Model 81*i*

Instruction Manual
Hg Calibrator
Part Number 103068-00
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WEEE Compliance

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

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

About This Manual

This manual provides information about installing, operating, maintaining, and servicing the Model 81*i*. 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 the product features, describes the principle of operation, and lists the specifications.
- Chapter 2 “Installation” describes how to unpack, setup, and start-up the instrument.
- Chapter 3 “Operation” describes the front panel display, the front panel pushbuttons, and the menu-driven software.
- Chapter 4 “Calibration” provides the procedures for calibrating the instrument 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 instrument failures, isolating faults, and includes recommended actions for restoring proper operation.
- Chapter 7 “Servicing” presents safety alerts for technicians working on the instrument, 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 software 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 instrument.
- 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 instrument 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 “Manufacturer’s Disclosure” provides information required per the EPA Interim Elemental Mercury Gas Traceability Protocol, Section 4.0.

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 will result in death or serious personal injury if the warning is ignored. ▲
	**WARNING**	A hazard is present or an unsafe practice can 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**	If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲ The service procedures in this manual are restricted to qualified service personnel only. ▲ The Model 81*i* is supplied with a three-wire grounding cord. Under no circumstances should this grounding system be defeated. ▲
	**Equipment Damage**	Do not attempt to lift the instrument by the cover or external fittings. ▲ Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

Alert	Description
	This adjustment should only be performed by an instrument service technician. ▲
	Handle all printed circuit boards by the edges only. ▲
	Do not remove the panel or frame from the LCD module. ▲
	The LCD module polarizing plate is very fragile, handle it carefully. ▲
	Do not wipe the LCD module polarizing plate with a dry cloth, it may easily scratch the plate. ▲
	Do not use Ketonics solvent or aromatic solvent to clean the LCD module, use a soft cloth moistened with a naphtha cleaning solvent. ▲
	Do not place the LCD module near organic solvents or corrosive gases. ▲
	Do not shake or jolt the LCD module. ▲

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 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 81*i* Hg Calibrator combines proven, easy to use menu-driven software, and advanced diagnostics to offer unsurpassed flexibility and reliability. The Model 81*i* has the following features:

- 320 x 240 graphics display
- Menu-driven software
- Field programmable ranges
- Multiple user-defined analog outputs
- Analog input options
- Fast response time
- Totally self contained
- User-selectable digital input/output capabilities
- Standard communications features include RS-232/485 and Ethernet
- C-Link, MODBUS, streaming data, and NTP (Network Time Protocol) protocols. Simultaneous connections from different locations over Ethernet.

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

- "Principle of Operation" on page 1-2
- "Specifications" on page 1-4

Thermo Fisher Scientific is pleased to supply this Hg calibrator. 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 calibrator. For more information on servicing, see the "Servicing" chapter.

Principle of Operation

The Model 81*i* Mercury (Hg) Calibrator generates known concentrations of gas phase elemental Hg by combining the output flow of a temperature controlled, saturated Hg vapor source with a flow of Hg-free dilution air. The Model 81*i* is normally configured as one component of an integrated Hg Continuous Emission Monitoring System (CEMS). Thermo Fisher Scientific's Mercury Freedom™ System is comprised of a Hg analyzer (Model 80*i*), a Hg calibrator (Model 81*i*), a Hg probe controller (Model 82*i*), and a Hg probe (Model 83*i*), along with additional peripheral components, such as a zero air supply, umbilical, and instrument rack. However, the Model 81*i* is also available as a stand-alone calibrator.

The Model 81*i* can be configured to support three sets of ranges (81*i* Low Level, Standard, and High Level). The ranges allow the Model 81*i* to be used for a variety of applications, such as research, electric, utilities, and cement manufacturing. Refer to **Table 1–2** for specific range capabilities.

Table 1–1 shows the Model 81*i* solenoid valve status for the different calibrator modes. Use this table along with **Figure 1–1** when reading the principle of operation description that follows. Note that a valve status shown as ON describes a valve that is energized, or in the Normally Closed (NC) state. A valve status shown as OFF describes a valve that is de-energized, or in the Normally Open (NO) state.

Table 1–1. Valve Mode Status

Solenoid ID	Standby	Instrument Zero	Instrument Span	Orifice Zero	Orifice Span	System Zero	System Span
Valve 1	ON	ON	ON	ON	ON	ON	ON
Valve 2	OFF	OFF	ON	OFF	ON	OFF	ON
Valve 3	OFF	OFF	ON	OFF	ON	OFF	ON
Valve 4	OFF	OFF	OFF	ON	OFF	ON	OFF
Valve 5	OFF	OFF	ON	ON	OFF	ON	OFF
Orifice Valve	OFF	OFF	OFF	ON	ON	OFF	OFF
Spike Valve	OFF	OFF	OFF	OFF	OFF	ON	ON

Clean, dry, Hg-free pressurized air (30-40 psig) feeds both a high flow (0–20 slpm) dilution air mass flow controller (MFC) and the Hg source MFC (Low 0–5, Standard 0–50, High 0–100 sccm). See **Figure 1–1**.

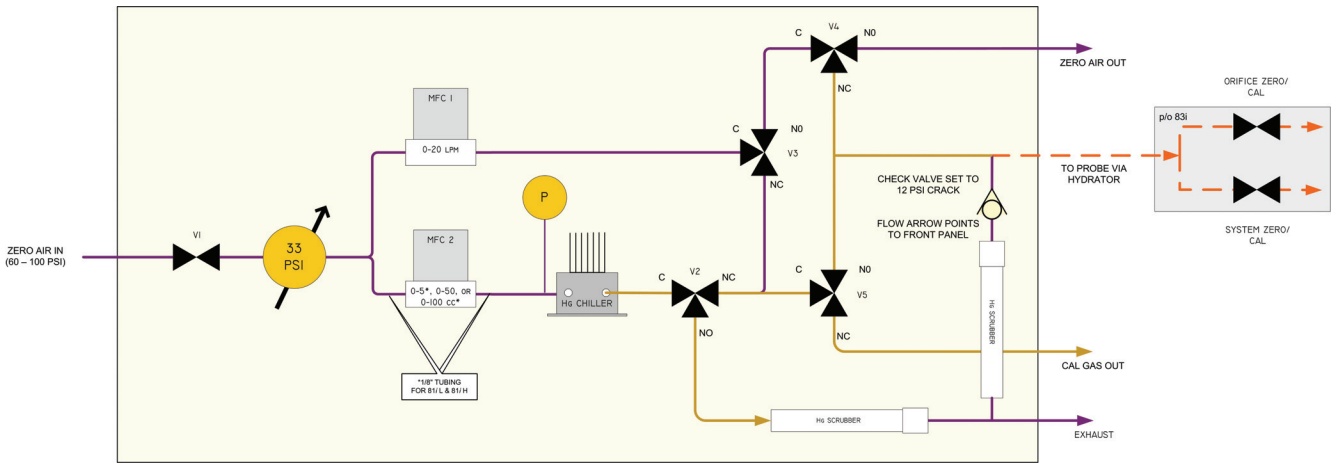


Figure 1–1. Model 81*i* Flow Schematic

The output of the low flow MFC is passed through a coiled, Teflon tube encapsulated Hg source, which is maintained at a precisely known temperature and pressure. The Hg saturated flow is directed by Valve V2 (NC) to combine with dilution flow from Valve V3 (NC) providing calibration gas to either:

- A Hg analyzer via Valve V5 (NC)
- Or the Hg probe via Valve V5 (NO)

Calibration gas to the probe is sent directly to the critical orifice or to the spike port (for inertial filter flooding) by switching the appropriate probe valve (orifice or spike).

The check valve is used to keep the orifice (located in the probe) from being over pressurized during an orifice zero or calibration.

Excess flow (atmospheric dump) during a probe calibration is routed through an internal Hg scrubber prior to being sent to exhaust. Also during any zero air mode (instrument, orifice, or system), the Hg saturated flow is directed via V2 (NO) through a Hg scrubber prior to being sent to exhaust.

Specifications

Table 1–2. Model 81*i* Specifications

Specification	Description
Hg output	Low 0.2 to 20 µg/m^3 Standard 1 to 50 µg/m^3 High 20 to 300 µg/m^3
Sample flow rate	3.0 to 20 LPM max. (function of Hg setpoint)
Operating temperature	20–30 °C (may be safely operated in the range of 0–45 °C) in non-condensing environments. Performance specifications based on operation within 20-30 °C range.
Power requirements	105 VAC/125 VAC @ 50/60 Hz, 3 amps
Physical dimensions	16.75″ (W) X 8.62″ (H) X 23″ (D)
Weight	Approximately 43 lbs.
Analog outputs	6 voltage outputs; 0–100 mV, 1, 5, 10 V (user selectable), 5% of full-scale over/under range (user selectable), 12-bit resolution, measurement output user selectable per channel
Digital outputs	1 power fail relay Form C, 10 digital relays Form A, user selectable alarm output, relay logic, 100 mA @ 200 VDC
Digital inputs	16 digital inputs, user select programmable, TTL level, pulled high
Serial ports	1 RS-232 or RS-485 with two connectors, baud rate 1200–115200, data bits, parity, and stop bits, protocols: C-Link, MODBUS, and streaming data (all user selectable)

Chapter 2
Installation

Installing the Model 81*i* includes the following recommendations and procedures:

Lifting

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

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

Unpacking and Inspection

The Model 81*i* is shipped complete in one container. If there is obvious damage to the shipping container when you receive the instrument, notify the carrier immediately and hold for inspection. The carrier is responsible for any damage incurred during shipment.

Use the following procedure to unpack and inspect the instrument.

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

2. Remove the cover to expose the internal components.

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

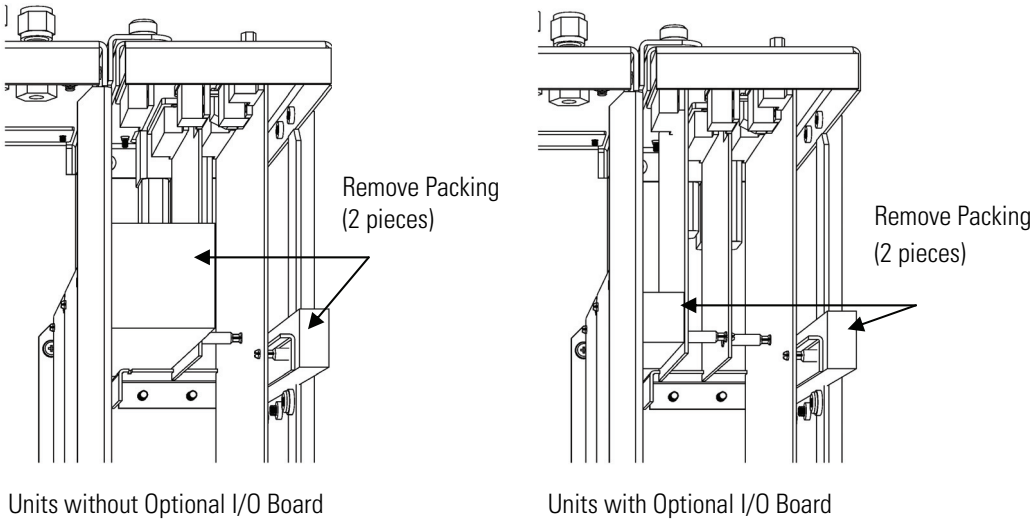


Figure 2–1. Remove the Packing Material

4. Check for possible damage during shipment.

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

6. Re-install the cover.

Setup

The procedure for setting up the Model 81*i* will vary depending on the particular configuration where the Model 81*i* is used, for example:

- in an integrated Hg Continuous Emission Monitoring System (CEMS), such as the Thermo Fisher Scientific Mercury Freedom System, or a Hg CEMS from another source
- as a stand-alone calibrator used with a Thermo Fisher Scientific Model 80*i* Hg Analyzer, or as a stand-alone calibrator used with a Hg analyzer from another source.

If the Model 81*i* is used with a Hg analyzer from another source, refer to the setup procedure in the manual from that source.

If the Model 81*i* is used in a Mercury Freedom System CEMS or as a stand-alone calibrator used with a Model 80*i*, use the procedure that follows.

WARNING The Model 81*i* is supplied with a three-wire grounding cord. Under no circumstances should this grounding system be defeated. ▲

1. When the Model 81*i* will be interconnected with a Model 80*i*, always make the connections to the Model 80*i* first, and then make the connections to the Model 81*i*. Refer to "Installation" in the "Model 80*i* Instruction Manual."

2. Connect the EXHAUST bulkhead connector on the Model 81*i* rear panel (**Figure 2–2** and **Figure 2–3**) to a vent suitable for mercury. The exhaust line should be restriction free and less than 10 feet long.

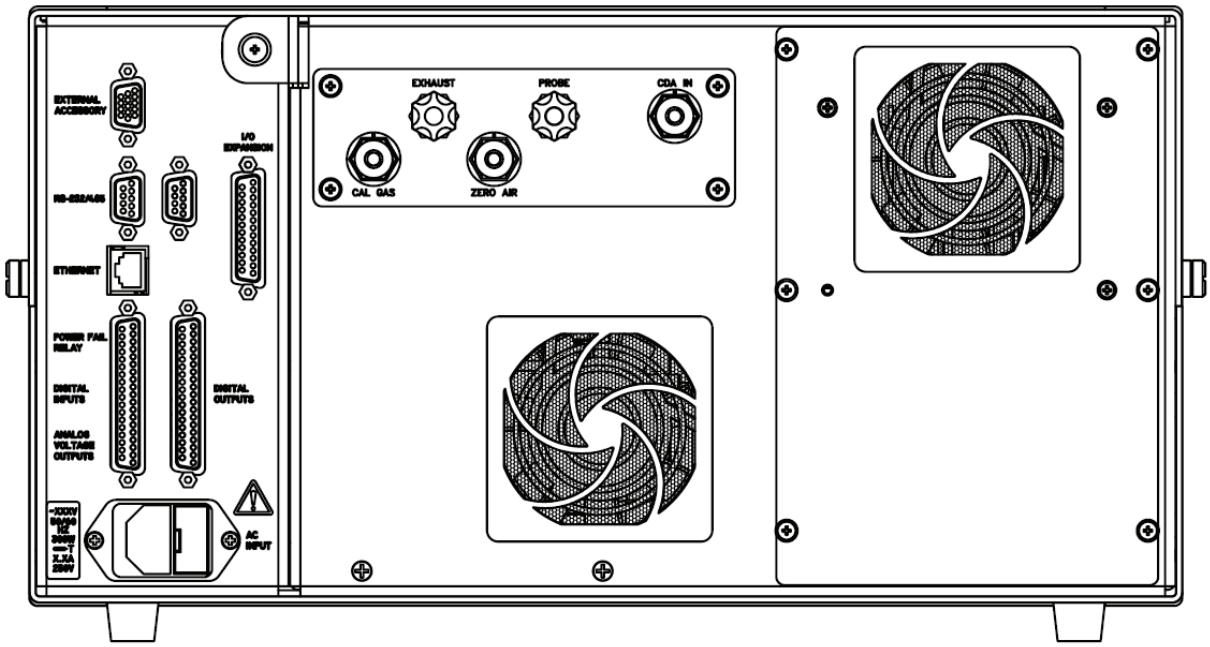


Figure 2–2. Model 81*i* Rear Panel

Note All tubing should be constructed of PFA Teflon® with an OD of 1/4-inch and a minimum ID of 1/8-inch, except the 3/8-inch OD probe line. ▲

3. Connect 40-90 PSIG dry, conditioned air to the Model 81*i* CDA IN bulkhead connector (**Figure 2–3**).

Note If you set up the Model 80*i* as instructed in Step 1 of this procedure, the Model 80*i* SPAN bulkhead is already connected to the Model 81*i* CAL

GAS bulkhead, and the Model 80*i* ZERO bulkhead is already connected to the Model 81*i* ZERO AIR bulkhead. ▲

4. Connect a suitable recording device to the rear panel connector. See "Instrument Controls > I/O Configuration" in the "Operation" chapter and the "Servicing" chapter for information about the rear panel pin-outs.

5. Plug the instrument into an electrical outlet of the appropriate voltage and frequency.

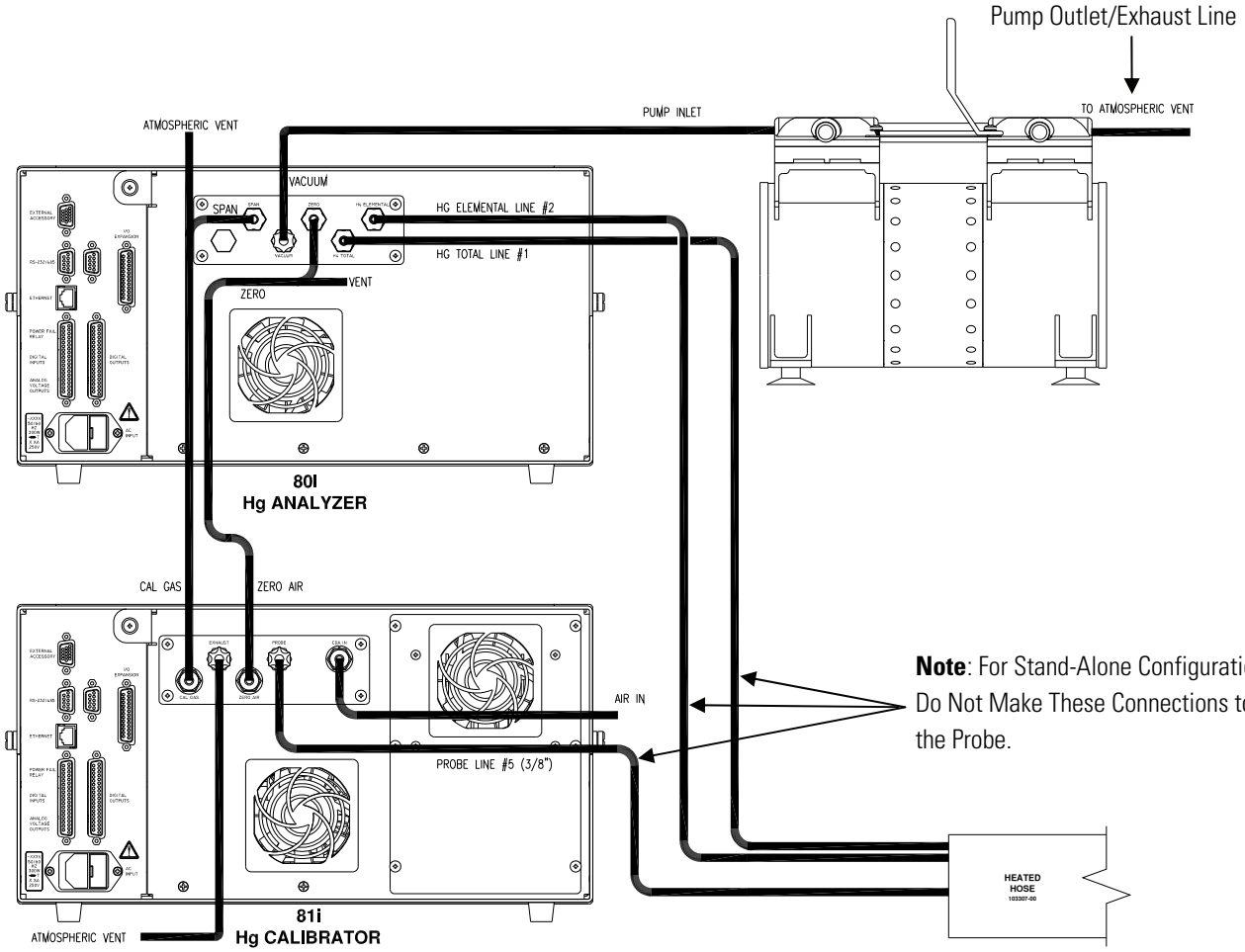


Figure 2–3. 80*i* and 81*i* Plumbing Connections

Connecting External Devices

Several components are available for connecting external devices to iSeries instruments.

These connection options include:

- Individual terminal board PCB assemblies
- 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" in the "Servicing" chapter.

Terminal Board PCB Assemblies

The terminal board PCB assembly is a circuit board with a D-Sub connector on one side and a series of screw terminals on the other. 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 iSeries instruments:

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

I/O Terminal Board

Figure 2–4 shows the recommended method for attaching the cable 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 this terminal board, if more I/O is desired, an alternative means of connection is required. ▲

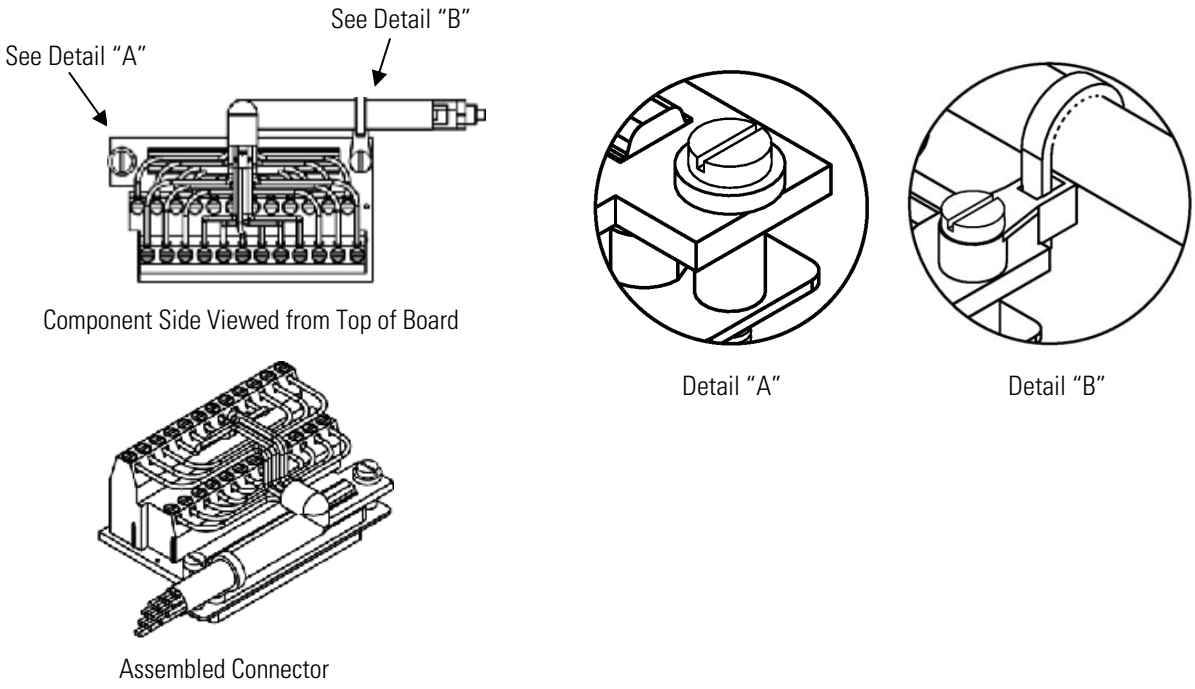


Figure 2–4. I/O Terminal Board Views

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

Pin	Signal Description	Pin	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

D/O Terminal Board

Figure 2–5 shows the recommended method for attaching the cable to the terminal board using the included tie-down and spacer. **Table 2–2** identifies the connector pins and associated signals.

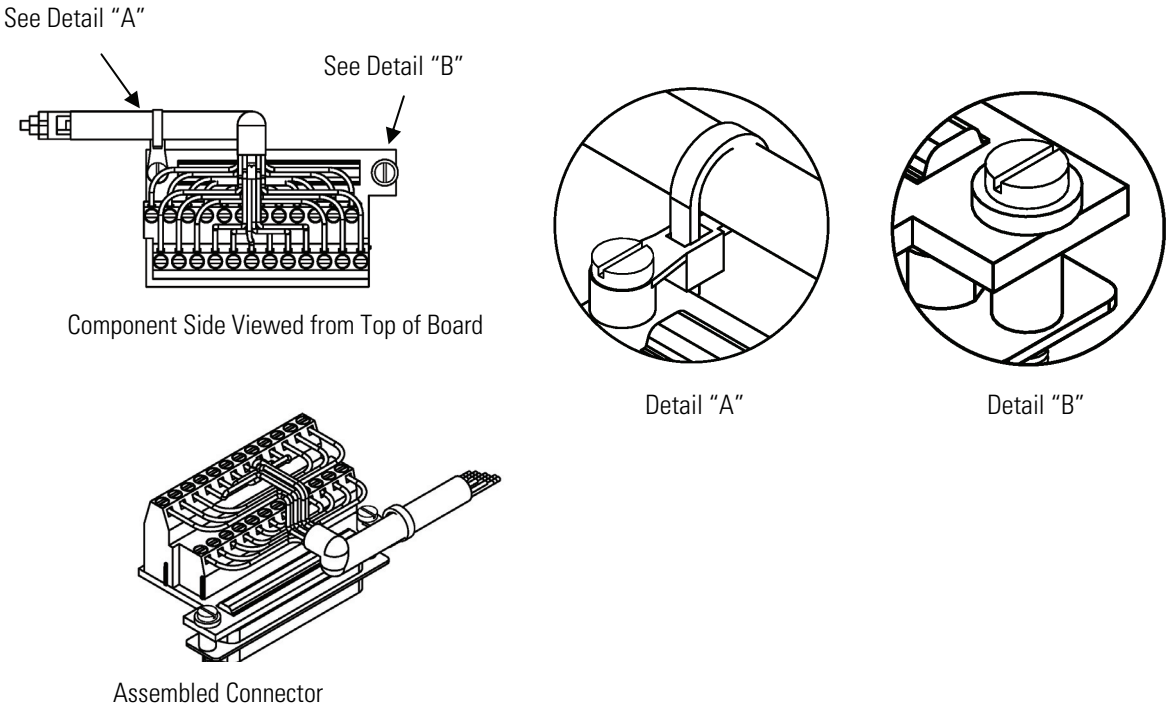


Figure 2–5. D/O Terminal Board Views

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

Pin	Signal Description	Pin	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	Solenoid_Drive_Output1
10	Relay5_ContactB	22	+24V
11	Relay6_ContactA	23	Solenoid_Drive_Output2

Pin	Signal Description	Pin	Signal Description
12	Relay6_ContactB	24	+24V

25-Pin Terminal Board

The 25-pin terminal board is included with the I/O Expansion Board.

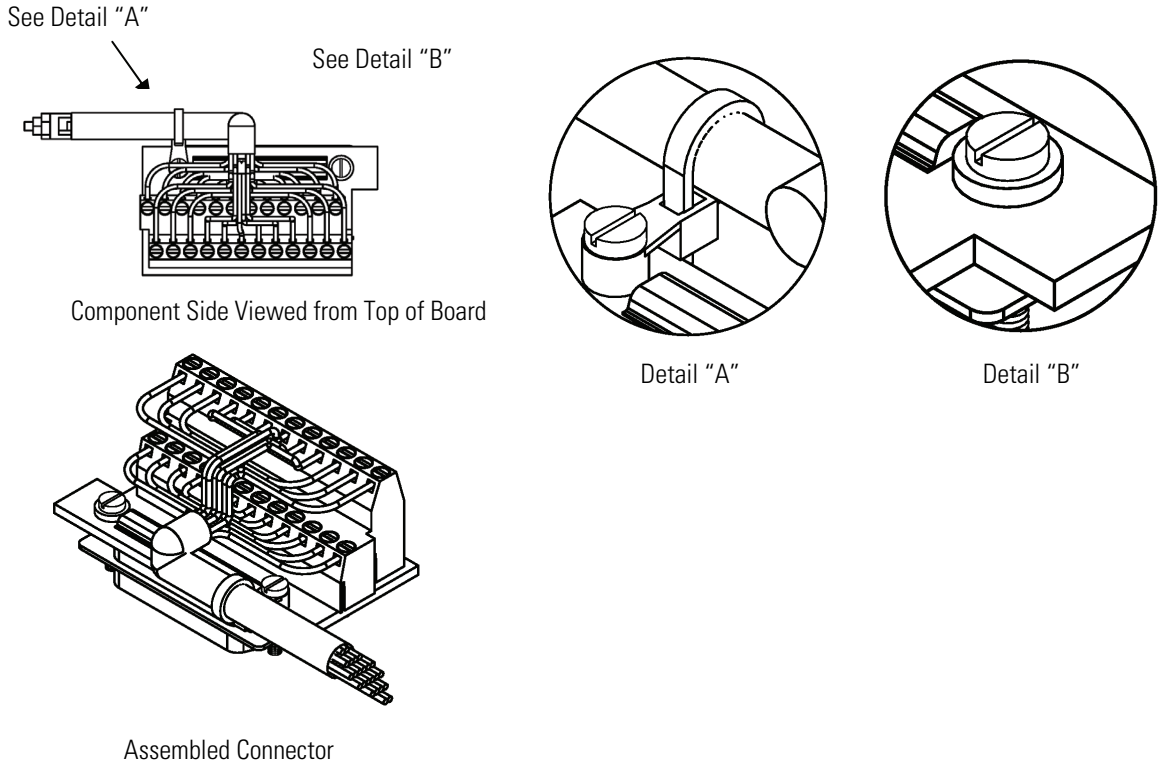


Figure 2–6. 25-Pin Terminal Board Views

Table 2–3. 25-Pin Terminal Board Pin Descriptions

Pin	Signal Description	Pin	Signal Description
1	IOut1	13	Analog_In1
2	GND_ISO	14	Analog_In2
3	IOut2	15	Analog_In3
4	GND_ISO	16	GNDD
5	IOut3	17	Analog_In4
6	GND_ISO	18	Analog_In5
7	IOut4	19	Analog_In6
8	GND_ISO	20	GNDD
9	IOut5	21	Analog_In7
10	GND_ISO	22	Analog_In8

Pin	Signal Description	Pin	Signal Description
11	IOut6	23	GNDD
12	GND_ISO	24	GNDD

Startup

The Model 81*i* is calibrated to NIST standards at the factory and should not require calibration upon startup.

Note The correct startup sequence is to start the 82*i*, the 81*i*, and the 80*i*. If the 81*i* and the 80*i* are ON, turn them OFF before starting the 82*i*. ▲

Use the following procedure when starting the instrument.

1. Turn the power ON.

2. Allow the instrument to stabilize overnight.

3. Set instrument parameters to appropriate settings. For more information about instrument parameters, see the “Operation” chapter.

Chapter 3
Operation

This chapter describes the front panel display, front panel pushbuttons, and menu-driven software. 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.

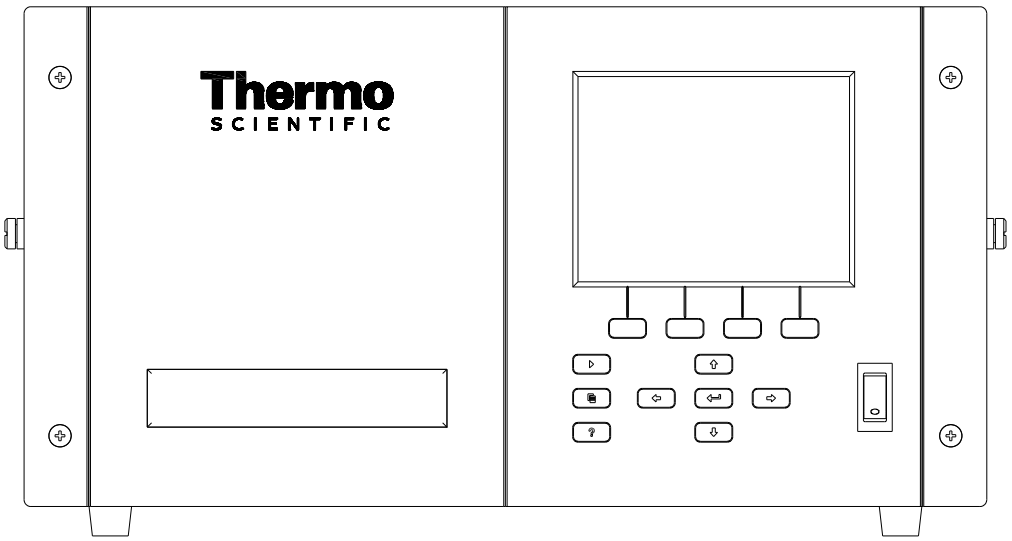


Figure 3–1. Front Panel Display

CAUTION If the LCD panel breaks, do not to 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 3–1** shows the front panel pushbuttons.

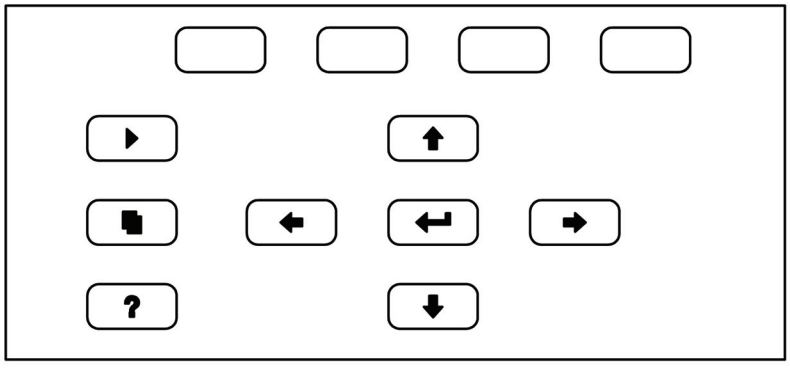


Figure 3–2. Front Panel Pushbuttons

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 Hg OUT concentration and Hg TEMP.
[▪] = 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. To exit a help screen, press [▪] or [?] to return to the previous screen, or [▶] to return to the Run 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 the lower part of the display to identify their function at any given moment. The function of the soft keys allows immediate access to the menu structure and most often used menus and screens. They are located directly underneath the display. As the keys' functions change, this is indicated by user-defined labels in the lower part of the display, so that the user knows what the keys are to be used for.

To change a soft key, place the menu cursor ">" on the item of the selected menu or screen you wish to set. Press [→] followed by the selected soft key within 1 second of pressing the right-arrow key. The edit soft key prompt will be displayed for configuration for 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 when entering right-arrow-soft key combinations. All items under the Service menu (including the menu itself) cannot be assigned soft keys. ▲

Software Overview

The Model 81*i* utilizes the menu-driven software 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. It displays the Hg OUT concentration and Hg TEMP depending on the gas mode. 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.

Note The values shown in the displays in this document are FOR REFERENCE ONLY and should not be used for operating an instrument. ▲

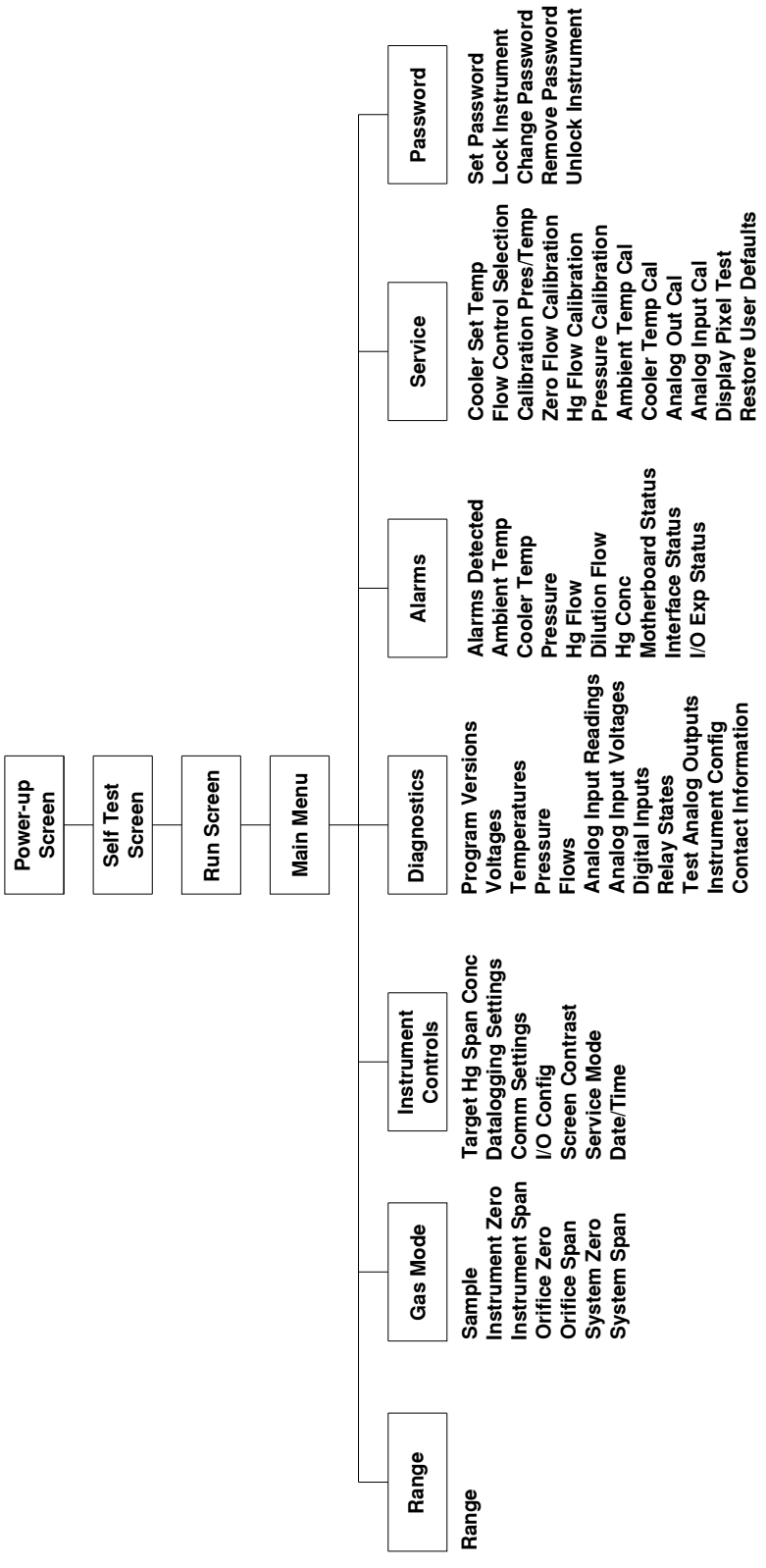


Figure 3–3. Flowchart of Menu-Driven Software

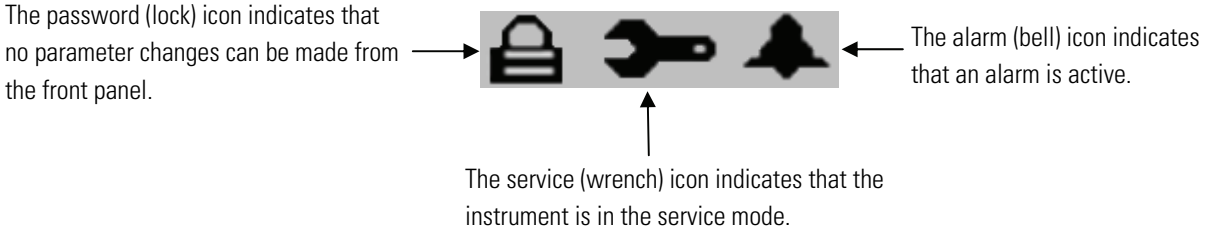
Power-Up Screen

The Power-up screen is displayed on power up of the Model 81*i*. The Self-Test screen is displayed while the internal components are warming up and diagnostic checks are performed.

Run Screen

The Run screen displays the Hg OUT concentration and the Hg TEMP. The title bar indicates the current gas mode and the status bar displays the gas mode, time, the password (lock) icon, service (wrench) icon, alarm (bell) icon. The word "SAMPLE" on the bottom left of the display indicates the instrument is in "SAMPLE" mode. For more information about the gas modes, see "Gas Modes" in this chapter.

Status Bar Icons



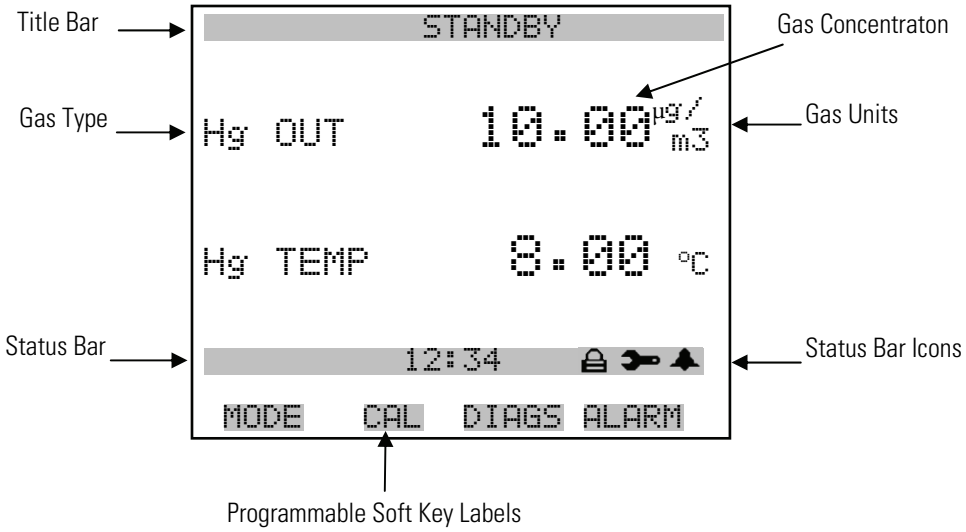
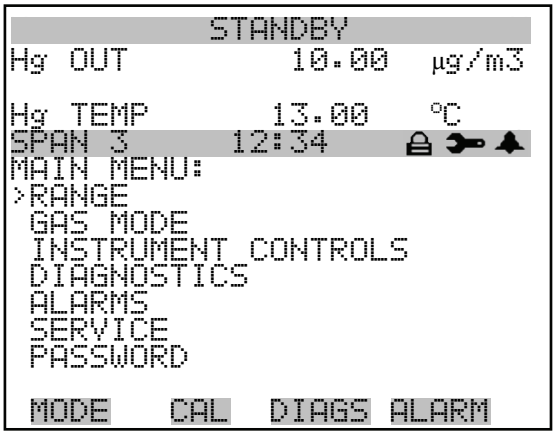


Figure 3–4. Run Screen Description

Main Menu

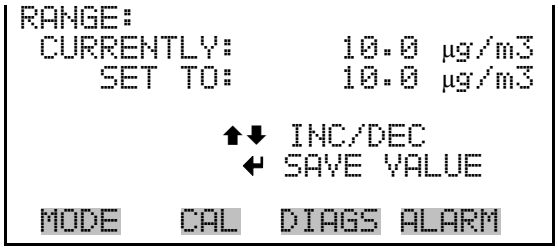
The Main Menu contains a number of submenus. Instrument parameters and settings can be read and modified within the submenus according to their function. The concentration appears above the Main Menu and submenus in every screen. The Service menu is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" later in this chapter.

- Press [ ] to access the Main Menu.
- Use [ ] and [ ] to move the cursor up and down.
- Press [ ] to select a choice.
- Press [ ] to return to the Main Menu or [ ] to return to the Run screen.



Range

The range screen allows the operator to set the 81*i* Calibrator to the span range specific to each site. Each span range allows eight settable span concentrations, all using a fixed dilution flow. When the range changes, the fixed dilution flow changes also.



Gas Mode

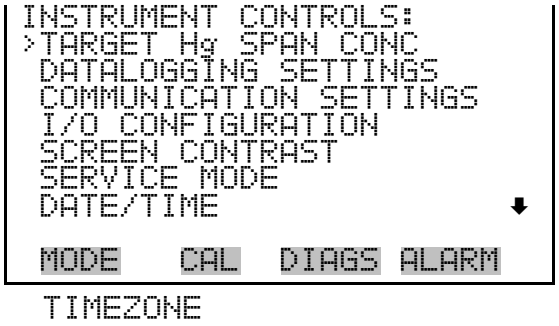
The Gas Mode screen allows the operator to set the operational mode of the calibrator. The current mode is shown by "<--" after it.

- In the Main Menu, choose **Gas Mode**.

Instrument Controls Menu

The Instrument Controls menu contains a number of items. The software controls listed in this menu enable control of the listed instrument functions.

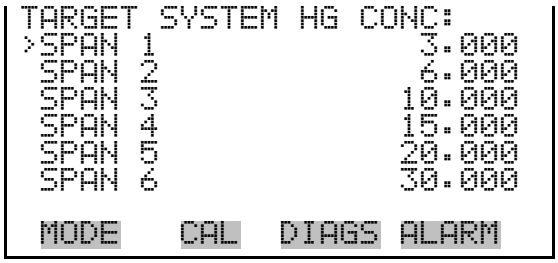
- In the Main Menu, choose **Instrument Controls**.



Target Hg Span Concentration

The Target Hg Span Concentration screen is used to set the span concentration of the calibrator when it is in instrument span mode.

- In the Main Menu, choose Instrument Controls > **Target Hg Span Conc**.



Datalogging Settings

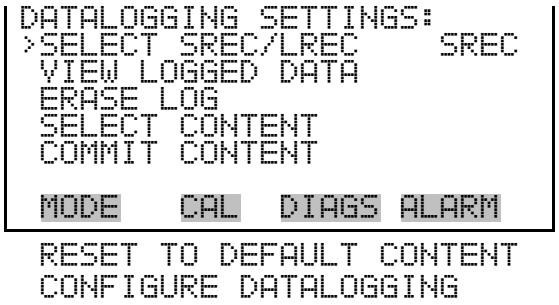
The Datalogging Settings menu allows the user flexibility in how data is stored and recorded.

The *i*Series instruments include a built-in data logging capability as a standard feature. The operator is allowed to create two different types of records, which for historical reasons are named lrecs 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 can be interleaved. For example, an srec containing just the current concentration level could be generated every five minutes while an lrec containing a full set of diagnostic data could be generated once every hour.

The instrument's computer system includes three megabytes of flash memory which is enough to store a full lrec containing 32 data items and a full srec containing 32 items once each minute for a week (>20,000 total records). If logging is limited to the minimum content of date, time, concentration and error flags, the analyzer can store data once each minute for four months (>190,000 records).

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



Select SREC/LREC

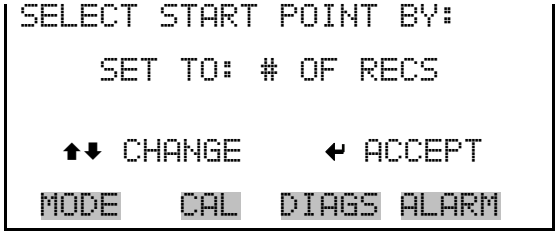
The Select SREC/LREC screen is used to select the log record type for other operations in this menu.

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

View Logged Data

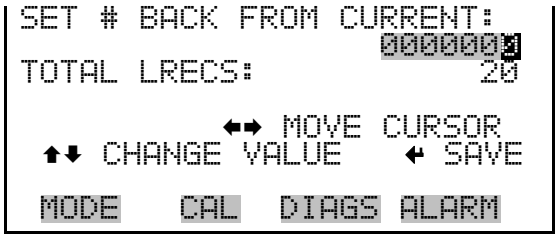
The View Logged Data screen is used to select the start point to view the logged data by number of records or by date and time. Note that both types of records cannot be viewed at the same time, only the selected record type.

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

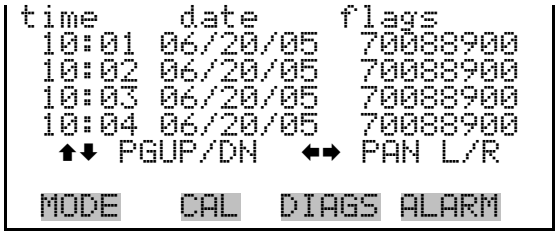


Number of Records

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

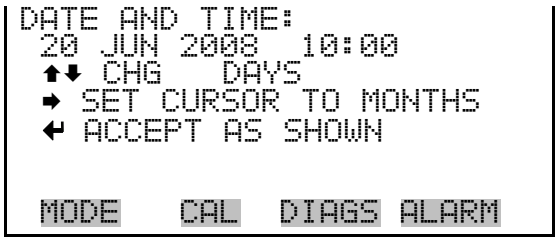


The Record Display screen (read only) displays the selected records. Use the UP and DOWN arrow keys to scroll through the records and the LEFT and RIGHT arrow keys to view the data items for each record.

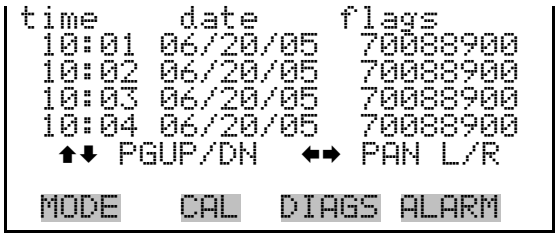


Date and Time

The Date and Time screen is used to set a start date and time for which to view logged data. For example, if "20 JUN 2008 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 JUN 2008 10:01".



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.



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**.

Select Content

The Select Content menu displays a list of 32 record fields to use and a submenu list of the analog output signal group choices to choose from. Choices are Concentrations, Other Measurements, and Analog Inputs. This is 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, as the format of the stored data is changed.

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

Concentrations

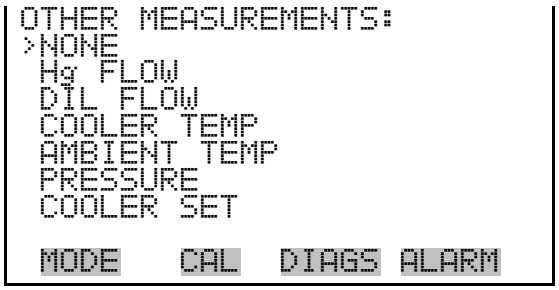
The Concentrations screen allows the user to select the output signal that is tied to the selected field item. The selected item is shown by "<--" after it. Note that at this point, pressing [↵] indicates that these are proposed changes as opposed to implemented changes. To change the selected record 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**.

Other Measurements

The Other Measurements screen allows the user to select the output signal that is tied to the selected field item. 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.

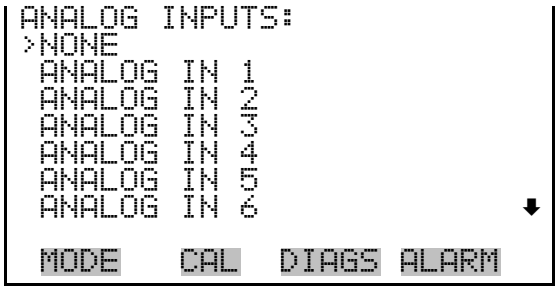
- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > Select Field > **Other Measurements**.



Analog Inputs

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

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



Commit Content

The Commit Content screen is used to save the selected output signal that is tied to the selected field item. If no changes have been made "NO CHANGES TO RECORD LIST!" will appear. For more information about selecting the analog output signal group choices, see "Select Content" above.

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

Reset to Default Content

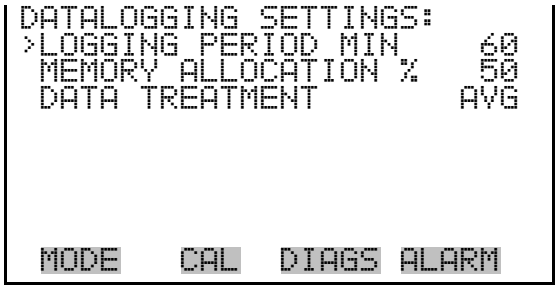
The Reset to Default Content screen is used to reset all of the datalogging field items to default values for the selected record type. For more information, about selecting the content of logged data fields, see "Select Content" described previously.

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

Configure Datalogging

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

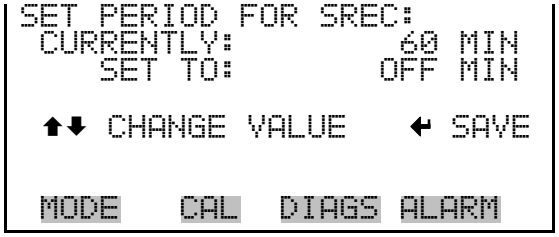
- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Configure Datalogging**.



Logging Period Min

The Logging Period Min screen is used to select the logging period in minutes for the record format (srec or lrec). List of choices include: OFF, 1, 5, 15, 30, and 60 minutes (default).

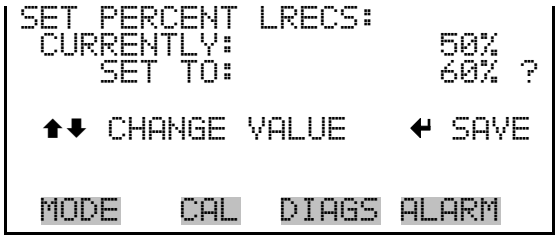
- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Logging Period Min**.



Memory Allocation Percent

The Memory Allocation Percent screen is used to select the percentage of each record type for both short records and long records. Percentages between 0 and 100% are available in increments of 10. Changing this value results in log erasure for both short records and long records.

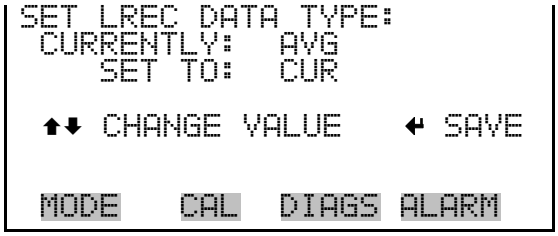
- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Memory Allocation %**.



Data Treatment

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

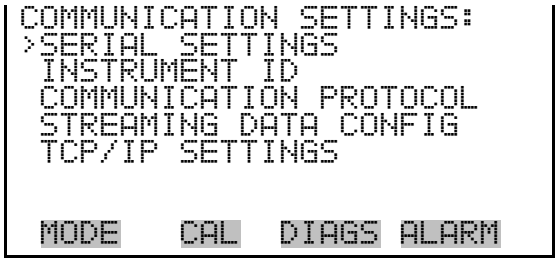
In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Data Treatment**.



Communication Settings

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

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



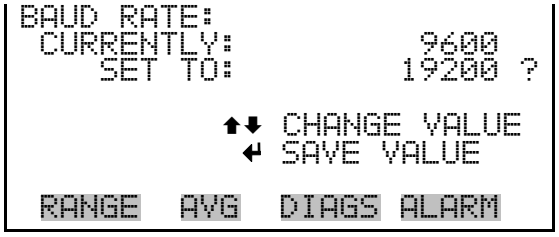
Serial Settings

The Serial Settings menu is used for serial communications control and configuration. In the Main Menu, choose Instrument Controls > Communication Settings > **Serial Settings**.

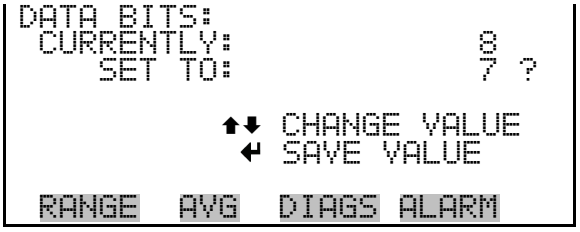
Baud Rate

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

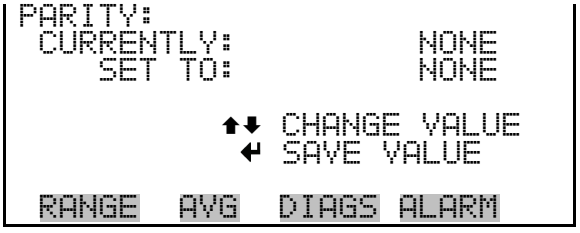
- In the Main Menu, choose Instrument Controls > Communication Settings > **Baud Rate**.



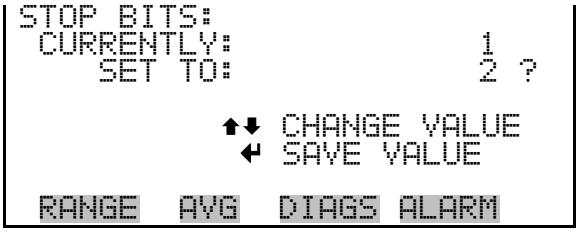
Data Bits The Data Bits screen is used to set the number of serial data bits. Selections of 7 or 8 are available (defaults to 8).



Parity The Parity screen is used to select the parity bit for the serial port. Selections of NONE, EVEN, or ODD are available (defaults to NONE).



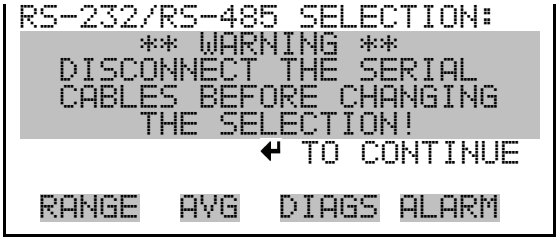
Stop Bits The Stop Bits screen is used to select the number of stop bits for the serial port. Selections of 1 and 2 are available (defaults to 1).



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.

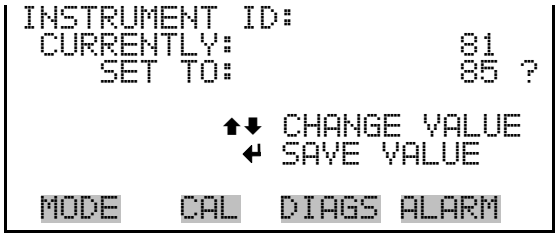
Equipment Damage Disconnect the serial cable before changing RS-232 and RS-485 selection to prevent damage to any equipment currently connected to the instrument. ▲



Instrument ID

The Instrument ID screen allows the operator to edit the instrument ID. The ID is used to identify the instrument when using the C-Link or MODBUS protocols to control the instrument or collect data. It may be necessary to edit the ID number if two or more of the same instruments are connected to one computer. Valid Instrument ID numbers are from 0 to 127. The Model 81*i* has a default Instrument ID of 81. For more information about the Instrument ID, see Appendix B "C-Link Protocol Commands" or Appendix C "MODBUS Protocol".

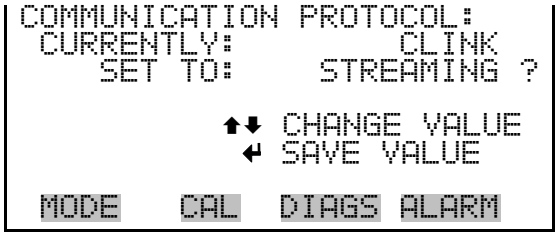
- In the Main Menu, choose Instrument Controls > Communication Settings > **Instrument ID**.



Communication Protocol

The Communication Protocol screen is used to change the instrument communication protocol for serial communications.

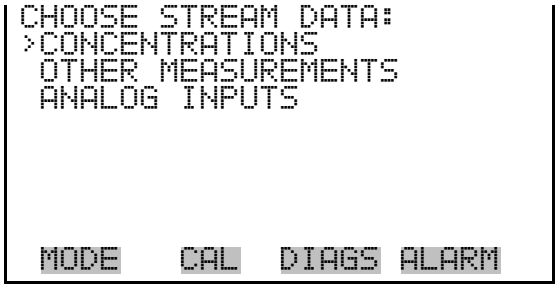
- In the Main Menu, choose Instrument Controls > Communication Settings > **Communication Protocol**.



Streaming Data Configuration

The Streaming Data Configuration menu is used to allow for configuration of the 8 streaming data output items, streaming interval, current data format, and current timestamp setting. The Choose Item Signal submenu displays a list of the analog output signal group choices to choose from. Choices are Concentrations, Other Measurements, and Analog Inputs.

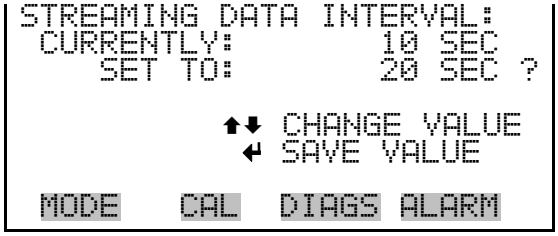
- In the Main Menu, choose Instrument Controls > Communication Settings > **Streaming Data Config**.



Streaming Data Interval

The Streaming Data Interval screen is used to adjust the streaming data interval. 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**.



Concentrations

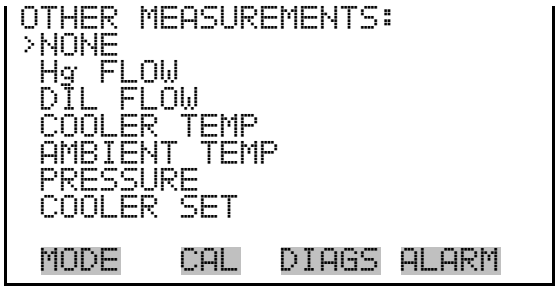
The Concentrations screen allows the user to select the output signal that is tied to the selected streaming data item. The selected item is shown by "<--" after it.

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

Other Measurements

The Other Measurements screen allows the user to select the output signal that is tied to the selected streaming data item. The selected item is shown by "<--" after it.

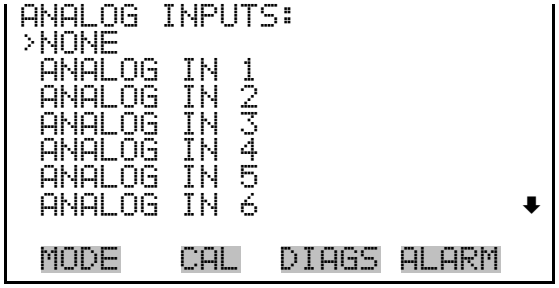
- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > Select Item > **Other Measurements**.



Analog Inputs

The Analog Inputs screen allows the user to select the analog input signal (none or analog inputs 1-8) that is tied to the selected streaming data item. The selected item is shown by "<--" after it.

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



TCP/IP Settings

The TCP/IP Settings menu is used for defining TCP/IP settings

Note The instrument power must be cycled after this parameter has been changed for the change to take effect. ▲

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

Use DHCP

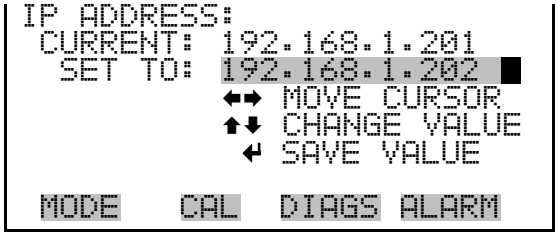
The Use DHCP screen is used to specify whether to use DHCP or not.

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

IP Address

The IP Address screen is used to edit the IP address. The IP address can only be changed when DHCP is on. For more information on DHCP, see "Use DHCP" above.

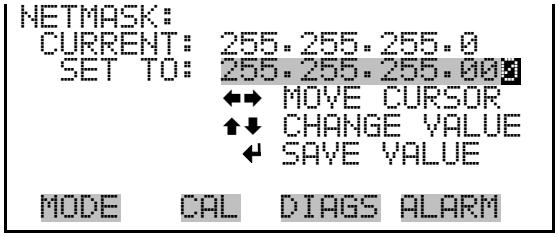
- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **IP Address**.



Netmask

The Netmask screen is used to edit the netmask.

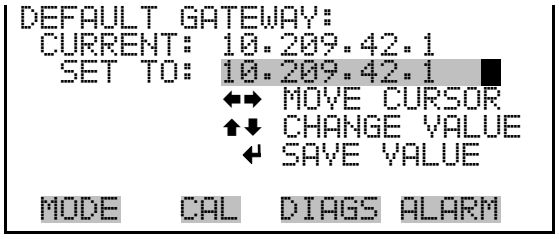
- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Netmask**.



Default Gateway

The Default Gateway screen is used to edit the gateway address.

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



Host Name

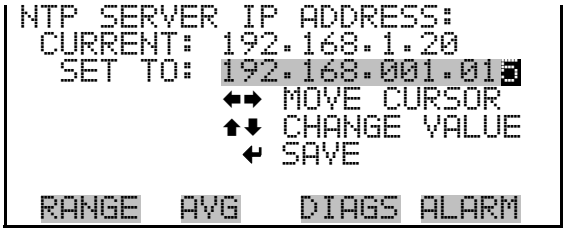
The Host Name screen is used to edit the host name. When DHCP is enabled, this name is reported to the DHCP server.

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

Network Time Protocol (NTP) 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 Server**.

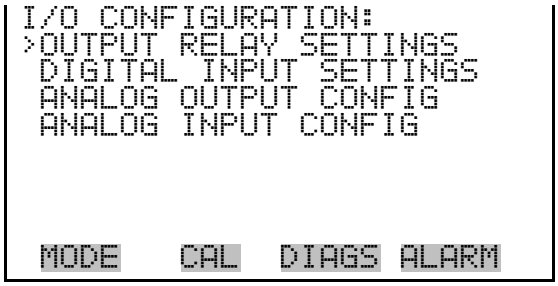


I/O Configuration

The I/O Configuration menu is used to configure the instrument's I/O system.

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

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



Output Relay Settings

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

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

Logic State

The Logic State screen is used to change the I/O relay to either normally open or normally closed.

Press ↵ to toggle and set the logic state open or closed.

Instrument State

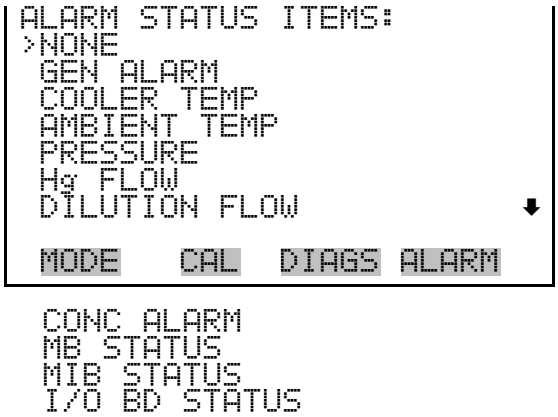
The Instrument State menu allows the user to select the instrument state that is tied to the selected relay output. A menu lists signal types of either alarm or non-alarm to choose from.

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

Alarms

The Alarms status screen allows the user to select the alarm status for the selected relay output. The selected item is shown by "<--" after it.

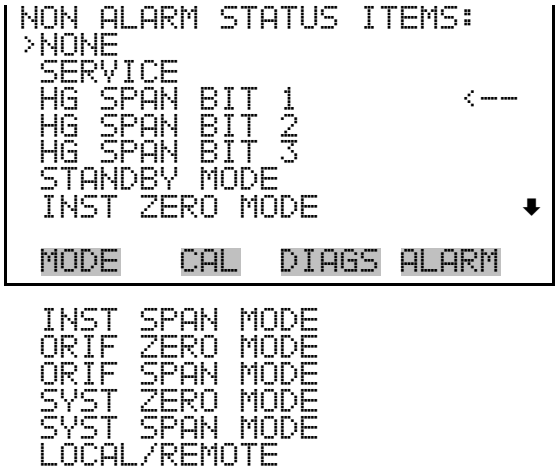
- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Settings > Select Relay > Instrument State > **Alarms**.



Non-Alarm

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

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



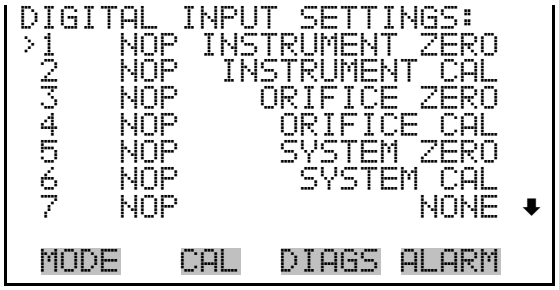
Digital Input Settings

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 this terminal board, if more I/O is desired, an alternative means of connection is required. ▲

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



Logic State

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

- Press [↵] to toggle and set the logic state open or closed.

Instrument Action

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

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

```
CHOOSE ACTION:
>NONE
 INSTRUMENT ZERO      <--
 INSTRUMENT CAL
 ORIFICE ZERO
 ORIFICE CAL
 SYSTEM ZERO
 SYSTEM CAL                ⬇

 MODE   CAL  DIAGS ALARM
```

```
 STANDBY
 AOUTS TO ZERO
 HG SPAN BIT 1
 HG SPAN BIT 2
 HG SPAN BIT 3
 AOUTS TO FS
```

Analog Output Configuration

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, voltage channels 1-6, and current channels 1-6. Configuration choices include selecting range, setting minimum/maximum values, and choosing signal to output.

- 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
 VOLTAGE CHANNEL 3
 VOLTAGE CHANNEL 4         ⬇

 MODE   CAL  DIAGS ALARM
```

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




 MODE   CAL  DIAGS ALARM
```

Allow Over/Under Range

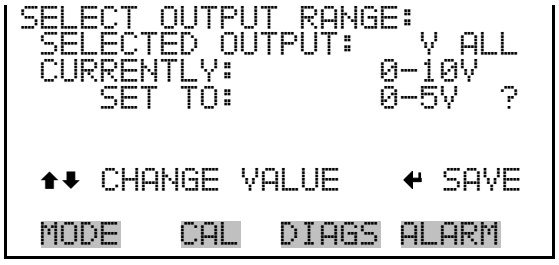
The Allow Over/Under Range screen, in Analog Output Configuration under I/O Configuration, is used to select whether or not the analog outputs are allowed to exceed the maximum selected value of 100 mV, 1 V, 5 V, 10 V, or 20 mA or the minimum selected value of 0 V, 0 mA, or 4 mA. By default this parameter 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**.

Select Output Range

The Select Output 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, 0-10 V.

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



Minimum and Maximum Value

The Minimum Value screen is used to edit the zero (0) to full-scale (100) value in percentages for the selected analog output channel. See **Table 3–2** for a list of choices. The minimum and maximum output value screens function the same way. The example below 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**.

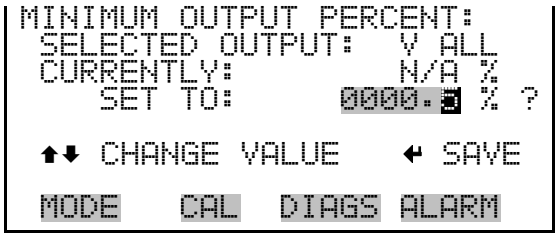


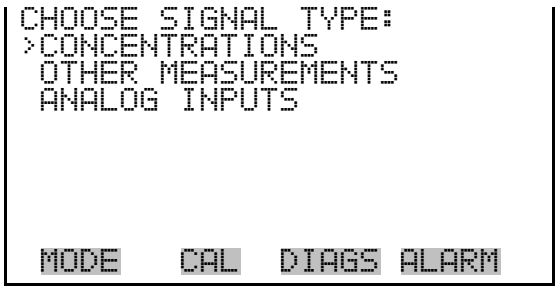
Table 3–2. Analog Output Zero to Full-Scale Table

Output	Zero % Value	Full-Scale 100% Value
Hg Conc	Zero (0)	Range Setting
Instrument Conc	Zero (0)	Range Setting
Probe Conc	Zero (0)	Range Setting
Hg Flow	User-set alarm min value	User-set alarm max value
Dilution Flow	User-set alarm min value	User-set alarm max value
Cooler Temperature	User-set alarm min value	User-set alarm max value
Ambient Temperature	User-set alarm min value	User-set alarm max value
Pressure	User-set alarm min value	User-set alarm max value
Cooler Set	User-set alarm min value	User-set alarm max value

Choose Signal to Output

The Choose Signal Type to Output screen displays a menu list of the analog output signal group choices. Group choices are Concentrations, Other Measurements, and Analog Inputs. This allows the user to select the output signal to the selected output channel. The Concentrations screen is shown below. See **Table 3–3** that follows 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**.



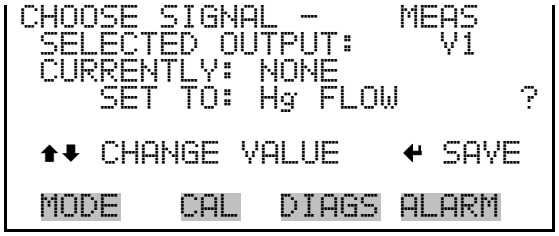


Table 3–3. Signal Type Group Choices

Concentrations	Other Measurements	Analog Inputs
None	None	None
Hg Conc	Hg Flow	Analog Input 1
Inst Hg Conc	Dilution Flow	Analog Input 2
Prob Hg Conc	Cooler Temperature	Analog Input 3
	Ambient Temperature	Analog Input 4
	Pressure	Analog Input 5
	Cooler Set	Analog Input 6
		Analog Input 7
		Analog Input 8

Analog Input Configuration

The Analog Input Configuration menu displays a list of the 8 analog input channels available for configuration. Configuration includes entering descriptor, units, decimal places, choice of 1-10 points in the table, and corresponding number of points selected.

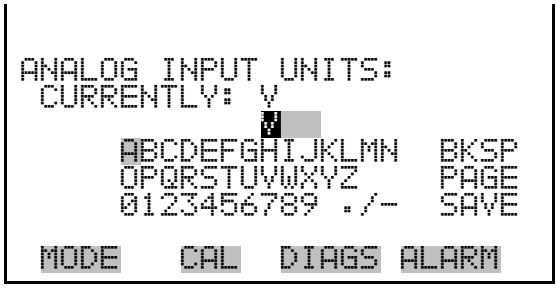
- In the Main Menu, choose Instrument Controls > I/O Configuration > **Analog Input Config**.

Descriptor The Descriptor screen allows the user to enter the descriptor 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**.

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**.



Decimal Places

The Decimal Places screen allows the user to select how many digits are displayed to the right of the decimal, 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**.

Number of Table Points

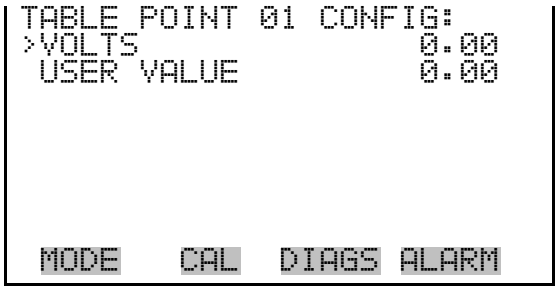
The Number of Table Points screen allows the user to select how many points are used in the analog input conversion table. The instrument uses linear interpolation between the points in this table to determine what the reading value is based on the analog input voltage. Each point in the table consists 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**.

Table Point

The Table Point menu 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 2-10**.

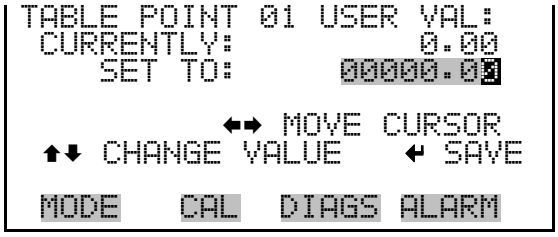


Volts The Volts screen allows the user to set the input voltage for the selected table point in the conversion table, from 0.00 to 10.50. The default table is a two-point table with point 1: 0.00 V = 000.0 U and point 2: 10.00 V = 10.0 U.

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

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.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > Select Channel > Select Point > **User Value**.



Screen Contrast

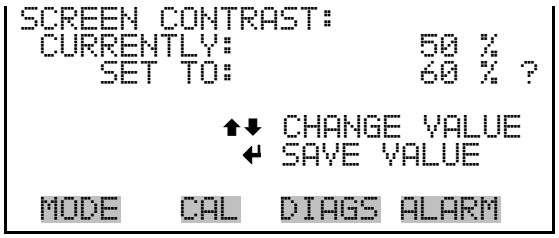
The Screen Contrast screen is used to change the contrast of the display. Values between 0 and 100% in increments of 5 are available. Changing the screen contrast may be necessary if the instrument is operated at extreme temperatures.

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

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

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

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



Service Mode

The Service Mode screen is used to turn the service mode on or off. The service mode locks out any remote actions and includes parameters and functions that are useful when making adjustments or diagnosing the Model 81*i*.

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

While in service mode the 81*i* will ignore commands issued to it by the Model 80*i*, when used in conjunction with the Hg Freedom System. ▲

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

Date/Time

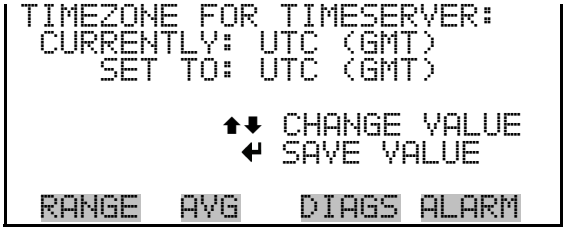
The Date/Time screen allows the user to view and change the system date and time (24-hour format). The internal clock is powered by its own battery when instrument power is off.

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

Timezone

The Timezone screen is used to set the timezone for the NTP time server. This should be set to the timezone that the instrument is located in. If the exact timezone is not shown in the list, it may be entered via the CLINK "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)

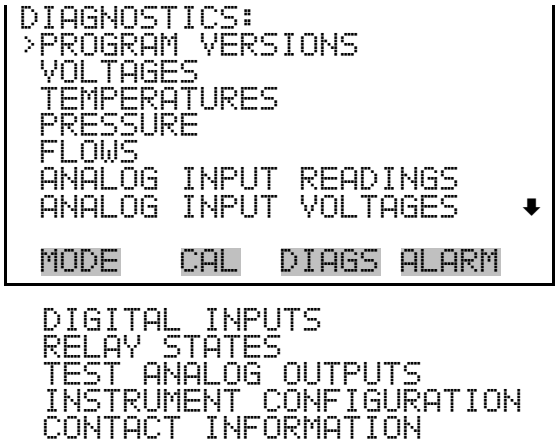
- In the Main Menu, choose Instrument Controls > **Timezone**.



Diagnostics Menu

The Diagnostics menu provides access to diagnostic information and functions. This menu is useful when troubleshooting the instrument.

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



Program Versions

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

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

Voltages

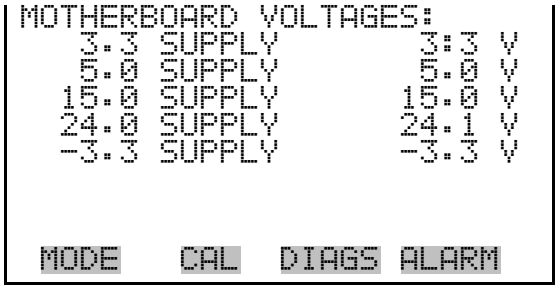
The Voltages menu displays the current diagnostic voltage readings. This screen enables the power supply to be quickly read for low or fluctuating voltages without having to use a voltage meter.

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

Motherboard Voltages

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

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



Interface Board

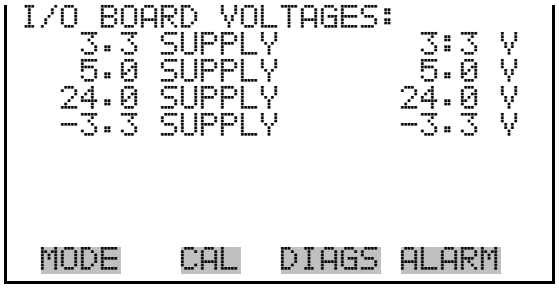
The Interface Board screen (read only) is used to display the current voltage readings on the interface board.

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

I/O Board Voltages

The I/O Board screen (read only) is used to display the current voltage readings on the I/O expansion board.

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



Temperatures

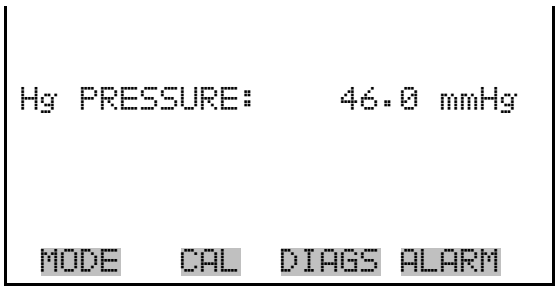
The Temperatures menu displays the current internal temperature and Hg Cooler temperature.

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

Pressure

The Pressure menu displays the current pressure of the source Hg in the cooler.

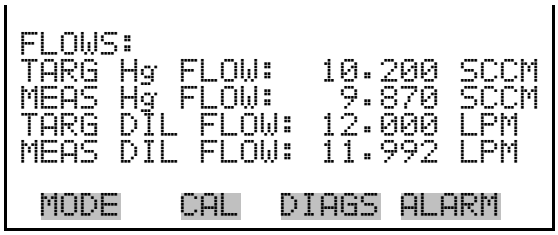
- In the Main Menu, choose Diagnostics > **Pressure**.



Flows

The Flows screen (read only) displays the current flow controller readings. The flow is measured by internal flow sensors. For more information, see Chapter 1, "Introduction."

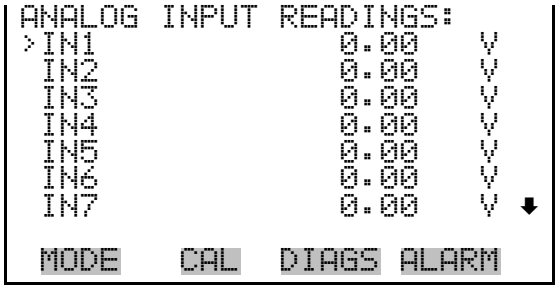
- In the Main Menu, choose Diagnostics > **Flow**.



Analog Input Readings

The Analog Input Readings screen (read only) displays the 8 current user-scaled analog readings.

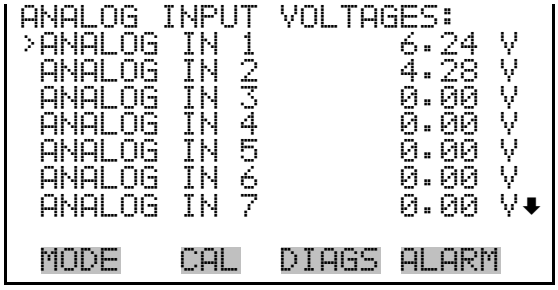
- In the Main Menu, choose Diagnostics > **Analog Input Readings**.



Analog Input Voltages

The Analog Input Voltages screen (read only) displays the 8 raw analog voltage readings.

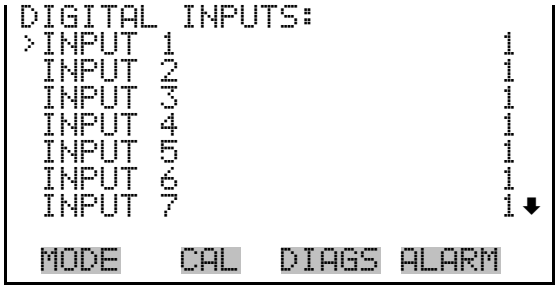
- In the Main Menu, choose Diagnostics > **Analog Input Voltages**.



Digital Inputs

The Digital Inputs screen (read only) displays the state of the 16 digital inputs. Pull-ups are provided on all the inputs, so if nothing is connected they will read (1), if an input is brought to ground, it will read (0).

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



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**.

Test Analog Outputs

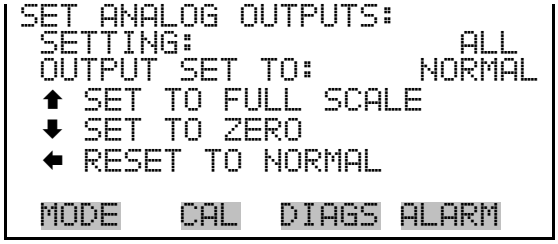
The Test Analog Outputs menu contains a number of digital to analog converter (DAC) calibration items. Channel choices include all analog outputs, 6 voltage channels, and 6 current channels.

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

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 normal operation. The example below shows the selected output state "ALL" is set to normal.

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



Instrument Configuration

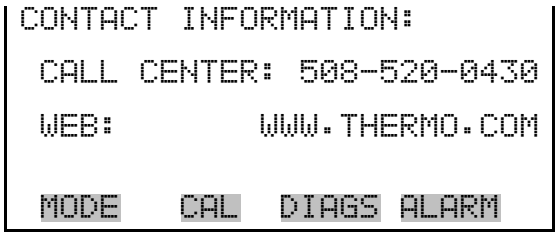
The Instrument Configuration screen displays information on the hardware configuration of the instrument. Dilution is a toggle item that changes between yes or no when selected.

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

Contact Information

The Contact Information screen displays the customer service information.

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



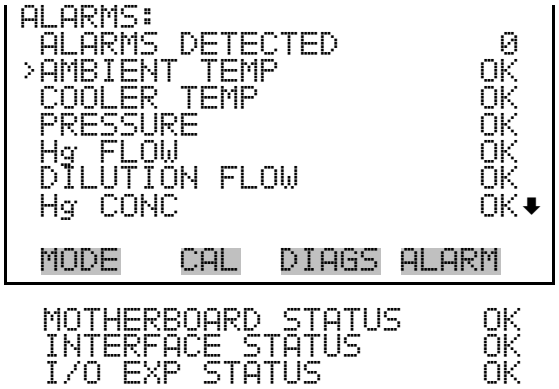
Alarms Menu

The Alarms menu displays a list of items that are monitored by the instrument. 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 number of alarms detected is displayed to indicate how many alarms have occurred. If no alarms are detected, the number zero is displayed.

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

The motherboard status, interface board status, and I/O Expansion board status (if installed) indicate that the power supplies are working and connections are successful. There are no setting screens for these alarms.

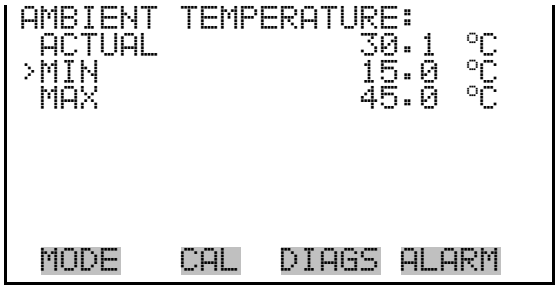
- In the Main Menu, choose **Alarms**.



Ambient Temperature

The Ambient Temperature screen displays the current ambient temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 8 to 47 °C. If the ambient temperature reading goes beyond either the minimum or maximum alarm limit, an alarm is activated. The word "ALARM" appears in the Run screen and in the Main Menu.

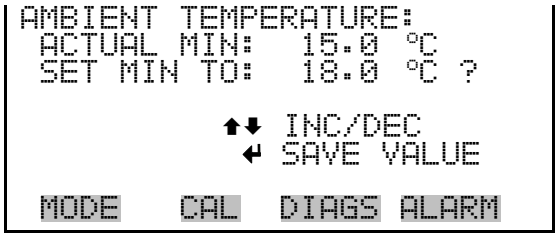
- In the Main Menu, choose Alarms > **Ambient Temp**.



Min and Max Ambient Temperature Limits

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

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



Cooler Temperature

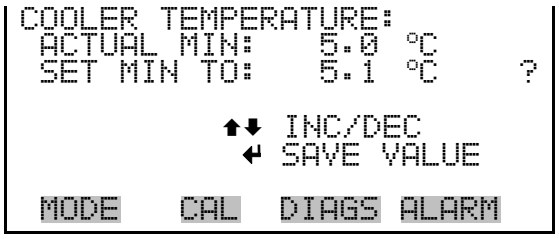
The Cooler Temperature screen displays the current cooler temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits are as follows: Low 4.5 to 10.5, Standard 5.0 to 15.0, and High 4.5 to 20.0 °C. If the cooler temperature reading goes beyond either the minimum or maximum limit, an alarm is activated. The word "ALARM" appears in the Run screen and in the Main Menu.

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

Min and Max Cooler Temperature Limits

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

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



Pressure

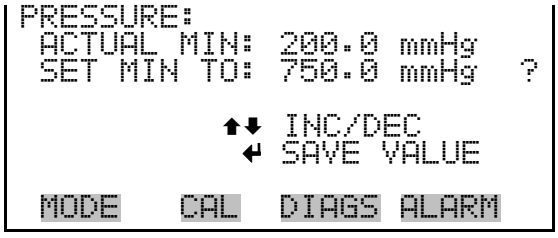
The Pressure screen displays the current Hg source pressure and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 200 to 1800 mmHg. If the pressure reading goes beyond either the minimum or maximum limit, an alarm is activated. The word “ALARM” appears in the Run screen and in the Main Menu.

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

Min and Max Pressure Limits

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

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



Hg Flow

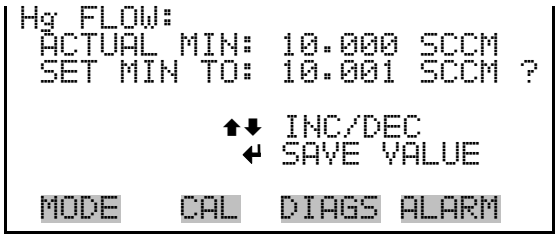
The Hg Flow screen displays the current sample flow reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 0 to 101 sccm. If the Hg flow reading goes beyond either the minimum or maximum limit, an alarm is activated. The word “ALARM” appears in the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > **Hg Flow**.

Min and Max Hg Flow Limits

The Minimum Hg Flow alarm limit screen is used to change the minimum sample flow alarm limit. The minimum and maximum Hg flow screens function the same way.

- In the Main Menu, choose Alarms > Hg Flow > **Min** or **Max**.



Dilution Flow

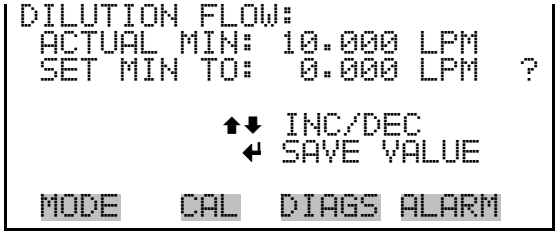
The Dilution Flow screen displays the current dilution flow reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 0 to 21 LPM. If the probe dilution flow goes beyond either the minimum or maximum limit, an alarm is activated. The word "ALARM" appears in the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > **Dilution Flow**.

Min and Max Dilution Flow Limits

The Minimum Dilution Flow alarm limit screen is used to change the minimum dilution flow alarm limit. The minimum and maximum dilution flow screens function the same way.

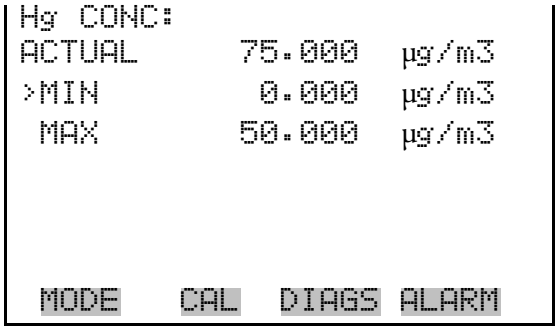
- In the Main Menu, choose Alarms > Dilution Flow > **Min** or **Max**.



Hg Concentration

The Hg Concentration screen displays the current Hg concentration and sets the minimum and maximum alarm limits. Acceptable alarm limits range as follows: Low 0 to 20, Standard 0 to 50, and High 0 to 300 µg/m^3. 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 Hg concentration goes beyond either the minimum or maximum limit, an alarm is activated. The word "ALARM" appears in the Run screen and in the Main Menu.

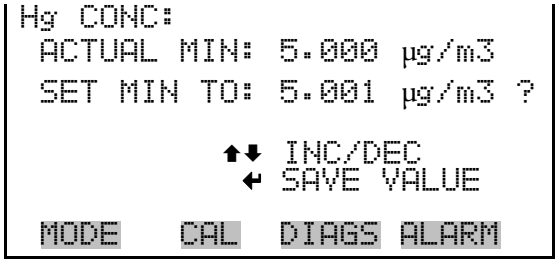
- In the Main Menu, choose Alarms > **Hg Conc**.



Min and Max Hg Concentration Limits

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

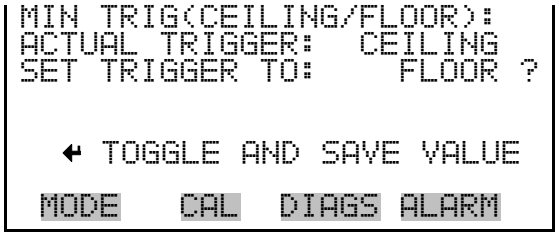
- In the Main Menu, choose Alarms > Hg Conc > **Min** or **Max**.



Min Trigger

The Minimum Trigger screen allows the user to view and set the concentration alarm trigger type to either floor or ceiling. The minimum alarm may be programmed as a floor trigger (alarm is triggered when the concentration falls below the minimum value) or a ceiling trigger (alarm is triggered when the concentratio n goes above the minimum value).

- In the Main Menu, choose Alarms > Hg Conc > **Min Trigger**.



Service Menu

The Service menu appears only when the instrument is in the service mode. To put the instrument into the service mode:

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

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**.

COOLER TEMP CALIBRATION
ANALOG OUT CALIBRATION
ANALOG INPUT CALIBRATION
DISPLAY PIXEL TEST
RESTORE USER DEFAULTS

Cooler Set Temperature

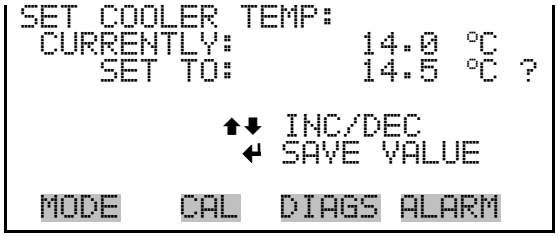
The Cooler Set Temperature screen is used to view and set the cooler temperature. The cooler set temperature screen is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” in this chapter.

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

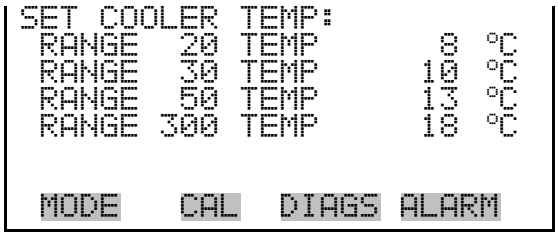
Note The Cooler Set Temperature screen for the 81*i*-H looks and functions differently from the standard 81*i* and 81*i*-L option. ▲

- In the Main Menu, choose Service > **Cooler Set Temp**.

The following screen shows what the Cooler Set Temperature looks like for the 81*i* and 81*i*-L options.



The following screen shows what the Cooler Set Temperature looks like for the 81*i*-H option.



Each range for the 81*i*-H has its own Cooler Set Point temperature. This is to accommodate the wide concentration range that the 81*i*-H Calibrator offers. The temperatures are user settable. However, only qualified individuals should change these set points on certified calibrators as this may nullify NIST traceability.

Flow Control Selection

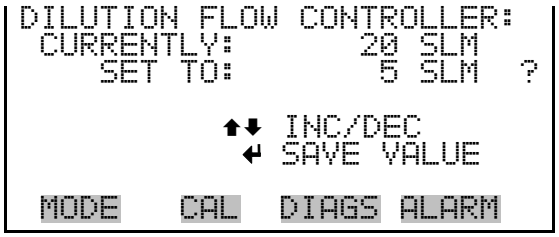
The Dilution Air Controller and Hg Flow Controller screens are used when installing new mass flow controllers. By default, the dilution flow is 20 LPM and the Hg flow depends on the 81*i* type (Low, Standard, or High). The flow control selection is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in this chapter.

- In the Main Menu, choose Service > **Flow Control Selection.**

Dilution Flow Controller

The Dilution Flow Controller screen is used to select the dilution air controller. Allowable selections are: 5, 10, 15, and 20 slm. The dilution flow controller calibration points are reset to defaults when a new controller is selected.

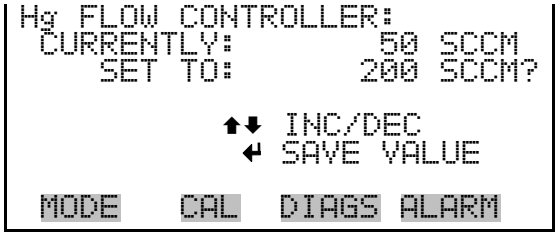
- In the Main Menu, choose Service > Flow Control Selection > **Dilution.**



Hg Flow Controller

The Hg Flow Controller screen is used to select the Hg controller. Allowable selections are: 5, 50, 100, 200, and 500 sccm. The Hg flow controller calibration points are reset to defaults when a new controller is selected.

- In the Main Menu, choose Service > Flow Control Selection > **Hg.**



Calibration Pressure/Temperature

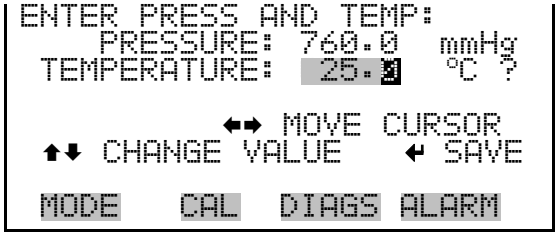
IMPORTANT NOTE Changing flow calibration, pressure calibration, or temperature calibration will void NIST Traceability! ▲

The Calibrate Pressure/Temperature screen is used only prior to calibrating the flow controllers. These values are used to convert from volumetric flow to standard flow in the flow controller calibration screens. The flow controllers are calibrated prior to shipment. However, if you need to re-calibrate the flow controllers, you can use this screen to enter the pressure and temperature that existed during re-calibration. The calibrate pressure/temperature screen is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in this chapter.

Note When calibrating the flow controller, the pressure and temperature of the area immediately around the external flow sensor must be entered for an accurate calibration. The pressure is in millimetres mercury and the temperature is degrees Celsius. ▲

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

- In the Main Menu, choose Service > **Calibration Pres/Temp.**



Zero Flow Calibration

The Zero Flow Calibration menu is used to calibrate the zero-air flow controller at 5, 20, 35, 50, 65, 80, and 95 percent of full-scale. The zero flow calibration is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in this chapter.

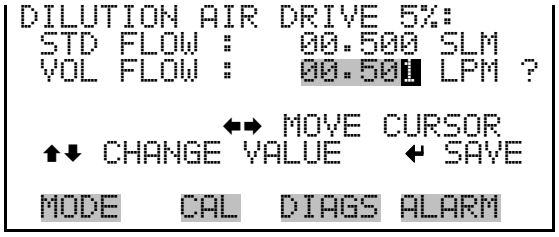
Note This adjustment should only be performed by an instrument service technician. ▲

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

Dilution Air Drive

The Dilution Air Drive 5% screen is used to calibrate the zero-air mass flow controller using a NIST traceable flow meter as a reference. The dilution air drive 20, 35, 50, 65, 80, and 95% FS screens function the same way.

- In the Main Menu, choose Service > Zero Flow Calibration > **5, 20, 35, 50, 65, 80, or 95% FS.**



Hg Flow Calibration

The Hg Flow Calibration menu is used to calibrate the Hg flow controller at 5, 20, 35, 50, 65, 80, and 95 percent of full-scale. The Hg flow calibration is visible only when the instrument is in service mode. For more information of the service mode, see "Service Mode" earlier in the chapter.

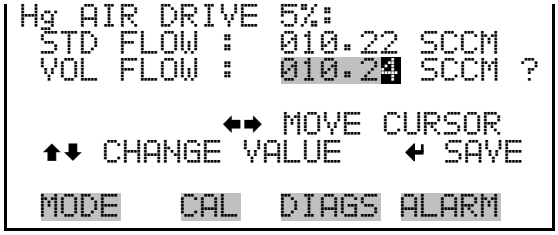
Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Hg Flow Calibration.**

Hg Air Drive

The Hg Air Drive 5% screen is used to calibrate the gas-air mass flow controller using a NIST traceable flow meter as a reference. The Hg air drive 20, 35, 50, 65, 80, and 95% FS screens function the same way.

- In the Main Menu, choose Service > Hg Flow Calibration > **5, 20, 35, 50, 65, 80, or 95% FS.**



Pressure Calibration

The Pressure Calibration menu is used to calibrate the pressure sensor to zero, span, or restore factory default values. The pressure calibration is visible only when the calibrator is in service mode. For more information on the service mode, see "Service Mode" in this chapter.

The pressure sensor's zero counts and span slope are displayed on the menu.

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

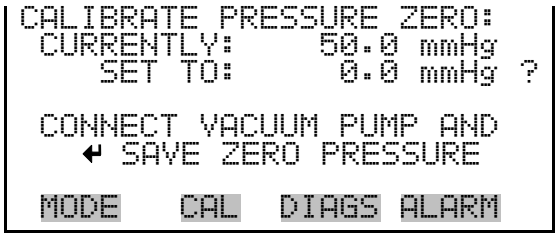
- In the Main Menu, choose Service > **Pressure Calibration**.

Calibrate Pressure Zero

The Calibrate Pressure Zero screen calibrates the pressure sensor at zero pressure.

Note A pump capable of a vacuum less than 1 torr absolute must be connected to the pressure sensor before performing the zero calibration. ▲

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

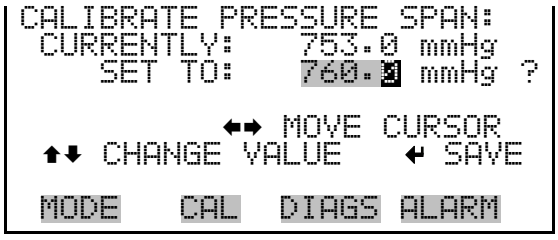


Calibrate Pressure Span

The Calibrate Pressure Span screen is used to view and set the pressure sensor calibration span point.

Note The plumbing going to the pressure sensor should be disconnected so the sensor is reading ambient pressure before performing the span calibration. The operator should use an independent, NIST traceable, barometer to measure the ambient pressure and enter the value on this screen before calibrating. ▲

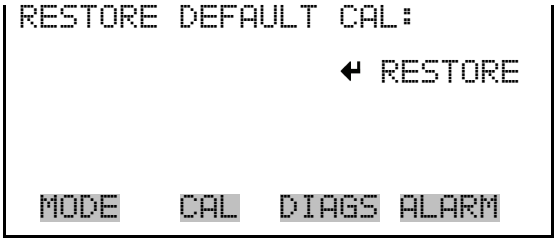
- In the Main Menu, choose Service > Pressure Calibration > **Span**.



Restore Default Calibration

The Restore Default Calibration screen is used to reset the pressure calibration configuration values to factory defaults.

- In the Main Menu, choose Service > Pressure Calibration > **Set Defaults**.

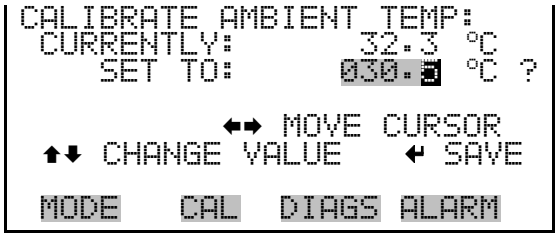


Ambient Temperature Calibration

The Ambient Temperature Calibration screen is used to view and set the ambient temperature sensor calibration. The ambient temperature calibration is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" in the chapter.

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

- In the Main Menu, choose Service > **Ambient Temp Calibration**.

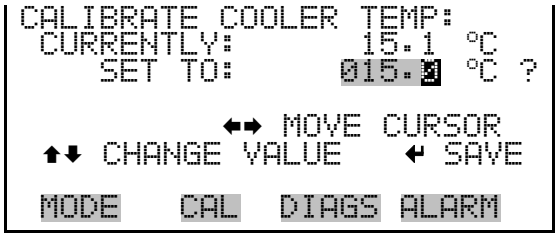


Cooler Temperature Calibration

The Cooler Temperature Calibration screen is used to view and set the cooler temperature sensor calibration. The cooler temperature calibration is visible only if the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in the chapter.

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

- In the Main Menu, choose Service > **Cooler Temp Calibration**.

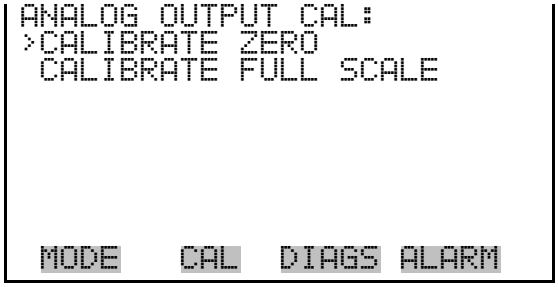


Analog Output Calibration

The Analog Output Calibration menu is a selection of 6 voltage channels and 6 current channels to calibrate, and allows the user to select the calibration action zero or span. The analog output calibration is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" in the chapter.

Note These adjustments should only be performed by an instrument service technician. ▲

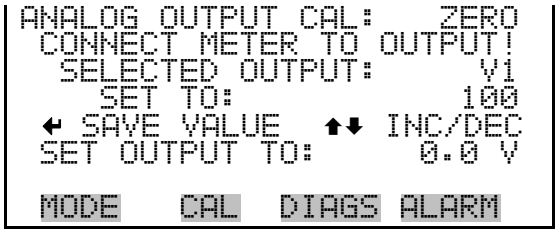
- In the Main Menu, choose Service > **Analog Out Calibration**.



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.

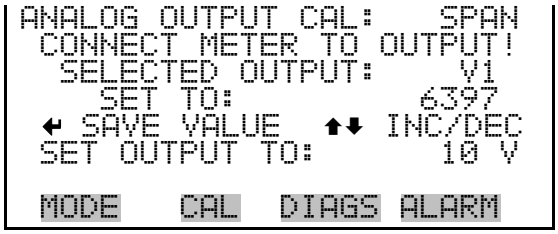
- In the Main Menu, choose Service > Analog Out Calibration > Select Channel > **Calibrate Zero**.



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 output until it reads the value shown in the set output to: field.

- In the Main Menu, choose Service > Analog Out Calibration > Select Channel > **Calibrate Full Scale**.



Analog Input Calibration

The Analog Input Calibration menu is a selection of 8 analog inputs to calibrate, and allows the user to select the calibration action zero or span.

The analog input calibration is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" in the chapter.

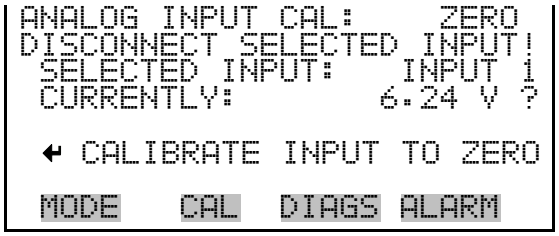
Note These adjustments should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Analog Input Calibration**.

Analog Input Calibrate Zero

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

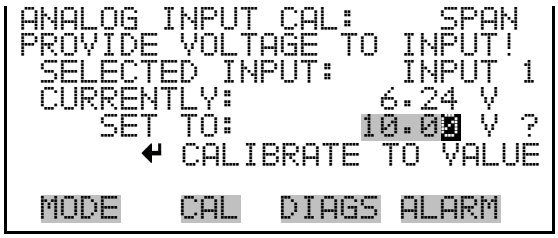
- In the Main Menu, choose Service > Analog Input Calibration > Select Channel > **Calibrate Zero**. (Hook up a voltage source of 0 V to the analog input channel.)



Analog Input Calibrate Full-Scale

The Analog Input Calibration Full-Scale screen allows the user to calibrate the full-scale state of the selected analog input.

- In the Main Menu, choose Service > Analog Input Calibration > Select Channel > **Calibrate Full Scale**. (Hook up a voltage source of 10 V to the analog input channel.)



Display Pixel Test

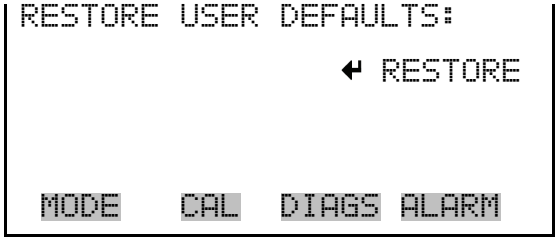
The Display Pixel Test screen is used to test the LCD display. The display pixel test is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” in the chapter.

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

Restore User Defaults

The Restore User Defaults screen is used to reset the user calibration and configuration values to factory defaults. The restore default user is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” in the chapter.

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



Password

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. The items visible under the password menu are determined by the instrument's password status.

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

Set Password

The Set Password screen is used to set the password to unlock the front panel. The set password is shown if the instrument is unlocked and the password is set.

- In the Main Menu, choose Password > **Set Password**

Lock Instrument

The Lock Instrument screen is used to lock the instrument's front panel so users can not change any settings from the front panel. The lock instrument is shown if the instrument is unlocked and the password is set.

Lock/Unlock and Local/Remote Operation

If the instrument keyboard is locked via the front panel using Password > Lock Instrument, the instrument reports being in Remote mode. In this mode, the keypad is locked, data can be viewed but not changed using the front panel interface, and the remote "Set" commands are active.

If the instrument keyboard is unlocked via the front panel using Password > Unlock Instrument, the instrument reports being in Local mode, the front panel interface is unlocked, and data can be changed from the front panel .

Refer to the "C-Link Protocol Commands" appendix for detailed information about "mode", "allow mode", and "power up mode" commands.

- In the Main Menu, choose Password > **Lock Instrument**

Change Password

The Enter New Password screen is used to change the password used to unlock the instrument's front panel. The change password is shown if the instrument is unlocked.

- In the Main Menu, choose Password > **Change Password**

Remove Password

The Remove Password screen is used to erase the current password and disable password protection. The remove password is shown if the instrument is unlocked and the password set.

- In the Main Menu, choose Password > **Remove Password**

Unlock Instrument

The Unlock Instrument screen is used to enter the password to unlock the front panel. The unlock instrument is shown if the instrument is locked.

- In the Main Menu, choose Password > **Unlock Instrument**

Chapter 4
Calibration

The Model 81*i* is calibrated to NIST standards at the factory and should not require calibration prior to startup. However, when a mass flow controller or pressure transducer is replaced it must be calibrated before operating the instrument.

IMPORTANT NOTE Before changing calibration factors or replacing parts that may void NIST traceability, refer to Appendix D for additional information. ▲

The following sections discuss the required apparatus and procedure for calibrating the instrument.

Mass Flow Controller Calibration

In order to calibrate the mass flow meter section of the zero or gas mass flow controller, a NIST traceable flow meter is required. The term calibration means determining the actual flow versus the flow setting for seven equally spaced flows along the range of the device. The Model 81*i* then corrects the output according to an internal algorithm.

Calibration may be done with a properly calibrated flow meter. For the most accurate calibration procedure, use a volumetric NIST traceable calibrator with the following step-by-step calibration procedure.

1. Connect a source of clean, dry air to the inlet of the mass flow controller.

2. Measure barometric pressure and room temperature.

3. Connect a suitable flow meter to the mass flow controller outlet.

4. Set Model 81*i* to Hg Flow or Zero Air Flow Calibration as described in the "Operation" chapter.

5. Set flow controller to 95 percent of full scale, then wait until flow meter reading stabilizes.

6. Enter the flow meter reading using the flow input screen.

7. Repeat Steps 5 and 6 for the remaining flow settings.

If you encounter a flow controller malfunction, contact Thermo Fisher Scientific.

Cooler Temperature Calibration

Use the following procedure to calibrate the cooler temperature when the cooler temperature does not match the cooler set temperature.

1. Connect an appropriate resistor for the desired setting temperature to J24 pins 1 and 2 on measurement interface board. For example, for a temperature of 14 °C use a resistor with a value of 15, 797 ohms. Verify ohm value with calibrated ohm meter or digital multimeter. Refer to **Table 4–1** for a list of resistors and associated temperature values.

Note After plugging in the test resistor, it may take several minutes for the reading to stabilize. ▲

2. From the Main Menu, press [↓] to scroll to Service, press [↵] > [↓] to scroll to Cooler Temp Calibration, and press [↵].

   The Calibrate Cooler Temp screen displays.

   If Service is not displayed on the Main Menu, use the following procedure to display it:

   a. At the Main Menu, press [↓] to scroll to Instrument Controls, press [↵] > [↓] to scroll to Service Mode, and press [↵].

      The Service Mode screen displays.

   b. Press [↵] to toggle the Service Mode to ON.

   c. Press [■] > [■] to return to the Main Menu.

   d. Continue the procedure at Step 2 to access the Calibrate Cooler Temp screen.

3. At the Calibrate Cooler Temp screen, use [↑] [↓] until the temperature reads 14 °C, then press [↵] to save the value.

Table 4–1. Temperature Values and Associated Resistors

Temperature (°C)	R Value (Ohms)
0	29,490
1	28,157
2	26,891
3	25,689
4	24,547
5	23,462
6	22,430
7	21,450
8	20,517
9	19,631
10	18,747
11	17,983
12	17,219
13	16,490
14	15,797
15	15,136
16	14,507
17	13,906
18	13,334
19	12,788
20	12,268

Chapter 5
Preventive Maintenance

This chapter describes the periodic maintenance procedures that should be performed on the instrument to ensure proper operation. Since usage and environmental conditions vary greatly, you should inspect the components frequently until an appropriate maintenance schedule is determined.

IMPORTANT NOTE Before changing calibration factors or replacing parts that may void NIST traceability, refer to Appendix D for additional information. ▲

This chapter includes the following maintenance information and replacement procedures:

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 ground 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. ▲

Replacement Parts

See the “Servicing” chapter for a list of replacement parts.

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.

Cooler Fins Inspection and Cleaning

Use the following procedure to inspect and clean the cooler fins.

Equipment Required:

#1 Philips screwdriver

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn the instrument off and unplug the power cord.
2. Remove the instrument cover.
3. Locate the cooler (**Figure 7–2**).
4. Remove fan filter and clean as described in ““Fan Filters Inspection and Cleaning” on page 5-3”.

5. Remove cooler assembly shroud screws and carefully lift the shroud.

6. Blow off the cooler fins using clean pressurized air. It may be more convenient to vacuum the fins. In either case, make sure that any particulate accumulation between the fins and fan blades has been removed.

   If necessary, use a small brush to remove residual particulate accumulation.

7. Replace the shroud and fan filter.

8. Replace the cover.

9. Connect the power cord and turn the instrument ON.

Fan Filters Inspection and Cleaning

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

1. Remove the two fan guards from the fans and remove the filters.

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

3. Re-install the filters and fan guards.

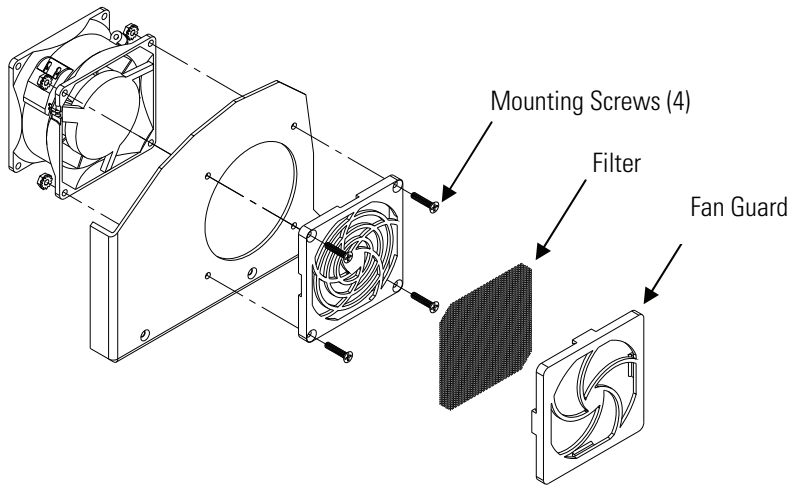


Figure 5–1. Inspecting and Cleaning the Fan Filters

Leak Test

Use the following procedure to locate leaks within the Model 81*i*.

1. Turn the instrument OFF.

2. Cap the following ports on the instrument's rear panel:

   EXHAUST

   ZERO AIR IN

   CAL GAS OUT

   ZERO AIR OUT

3. Note the check valve orientation then temporarily replace the check valve with a union connector.

4. Connect an external pump (Thermo part number 101426 or equivalent) to the PROBE bulkhead connector on the instrument's rear panel.

5. Connect a 500 cc DryCal® to the pressure side of the pump.

6. Turn the pump ON.

   DryCal® flow should increase to less than 10 cc/min. Allow ten minutes to evacuate the calibrator lines.

7. Remove the union connector installed in Step 3, and replace the check valve with the flow arrow facing the FRONT panel.

8. Verify that the check valve is functioning correctly.

   a. Connect a pressure gauge to the PROBE bulkhead.

   b. In the Instrument Controls menu, select Gas Mode > Orifice Zero.

      The gauge should not read greater than 12 psig. If the reading is greater than 12 psig, check the plumbing and valve set point.

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 Service menu includes some of the same information found in the Diagnostic menu, however, readings are updated every second in the service mode compared with every 10 seconds in the Diagnostics menu.

The Technical Support Department at Thermo Fisher Scientific can also be consulted in the event of problems. See "Service Locations" at the end of this chapter for contact information. In any correspondence with the factory, please note both the serial number and program number of the instrument.

IMPORTANT NOTE Before changing calibration factors or replacing parts that may void NIST traceability, refer to Appendix D for additional information. ▲

This chapter provides the following troubleshooting and service support information:

Safety Precautions

Read the safety precautions in the Preface and the "Servicing" chapter before performing any actions listed in this chapter.

Troubleshooting Guides

The troubleshooting guides presented in this chapter are designed to help isolate and identify instrument problems.

Table 6–1 and **Table 6–2** provide general troubleshooting information and indicate 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 display and provides recommendations about how to resolve the alarm condition.

Table 6–1. Troubleshooting - Power-Up Failures

Malfunction	Possible Cause	Action
Does not start. (Light on power switch does not come on.)	No power or wrong power configuration	Check the line to confirm that power is available and that it matches the voltage and frequency configuration of the instrument.
	Main fuse is blown or missing	Unplug the power cord, open the fuse drawer on the back panel, and check the fuses visually or with a multimeter.
	Bad switch or wiring connection	Unplug the power cord, disconnect the switch and check operation with a multimeter.
Display does not come on. (Light on power switch does come on.)	DC power supply failure	Check the green LED on the back edge of the power supply. If the LED is off, the supply has failed.
	DC power distribution failure	Check surface mount LEDs labeled "24V PWR" on the motherboard and the interface board. If lit, power is OK.
	Display failure	If possible, check instrument function through RS-232 or Ethernet. Reboot the instrument. Contact Thermo Fisher Scientific Service Department.

Table 6–2. Troubleshooting - Measurement Failures

Malfunction	Possible Cause	Action
Analog signal doesn't match expected value.	Software has not been configured.	Verify that the selected analog output has been properly configured to match the data system.
	Analog output goes above full-scale value or below zero	By default, a 5% over and underrange on the analog outputs is provided. If this is not desirable due to system restrictions, it may be turned off in the INSTRUMENT CONTROLS > I/O CONFIGURATION > ANALOG OUTPUT CONFIG screens.
	Recorder is drawing down output.	Verify that the recorder or data logger input impedance meets minimum requirements.

Table 6–3. Troubleshooting - Alarm Messages

Alarm Message	Possible Cause	Action
Alarm - Ambient Temp	Instrument overheating	Replace fan if not operating properly. Clean or replace foam filter, refer to the "Preventive Maintenance" chapter in this manual.
Alarm – Cooler Temp	Cooler temp does not match setting	Calibrate Cooler temp. Refer to "Cooler Temp Calibration" in the "Calibration" chapter.
Alarm – Pressure (ambient pressure)	High pressure indication	Verify that the pressure transducer is working properly. From the Main Menu select Diagnostics > Pressure. Disconnect the line from the transducer. If the reading is above ambient, calibrate the pressure transducer. Refer to "Pressure Transducer Calibration" in the "Servicing" chapter. Reconnect the line to the transducer. Valve malfunctions within and outside the 81*i* may cause this. Refer to **Table 1–1** for 81*i* valve status per gas mode.
The following board related alarms only occur during power up or reboot.		
Alarm - Motherboard Status Alarm - Interface Status Alarm - I/O Exp Status	Internal cables not connected properly Board is defective	Check that all internal cables are connected properly. Recycle AC power to instrument. If still alarming, change board.

Board-Level Connection Diagram

Figure 6–1 is board-level connection diagram for the common electronics and measurement system. This illustration can be used along with the connector pin descriptions in **Table 6–4** through **Table 6–8** to troubleshoot board-level faults.

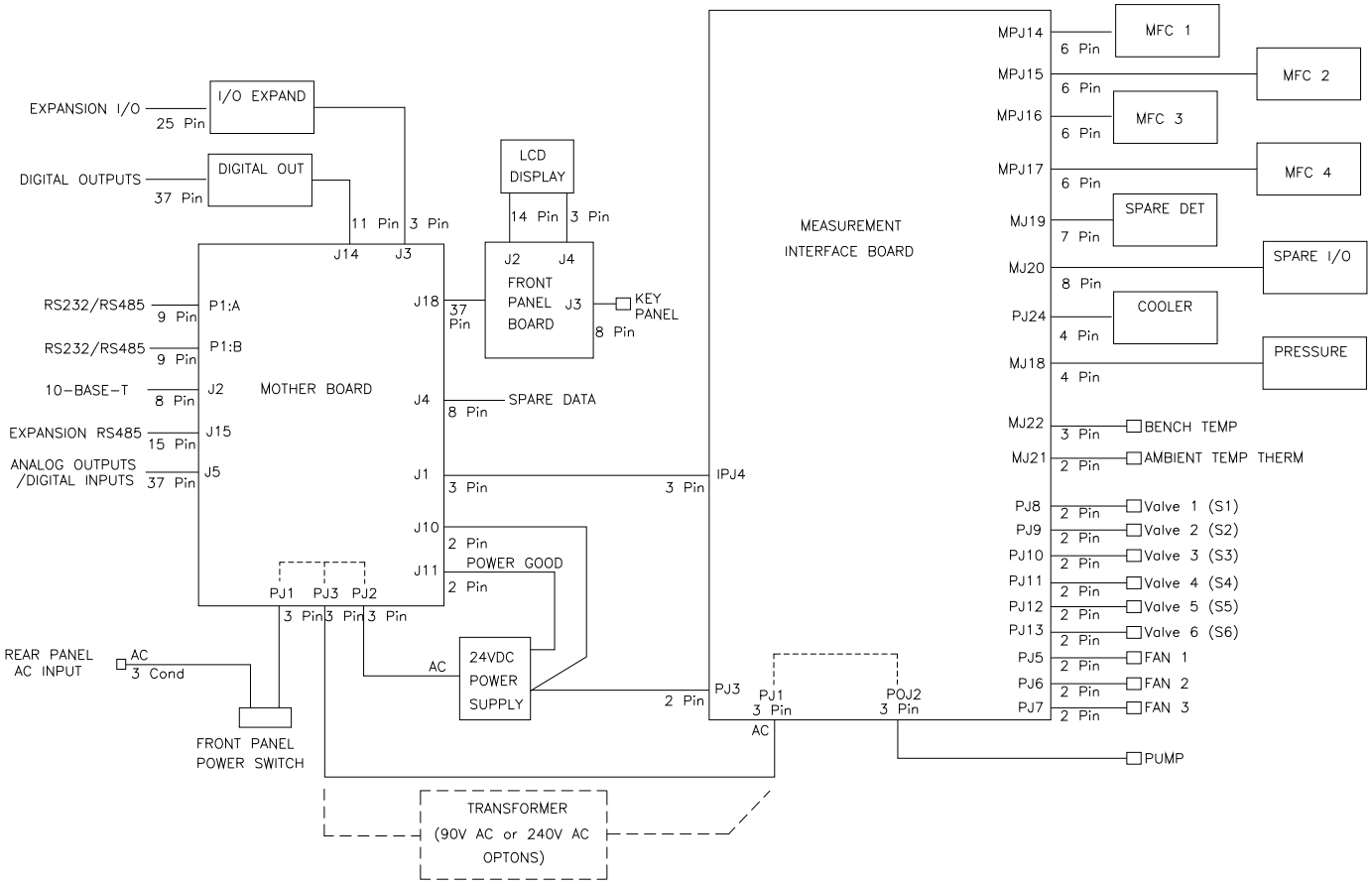


Figure 6–1. Board-Level Connection Diagram

Connector Pin Descriptions

The connector pin descriptions in **Table 6–4** through **Table 6–8** can be used along with the board-level connection diagrams to troubleshoot board-level faults.

Note For associated I/O terminal board pin descriptions, refer to **Table 2–1**. ▲

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
SPARE DATA	J4	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	+RS485 to Spare Board

Connector Label	Reference Designator	Pin	Signal Description
		8	-RS485 to Spare Board
For associated I/O terminal board pin descriptions, refer to **Table 2–1**.			
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
		27	TTL Input 9
		28	TTL Input 11
		29	TTL Input 12
		30	TTL Input 14
		31	TTL Input 16
		32	Ground

Connector Label	Reference Designator	Pin	Signal Description
		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 I/O	J14	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	SPI Reset
		8	SPI Input
		9	SPI Output
		10	SPI Board Select
		11	SPI Clock
EXT. RS485	J15	1	-RS485 to Rear Panel
		2	+RS485 to Rear Panel
		3	+5V
		4	+5V
		5	+5V
		6	Ground
		7	Ground
		8	Ground
		9	NC
		10	NC
		11	+24V
		12	+24V
		13	+24V
		14	+24V

Connector Label	Reference Designator	Pin	Signal Description
		15	+24V
24V 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
		26	Keypad Col 1 Select
		27	Keypad Col 4 Select
		28	Keypad Col 3 Select
		29	Ground
		30	Ground
		31	Ground

Connector Label	Reference Designator	Pin	Signal Description
		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
		2	AC-NEUT
		3	AC-Ground

Table 6–5. Measurement Interface Board Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
DATA	J4	1	GND
		2	+RS485
		3	-RS485
PRES	J18	1	AIN_PRESSURE
		2	GND
		3	+15VA
		4	-15VA
AMB TEMP THERM	J21	1	AMBIENT_THERM
		2	GND
BENCH TEMP	J22	1	BENCH_THERM
		2	GND
SPARE TEMP	J23	1	SPARE2_THERM
		2	GND
COOLER	J24	1	AIN_COOLERTEMP
		2	GND
		3	+5VD
		4	COOLER_ONOFF
SPARE I/O	J20	1	AOUT_SPARE
		2	SPARE_CNTRL
		3	SPARE1_THERM
		4	+24V
		5	GND
		6	SPARE_ONOFF
		7	GND
		8	GND
SPARE DET	J19	1	FREQ
		2	+15VA
		3	GND
		4	GND
		5	-15VA
		6	GND
MFC 1 (Z_AIR)	J14	1	AIN_MASS_FLOW1

Connector Label	Reference Designator	Pin	Signal Description
		2	AOUT_MASS_FLOW1
		3	GND
		4	+15VA
		5	-15VA
		6	GND
MFC 2	J15	1	AIN_MASS_FLOW2
		2	AOUT_MASS_FLOW2
		3	GND
		4	+15VA
		5	-15VA
		6	GND
MFC 3 (SPARE 1)	J16	1	AIN_MASS_FLOW3
		2	AOUT_MASS_FLOW3
		3	GND
		4	+15VA
		5	-15VA
		6	GND
MFC 4 (SPARE 2)	J17	1	AIN_MASS_FLOW4
		2	AOUT_MASS_FLOW4
		3	GND
		4	+15VA
		5	-15VA
		6	GND
VALVE 1 (S1)	J8	1	+24V
		2	SOLDRV1
VALVE 2 (S2)	J9	1	+24V
		2	SOLDRV2
VALVE 3 (S3)	J10	1	+24V
		2	SOLDRV3
VALVE 4 (S4)	J11	1	+24V
		2	SOLDRV4
VALVE 5 (S5)	J12	1	+24V
		2	SOLDRV5
VALVE 6 (S6)	J13	1	+24V

Connector Label	Reference Designator	Pin	Signal Description
		2	SOLDRV6
FAN 1	J5	1	+24V
		2	GND
FAN 2	J6	1	+24V
		2	GND
FAN 3	J7	1	+24V
		2	GND
AC PUMP	J2	1	AC+
		2	PUMP_AC-
		3	AC_GND
AC IN	J1	1	AC+
		2	AC-
		3	AC_GND
24V	J3	1	+24V
		2	GND

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
		11	LD1 – LCD Signal
		12	LD6 – LCD Signal
		13	LD2 – LCD Signal
		14	LD7 – LCD Signal
		15	LD3 – LCD Signal
		16	LCD Bias Voltage

Connector Label	Reference Designator	Pin	Signal Description
		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	LFLM_5V – LCD Signal
		2	LLP_5V – LCD Signal
		3	LCLK_5V – LCD Signal
		4	LCD_ONOFF_5V – LCD Signal
		5	+5V
		6	Ground
		7	LCD Bias Voltage
		8	LD0_5V – LCD Signal
		9	LD1_5V – LCD Signal
		10	LD2_5V – LCD Signal
		11	LD3_5V – LCD Signal
		12	LD4_5V – LCD Signal
		13	LD5_5V – LCD Signal
		14	LD6_5V – LCD Signal
		15	LD7_5V – LCD Signal
		16	Ground

Connector Label	Reference Designator	Pin	Signal Description
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	LCD Backlight Voltage 1
		2	NC
		3	NC
		4	LCD Backlight Voltage 2

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
		15	Current Output 1
		16	Current Output Return
		17	Current Output 2
		18	Current Output Return
		19	Current Output 3

Connector Label	Reference Designator	Pin	Signal Description
		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 Designation	Pin	Signal Description
MOTHER BD	J1	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	SPI Reset
		8	SPI Input
		9	SPI Output
		10	SPI Board Select
		11	SPI Clock
DIGITAL OUTPUTS	J2	1	Relay 1 Contact a
		2	Relay 2 Contact a
		3	Relay 3 Contact a
		4	Relay 4 Contact a
		5	Relay 5 Contact a
		6	Relay 6 Contact a

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

Service Locations

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

1-866-282-0430 Toll Free

1-508-520-0430 International

Chapter 7
Servicing

This chapter explains how to replace the Model 81*i* subassemblies. It assumes that a subassembly has been identified as defective and needs to be replaced (or is an "expendable" item not covered under warranty). Expendable items are indicated by an asterisk (*) in the "Model 81*i* Replacement Parts" table.

IMPORTANT NOTE Before changing calibration factors or replacing parts that may void NIST traceability, refer to Appendix D for additional information. ▲

For fault location information refer to the "Preventive Maintenance" chapter and the "Troubleshooting" 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.

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

Read the safety precautions before beginning any procedures in this chapter.

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

If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲

CAUTION Carefully observe the instructions in each procedure. ▲

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

Handle all printed circuit boards by the edges. ▲

Do not remove the LCD panel or frame from the LCD module. ▲

The LCD polarizing plate is very fragile, handle it carefully. ▲

Do not wipe the LCD polarizing plate with a dry cloth, it may easily scratch the plate. ▲

Do not use alcohol, acetone, MEK or other Ketone based or aromatic solvents to clean the LCD module, use a soft cloth moistened with a naphtha cleaning solvent. ▲

Do not place the LCD module near organic solvents or corrosive gases. ▲

Do not shake or jolt the LCD module. ▲

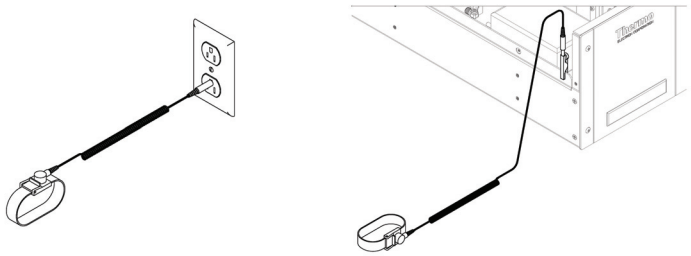


Figure 7–1. Properly Grounded Antistatic Wrist Strap

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.

Replacement Parts List

Table 7–1 lists the replacement parts for the Model 81*i* major subassemblies. Refer to **Figure 7–2** to identify the component location.

Table 7–1. Model 81*i* Replacement Parts

Part Number	Description
100480-00	Front Panel Pushbutton Board
101491-22	Processor Board
100539-00	Digital Output Board

Part Number	Description
102014-00	I/O Expansion Board (Optional)
102340-00	Front Panel Connector Board
102496-00	Front Panel Display
100533-00	Motherboard
102664-00	Measurement Interface Board
111899-00	Pressure Transducer Assembly, Hi Range
102204-00	Pressure Regulator Assembly
112775-00	Mass Flow Controller, 5 sccm
103059-00	Mass Flow Controller, 50 sccm
102628-00	Mass Flow Controller, 100 sccm
8094	Mass Flow Controller, 20 SLPM
102201-00	Scrubber Bracket Assembly
101707-00	Scrubber Assembly
102526-00	Solenoid Assembly, Valve 1
102527-00	Solenoid Assembly, Valve 2
102528-00	Solenoid Assembly, Valve 3
102529-00	Solenoid Assembly, Valve 4
102530-00	Solenoid Assembly, Valve 5
103055-00	Calibrator Scrubber
101390-00	Solenoid Valve 1, 2-way, 24VDC
7368	Solenoid Valves 2, 3,4 and 5; 3-way, 24VDC
102172-00	Line Cooler Assembly
101055-00	AC Receptacle Assembly
101681-00	Power Supply Assembly, 24VDC, w/Base Plate and Screws
100907-00	Fan, 24VDC, Rear Panel and MFC
8630	Fan Filter*
104235-00	Fuse Kit
101688-00	Thermistor with Ambient Temperature Connector

*Expendable item not covered by warranty.

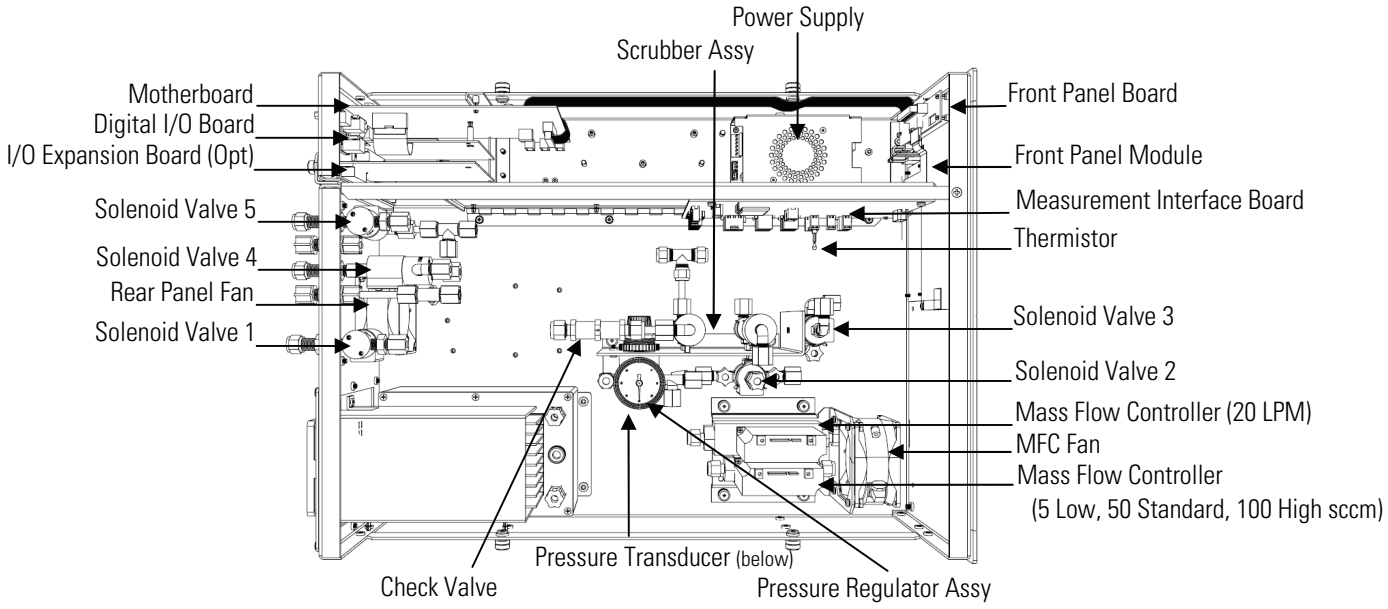


Figure 7–2. Model 81*i* Component LayoutCable List

Table 7–2 describes the Model 81*i* cables. See the "Troubleshooting" chapter for associated connection diagrams and board connector pin descriptions.

Table 7–2. Model 81*i* Cables

Part Number	Description
101036-00	DC Power Supply 24V Output
101037-00	115VAC Supply to Interface Board
101048-00	RS-485/Data
101038-00	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
101033-00	AC from Receptacle
101377-00	AC to Power Switch
101267-00	Fan Power Cable (3 each)
103284-00	MFC Cables (2 each)

External Device Connection Components

Table 7–3 lists the standard and optional cables and components used for connecting external devices such as PCs and data loggers to an iSeries instrument.

Table 7–3. External Device Connection Components

Part Number	Description
102562-00	Terminal Block and Cable Kit (DB25) (optional)
102556-00	Terminal Block and Cable Kit (DB37) (optional)
102645-00	Cable, DB37M to Open End Cable, Six Feet (optional)
102646-00	Cable, DB37F to Open End, Six Feet (optional)
102659-00	Cable, DB25M to Open End, Six Feet (optional)
6279	Cable, RS-232 (optional)
102888-00	Terminal Board PCB Assembly, DB37F (standard)
102891-00	Terminal Board PCB Assembly, DB37M (standard)
103084-00	Terminal Board PCB Assembly, DB25M (included with optional I/O Expansion Board)

Removing the Measurement Bench and Lowering the Partition Panel

The measurement bench 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 (see **Figure 7–3**).

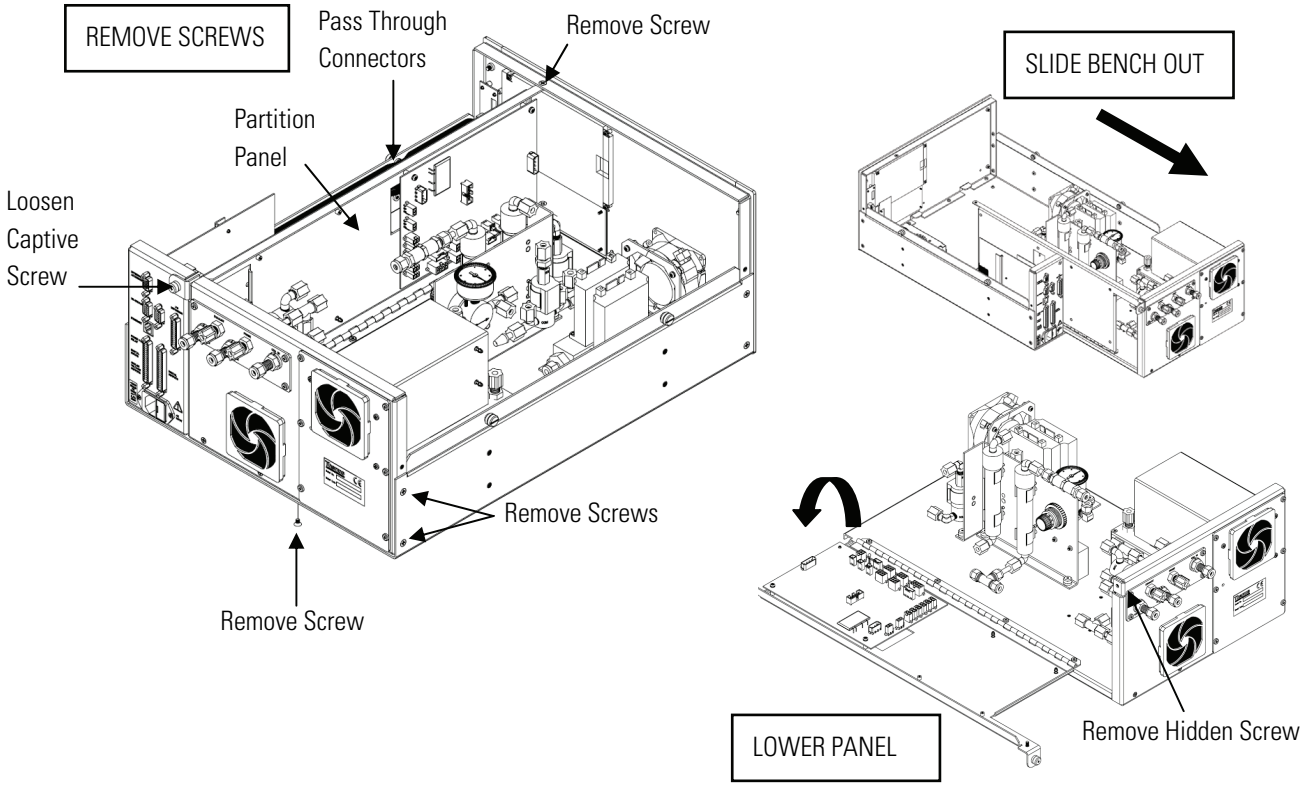


Figure 7–3. Removing the Measurement Bench and Lowering the Partition Panel

Equipment Required:

Philips screwdriver

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument OFF 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 plumbing connections at the rear of the measurement bench.

5. Disconnect the connectors that pass through the center of the partition panel.

6. Remove two screws from the left side of the case.

7. Remove one screw from the bottom rear of the case.

8. Remove one screw from the top front of the partition panel.

9. While holding the case securely, loosen the captive screw at the rear of the measurement bench, and pull the measurement bench from the rear of the case.

10. Remove the screw at the top rear of the partition panel securing the top of partition panel to the measurement bench, and lower the panel being, careful not to put excessive tension on the cables.

11. Replace the measurement bench by following previous steps in reverse.

Accessing the Service Mode

If the Service mode is not displayed on the Main Menu, use the following procedure to display it.

1. At the Main Menu, press ↓ to scroll to Instrument Controls > press ↵ > ↓ to scroll to Service Mode and press ↵.

   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.

Fuse Replacement

Use the following procedure to replace the fuse.

Equipment Required:

Replacement fuses – refer to the "Replacement Parts List" on page 7-3.

1. Turn instrument OFF and unplug the power cord.
2. Remove fuse drawer, located on the AC power connector.
3. If either fuse is blown, replace both fuses.
4. Insert fuse drawer and reconnect power cord.

Rear Panel Fan Replacement

Use the following procedure to replace the rear panel fan (**Figure 7–4**).

Equipment Required:

Fan

Philips screwdriver

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Remove the fan guard from the fan and remove the filter.
3. Pull the power connectors off the fan.
4. Remove the four fan mounting screw s and remove the fan.
5. Install a new fan following the previous steps in reverse.

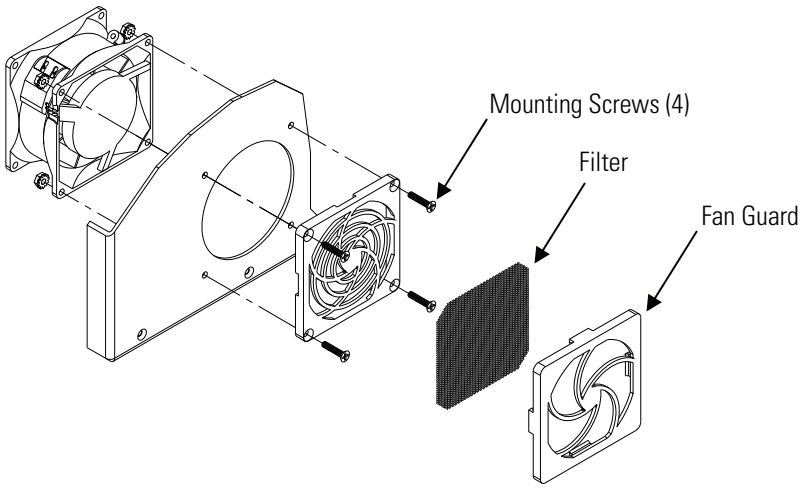


Figure 7–4. Replacing the Rear Panel Fan

MFC Fan Replacement

Use the following procedure to replace the mass flow controller (MFC) fan (**Figure 7–5**).

Equipment Required:

MFC Fan

#2 Philips screwdriver

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Pull the power connector off the fan.
3. Remove the four fan mounting screws and nuts and remove the fan.
4. Install a new fan following the previous steps in reverse.

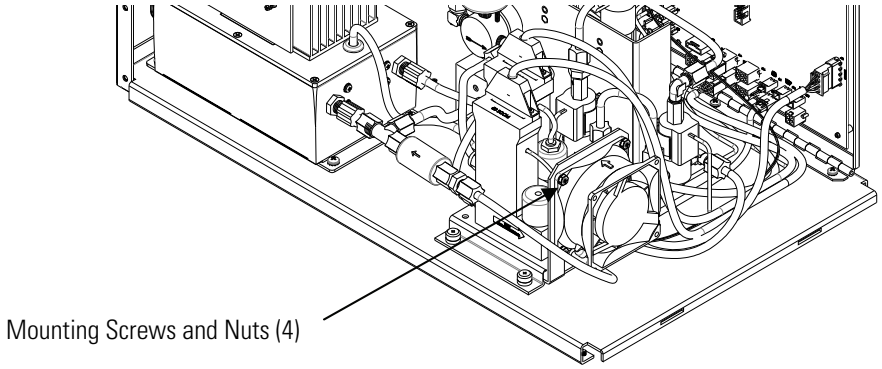


Figure 7–5. Replacing the MFC Fan

Cooler Assembly Replacement

Use the following procedure to replace the cooler assembly (see **Figure 7–6**).

Equipment Required:

Cooler

Nut driver, 1/4-inch

Wrench, 7/16-inch

Wrench, 9/16-inch

Wrench, 5/8-inch

Philips screwdriver

Wire cutters

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

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

2. Pull the power connector off the cooler fan, and remove pneumatic and electrical connections.

3. Remove the four screws securing the cooler shroud and remove the shroud (**Figure 7–6**).

4. Loosen four captive screws holding cooler to floor plate and remove the cooler assembly.

5. Install new cooler by following previous steps in reverse. Be sure to connect the fan power cable before installing the shroud.

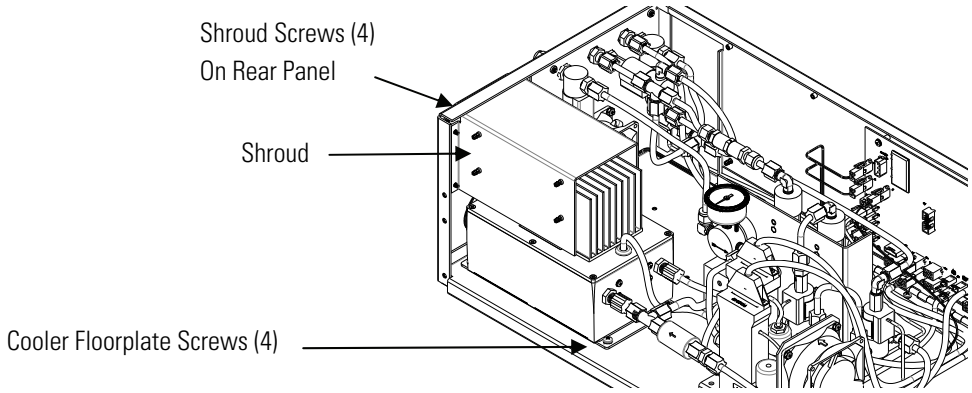


Figure 7–6. Replacing the Cooler

Solenoid Valve Replacement

Use the following general procedure to replace a solenoid valve.

Equipment Required:

Solenoid valve

Wrench, 9/16-inch and 5/8-inch

Philips screwdriver

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

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

2. Disconnect pneumatic and electrical connections from the solenoid and mark as approprite to facilitate reassembly.

3. Pull solenoid valve from mounting clip or remove it from the rear panel by removing the rear panel solenoid retaining nut and lock washer.

4. To replace solenoid, follow previous steps in reverse.

Mass Flow Controller Replacement

Use the following procedure to replace a mass flow controller (MFC).

Equipment Required:

Mass flow controller

#1 and #2 Philips screwdriver

Wrench, 916-inch

Flatblade screwdriver

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Disconnect the electrical connectors from the top on the MFCs and the fan.

2. Disconnect the pneumatics from the MFCs.

3. Loosen the four captive retaining screws securing the MFC assembly to the base and lift the assembly off.

4. Turn the assembly over and remove the two retaining screws from the MFC to be replaced.

5. Install the new MFC by following the previous steps in reverse.

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 ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

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

2. Disconnect 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 lift out the power supply.

4. To install the DC power supply, follow the previous steps in reverse.

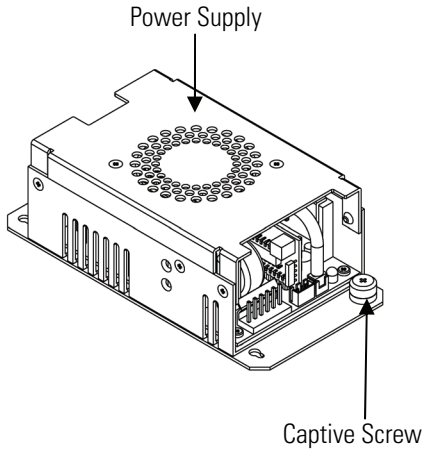


Figure 7–7. Replacing the DC Power Supply

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, you connect a meter to an analog output channel (voltage or current) and compare the meter reading with the output value displayed 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, press ↓ to scroll to Diagnostics, press ↵ > ↓ to scroll to **Test Analog Outputs**, and press ↵.

   The Test Analog Outputs screen displays.

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 displays.

4. Press ↓ to set the output to zero.

   The Output Set To line displays Zero.

5. Check that the meter is displaying a zero value. If the meter reading differs by more than one percent, the analog outputs should be adjusted. Refer to “Analog Output Calibration” on page 7-17.

6. Press ↑ to set the output to full scale.

   The Output Set To line displays Full Scale.

7. Check that the meter is displaying the full scale value. If the meter reading differs by more than one percent, the analog outputs should be adjusted. Refer to “Analog Output Calibration” on page 7-17.

8. Press ← to reset the analog outputs to normal.

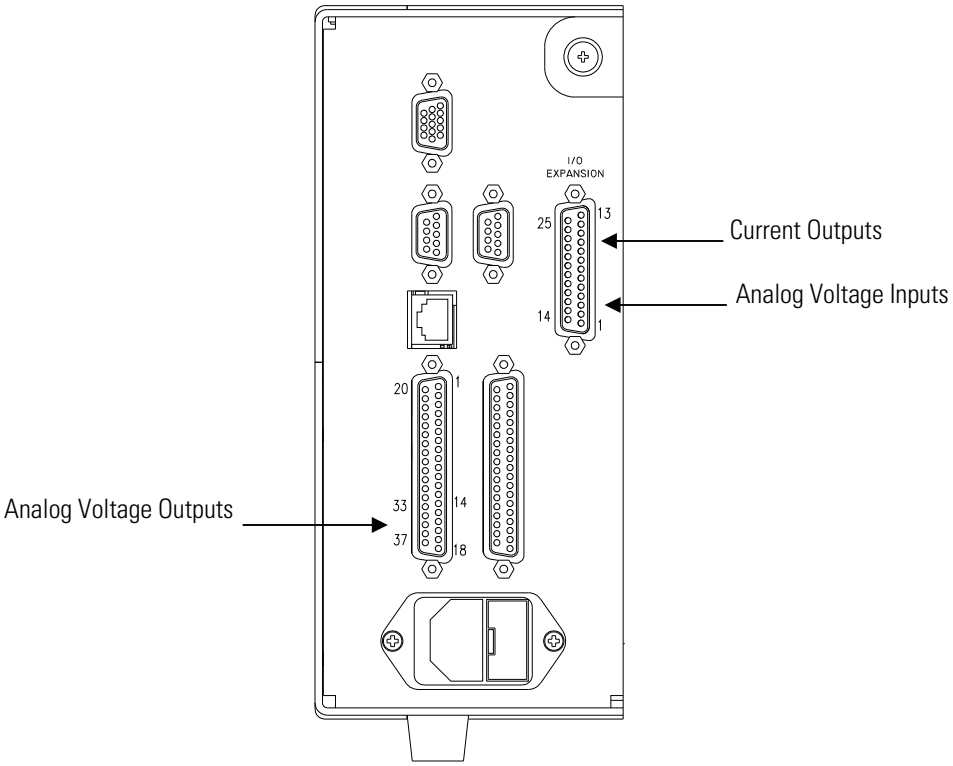


Figure 7–8. Rear Panel Analog Input and Output Pins

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	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 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, press ⬇ to scroll to Service, press ↵ > ⬇ to scroll to Analog Out Calibration**,** and press ↵.

   The Analog Output Cal menu displays.

Note If the Service menu selection is not displayed, refer to "Accessing the Service Mode" in this chapter, then return to the beginning of this step. ▲

3. At the Analog Output Cal screen, press ⬇ to scroll to the voltage channel or current channel corresponding to the rear panel terminal pins 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.

Use the following procedure to calibrate the input channels to zero volts.

Calibrating the Input Channels to Zero Volts

1. From the Main Menu, press ↓ to scroll to Service, press ↵ > ↓ to scroll to Analog Input Calibration**,** and press ↵.

2. The Analog Input Cal screen displays.

   Note If the Service menu selection is not displayed, refer to "Accessing the Service Mode" in this chapter, then return to the beginning of this step. ▲

3. At the Analog Input Cal screen, press ↓ to scroll to a channel, and press ↵.

4. With the cursor at Calibrate Zero, press ↵.

5. The screen displays the input voltage for the selected channel.

6. 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.

7. The screen displays 0.00 V as the voltage setting.

8. Press [ ] > [ ] to return to the Analog Input Cal screen and repeat Steps 2 through 4 to calibrate other input channels to zero as necessary.

9. 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 output pins and **Table 7–4** identifies the associated channels.

2. From the Main Menu, press [↓] to scroll to Service, press [↵] > [↓] to scroll to Analog Input Calibration**,** and press [↵].

   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 current 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 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.

Pressure Transducer Assembly Replacement

Use the following procedure to replace the pressure transducer assembly (**Figure 7–9**).

Equipment Required:

Pressure transducer assembly

Philips screwdriver

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

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

2. Disconnect plumbing from the pressure transducer assembly. Note the plumbing connections to facilitate reconnection.

3. Disconnect the pressure transducer cable from the measurement interface board.

4. Loosen the two pressure transducer assembly retaining screws and remove the pressure transducer assembly by sliding it down then taking it out.

5. To install the pressure transducer assembly, follow the previous steps in reverse.

6. Calibrate the pressure transducer. Refer to the “Pressure Transducer Calibration” procedure that follows.

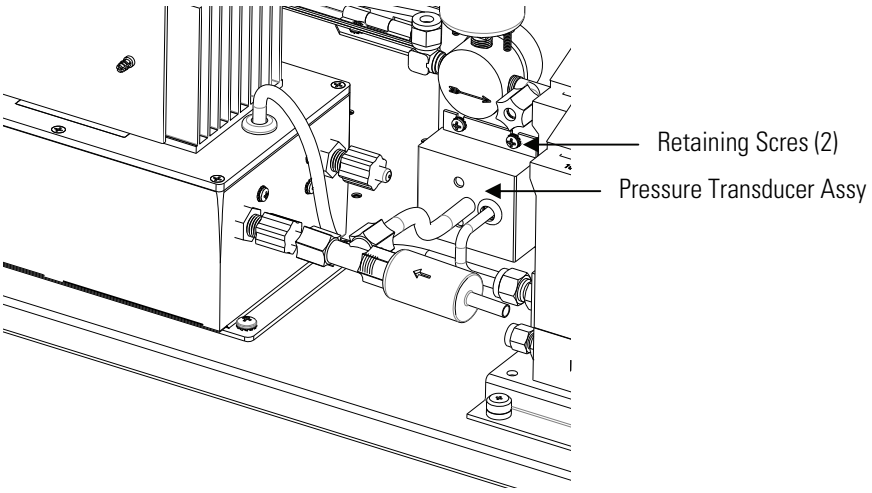


Figure 7–9. Replacing the Pressure Transducer Assembly

Pressure Transducer Calibration

Use the following procedure to calibrate the pressure transducer.

Note Do not try to calibrate the pressure transducer unless the pressure is known accurately and with NIST Traceability. ▲

Equipment Required:

Vacuum pump

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Remove the cover.

2. Disconnect the tubing from the pressure transducer and connect a vacuum pump known to produce a vacuum less than 1 mmHg.

3. From the Main Menu, press ↓ to scroll to **Service** > press ↵ > ↓ to scroll to **Pressure Calibration** > and press ↵.

The Pressure Sensor Cal menu appears.

Note If the Service menu selection is not displayed, refer to "Accessing the Service Mode" in this chapter, then return to the beginning of this step. ▲

4. At the Pressure Sensor Cal screen, press [↵] to select **Zero**.

   The Calibrate Pressure Zero screen appears.

5. Wait at least 30 seconds for the zero reading to stabilize, then press [↵] to save the zero pressure value.

6. Disconnect the pump from the pressure transducer.

7. Press [■] to return to the Pressure Sensor Cal screen.

8. At the Pressure Sensor Cal screen, press [↓] [↵] to select **Span**.

   The Calibrate Pressure Span screen appears.

9. Wait at least 30 seconds for the ambient reading to stabilize, use [←] [→] and [↑] [↓] to enter the known barometric pressure, and press [↵] to save the pressure value.

10. Reconnect the instrument tubing to the pressure transducer.

11. Install the cover.

Pressure Regulator Replacement

Use the following procedure to replace the pressure regulator assembly (**Figure 7–9**).

Equipment Required:

Pressure regulator assembly

Channel lock pliers, Nylon jaw

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Disconnect the pneumatic fittings.
3. Remove the pressure regulator retaining nut and remove the pressure regulator.
4. Remove the gauge from the pressure regulator.
5. Fit the new pressure regulator with the gauge and plug the unused port.

Ambient Temperature Calibration

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

Equipment Required:

Calibrated thermometer or 10K ±1% resistor

WARNING The service procedures in this manual are restricted to qualified 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 ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Remove the instrument cover.

2. Tape the thermistor (plugged into the measurement interface board) to a calibrated thermometer

Note Since the thermistors are interchangeable to an accuracy of ±0.2 °C, and have a value of 10K ohms at 25 °C, an alternate procedure is to connect an accurately known 10K 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, press [↓] to scroll to Service > press [↵] > [↓] to scroll to **Temperature Calibration** > and press [↵].

   The Calibrate Ambient Temperature screen appears.

Note If the Service menu selection is not displayed, refer to "Accessing the Service Mode" in this chapter, then return to the beginning of this step. ▲

4. Wait at least 30 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.

Scrubber Replacement

Use the following procedure to replace the Hg scrubber (**Figure 7–10**).

Equipment Required:

Hg scrubber assembly

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Disconnect the pneumatic connections from the scrubber assembly.
3. Unscrew the Teflon tubing at both ends of the scrubber.
4. Pull the scrubber off the mounting clips.
5. Push the replacement scrubber into the mounting clips.
6. Attach the Teflon tubing at both ends of the scrubber.
7. Replace the cover.

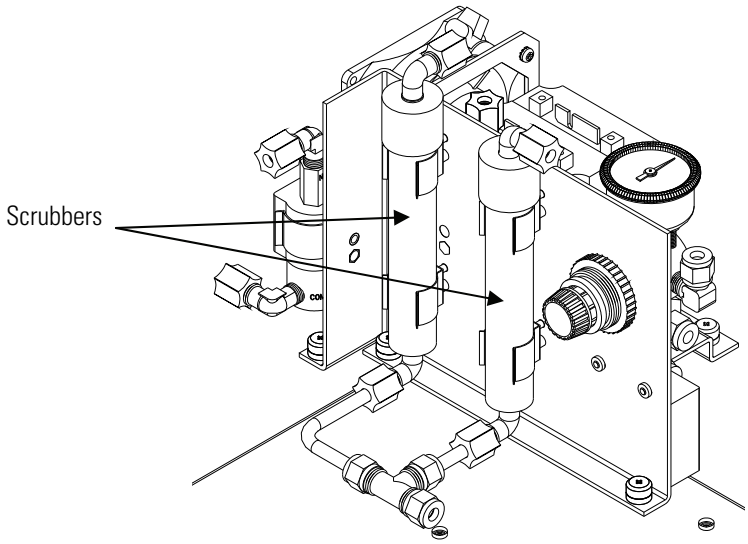


Figure 7–10. Replacing the Scrubber

I/O Expansion Board (Optional) Replacement

Use the following procedure to replace the optional I/O expansion board (**Figure 7–11**).

Note After replacing the optional I/O expansion board, calibrate the current outputs and the analog voltage inputs. See the "Analog Output Calibration" procedure and the "Analog Input Calibration" procedure in this chapter. ▲

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 ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

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

2. 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 7–12**).

4. Pop off the board from the mounting studs and remove the board.

5. To install the I/O expansion board, follow previous steps in reverse.

6. Calibrate the analog current outputs and analog voltage inputs per the procedure earlier in this chapter.

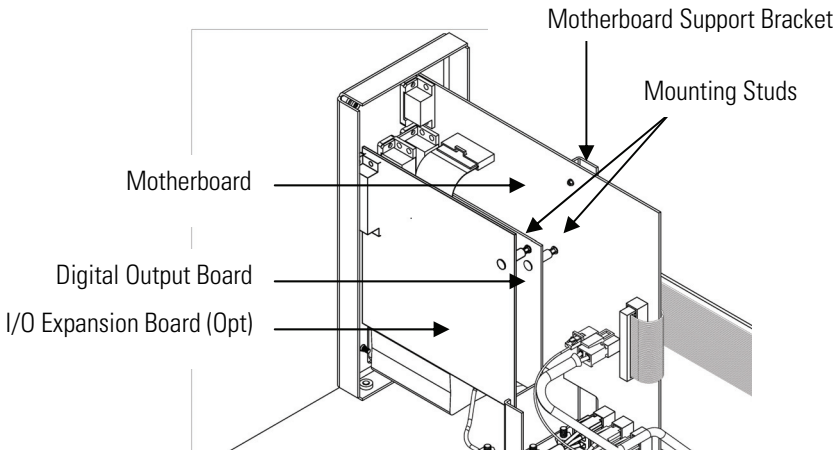


Figure 7–11. Replacing the I/O Expansion Board (Optional)

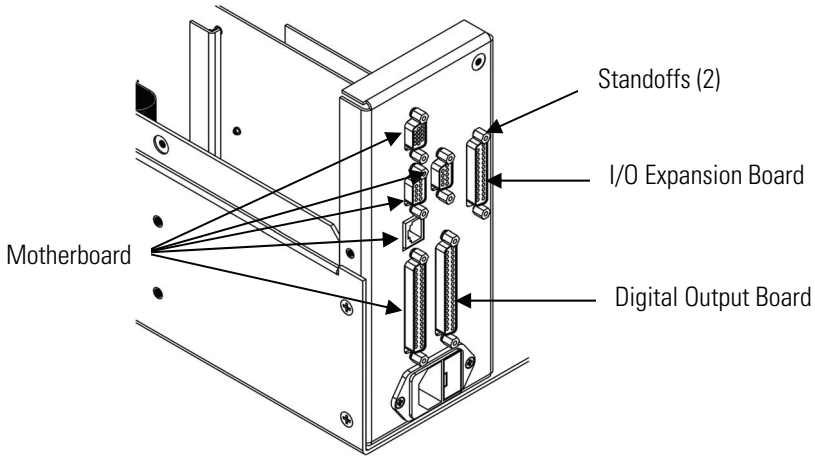


Figure 7–12. Rear Panel Board Connectors

Digital Output Board Replacement

Use the following procedure to replace the digital output board (**Figure 7–11**).

Equipment Required:

Digital output board

Nut driver, 3/16-inch

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

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

2. Remove the I/O expansion board (optional), if used. See "I/O Expansion Board (Optional) Replacement" on page 7-26 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 7–12**).

5. Pop off the digital output board from the mounting studs and remove the board.

6. To install the digital output board, follow previous steps in reverse.

Motherboard Replacement

Use the following procedure to replace the motherboard (**Figure 7–11**).

Equipment Required:

Motherboard

Philips screwdriver

Nut driver, 3/16-inch

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

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

2. Remove the I/O expansion board (optional), if used. See the "I/O Expansion Board Replacement" procedure in this chapter.

3. Remove the digital output board. See the "Digital Output Board Replacement" procedure in this chapter.

4. Unplug all connectors from the motherboard. Note connector locations to facilitate reconnection.

5. Using the nut driver, remove the standoffs securing the board to the rear panel (**Figure 7–12**).

6. Pop off the motherboard from motherboard support bracket, and remove the motherboard.

7. To install the motherboard, follow previous steps in reverse.

8. Calibrate the analog voltage outputs. Refer to the "Analog Output Calibration" procedure on page 7-17.

Measurement Interface Board Replacement

Use the following procedure to replace the measurement interface board (**Figure 7–13**).

Equipment Required:

Measurement interface board

Philips screwdriver

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

1. Refer to "Removing the Measurement Bench and Lowering the Partition Panel" in this chapter to lower the partition panel, then proceed to the next step below.

2. Unplug all connectors. Note the locations of the connectors to facilitate reconnection.

3. Unscrew the two screws at the top of the measurement interface board. Pop off the measurement interface board from the two bottom mounting studs and remove the board.

4. To install the measurement interface board, follow previous steps in reverse.

5. Re-install the measurement bench. Refer to "Removing the Measurement Bench and Lowering the Partition Panel" in this chapter.

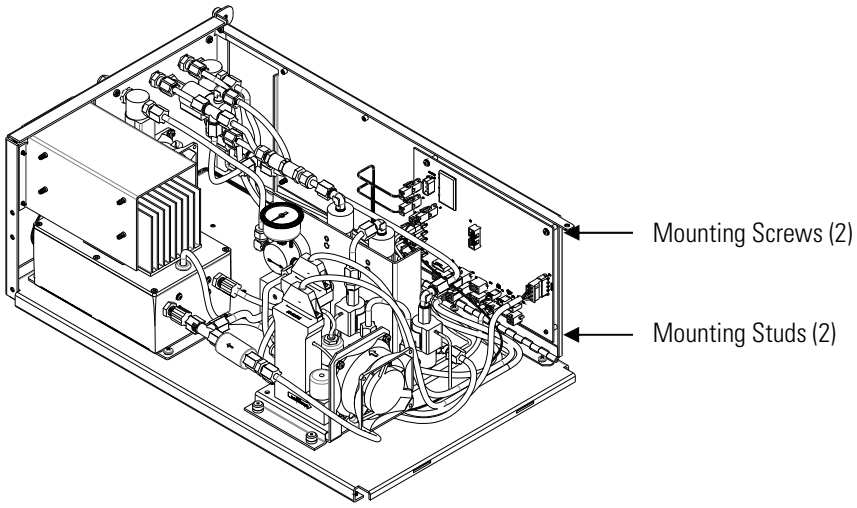


Figure 7–13. Replacing the Measurement Interface Board

Front Panel Board Replacement

Use the following procedure to replace the front panel board (**Figure 7–14**).

Equipment Required:

Front panel board

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

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

2. Remove the three ribbon cables and the two-wire connector from the front panel board.

3. Pop off the board from the two top mounting studs and remove the board by lifting it up and off the slotted bottom support.

4. Replace the front panel board by following previous steps in reverse.

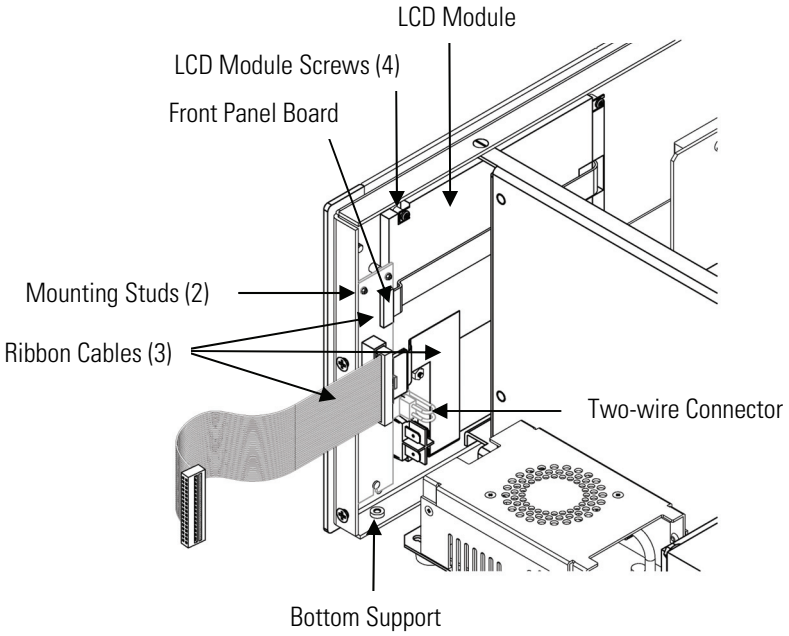


Figure 7–14. Replacing the Front Panel Board and the LCD Module

LCD Module Replacement

Use the following procedure to replace the LCD module (**Figure 7–14**).

Equipment Required:

LCD module

Philips screwdriver

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

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

Do not remove the LCD panel or frame from the LCD module. ▲

The LCD polarizing plate is very fragile, handle it carefully. ▲

Do not wipe the LCD polarizing plate with a dry cloth, it may easily scratch the plate. ▲

Do not use alcohol, acetone, MEK or other Ketone based or aromatic solvents to clean the module, use a soft cloth moistened with a naphtha cleaning solvent. ▲

Do not place the LCD module near organic solvents or corrosive gases. ▲

Do not shake or jolt the LCD module. ▲

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

2. Disconnect the ribbon cable and the two-wire connector from the front panel board.

3. Remove the four screws at the corners of the LCD module.

4. Slide the LCD module out towards the center of the instrument.

5. Replace the LCD module by following previous steps in reverse.

Note The optimal contrast will change from one LCD screen to another. After replacing the LCD screen, the contrast may need to be reset. If the content on the screen is visible, select Instrument Controls > **Screen Contrast** and adjust the screen contrast. If the content on the screen is not visible, use the "set contrast" C-Link command to set screen contrast to mid range, then optimize the contrast. See the "C-Link Protocol Commands" appendix for more information on this command. ▲

Service Locations

For additional assistance, 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 software structure, and includes a description of the system electronics and input/output connections and functions.

Hardware

Model 81*i* hardware components (**Figure 8–1**) include:

- Pressure transducer
- Pressure regulator
- Mass flow controllers
- MFC fan
- Solenoid valves
- Check Valve
- Cooler assembly
- Scrubber assembly
- Thermistor
- Rear panel fan

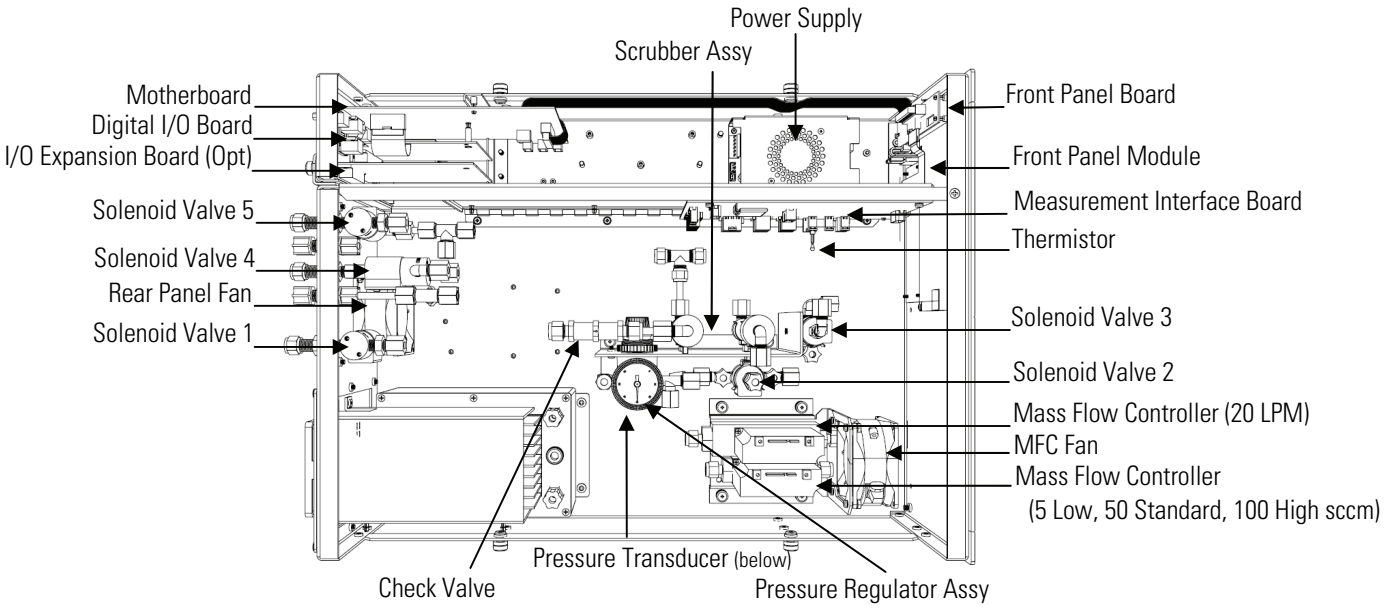


Figure 8–1. Hardware ComponentsPressure Transducer

The pressure transducer monitors calibration pressure for inclusion into the concentration calculation.

Pressure Regulator

The pressure regulator controls the flow of clean dry air to the MFCs.

Mass Flow Controllers

The 20 LPM MFC governs the dilution of Hg vapor. The 5, 50, or 100 sccm MFC controls air flow through the Hg vapor source.

MFC Fan

The mass flow controller fan provides cooling air for the mass flow controllers.

Solenoid Valves

The solenoid valves control the flow of calibration gas and zero air within the system for the different calibration modes.

Check Valve

The check valve is used to keep the orifice (located in the probe) from being over pressurized in the event of solenoid valve failure. Check valve flow arrow should face instrument front panel.

Cooler Assembly

The cooler controls the temperature of the Hg vapor source.

Scrubber Assembly

The scrubber assembly removes elemental Hg from the Hg saturated flow prior to the gas being sent to exhaust. Hg saturated flow is routed through the scrubber assembly during any zero air mode (instrument, orifice, or system).

Thermistor

The internal temperature thermistor monitors the ambient temperature within the instrument.

Rear Panel Fan

The rear panel fan provides cooling air for the internal components.

Software

The processor software 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 common firmware that is bundled with the high-level firmware and loaded on power-up if a different version is detected.

Each board has a specific address that is used to identify to the firmware what functions are supported on that board. This address is also used for the communications between the low-level processors and the high-level processor.

Every tenth of a second the frequency counters, analog I/O, and digital I/O are read and written to by the low-level processor. The counters are accumulated over the past second and the analog inputs are averaged over that second. The high-level processor polls the low-level processors once per second to exchange the measurement and control data.

Monitoring Signals

Signals are gathered from the low-level processors once per second, and then processed by the high-level processor to produce the final measurement values. The one-second accumulated counts are accumulated and reported for the user-specified averaging time. If this averaging time is greater than ten seconds, the measurement is reported every 10 seconds. The one-second average of the other analog inputs are reported directly (no additional signal conditioning is performed by the high-level processor).

Measurement Calculations

The calculation begins by subtracting the appropriate electronic offset from the seven-second count accumulation. Following this correction, the raw accumulated counts are scaled according to the gain setting of the input board.

Next, the uncorrected values are determined according to a unique averaging algorithm which minimizes errors resulting from rapidly changing gas concentrations. This algorithm results in values which are stored in RAM in a circular buffer that holds all the ten second data from the previous five minutes. This data is averaged over the selected time interval, which can be any multiple of ten between 10 and 300 (the manual modes have additional intervals of 1, 2, and 5 seconds).

The background values, which are corrected for temperature, are subtracted from their respective averages. The reading is corrected by the stored span factor and by the temperature factor.

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 Hg concentrations. The display is updated every 1-10 seconds, depending on the averaging time.

The analog output ranges are user selectable via software. The analog outputs are defaulted based on the measurement range. The defaults are calculated by dividing the data values by the full-scale range for each of the three parameters and then multiplying each result by the user-selected output range. Negative concentrations can be represented as long as they are within -5% of full-scale. The zero and span values may be set by the user to any desired value.

Electronics

All electronics operate from a universal switching supply, which is capable of auto-sensing the input voltage and working over the entire operating range.

The external pump and heaters all operate on 110VAC. An optional transformer is required if operating on the 210-250VAC or 90-110VAC ranges.

An on/off switch controls all power to the instrument, and is accessible on the front panel.

Motherboard

The motherboard contains the main processor, power supplies, a sub-processor and serves as the communication hub for the instrument.

The motherboard receives operator inputs from the front panel mounted function key panel and/or over I/O connections on the rear panel and sends commands to the other boards to control the functions of the instrument and to collect measurement and diagnostic information.

The motherboard outputs instrument status and measurement data to the front-panel mounted graphics display and to the rear-panel I/O.

The motherboard also contains I/O circuitry and the associated connector to monitor external digital status lines and to output analog voltages that represent the measurement data.

Connectors located on the motherboard include:

External Connectors

External connectors include:

- External Accessory
- RS-232/485 Communications (two connectors)
- Ethernet Communications
- I/O connector with Power Fail Relay, 16 Digital Inputs, and 6 Analog Voltage Outputs.

Internal Connectors

Internal connectors include:

- Function key panel and Display
- Measurement Interface Board Data
- I/O Expansion Board Data
- Digital Output Board

- AC distribution

Measurement Interface Board

The measurement interface board serves as a central connection area for all measurement electronics in the instrument. It contains power supplies and interface circuitry for sensors and control devices in the measurement system. It sends status data to the motherboard and receives control signals from the motherboard.

Measurement Interface Board Connectors

Connectors located on the measurement interface board include:

- Data communication with the motherboard
- 24V and 120VAC power supply inputs
- Fan and solenoid outputs
- Flow and pressure sensors
- Ambient temperature sensor

Pressure Sensor Assembly

The pressure sensor assembly consists of a board containing an instrumentation amplifier and a pressure transducer with a gas input fitting. The pressure transducer output is produced by measuring the pressure difference between the sample gas pressure and ambient air pressure.

Temperature Control

The temperature is measured with a thermistor. The voltage across the thermistor is fed to the main processor for use in calculating and displaying the temperature.

Digital Output Board

The digital output board connects to the motherboard and provides solenoid driver outputs and relay contact outputs to a connector located on the rear panel of the instrument. Ten relay contacts normally open (with power off) are provided which are electrically isolated from each other. Eight solenoid driver outputs (open collector) are provided along with a corresponding +24VDC supply pin on the connector.

Front Panel Connector Board

The front panel connector board interfaces between the motherboard and the front panel mounted function key panel and Graphics display. It serves as 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 Expansion Board (Optional)

The optional I/O Expansion board connects to the motherboard and adds the capability to input external analog voltage inputs and to output analog currents via a connector located on the rear panel of the instrument. It contains local power supplies, a DC/DC isolator supply, a sub-processor and analog circuits. Eight analog voltage inputs are provided with an input voltage range of 0V to 10 VDC. Six current outputs are provided with a normal operating range of 0 to 20 mA.

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 software configured for any one of the following ranges, while maintaining a minimum resolution of 12 bits:

- 0-100mV
- 0-1V
- 0-5V
- 0-10V

The user can calibrate each analog output zero and span point through firmware. At least 5% of full-scale over and under range are also supported, but may be overridden in software 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

The optional I/O Expansion board includes six isolated current outputs. These are software 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 firmware. At least 5% of full-scale over and under range are also supported, but may be overridden in software if required.

The analog outputs may be assigned to any measurement or diagnostic channel with a user-defined range in the units of the selected parameter. The current outputs are independent of the voltage outputs. The current outputs are isolated from the instrument power and ground, but they share a common return line (Isolated GND).

Analog Voltage Inputs (Optional)

Eight analog voltage inputs are used to gather measurement data from third-party devices. The user may assign a label, unit, and a conversion table (2 to 10 points). Each point in the conversion table consists of an analog input voltage value (0-10.5 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 10.5 volts.

Digital Output Relays

The instrument includes one power fail relay on motherboard and ten digital output relays on the digital output board. These are reed relays rated for at least 500 mA @ 200VDC.

The power fail relay is Form C (both normally 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 instrument, as well as remote control to other devices, such as for controlling valves during calibration. The user may select what information is sent out 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. The actual use of these inputs will vary based on instrument configuration.

The digital inputs are TTL level compatible and are pulled up within the instrument. The active state can be user defined in firmware.

Serial Ports

Two serial ports allow daisy chaining so that multiple instruments 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 firmware for standard speeds from 1200 to 19,200 baud. The user can also set the data bits, parity, and stop bits. The following protocols are supported:

- C-Link
- Streaming Data
- Modbus Slave
- Geysitech (Bayern-Hessen)

The Streaming Data protocol transmits user-selected measurement data via the serial port in real-time for capture by a serial printer, data logger, or PC.

RS-232 Connection

A null modem (crossed) cable is required when connecting the instrument to an IBM Compatible PC. However, a straight cable (one to one) may be required when connecting the instrument 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 port is used in to communicate with smart external devices, such as the 82*i* Probe Controller. These devices may be mounted hundreds of feet from the instrument using an RS-485 electrical interface.

Chapter 9
Optional Equipment

The Model 81*i* is available with the following options:

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 (0-10V). The DB25 connector on the rear panel provides the interface for these inputs and outputs.

25-Pin Terminal Board Assembly

The 25-pin terminal board assembly is included with the I/O expansion board. Refer "Terminal Board PCB Assemblies" in the "Installation" chapter for information on attaching the cable to the connector board. For associated part numbers, refer to "External Device Connection Components" in the "Servicing" chapter.

Terminal Block and Cable Kits

The optional terminal block and cable kits provide a convenient way to connect devices to the instrument. These kits break out the signals on the rear panel connector to individual numbered terminals.

Two types of terminal block and cable kits are available. One kit is for the DB37 connectors and can be used for either the analog output connector or the relay output connector. The other kit is for the DB25 connector and can be used for the I/O expansion board. For associated part numbers, refer to "External Device Connection Components" in the "Servicing" chapter.

Each kit consists of:

- one six-foot cable
- one terminal block

- one snap track

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 provides the cable color codes. For associated part numbers, refer to "External Device Connection Components" in the "Servicing" chapter.

Note Table 9–2 provides the color coding for both 25-pin cables and 37-pin cables. Color codes for pins 1-25 are for 25-pin cables; color codes for pins 1-37 are for 37-pin cables. ▲

Table 9–1. Cable Options

Description	Cable Length
DB37M to open end	Six feet
DB37F to open end	Six feet
DB25M to open end	Six feet
RS-232	

Table 9–2. Color Codes for 25-Pin and 37-Pin Cables

Pin	Color	Pin	Color
1	BLACK	20	RED/BLACK
2	BROWN	21	ORANGE/BLACK
3	RED	22	YELLOW/BLACK
4	ORANGE	23	GREEN/BLACK
5	YELLOW	24	GRAY/BLACK
6	GREEN	25	PINK/BLACK
7	BLUE	End color codes for 25-pin cables continue for 37-pin cables.	
8	VIOLET	26	PINK/GREEN
9	GRAY	27	PINK/RED
19	WHITE	28	PINK/VIOLET

Pin	Color	Pin	Color
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 instrument 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	The rail mounting location is lower on the case and the front mounting screw slots are in non-standard EIA locations.

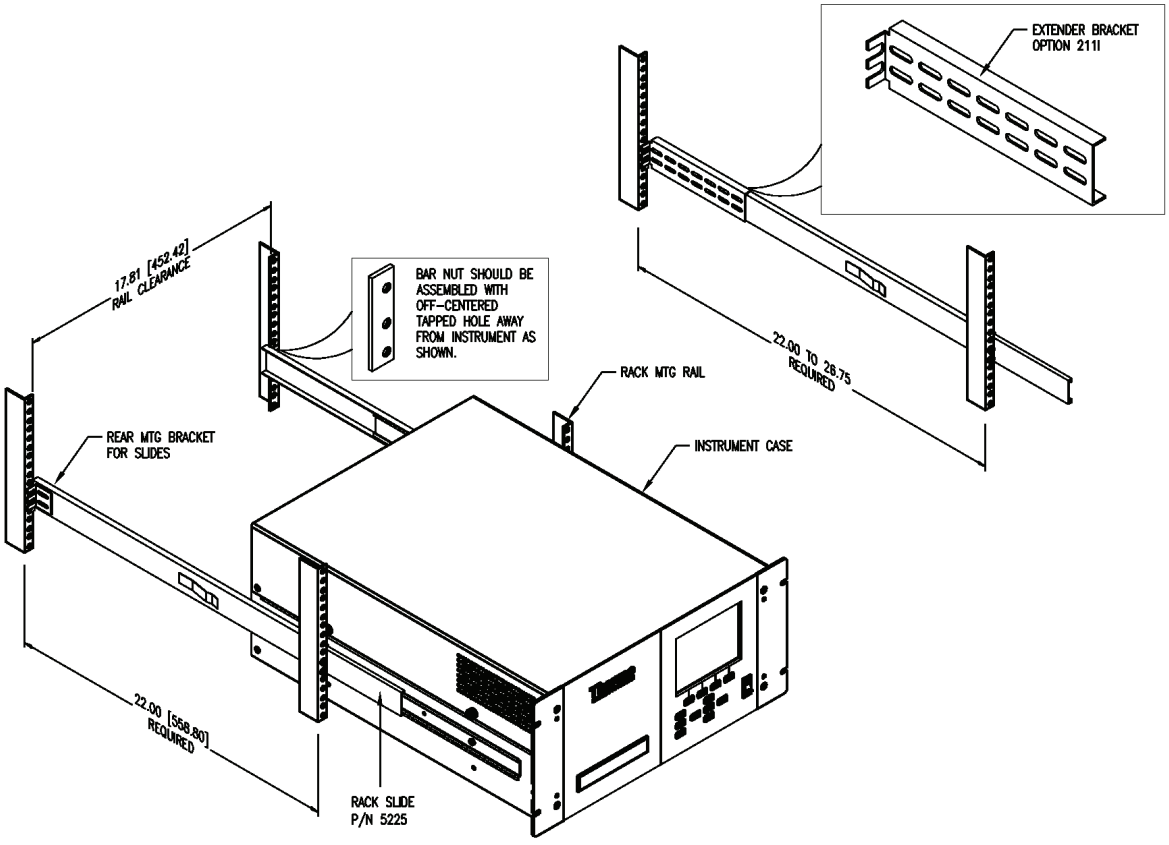


Figure 9–1. Rack Mount Option Assembly

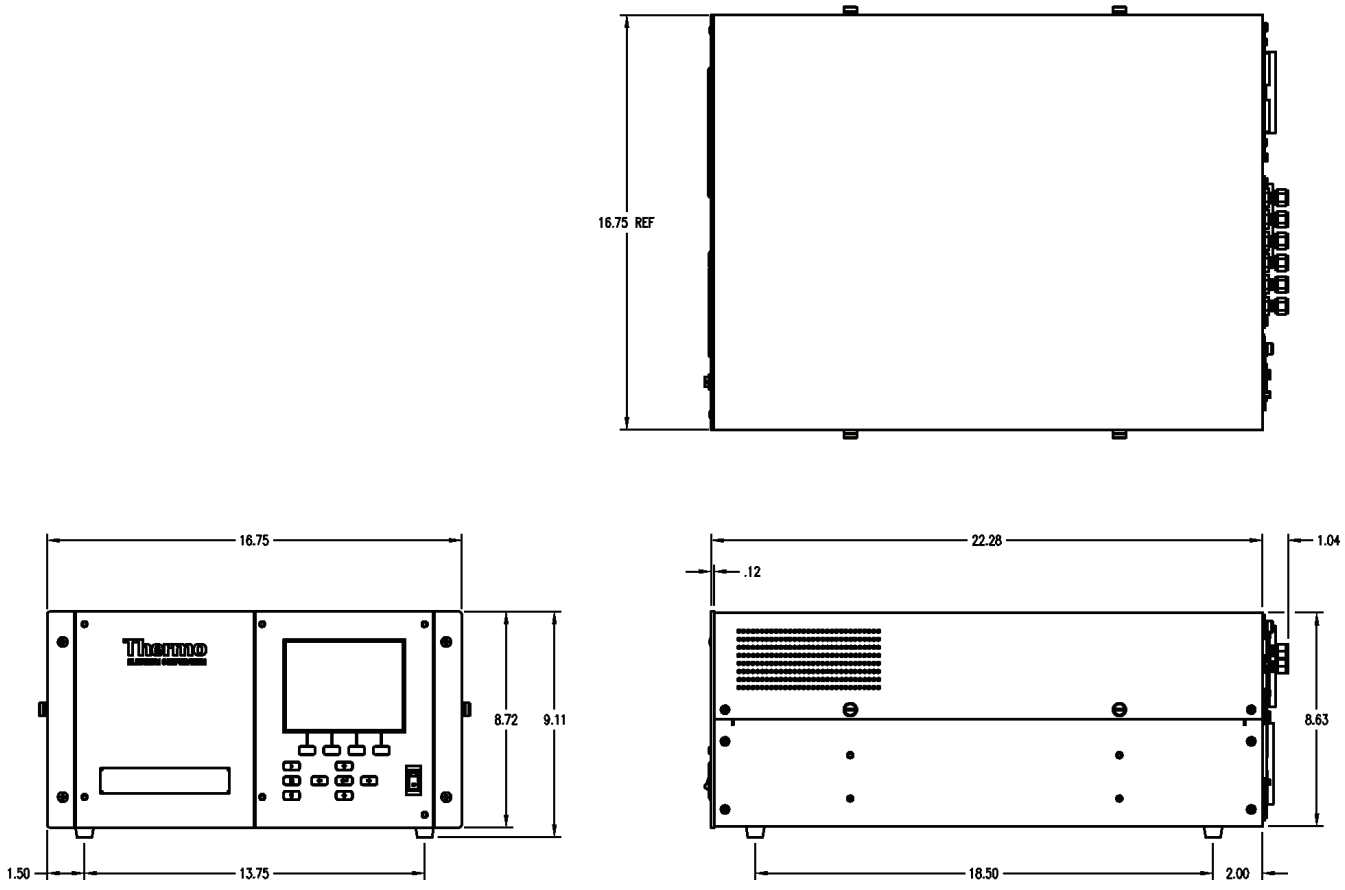


Figure 9–2. Bench Mounting

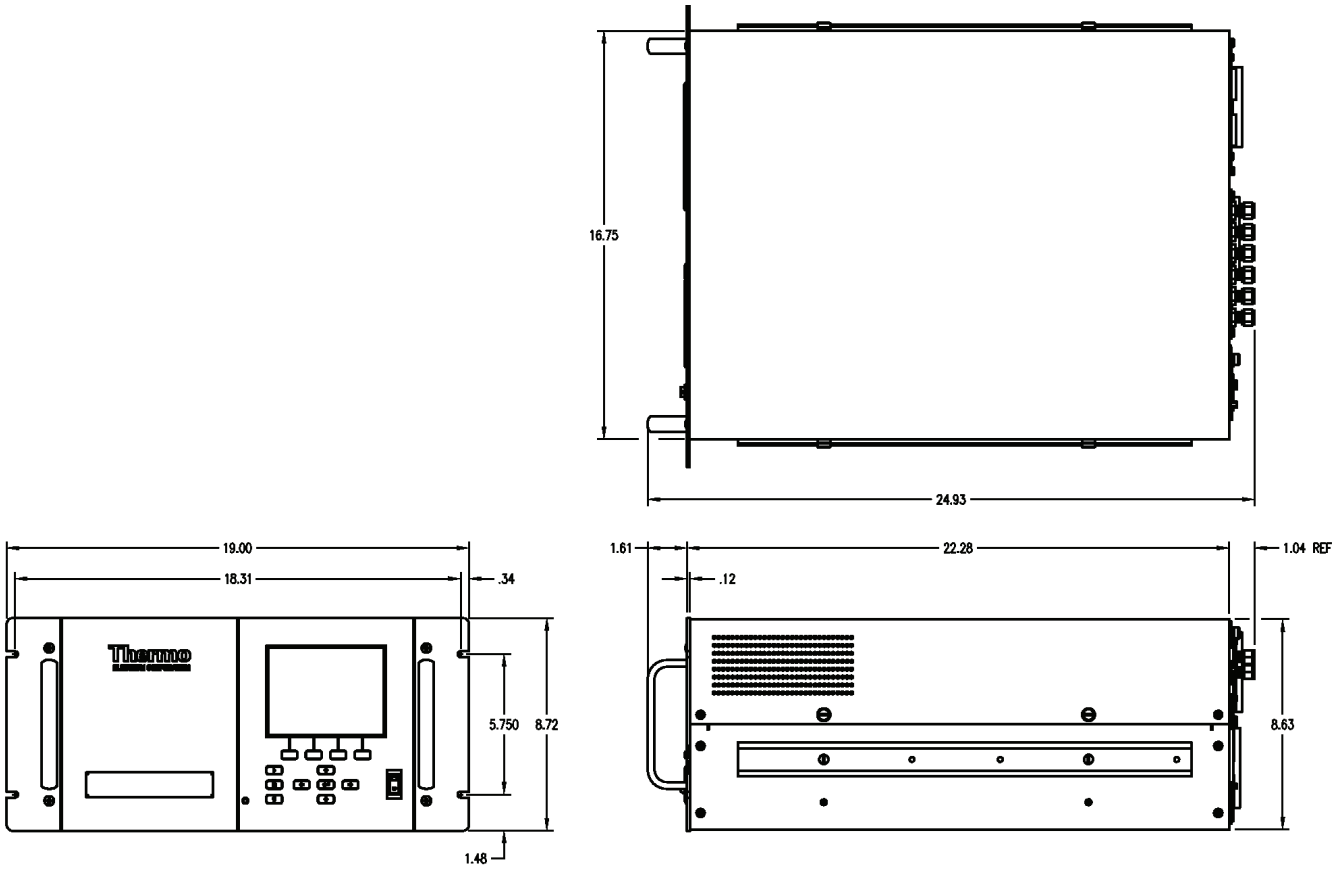


Figure 9–3. EIA Rack Mounting

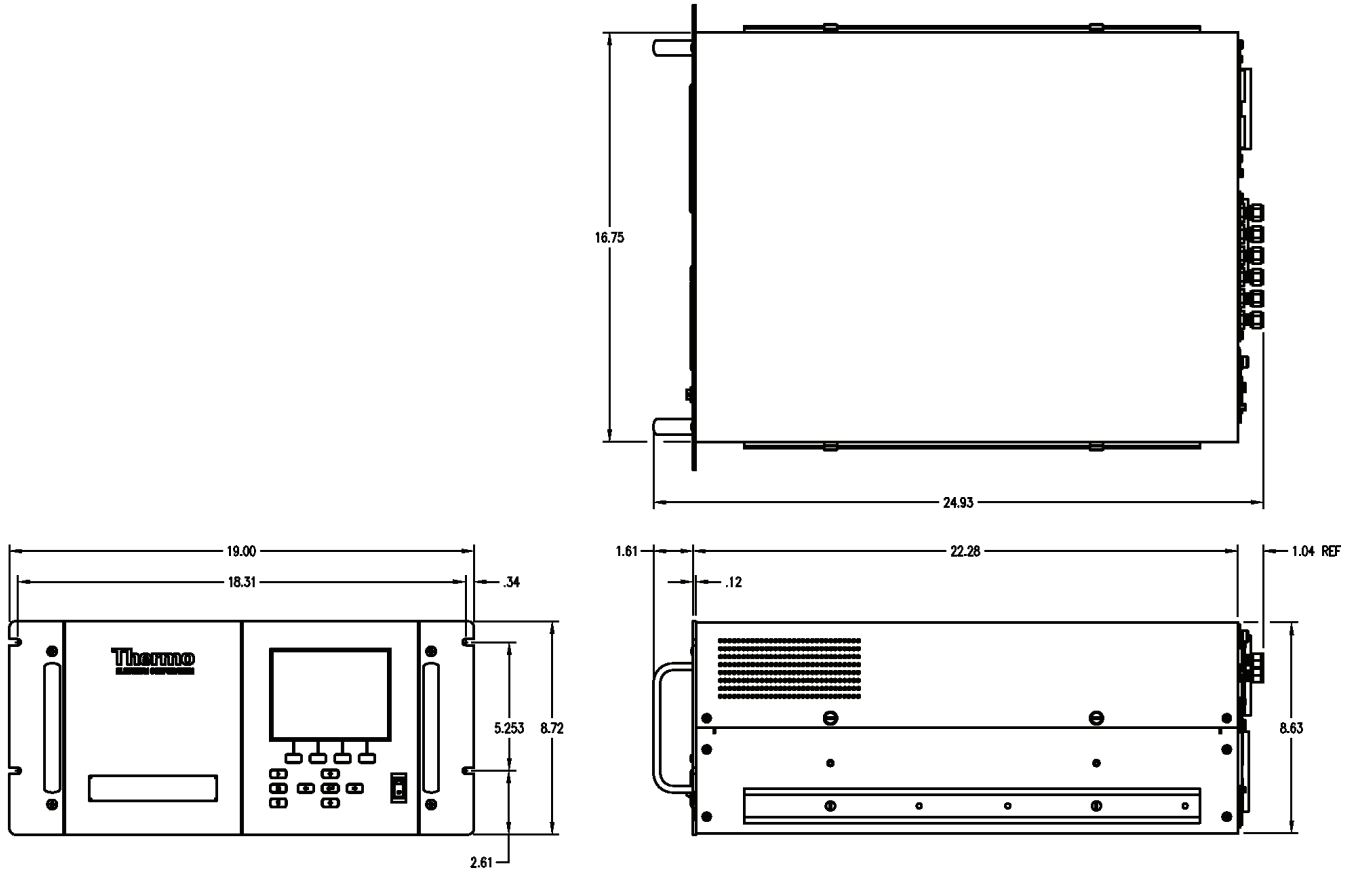


Figure 9–4. Retrofit Rack Mounting

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.

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Appendix B
C-Link Protocol Commands

This appendix provides a description of the C-Link protocol commands that can be used to remotely control a Model 81*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/IP port 9880. Streaming data may be accessed over Ethernet using TCP/IP port 9881. Up to three simultaneous connections per protocol may be made over Ethernet.

Instrument Identification Number

Each command sent to the instrument must begin with the American Standard Code for Information Interchange (ASCII) symbol or byte value equivalent of the instrument's identification number plus 128. For example, if the instrument ID is set to 25, then each command must begin with the ACSII character code 153 decimal. The instrument 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 instrument must be in the remote mode in order to change instrument parameters via remote. However, the command "set mode remote" can be sent to the instrument 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 can be sent in either uppercase or lowercase characters. Each command must begin with the proper instrument identification number (ASCII) character. The command in the example that follows begins with the ASCII character code 208 decimal, which directs the command to the Model 81*i,* and is terminated by a carriage return “CR” (ASCII character code 13 decimal).

<ASCII 208>	T	I	M	E	<CR>

If an incorrect command is sent, a “bad command” message will be received. The example that follows sends the incorrect command “set sp field 1” instead of the correct command “`set sp field 1 34`”.

```
Send:          set sp field 1
Receive:       set sp field 1 bad cmd
```

Table B–1 provides a description of the command response errors.

Table B–1. Command Response Error Descriptions

Command Response	Description
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

The "save" and "set save params" commands "stores parameters in FLASH. 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.

Accessing Streaming Data

Streaming data is sent out the serial port or the Ethernet port on a user-defined periodic basis. Streaming data over Ethernet is only generated when a connection is made on TCP port 9881. Up to three simultaneous connections are allowed per protocol.

Service Mode

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.

Commands List

Table B–2 lists the 81*i* C-Link protocol commands. The interface will respond to the associated command strings.

Table B–2. C-Link Protocol Commands

Command	Description	Page
addr dns	Reports/sets domain name server address	B-27
addr gw	Reports/sets default gateway address	B-27
addr ip	Reports/sets IP address	B-28
addr nm	Reports/sets netmask address	B-28
addr ntp	Reports the IP address for the NTP time server	B-29
alarm ambient temp max	Reports/sets ambient alarm maximum value	B-10
alarm ambient temp min	Reports/sets ambient alarm minimum value	B-10
alarm conc hg max	Reports/sets Hg concentration alarm maximum value	B-10
alarm conc hg min	Reports/sets Hg concentration alarm minimum value	B-10
alarm cooler temp max	Reports/sets current cooler alarm maximum value	B-11
alarm cooler temp min	Reports/sets current cooler alarm minimum value	B-11
alarm dilution flow max	Reports/sets current dilution flow alarm maximum value	B-11
alarm dilution flow min	Reports/sets current dilution flow alarm minimum value	B-11
alarm hg flow max	Reports/sets current Hg flow alarm maximum value	B-12
alarm hg flow min	Reports/sets current Hg flow alarm minimum value	B-12
alarm pressure max	Reports/sets current pressure alarm maximum value	B-12
alarm pressure min	Reports/sets current pressure alarm minimum value	B-12
alarm trig conc hg	Reports/sets current trig conc Hg alarm trigger sense	B-13
allow mode cmd	Reports/sets the current allow set mode remote" commands.	B-32
ambient temp	Reports current ambient temperature	B-8

Command	Description	Page
analog iout range	Reports/sets analog current output range per channel	B-34
analog vin	Retrieves analog voltage input data per channel	B-35
analog vout range	Reports/sets analog voltage output range per channel	B-35
baud	Reports/sets current baud rate	B-29
clr lrecs	Clears away only long records that have been saved	B-14
clr records	Clears away all logging records that have been saved	B-14
clr srecs	Clears away only short records that have been saved	B-14
contrast	Reports/sets current screen contrast	B-25
cooler setpoint	Reports/sets current cooler setpoint for 81*i* and 81*i*-L options	B-8
cooler temp	Reports current cooler temperature	B-8
copy lrec to sp	Sets/copies current lrec selection into the scratch pad	B-20
copy sp to lrec	Sets/copies current selections in scratch pad into lrec list	B-20
copy sp to srec	Sets/copies current selections in scratch pad into srec list	B-20
copy sp to stream	Sets/copies current selections in scratch pad into stream list	B-20
copy srec to sp	Sets/copies current srec selection into the scratch pad	B-20
copy stream to sp	Sets/copies current streaming data selection into the scratch pad	B-20
data treatment lrec/srec	Reports/sets the current selection of data treatment for concentrations in the lrecs or srecs	B-19
date	Reports/sets current date	B-26
default params	Sets parameters to default values	B-26
dhcp	Reports/sets state of use of DHCP	B-29
diag volt iob	Reports diagnostic voltage level for optional I/O expansion board	B-13
diag volt mb	Reports diagnostic voltage level for motherboard	B-13
diag volt mib	Reports diagnostic voltage level for measurement interface board	B-13
diag volt probe	Reports diagnostic voltage level for 82*i* measurement interface board	B-14
dig in	Reports status of the digital inputs	B-35
dilution flow	Reports the current dilution flow	B-8
din	Reports/sets digital input channel and active state	B-35
do (down)	Simulates pressing down pushbutton	B-22
dout	Reports/sets digital output channel and active state	B-36
dtoa	Reports outputs of the digital to analog converters per channel	B-36
en (enter)	Simulates pressing enter pushbutton	B-22
er	Returns a brief description of the main operating conditions in the format specified in the commands	B-15

Command	Description	Page
erec	Returns a snapshot of the main operating conditions (measurements and status) in the specified format	B-15
erec format	Reports/sets erec format (ASCII or binary)	B-16
erec layout	Reports current layout of erec data	B-16
flags	Reports 8 hexadecimal digits (or flags) that represent the status of the PMT, gas mode, and alarms	B-9
format	Reports/sets current reply termination format	B-30
gas mode	Reports/sets current gas mode	B-24
he (help)	Simulates pressing help pushbutton	B-22
hg	Reports current measured Hg concentration	B-8
hg flow	Reports current measured Hg flow	B-9
hg span	Reports/sets Hg span values	B-24
hg span conc	Reports/sets Hg span concentration	B-25
hg span range	Reports/sets Hg span range	B-24
host name	Reports/sets host name string	B-30
instr name	Reports instrument name	B-31
instrument id	Reports/sets instrument id	B-31
isc (iscreen)	Retrieves framebuffer data used for the display	B-22
layout ack	Disables stale layout/layout changed indicator ('*')	B-31
le (left)	Simulates pressing left pushbutton	B-22
list din	Lists current selection for digital input	B-14
list dout	Lists current selection for digital output	B-14
list lrec	Lists current selection lrec logging data	B-15
list sp	Lists current selection in the scratchpad list	B-15
list srec	Lists current selection srec logging data	B-15
list stream	Lists current selection streaming data output	B-15
list var aout	Reports list of analog output, index numbers, and variables	B-37
list var din	Reports list of digital input, index numbers, and variables	B-37
list var dout	Reports list of digital output, index numbers, and variables	B-37
lr	Outputs long records in the format specified in the command	B-15
lrec	Outputs long records	B-17
lrec format	Reports/sets output format for long records (ASCII or binary)	B-16
lrec layout	Reports current layout of lrec data	B-16
lrec mem size	Reports maximum number of long records that can be stored	B-17

Command	Description	Page
lrec per	Reports/sets long record logging period	B-18
malloc lrec	Reports/sets memory allocation for long records	B-18
malloc srec	Reports/sets memory allocation for short records	B-18
me (menu)	Simulates pressing menu pushbutton	B-22
mode	Reports the operating mode in local, service, or remote	B-33
no of lrec	Reports/sets number of long records stored in memory	B-18
no of srec	Reports/sets number of short records stored in memory	B-18
power up mode	Reports/sets the power up mode which configures the instrument to power up in either the local/unlocked mode or the remote/locked mode.	B-33
pres	Reports current optical chamber pressure	B-9
program no	Reports instrument program number	B-34
push	Simulates pressing a key on the front panel	B-22
r cooler setpoint	Reports/sets cooler setpoint according to range (20, 30, 50, 300) for 81*i*-H only	B-19
ri (right)	Simulates pressing right pushbutton	B-22
ru (run)	Simulates pressing run pushbutton	B-22
save	Stores parameters in FLASH	B-26
save params	Stores parameters in FLASH	B-26
sc (screen)	C-series legacy command that reports a generic response (Use iscreen instead)	B-23
sp field	Reports/sets item number and name in scratch pad list	B-20
sr	Reports last short record stored	B-15
srec	Reports maximum number of short records	B-17
srec format	Reports/sets output format for short records (ASCII or binary)	B-16
srec layout	Reports current layout of short record data	B-16
srec mem size	Reports maximum number of short records	B-17
srec per	Reports/sets short record logging period	B-18
stream per	Reports/sets current set time interval for streaming data	B-21
stream time	Reports/sets a time stamp to streaming data or not	B-21
time	Reports/sets current time (24-hour time)	B-27
tz	Reports the "tz" timezone string for the NTP server	B-34
up	Simulates pressing up pushbutton	B-22

Measurements

ambient temp
This command reports the current ambient temperature. The example below shows that the ambient temperature is 30 °C.

```
Send:         ambient temp
Receive:      ambient temp 30 deg C
```

cooler setpoint
This command reports the current setpoint of the cooler. The example below shows that the cooler setpoint is 9 °C.

```
Send:         cooler setpoint
Receive:      cooler setpoint 9 deg C
```

set cooler setpoint *temp*
temp = integer value between 5 and 10 °C for 81*i* and 7 and 12 °C for 81*i*-L.
This command sets the current setpoint of the cooler. The example below sets the cooler setpoint to 9 °C.

```
Send:         set cooler setpoint 9
Receive:      set cooler setpoint 9 ok
```

Note The cooler setpoint and set cooler setpoint commands are only available for the standard 81*i* and 81*i*-L option. To view and set cooler setpoints for the 81*i*-H option, see the command r*xxx* cooler setpoint below. ▲

cooler temp
This command reports the current cooler temperature. The example below shows that the cooler temperature is 13.9 °C.

```
Send:         cooler temperature
Receive:      cooler temperature 13.9 deg C
```

dilution flow
This command reports the current dilution flow. The example below shows that the dilution flow is 12.625 lpm.

```
Send:         dilution flow
Receive:      dilution flow 12.625 lpm
```

hg
This command reports the measured Hg concentration. The example below shows that the Hg concentration is 10 µg/m^3.

```
Send:          hg
Receive:       hg 1.000E+01
```

hg flow

This command reports the measured Hg flow. The example below shows that the Hg flow is 9.250 sccm.

```
Send:          hg
Receive:       hg 9.250 sccm
```

pres

This command reports the Hg source pressure. The example below shows that the actual Hg source pressure is 48.7 mmHg.

Troubleshooting Note The pres command reports the Hg source pressure not to exceed 1300 mmHg (high) or 750 mmHg (low). A low pressure reading indicates a possible leak in the Hg source path. ▲

```
Send:          pres
Receive:       pres 48.7 mm Hg
```

flags

This reports 8 hexadecimal digits (or flags) that represent status of gas mode, service mode, password locked, and alarms. To decode the flags, each hexadecimal digit is converted to binary as shown in the **Figure B–1**. It is the binary digits that define the status of each parameter. In the example below, the instrument is reporting that there is an Hg Concentration alarm (high) and a Pressure alarm (low).

```
Send:          flags
Receive:       flags 00000042
```

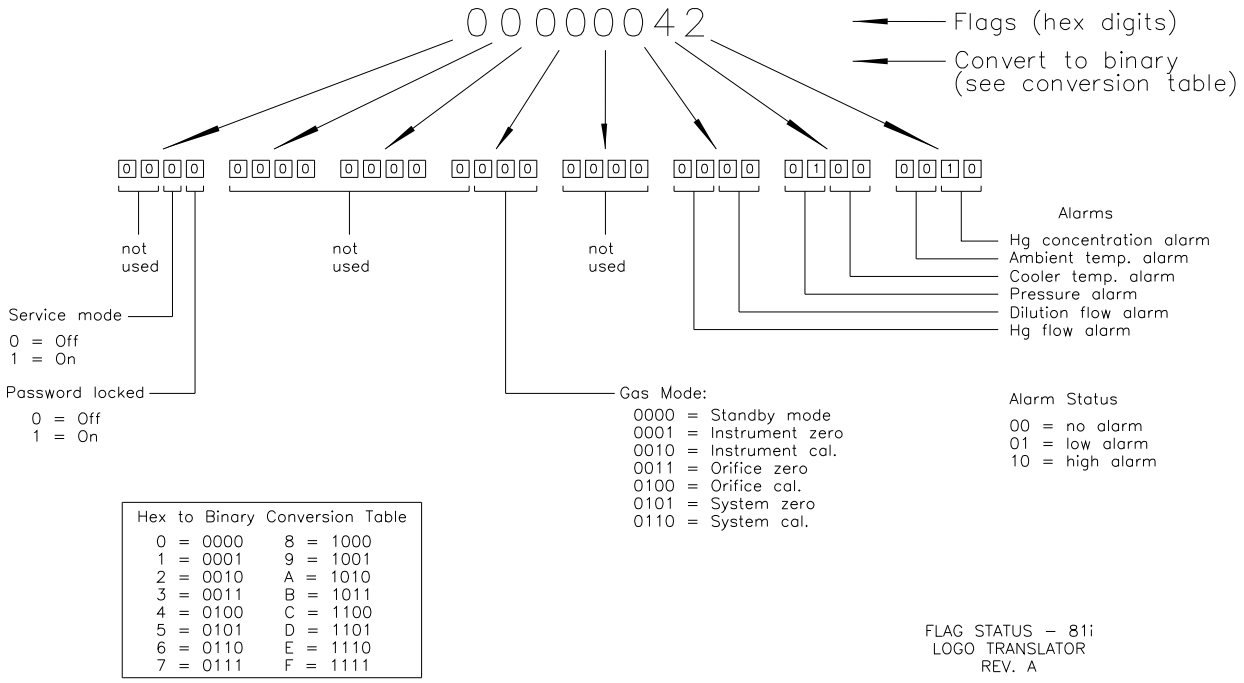

Figure B–1. Flag Status

Alarms

alarm ambient temp min
alarm ambient temp max
These commands report the ambient temperature alarm minimum and maximum value current settings. The example below reports that the ambient temperature alarm minimum value is 15.0 °C.

```
Send:          alarm ambient temp min
Receive:       alarm temp min 15.0 deg C
```

set alarm ambient temp min *value*
set alarm ambient temp max *value*
These commands set the ambient temperature alarm minimum and maximum values to value, where value is a floating-point number representing ambient temperature alarm limits in degrees C. The example below sets the ambient temperature alarm maximum value to 35.0 °C.

```
Send:          set alarm ambient temp max 35
Receive:       set alarm ambient temp max 35 ok
```

alarm conc hg min
alarm conc hg max

These commands report the Hg concentration alarm minimum and maximum value current setting. The example below reports that the Hg concentration minimum is 2.5 µg/m^3.

```
Send:         alarm conc hg min
Receive:      alarm conc hg min 2.5 ug/m3
```

set alarm conc hg min *value*
set alarm conc hg max *value*
These commands set the Hg concentration alarm minimum and maximum value to value, where value is a floating-point representation of the concentration alarm limits. The example below sets the Hg concentration alarm maximum value to 55 µg/m^3.

```
Send:         set alarm conc hg max 55
Receive:      set alarm conc hg max 55 ug/m3 ok
```

---

alarm cooler temp min
alarm cooler temp max
These commands report the cooler temperature alarm minimum and maximum value current settings. The example below reports that the cooler temperature alarm minimum value is 13.0 °C.

```
Send:         alarm cooler temp min
Receive:      alarm cooler temp min 13.0 deg C
```

set alarm cooler temp min *value*
set alarm cooler temp max *value*
These commands set the cooler temperature alarm minimum and maximum values to value, where value is a floating-point number representing cooler temperature alarm limits in degrees C. The example below sets the cooler temperature alarm maximum value to 17.0 °C.

```
Send:         set alarm cooler temp max 17
Receive:      set alarm cooler temp max 17 deg C ok
```

---

alarm dilution flow min
alarm dilution flow max
These commands report the dilution flow alarm minimum and maximum value current settings. The example below reports that the dilution flow alarm minimum value is 1.0 lpm.

```
Send:         alarm dilution flow min
Receive:      alarm dilution flow min 1.000 lpm
```

set alarm dilution flow min *value*
set alarm dilution flow max *value*

These commands set the dilution flow alarm minimum and maximum values to *value*, where *value* is a floating-point number representing dilution flow limits in psi. The example below sets the dilution flow alarm maximum value to 25 lpm.

```
Send:         set alarm dilution flow max 25
Receive:      set alarm dilution flow max 25 ok
```

---

alarm hg flow min
alarm hg flow max
These commands report the hg flow alarm minimum and maximum value current settings. The example below reports that the hg flow alarm minimum value is 2.5 sccm.

```
Send:         alarm hg flow min
Receive:      alarm hg low min 2.500 sccm
```

set alarm hg flow min *value*
set alarm hg flow max *value*
These commands set the hg flow alarm minimum and maximum values to *value*, where *value* is a floating-point number representing hg flow limits in psi. The example below sets the hg flow alarm maximum value to 52.5 sccm.

```
Send:         set alarm hg flow max 52.5
Receive:      set alarm hg flow max 52.500 ok
```

---

alarm pressure min
alarm pressure max
These commands report the pressure alarm minimum and maximum value current settings. The example below reports that the pressure alarm minimum value is 800 mmHg.

```
Send:         alarm pressure min
Receive:      alarm pressure min 800.0 mm Hg
```

set alarm pressure min *value*
set alarm pressure max *value*
These commands set the pressure alarm minimum and maximum values to value, where value is a floating-point number representing pressure alarm limits in millimeters of mercury. The example below sets the pressure alarm maximum value to 800 mmHg.

```
Send:         set alarm pressure max 800
Receive:      set alarm pressure max 800.0 ok
```

alarm trig conc hg
This command reports the Hg concentration alarm trigger action for minimum alarm, current setting, to either floor or ceiling. The example below shows the Hg concentration minimum alarm trigger to ceiling, according to **Table B–3**.

```
Send:         alarm trig conc hg
Receive:      alarm trig conc hg 1
```

set alarm trig conc hg *value*
This command sets the Hg concentrations alarm minimum value, where value is set to either floor or ceiling, according to **Table B–3**. The example below sets the Hg concentration minimum alarm trigger to ceiling.

```
Send:         set alarm trig conc hg 1
Receive:      set alarm trig conc hg 1 ok
```

Table B–3. Alarm Trigger Values

Value	Alarm Trigger
00	Floor
01	Ceiling

Diagnostics

diag volt mb
This command reports the diagnostic voltage measurements on the motherboard. The sequence of voltages is: positive 24, positive 15, positive 5, positive 3.3, and negative 3.3. Each voltage value is separated by a space.

```
Send:         diag volt mb
Receive:      diag volt mb 24.1 14.9 4.9 3.2 -3.2
```

diag volt mib
This command reports the diagnostic voltage measurements on the measurement interface board. The sequence of voltages is: positive 24, positive 15, negative 15, positive 5, positive 3.3, and positive 15. Each voltage value is separated by a space.

```
Send:         diag volt mib
Receive:      diag volt mb 24.1 14.9 -14.9 4.9 3.2 14.9
```

diag volt iob
This command reports the diagnostic voltage measurements on the optional I/O expansion board. The sequence of voltages is: positive 24, positive 5, positive 3.3, and negative 3.3. Each voltage value is separated by a space.

```
Send:         diag volt iob
Receive:      diag volt iob 24.1 4.9 3.2 -3.2
```

diag volt probe

This command reports the diagnostic voltage measurements on the 82i measurement interface board. The sequence of voltages is: positive 24, positive 15, negative 15, positive 5, positive 3.3, and positive 15. Each voltage value is separated by a space.

```
Send:         diag volt probe
Receive:      diag volt iob 24.1 14.9 -14.8 5.1 3.2 15.1
```

Datalogging

clr records

This command will clear all long and short records that have been saved.

```
Send:         clr records
Receive:      clr records ok
```

set clr lrecs

set clr srecs

These commands will clear only the long records or only the short records that have been saved. The example below clears short records.

```
Send:         set clr srecs
Receive:      set clr srecs ok
```

list din

list dout

These commands report the current selection for the digital outputs in the format: output no | index number | variable name | active state. The active state for digital outputs is open or closed. The active state for digital inputs is high or low.

```
Send:         list dout
Receive:      list dout
output index variable state
 1  3 HG SPAN BIT 2 open
 2  4 HG SPAN BIT 2 open
 3  5 GEN ALARM open
 4  6 STANDBY MODE open
 5  7 INST ZERO MODE open
 6  8 INST SPAN MODE open
 7  9 SYST ZERO MODE open
 8  2 HG SPAN BIT 1 open
 9 15 PRESSURE open
```

list lrec
list srec
list stream
list sp
These commands report the list of current selections for long record logging data, short record logging data, streaming data output, or the scratch pad (sp) list.

The scratch pan 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 example below shows the list for streaming data output.

```
Send:         list stream
Receive:      list stream
field index variable
x x time
1 1 conc
2 2 syssp
3 3 hgflo
4 4 dlflo
5 5 ctemp
```

er *xy*
lr *xy*
sr *xy*
x = | 0 | 1 | : Reply termination format (see "set format format" command)
y = | 0 | 1 | 2 | : Output format (see "set erec/lrec/srec format format" command)

These commands report the last long and short records stored or the dynamic data record. In the example below, the command requests a long record with no checksum, in ASCII format with text. For details on how to decode the flag fields within these records, see **Figure B–1** in the "flags" command.

```
Send:         lr01
Receive:      lr01
lr01
09:59 04-13-07 flags 000000 conc 0.000 syssp 2.951 hgflo 17.939 dlflo
10145.800 ctemp 14.020
```

erec
This command returns a snapshot of the main operating conditions (measurments and status) at the time the command is issued. The example that follows shows a typical response.

The format is defined by the current settings of the "format" and "erec format" commands. For details on erec formatting, see the "Record Layout Definition" section at the end of this appendix. For details on how to decode the flag fields within these records, see the "flags" command.

```
Send:          erec
Receive:       erec
05:07 04-10-07 flags 00000068 dilf 0.000 hgf 0.000 tcolr 99.000 tamb
112.190 press 0.000 colrsp 15 tanco 3.000 syslv 0 hgout 0.000
```

---

erec format
srec format
lrec format
These commands report the output format for long and short records, and dynamic data in various formats such as ASCII without text, ASCII with text, or binary. The example below shows the output format for long records is ASCII with text, according to **Table B–4**.

```
Send:          lrec format
Receive:       lrec format 1
```

set erec format
set srec format
set lrec format
These commands set the output format for long and short records, and dynamic data, according to **Table B–4**. The example below sets the long record output format to ASCII with text.

```
Send:          set lrec format 1
Receive:       set lrec format 1 ok
```

Table B–4. Record Output Formats

Format	Output Format
0	ASCII no text
1	ASCII with text
2	binary data

---

erec layout
lrec layout
srec layout
These commands reports the layout (string indicating the data formats) for data that is sent out in response to the erec, lrec, srec, and related commands The example below shows a typical response. For details on

how to interpret the strings, see "Record Layout Definition" later in this appendix.

```
Send:         lrec layout
Receive:      lrec layout %s %s %lx %f %f %f %f %f %f
              t D L ffffff
              flags conc syssp hgflo dlflo ctemp
```

---

lrec
srec
lrec *xxxx yy*
srec *xxxx yy*
lrec *aa:bb oo-pp-qq yy*
srec *aa:bb oo-pp-qq yy*
xxxx = the number of past records
yy = the number of records to return (1 to 10)
aa = hours (01 to 24)
bb = minutes (01 to 59)
oo = month (01 to 12)
pp = day (01 to 31)
qq = year

These commands output long or short records and dynamic 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, there are 740 long records currently stored in memory. When the command lrec 100 2 is sent, the instrument counts back 100 records from the last record collected (record 740), and then returns two records. For details on how to decode the flag fields within these records, see **Figure B–1** in the "flags" command.

```
Send:         lrec 100 2
Receive:      lrec 100 2
lrec 100 2
08:27 04-13-07  flags 0000 conc 0.000 syssp 2.951 hgflo 17.939 dlflo
10151.200 ctemp 14.018
08:28 04-13-07  flags 0000 conc 0.000 syssp 2.951 hgflo 17.939 dlflo
10151.200 ctemp 14.047
```

---

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 example that follows shows that 1075 blocks were reserved for lrecs and the maximum number of lrecs that can be stored in memory is 241979. Memory allocation can be changed using the malloc command.

```
Send:         lrec mem size
Receive:      lrec mem size 241979 recs, 1075 blocks
```

---

lrec per
srec per
These commands report the long and short records logging period. The example below shows that the short record logging period is 5 minutes.

```
Send:         srec per
Receive:      srec per 5 min
```

set lrec per *value*
set srec per *value*
value = | 1 | 5 | 15 | 30 | 60 |

These commands set the long and short records logging period to *value* in minutes. The example below sets the long record logging period to 15 minutes.

```
Send:         set lrec per 15
Receive:      set lrec per 15 ok
```

---

no of lrec
no of srec
These commands report the number of long and short records stored in the long and short records memory. The example below shows that 50 long records 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 long and short records 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 long and short records to *value*, where *value* is a floating-point number representing percent. The example below sets the memory allocation for long records to 10.

Note Issuing these commands will clear all the logging data memory. All the existing records should be retrieved using appropriate commands, if required. ▲

```
Send:         set malloc lrec 10
Receive:      set malloc lrec 10 ok
```

---

data treatment lrec
data treatment srec
These commands report the current selection of data treatment for concentrations in the long records (lrecs) or short records (srecs). The example that follows reports the data treatment for concentrations in lrec is minimum.

```
Send:         data treatment lrec
Receive:      data treatment lrec min
```

set data treatment lrec *string*
set data treatment srec *string*
string = | cur | avg | min | max |
These commands set the data treatment to *string*, where *string* is current, average, minimum, or maximum for the concentration values recorded in the long records (lrecs) or short records (srecs). The example that follows sets the data treatment for concentrations in lrec to minimum.

```
Send:         set data treatment lrec min
Receive:      set data treatment lrec min ok
```

---

r*xxx* cooler setpoint
This command reports the current setpoint of the cooler for the 81*i*-H option. The 81*i*-H has 4 ranges, each with its own cooler setpoint. The example below shows that the cooler setpoint for range 20 is 8 °C.

```
Send:         r20 cooler setpoint
Receive:      r20 cooler setpoint 8 deg C
```

set r*xxx* cooler setpoint *temp*
xxx= | 20 | 30 | 50 | 300 |
temp = integer value between 0 and 19 °C
This command sets the cooler setpoint for the 81*i*-H option according to *xxx*, where *xxx* is one of the 4 ranges, each with its own cooler setpoint. The example below sets the cooler setpoint for range 300 to 18 °C.

```
Send:         set r300 cooler setpoint 18
Receive:      set r300 cooler setpoint 18 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 long record, short record, or streaming data list.

The scratch pan 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 example below copies the current list in scratch pad into the long records 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 long record, short record, or streaming data list into the scratch pad (sp). These commands are useful in easy modification of current long record, short record, or streaming data lists.

The scratch pan 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 example below copies the current list of long records 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 index in the scratch pad list.

The scratch pan 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 example below shows that the field 5 in the scratch pad is set to index number 1, which is for the variable for concentration.

```
Send:         sp field 5
Receive:      sp field 5 1 conc
```

set sp field *number value*
number = 1-32 is the maximum number of fields in long and short record lists.

number = 1-18 is 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 out 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 long record, short record, 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 34
Receive:      set sp field 1 34 ok
```

---

stream per
This command reports the currently set time interval in seconds for streaming data.

```
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 example below sets the number value to 10 seconds.

```
Send:         set stream per 10
Receive:      set stream per 10 ok
```

---

stream time
This command reports if the streaming data string will have a time stamp attached to it or not, according to **Table B–5**.

```
Send:         stream time
Receive:      stream time 1
```

set stream time *value*
This command enables value, where value is to attach or disable time stamp to streaming data string, according to **Table B–5**. The example below attaches a time stamp to streaming data.

```
Send:         set stream time 0
Receive:      set stream time 0 ok
```

Table B–5. Stream Time Values

Value	**Stream Time**
00	Attaches time stamp to streaming data string
01	Disables time stamp to streaming data string

Keys/Display

push *button*
button = | do | down | en | enter | he | help | le | left | me | menu | ri | right | ru | run | up | 1 | 2 | 3 | 4 |
These commands simulates pressing the front panel pushbuttons. The numbers represent the front-panel soft keys, from left to right.

```
Send:         push enter
Receive:      push enter ok
```

isc
iscreen
This command retrieves the framebuffer data used for the display on the iSeries instrument. It is 19200 bytes in size, 2-bits per pixel, 4 pixels per byte arranged as 320 by 240 characters. The data is sent in RLE encoded form to save time in transmission. It is sent as a type '5' binary c_link response with no checksum.

The RLE encoding consists of a 0 followed by an 8-bit count of consecutive 0xFF bytes. The following 'c' code will expand the incoming data.

```
void      unpackDisplay ( void far* tdib, unsigned char far* rlescreen )
{
int i,j,k;
unsigned char far *sc4bpp, *sc2bpp, *screen, *ptr;

   ptr = screen = (unsigned char far *)malloc(19200);
   //RLE decode the screen
   for (i=0; i<19200 && (ptr - screen) < 19200; i++)
   {
      *(ptr++) = *(rlescreen + i);
      if (*(rlescreen + i) == 0)
      {
         unsigned char rlecount = *(unsigned char *)(rlescreen + ++i);
```

```
            while (rlecount)
            {
               *(ptr++) = 0;
               rlecount--;
            }
         }
         else if (*(rlescreen + i) == 0xff)
         {
            unsigned char rlecount = *(unsigned char *)(rlescreen + ++i);

            while (rlecount)
            {
               *(ptr++) = 0xff;
               rlecount--;
            }
         }
      }
   }
```

To convert this data into a BMP for use with windows, it needs to be turned into a 4BPP as that is the smallest windows can display. Also note that BMP files are upside down relative to this data, i.e. the top display line is the last line in the BMP.

---

sc
screen
This command is meant for backward compatibility on the C series. Screen information is reported using the "iScreen" command above.

```
Send:         screen
Receive:      screen This is an I series instrument. Screen
information not available
```

Measurement Configuration

---

hg span range
This command reports the current span range. The example below reports that the range is 10 µg/m^3, where "10.0" is the range in µg/m^3 and "1" is the first range available for that 81*i* variant according to **Table B–6**.

```
Send:         hg span range
Receive:      hg span range 10.0 1
```

set hg span range *range*
range = | 1 | 2 | 3 | 4 | 5 | 6 |

This command sets the hg span range, according to **Table B–6**. The example below sets the hg span range to 20 µg/m^3 for a standard 81*i*.

```
Send:          set hg span range 3
Receive:       set hg span range 3 ok
```

Table B–6. 81*i* Variant Span Ranges

Standard 81*i*	Low Level 81*i*	High Level 81*i*
Span Range 1 = 5 µg/m^3	Span Range 1 = 1 µg/m^3	Span Range 1 = 20 µg/m^3
Span Range 2 = 10 µg/m^3	Span Range 2 = 2 µg/m^3	Span Range 2 = 30 µg/m^3
Span Range 3 = 20 µg/m^3	Span Range 3 = 5 µg/m^3	Span Range 3 = 50 µg/m^3
Span Range 4 = 30 µg/m^3	Span Range 4 = 10 µg/m^3	Span Range 4 = 300 µg/m^3
Span Range 5 = 40 µg/m^3	Span Range 5 = 20 µg/m^3	
Span Range 6 = 50 µg/m^3		

gas mode
This command reports the current mode. The example below reports that the gas mode is standby.

```
Send:          gas mode
Receive:       gas mode standby
```

set gas mode *mode*
mode = | a cal | a zero | o ca | o zero | ox cal | s cal | s zero | standby |

This command sets the gas mode to a cal, a zero, 0 cal, 0 zero, ox cal, s cal, s zero or standby. The example below sets the gas mode to a zero.

```
Send:          set gas mode a zero
Receive:       set gas mode a zero ok
```

hg span
This command reports the current hg span selection. The example below reports that the hg span selection is span 4.

```
Send:          hg span
Receive:       hg span 4
```

set hg span
This command sets the hg span selection (1-6). The example below sets the hg span selection to span 3.

```
Send:          set hg span 3
Receive:       set hg span 3 ok
```

hg span conc
This command reports the current hg span concentration value followed by the span selection number (0-5). The example below reports that the hg span concentration is 10.0 µg/m^3 and the current span selection is 4 (n+1).

```
Send:          hg span conc
Receive:       hg span conc 10.0 3
```

set hg span conc
This command sets the hg span concentrations. The example below sets span 4 to a hg span concentration to 10.0 µg/m^3.

```
Send:          set hg span conc 10 4
Receive:       set hg span conc 10 4 ok
```

Hardware Configuration

contrast
This command reports the screen's level of contrast. The example below shows the screen contrast is 40%, according to **Table B–7**.

```
Send:          contrast
Receive:       contrast 8: 40%
```

set contrast level
This command sets the screen's level of contrast, according to **Table B–7**. The example below sets the contrast level to 50%.

```
Send:          set contrast 10
Receive:       set contrast 10 ok
```

Table B–7. Contrast Levels

Level	Contrast Level
0	0%
1	5%
2	10%
3	15%
4	20%
5	25%
6	30%
7	35%
8	40%
9	45%

Level	Contrast Level
10	50%
11	55%
12	60%
13	65%
14	70%
15	75%
16	80%
17	85%
18	90%
19	95%
20	100%

date

This command reports the current date. The example below reports the date as May 9, 2007.

```
Send:          date
Receive:       date 05-09-07
```

set date *mm-dd-yy*

mm = month
dd = day
yy = year

This command sets the date of the instrument's internal clock. The example below sets the date to March 19, 2007.

```
Send:          set date 03-19-07
Receive:       set date 03-19-07 ok
```

set default params

This command sets all the parameters to their default values. This does not affect the factory-calibrated parameters.

```
Send:          set default params
Receive:       set default params ok
```

save
set save params

This command stores all current parameters in FLASH memory. It is important that each time instrument parameters are changed, that this

command be sent. If changes are not saved, they will be lost in the event of a power failure. The example below saves the parameters to FLASH memory.

```
Send:         set save params
Receive:      set save params ok
```

---

time
This command reports the current time (24-hour time). The example below 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 time). The example below 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. The default address is 192.168.1.201, however this can be changed to another address.

```
Send:         addr dns
Receive:      addr dns 192.168.1.201
```

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. 201
Receive:      set addr dns 192.168.1. 201 ok
```

---

addr gw
This command reports the default TCP/IP gateway address.

Note This command cannot be used when DHCP is on. Refer to the DHCP command that follows for additional information. ▲

```
Send:         addr gw
Receive:      addr gw 192.168.1. 201
```

set addr gw *address*
This command sets the default gateway *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by ".".

```
Send:         set addr gw 192.168.1. 201
Receive:      set addr gw 192.168.1. 201 ok
```

---

addr ip
This command reports the IP address of the instrument.

Note This command cannot be used when DHCP is on. Refer to the DHCP command that follows for additional information. ▲

```
Send:         addr ip
Receive:      addr ip 192.168.1. 201
```

set addr ip *address*

This command sets the instrument's IP *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by ".".

```
Send:         set addr ip 192.168.1. 201
Receive:      set addr ip 192.168.1. 201 ok
```

---

addr nm
This command reports the TCP/IP netmask address.

Note This command cannot be used when DHCP is on. Refer to the DHCP command that follows for additional information. ▲

```
Send:         addr nm
Receive:      addr nm 255.255.255.0
```

set addr nm *address*
This command sets the netmask address, where address consists of four numbers ranging from 0-255 inclusive, separated by ".".

```
Send:         set addr nm 255.255.255.0
Receive:      set addr nm 255.255.255.0 ok
```

addr ntp
This command reports the IP address for the NTP time server. See "Network Time Protocol Server" in the "Communications Settings" section of the "Operation" chapter for more information.

```
Send:          addr ntp
Receive:       addr ntp 192.168.1.2
```

set addr ntp *address*
This command sets the NTP time server *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by ".".

```
Send:          set addr ntp 192.168.1.2
Receive:       set addr ntp 192.168.1.2 ok
```

baud
This command reports the current baud rate for the serial port (RS232/RS485). The example below reports that the current baud rate is 9600.

```
Send:          baud
Receive:       baud 9600
```

set baud *rate*
rate = | 1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200 |

This command sets the instrument baud *rate*. The example below sets the instrument's baud rate to 115200.

Note After the command is sent, the baud rate of the sending device must be changed to agree with the instrument. ▲

```
Send:          set baud 115200
Receive:       set baud 115200 ok
```

dhcp
This command reports the current state of use of DHCP on or off. DHCP is used to assign an IP address to the instrument automatically. The example below shows that DHCP is on.

```
Send:          dhcp
Receive:       dhcp on
```

set dhcp *onoff*
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.

Note When changing the IP address, the netmask address, or the gateway address, you must cycle power to the instrument before the change takes effect. Until you cycle 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 example below shows that the reply format is 00, which means reply with no checksum, according to **Table B–8**.

```
Send:          format
Receive:       format 00
```

set format *format*

This command sets the reply termination *format*, where *format* is set according to **Table B–8**. The example below sets the reply termination format to checksum.

```
Send:          set format 01
Receive:       set format 01 ok
```

Table B–8. Reply Termination Formats

Format	Reply Termination
00	<CR>
01	<NL> sum xxxx <CR>

where xxxx = 4 hexadecimal digits that represent the sum of all the characters (bytes) in the message

---

host name
This command reports the host name string.

```
Send:          host name
Receive:       host name 81i
```

set host name *string*

This command sets the host name *string*, where *string* is 1-13 alphanumeric characters.

```
Send:         set host name 81i
Receive:      set host name 81i ok
```

---

instr name
This command reports the instrument name.

```
Send:         instr name
Receive:      instr name
              Calibrator
              Calibrator
```

---

instrument id
This command reports the instrument id.

```
Send:         instrument id
Receive:      instrument id 81
```

set instrument id *value*
This command sets the instrument id to value, where value is a decimal number between 0 and 127 inclusive.

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 50
Receive:      set instrument id 50 ok
```

---

set layout ack
This command disables the stale layout/layout change indicator ('*') that is attached to each response if the layout has changed since the last time erec layout was requested. Refer to **Table B–9**.

```
Send:         set layout ack
Receive:      set layout ack ok
```

Table B–9. Set Layout Ack Values

Value	Function
0	Do nothing (default)
1	Append "*"

allow mode cmd
This command reports the current allow mode setting: 1 = allow "set mode local" or "set mode remote" commands; 0 = ignore "set mode local" or "set mode remote" commands. Refer to **Table B–10**. The default value is 0; ignore the commands. The example that follows shows that the instrument is configured to ignore "set mode local" or "set mode remote" commands.

```
Send:          allow mode cmd
Receive:       allow mode cmd 0
```

set allow mode cmd *value*
This command is used to configure the instrument to *value,* where *value* is either 1 = accept or 0 = ignore the "set mode local" or "set mode remote" commands. Refer 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 will not change the instrument lock status** (this is for compatibility with systems expecting an "ok" response).

Note The instrument will always respond to the command "mode" with the status of the password lock as "mode local" or "mode remote" regardless of the above setting.▲

The example that follows sets the instrument to accept the "set mode local" or "set mode remote" commands.

```
Send:          set allow mode cmd 1
Receive:       set allow mode cmd 1 ok
```

Table B–10. Allow Mode Command

Value	Allow Mode Command
0	Ignore (default)
1	Accept

mode
This command reports what operating mode the instrument is in: local, service, or remote. The example below 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 example below sets the instrument to the local mode.

```
Send:         set mode local
Receive:      set mode local ok
```

power up mode
This command reports the current power up mode setting, where *value,* is either 0 = local/unlocked or 1 = remote/locked. The default value is 0; power up in local/unlocked mode. The example that follows shows that the instrument is configured to power up in the remote/locked mode.

```
Send:         power up mode
Receive:      power up mode 1
```

set power up mode *value*
This command is used to configure the instrument to power up in the local/unlocked mode (*value* = 0) or the remote/locked mode (*value* = 1) as indicated in **Table B–11**.

If the instrument is set to power up in the local/unlocked mode, the keypad can be used to make changes via the front panel. If the instrument is set to power up in the remote/locked mode, changes can not be made from the front panel. The example that follows sets the instrument to power up in remote/locked mode.

```
Send:         set power up mode 1
Receive:      set power up mode 1 ok
```

Table B–11. Power Up Mode Values

Value	Power Up Mode Command
0	Local/Unlocked (default)
1	Remote/Locked Mode

program no
This command reports the instrument's model information and program version number, which will be dependant on the current version.

```
Send:         program no
Receive:      program no iSeries 81i 00.04.54.058
```

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 time server, where *string* is a standard timezone string. Common strings are listed in the timezone screen description in the "Operation chapter".

```
Send:         set tz EST+5EDT
Receive:      set tz EST+5EDT ok
```

I/O Configuration

analog iout range *channel*

This command reports the analog current output range setting for *channels*, where *channel* must be between 1 and 6, inclusive. The example below reports current output channel 4 to the 4-20 mA range, according to **Table B–12**. This command responds with "feature not enabled" if the optional 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 *channel range* where *channel* is between 1 and 6 inclusive, and range is set according to **Table B–12**. The example below sets current output channel 4 to the 0-20 mA range. This command responds with "feature not enabled" if the optional I/O expansion board is not detected.

```
Send:         set analog iout range 4 1
Receive:      set analog iout range 4 1 ok
```

Table B–12. Analog Current Output Range Values

Range	Output Range
1	0-20 mA
2	4-20 mA
0 [cannot be set to this, but may report]	Undefined

analog vin *channel*
This command retrieves the analog voltage input *channel* data, both the calculated value and the actual voltage. In the example below, the "calculated" value of channel 1 is 75.325 degrees F, volts are 2.796. This command responds with "feature not enabled" if the optional I/O expansion board is not detected.

```
Send:          analog vin 1
Receive:       analog vin 1 75.325 2.796
```

analog vout range *channel*
This command reports the analog voltage output *channel* range, where *channel* is between 1 and 6 inclusive, according to **Table B–13**.

```
Send:          analog vout range 2
Receive:       analog vout range 2 3
```

set analog vout range *channel range*
This command sets analog voltage output *channel* to the range, where *channel* is between 1 and 6 inclusive, and *range* is set according to **Table B–13**. The example below sets channel 2 to the 0-10 V range.

```
Send:          set analog vout range 2 3
Receive:       set analog vout range 2 3 ok
```

Table B–13. Analog Voltage Output Range Values

Range	Output Range
1	0-1 V
2	0-100 mV
3	0-10 V
4	0-5 V
0 [cannot be set to this, but may report]	Undefined

dig in
This command reports the status of the digital inputs as a 4-digit hexadecimal string with the most significant bit (MSB) being input 16.

```
Send:          dig in
Receive:       dig in 0xffff
```

---

din *channel*
This command reports the action assigned to input *channel* and the corresponding active state. The example below reports the input 5 to be assigned an index number 5 corresponding to action of "filter zero" with the active state being high.

```
Send:          din 5
Receive:       din 5 5 FILTER ZERO high
```

set din *channel index state*
This command assigns digital input *channel* (1-16) to activate the action indicated by *index* (1-35), when the input transitions to the designated *state* (high or low). Use "list din var" command to obtain the list of supported *index* values and corresponding actions.

```
Send:          set din 1 3 high
Receive:       set din 1 3 high ok
```

---

dout *channel*
This command reports the index number and output variable and the active state assigned to output *channel*. The example below reports the input 4 to be assigned an index number 11 corresponding to "general alarm" with the active state being open.

```
Send:          dout 4
Receive:       dout 4 11 GEN ALARM open
```

set dout *channel index state*
This command assigns digital output *channel* to be assigned to the action associated with *index*, and assigns it an active *state* of state (open or closed).

```
Send:          set dout 4 11 open
Receive:       set dout 4 11 open ok
```

---

dtoa *channel*
This reports the outputs of the 6 or 12 digital to analog converters, according to **Table B–14**. The example below shows that the DAC 1 is 97.7% full-scale.

```
Send:          dtoa 1
Receive:       dtoa 1 97.7%
```

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

Table B–14. Default Output Assignment

D to A	Assignment	Function
1	Hg CONC	Voltage Output
2	Hg SPAN	Voltage Output
3	Hg FLOW	Voltage Output
4	DIL FLOW	Voltage Output
5	COOLER TEMP	Voltage Output
6	NONE	Voltage Output
7	Hg CONC	Current Output
8	Hg SPAN	Current Output
9	Hg FLOW	Current Output
10	DIL FLOW	Current Output
11	COOLER TEMP	Current Output
12	NONE	Current Output

list var aout
list var dout
list var din
These commands report the list of index numbers, and the variables (associated with that index number) available for selection in the current mode for analog output, digital output 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 example below reports the list of analog output, index numbers, and variables.

```
Send:         list var aout
Receive:      list var aout
```

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 displays

In operation, values are read in 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 (e.g., 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 Front-Panel 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 DATA/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. This 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', or 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 (e.g., 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 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.

' hg0:3s\n'

This is a line which appears slightly indented. The text field is 'Hg0', the value is taken from the third element of the data response, and interpreted as a string.

' hg0:18sBd.ddd;set hg0 coef %s\n'

This is a line which also appears slightly indented. The next field is also 'Hg0', 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 Hg0 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 Hg0 coef 1.234'.

' hg0:21f{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 hg0 %d\n'

This is a line which appears slightly indented, the title is again 'Hg0', and the value 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 zeroth 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 iSeries enables the user to perform the functions of reading the various concentrations and other analog values or variables, read the status of the digital outputs of the instrument, and to trigger or simulate the activation of a digital input to the instrument. This is achieved by using the supported MODBUS commands listed below.

For details of the Model 81*i* MODBUS Protocol specification, see the following topics:

Additional information on the MODBUS protocol can be obtained at http://www.modbus.org. References are from MODBUS Application Protocol Specification V1.1a MODBUS-IDA June 4, 2004.

Serial Communication Parameters

The following are the communication parameters that are used to configure the serial port of the *i*Series to support MODBUS RTU protocol.

Number of Data bits : 7 or 8

Number of Stop bits : 1 or 2

Parity : None, Odd, or Even

Data rate : 1200 to 115200 Baud (9600 is default)

TCP Communication Parameters

*i*Series instruments support the MODBUS/TCP protocol. The register definition is the same as for the serial interface. Up to three simultaneous connections are supported over Ethernet.

TCP connection port for MODBUS: 502

Application Data Unit Definition

Here are the MODBUS ADU (Application Data Unit) formats over serial and TCP/IP:

Serial:	Slave Address	Function Code	Data	Error Check
TCP/IP:	MBAP Header	Function Code	Data	

Slave Address

The MODBUS slave address is a single byte in length. This is the same as the instrument ID used for C-Link commands and can be between 1 and 127 decimal (i.e. 0x01 hex to 0x7F hex). This address is only used for MODBUS RTU over serial connections.

Note Device ID '0' used for broadcast MODBUS commands, is not supported. Device IDs 128 through 247 (i.e. 0x80 hex to 0xF7 hex) are not supported because of limitations imposed by C-Link. ▲

MBAP Header

In MODBUS over TCP/IP, a MODBUS Application Protocol Header (MBAP) is used to identify the message. This header consists of the following components:

Transaction Identifier	2 Bytes	0x0000 to 0xFFFF (Passed back in response)
Protocol Identifier	2 Bytes	0x00 (MODBUS protocol)
Length	2 Bytes	0x0000 to 0xFFFF (Number of following bytes)
Unit Identifier	1 Byte	0x00 to 0xFF (Passed back in response)

A Slave address is not required in MODBUS over TCP/IP because the higher-level protocols include device addressing. The unit identifier is not used by the instrument.

Function Code

The function code is a single byte in length. The following function codes are supported by the instrument:

Read Coils	:	0x01
Read Inputs	:	0x02
Read Holding Registers	:	0x03
Read Input Registers	:	0x04
Force (Write) Single Coil	:	0x05
Read Exception Status	:	0x07

If a function code is received that is not in this list, and invalid function exception is returned.

Data

The data field varies depending on the function. For more description of these data fields, see "Function Codes" 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 81*i*.

(0x01/0x02) Read Coils / Read Inputs

Read Coils/Inputs reads the status of the digital outputs (relays) in the instrument. Issuing either of these function codes will generate the same response.

These requests specify the starting address, i.e. the address of the first output specified, and the number of outputs. The outputs are addressed starting at zero. Therefore, outputs numbered 1–16 are addressed as 0–15.

The outputs in the response message are packed as one per bit of the data field. Status is indicated as 1 = Active (on) and 0 = Inactive (off). The LSB of the first data byte contains the output addressed in the query. The other outputs follow toward the high order end of this byte, and from low order to high order in subsequent bytes. If the returned output quantity is not a multiple of eight, the remaining bits in the final data byte will be padded

with zeros (toward the high order end of the byte). The Byte Count field specifies the quantity of complete bytes of data.

Note The values reported may not reflect the state of the actual relays in the instrument, as the user may program these outputs for either active closed or open. ▲

Request

Function code	1 Byte	0x01 or 0x02
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Quantity of outputs	2 Bytes	1 to maximum allowed by instrument
Unit Identifier	1 Byte	0x00 to 0xFF (Passed back in response)

Response

Function code	1 Byte	0x01 or 0x02
Byte count	1 Byte	N*
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.

The status of outputs 2–10 is shown as the byte value 0xCD, or binary 1100 1101. Output 10 is the MSB of this byte, and output 2 is the LSB. By convention, bits within a byte are shown with the MSB to the left, and the LSB to the right. Thus, the outputs in the first byte are '10 through 2', from left to right. In the last data byte, the status of outputs 15-11 is shown as the byte value 0x0A, or binary 0000 1010. Output 15 is in the fifth bit position from the left, and output 11 is the LSB of this byte. The four remaining high order bits are zero filled.

The request specifies the starting register address and the number of registers. Registers are addressed starting at zero. Therefore, registers numbered 1–16 are addressed as 0–15. The register data in the response

message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Request

Function code	1 Byte	0x03 or 0x04
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Quantity of Registers	2 Bytes	1 to maximum allowed by instrument

Response

Function code	1 Byte	0x03 or 0x04
Byte count	1 Byte	2 x N*
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 Addresses Supported

Table C–1 through **Table C–3** list the MODBUS addresses supported for the Model 81*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 81*i*

Coil Number	Status	Used Exclusively In
0	Invalid	
1	SERVICE	
2	HG SPAN BIT 1	
3	HG SPAN BIT 2	

Coil Number	Status	Used Exclusively In
4	HG SPAN BIT 3	
5	GENERAL ALARM	
6	STANDBY MODE	
7	INSTRUMENT ZERO MODE	
8	INSTRUMENT SPAN MODE	
9	ORIFICE ZERO MODE	
10	ORIFICE SPAN MODE	
11	SYSTEM ZERO MODE	
12	SYSTEM SPAN MODE	
13	COOLER TEMPERATURE ALARM	
14	AMBIENT TEMPERATURE ALARM	
15	PRESSURE ALARM	
16	Hg FLOW ALARM	
17	DILUTION FLOW ALARM	
18	CONCENTRATION ALARM	
19	MOTHERBOARD STATUS ALARM	
20	MEASUREMENT INTERFACE BOARD STATUS ALARM	
21	I/O BOARD STATUS ALARM	I/O Expansion Board Option
22	LOCAL/REMOTE	
23	EXT ALARM 1	
24	EXT ALARM 2	
25	EXT 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 81*i*

Register Number	Variable	Used Exclusively In
0	Invalid	
1&2	Hg CONCENTRATION	
3&4	Hg SPAN	
5&6	Hg FLOW	
7&8	DILUTION FLOW	
9&10	COOLER TEMPERATURE	
11&12	AMBIENT TEMPERATURE	
13&14	PRESSURE	
15&16	COOLER SET TEMPERATURE	
17&18	ANALOG IN 1	I/O Expansion Board Option
19&20	ANALOG IN 2	I/O Expansion Board Option
21&22	ANALOG IN 3	I/O Expansion Board Option
23&24	ANALOG IN 4	I/O Expansion Board Option
25&26	ANALOG IN 5	I/O Expansion Board Option
27&28	ANALOG IN 6	I/O Expansion Board Option
29&30	ANALOG IN 7	I/O Expansion Board Option
31&32	ANALOG IN 8	I/O Expansion Board Option
33&34	EXT ALARMS	
35&36	Hg RANGE	

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 a 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 81*i*

Coil Number	Action Triggered	Coil Group	Used Exclusively In
100	Invalid		
101	INSTRUMENT ZERO MODE	Zero Span Mode	
102	INSTRUMENT CAL MODE	Zero Span Mode	
103	ORIFICE ZERO MODE	Zero Span Mode	
104	ORIFICE CAL MODE	Zero Span Mode	
105	SYSTEM ZERO MODE	Zero Span Mode	
106	SYSTEM CAL MODE	Zero Span Mode	
107	STANDBY		
108	AOUTS TO ZERO	Analog Out Test	I/O Expansion Board Option
109	HG SPAN BIT 1	Span Level	
110	HG SPAN BIT 2	Span Level	
111	HG SPAN BIT 3	Span Level	
112	AOUTS TO FS	Analog Out Test	I/O Expansion Board Option
113	EXT ALARM 1		
114	EXT ALARM 2		
115	EXT ALARM 3		
116	RANGE 20	81*i*-H Range	81*i*-H
117	RANGE 30	81*i*-H Range	81*i*-H
118	RANGE 50	81*i*-H Range	81*i*-H
119	RANGE 300	81*i*-H Range	81*i*-H

Appendix D
Manufacturer's Disclosure

The following information is for the Thermo Fisher Scientific Model 81*i* Elemental Mercury Generator. Failure to meet the specification detailed here may result in less than optimum performance.

Per the EPA Interim Elemental Mercury Gas Traceability Protocol (Protocol), Section 4.0, the information that follows must be made available. See link below.

http://www.epa.gov/airmarkt/emissions/mercury/hgmonitoring.html

For example, Section 4.1 requires that manufacturers include documentation and other relevant information for the elemental Hg generator model and that the information be provided to the end user in the generator manual and/or other documents.

This documentation includes information describing the generator design, nominal concentration ranges, operational and environmental conditions, as well as operation, maintenance, and quality assurance procedures.

Range

The Model 81*i* is able to output elemental mercury concentration from 1 to 50 µg/m^3 (normalized to 20c and 760 mmHg). There are 6 ranges; 5, 10, 20, 30, 40, and 50 µg/m^3. Each range has a fixed dilution flow associated with a minimum and maximum setpoint. Refer to **Table D–1**.

Table D–1. Elemental Mercury Output Concentration Ranges

Flow Rate (lpm)	Output Range (µg/m^3)
3	7 to 50
4	6 to 40
5	5 to 31
7	3 to 21
12	2 to 11
17	1 to 6

Operational and Environmental Conditions

The operational and environmental conditions are provided in **Table D–2** and the detailed descriptions that follow.

Table D–2. Operational and Environmental Conditions

Item	Value
Carrier gas dewpoint	< 0 °C
Carrier gas pressure range	30-40 psig
Back pressure	600-1800 mmHg absolute
Temperature range	20–30 °C (may be safely operated in the range of 0–45 °C) in non-condensing environments. Performance specifications based on operation within 20-30 °C range.
Warm up period	4 hours before use power up and supply carrier gas
Line voltage	Between 105 VAC and 125 VAC, 50/60 Hz, 3 amps

Carrier Gas Supply

Air, Nitrogen or Argon can be used as a carrier gas with the model 81*i*. It should be noted that the carrier gas source for the elemental generator should be the same as the carrier gas source for the sample diluent used in the probe. The carrier gas must be free from hydrocarbons, mercury or sulfur compounds. Dewpoint of carrier gas must be less than 0 °C. A 5 micron or small particulate filter must be used upstream of the generator. The acceptable pressure range of the carrier gas at the inlet of the generator is 30 – 40 psig. Use of a nitrogen generator is acceptable only if the O_2 output does not vary by more than 0.05% O_2. Use of PSA (Pressure Swing Adsorption) type generators is not acceptable.

Back Pressure

The acceptable back pressure range of the 81*i* is between 600 and1800 mmHg absolute.

Temperature Operating Range

The operating temperature should be 20–30 °C (may be safely operated in the range of 0–45 °C) in non-condensing environments. Performance specifications are based on operation within a 20-30 °C range.

Warm Up Period

The Model 81*i* should be powered up and have carrier gas supplied to it for a minimum of 4 hours before use.

Line Voltage

The Model 81*i* should be supplied with power between 105 and 125 VAC, 50/60 Hz, 3 amps.

Quality Assurance

Per the requirements in the EPA Protocol (July 01, 2009), periodic data quality evaluations of the generator shall be conducted as follows:

1. At least once each calendar quarter, except where otherwise indicated by a permeation tube comparison as outlined in the aforementioned Protocol. A permeation tube comparison approach is viable, however, it requires a higher (monthly) frequency of comparison. See Section 7.1.2.1 of the EPA Protocol.

2. Following any malfunction, repair, or corrective action that may reasonably be expected to affect the generator's output, but does not necessitate recertification.

The following list of situations **will** require recertification:

1. The elemental mercury source tube (replacement of thermoelectric coolers are separate from the source tube and do not constitute recertification)

2. The mercury source tube cooling block which contains the thermistor

3. The generator fails to meet the acceptance criteria of the periodic data quality assessments outlined in the EPA Protocol.

Conducting Periodic Data Quality Assessments

There are a variety of approaches to conducting periodic data quality assessments, such as comparisons to a Field Reference generator, a permeation tube source, and a gas cylinder. All these approaches, along with pass/fail criteria, are outlined in detail in the EPA Protocol. These procedures must be read and understood before conducting either the periodic data quality assessment or recertification. See link below.

http://www.epa.gov/airmarkt/emissions/mercury/hgmonitoring.html

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