI Board Select

Connector Label	Reference Designator	Pin	Signal Description
		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
		32	+24V

Connector Label	Reference Designator	Pin	Signal Description
		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

Performance Problems

Performance problems, such as poor accuracy or repeatability, can usually be traced to issues involving either the detector or the chromatographic system. Poor chromatography typically causes problems such as inability to obtain a valid calibration, high readings when analyzing zero air, or lower than expected readings on the actual sample. Chromatography problems appear most often at the time of initial installation, or after a prolonged shut down.

Some detector malfunctions, such as difficulty keeping the flame lit, are easily identified and are addressed under the discussion of hardware malfunctions. However, more subtle detector problems can also occur. Detector malfunctions most often show up in test chromatograms as a noisy baseline signal, as negative peaks or dips in the baseline, or as extreme sensitivity to vibration. In most cases, detector problems must be corrected

by replacement of the detector O-rings and cleaning of the jet, collector, and insulators. Procedures for removing and cleaning the detector are described in the chapter on service.

In order to analyze instrument performance problems, it is essential to have a chart recorder or other data acquisition system that can be used to record the instrument chromatograms. A flow meter and a mirror or chrome tool will also be helpful.

As discussed in Chapter 2, the chromatogram is obtained by attaching a chart recorder or other datalogging device to the BNC connector on the rear panel. The chart speed should be set to about 6 inches per minute and the recorder range should be approximately half of the Model 55*i*'s full scale output (5 volts).

Some sample chromatograms showing proper instrument performance, and the effects of various malfunctions are included on the following pages. In each case, a blank, a zero air chromatogram and a span chromatogram are included. Blank chromatograms, which illustrate the instrument's basic function, can be obtained by disconnecting the sample line, turning off the pump, and running three or four analysis cycles to flush any sample air out of the system. Zero air chromatograms are run with the pump on and the sample line connected to a source of hydrocarbon free zero air. Span chromatograms shown in these examples were obtained by analyzing a span mix containing 2 ppm each of methane and propane in air.

The first step in using this portion of the trouble shooting guide is obtain a full set of chromatograms from the Model 55*i* and to compare those to the chromatograms shown here. Based on that comparison, it may be possible to narrow down the problem to one instrument area. If the source of the problem is not clear from the chromatogram, it may be helpful to check the table of possible problems that follows the sample chromatograms, or to check the instrument's Diagnostics menu described at the end of this chapter.

Normal Chromatograms

When operating correctly, instrument should produce chromatograms similar to those shown here. The top chromatogram was obtained with a span gas containing 2 ppm each of methane and propane in air. Note the relative size and position of the methane and air peaks. As shown in Figure 6–3, the methane peak should have a retention time of 16 to 17 seconds and should be at least 1.5 times the size of the air peak. The center chromatogram was produced by analysis of hydrocarbon free zero-air. As shown here, good quality zero air should produce an air peak in the normal position, but there should be no methane or NMHC peak. The bottom chromatogram was obtained by turning the pump off and allowing the instrument to cycle without sample. Note that the baseline is relatively flat and maintains the same signal level during injection and backflush. The two small spikes represent pressure pulses that result from the rotary valve shifting position. In some cases, the pressure pulses may be larger, but the baseline is fully stabilized within 5 seconds or less.
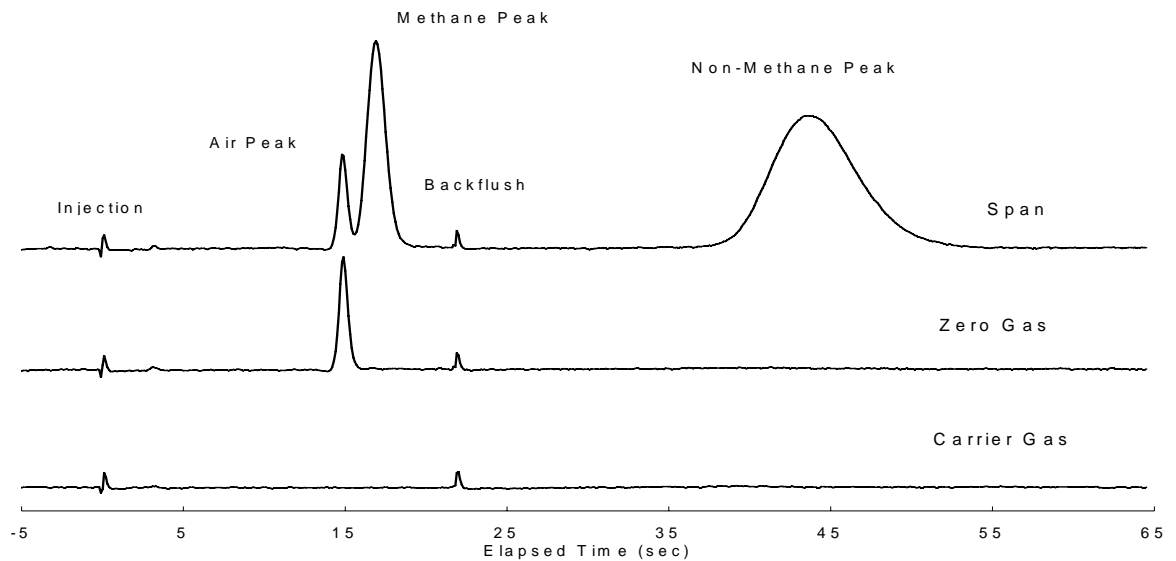
Figure 6–3. Normal Chromatograms

Gas Leak in Column Oven

The chromatograms shown in Figure 6–4, illustrates the effect of a leak in the chromatographic system. In this case, the leak is located at the backflush end of the column. As seen in the blank chromatogram, a leak usually causes the baseline to shift each time the valve is actuated. This shift is caused by a difference in the carrier flow rates in the inject and backflush portions of the chromatogram. In addition, if the leak develops after system optimization the peak retention times may be noticeably affected. In this case the NMHC peak is severely delayed by the decreased flow rate during the backflush.
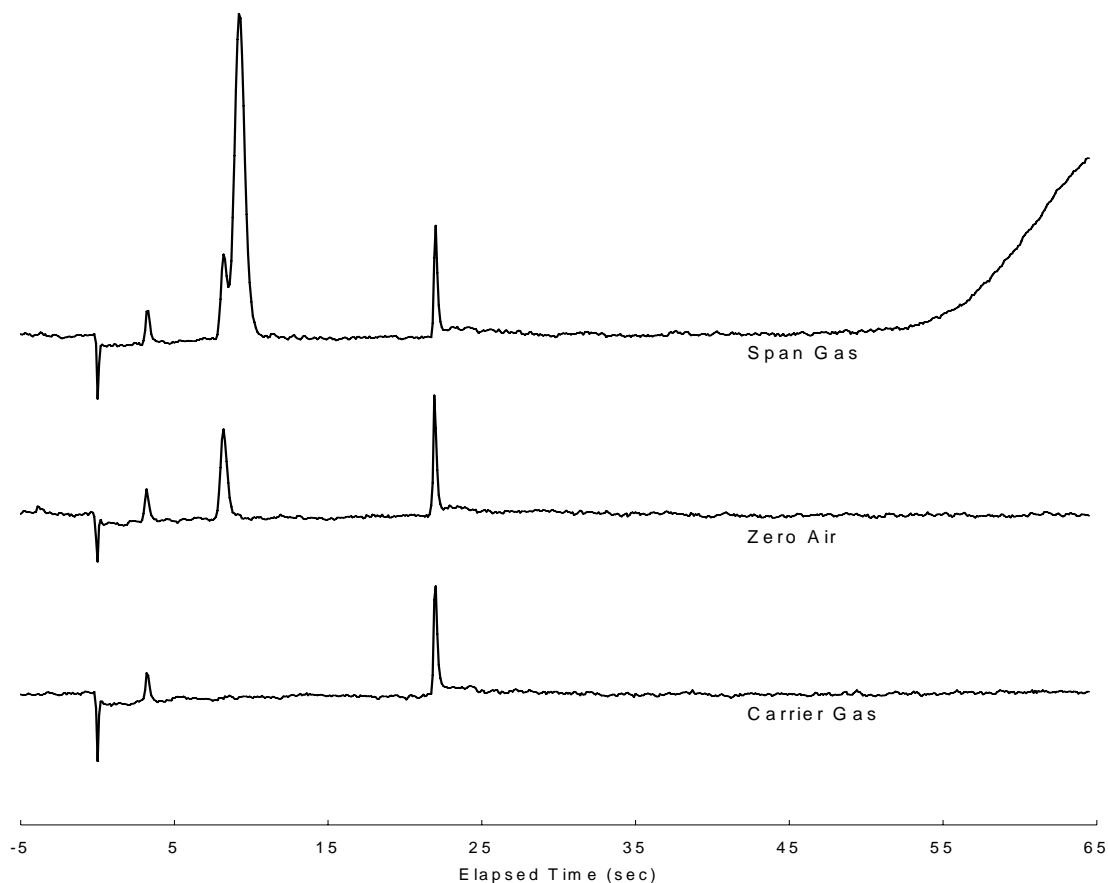
Figure 6–4. Gas Leak in Column Oven Chromatograms

Contaminated Carrier Gas

This set of chromatograms in Figure 6–5 shows one possible result of hydrocarbon contamination in the carrier gas. At the point of injection, the baseline signal jumps up, and then starts a very gradual downward slope. When the valve switches to the backflush position, the baseline either stays at the same level, or in some cases, will jump to an even higher level, and then drop off through the rest of the analysis. The same pattern is seen in all three chromatograms. However, it may be difficult to recognize the problem in the span chromatogram because the NMHC peak obscures the baseline shift that occurs during the backflush. Note that higher levels of contamination may cause different patterns. However, in all cases, carrier contaminants will produce an unstable baseline.
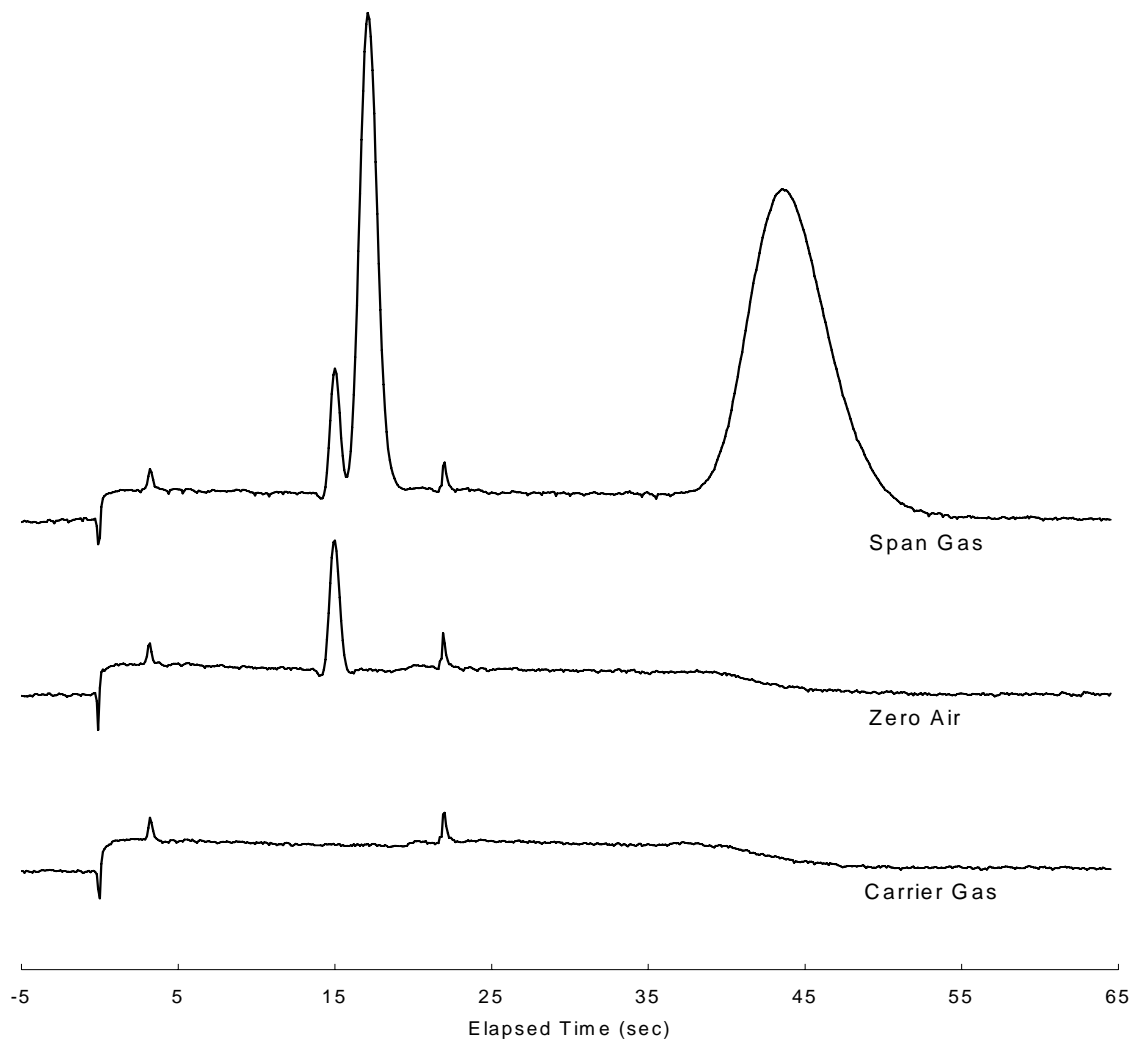
Figure 6–5. Contaminated Carrier Gas Chromatograms

Contaminated Column

Contaminated column chromatograms, as shown in Figure 6–6, illustrate the effects of a badly contaminated column. Looking at the blank chromatogram, note that the baseline drops rapidly following injection, and then stays relatively flat until the backflush. Immediately following the backflush there is a slight drop in the baseline. This is followed by an exponential rise that occurs from 5 to 30 seconds after the backflush. Following the rise, the baseline appears to re-stabilize at the higher signal level. Chromatograms made with span gas or with zero air show the same general shape, but with the normal peaks superimposed over the unstable baseline.
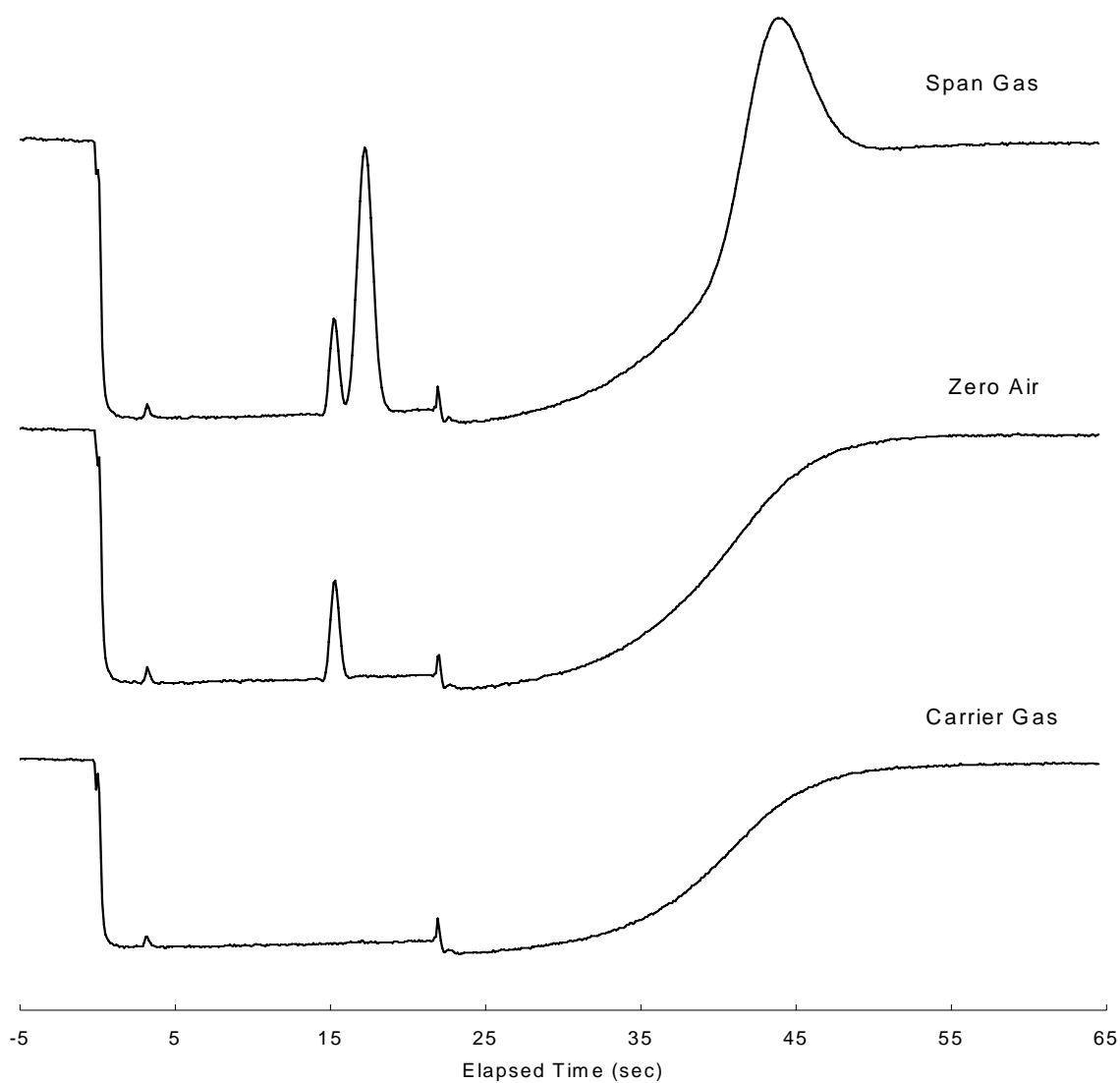
Figure 6–6. Contaminated Column Chromatograms

Table 6–10. Troubleshooting - Performance Problems

Alarm Message	Possible Cause	Action
Not Repeatable	Carrier pressure out of adjustment	Check methane retention time and adjust to 12-13 seconds by changing carrier pressure.
	Gas flows not optimized	Check and adjust support air and fuel pressures and, if necessary, re-optimize.
	Sampling system leaks	Check for leaks or pressure fluctuations at sample inlet.
	Bias voltage bad	Check detector bias voltage as described in general guide troubleshooting section.
	Carrier contamination	Check chromatogram baseline while running blanks.
		Re-condition column.
		Replace gas scrubbers and use higher quality carrier.
	Insufficient span flow	Check that span flow rate is higher than the instrument sampling rate.
Non-Linear Response	Sample exceeds current instrument range	Check the range setting in the Range menu and adjust as necessary If sample exceeds maximum range, consult Thermo Fisher Scientific Service Department.
	Gas flows incorrect	Check and adjust support gas pressures at the instrument.
	Bad calibration	Check calibration factors in Crucial Settings menu, and re-calibrate.
	Span gas supply and sample inlet flow don't match	Check that span flow is sufficient and that excess flow is vented.
	Chromatograms baseline is not flat	Check test chromatograms against samples detailed in manual.
Span Drift	Clogged sample inlet	Check flow rate at sample inlet and sample by-pass.
	Warm-up not complete	Check temperature readings in Diagnostic menu and wait for stabilization.
	Carrier contamination	Check chromatogram baseline against samples shown.
	Column is dirty	Run column conditioning routine located in Service menu.
		Replace gas scrubbers and use higher quality carrier.
Excessive Response Time	Sample leak	Leak test sampling lines and fittings under positive pressure or replace sample bag.

Alarm Message	Possible Cause	Action
	Sample filter dirty	Replace external filters first then clean internal filter with acetone and bake-out if problem continues.
	Cold spots in sampling system or column oven	Check column temperatures under Diagnostic menu
		Check detector and filter oven temperatures for low or no temperature.

Service Locations

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

1-866-282-0430 Toll Free

1-508-520-0430 International

Chapter 7
Servicing

This chapter explains how to replace the Model 55*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 7-9
- "Pump Replacement" on page 7-10
- "Fan/Filter Replacement" on page 7-12
- "Input Board Replacement" on page 7-13
- "Input Board Calibration" on page 7-14
- "DC Power Supply Replacement" on page 7-15
- "Analog Output Testing" on page 7-16
- "Analog Output Calibration" on page 7-19
- "Analog Input Calibration" on page 7-20

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 disassemble the valve unless the system malfunction is definitely isolated to the valve: perform all other system checks first. If disassembly is required, make certain, the instructions that follow are carefully observed. ▲

Any contact between the interior of the valve body and the metal of the rotor or any tool is likely to cause damage. ▲

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 the Model 55*i* major subassemblies. Refer to Figure 7-2 to identify the component location.

Table 7–1. Model 55*i* Replacement Parts

Part Number	Description
100480-00	Front Panel Pushbutton Board
101491-32	Processor Board
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)
103002-01	Measurement Interface Board
108099-00	Input Board Assembly
105213-00	Solenoid Valve, 3-Way
103762-00	Solenoid Valve, 2-Way
104340-00	Pump Assembly
108002-00	Pump Repair Kit (new technology pump)
8606	Pump Repair Kit
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
108100-00	Column Assembly
105567-00	Ignitor/Cable Assembly[*]
10981	Ignitor (without wire and connector attached, requires soldering)[*]
103581-00	Flame Sensor Thermocouple Assembly
103949-00	Thermocouple Cable Assembly

Part Number	Description
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)
103936-00	50W Heater Assembly
104168-00	Column Heater Assembly
104350-00	Pressure Controller, 50PSI
103687-00	Detector Pogo Assembly
104151-00	Exhaust Frit Bulkhead Fitting
14977	Valve Rotor Replacement
14978	Valve Actuator O-ring Replacement Kit
11032	O-ring, FID Flame Sensor (006 red silicone)
14695	Column Ferrules

*Expendable item, not covered by warranty

Cable List

Table 7–2 lists the Model 55*i* cables. See the "Troubleshooting" chapter for associated connection diagrams and board connector pin descriptions.

Table 7–2. Model 55*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
101055-00	Main AC Receptacle Assembly
101377-00	AC to Power Switch
104631-00	Signal Ribbon
103905-00	Heater Power
103952-01	Cable, Pressure Controller, Air
103952-02	Cable, Pressure Controller, Fuel

Part Number	Description
103952-03	Cable, Pressure Controller, Back Pressure
103954-00	Detector Ignitor, BNC Cable Assembly
105209-00	Analog Output BNC Cable Assembly
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, Six Feet (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.
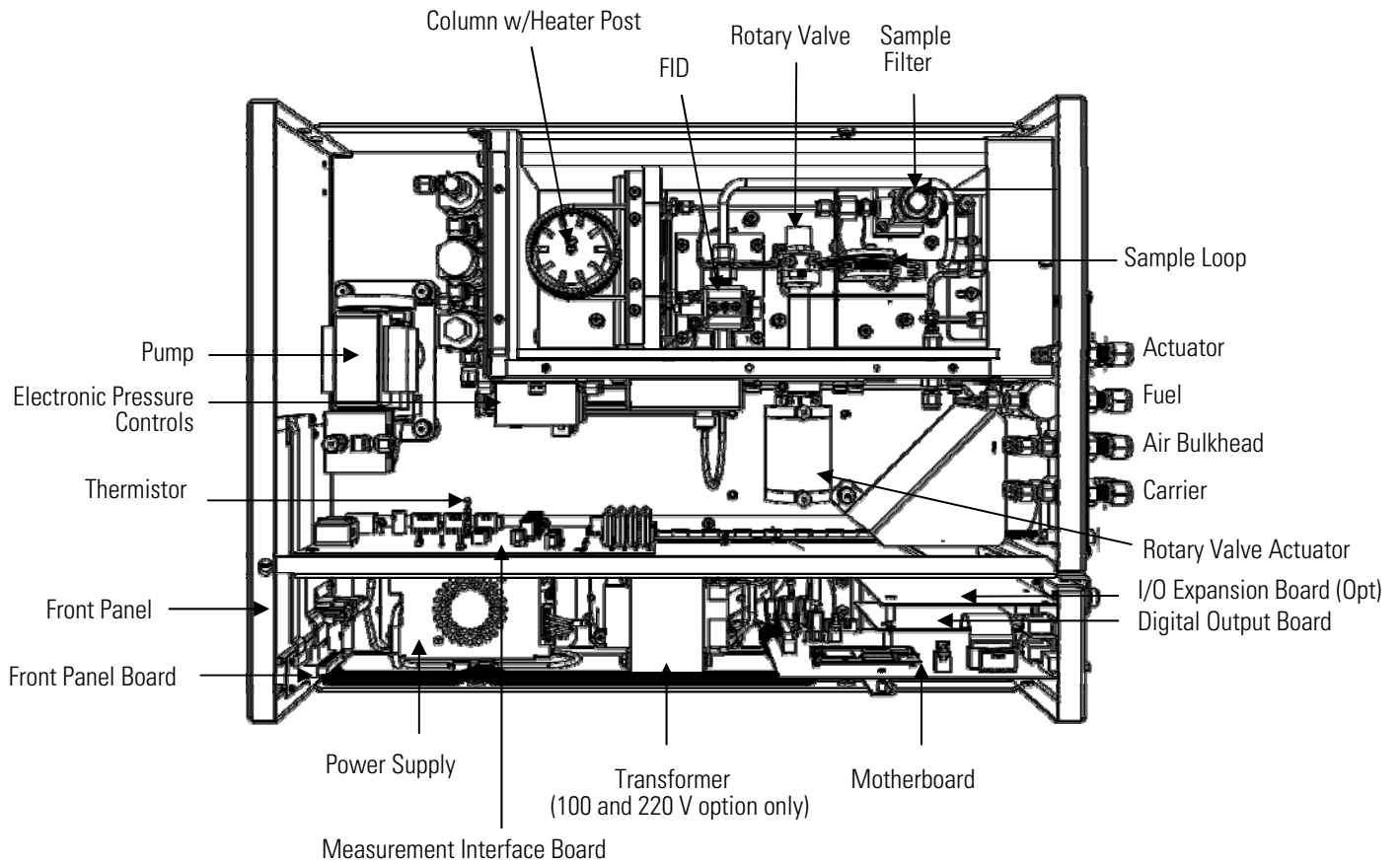
Figure 7–2. Model 55*i* Component Layout

Removing the Measurement Case Assembly and Lowering the Partition Panel

The measurement case assembly can be removed and the partition panel can be lowered to improve access to connectors and components. Refer to the following steps when a procedure requires lowering the partition panel (Figure 7–3).

REMOVE SCREWS

SLIDE CASE ASSEMBLY OUT

Pass Through Connectors

Remove Screw

Loosen Captive Screw

Partition Panel

Remove Screw

Remove Screws

LOWER PANEL

Remove Hidden Screw
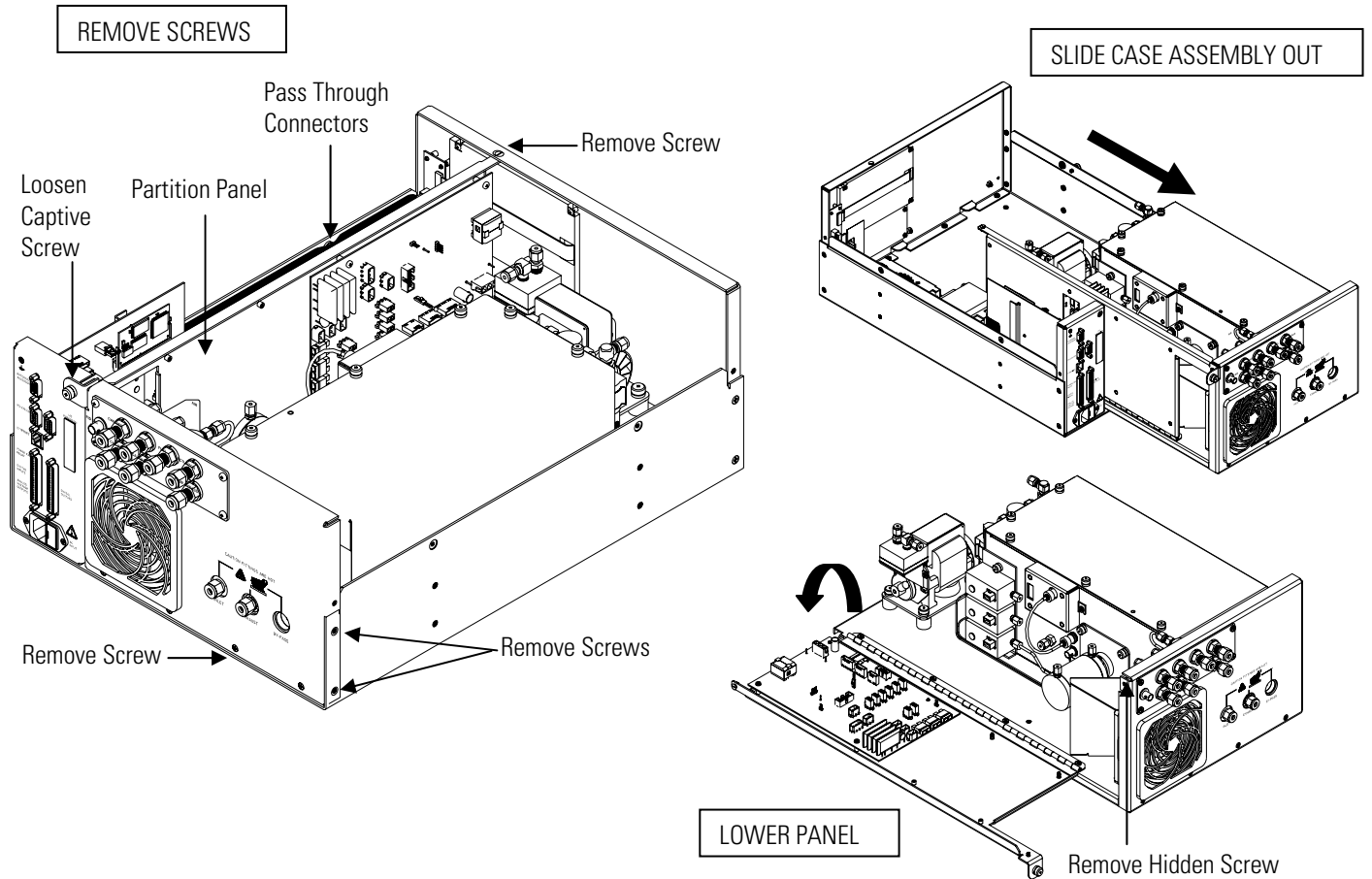
Figure 7–3. Removing the Measurement Case Assembly and Lowering the Partition Panel

Equipment Required:

Philips screwdriver

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

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 7–4). To rebuild the pump, see "Pump Rebuilding" in the "Preventive Maintenance" chapter.

Equipment Required:

Pump

Philips screwdriver

Wrench, 7/16-inch

Nut driver, 1/4-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 power lines from the measurement interface board.

3. Disconnect the air lines from the pump head.

4. Loosen and release the four screws holding the pump mounting plate to the floor.

5. Remove the two screws holding the pump to the mounting plate.

6. Install the new pump by following the previous steps in reverse.
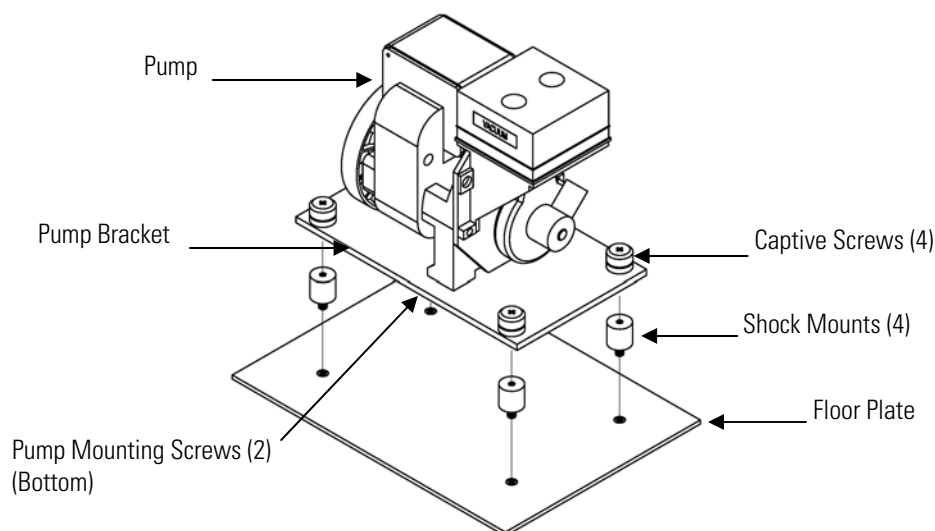
Figure 7–4. Replacing the Pump

Fan/Filter Replacement

Use the following procedure to replace the fan and the fan filter (Figure 7–5).

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.

5. Remove the four fan mounting screws and remove the fan. Do not lose the four nuts.

6. Install a new fan following the previous steps in reverse order.
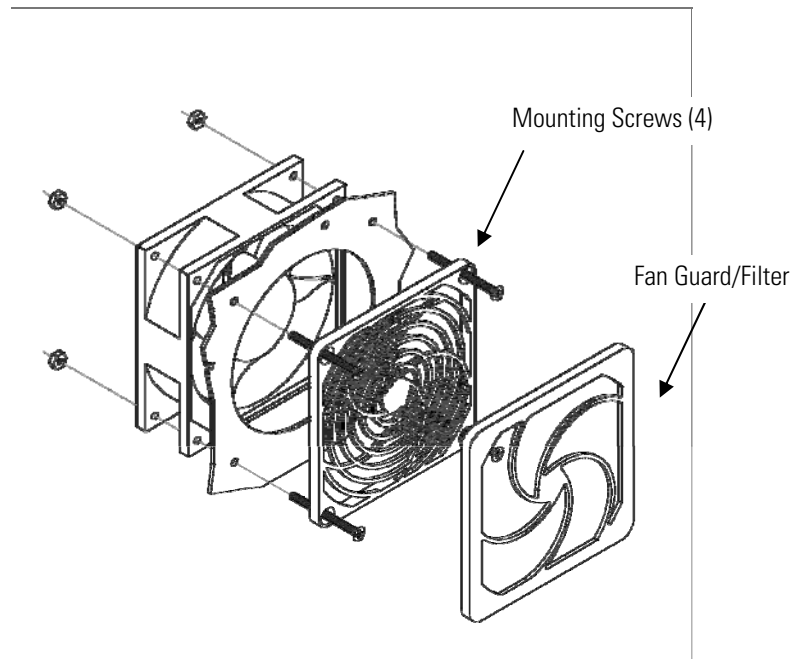
Figure 7–5. Replacing the Fan

Mounting Screws (4)

Fan Guard/Filter

Input Board Replacement

Use the following procedure to replace the input board (Figure 7–6).

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.
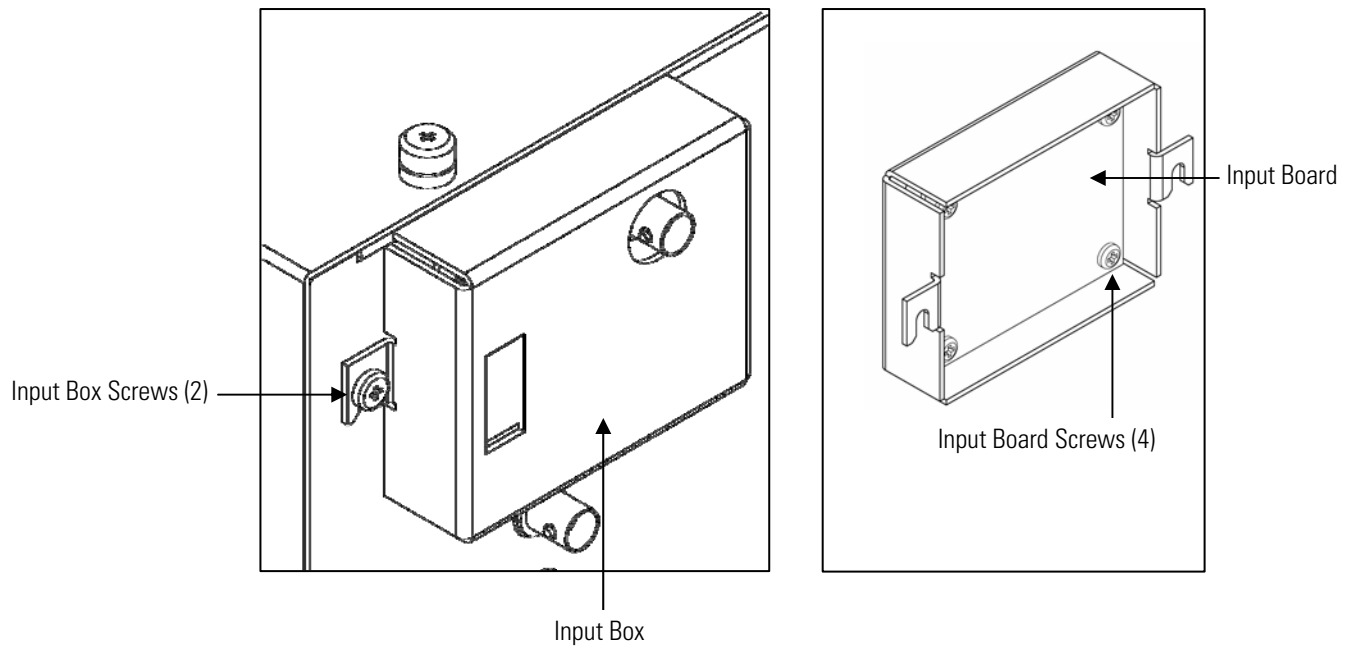
Figure 7–6. Replacing the Input Board

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 menu 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 menu, 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 7–7).

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.
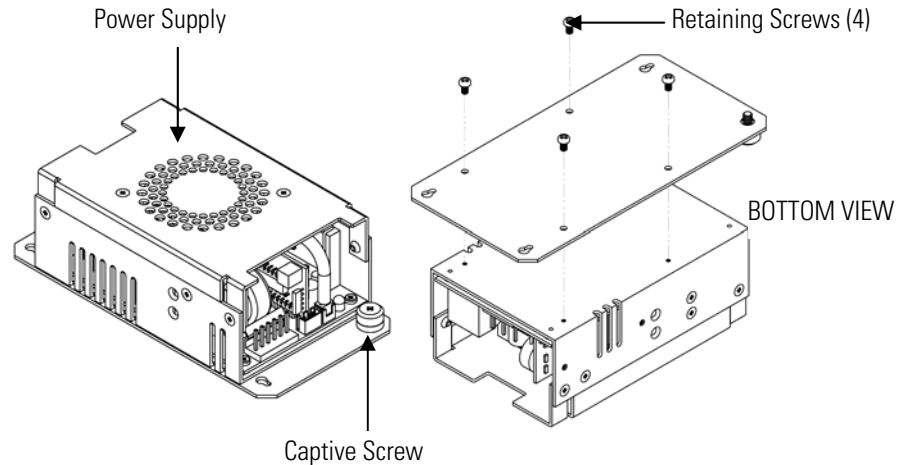
Figure 7–7. Replacing the DC Power Supply

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 7–8 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.
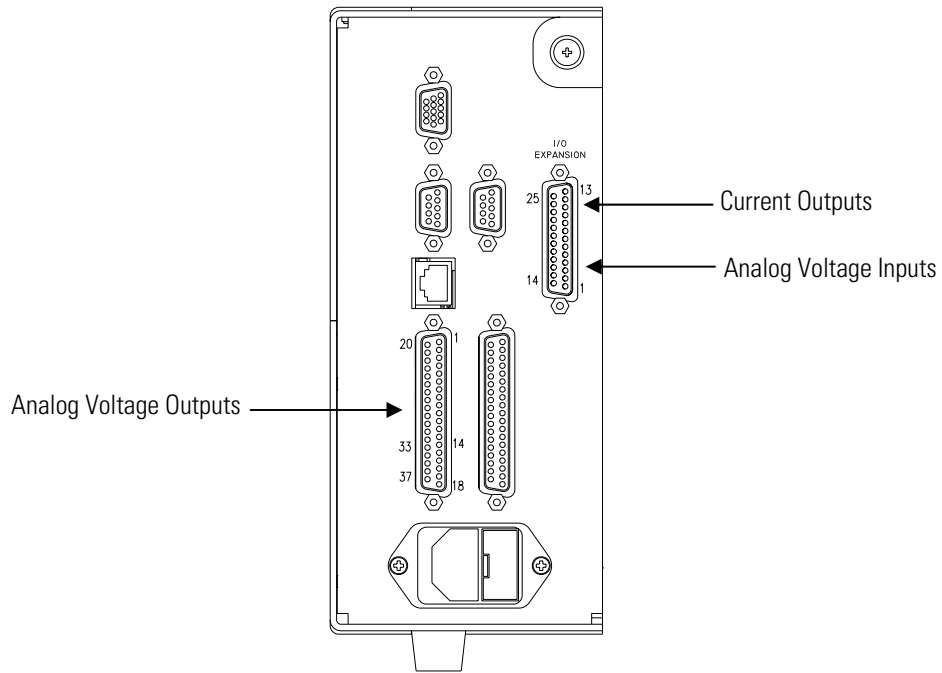
Figure 7–8. Rear Panel Analog Input and Output Pins

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 motherboard or 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 7–8 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 7–8 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 7–9).

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.
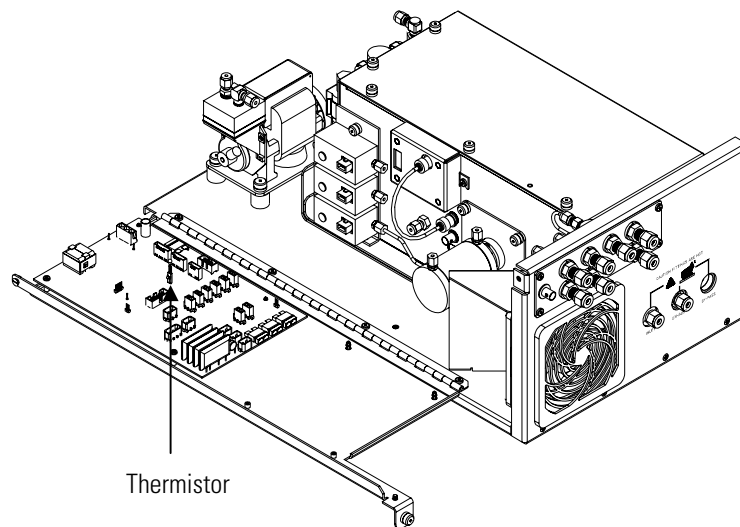
Thermistor

Figure 7–9. 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 7–9).

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.

Fuel/Calibraion Solenoid Valve Replacement

Use the following procedure to replace the fuel or calibration 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

![warning triangle] **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. Disconnect the solenoid from the measurement interface board. Note electrical connections to facitate re-connection.

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.

8-Port Valve Rotor Replacement

Use the following procedure to replace the 8-port valve rotor (Figure 7–10).

Equipment Required:

  Valve rotor repair kit

  Pencil magnet

  Needle-nose pliers

⚠ **Equipment Damage** Do not disassemble the valve unless the system malfunction is definitely isolated to the valve: perform all other system checks first. If disassembly is required, make certain, the instructions that follow are carefully observed. ▲

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. ▲

Disassembly

Use the following procedure to disassemble the valve rotor.

Note All disassembly operations must be performed in a clean, well-lit area. ▲

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

2. Unscrew the knurled pre load assembly. Do not tamper with the preset socket adjustment screw.
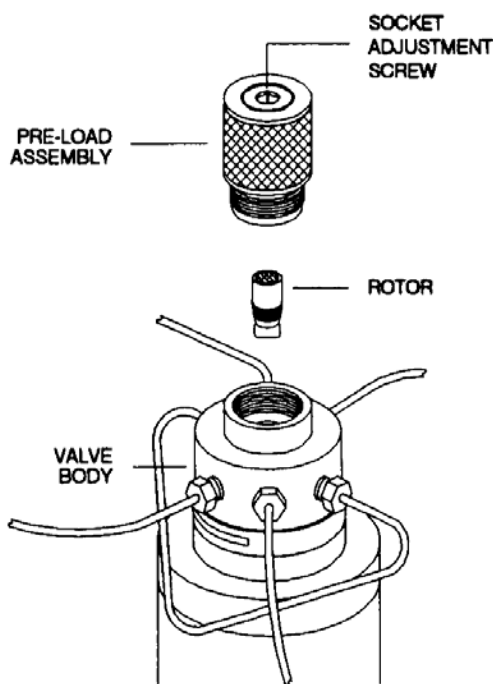
Figure 7–10. 8-Valve Rotor Disassembly

3. Engage the end of the rotor (Figure 7–11) with a pencil type magnet. Cycle the valve one time to break the "shear seal" between the rotor and the valve body.

⚠️ **Equipment Damage** Any contact between the interior of the valve body and the metal of the rotor or any tool is likely to cause damage. ▲
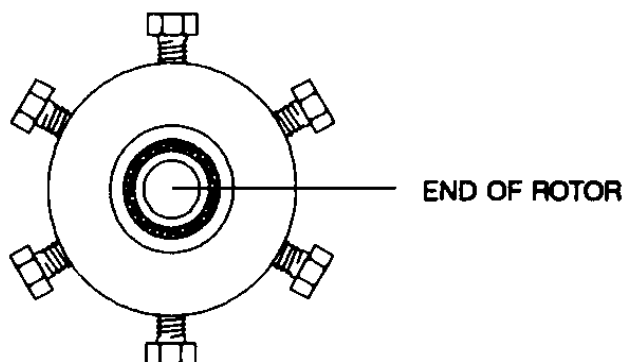
Figure 7–11. Valve with Pre-Load Removed

4. Carefully withdraw the rotor from the valve body with the magnet. Once the rotor is removed, note the orientation of the rotor tab, which is marked with an ID letter denoting the type of seal material.

Cleaning the Valve Body

Use the following procedure to clean the valve body.

1. Wet a cotton swab with a solvent that is compatible with the chromatographic system; isopropyl alcohol is recommended.

2. Gently swab the polished interior of the valve to remove any loose residue.

3. Blow with clean compressed gas to remove any lint left by the swab.

4. Visually inspect the interior of the valve body. The conical surface should appear highly polished. If any scratches are visible between the ports or anywhere that might suggest a potential leakage path or wear source, the valve should be returned to the factory.

Cleaning the Rotor   Use the following procedure to clean the rotor.

1. Carefully grasp the rotor on either end and briefly immerse it in solvent. If it is difficult to grip the rotor securely, hemostats or needlenose pliers may be helpful (see Figure 7–12). Grip the tab end, being careful not to mar the metal or touch the polymer.

2. Gently wipe the polymer with a clean tissue.

3. Blow with clean compressed gas to remove any lint left by the tissue.

4. Visually inspect the rotor. If it shows any scratches and/or narrowing of the flow passages, replacement is necessary.
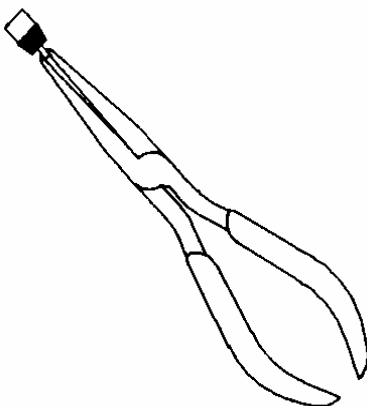
Figure 7–12. Holding the Rotor (Viewed from Pre-Load End)

Assembly   Use the following procedure to assemble the valve rotor (new or used rotor).

1. Place the clean rotor on the pencil magnet and orient it so that the tab will properly engage the slot of the drive mechanism. Orient the ID letter toward port 5 of the valve body (see Figure 7–13).

Figure 7–13. Location of the ID Letter on the Rotor

2. Insert the rotor into the valve body, again being careful that the tab doesn't touch the polished interior of the valve body. Make sure the rotor tab is fully inserted into the slot in the driver. Using a pencil or other small pointed object, hold the rotor in place in the valve body while the magnet is pulled free.

3. Replace the knurled pre load assembly, tightening it into the valve body by hand just beyond the point where it touches the rotor. Cycle the valve ten times to seat the sealing surfaces, leaving the valve fully in its clockwise or counterclockwise position.

4. Tighten the pre load in quarter turn increments, cycling the valve ten times after each step. The pre load must end up fully bottomed out, but attempts at further tightening will not affect the sealing forces.

Note Make certain that the valve is never left partially actuated. It should always be in either a fully clockwise or fully counterclockwise position. ▲

Testing and Replacing the Ignitor

The FID flame ignition is achieved 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. A second ignitor is included in the detector assembly as a backup. If the first ignitor fails, the second ignitor may be used by disconnecting the bad ignitor and connecting the cable to the insulated STA-KON® connector on the ignitor cable assembly.

Equipment Required:

Replacement ignitor 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. ▲

Use the following procedure to replace the ignitor (Figure 7–14).

4. Remove the oven cover to access the detector and locate the ignitor screwed into the side of the detector housing.

5. Locate and disconnect the ignitor power cable at the Sta-kon® connector located about 14-inches down the cable.

Note The Sta-con connector should lie outside of the oven. ▲

6. Using the 5/16-inch wrench, unscrew the ignitor and lead wire from the detector.

7. Install the new ignitor and lead wire into the detector, being sure to include the copper ring that acts as a gasket between the plug and the detector housing.

8. Dress the lead wire through the access hole in oven housing and reconnect to lead wire from connector 27.

9. 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.

10. Before installing the oven cover, test the new ignitor. 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.

11. Turn the main power ON and wait for the run screen to appear.

12. 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. ▲

13. If the ignitor is pulsing correctly, shut the instrument power OFF, replace the flame sensor thermocouple, re-install the fuel line to the rear panel and re-install the oven cover.

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 7–14).

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. 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. ▲

8. Locate and disconnect the ignitor power cable by disconnecting the ignitor lead wire at the Sta-kon connector and pulling it through the oven bulkhead access port.

9. Using an Allen wrench, remove the four screws holding the upper detector base to the lower detector base.

10. Disconnect the ignitor grounding wire from the detector base.

11. Lift the detector assembly straight up about 1/4-inch and slide it off to the side, to allow the signal pogo and bias pogo to clear the oven bulkhead.

Note Use caution not to damage the Teflon loose, located on the under side of the upper detector mounting base. ▲

12. Continue with the rebuild procedure in this chapter.

13. Once the detector unit is re-assembled, it can be re-installed using the previous steps in reverse and observing all cautionary procedures to avoid assembly damage.
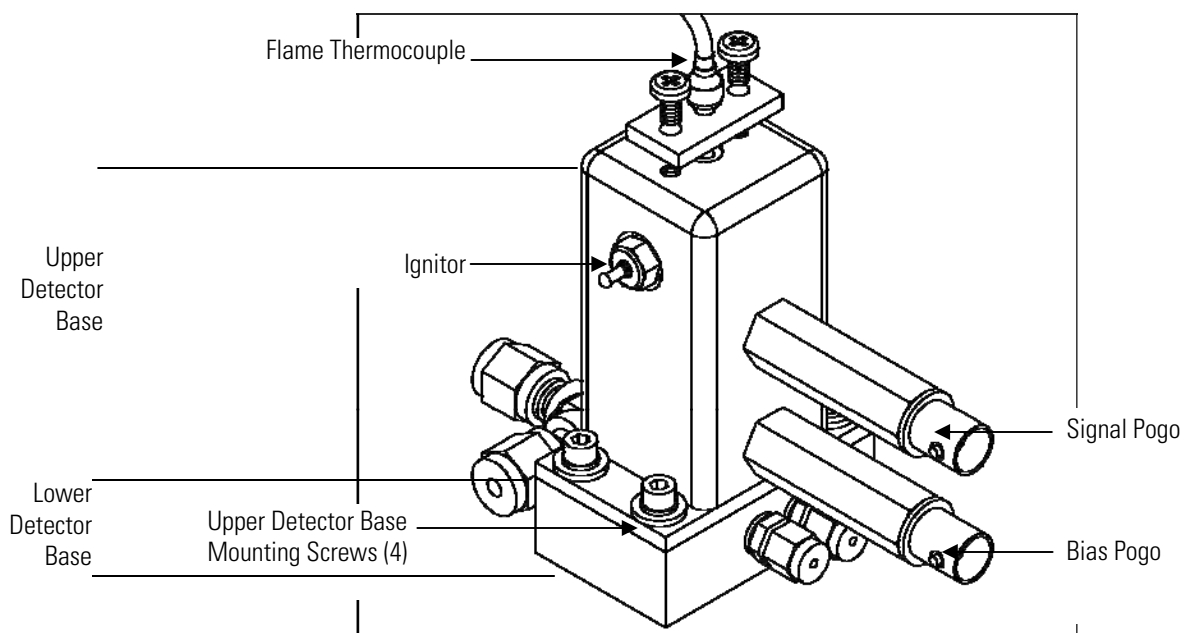
Figure 7–14. Removing the Detector

Detector Rebuilding

This section provides the equipment and instructions for rebuilding the detector assembly as shown in Figure 7–15. 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. Use caution when assembling the upper detector base to the lower detection base to avoid damage to the Teflon boss located on the underside of the upper detector mounting 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. ▲
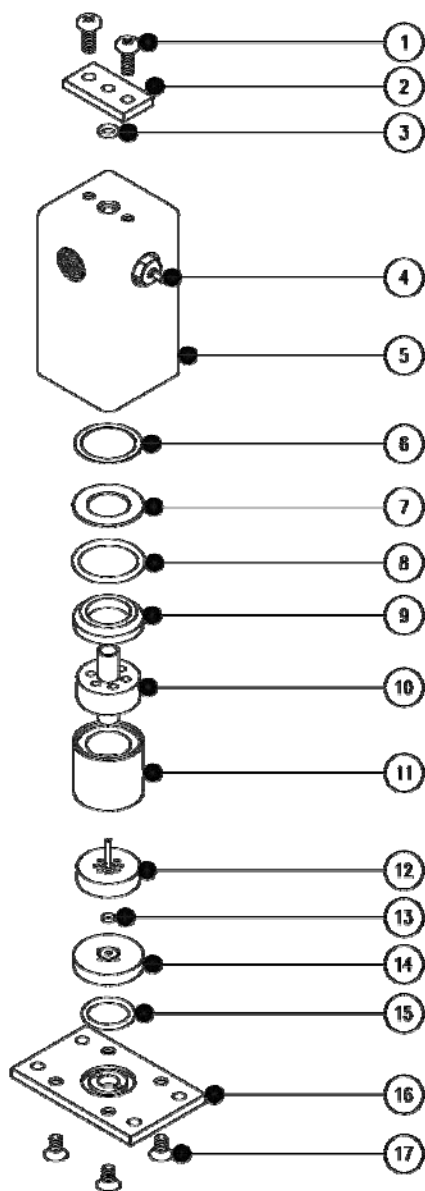
Figure 7–15. Rebuilding the Detector

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	Glow plug (ignitor)	105567-00	10981	2
5	Detector cover	103689-00	103689-00	1
6	Wavy washer	104165-00	104165-00	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		101398-00	4

Internal Sample Filter Replacement

Use the following procedure to replace the internal filter element and aluminum seal-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.

Valve Actuator Repair

The actuator O-rings need periodic replacement. In rare cases the entire actuator may need to be replaced. This section describes the procedure for changing the actuator O-rings, which also includes instructions for replacing the whole actuator. The alignment of the valve will need to be checked and adjusted if needed whenever the actuator is removed from the instrument.

Equipment Required:

    Valve O-ring replacement kit or

    Valve actuator replacement

    Wrench, open end, 3/8-inch

    Hex wrench set

    Screwdriver, 3/16-inch

    Fine-pointed pick or other tool for removing O-rings

    Silicone lubricant

    Lint free tissues and a clean shop rag

⚠ **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. ▲

Disassembly

Use the following procedure to disassemble the valve actuator.

1. With the instrument power on, go to the Manual Operation Menu and place the valve in the backflush position.

2. Disconnect the air lines from the actuator using the 3/8-inch wrench.

3. Use the 9/64-inch hex driver to loosen the socket-head screw in the black anodized clamp ring on the actuator. Gently slide the actuator off of the standoff. Using the same hex driver, remove the two screws holding the clamp ring onto the actuator (see Figure 7–15).
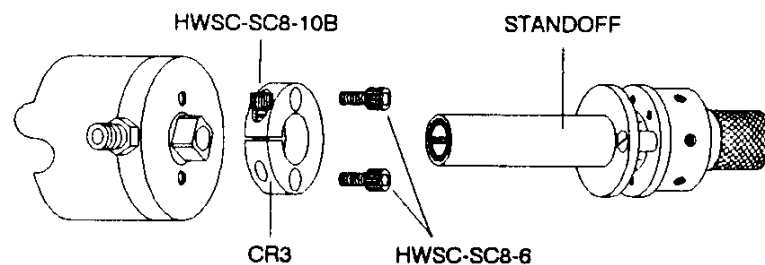
Figure 7–16. Removal of a Valve on a Standoff

4. Use the 9/64-inch hex driver to remove the three O-ring screws, see **Figure 7–17** (some models have slotted screws here).
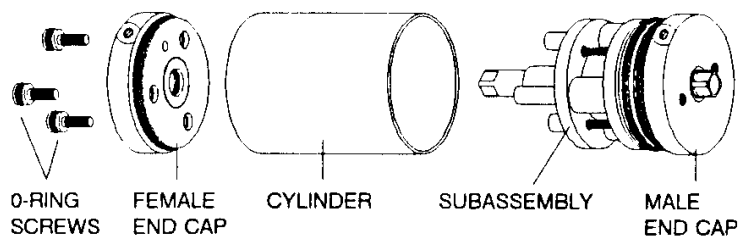
Figure 7–17. End Cap Removal

5. Place the actuator on a hard work surface with the O-ring screw holes up. Push down on the cylinder and the female end cap will pop up.

6. While holding the cylinder and the rest of the assembly together, pull the female cap all the way off. If the bearing and washers fall out, just set them aside.

7. Repeat the procedure with the actuator inverted, so that the cylinder slides loose from the male end cap. Remove the cylinder.

8. Pull the subassembly off the male end cap as indicated in Figure 7–17. (Note: Recently purchased actuators may have a subassembly made primarily from molded plastic, differing in appearance from the one shown in Figure 7–17, Figure 7–18, and Figure 7–19. The procedures are the same for either type.)
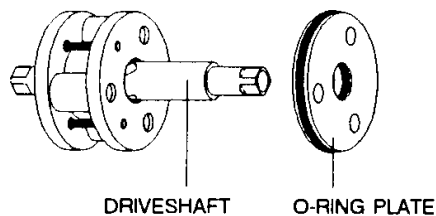
Figure 7–18. Removal of Subassembly from Male End Cap
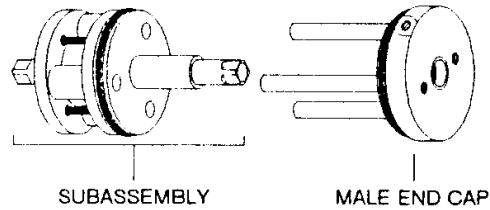
Figure 7–19. Sliding the O-Ring Plate Off of Shaft

9. Loosen but do not remove the three slotted head screws that hold the subassembly together.

10. Take care to hold the rest of the subassembly together, and slide the O-ring plate off the drive shaft, see Figure 7–19. (If the subassembly comes apart despite your caution, reassembly instructions are provided at the end of this procedure.)

O-Ring Replacement

The O-rings to be replaced are in the two end caps, the three O-ring screws, and the O-ring plate. Some "O-ring" screws use washers instead of O-rings and both types of replacement seals are included in the kit. The internal end cap O-rings are easier to get to if the washers and bearings are removed (see Figure 7–20).

1. Use a small screwdriver or pick to remove the old O-rings, being careful not to scratch the metal.

2. Use a lint free tissue to clean the O-ring grooves as completely as possible.

3. As each new O-ring is installed, coat it with a thin layer of silicone lubricant. Dow-Corning™ DC-111 is recommended.
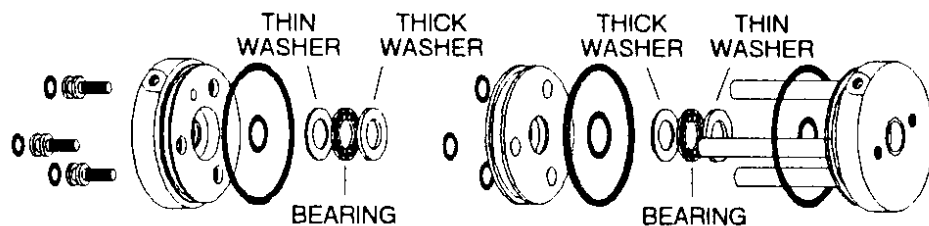
Figure 7–20. O-Ring Locations

Reassembly   Where it is possible to do so, apply a slight rotating action to the parts as they go over or through the new O-rings to help prevent any nicking or tearing of the new parts.

1. While being careful that the subassembly does not come apart, gently push the O-ring plate onto the drive shaft. Make sure that the threaded holes in the plate are facing the subassembly.

2. Screw the slotted-head screws into the O-ring plate, and push the drive shaft into the O-ring plate as far as it will go, see Figure 7–21.
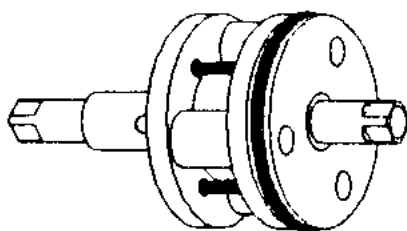
Figure 7–21. Subassembly Ready to Go On

3. Place the washers and bearing in the male end cap. (The thin washer goes in first, as in Figure 7–20.) One of the flats on the drive shaft will line up with a line drawn between two of the holes in the O-ring plate, as shown in Figure 7–22. Slide the subassembly onto the pins of the male end cap with this flat lined up with the air inlet on the end cap.

4. Install the cylinder, sliding it over the subassembly and pressing the male endcap into it.

5. Place the washers and bearing in the female end cap. (The thin washer goes in first, as in Figure 7–20.) Press the endcap into the cylinder, making sure the air inlet hole is in the same orientation as the one in the male end cap.

6. Install the three O-ring screws.

7. Replace the valve mounting hardware and air supply lines.

8. Apply air pressure to the actuator inlet nearest to the valve so that the actuator will be in the same position it was in when it was removed.
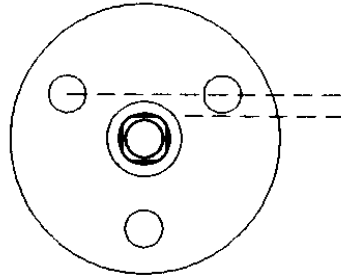
Figure 7–22. O-Ring Plate Orientation

9. Slide the actuator onto the standoff, making sure that the square hole in the end of the standoff drive shaft is fully engaged by the square of the actuator drive shaft. Tighten the clamp ring screw.

10. Check the alignment of the valve and adjust if needed (see "Valve Alignment" in this section.)

Rebuilding the Subassembly

This section will be unnecessary, but just in case the subassembly fell apart somewhere along the line, here is how to get it back together. See Figure 7–23 for parts identification.

1. Put a liberal coating of silicone lubricant on the slots in the driveshaft.

2. Place the ball retainer over the shaft so that the hole in the retainer line up with the slots in the shaft.

3. Put the balls in the holes of the retainer so that they rest in the slots. They should be held in place by the thick lubricant.

4. Notice that the slots in the female race extend all the way to one end but not the other. Observe also that one end of the driveshaft has a ¼-inch hole. Put that end of the driveshaft into the end of the female race that has the slot openings, sliding the balls into the slots.

5. Place the male end cap on a flat work surface. Set the O-ring plate on the end cap with the pins lined up to go through the three small O-rings. Do not press it on yet; this would dislodge the O-rings.
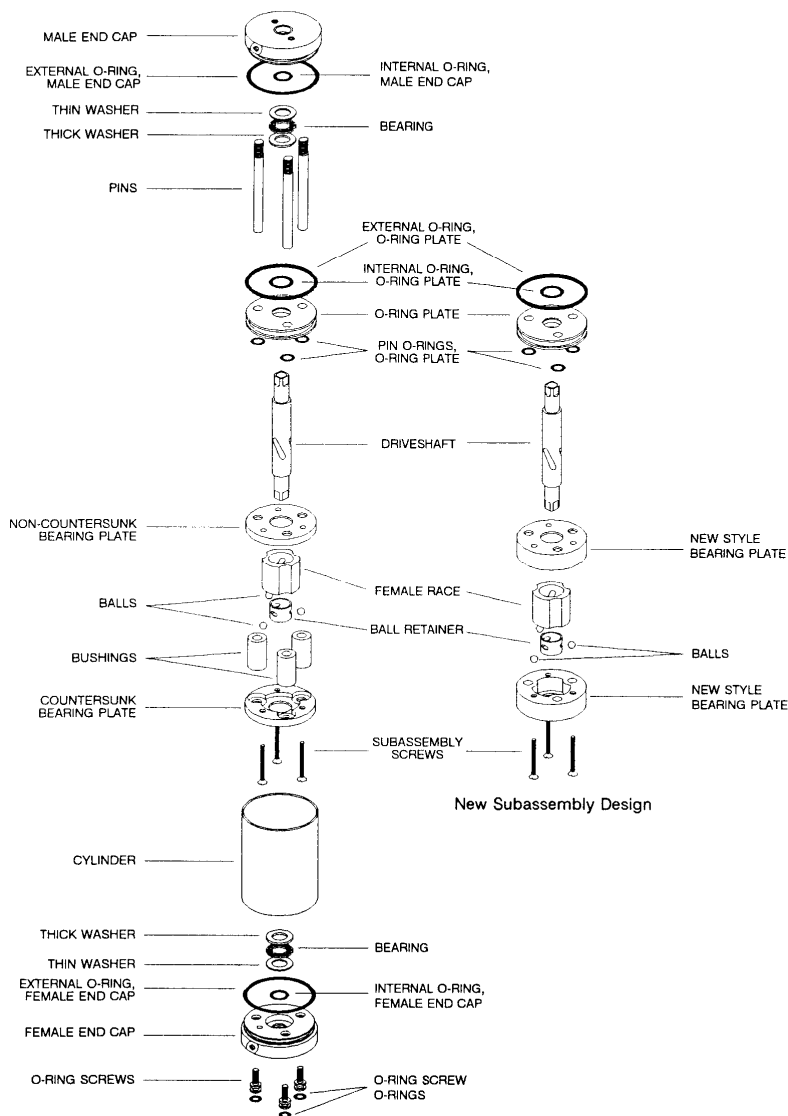
Figure 7–23. Two-Position Actuator (Exploded View)

6. The two bearing plates are identical except that one of them has three countersunk holes to accept the heads of the assembly screws. Locate the one that is not countersunk and line it up on top of the O-ring plate. (In the rare cases where both bearing plates are countersunk, they are interchangeable.) Press down to force the pins through the O-rings and bearing plate, continuing until the two parts are riding about halfway down the pins.

7. Slide the three bushings over the pins.

8. Install the driveshaft/ball assembly with the 1/4-inch hole end down. The female race will rest between the bushings.

9. Place the remaining bearing plate in position with the countersunk holes up, and screw the entire assembly together. Tighten the screws in rotation to insure optimum alignment.

10. Now pull the subassembly off the male end cap so that its orientation can be checked, and go on with Step 2 of the assembly procedure.

Valve Alignment

The Model 55*i* supplies air to the valve in three-second bursts. For accurate valve alignment, a temporary method of supplying continuous air pressure to the selected air inlet must be devised.

Equipment Required:

Hex driver, 9/64-inch

Wrench, open end, 7/16"

Visually Checking Alignment

It is important to note that the actuator drives only the rotor within the valve body, via the standoff driveshaft. The valve body remains stationary with respect to the actuator. To check alignment, cycle the actuator from one position to the other and observe the location of the rotor pin, see Figure 7–24. The rotor pin should come to rest against both sides of the cutout in the valve body. Re-alignment is needed if it does not.
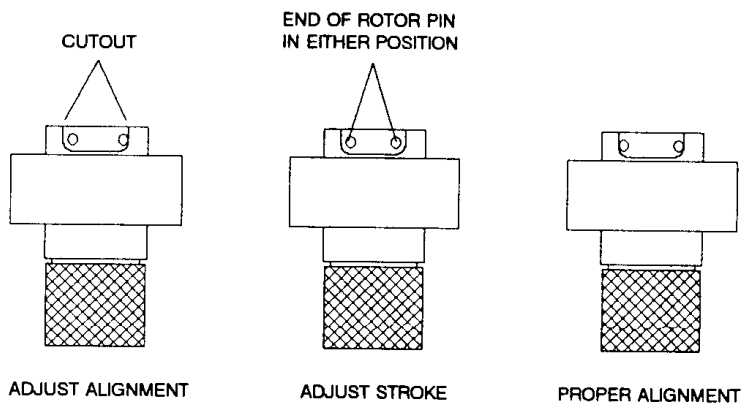
Figure 7–24. Visual Check of Alignment (Rotor Pin Shown in Both Positions

Alignment   Use the following procedure for accurate valve alignment.

1. Actuate the valve to the position in which the rotor pin is against the stop.

2. With the 9/64-inch hex driver, slightly loosen the screw in the clamp ring on the actuator body, allowing the actuator to complete its travel. The actuator may rotate a few degrees.

3. Tighten the clamp ring screw and cycle the actuator to the other position. The pin should now come to rest against the stop. If it does not, repeat the procedure. If, after several attempts, the pin still does not contact the stop in both positions, the actuator does not stroke properly and must be serviced. Contact the service department for further instructions.

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
J3 Column Heater (P/C)	140 ohm	±10 ohm
J4 Detector Heater (DET)	140 ohm	±10 ohm
J5 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. **Column (PMP/COL) Thermocouple**: Disconnect the column thermocouple from the measurement interface board (J14). Connect the column 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%

Note 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 22 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 **48 ml/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 **46 ml/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 Carrier Pressure

1. Return to the Set Pressure and Flow screen, choose **Carrier Run**. Set the pressure to create a sample air flow of **55 ml/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 **Carrier Ignite**. Set the pressure to create a sample air flow of **55 ml/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 **315 ml/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 ml/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 (H₂/He)

Use the following procedure to adjust the gas flows for mixed fuel (H_2/He). This includes:

● Set the Fuel Pressure

● Set the Carrier 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 ml/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 **125 ml/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 Carrier Pressure.

1. Return to the Set Pressure and Flow screen, choose **Carrier Run**. Set the pressure to create a carrier gas flow of **55 ml/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 **Carrier Ignite**. Set the pressure equal to the setting entered in the Carrier 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 **315 ml/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 ml/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 $\boxed{\rightarrow}$ 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 (H₂ or MIXED) **Fuel Run**. At the Set Pressure screen, increase the pressure by 1.0 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 1.0 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 7–25).

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 7–26).

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.
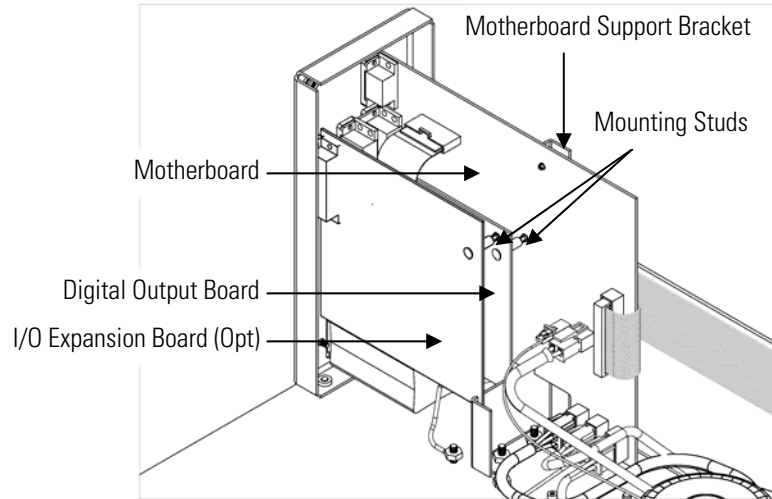
Figure 7–25. Replacing the I/O Expansion Board (Optional)
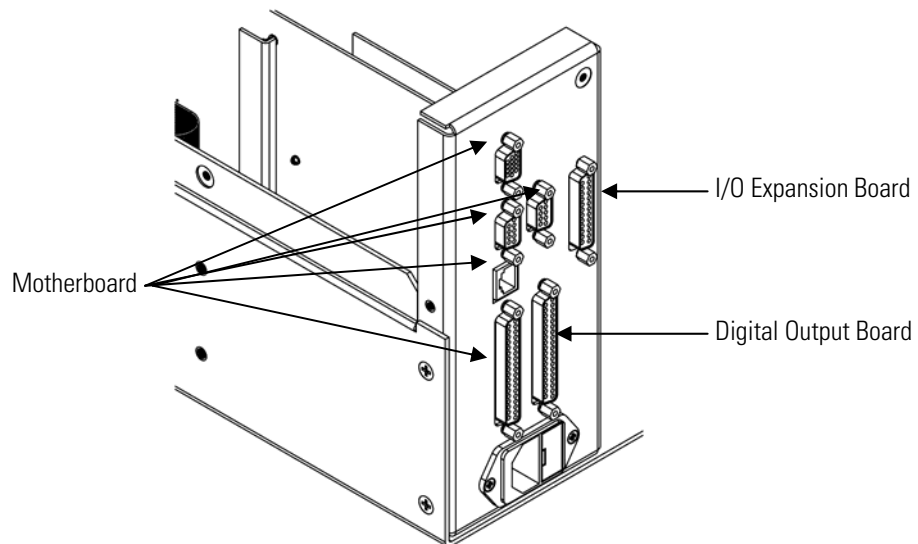
Figure 7–26. Rear Panel Board Connectors

Digital Output Board Replacement

Use the following procedure to replace the digital output board (Figure 7–25).

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 7–26).

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 7–25).

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 7–26).

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 7–27).

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.
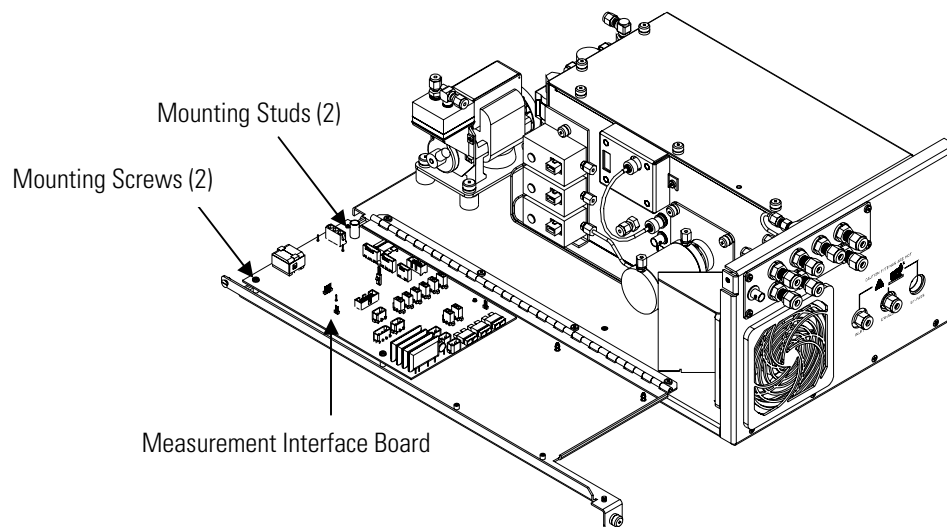
Figure 7–27. Replacing the Measurement Interface Board

Front Panel Board Replacement

Use the following procedure to replace the front panel board (Figure 7–28).

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.

LCD Module

LCD Module Screws (2)

Front Panel Board

Retaining Screw

Mounting Studs (2)

Ribbon Cables (3)

Two-Wire Connector

Bottom Support
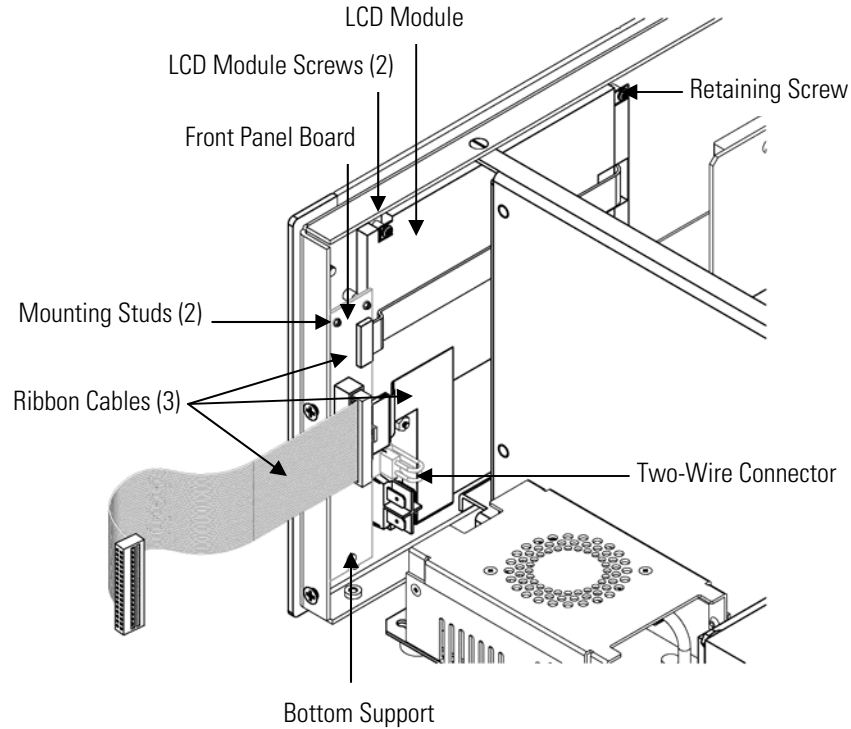
Figure 7–28. Replacing the Front Panel Board and the LCD Module

LCD Module Replacement

Use the following procedure to replace the LCD module (Figure 7–28).

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, service is available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information or visit us on the web at www.thermo.com/aqi.

1-866-282-0430 Toll Free

1-508-520-0430 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 8-4
- "Electronics" on page 8-5
- "I/O Components" on page 8-8

Hardware

Model 55*i* key hardware components (Figure 8-1) include:

- Flame Ionization Detector (FID)
- Sample Filter
- Internal Pump
- Rotary Valve
- Electronic Pressure Controllers
- Fuel Shutoff Solenoid
- Zero/Span Solenoids
- Separation Column
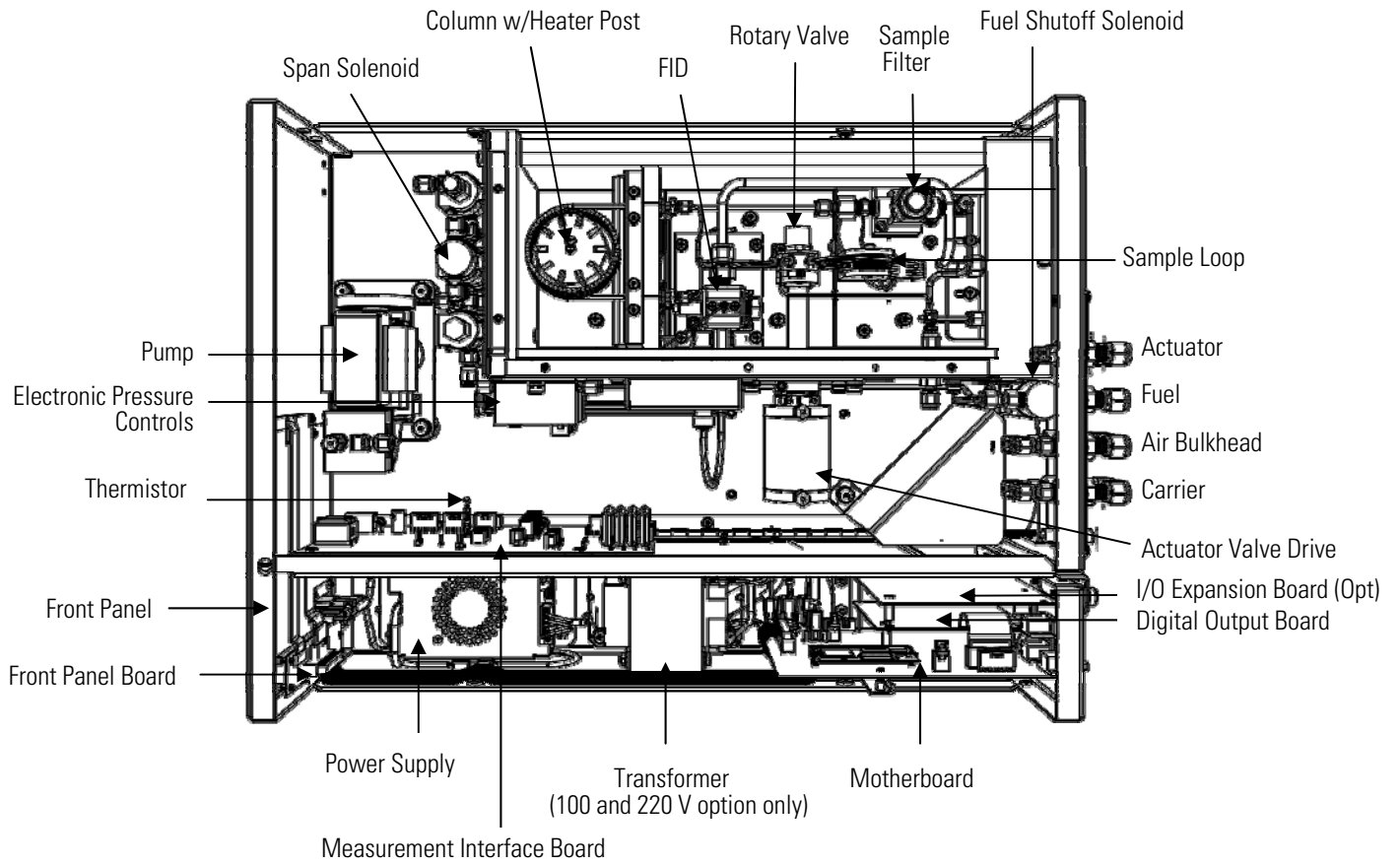
Figure 8–1. Hardware Components

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 downstream of the sample inlet bulkhead fitting and protects the pump, rotary valve 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 0.5 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, if installed, draws sample into the analyzer and into the oven through the sample inlet port. The sample is delivered to the Sample Loop through a venturi, which develops a differential pressure from the sample stream supplied by the pump. 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.

Rotary Valve

The rotary valve is a key piece of hardware central to the operation of the instrument. It consists of an 8 port valve body containing a valve rotor and driven by a pneumatic actuator. The valve assembly operates between two positions, "Inject" and "Backflush". The inject mode directs sample gas stored in the Sample Loop into the front end of the separation column. The Backflush mode provides two functions, it reloads the empty sample loop and reverses the directional flow of the carrier gas such that the hydrocarbons trapped within the column are released from the internal packing materials to exit the column from the direction that they entered.

Electronic Pressure Controllers

The analyzer utilizes electronic pressure controllers and fixed flow restrictors to control the flow rate of fuel, combustion air and carrier gas 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 and the internal oven plumbing.

The pressure controller assembly consists of three closed loop 0-50 psi pressure 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).

Separation Column

The Separation Column acts as a trap to separate out methane from non-methane hydrocarbons present in the sample stream. It is comprised of a series of proprietary packing materials stacked in series and designed to allow methane to free flow through the column directly to the FID while entraining the heavier hydrocarbons as they traverse the column length during the inject mode. When the instrument is placed in the Backflush mode the carrier gas reverses direction through the column and carries off the trapped hydrocarbons, arriving at the FID as a single bell shaped peak.

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, located on the inside rear panel.

Calibration Solenoid

The calibration solenoid valve can be used to control the flow of calibration 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 by the firmware to identify 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 tenth-second accumulated counts representing the chromatogram are used to determine the CH_4 and NMHC concentrations, which are reported at the end of each discrete sample run. 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).

The model 55i also provides a separate shielded analog output available through a BNC connector located on the rear panel. This signal output is specifically for tapping into the FID raw signal and produces a real-time, non-time stamped reproduction of the chromatogram emerging from the FID during a run. It is provided for chromatographic signal diagnostic purposes.

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 CH_4 and NMHC concentrations. The display is updated at the end of each run.

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

- Shielded Analog FID signal output

Input Board

The input board is located in an aluminum housing mounted on the side 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, active filters, 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 an offset null teature and 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:

● Start Run

● Start Cal

● Start Cal Chk

● Stop

● Inject

● Backflush

● Analog outputs to zero

● Analog outputs to full-scale

● Set Idle Mode

● Ext. Alarms 1, 2, 3

The actual use of these inputs will vary based on analyzer configuration. All inputs are assignable.

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

● AK

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 55*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 55*i* is available with the following options:

- "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

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	Six feet

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 are in non-standard EIA locations.
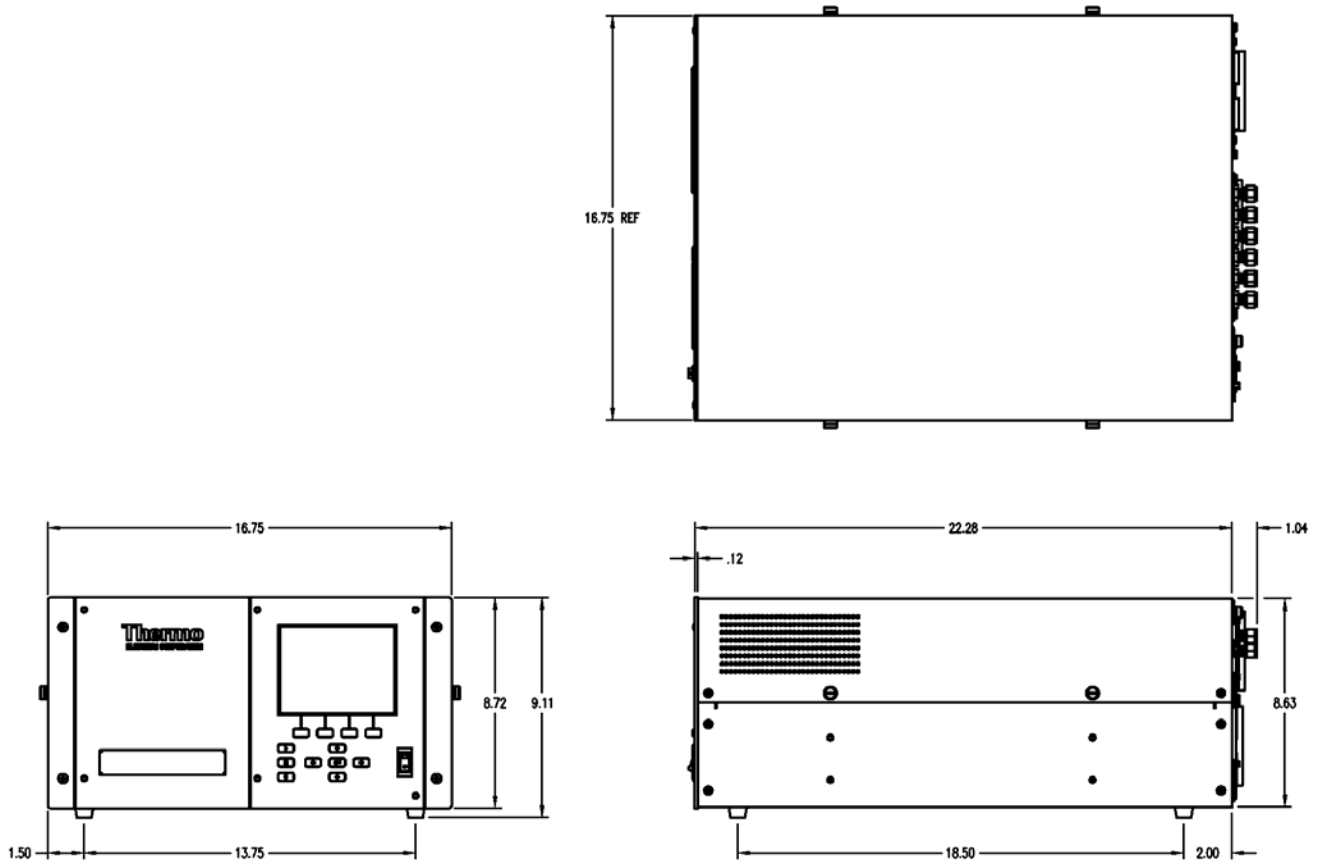
Figure 9–1. Bench Mounting
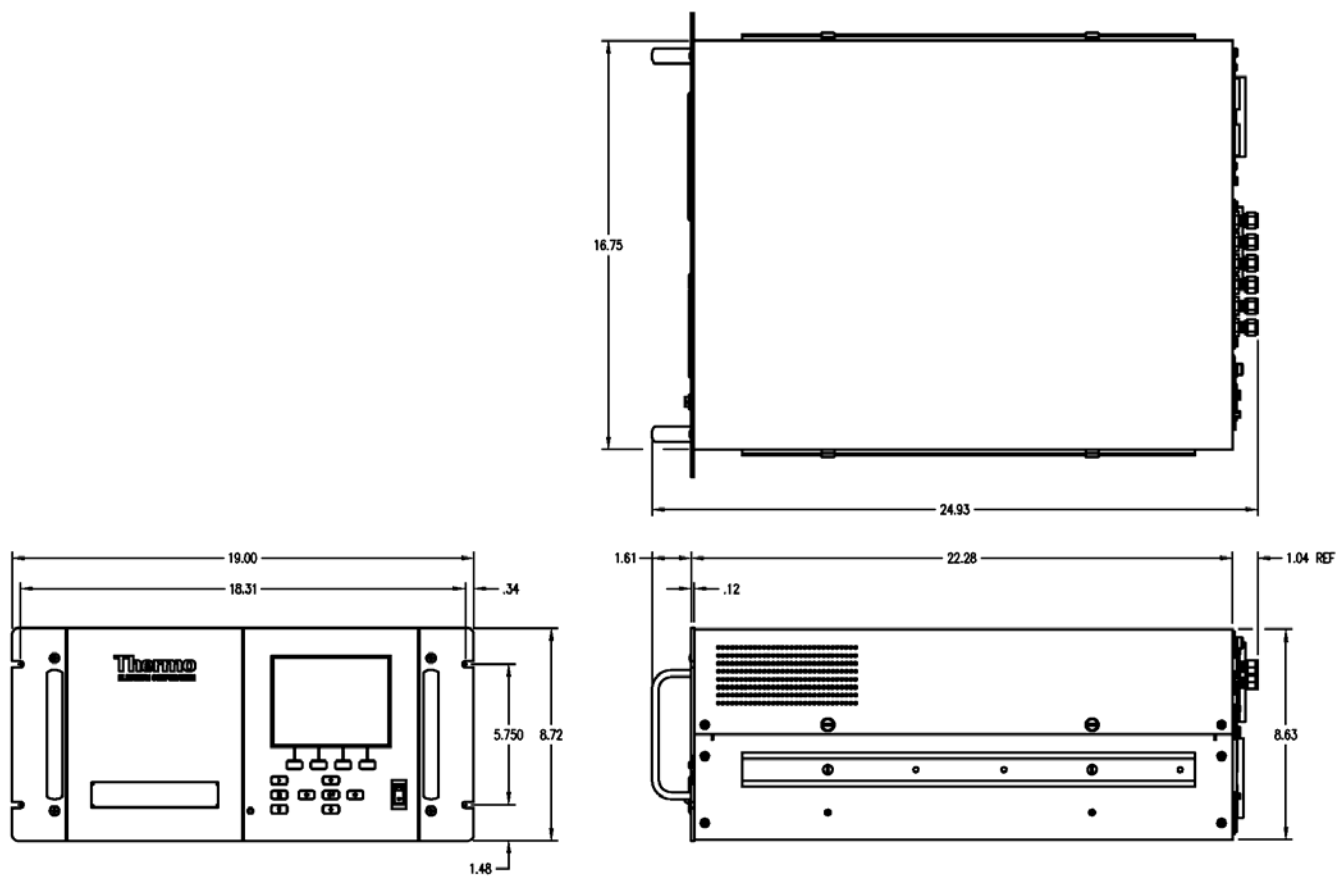
Figure 9–2. EIA Rack Mounting
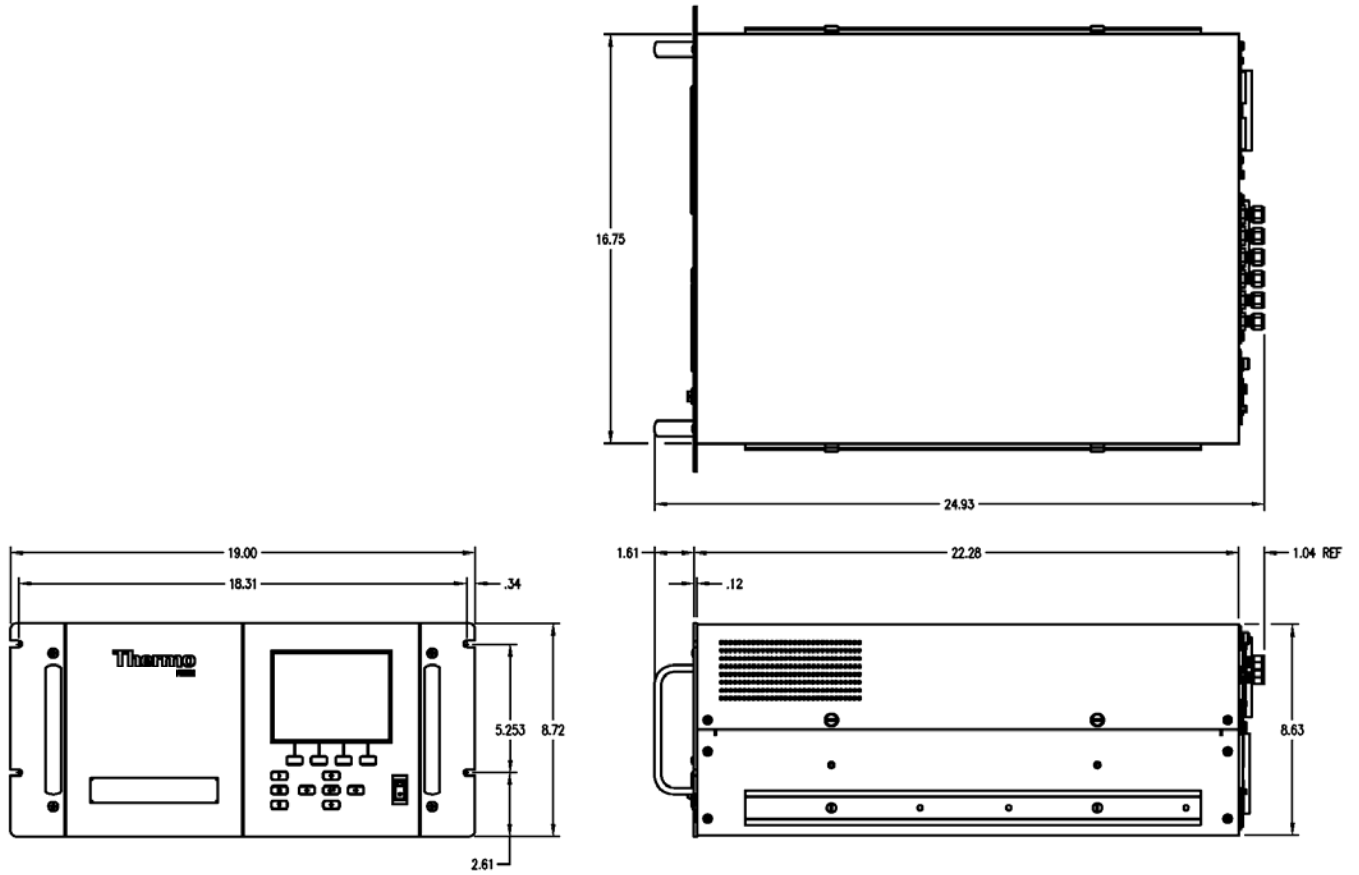
Figure 9–3. Retrofit Rack Mounting
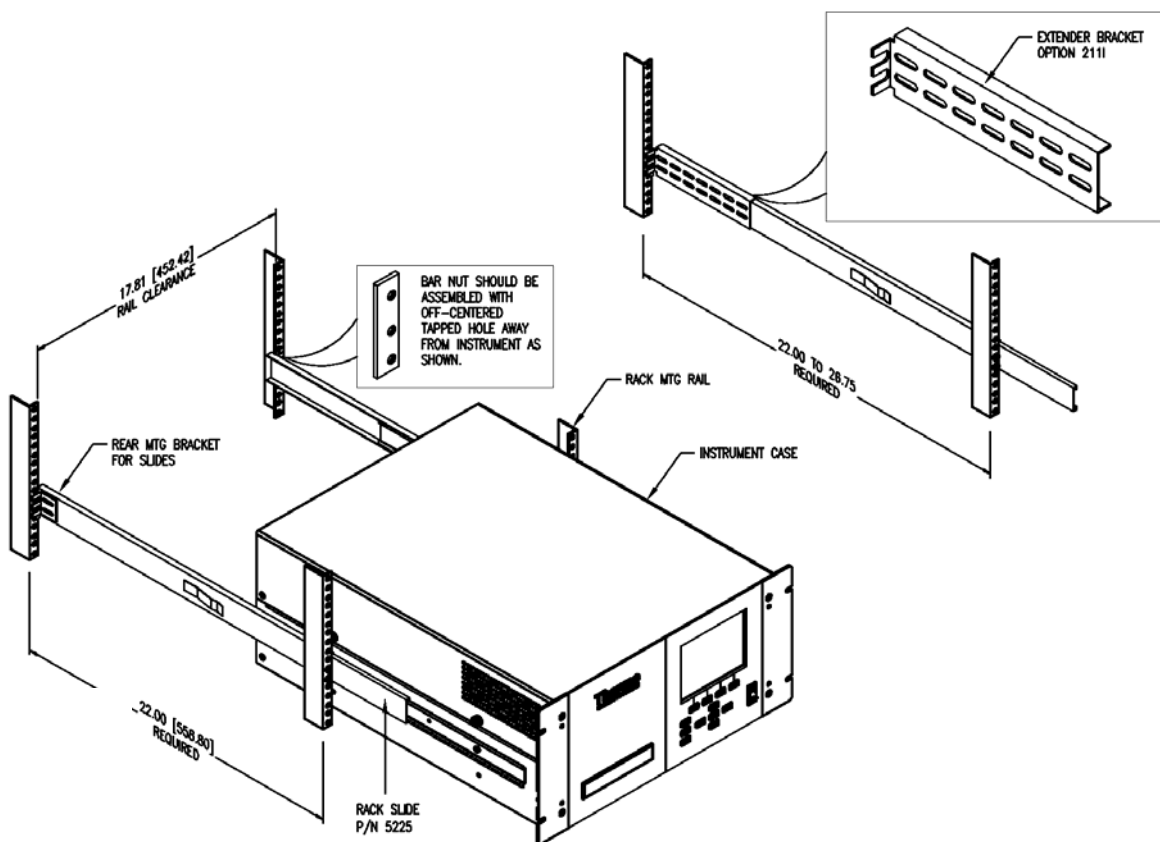
Figure 9–4. Rack Mount Option Assembly

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.

THE OBLIGATIONS CREATED BY THIS WARRANTY STATEMENT TO REPAIR OR REPLACE A DEFECTIVE PRODUCT SHALL BE THE SOLE REMEDY OF BUYER IN THE EVENT OF A DEFECTIVE PRODUCT. EXCEPT AS EXPRESSLY PROVIDED IN THIS WARRANTY STATEMENT, SELLER DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, ORAL OR WRITTEN, WITH RESPECT TO THE PRODUCTS, INCLUDING WITHOUT LIMITATION ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE PRODUCTS ARE ERROR-FREE OR WILL ACCOMPLISH ANY PARTICULAR RESULT.

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 55*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 55, then each command must begin with the ACSII character code 183 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 183 decimal, which directs the command to the Model 55*i*, and is terminated by a carriage return "CR" (ASCII character code 13 decimal).

<ASCII 183>	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

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 55*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
1	Stimulates pressing soft key 1 pushbutton	B-31
2	Stimulates pressing soft key 2 pushbutton	B-31
3	Stimulates pressing soft key 3 pushbutton	B-31
4	Stimulates pressing soft key 4 pushbutton	B-31
addr dns	Reports/sets domain name server address for Ethernet port	B-40
addr gw	Reports/sets default gateway address for Ethernet port	B-41
addr ip	Reports/sets IP address for Ethernet port	B-41
addr nm	Reports/sets netmask address for Ethernet port	B-41
addr ntp	Reports/sets IP address for network time protocol server	B-42
air control pressure	Reports/sets current air control pressure	B-35
air pressure	Reports current air pressure	B-10

Command	Description	Page
alarm bias voltage max	Reports/sets bias voltage alarm maximum value	B-13
alarm bias voltage min	Reports/sets bias voltage alarm minimum value	B-13
alarm ch4 chk max	Reports/sets current methane cal check alarm maximum value	B-13
alarm ch4 chk min	Reports/sets current methane cal check alarm minimum value	B-13
alarm column temp max	Reports/sets column temperature alarm maximum value	B-14
alarm column temp min	Reports/sets column temperature alarm minimum value	B-14
alarm conc c1 max	Reports/sets current methane concentration alarm maximum value	B-14
alarm conc c1 min	Reports/sets current methane concentration alarm minimum value	B-14
alarm conc nm max	Reports/sets current non-methane concentration alarm maximum value	B-14
alarm conc nm min	Reports/sets current non-methane concentration alarm minimum value	B-14
alarm detector temp max	Reports/sets detector temperature alarm maximum value	B-15
alarm detector temp min	Reports/sets detector temperature alarm minimum value	B-15
alarm filter temp max	Reports/sets filter temperature alarm maximum value	B-15
alarm filter temp min	Reports/sets filter temperature alarm minimum value	B-15
alarm internal temp max	Reports/sets internal temperature alarm maximum value	B-16
alarm internal temp min	Reports/sets internal temperature alarm minimum value	B-16
alarm nm chk max	Reports/sets current non-methane cal check alarm maximum value	B-16
alarm nm chk min	Reports/sets current non-methane cal check alarm minimum value	B-16
alarm pressure air max	Reports/sets air pressure alarm maximum value	B-16
alarm pressure air min	Reports/sets air pressure alarm minimum value	B-16

Command	Description	Page
alarm pressure carrier max	Reports/sets carrier pressure alarm maximum value	B-17
alarm pressure carrier min	Reports/sets carrier pressure alarm minimum value	B-17
alarm pressure fuel max	Reports/sets fuel pressure alarm maximum value	B-17
alarm pressure fuel min	Reports/sets fuel pressure alarm minimum value	B-17
alarm trig conc c1	Reports/sets current methane concentration alarm trigger sense	B-18
alarm trig conc nm	Reports/sets current non-methane concentration alarm trigger sense	B-18
allow mode cmd	Reports/sets whether "set mode" locks instrument front panel	B-45
analog iout range	Reports/sets analog current output range per channel	B-48
analog vin	Retrieves analog voltage input data per channel	B-48
analog vout range	Reports/sets analog voltage output range per channel	B-49
backflush	Sets multiport valve to move to backflush position	B-12
backflush time	Reports/sets delay value from injection to the switching of the multiport valve to the backflush position	B-32
baud	Reports/sets current baud rate	B-42
bias voltage	Reports current bias supply voltage	B-18
c1 alarm level	Reports/sets current methane concentration maximum alarm value	B-14
c1 alarm status	Reports alarm status for methane	B-13
c1 range	Reports/sets current methane measurement range	B-34
c1 span	Reports/sets methane 1-span-gas concentration	B-29
c1 span high	Reports/sets methane 3-span-gas concentration	B-29
c1 span low	Reports/sets methane 3-span-gas concentration	B-29
c1 span med	Reports/sets methane 3-span-gas concentration	B-29
c1 value	Reports current methane concentration	B-11
c1 window end	Reports/sets delay time from injection to closing of the methane window	B-33
c1 window start	Reports/sets delay time from injection to opening of the methane window	B-33
cal check	Initiates a calibration check cycle	B-28

Command	Description	Page
cal verify	Reports/sets whether calibration verification is set to on or off	B-28
calibrate	Initiates a calibration cycle	B-28
carrier control pressure	Reports/sets current carrier control pressure	B-36
carrier pressure	Reports current carrier pressure	B-10
clr lrecs	Clears away only lrecs that have been saved	B-22
clr records	Clears away all logging records that have been saved	B-22
clr srecs	Clears away only srecs that have been saved	B-22
column base temp	Reports temperature at the column base	B-10
column oven	Reports/sets the setpoint for the column oven	B-36
condition column	Reports/sets column conditioning mode	B-12
contrast	Reports/sets current screen contrast	B-37
copy lrec to sp	Sets/copies current lrec selection into the scratch pad	B-26
copy sp to lrec	Sets/copies current selections in scratch pad into lrec list	B-26
copy sp to srec	Sets/copies current selections in scratch pad into srec list	B-26
copy sp to stream	Sets/copies current selections in scratch pad into stream list	B-26
copy srec to sp	Sets/copies current srec selection into the scratch pad	B-26
copy stream to sp	Sets/copies current streaming data selection into the scratch pad	B-26
date	Reports/sets current date	B-38
default params	Sets parameters to default values	B-38
detector base temp	Reports temperature at the detector base	B-11
detector oven	Reports/sets the setpoint for the detector oven	B-37
dhcp	Reports/sets state of use of Dynamic Host Configuration Protocol (DHCP)	B-43
diag volt iob	Reports diagnostic voltage levels for I/O expansion board	B-19
diag volt mb	Reports diagnostic voltage levels for motherboard	B-19
diag volt mib	Reports diagnostic voltage levels for measurement interface board	B-19
dig in	Reports status of the digital inputs	B-49
din	Reports/sets digital input channel and active state	B-49
do (down)	Simulates pressing down pushbutton	B-31
do zero run	Runs a zero chromatogram	B-31
dout	Reports/sets digital output channel and active state	B-50

Command	Description	Page
dtoa	Reports outputs of the digital to analog converters per channel	B-50
dump run current	Reports the raw chromatogram data for the most recent run	B-19
dump run previous	Reports the raw chromatogram data for the previous run	B-19
dump zero data array	Reports the raw chromatogram data for the most recent zero chromatogram run	B-19
en (enter)	Simulates pressing enter pushbutton	B-31
er	Returns a brief description of the main operating conditions in the format specified in the commands	B-23
erec	Returns a snapshot of the main operating conditions (measurements and status) in the specified format	B-23
erec format	Reports/sets erec format (ASCII or binary)	B-24
erec layout	Reports current layout of erec data	B-25
fid signal	Reports current raw FID signal	B-11
filter temp	Reports temperature at the sample filter	B-11
flags	Reports current active measurement status flags in HEX	B-20
flame status	Reports the state of the FID flame	B-20
flame temp	Reports FID flame temperature	B-11
format	Reports/sets current reply termination format	B-43
fuel control pressure	Reports/sets current fuel control pressure	B-36
fuel pressure	Reports current fuel pressure	B-10
fuel type	Reports/sets current fuel type	B-39
gas unit	Reports/sets current gas units	B-34
he (help)	Simulates pressing help pushbutton	B-31
history cal	Reports the calibration history records in ASCII table form	B-21
history run	Reports the run history in ASCII table form	B-20
host name	Reports/sets host name string	B-44
idle	Reports/sets instrument in idle mode	B-39
ignite flame	Sets to attempt to light the FID flame	B-39
inject	Sets multiport valve to move to injection position	B-12
instr name	Reports instrument name	B-44
instrument id	Reports/sets instrument id	B-44
internal temp	Reports current internal instrument temperature	B-11
isc (iscreen)	Retrieves framebuffer data used for the display	B-31

Command	Description	Page
layout ack	Reports/disables stale layout/layout changed indicator ('*')	B-47
le (left)	Simulates pressing left pushbutton	B-31
list din	Lists current selection for digital inputs	B-51
list dout	Lists current selection for digital outputs	B-51
list lrec	Lists current selection lrec logging data	B-22
list sp	Lists current selection in the scratchpad list	B-22
list srec	Lists current selection srec logging data	B-22
list stream	Lists current selection streaming data output	B-22
list var aout	Reports list of analog output, index numbers, and variables	B-51
list var din	Reports list of digital input, index numbers, and variables	B-51
list var dout	Reports list of digital output, index numbers, and variables	B-51
lr	Reports the last lrec stored	B-23
lrec	Reports maximum number of lrecs	B-23
lrec format	Reports/sets output format for lrecs (ASCII or binary)	B-24
lrec layout	Reports current layout of lrec data	B-25
lrec mem size	Reports maximum number of lrecs that can be stored	B-25
malloc lrec	Reports/sets memory allocation for lrecs	B-25
malloc srec	Reports/sets memory allocation for srecs	B-25
me (menu)	Simulates pressing menu pushbutton	B-31
mode	Reports/sets operating mode as local or remote	B-45
nm alarm level	Reports/sets current non-methane concentration maximum alarm value	B-14
nm alarm status	Reports alarm status for non-methane	B-13
nm range	Reports/sets current non-methane measurement range	B-34
nm span	Reports/sets non-methane 1-span-gas concentration	B-29
nm span high	Reports/sets non-methane 3-span-gas concentration	B-29
nm span low	Reports/sets non-methane 3-span-gas concentration	B-29
nm span med	Reports/sets non-methane 3-span-gas concentration	B-29
nm value	Reports current non-methane concentration	B-11
nm window end	Reports/sets delay time from injection to closing of the non-methane window	B-33
nm window start	Reports/sets delay time from injection to opening of the non-methane window	B-33
no of lrec	Reports number of lrecs stored in memory	B-25
no of srec	Reports number of srecs stored in memory	B-25

Command	Description	Page
power up mode	Reports/sets the power up mode as local or remote	B-46
program no	Reports analyzer program number	B-47
pump	Reports the status of the pump	B-39
pump off always	Sets the pump always off	B-40
pump on always	Sets the pump always on	B-40
pump on when hot	Turns the pump on when hot	B-40
push	Simulates pressing a key on the front panel	B-31
relay	Sets relay logic status for the designated relay(s)	B-53
relay stat	Reports relay logic status for all relays	B-52
response factor	Reports/sets the non-methane response factor	B-34
return ch4 cal chk	Reports result of the most recent methane cal check run	B-29
return nm cal chk	Reports result of the most recent non-methane cal check run	B-29
ri (right)	Simulates pressing right pushbutton	B-31
ru (run)	Simulates pressing run pushbutton	B-31
sampling time	Reports/sets the sampling delay	B-35
save	Stores parameters in FLASH	B-40
save params	Stores parameters in FLASH	B-40
sc (screen)	C-series legacy command that reports a generic response (Use iscreen instead)	B-32
service alarm status	Reports state of service alarm	B-18
sp field	Reports/sets item number and name in scratch pad list	B-27
span conc c1	Reports/sets methane 1-span-gas concentration	B-29
span conc c1 high	Reports/sets methane 3-span-gas concentration	B-29
span conc c1 low	Reports/sets methane 3-span-gas concentration	B-29
span conc c1 med	Reports/sets methane 3-span-gas concentration	B-29
span conc nm	Reports/sets non-methane 1-span-gas concentration	B-29
span conc nm high	Reports/sets non-methane 3-span-gas concentration	B-29
span conc nm low	Reports/sets non-methane 3-span-gas concentration	B-29
span conc nm med	Reports/sets non-methane 3-span-gas concentration	B-29
sr	Reports the last srec stored	B-23
srec	Reports maximum number of srecs	B-23
srec format	Reports/sets output format for srecs (ASCII or binary)	B-24
srec layout	Reports current layout of srec data	B-25
srec mem size	Reports maximum number of srecs that can be stored	B-25

Command	Description	Page
start	Starts measurement cycle	B-12
stop	Stops current measurement cycle	B-13
stream per	Reports/sets current time interval for streaming data	B-27
stream time	Reports/sets a time stamp to streaming data or not	B-28
thc	Reports current THC concentration	B-11
thc value	Reports current THC concentration	B-11
time	Reports/sets current time (24-hour format)	B-40
tz	Reports/sets the timezone string for the network time protocol server	B-47
up	Simulates pressing up pushbutton	B-31
zero chromatogram	Reports/sets whether use chromatogram option is set to on or off	B-30

Measurements

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
```

carrier pressure

This command reports the current carrier pressure measurement, in PSI. The following example reports that the carrier pressure measurement is 15.6 psi.

```
Send:       carrier pressure
Receive:    carrier pressure 15.6 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
```

column base temp

This command reports the current column base temperature, in degrees C. The following example reports that the current column base temperature is 78.5 °C.

```
Send:       column base temp
Receive:    column base temp 78.5 deg C
```

detector base temp
This command reports the current detector base temperature, in degrees C.
The following example reports that the current detector base temperature is
174.9 °C.

```
Send:          detector base temp
Receive:       detector base temp 174.9 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 175.1
°C.

```
Send:          filter temp
Receive:       filter temp 175.1 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
```

fid signal
This command reports the average raw FID signal, in Hz. The following
example reports that the fid signal is 4577.

```
Send:          fid signal
Receive:       fid signal 4577
```

internal temp
This command reports the current internal instrument temperature. The
following example reports that the internal temperature is 25.3 °C.

```
Send:          internal temp
Receive:       internal temp 025.3 deg C
```

c1 value
nm value
thc
thc value
These commands report the measured methane, non-methane, and total
hydrocarbon concentrations. The following example shows that the THC
concentration is 40 ppm.

```
Send:        thc
Receive:     thc 4.000E+04 ppb
```

Instrument Control

backflush

This commands the multiport valve to move to the backflush position. This command will not be processed if service mode is active.

```
Send:        backflush
Receive:     backflush ok
```

inject

This commands the multiport valve to the injection position. This command will not be processed if service mode is active.

```
Send:        inject
Receive:     inject ok
```

condition column

This command reports the column condition mode to either on or off, according to Table B–3.

```
Send:        condition column
Receive:     condition column 0
```

set condition column *value*

This command sets the column condition mode according to *value*, where *value* is set to either on or off, according to Table B–3. The following example sets the condition column to on.

```
Send:        set condition column 1
Receive:     set condition column 1 ok
```

Table B–3. Condition Column Values

Value	**Condition Mode**
0	Off
1	On

start

This command starts a measurement cycle. It returns an error if a run cycle is already in progress. This command will not be processed if service mode is active.

```
Send:        start
Receive:     start ok
```

stop

This command stops the current measurement cycle. This command will not be processed if service mode is active.

```
Send:        stop
Receive:     stop ok
```

Alarms

c1 alarm status *onoff*
nm alarm status *onoff*
on = | above setpoint |
off = | below setpoint |

These commands report the alarm status for methane and non-methane to either *on* (above setpoint) or *off* (below setpoint). The following example reports that the methane alarm status is on (above setpoint).

```
Send:        c1 alarm status
Receive:     c1 alarm status on
```

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 -310.

```
Send:        alarm bias voltage min
Receive:     alarm bias voltage min -310.0 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 -290.

```
Send:        set alarm bias voltage max -290
Receive:     set alarm bias voltage max -290 ok
```

alarm ch4 chk min
alarm ch4 chk max

These commands report the current methane calibration check alarm minimum and maximum value settings. The following example reports that the methane calibration check alarm minimum value is 97%.

```
Send:        alarm ch4 chk min
Receive:     alarm ch4 chk min 97.0 %
```

set alarm ch4 chk min *value*
set alarm ch4 chk max *value*
These commands set the methane calibration check alarm minimum and maximum values to *value*, where *value* is a floating-point number representing the methane calibration check alarm limits in percent. The following example sets the methane calibration check alarm maximum value to 103%.

```
Send:        set alarm ch4 chk max 103
Receive:     set alarm ch4 chk max 103 ok
```

alarm column temp min
alarm column temp max
These commands report the current column temperature alarm minimum and maximum value settings. The following example reports that the column temperature alarm minimum value is 65.0 °C.

```
Send:        alarm column temp min
Receive:     alarm column temp min 65.0 deg C
```

set alarm column temp min *value*
set alarm column temp max *value*
These commands set the column temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing the column temperature alarm limits in degrees C. The following example sets the column temperature alarm maximum value to 75 °C.

```
Send:        set alarm column temp max 75
Receive:     set alarm column temp max 75 ok
```

alarm conc c1 min
alarm conc c1 max
c1 alarm level
alarm conc nm min
alarm conc nm max
nm alarm level
These commands report the current methane and non-methane concentration alarm minimum and maximum values settings. The "c1 alarm level" and "nm alarm level" commands report only the max alarm. The following example reports that the methane concentration minimum is 200 ppb.

```
Send:        alarm conc c1 min
Receive:     alarm conc c1 min 200.000 ppb
```

set alarm conc c1 min *value*
set alarm conc c1 max *value*

set c1 alarm level *value*
set alarm conc nm min *value*
set alarm conc nm max *value*
set nm alarm level *value*
These commands set the methane, non-methane, and total hydrocarbon 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 "set c1 alarm level" and "set nm alarm level" commands set only the max alarm. The following example sets the C1 concentration alarm maximum value to 2000.

```
Send:        set alarm conc c1 max 2000
Receive:     set alarm conc c1 max 2000 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 170.0 °C.

```
Send:        alarm detector temp min
Receive:     alarm detector temp min 170.0 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 180 °C.

```
Send:        set alarm detector temp max 180
Receive:     set alarm detector temp max 180 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 170.0 °C.

```
Send:        alarm filter temp min
Receive:     alarm filter temp min 170.0 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 180 °C.

```
Send:          set alarm filter temp max 180
Receive:       set alarm filter temp max 180 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 8.0 °C.

```
Send:          alarm internal temp min
Receive:       alarm internal temp min 8.0 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 47 °C.

```
Send:          set alarm internal temp max 47
Receive:       set alarm internal temp max 47 ok
```

alarm nm chk min
alarm nm chk max
These commands report the current non-methane calibration check alarm minimum and maximum value settings. The following example reports that the non-methane calibration check alarm minimum value is 97%.

```
Send:          alarm nm chk min
Receive:       alarm nm chk min 97.0 %
```

set alarm nm chk min *value*
set alarm nm chk max *value*
These commands set the non-methane calibration check alarm minimum and maximum values to *value*, where *value* is a floating-point number representing the non-methane calibration check alarm limits in percent. The following example sets the non-methane calibration check alarm maximum value to 103%.

```
Send:          set alarm nm chk max 103
Receive:       set alarm nm chk max 103 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 8.0 psi.

```
Send:        alarm pressure air min
Receive:     alarm pressure air min 8.0 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 22 psi.

```
Send:        set alarm pressure air max 22
Receive:     set alarm pressure air max 22 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 8.0 psi.

```
Send:        alarm pressure fuel min
Receive:     alarm pressure fuel min 8.0 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 22 psi.

```
Send:        set alarm pressure fuel max 22
Receive:     set alarm pressure fuel max 22 ok
```

alarm pressure carrier min
alarm pressure carrier max
These commands report the current carrier pressure alarm minimum and maximum value settings. The following example reports that the carrier pressure alarm minimum value is 5 psi.

```
Send:        alarm pressure carrier min
Receive:     alarm pressure carrier min 5.0 psi
```

set alarm pressure carrier min *value*
set alarm pressure carrier max *value*

These commands set the carrier pressure alarm minimum and maximum values to *value*, where *value* is a floating-point number representing the carrier pressure alarm limits in pounds per square inch. The following example sets the carrier pressure alarm maximum value to 10 psi.

```
Send:          set alarm pressure carrier max 10
Receive:       set alarm pressure carrier max 10 ok
```

service alarm status
This command reports the status of the service alarm status as *on* or *off*. The service alarm is active if any alarms other than concentration alarms are active. The following reports that service alarm status is off.

```
Send:          service alarm status
Receive:       service alarm status off
```

alarm trig conc c1
alarm trig conc nm
These commands report the current methane or the non-methane concentration alarm trigger action for the minimum alarm, to either floor or ceiling. The following example shows the C1 concentration minimum alarm trigger to ceiling, according at Table B–4.

```
Send:          alarm trig conc c1
Receive:       alarm trig conc c1 1
```

set alarm trig conc c1 *value*
set alarm trig conc nm *value*
These commands set the methane or the non-methane concentration alarm minimum *value*, where *value* is set to either floor or ceiling, according to Table B–4. The following example sets the C1 concentration minimum alarm trigger to ceiling.

```
Send:          set alarm trig conc c1 1
Receive:       set alarm trig conc c1 1 ok
```

Table B–4. Alarm Trigger Values

Value	**Alarm Trigger**
0	Floor
1	Ceiling

Diagnostics

bias voltage
This command reports the current bias supply voltage. The following example reports that the bias voltage is -276.190 volts.

```
Send:          bias voltage
Receive:       bias voltage -276.190 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 detector bias voltage. 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 -293.97
```

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
```

dump run current
dump run previous
dump zero data array

These commands report the raw chromatogram data for the most recent run, the second to last run, and the most recent zero chromatogram run. The user will get a dump of 1000 values separated by line feeds representing the raw data. Each value is the FID reading for the tenth-second (ten values = 1 second of data). These values can be imported into a spreadsheet for graphing or calculation. The following example reports the raw data for the stored zero chromatogram.

```
Send:          dump zero data array
Receive:       dump zero data array
               3623
               3595
               3580
               -
               -
               -
```

flags

This reports 8 hexadecimal digits (or flags) that represent the status of the service mode, password lock, idle mode, flame, fuel type, run or ignite, and alarms. To decode the flags, each hexadecimal digit is converted to binary as shown in Figure B–1. It is the binary digits that define the status of each parameter. In the following example, the instrument is reporting that the service and idle mode are both off, fuel type is H_2, flame status is lit, and the low fuel pressure alarm is activated.

```
Send:          flags
Receive:       flags 04520042
```
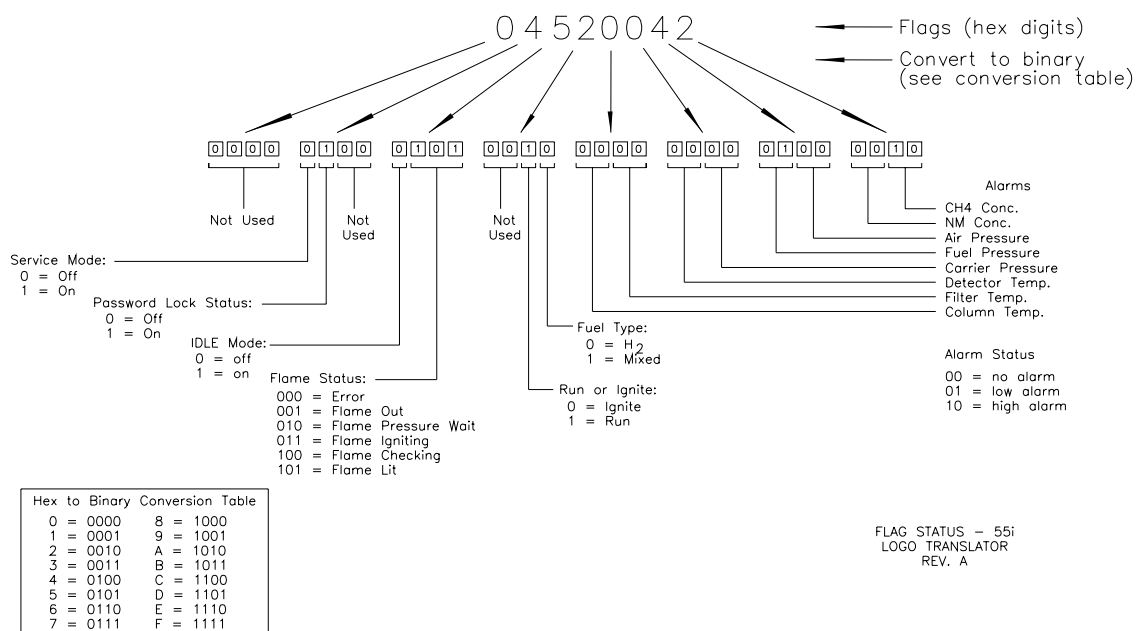

Figure B–1. Flags Field

flame status

This command reports the status of the FID flame status as *on* or *off*. The following reports that flame status is on.

```
Send:          flame status
Receive:       flame status on
```

history run

This command reports the run history records in an ASCII table form.

Note Each row has five values, which are associated with the record timestamp in the top "time" row. The columns may not line up, as evident in the following example. ▲

```
Send:          history run
Receive:       history run
               time: 19Feb08 10:26 14Feb08 10:56 14Feb08 10:49 14Feb08
               09:15 12Feb08 10:06
               ch4 pk ht: 382 16 196 262 79
               ch4 rt:  14.4  14.4  14.4  14.4  14.4
               ch4 base:  1735  1673  1663  1713  1639
               ch4 lod:   23    11     9    10    14
               ch4 sd:     7     3     3     3     4
               ch4 conc: 0.19 0.01 0.1 0.13 0.04
               nm ht: 188 144 222 200 186
               nm area: 0 0 0 0 0
               nm conc: 0 0 0 0 0
               nm base st:  2888   2729   2726   2798   2724
               nm base end:  2821   2652   2656   2833   2849
               nm lod:  2176   2070   2081   1170    759
               nm st idx: 2 2 2 2 2
               nm end idx: 101 90 106 108 105
               nm max slp: 10 10 12 10 10
               nm min slp: -5 -2147483648 -7 -4 -3
               nm pt cnt: 0 0 0 0 0
```

history cal
This command reports the calibration history records in and ASCII table form.

Note Each row has five values, which are associated with the record timestamp in the top "time" row. The columns may not line up, as evident in the following example. ▲

Note If less than five calibrations have been performed, the type and status will be reported as ERROR for the columns in which a calibration has not been performed. ▲

```
Send:          history cal
Receive:       history cal
               time: 18Jan08 15:52 18Jan08 15:48 17Jan08 14:12 17Jan08
               10:41 17Jan08 09:50
               type:      SPAN      SPAN      SPAN      SPAN      SPAN
               status:    GOOD      GOOD      GOOD      GOOD      GOOD
               chk/adj: adjust adjust adjust adjust adjust
               ch4 span: 1801.00 1801.00  4.50  4.50  4.50
               ch4 ratio: 4.897e-04 1.641e-03 4.551e-04 3.881e-06
               3.962e-06
```

```
ch4 rt:  15.0  15.2  15.0  15.0  15.8
ch4 pk idx: 35 36 35 35 39
ch4 pk ht: 3677455 1097292 9888 9850 6043
nm span: 598.00 598.00  1.50  1.50  1.50
nm rat: 1.08515e-05 4.33798e-05 4.32913e-06 4.20798e-06
3.881e-06
nm area: 55107840 13785232 346490 356466 386498
```

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
```

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 CH4
              2  2 NMHC
              3  4 Det_Temp
              4  6 Col_Temp
              5  9 Air_PSI
              6 10 Carrier_PSI
              7 11 Fuel_PSI
```

erec
er*xy*
x = | 0 | 1 | : Reply termination format (see "set format *format*" command)
y = | 0 | 1 | 2 | : Output format (see "set erec format *format*" command)

These commands return a snapshot of the main operating conditions (measurements and status) at the time the command is issued. The following example shows a typical response.

The format is defined within the command (in the case of er*xy*) or by the current settings of the "format" and "erec format" commands (in the case of erec). 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
            10:56 11-27-07 flags 08100040 CH4_CONC 1.972 NMHC_CONC
            0.000 THC_CONC 1.972 CH4_RANGE 20.000  1 NMHC_RANGE
            20.000  1 CH4_ALARM 2000.000 NMHC_ALARM 2000.000
            CH4_SPAN_GAS 89.800 NMHC_SPAN_GAS 30.200 SAMPLE_TIME 15
            OP_MODE 1 FLAME_STATUS 1 AIR_PRESS 16.889 FUEL_PRESS
            0.000 CARRIER_PRESS 29.702 DET_OVEN_SET 175
            COL_OVEN_SET 75 DET_BASE_TEMP 174.713 FILTER_BASE_TEMP
            174.921 COL_BASE_TEMP 75.897 INTERNAL_TEMP 26.043
            FLAME_TEMP 161.901
```

lrec
srec
lrec *rec num*
srec *rec num*
lr*xy rec num*
sr*xy rec num*
lrec *aa:bb oo-pp-qq yy*
srec *aa:bb oo-pp-qq yy*
rec = The starting record index number (1=most recent)
num = The number of records to return (1 to 10)
x = | 0 | 1 | : Reply termination format (see "set format *format*" command)
y = | 0 | 1 | 2 | : Output format (see "set lrec/srec format *format*" command)
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 lrec or srec logged 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
                14:12 11-15-07  flags 08528225 CH4 0.323 NMHC 0.000
                Det_Temp 174.774 Col_Temp 75.971 Flame 1.000
                14:13 11-15-07  flags 08528225 CH4 0.000 NMHC 0.000
                Det_Temp 175.153 Col_Temp 75.861 Flame 1.000
                14:15 11-15-07  flags 08528225 CH4 0.000 NMHC 0.000
                Det_Temp 174.811 Col_Temp 75.812 Flame 1.000
                14:16 11-15-07  flags 08528225 CH4 0.000 NMHC 0.000
                Det_Temp 175.055 Col_Temp 75.763 Flame 1.000
                14:17 11-15-07  flags 08528225 CH4 0.004 NMHC 0.000
                Det_Temp 174.786 Col_Temp 75.421 Flame 1.000
```

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 1
```

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
            t D L f_f_f_f_f
            flags CH4 NMHC Det_Temp Col_Temp_Flame
```

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
```

no of lrec
no of srec
These commands report the number of lrecs and srecs stored memory. The following example shows that 50 lrecs have been stored in the memory.

```
Send:       no of lrec
Receive:    no of lrec 50 recs
```

malloc lrec
malloc srec
These commands report the currently set memory allocation for lrecs and srecs in percent of total memory.

```
Send:        malloc lrec
Receive:     malloc lrec 10 %
```

set malloc lrec *value*
set malloc srec *value*
value = 0 to 100

These commands set the percent of memory space allocated for lrecs and srecs to *value*, where *value* is a floating-point number representing percent. The following example sets the memory allocation for lrecs to 10%.

Note Issuing these commands will clear all the logged data in memory. All the existing records should be retrieved using appropriate commands, if required. ▲

```
Send:        set malloc lrec 10
Receive:     set malloc lrec 10 ok
```

---

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 sec
```

set stream per *number value*
number value = | 1 | 2 | 5 | 10 | 20 | 30 | 60 | 90 |120 | 180 | 240 | 300 |

This command sets the time interval between two consecutive streaming data strings to *number value* in seconds. The following example sets the number value to 10 seconds.

```
Send:          set stream per 10
Receive:       set stream per 10 ok
```

stream time

This command reports if the streaming data string will have a time stamp attached to it or not, according to Table B–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	Disables time stamp to streaming data string
1	Attaches time stamp to streaming data string

Calibration

cal check
set cal check

These commands initiate a calibration check cycle if not in Service Mode, run is "done", flame is lit, and not in column conditioning. Otherwise it returns with "cal check can't, wrong settings".

```
Send:          cal check
Receive:       cal check ok
```

calibrate
set calibrate

These commands initiate a calibration cycle if not in Service Mode, run is "done", flame is lit, and not in column conditioning. Otherwise it returns with "calibrate can't, wrong settings".

```
Send:          calibrate
Receive:       calibrate ok
```

cal verify

This command reports whether calibration verification is on (yes) or off (no). The following example shows that the calibration verification is on.

```
Send:         cal verify
Receive:      cal verify yes
```

set cal verify *onoff/yesno*
onoff = | on | off |
yesno = | yes | no |

This command sets the calibration verification to *on (yes)* or *off (no)*. The following example turns the calibration verification off.

```
Send:         set cal verify off
Receive:      set cal verify off ok
```

---

return ch4 cal chk
return nm cal chk
These commands report the results of the most recent methane or non-methane calibration check run. The following example reports result of the most recent non-methane calibration check run in percent.

```
Send:         return nm cal chk
Receive:      return nm cal chk 98
```

---

c1 span
c1 span low
c1 span med
c1 span high
span conc c1
span conc c1 low
span conc c1 med
span conc c1 high
nm span
nm span low
nm span med
nm span high
span conc nm
span conc nm low
span conc nm med
span conc nm high
These commands report the methane and non-methane span gas concentration in 1-span gas mode OR the selected low, middle, or high concentration in 3-span mode. The following example reports that the methane calibration gas concentration in 1-span gas mode is 40.0 ppb.

```
Send:         span conc c1
Receive:      span conc c1 4.000E+01 ppb
```

set c1 span *value*
set c1 span low *value*

set c1 span med *value*
set c1 span high *value*
set span conc c1 *value*
set span conc c1 low *value*
set span conc c1 med *value*
set span conc c1 high *value*
set nm span *value*
set nm span low *value*
set nm span med *value*
set nm span high *value*
set span conc nm *value*
set span conc nm low *value*
set span conc nm med *value*
set span conc nm high *value*

These commands set the methane and non-methane span gas concentration in 1-span gas mode OR the selected low, middle, or high concentration in 3-span mode to *value*, where *value* is a floating-point representation of the gas concentration in the currently selected units. The gas units must be the same as those chosen by the user in the Range menu. The following example sets the high range calibration gas for non-methane to 1800 in the units chosen in the Range menu.

```
Send:       set nm span high 1800
Receive:    set nm span high 1800 ok
```

zero chromatogram
This command reports whether the use zero chromatogram option is turned on or off. The following example reports that the use zero chromatogram option is turned off.

```
Send:       zero chromatogram
Receive:    zero chromatogram off
```

set zero chromatogram *onoff*
onoff = | on | off |

This command sets the use zero chromatogram option to *on* or *off*. The following example sets the use zero chromatogram option on.

```
Send:       set zero chromatogram on
Receive:    set zero chromatogram on ok
```

do zero run
This command will run a zero chromatogram if the analyzer is in the proper state to do so. If the unit is not in the proper state, the message "can't, wrong settings" is returned. The following example reports that the unit is not in the proper state to perform a zero chromatogram.

```
Send:          do zero run
Receive:       do zero run can't, wrong settings
```

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

backflush time
This command reports the delay value from the injection to the switching of the mulitport valve to the backflush position. The following example reports that the backflush time is 20 seconds.

```
Send:        backflush time
Receive:     backflush time 20.0
```

set backflush time *value*
This command sets the delay valve from the injection to the switching of the multiport valve to the backflush position to *value*, where *value* is a floating-point number representing 0-999 in seconds. In addition, the backflush time must be between the c1 window end time + 2.0 seconds and the nm window start time. The following example sets the backflush time delay to 15.0 seconds.

```
Send:          set backflush time 15
Receive:       set backflush time 15 ok
```

c1 window start
nm window start
These commands report the delay time from injection to the opening of the methane and non-methane window. The following example reports that the methane window start time is 10 seconds.

```
Send:          c1 window start
Receive:       c1 window start 10.0
```

set c1 window start *value*
set nm window start *value*
These commands set the delay time from the injection to the opening of the methane and non-methane window to *value*, where *value* is a floating-point number representing 0-999 in seconds. In addition, the c1 window start time can not be greater than the c1 window end time - 0.1 seconds and the nm window start time must be between the backflush time + 0.5 seconds and the nm window end time. The following example sets the non-methane window start time delay to 20.0 seconds.

```
Send:          set nm window start 20
Receive:       set nm window start 20 ok
```

c1 window end
nm window end
These commands report the delay time from injection to closing of the methane and non-methane window. The following example reports that the non-methane window end time delay is 60 seconds.

```
Send:          nm window end
Receive:       nm window end 60
```

set c1 window end *value*
set nm window end *value*
These commands set the delay time from injection to closing of the methane and non-methane window to *value*, where *value* is a floating-point number representing 0-999 in seconds. In addition, the c1 window end time must be between the c1 window start time + 0.1 seconds and the

backflush time and the nm window end time must be greater than the nm window start time + 0.1 seconds. The following example sets the methane window end time delay to 45.0 seconds.

```
Send:          set c1 window end 45
Receive:       set c1 window end 45 ok
```

c1 range
nm range
These commands report the current methane and non-methane measurement range. The following example reports that the measurement range for methane is medium.

```
Send:          c1 range
Receive:       c1 range med
```

set c1 range *value*
set nm range *value*
value = | low | med | high |

These commands set the methane and non-methane measurement range to low, medium, high. The following example sets the measurement range for non-methane to high.

```
Send:          set nm range high
Receive:       set nm range high ok
```

gas unit
This command reports the current gas units (ppm, ppb, $\mu g/m^3$, mg/m^3, %, 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 | percent | ppmc |

This command sets the gas units to ppm, ppb, $\mu g/m^3$, mg/m^3, %, or ppmc. The following example sets the gas units to mg/m^3.

```
Send:          set gas unit mg/m3
Receive:       set gas unit mg/m3 ok
```

response factor
This command reports the current non-methane response factor, that is, the multiplier set for the non-methane 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 non-methane response factor to *value*, where *value* is any floating-point number representing the non-methane response factor. The following example sets the non-methane response factor to 5.

```
Send:          set response factor 5
Receive:       set response factor 5 ok
```

sampling time
This command reports the sampling delay time before making a measurement. The following example reports that the sampling time delay is 60 seconds.

```
Send:          sampling time
Receive:       sampling time 60
```

set sampling time *value*
This command sets the sampling delay time before making a measurement to *value*, where *value* is a floating-point number representing 4-999 in seconds. The following example sets the sampling time delay to 15 seconds.

```
Send:          set sampling time 15
Receive:       set sampling time 15 ok
```

Hardware Configuration

air control pressure
This command reports the current air control pressure according to Table B–7. 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–7. 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–7. Fuel and Status Values

Fuel	**Type**	*Status*	**Set**
0	Hydrogen	0	Run
1	Mixed	1	Ignite

carrier control pressure
This command reports the current carrier control pressure according to
Table B–7. The following example shows that for mixed fuel during
ignition, the carrier control pressure is set to 5 psi.

```
Send:        carrier control pressure 1 1
Receive:     carrier control pressure 1 1 5.000
```

set carrier control pressure *fuel status value*
This command sets the carrier control pressure according to Table B–7.
The following example sets the carrier control pressure for mixed fuel
during the run mode to *value*, where *value* is a floating-point number
representing the carrier control pressure in PSI. The following example sets
the carrier control pressure to 5 psi.

```
Send:        set carrier control pressure 1 0 5.000
Receive:     set carrier control pressure 1 0 5.000 ok
```

fuel control pressure
This command reports the current fuel control pressure according to Table
B–7. 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–7. 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
```

column oven
This command reports the current setpoint for the column oven. The
following example shows that the column oven setpoint is set to 78.

```
Send:         column oven
Receive:      column oven 78
```

set column oven *value*
This command sets the column oven setpoint to *value*, where *value* is a floating-point number representing the column oven setpoint. The following example sets the column oven setpoint to 75.

```
Send:         set column oven setpoint 75
Receive:      set column oven setpoint 75 ok
```

detector oven
This command reports the current setpoint for the detector oven. The following example shows that the detector oven setpoint is set to 175.

```
Send:         detector oven
Receive:      detector oven 175
```

set detector oven *value*
This command sets the detector oven setpoint to *value*, where *value* is a floating-point number representing the detector oven setpoint. The following example sets the detector oven setpoint to 150.

```
Send:         set detector oven setpoint 150
Receive:      set detector oven setpoint 150 ok
```

contrast
This command reports the LCD screen's level of contrast. The following example shows the screen contrast is 50%, according to Table B–8.

```
Send:         contrast
Receive:      contrast 10: 50%
```

set contrast *level*
This command sets the LCD screen's *level* of contrast, according to Table B–8. The following example sets the contrast level to 50%.

```
Send:         set contrast 10
Receive:      set contrast 10 ok
```

Table B–8. Contrast Levels

Level	**Contrast Level**
0	0%
1	5%
2	10%
3	15%

Level	Contrast Level
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%
18	90%
19	95%
20	100%

date
This command reports the current date, in mm-dd-yy format. 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.

Note The instrument will re-boot and connection will be lost after this command is issued. ▲

```
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 flame
This command will set the instrument to attempt to light the FID flame.

```
Send:        set ignite flame
Receive:     set ignite flame 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, hh:mm:ss). 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 10.209.40.97
```

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 10.209.40.97
Receive:     set addr ip 10.209.40.97 ok
```

addr nm
This command reports the IP netmask.

```
Send:        addr nm
Receive:     addr nm 255.255.252.0
```

set addr nm *mask*
This command sets the netmask *mask*, where *mask* 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. See "Network Time Protocol Server" in the "Communications Settings" section of the "Operation" chapter for more information.

```
Send:        addr ntp
Receive:     addr ntp 208.184.349.9
```

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 208.184.349.9
Receive:     set addr ntp 208.184.349.9 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–9.

```
Send:          format
Receive:       format 00
```

set format *format*
This command sets the reply termination *format*, where *format* is set according to Table B–9. The following example sets the reply termination format to checksum.

```
Send:          set format 01
Receive:       set format 01 ok
```

Table B–9. 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. This command returns "bad cmd" if no host name has been set.

```
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 (with no spaces). The following example sets the host name to analyzer01. This command returns "bad cmd" if no host name has been set.

```
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 55*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 55
```

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 56.

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 56
Receive:     set instrument id 56 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–10. 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–10.

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–10. 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–11. 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/locked mode.

```
Send:        power up mode
Receive:     power up mode 1
```

set power up mode *value*
This command is used to configure the instrument to power up in the local/unlocked mode (*value* = 0*)* or the remote/locked mode (*value* = 1), according to Table B–11.

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–11. 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 55i 01.00.01.074
```

layout ack
This command reports 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–12. The following example reports that the instrument is configured to do nothing.

```
Send:        layout ack
Receive:     layout ack 0
```

set layout ack *value*
This command disables the stale layout/layout change indicator (*) that is attached to each response if the erec layout has changed since the last time erec layout was requested, where *value* represents the function, according to Table B–12.

```
Send:        set layout ack 1
Receive:     set layout ack 1 ok
```

Table B–12. 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–13. 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–13. 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–13. Analog Current Output Range Values

Range	**Output Range**
1	0-20 mA
2	4-20 mA
0 [cannot be set to this, but may report]	Undefined

analog vin *channel*
This command retrieves the analog voltage input *channel* data, both the calculated value and the actual voltage. In the following example, the "calculated" value of channel 1 is 75.325 degrees F, volts are 2.796. This command responds with "feature not enabled" if the I/O expansion board is not detected.

```
Send:        analog vin 1
Receive:     analog vin 1 75.325 2.796
```

analog vout range *channel*
This command reports the analog voltage output *channel* range, where *channel* is between 1 and 6 inclusive, according to Table B–14. 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–14. 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–14. 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* (1-12), 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 example below 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* (1-10) to be assigned to the action associated with *index* (1-34), 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–15. The following example shows that the D/A #1 is 97.7% full-scale.

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. ▲

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

```
Send:          dtoa 1
Receive:       dtoa 1 97.7%
```

Table B–15. Default Analog Output Channel Assignments

D to A	Function	Parameter
1	Voltage Output	Raw Signal
2	Voltage Output	Methane
3	Voltage Output	NMHC
4	Voltage Output	THC
5	Voltage Output	Not Assigned
6	Voltage Output	Not Assigned
7	Current Output	Raw Signal
8	Current Output	Methane
9	Current Output	NMHC
10	Current Output	THC
11	Current Output	Not Assigned
12	Current Output	Not Assigned

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. Channels that have not been assigned a variable index are not displayed.

```
Send:        list dout
Receive:     list dout
             output index variable state
             1  9 SPAN MODE open
             2 11 CH4 CONC MAX open
             3 23 CH4 OVERRANGE open
             4  8 ZERO MODE open
             5  7 INJECT open
             6  3 CAL MODE open
             7  4 CAL CHK MODE open
             8  5 RUN MODE open
```

list var aout
list var dout
list var din
These commands report the list of possible 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 CH4
              2 NMHC
              3 THC
              4 Det_Temp
              5 Filt_Temp
              6 Col_Temp
              7 Flame_Temp
              8 Int_Temp
              9 Air_PSI
             10 Carrier_PSI
             11 Fuel_PSI
             12 Raw_Hz
             13 Flame
             14 CH4_pk_ht
             15 CH4_rt
             16 CH4_base
             17 CH4_lod
             18 CH4_pk_ht
             19 nm_area
             20 nm_base_st
             21 nm_base_end
             22 nm_lod
             23 nm_st_idx
             24 nm_end_idx
             25 nm_max_slp
             26 nm_min_slp
             27 nm_pts
             36 exfg
```

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 number 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 55*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. The default value is 55.

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 55*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 55*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 55*i*

Coil Number	Status
0	INVALID
1	LOCAL/REMOTE
2	SERVICE
3	CAL MODE
4	CAL CHECK MODE
5	RUN MODE

Coil Number	Status
6	IDLE MODE
7	INJECT
8	ZERO MODE
9	SPAN MODE
10	GEN ALARM
11	CH4 CONC MAX ALARM
12	CH4 CONC MIN ALARM
13	NM CONC MAX ALARM
14	NM CONC MIN ALARM
15	INTERNAL TEMP ALARM
16	DETECTOR TEMP ALARM
17	FILTER TEMP ALARM
18	COLUMN TEMP ALARM
19	AIR PRESSURE ALARM
20	CARRIER PRESSURE ALARM
21	FUEL PRESSURE ALARM
22	FLAME OUT ALARM
23	CH4 OVERRANGE ALARM
24	NM OVERRANGE ALARM
25	CAL FAILURE ALARM
26	HEATER FAILURE ALARM
27	SENSOR FAILURE ALARM
28	BIAS VOLTAGE ALARM
29	DATA INTEGRITY ALARM
30	CH4 SPAN CHK ALARM
31	NM SPAN CHK ALARM
32	WINDOWS SANITY ALARM
33	MOTHERBOARD STATUS ALARM
34	INTERFACE BD STATUS ALARM
35	I/O EXP BD STATUS ALARM
36	EXTERNAL ALARM 1
37	EXTERNAL ALARM 2
38	EXTERNAL ALARM 3

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 55*i*

Register Number	Variable
0	INVALID
1 & 2	METHANE
3 & 4	NMHC
5 & 6	THC
7 & 8	DETECTOR TEMP
9 & 10	FILTER TEMP
11 & 12	COLUMN TEMP
13 & 14	FLAME TEMP
15 & 16	INTERNAL TEMP
17 & 18	AIR PRESSURE
19 & 20	CARRIER PRESSURE
21 & 22	FUEL PRESSURE
23 & 24	RAW SIGNAL
25 & 26	FLAME STATUS
27 & 28	CH4 PEAK HEIGHT
29 & 30	CH4 PEAK RETENTION TIME
31 & 32	CH4 BASELINE
33 & 34	CH4 LOD
35 & 36	NM PEAK HEIGHT
37 & 38	NM PEAK AREA
39 & 40	NM BASE START
41 & 42	NM BASE END
43 & 44	NM LOD
45 & 46	NM START INDEX
47 & 48	NM END INDEX

Register Number	Variable
49 & 50	NM MAX SLOPE
51 & 52	NM MIN SLOPE
53 & 54	NM DATA POINTS
55 & 56	ANALOG IN 1
57 & 58	ANALOG IN 2
59 & 60	ANALOG IN 3
61 & 62	ANALOG IN 4
63 & 64	ANALOG IN 5
65 & 66	ANALOG IN 6
67 & 68	ANALOG IN 7
69 & 70	ANALOG IN 8
71 & 72	EXTERNAL ALARMS

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 55*i*

Coil Number	Action Triggered
100	INVALID
101	INITIATE RUN
102	INITIATE CAL
103	INITIATE CAL CHECK
104	STOP
105	INJECT
106	BACKFLUSH

Coil Number	Action Triggered
107	SET IDLE MODE
108	AOUTS TO ZERO
109	AOUTS TO FS
110	EXTERNAL ALARM 1
111	EXTERNAL ALARM 2
112	EXTERNAL ALARM 3

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 55*i* Geysitech Protocol specification, see the following topics:

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 default instrument address is 55.

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 seven control commands supported by the Geysitech protocol in the Model 55*i*.

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 for all commands except 'X' the instrument must **not** be currently executing a run. For commands that initiate a run, the instrument must also not be in column conditioning mode, and the flame must be lit.

Command 'N' initiates a zero chromatogram run.

Command 'K' initiates a span chromatogram run.

Command 'M' initiates a sample chromatogram run.

Command 'C' initiates a span check chromatogram run.

Command 'I' puts rotary valve in inject position.

Command 'B' puts rotary valve in backflush position.

Command 'X' cancels any run in progress.

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 initiate a zero chromatogram run, instrument address 55:

<STX>ST055<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>DA055<CR>

<STX>DA<SP>55<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 3 measurements reported in response to DA command for the Model 55*i* include:

● Methane

● Non-Methane

● THC

Operating and Error Status

See Table D–1 for operating status and Table D–2 for error status for the Model 55*i*.

Table D–1. Operating Status for Model 55*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
Running a Zero Chromatogram	0	0	0	0		0	1	0	0
Running a Span Chromatogram	0	0	0	0		1	0	0	0
Running a Sample Chromatogram	0	0	0	1		0	0	0	0
Valve in Inject Position	0	0	1	0		0	0	0	0
Valve in Backflush Position	0	1	0	0		0	0	0	0
Column Conditioning State	1	0	0	0		0	0	0	0

Table D–2. Error Status for Model 55*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 Column 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 (CH_4 or NMHC)	1	0	0	0		0	0	0	0

Appendix E
AK Protocol Commands

This appendix provides a description of the AK protocol commands that can be used to remotely control a Model 55*i* analyzer using a host device such as a PC or a datalogger. AK protocol may be used over RS-232, RS-485, or Ethernet. AK functions can be accessed over Ethernet using TCP port 9883.

Up to three simultaneous connections per protocol may be made over Ethernet.

For details of the Model 55*i* AK protocol specification, see the following topics:

TCP Communication Parameters

*i*Series instruments support the AK 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 AK: 9883

Conventions

The following conventions are used by the AK protocol:

C1 = Methane Channel

NM = Non-Methane Channel

Abbreviations Used

The following is a list of abbreviations used in this document:

<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 an AK command.

All commands issued follow the message format:

<STX><SP>AAAA<SP>argument<SP>argument<ETX>

Where:

   AAAA = the 4-character command code

Response Format:

<STX><SP>AAAA<SP>digit<SP>argument<ETX>

Where:

   digit = a single digit sum of the number of alarm conditions present in the analyzer

Each command is framed by control characters, <STX> at the start and terminated with <ETX>.

Values within brackets are ASCII characters (see Abbreviations Used above).

Error messages are generated if a command cannot be executed at the current time or if the command parameters are out of range. 'BS' returned with a command indicates that the instrument is in the wrong state to execute the command. 'SE' indicates that at least one of the command's parameters is out of range.

Commands List

Table E–1 lists the 55*i* AK protocol commands. The interface will respond to the command strings outlined below.

Table E–1. Command List

Command	Description	Page
AEMB	Returns current range setting	E-7
AFDA	Returns total time for a measurement cycle	E-3
AKAK	Returns current span gas setting	E-6
AKEN	Returns instrument ID string	E-9
AKON	Returns last measurement	E-4
ASOL	Returns requested temperature setpoint	E-8
ASTF	Returns error status	E-5
ASTZ	Returns analyzer status	E-4
ATEM	Returns requested temperature	E-5
AUKA	Returns instantaneous FID signal	E-5
EFDA	Sets sampling time	E-7
EKAK	Sets span gas concentration	E-6
EKEN	Sets instrument ID string	E-10
ESOL	Sets oven temperatures	E-9
ESYZ	Sets instrument time and date	E-9
SATK	Run calibration	E-7
SEMB	Sets instrument range	E-8
SINT	Run measurement cycle	E-8
SMAN	Sets manual mode	E-10
SREM	Sets remote mode	E-10
STBY	Go to standby	E-8
SAMC	Allows analyzer to accept/reject SREM and SMAN sets	E-10

Measurements

AFDA K0

This command returns the total time for a measurement cycle, in seconds. The time returned is the total of the sampling time + measurement time + processing time.

```
Send:        AFDA K0
Receive:     AFDA 0 58
```

AKON Km

m = Measurement

This command returns last measurement of methane, non-methane or both, according to Table E–2. If both measurements are requested, the methane is the first value reported.

Note If no measurements have been run, the instrument returns 0. ▲

```
Send:          AKON K0
Receive:       AKON 0 1.325 4.793
```

Table E–2. Measurement Values

Measurement	Description
0	Both
1	Methane
2	Non-methane

ASTZ K0

This command returns status of the instrument, according to the format "ASTZ x MMMM FFFF SSSS V1V1 V2V2…"

where:

MMMM	**Mode**
SREM	Remote
SMAN	Manual

FFFF	**Active Function**
STBY	Standby
SATK	Calibration in progress
SINT	Measurement in progress

SSSS	**Analyzer Specific Measurement Mode**
SCAL	Calculation time
SINJ	Inject
SRUC	Backflush
SDLY	Dead Time

VxVx	**Vendor Specific Codes**
OHOT	Ovens Hot – Pre-Operation State
OCLD	Ovens Cold – Pre-Operation Warm Up State
CCMD	Condition Column State – Maintenance Only Condition
AUCL	Auto-calibration Mode
FAIL	Failure Mode (flame not lit)

The following example shows that the instrument is in remote mode, measurement is in progress, the valve is in the inject position, and that the oven is hot.

```
Send:        ASTZ K0
Receive:     ASTZ 0 SREM SINT SINJ OHOT
```

ATEM Km
m = Temperature

This command returns the requested temperature in Kelvin, according to Table E–3. The following example reports that the detector base temperature is 448 K (175 °C). If all are requested, they are reported in the order shown in the table below.

```
Send:        ATEM K1
Receive:     ATEM 2 448
```

Table E–3. Temperature Values

Temperature	Description
0	All
1	Detector Base
2	Column Base
3	Filter Base
4	Flame

AUKA K0
This command reports the current Instantaneous FID signal, in hertz. The following example reports that the current FID reading is 19988 Hz.

```
Send:        AUKA K0
Receive:     AUKA 0 19988
```

Alarms

ASTF K0
This command returns the error status, each separated by space, according to Table E–4. The number of errors is not reported in the response of this command, only the active alarm status. The following example reports that the bad calibration and service alarms are activated.

```
Send:        ASTF K0
Receive:     ASTF 64 1
```

Table E–4. Alarm Status Descriptions

Alarm Number	Description
256	Flame Out Flag (set if flame is out)
64	Bad Calibration
32	NM Concentration Alarm (Over Alarm Setpoint)
16	C1 Concentration Alarm (Over Alarm Setpoint)
8	Low Carrier Pressure Alarm
4	Low Fuel Pressure Alarm
2	Low Air Pressure Alarm
1	Service Alarm

Calibration

AKAK Km Mr
This command returns the current span gas concentration for the requested measurement (m) and range (r), according to Table E–5 and Table E–6. The following example shows the low range methane span concentration is 2.500. If both measurements are requested, the methane is the first value reported.

```
Send:       AKAK K1 M1
Receive:    AKAK 1 2.500
```

Table E–5. Measurement Values

Measurement	Description
0	Both
1	Methane
2	Non-Methane

Table E–6. Range Values

Range	Description
0	Low
1	Medium
2	High

EKAK Km Mr *xxxx yyyy*
This command sets the span gas concentrations for the selected range (Table E–6) for methane and non-methane, to *xxxx* and *yyyy*, where *xxxx* and *yyyy* are floating-point representations of the gas concentrations 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 calibration gas concentration for methane to 2.500 and non-methane to 5.000 for the medium range.

```
Send:          EKAK K0 M1 2.500 5.000
Receive:       EKAK 2
```

SATK K0

This command starts a calibration run. The following example indicates that the calibration command was executed.

```
Send:          SATK K0
Receive:       SATK 1
```

Measurement Configuration

AEMB Km

This command reports the current methane or non-methane range (Table E–5). The following example reports that the methane range is set to custom range 1, according to Table E–7. If both range settings are requested, methane is returned first.

```
Send:          AEMB K1
Receive:       AEMB 0 4
```

Table E–7. Range Values

Range	Description
1	Low
2	Medium
3	High
4	Custom Range 1
5	Custom Range 2
6	Custom Range 3

EFDA K0 *ttt*

This command sets the sample time to *value*, where *value* is an integer representation of the sample time. The following example sets the sample time to 30 seconds.

```
Send:          EFDA K0 30
Receive:       EFDA 1
```

SEMB Km Mr
This command sets the methane or non-methane (m) full-scale range (r), according to Table E–5 and Table E–7, respectively. The following example sets the methane range to high.

```
Send:        SEMB K1 M3
Receive:     SEMB 0
```

Table E–8. Measurement Values

Measurement	Description
1	Methane
2	Non-Methane

SINT K0
This command starts a measurement cycle.

```
Send:        SINT K0
Receive:     SINT 0
```

STBY K0
This command puts the instrument in standby, cancelling any run in progress and stopping further runs if in auto mode.

```
Send:        STBY K0
Receive:     STBY 1
```

Hardware Configuration

ASOL Km
This command returns the requested oven temperature setpoint in Kelvin, according to Table E–9. The following example reports that the column oven setpoint is 343 K (70 °C). If both are requested, the detector oven is reported first.

```
Send:        ASOL K2
Receive:     ASOL 0 343
```

Table E–9. Oven Temperature Values

Temperature	Description
0	Both
1	Detector Base
2	Column Base

ESOL Km *ttt*

This command sets the requested oven setpoint to *ttt*, where *ttt* is an integer representation of the temperature in Kelvin, according to Table E–10. The following example sets the detector oven setpoint to 443 K (170 °C).

```
Send:          ESOL K1 443
Receive:       ESOL 0
```

Table E–10. Oven Temperature Values

Temperature	Description
1	Detector Base
2	Column Base

ESYZ K1 *hhmmss*

hh = hours
mm = minutes
ss = seconds

This command sets the internal clock (24-hour format). The following example sets the internal time to 14:57:00.

```
Send:          ESYZ K1 145700
Receive:       ESYZ 0
```

ESYZ K2 *mmddyy*

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:          ESYZ K2 120106
Receive:       ESYZ 0
```

Communications Configuration

AKEN K0

This command returns the instrument identification (string). The following example returns the current setting of the instrument ID.

```
Send:          AKEN K0
Receive:       AKEN 0 55i
```

EKEN K0 *sssssss*

This command sets the instrument identification string to s*ssssss*, where s*ssssss* can be up to 40 characters long. The string is free form and can contain spaces. Longer strings will be truncated. The following example shows the instrument ID changed to 55*i*.

```
Send:          AKEN K0 55i
Receive:       AKEN 0
```

SMAN K0

This command sets the instrument to manual mode. The following example sets the instrument to manual mode if the instrument has been set to allow remote mode changes.

```
Send:          SMAN K0
Receive:       SMAN 1
```

SREM K0

This command sets the instrument to remote mode. The following example sets the instrument to remote mode if the instrument has been set to allow remote mode changes.

```
Send:          SREM K0
Receive:       SREM 2
```

SAMC K0 *y*

This command sets the unit to *y*, where *y* is either 1 = accept or 0 = reject remote mode changes, according to Table E–11. The following example sets the instrument to accept remote mode changes.

```
Send:          SAMC K0 1
Receive:       SAMC 0
```

Table E–11. Remote Values

y	Description
0	Reject remote mode change
1	Accept remote mode change