Model 84*i*
Hg Permeation Source

Instruction Manual
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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, maintaining, and servicing the Model 84*i* Hg Permeation Source. It also contains important alerts to ensure safe operation and prevent equipment damage. The manual is organized into the following chapters and appendixes to provide direct access to specific operation and service information.

- Chapter 1 "Introduction" provides an overview of the product, describes the principle of operation, and lists the specifications.
- Chapter 2 "Installation" describes how to install and connect the Hg Permeation Source into the Thermo Scientific Mercury System.
- Chapter 3 "Operation" describes the associated menu-driven software and permeation/generator calculation.
- Chapter 4 "Preventive Maintenance, Troubleshooting and Servicing" presents safety alerts for technicians working on the instrument, preventive maintenance information, troubleshooting tips, and component replacement information. It also includes contact information for product support and technical information.
- Appendix A "Warranty" is a copy of the warranty statement.
- Appendix B "C-Link Protocol Commands" provides a list of the 84*i* C-Link protocol commands that can be used to remotely control an analyzer using a host device such as a PC or datalogger.
- Appendix C "MODBUS Protocol" provides details of the MODBUS Protocol for the 84*i*.

Safety

Review the following information carefully before using the Model 84*i*. This manual provides specific information on how to operate the instrument, however if the instrument is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Safety and Equipment Damage Alerts

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

Safety and Equipment Damage Alert Descriptions

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

Safety and Equipment Damage Alerts in this Manual

Alert		Description
	**WARNING**	The service procedures in this manual are restricted to qualified service personnel only. ▲ If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲
	**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. ▲

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.thermoscientific.com/aqi.

1-866-282-0430 Toll Free

1-508-520-0430 International

We continue to support our customers with advanced online resources. Our Air Quality Instruments Online Library allows our customers access to product documents and information on a constant basis.

Available 24-hours a day and seven-days a week, the online library provides quick access to information regardless of time zone or office hours.

To register for an account or log in, please visit www.thermoscientific.com/aqilibrary.

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Chapter 1
Introduction

The Thermo Scientific™ 84*i* Hg Permeation Source compliments the Mercury Freedom System by periodically assessing and qualifying the constancy of the 81*i*'s mercury concentration output. The 80*i* Mercury Analyzer is used to control the functions of the 84*i*. An option in the model 80*i* software has been added to allow the user to access and manage the 84*i* Hg Permeation Source. For details see the following topics:

Principle of Operation

The Model 84*i* Hg Permeation Source uses a process by which a specific and consistent concentration of Mercury is generated from a permeation assembly (Figure 1–1). The Hg permeation tube generates a known and reliable concentration of mercury at a constant temperature and flow. The 84*i* is located in the Mercury System rack. The generated 84*i* mercury concentration, as measured by the 80*i* Mercury Analyzer, will be used to confirm the reliability of the 81*i* Mercury Calibrator output in accord with requirements.

In compliance with the "Interim Traceability Protocol for Qualification and Certification of Elemental Mercury Gas Generators", periodic quality assessments of Mercury Gas Generators are required following initial certification of an elemental Hg Generator.

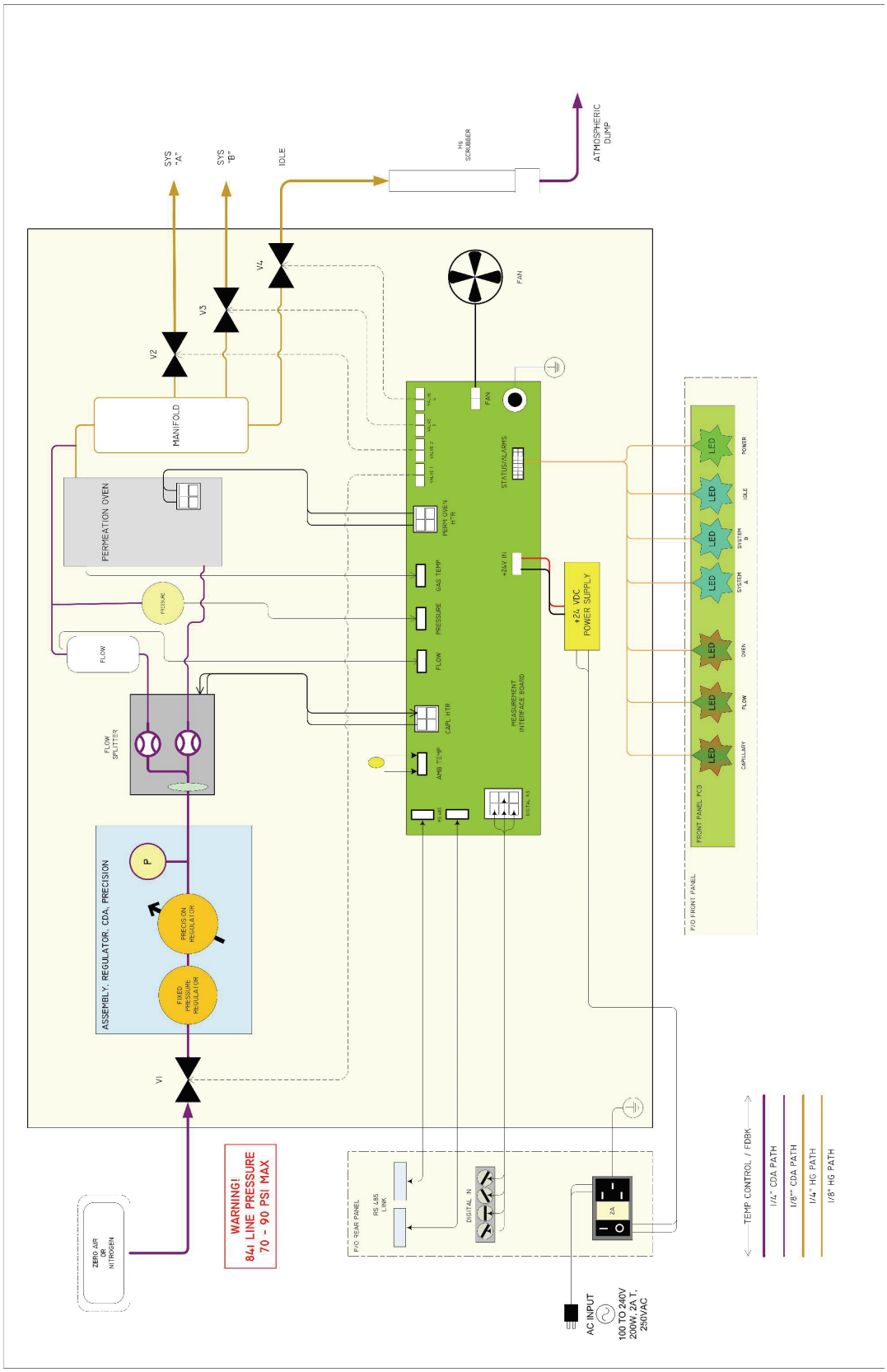


Figure 1–1. Model 84*i* Hg Permeation Source Flow Diagram

Component Description

This section describes the function and location of the 84*i* components. Refer to Figure 1–2 to locate the instrument components.

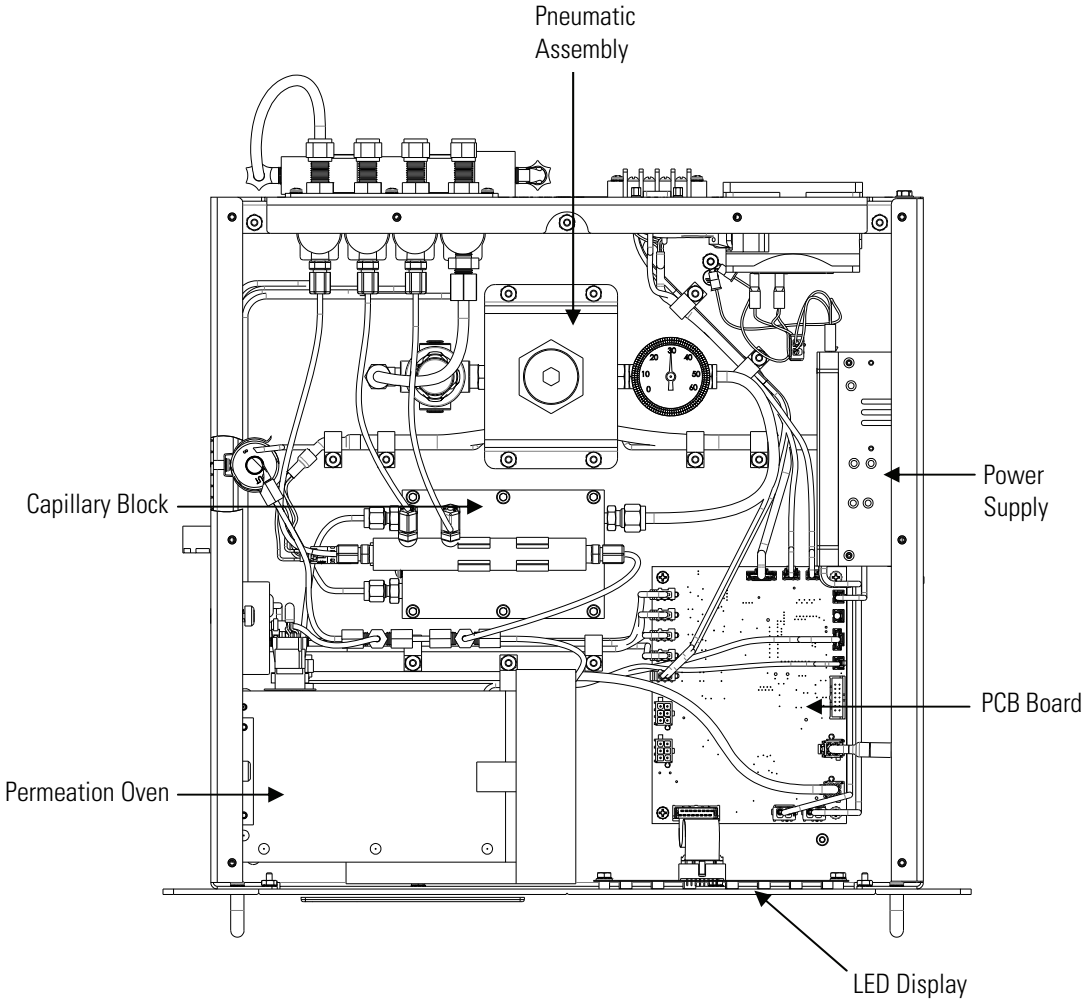


Figure 1–2. Model 84*i* Component Layout

Permeation Oven

The Permeation Oven supplies a reliable and consistent mercury concentration. It contains a permeation tube, permeation oven heater, oven thermistor and a gas thermistor. When held at a constant temperature the permeation tube outgases a steady amount of mercury that is transported to the 80*i* Mercury Analyzer. A fixed and continuous flow rate and tight control of the permeation oven temperature assures a repeatable and stable mercury concentration.

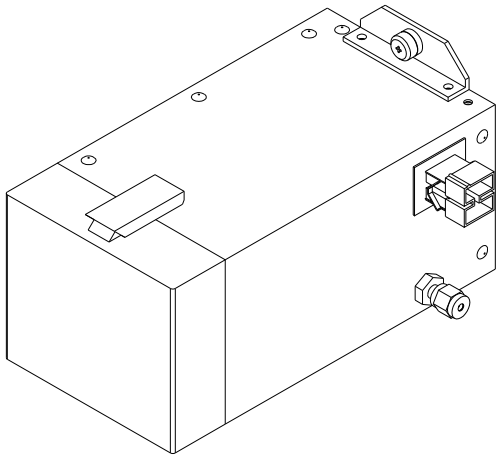


Figure 1–3. Permeation Oven

Capillary Block Assembly

The Heated Capillary Block maintains a consistent and reliable flow through the permeation oven. The heated Capillary Block Assembly (84*i* Flow Splitter) contains two capillaries, a heater, thermistor and an inline screen. Both capillaries receive Zero Air supplied from the rear panel. Air flow going through the 0.004-inch sized capillary leads into the permeation oven. The air flow from the 0.006-inch capillary acts as permeation dilution air and recombines with the Hg permeation air flow post permeation oven. The Capillary Block Assembly is kept at a constant temperature. Also, the precision pressure regulator, located upstream in the Pneumatic Assembly, supplies the Capillary Block with air at a constant pressure. With constant temperature and pressure, the flows of the two air streams remain constant giving a stable and continuous mercury concentration.

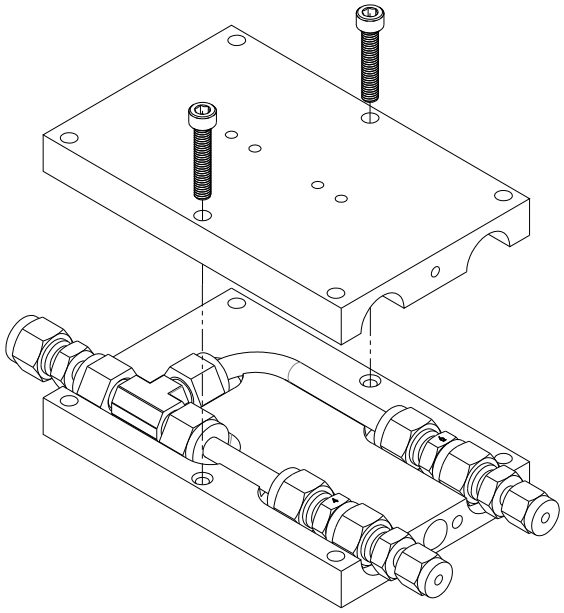


Figure 1–4. Capillary Block Assembly

Pneumatic Assembly

The Pneumatic Assembly consists of two pressure regulators. It supplies the Capillary Block with precise and constant air pressure. The first pressure regulator is un-adjustable and set to 60 psig in order to minimize large changes in the feed gas pressure. A second, precision regulator is located immediately downstream of the first regulator. This regulator has been set at the factory in order to supply precise flow to the capillaries downstream. There is a pressure gauge located on the second pressure regulator which is used during the initial configuration as well as a diagnostic tool. Nominal pressure when operating correctly is between 25 and 40 psig. Adjusting the precision regulator will result in a change of mercury concentration and should only be done by qualified individuals.

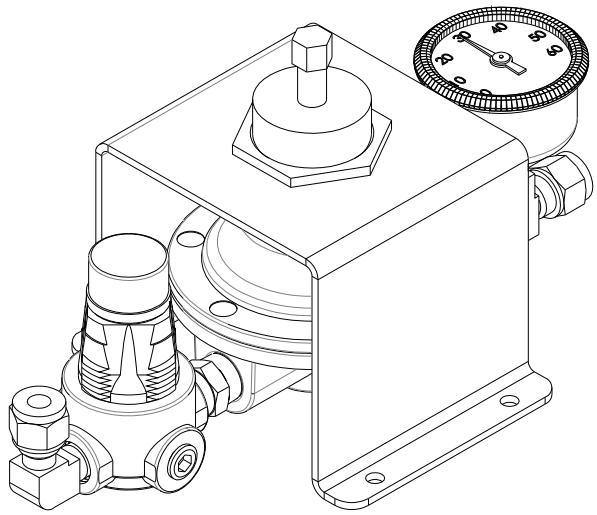


Figure 1–5. Pneumatic Assembly

Manifold

The Manifold is the mixing chamber for the permeation span gas and the dilution air. The output from the permeation oven combines with the dilution air in a tee immediately upstream of the manifold. The manifold allows proper mixing of the gases as well as provides outputs to three output valves (SYS A, SYS B, and Exhaust).

Valves

There are four valves. See Table 1–1 for valve configurations.

CDA – Main air intake valve

SYS A – Permeation span gas leading to 80*i* Analyzer A

SYS B – Permeation span gas leading to 80*i* Analyzer B

Exhaust (Idle) – Atmospheric dump leading to scrubber

Table 1–1. 84*i* Valve Configurations

		84*i* Gas Modes via 80*i*		
Valve Description	**MIB Valve**	**System "A" Permeation Span**	**System "B" Permeation Span**	**Idle**
CDA	Valve 1	ON	ON	ON
SYS A	Valve 2	ON	OFF	OFF
SYS B	Valve 3	OFF	ON	OFF
Exhaust	Valve 4	OFF	OFF	ON

Scrubber

When system is in idle mode, the generated mercury will be sent through the exhaust valve, scrubbed and sent to an atmospheric dump.

Flow Switch

The Flow Switch enables an automatic alarm if the flow is below threshold. When the flow switch is in alarm state, the perm oven heater will be OFF. To turn the perm oven heater back on, go to the screen, Service > 84i Perm Oven Settings > Perm Oven Setpoint and press Enter without changing the temperature. Rebooting the system will also turn the perm oven heater back on.

Pressure Sensor

The Pressure Sensor monitors the air pressure post capillary block.

Regulators

There are two gas regulators:

Course Regulator – initial regulator fixed at 60 psi.

Precision Regulator – set at factory to 25–40 psi.

Ambient Temperature Thermistor

The Ambient Temperature Thermistor measures the 84*i* box operating temperature.

84*i* Control Board

The Process Control Board that operates the 84*i* components.

Power Receptacle

The Power Receptacle includes the 84*i* power switch and a 2 amp fuse.

LEDs

Table 1–2 lists the seven LEDs located on the front panel.

Table 1–2. 84*i* LEDs

LED	Color	Description
Capillary	Green/Red	Indicates capillary block temperature status
Flow	Green/Red	Indicates air flow status
Oven	Green/Red	Indicates Permeation Oven temperature status
System A	Blue	When lit, System A is receiving mercury span gas
System B	Blue	When lit, System B is receiving mercury span gas
Idle	Blue	When lit, the 84*i* is in not in use by System A or B

LED	Color	Description
Power	Green	When lit, the 84*i* is powered On

RS 485 Link

The RS-485 connects the 84*i* to the 80*i* through the 82*i* or directly to the 80*i* in bench top applications.

Specifications

Table 1–3 lists the specifications for the Model 84*i* Hg Permeation Source.

Table 1–3. Model 84*i* Specifications

Hg output	Default: 5 μg/m^3
Sample flow rate	Default: 700 cc/min
Operating temperature	10 to 30 °C
Power requirements	105 to 240 VAC @ 50/60 Hz, 2 A
Physical dimensions	19-inch rack, 3U, 16.75" (W) x 5.25" (H) x 17" (D)
Weight	20 lbs.
Serial ports	RS-485 with two connectors (DB-15F)
Precision	0.04 μg/m^3 daily
Drift	<0.05 μg/m^3 over 60 days
Accuracy	Comparison against vendor prime reference for future
Carrier gas	Common input with model 81*i* Air or Nitrogen <20 °C dew point Oil, particulate and hydrocarbon free Per ISO 8573.1 <0.05 μg/m^3 Mercury
Supply pressure	70 to 90 psig
Back pressure	0 to 4 psig

Chapter 2
Installation

This chapter describes the instructions for Model 84*i* permeation source integration into Mercury Freedom System. For details, see the following topics:

Note This procedure assumes work is to be performed on one each fully functional and upgraded Mercury Freedom System. ▲

Note Custom systems or systems with multiple instruments may require more equipment and time to retrofit. ▲

Equipment Required

The various parts that are required for installation of the Model 84*i* Permeation Source are included and listed in Table 2–1. Verify that all the necessary parts have been received and are not damaged.

Table 2–1. 84*i* Hg Permeation Source Parts List

Description	Part Number	Quantity
Plate, Side, Blank 3U	113770-00	2
Nut, Lock, Hex, W/Tooth Washer #6	21-004542	4
Manual, 84*i*	114051-00	1
Tubing, PFA, 1/4-inch OD	5512	30 feet
Fitting, Union Tee, 1/4T, SS316	2049.514	2
Connector, Port, 1/4-inch	2049.798	1
Fitting, Union, 1/4T, SS316	262113322	1
Fitting, Tee, Union, PTFE	4453	1
Cable Assembly, DBM15, 6-feet	103299-00	1
Feet, Rubber, Steel Support	4303	4

Description	Part Number	Quantity
Screw, Phillips, Pan HD, 6-32 X 3/8-inch	101709-00	4
Cord, Power, 125V, C-13 NEMA 5-15P	101349-00	1
Kit, Slide Rail	113292-00	1
Interconnect Diagram	114114-00	1
Kit, Bracket, Extension, Slide Rail (2 per)*	5235	

*May be required, but not included with the kit.

Note Any equipment, cabling, or tubing removed during this procedure is to be properly disposed of or reused in accordance with local directives. ▲

System Preparation

Use the following procedure to prepare the Model 84*i* Permeation Source for installation.

1. Shut down Mercury Freedom System air supply by closing inlet valve to zero air panel.

2. Monitor pressure gauge on regulator assembly; proceed when pressure drops to zero psi.

Sequence of Work, Mechanical

Per the following:

1. Remove blank panel(s) below Freedom System Air Scrubber tray (Figure 2–1).

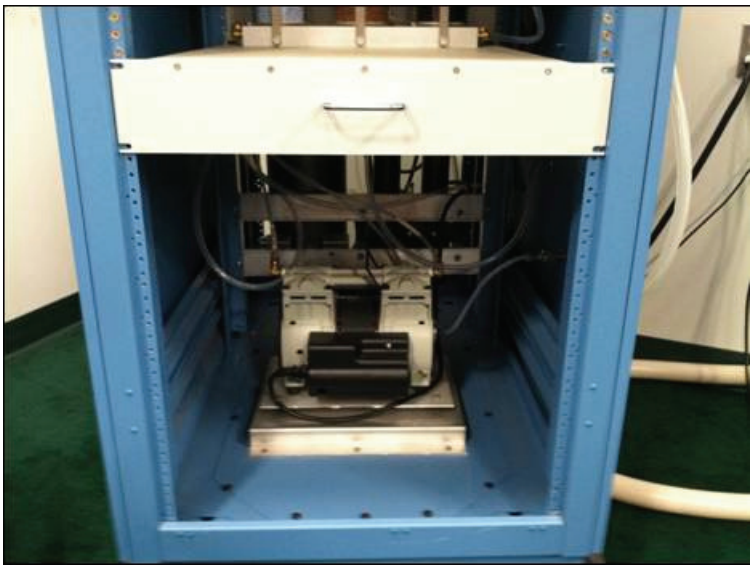


Figure 2–1. 84*i* Mounting Location

2. Using a tape measure, ruler or other suitable measuring device, measure down from Scrubber Tray approximately 3 inches and locate/mark the nearest mounting hole. Repeat for opposite side. These are the locations of the lower screw mounts for the front of the rails (Figure 2–2).

Figure 2–2. Slide Rail Mounting Holes

3. Remove Slide Rail Kit from packaging. Assemble IAW product literature, leaving rear slide rail hardware a little loose to allow position adjustment. Mount rails into rack at the location determined in the previous step, and tighten screws supplied with rails just enough to hold rail in place and allow slight adjustment.

4. Moving to the rear of the rack, locate the corresponding slide rail mount holes, and screw in two of the screws provided deep enough to allow the rail fingers to slip behind them. Mount rear of slides behind the screws. Repeat for opposite side. Check for level using a torpedo level or tape measure, leave screws tight enough so the rail moves with some force. This will facilitate final positioning of the 84*i* Permeation Source. If the rack is deeper than standard, order rail extension kit from Thermo Fisher Scientific Customer Service.

5. Remove 84*i* Hg Permeation Source from final packaging, inspect for physical defects. If the product appears satisfactory, mount inner slide rails onto 84*i* chassis using hardware provided in slide rail kit. Slide 84*i* fully into the rack to ensure proper positioning. Adjust position as necessary to allow smooth and level extension of the instrument.

6. Extend unit from rack approximately three inches, tightened the front slide rail mount screws, then the rear mount screws. Check position of the instrument for level and center (Figure 2–3).When the rail mounts are tight, leave 84*i* fully extended.

Figure 2–3. 84*i* Permeation Source Mounted in Rack

7. Remove the PFA tubing from the Accessory Kit, measure and cut into 3 separate tubes of 10 feet continuous length each. Take one length of tubing, and starting from the rear of the 81*i*, uncoil and route tubing along the entire run of the "CDA IN" pneumatic line, into the Panduit or system-particular routing scheme. Secure with two tie straps, then fully extend the 81*i* Hg Calibrator, ensure tubing and cables extend without getting caught. Sufficient tubing must be available for both the 81*i* and 84*i* to fully extend simultaneously out of the rack during operation.

8. Route the tubing down through the Panduit, then exit the channel as it nears the rear slide rail mounts of the 84*i*. Route tubing along the right-hand slide rail (as viewed from the rear of the rack), to the 84*i* CDA input. Allow excess to protrude from bottom of rack. Loosely secure with two tie straps.

9. Remove air line from rear panel of 81*i* "CDA IN" fitting. Allow to dangle (Figure 2–4).

Figure 2–4. 81*i* CDA Line Removed

10. Remove SS316 Tee and Port Connector from kit, install onto "CDA IN" fitting on rear of 81*i* (Figure 2–5).

Figure 2–5. 81*i* CDA Fitting Installation

11. Connect and properly swage the 1/4-inch tubing routed earlier (84*i* CDA feed) onto the newly fitted tee branch (lower port). *TIP* Install a shutoff valve on the lower port to facilitate periodic filter change out. Reconnect the air line removed from 81*i* "CDA IN" fitting to the run portion of the tee. Pull enough tubing to make a smooth run. Add another tie strap; cinch tightly (Figure 2–6).

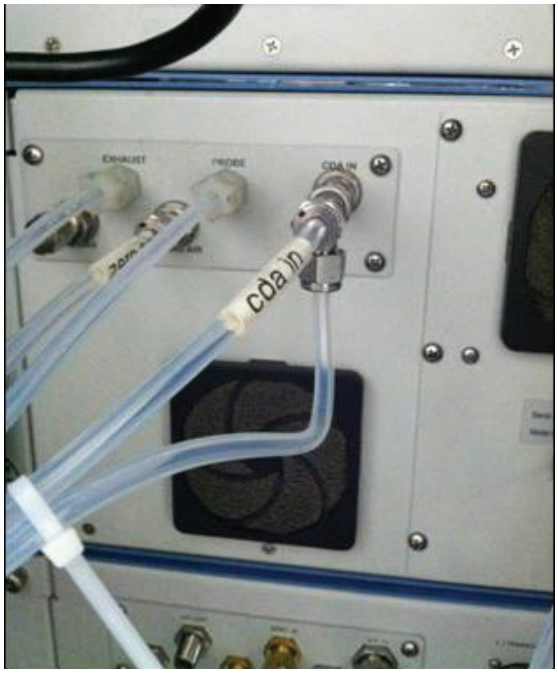


Figure 2–6. Retrofitted 81*i* CDA Plumbing to Support 84*i*

12. Trim the air line at the 84*i* end as needed and swage line onto the 1/4-inch CDA bulkhead fitting.

13. Remove the second ten foot length of PFA tubing from the kit. Starting at the 84*i*, uncoil and route along the air line tubing routed previously to the "CDA IN" bulkhead. Swage onto the 84*i* Hg Permeation Source scrubber mounted to the rear panel, and run line into the Panduit at the rear of the rack, and allow to dangle. Loosely secure with two tie straps. **Do not cinch tight!** Sufficient tubing must be allowed for the 84*i* to slide completely out of the rack during operation.

14. Route this tube up through the Panduit channel and exit the channel as it nears the exhaust manifold. If the exhaust manifold has an open port, cut tube to length and connect tubing. If no exhaust port is available, drill and tap for 1/8 NPT and install appropriate pipe fitting. Cinch loose tie straps tight, trim flying leads off.

15. Take the last 10 foot length of PFA tubing, uncoil and route along the two runs of tubing routed previously to the "CDA IN" bulkhead and scrubber lines using the tie straps provided. Swage onto the 84*i* Hg Permeation Source "SYSTEM A" at the rear panel, and run line into the Panduit at the rear of the rack, and allow to dangle. Loosely secure with two tie straps. **Do not cinch tight!** Sufficient tubing must be allowed for the 80*i* and 84*i* to slide completely out of the rack during operation.

16. Take this last tube and route the up through the Panduit to where the 80*i* tubing exits. Remove the "SPAN" tube going into the "SPAN" input bulkhead. Take PFE Tee from Retrofit kit, and approximately 3 inches of tubing, and connect to the open port vacated by the "SPAN" line. Fully extend 80*i* from rack, and run 84*i* tubing run along the "SPAN" line, trim line and terminate at the Tee installed earlier. Sufficient tubing must be allowed for the 80*i* and 84*i* to slide completely out of the rack during operation.

17. If the particular installation has a second system (SYSTEM "B"), route 1/4-inch PFA tubing (not supplied), as described above. Unused "system" output may be vented to exhaust manifold by teeing in with scrubber.

18. Take Cable Assembly 103299-00 from Retrofit Kit; attach one end to either RS-485 DB15 port on the 84*i* rear panel, secure with thumbscrews provided. Route this cable along the left-hand slide rail as

viewed from the rear of the instrument rack. Allow cable to extend out the rear of the rack.

19. Take cable 103299-00 and make as direct run as possible to the lower RS-485 port on the 82*i* Mercury Probe Controller. Take care to not entangle other electrical or pneumatic runs. Seat fully and secure with thumbscrews provided.

20. Carefully extend 82*i* fully from rack, while observing cable and plumbing runs. Instruments should be able to fully extend to at least the slide stops. Ensure no binding occurs as the 82*i* is pushed back into the rack. Use tie straps provided at the 82*i* end to secure the new 103299-00 cable to the existing 103299-00 attached to the top RS-485 port.

21. Take Power Cord included with kit and plug 84*i* into the outlet strip provided within the rack. Tighten all pneumatic fittings, secure tubing and communication/power cords with tie straps provided for a neat, orderly appearance.

22. Reseat both instruments fully into the rack, and ensure tubing and wiring travels freely behind the instruments without binding. Reroute as required. Turn 84*i* rear panel power switch “ON”. All 7 LEDs should light on 84*i* front panel and 84*i* fan should be running.

Sequence of Work, Software

Per the following:

1. Prior to loading software image into the 80*i*, download all logged records and perform a backup configuration on 80*i* and 81*i* using *i*Port and following the Read Me instructions. Log onto the Thermo Fisher Scientific Online Library at:

   www.thermoscientific.com/aqilibrary.

2. Locate the software download section, select 80*i* code numbered 02.01.01.342 or higher and download. Ensure the code you download will support 84*i* operation. Using *i*Port, upload software onto 80*i*, and during the boot up scripts, note the 80*i* reports the 84*i* board status as "OK".

3. Following boot up, the 80*i* should be communicating with the 84*i* and the "IDLE" front-panel LED should be lit. Verify communication between instruments as follows:

   a. At the 80*i* User Interface Main Menu, select Instrument Controls > Gas Mode > Permeation Span. Note the "System A" LED on the 84*i* front panel illuminates. Return to the Main Menu.

   b. From the 80*i* User Interface Main Menu, select Instrument Controls > Service Mode > select "ON". Return to Main Menu > select Service > 84i Perm Oven Settings > 84i Connection. Set to "B". Note the "System B" LED on the 84*i* front panel illuminates. "System A" and "IDLE" LEDs should be extinguished.

   c. From the 80*i* User Interface Main Menu, select Instrument Controls > Gas Mode > Sample. Note the "IDLE" LED on the 84*i* front panel illuminates. "System A" and "System B" LEDs should be extinguished.

4. Open valve for air feed to zero air panel, note air pressure on input regulator returns to normal level. At the 81*i* User Interface Main Menu, select Diagnostics > Flows. Note 81*i* flows should return to setpoints displayed. Allow 24 hours for 84*i* temperatures to stabilize prior to operation.

Note If communication is lost between 80*i* and 84*i*, the 80*i* will need to be rebooted. ▲

Chapter 3
Operation

This chapter describes the associated menu-driven software and Permeation/Generator calculation for the Periodic Quality Assurance Assessments of Certified User Generators. For details, see the following topics:

Turning On the Permeation Option

To turn on the Permeation option, go to the Model 80*i* screen Diagnostics > **System Configuration**. The Permeation option can be set to either Primary System, Secondary System or Off.

Note In order to turn ON the Permeation Option, the instrument needs to be in Service mode. To turn on Service mode, from the Main Menu, choose Instrument Controls > **Service Mode** and set to ON. ▲

Primary System

If there is only one Mercury Freedom System being audited by the 84*i* then choose "Primary System" for the Permeation Option. When the Permeation Option is set to Primary System, the 80*i* will display 84*i* menu items in the following screens: Gas Mode, Calibration, Calibration Factors, Diagnostics, Service and Alarms. Also, since the Primary System is electrically connected to the 84*i*, the Primary System's 80*i* will have complete read/write control of the 84*i*.

Note Most users will have a dedicated Model 84*i* Permeation Source for their Mercury Freedom Systems. Therefore, those users can skip the parts in this chapter that deal with using a Secondary System. ▲

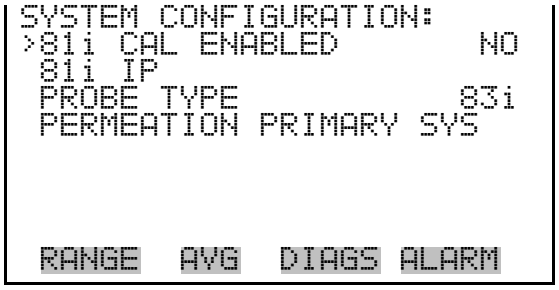
Secondary System

If there are two co-located Mercury Freedom Systems being audited by one 84*i*, then one of the Mercury Freedom Systems should be set as the "Primary System" and the other should be set as the "Secondary System". When the Permeation Option is set to Secondary System in the 80*i*, only the Gas Mode screen will have an item for the 84*i*. All other 84*i* screens will be masked in the 80*i*. This is because only the Primary System's 80*i* can be electrically connected to the 84*i*. The Secondary System's 80*i* will not have any read/write control over the 84*i*. Rather, it will be dependent on the Primary System's control of the Model 84*i*.

Off

If the Permeation option is set to OFF, then all 84*i* screens and menu items will be masked.

From the Main Menu, choose Diagnostics > **System Configuration**.



Gas Modes Menu

This menu allows the user to manually choose the Permeation Span Gas mode. The Permeation Span Gas Mode will appear at the bottom of the Gas Mode list when the Permeation Option is ON. Selecting the Permeation Span Gas Mode will open up the span bulkhead on the rear panel of the 80*i*. This will allow permeated mercury span to flow from the 84*i* to the 80*i* Span bulkhead without affecting the 81*i*. Choosing the Permeation Span Gas mode will not perform the Auto Permeation Schedule discussed later in this chapter. Rather, it will only put the system into Permeation Mode, allowing the permeated mercury span gas from the 84*i* to enter the corresponding 80*i*.

Note For a System designated as the Primary System, choosing Permeation Span will open up the "Sys A" valve in the 84*i* and also open the Span valve in the 80*i* allowing permeation span gas to be sent from the Model 84*i* and analyzed by the Model 80*i*.

For a System designated as the Secondary System, choosing Permeation Span will only open the Span valve in the Secondary System's 80*i*. Since the Secondary System is not electrically connected to the 84*i*, the 84*i* will be unaffected and stay in Idle mode. In order to direct 84*i* span gas to the Secondary 80*i*, the Primary System will need to set the 84*i* Connection to Connection "B". This is discussed later in this chapter. ▲

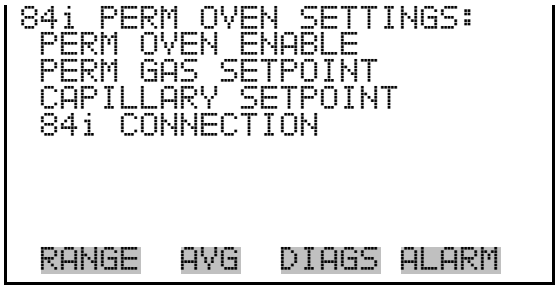
From the Main Menu, choose Instrument Controls > **Gas Modes**.

84*i* Permeation Oven Settings Menu

This section describes how to set the 84*i* Permeation Oven temperature settings and connection setting. These controls are located at the Service menu.

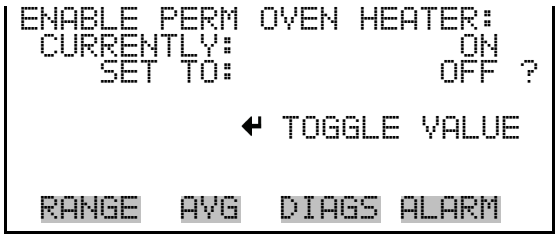
Note In order to view the 84*i* Perm Oven Settings menu, the instrument needs to be in Service mode. To turn on Service mode, from the Main Menu, choose Instrument Controls > **Service Mode** and set to ON. ▲

From the Main Menu, choose Service > **84i Perm Oven Settings**.



Permeation Oven Enable

The Perm Oven Enable screen allows the user to turn off the permeation oven heater. This is especially important if the user wishes to turn the Model 84*i* off. There should always be air flow going through the permeation oven when it is hot. **Prior to turning off the 84*i*, it is very important to cool down the permeation oven to room temperature**. To do this, the user should leave the 84*i* power switch in the ON position and turn OFF the Perm Oven Heater. It may take several hours for the heaters to cool to room temperature. When the 84*i* is powered back on, the permeation oven will automatically be turned ON.



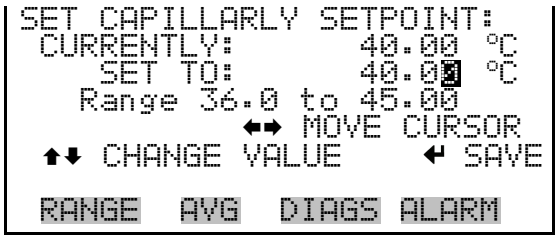
Permeation Gas Setpoint

The Perm Gas Setpoint screen is used to set the permeation gas temperature. An increase in temperature will increase the amount of mercury being off gassed from the permeation tube. Changing this

temperature setting will affect the qualification test results. This setting should only be changed by qualified individuals.

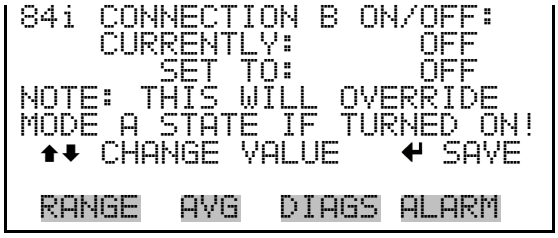
Capillary Setpoint

The Set Capillary Setpoint screen is used to set the capillary block temperature. Within the capillary block there are two orifices. One supplies the permeation oven with zero air. The other orifice supplies dilution air post permeation oven. A change in temperature will alter the flows and change the mercury concentration. Therefore, changing this temperature setting will affect the qualification test results. This setting should only be changed by qualified individuals.



84i Connection B

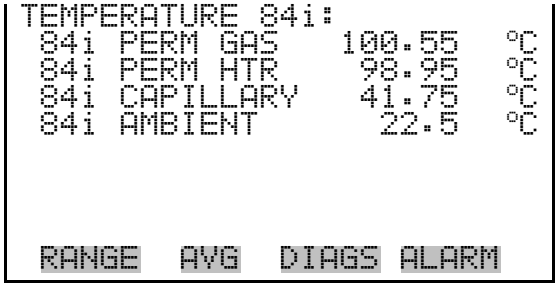
This screen is only used when auditing a second Mercury Freedom System with the same 84*i*. The 84*i* Connection screen, located at Service > 84*i* Perm Oven Settings > 84*i* Connection, allows the user to supply permeated mercury span gas to a second 80*i* Analyzer through the "SYS B" bulkhead. On the rear panel of the 84*i*, there are bulkheads labelled "SYS A", "SYS B" and "Idle". The 84*i* supplies Permeation span through only one of these bulkheads at a time. The 84*i* connection screen allows the user to choose the B connection (SYS B bulkhead) when auditing a second Mercury Freedom System. This will allow permeation span to go to the SYS B bulkhead and to the Secondary System's 80*i*. This screen, along with the other 84*i* menu items, is available in the Primary System's menu structure. If auditing only one System, the Connection B screen can be disregarded and the 84*i* Connection B setting should remain OFF at all times.



Temperature Diagnostics

A screen called Temperature 84*i* displays the four temperatures associated with the 84*i*.

From the Main Menu choose Diagnostics > Temperatures > **84i**.



84*i* Perm Gas Temperature

The Permeation Device Assembly has two thermistors measuring temperature. The first one listed, the Perm Gas Temperature thermistor, measures the span gas temperature.

84*i* Perm Heater Temperature

The 84*i* Perm Heater Temperature thermistor measures the actual heater temperature inside the Permeation assembly.

84*i* Capillary Temperature

The 84*i* Capillary Temperature measures the capillary block temperature.

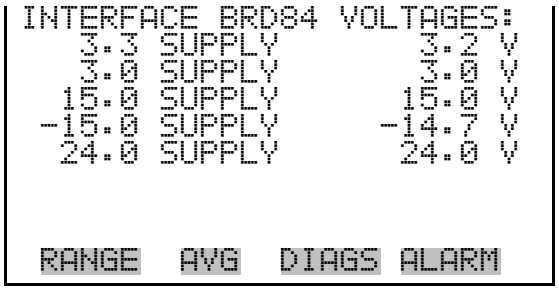
84*i* Ambient Temperature

The 84*i* Ambient Temperature measures the ambient temperature inside the 84*i*.

Voltage Diagnostics

A screen called Interface Brd84 displays five voltages associated with the 84*i* PCB board.

From the Main Menu choose Diagnostics > Voltages > **Interface Board 84i**.



Alarms

A new selection called “84i” in the Alarms menu will be visible when the Permeation Option is set to “Primary Sys”.

From the Main Menu choose Diagnostics > Alarms > **84i**.

Alarms Detected

This displays the total number of alarms associated with the 84*i*.

Permeation Gas Temperature

If the Permeation Gas temperature falls outside of the alarm limits, an alarm will be displayed reading either Low or High.

Permeation Heater Temperature

If the Permeation Heater temperature falls outside of the alarm limits, an alarm will be displayed reading either Low or High.

Capillary Temperature

If the Capillary Block temperature falls outside of the alarm limits, an alarm will be displayed reading either Low or High.

Pressure

The Pressure reading measures the gas pressure directly after the capillary block. An alarm of Low or High will be displayed if the pressure reading falls outside the alarm limits.

Flow

The Flow alarm is a binary alarm that will display either OK or Fail. There are no alarm limits associated with this alarm. If there is no air flow the alarm reading will display Fail and the Permeation Oven will turn off. To turn the perm oven heater back on, go to the screen, Service > 84i Perm Oven Settings > Perm Oven Setpoint and press Enter without changing the temperature. Rebooting the system will also turn the perm oven heater back on.

Board Status

This alarm displays the functionality of the 84*i* Interface board and will either say OK or Fail.

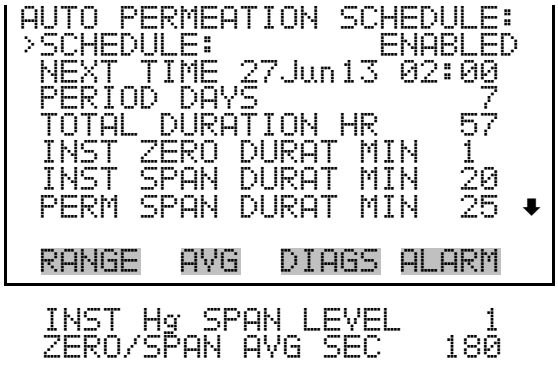
Performing an Audit using the Auto Permeation Schedule

This section discusses how to set up and run an Auto Permeation Schedule located in the Calibration menu.

This menu is similar to the Auto Zero/Span Check menu in the Model 80*i*. The timing and duration of the calibration is programmed using this menu. The Auto Permeation Schedule will first zero the background using the 81*i* zero air. Secondly, the 81*i* will send span gas to the 80*i*. Third, the 84*i* will send span gas to the 80*i*. At the end of this step, the Perm/Gen Ratio will be calculated and updated. This procedure should also be followed if the user is using a DAS.

In cases where there are two co-located 80*i*'s using one 84*i*, the Auto Permeation Schedule can only be used with the Primary System (the system electrically connected to the 84*i*).

From the Main Menu, choose Calibration > **Auto Permeation Sch**.



Schedule

The Auto Permeation Schedule can be activated or deactivated by toggling Enabled/Disabled. When Enabled, the Auto Permeation Schedule will run at the Next Time date. When Disabled, the Auto Permeation Schedule will not run.

Next Time

The Next Time screen is used to view and set the next Auto Permeation Schedule date and time. Once the Permeation Schedule begins, the date and time of the next Auto Permeation Schedule is calculated based on the Period.

Period Days

The Auto Permeation Schedule Period Days screen defines the period or interval between Auto Permeation Schedules.

Total Duration

The Auto Permeation Schedule Duration Minutes screen calculates how long the Auto Permeation Schedule will take based on the Instrument Zero Duration, Instrument Span Duration and the Perm Span Duration settings.

INST Zero Duration Minutes

This defines how long zero air from the 81*i* is sampled by the 80*i* Analyzer. At the end of the INST Zero Duration, the Instrument's zero background will be updated.

INST Span Duration Minutes

This defines how long span gas from the 81*i* is sampled by the 80*i* Analyzer. At the end of the INST Span Duration, the averaged span concentration will be temporarily recorded. The span coefficients will not be calibrated.

PERM Span Duration Minutes

This defines how long span gas from the 84*i* is sampled by the 80*i* Analyzer. The Perm/Gen Ratio located at the Calibration Factors screen will be calculated and updated. See the subheading "Permeation/Generator Ratio" located below for more information.

INST Hg Span Level

The Instrument Hg Span Level screen is used to set the span concentration for the 81*i* during the Auto Permeation Schedule. During an Auto Permeation Schedule the 81*i* concentration associated with this integer will be requested by the 80*i* Analyzer during the INST Span Duration. It is

important to use the same 81*i* concentration as used when the Base Perm/Gen Ratio was determined.

Zero/Span Averaging Seconds

This defines the 80*i* concentration averaging time during the Auto Permeation Schedule.

System Configurations

There are two possible configurations for Auditing Systems. The first configuration is most common with one Mercury Freedom System getting audited by one Model 84*i*. The second configuration is with 2 Mercury Freedom Systems getting audited by one Model 84*i*.

Configuration for Auditing One Mercury Freedom System

Physical Connection to Primary System

At the 80*i* screen, Diagnostics>System Configuration, choose "Primary Sys" for the Permeation option. The bulkhead labelled "SYS A" on the rear panel of the 84*i* should be used to connect tubing from the Model 84*i* Permeation Source to the Model 80*i* Analyzer as follows:

On the rear panel of the 80*i*, remove the PFA tubing from the Span bulkhead. Install a PFA tee at the end of the tubing. With a small piece of PFA tubing, attach the tee to the 80*i* Span bulkhead. Next, attach another piece of tubing from the newly installed tee to the SYS A bulkhead on the rear panel of the Model 84*i*. The atmospheric dump from the other tee already in line should not be modified. For this configuration, see Figure 3–1.

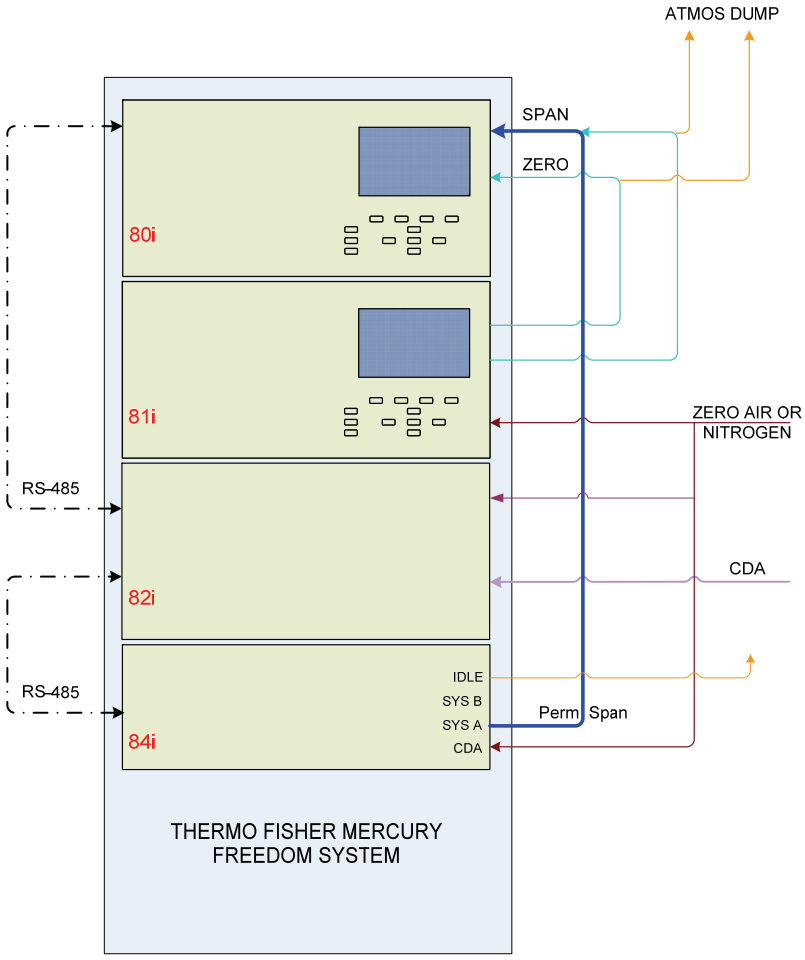


Figure 3–1. Tubing and Electrical Configuration

Electrical Connection to Primary System

To electrically connect the 80*i* to the 84*i*, connect an RS-485 cable from the 80*i* to the 82*i* (if not already present). Connect a second RS-485 cable from the 82*i* to the 84*i*. Turn on Model 84*i* and then cycle the power on the Model 80*i*.

The following Figure 3–2 displays the RS-485 connections on the rear panel of the 84*i*.

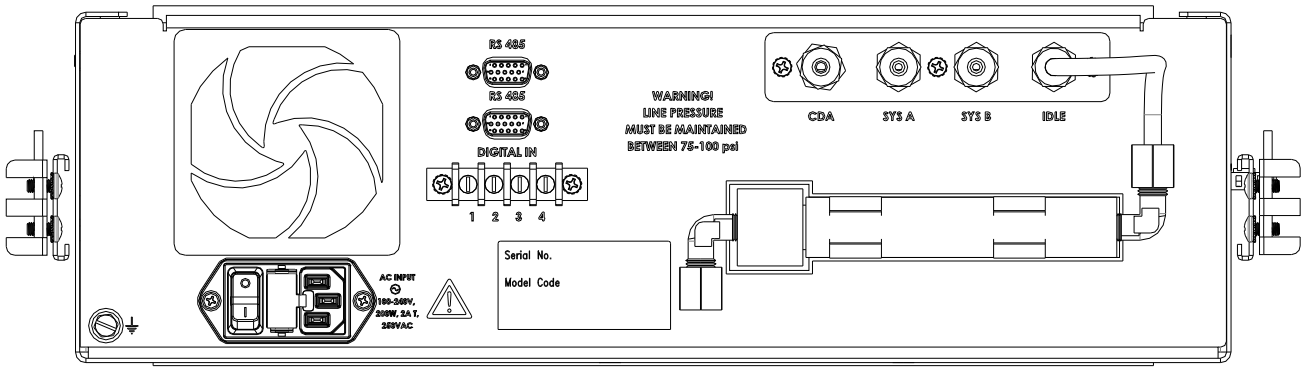


Figure 3–2. RS-485 Connections Diagram

Configuration for Auditing Two Mercury Freedom Systems using Connections A and B

Physical Connection to Primary and Secondary Systems

If two systems are being audited by the same 84*i* Permeation Source, the user must designate one System as the Primary System and the other as the Secondary System. This is done at the 80*i* screen, Diagnostics>Instrument Configuration, next to the Permeation option. The 80*i* of the Primary System will have complete control of the 84*i* and will also be able to read the 84*i* diagnostics, settings, alarms, gas mode menu and calibration menu. The Secondary System will have these menu screens masked since only one system (the Primary System) can be electrically connected and read/write to the 84*i*. The only 84*i* item in the Secondary System's 80*i* menu, that is not masked, is the Permeation Gasmode found in the screen, Instrument Controls > Gasmode.

The PFA tubing connection for the Primary System is the same as described above in the section "Auditing One Mercury Freedom System". The PFA tubing from the Secondary System's 80*i* should be connected to the bulkhead labelled "SYS B" on the rear panel of the 84*i* in similar fashion to how the Primary System's 80*i* is connected to the "SYS A" bulkhead. See Figure 3–3.

Note If using a single 84*i* for auditing two Mercury Freedom Systems, the same Nitrogen feed must be connected to both systems to avoid any quenching issues. ▲

Electrical Connection only to the Primary System

The Secondary System's 80i is not connected to the 84*i* via an RS-485 cable. Therefore, the Primary System's 80*i*, which is electrically connected to the 84*i*, will be the system used to control and communicate with the 84*i* through DAS or similar remote programs when auditing the Secondary System. Only one system can be audited at a time.

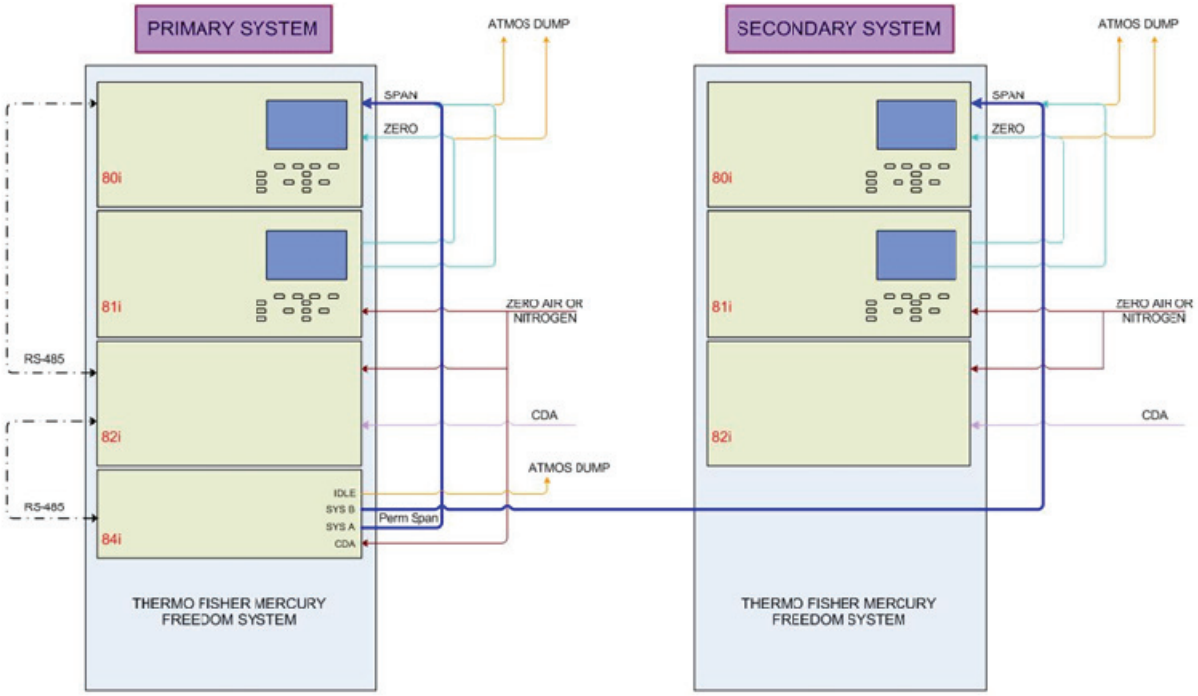


Figure 3–3. Physical and Electrical Connections for auditing two Mercury Freedom Systems using one 84*i* Permeation Source

General Procedure for Running an Audit

Before initiating an Audit to maintain NISTtraceability of a mercury (Hg) source (i.e. Model 81*i* mercury calibrator), it is up to the user to read and understand the "Traceability Protocol for Qualification and Certification of Elemental Mercury Gas Generators" document.

The following is the General procedure for running audits with the Model 84*i*:

1. Instrument Zero sent from the Model 81*i* Calibrator to the Model 80*i* Analyzer for at least 10 minutes.
   a. Perform a Zero Background adjustment.

2. Instrument Span sent from the Model 81*i* Calibrator to the Model 80*i* Analyzer for about 20 minutes.

a. Record span reading from the Model 80*i* Analyzer.

3. Permeation Span sent from the Model 84*i* Permeation Source to the Model 80*i* Analyzer for about 25 minutes.
   a. Record span reading from the Model 80*i* Analyzer.

4. Calculate the Permeation/Generator ratio.
   a. Divide the 84*i* Permeation Span reading by the 81*i* Calibrator Instrument span reading (Step 3a/Step 2a).

Running an Audit on the Primary Mercury Freedom System

For most users, each Mercury Freedom System will have a dedicated Model 84*i* Permeation Source. Therefore, the 80*i* will be designated as the Primary System. For the Primary System, the audit can be done one of three ways: Manually with the front panel screen, Automated Schedule or DAS control.

Manual Audit

1. Manually put the Primary System in Instrument Zero mode using the display screen. After at least 10 minutes, the user will Zero the Model 80*i*.

2. Manually put the Primary System in Instrument Span mode. After about 20 minutes, the user will record the concentration reading from the Model 80*i* Analyzer.

3. Manually put the Primary System in Permeation Span mode. After about 25 minutes, the user will record the concentration reading from the Model 80*i* Analyzer.

4. The user will manually calculate the Permeation/Generator Ratio by dividing the results from Step 3 by Step 2.

Automated Permeation Schedule

Go to the screen, Calibration > Auto Permeation Schedule. Set the parameters at that screen (see information stated earlier in this chapter). The Audit will begin at the specified time and will automatically run through the 4 steps listed above. The Perm/Gen ratio will be automatically

calculated at the end of the schedule. This value can be found at the screen Calibration Factors next to the text "Perm/Gen Ratio". The Perm/Gen Ratio can be included in the analog outputs, logged data, and streamed data.

Using a DAS (Data Acquisition System) to perform an Audit

The same sequence as the Manual Audit described above will be used. The following information explains how a user can externally perform an Audit on their Thermo Scientific™ Model 81*i* Mercury Calibrator by means of the Modbus protocol using the Thermo Scientific™ Model 84*i* Permeation Source in the Thermo Scientific™ Mercury Freedom System.

All communication using Modbus is written to and read from the Model 80*i* Mercury Analyzer. Control of the Model 81*i* Calibrator and the Model 84*i* Permeation Source is achieved through the 80*i* Mercury Analyzer. See Appendix C in the 80*i* manual, "Modbus Addresses Supported", for a full list of all Write Coils, Read Coils and Read Registers. An abbreviated list of Modbus commands can be found in Appendix C of this manual.

When using a DAS to run Audits, the Automatic Permeation Schedule should be Disabled in the Model 80*i* menu structure at the screen Calibration > Auto Permeation Sch.

In the event that Modbus is unavailable, this automation routine can also be performed using standard TTL style relay inputs and outputs located on the Model 80*i* Analyzer.

Please note that all communication via relay interface is between the DAS and the Model 80*i* Analyzer. The DAS does not need to interface with the Model 81*i* Calibrator or the Model 84*i* Permeation Source to perform this automated check.

Performing an Audit on the Primary System through DAS using the Mercury Freedom System and the Model 84*i* Permeation Source via Modbus Commands

Note In order to achieve the most representative span readings, the user may want to increase the averaging time. This can be done at the Model 80*i* Analyzer screen: Main Menu > Averaging Time. ▲

1. Put the system in the Hg^0 only mode by activating and holding **Write Coil 101**. This will allow the user to perform the audit more quickly compared to a system in speciation mode. This Write Coil should be

activated for the entire duration of the audit. **Read Coil 2**, Hg^0 mode, will now be activated.

2. Turn on the Instrument Zero gas mode by activating and holding **Write Coil 104**. This will supply the zero air from the Model 81*i* Calibrator to the Model 80*i* Analyzer. Remain in this gas mode for 12 minutes. **Read Coil 6**, Instrument Zero gas mode, will be activated during this time.

3. Next, set the Zero Background of the Model 80*i* Analyzer by temporarily activating the **Write Coil 112** for at least two seconds. The Zero Background value at **Read Register 49&50** will be updated.

4. Deactivate Instrument Zero gas mode, **Write Coil 104**.

5. Select the desired Model 81*i* Instrument Span value by choosing the correct Instrument Span integer 1, 2 or 3. This is done by temporarily activating the Instrument Span integer **Write Coil 126, 127** or **128**. The Write Coil should be activated for at least 2 seconds and then can be deactivated.

6. Turn on the Instrument Span gas mode by activating and holding **Write Coil 105**. This will supply calibration gas from the Model 81*i* Calibrator to the Model 80*i* Analyzer. Remain in this gas mode for about 20 minutes. **Read Coil 7**, Instrument Span mode, will be activated during this time.

7. At the end of the 20 minutes, record the averaged Hg^0 concentration of the last three minutes from the **Read Register 1&2**.

8. Deactivate Instrument Span gas mode, **Write Coil 105**.

9. Turn on the Permeation Span mode by activating and holding **Write Coil 134**. This will supply span gas from the Model 84*i* Permeation Source to the Model 80*i* Analyzer. Remain in this gas mode for about 25 minutes. **Read Coil 53**, Permeation Span mode, will be activated during this time.

10. At the end of the 20 minutes, record the averaged Hg^0 concentration of the last three minutes from the **Read Register 1&2**. The audit is now finished.

11. To return the system to Sample mode, deactivate the Permeation Span mode, **Write Coil 134**. By default, the system will return to Sample mode if no gas mode Write Coils are activated.

12. Deactivate Hg^0 only mode, **Write Coil 101**. To return the system to Hg^0/Hg^t Speciation mode, use **Write Coil 103 (Read Coil 4** will be activated). Or, to return the system to Hg^t only mode use **Write Coil 102 (Read Coil 3** will be activated).

13. Determine the Permeation/Generator Ratio. See the top of this section to locate documentation on how to calculate the Perm/Gen Ratio.

Running an Audit on a Secondary Mercury Freedom System

For the Secondary System, the Audit can be done one of two ways: Manually with the front panel screen or DAS control.

Manual Audit

1. Put the Secondary System in Instrument Zero mode. After at least 10 minutes, the user will Zero the Secondary System's Model 80*i*.

2. Put the Secondary System in Instrument Span mode. After about 20 minutes, the user will record the concentration reading from the Secondary System's Model 80*i* Analyzer.

3. Put the Secondary System in Permeation Span as described:
   a. Put the Secondary System in Permeation Mode.
   b. Using the Primary System, turn on the Service mode by going to the Model 80*i* screen, Instrument Controls > Service Mode.
   c. Using the Primary System, switch the Model 84*i* valve from Idle to Connection "B". This is done by going to the Primary System's Model 80*i* menu located at: Service > 84i Perm Oven Settings > 84i Connection. Turn ON Connection "B". Permeation span will now being directed to the SYS B bulkhead which should be connected to the tubing going to the Secondary System's Model 80*i* Span bulkhead as explained earlier in this chapter.
   d. After about 25 minutes, the user will record the concentration reading from the Secondary System's Model 80i Analyzer.

4. Calculate the Permeation/Generator Ratio by dividing the results from Step 3d by Step 2.

5. Using the Primary System, switch the Model 84*i* valve from Connection "B" to Idle. This can be done by going to the Primary System's Model 80*i* menu located at: Service > 84i Perm Oven Settings > 84i Connection. Turn OFF Connection "B". Permeation span will now being directed to the Idle bulkhead which is connected to a scrubber.

6. At the end of the Audit, turn off Service mode in the Primary System.

Using a DAS (Data Acquisition System) to perform an Audit on the Secondary System

All the commands listed in the section above under the heading, "Performing an Audit on the Primary System through DAS using the Mercury Freedom System and the Model 84*i* Permeation Source via Modbus Commands", should be used as DAS commands **directed to the Secondary System's 80*i*** when auditing the Secondary System.

However, in addition, **two commands** will be needed to be sent from the **DAS connected to the Primary System's 80*i*** at specific times. The Secondary System's 80*i* span bulkhead is connected to the SYS B bulkhead on rear panel of the Model 84*i*. In order to direct permeation span gas to the Secondary System the user will need to select Connection B. This is done by sending a DAS command to the Primary System's 80*i* at a specific time.

Here are the additions at the proper time in the sequence:

8.1 Direct permeation span through the Model 84*i* SYS B bulkhead by activating and holding Connection B, Write Coil 136. This is done through the DAS connected to the Primary System.

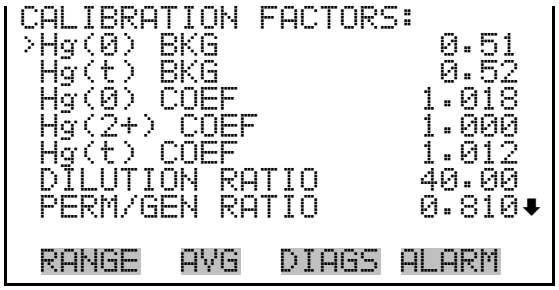
11.1 Direct permeation span through the IDLE bulkhead by deactivating Connection B, Write Coil 136. This is done through the DAS connected to the Primary System.

Note During the auditing of the Secondary System, the Primary System's 80*i* (that is electrically connected to the 84*i*) can be used for normal operation. However, the Primary System's 80*i* should not be put into Permeation Gas Mode when auditing the Secondary System. ▲

Permeation/Generator Ratio

The Perm/Gen Ratio located in the Calibration Factors Main Menu displays the calculation result of the most recent Auto Permeation Schedule. The equation is as follows:

$$Perm/Gen\ Ratio = \frac{Last\ averaged\ value\ of\ the\ PERM\ Span\ Duration}{Last\ averaged\ value\ of\ the\ INST\ Span\ Duration}$$



Obtaining the Base Perm/Gen Ratio

The initial "Base" Permeation/Generator Ratio is used to compare all subsequent Perm/Gen Ratios. Therefore, it is important to get an accurate Base Perm/Gen Ratio. Upon startup of the 84*i*, the permeation gas temperatures will take 12 hours to stabilize at 100.0 °C. Additional time will be needed for the permeation span gas concentration to stabilize. There should **always** be air flow through the 84*i*, when powered. The 84*i* flow alarm should say "OK" and the Flow LED on the front panel of the instrument should be green.

It is suggested to perform three audits, on three different days, yielding three separate Perm/Gen Ratios. If no significant drift is seen, the average of the three Perm/Gen Ratios can be used as the Base Perm/Gen Ratio.

The graph in Figure 3–4 shows what a typical Quality Assurance Audit looks like.

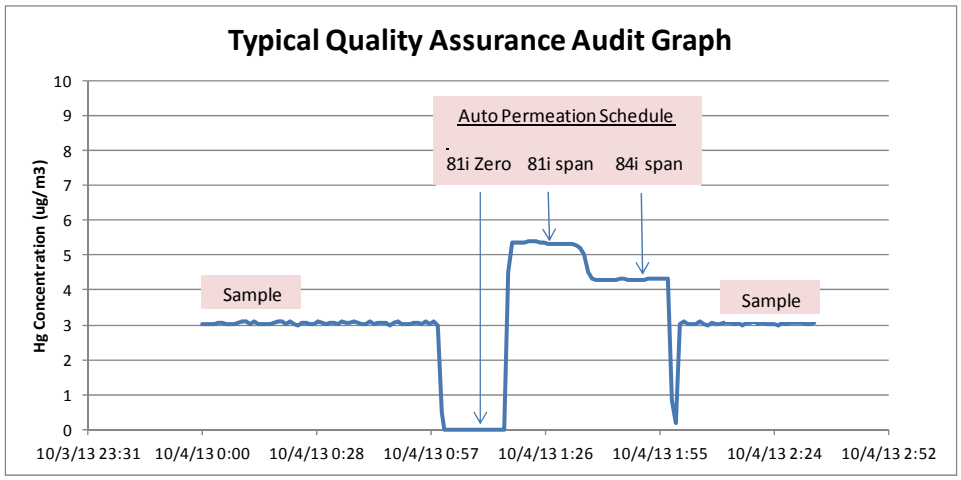


Figure 3–4. Typical Quality Assurance Audit Graph

Figure 3–5 below shows the typical correlation between the Base Perm/Gen Ratio and all subsequent Perm/Gen Ratios. In this example, the acceptable range based on the initial Base Perm/Gen Ratio is also shown as solid lines.

Note Perm/Gen Ratio values will differ from values shown below. ▲

Note The operating temperature for the 84*i* is from 10 °C to 30 °C. However, sharp, quick changes in ambient air temperature during the audit may affect Perm/Gen Ratio results. ▲

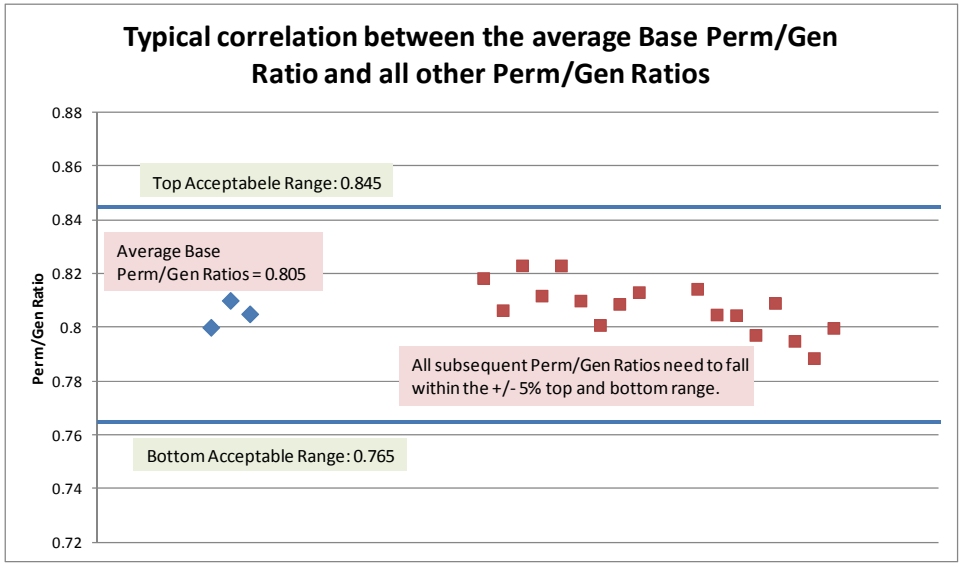


Figure 3–5. Typical Correlation between the averaged Base Perm/Gen Ratio and Subsequent Perm/Gen Ratios

Data Logging

Five additional data logging variables will be available when the Permeation Option is enabled. The user will need to add each variable to the data logging list in order to view and save 84*i* data.

Data logging variable content can be added from the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content. After selections are made the user will need to press "Commit Content" located in the same menu. This will store the new variables in the data logging list, but also **erases** all historical data logged values.

84*i* data logging variables include:

- P-G Ratio – Permeation/Generator Ratio
- Perm Ovn Gas – Permeation Gas Temperature
- Perm Ovn Heater – Permeation Oven Heater Temperature
- Capillary – Capillary Block Temperature
- 84*i* Pressure – 84*i* Span Gas Pressure

Shutting Off the 84*i*

The Permeation Oven should be **cooled down** before powering OFF the 84*i* in order for there not to be a build up of mercury gas in the heated permeation assembly. Air flow through the 84*i* is needed when cooling down the permeation oven. To cool down the permeation oven go to the screen, Service > 84i Perm Oven Settings > Perm Oven Enable and turn off the permeation oven. Allow the permeation oven to reach room temperature with air flow going through it before powering off the 84*i*.

Stand-alone Configuration

The model 84*i* Permeation Source is designed to work with the Mercury Freedom System by interfacing with the model 80*i* Mercury Analyzer. However, there is an option to run the 84*i* in a stand-alone configuration. This option is configured at the factory. The regular system version of the 84*i* cannot be configured to the stand-alone version in the field.

When operated independent of an 80*i*, the 84*i* will maintain default temperature setpoints. The alarm parameters are fixed and will continue to function with failsafe modes. Performing a permeation audit in stand-alone mode is achieved through the digital inputs on the rear panel of the 84*i*.

Digital Inputs for Stand-alone version

The digital inputs on the rear panel of the Model 84*i* will not function unless the 84*i* board located inside the 84*i* instrument has been coded with

the stand-alone version of firmware at the factory. Digital input 3 and 4 as shown below will activate the SYS A bulkhead and the SYS B bulkhead respectively.

To activate the SYS A bulkhead using the digital ins on the rear panel of the 84*i*, connect the 3rd digital in to ground. The SYS A valve will open allowing permeation span gas to flow through the SYS A bulkhead. Also, the System A LED located on the front panel of the 84*i* will be lit.

To activate the SYS B bulkhead using the digital ins on the rear panel of the 84*i*, connect the 4th digital in to ground. The SYS B valve will open allowing permeation span gas to flow through the SYS B bulkhead. Also, the System B LED located on the front panel of the 84*i* will be lit.

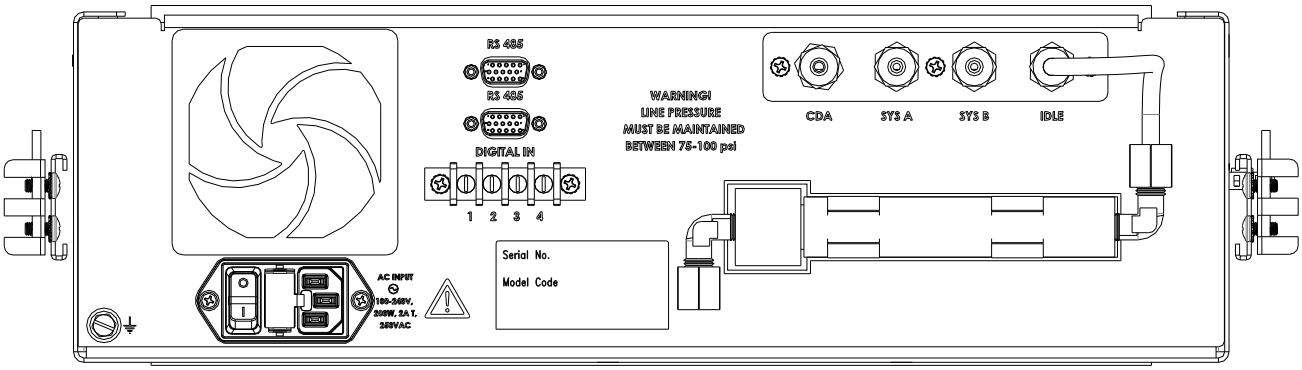


Figure 3–6. Digital In Connection Diagram

Note The majority of 84*i* instruments will have computer boards that are not programmed with Standalone firmware. Therefore, activation of SYS A and SYS B bulkheads should be done in the normal fashion, through the Model 80*i*, as explained in this manual.

For instance, the normal way to allow permeation span to flow through the SYS A bulkhead, is to turn on the Permeation Span Gas mode as explained above in this manual. The user that has a dedicated 84*i* for each Mercury Freedom System will most likely not have to use Connection B. However, the normal way to allow permeation span to flow through the SYS B bulkhead, is to go to the 84*i* Connection menu and turn ON Connection B (or use the corresponding Modbus Write Coil) as explained above in this manual. ▲

Chapter 4
Preventive Maintenance, Troubleshooting and Servicing

This chapter includes preventive maintenance information, fault isolation tips, and servicing information. For additional service assistance, see "Service Locations" at the end of this chapter.

Safety Precautions

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

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

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

Replacement Parts List

Table 4–1 lists the replacement parts for the 84*i* Hg Permeation Source.

Note The recommended replacement interval is site specific; therefore, these are only guidelines. ▲

Table 4–1. Model 84*i* Hg Permeation Source Replacement Parts

Part Description	Part Number	Qty	Replacement Interval
Scrubber, Mercury	101707-00	1	6 Months
Permeation Tube	113719-00	1	As Required
Fan	100907-00	1	As Required
Fan Filter and Guard	8630	1	As Required
DC Power Supply	101681-00	1	As Required
Solenoid Assembly	113713-00	1	As Required
Permeation Oven	102030-00	1	As Required
Pressure Transducer	101368-00	1	As Required
Capillary Block Heater Assembly	113721-00	1	As Required
Assembly Plumbing Flow Splitter	113747-00	1	As Required
PCB, Measurement Interface Board	113359-00	1	As Required
Precision Regulator Assembly	113734-00	1	As Required
Thermistor, Ambient	101688-00	1	As Required
PCB, LED	113804-00	1	As Required

Hg Scrubber Replacement

Use the following procedure to replace the Hg Scrubber. This should be done every 6 months.

1. Shut air feed off to 84*i* via shutoff valve installed during installation, or system-particular procedure. Do not proceed until air flow stops.

2. Turn Instrument OFF via rear-panel power switch.

3. Disconnect tubing at output of the Hg Scrubber, then disconnect the input tubing. Take new Hg Scrubber and orient according to silkscreen on rear of unit. Reconnect tubing at input and output of Hg Scrubber. Ensure fittings are tight, leak check if desired.

Fan and Fan Filter Guard Replacement

Use the following procedure to replace the fan and fan filter guard (Figure 4–1).

Equipment Required:

Fan

Phillips 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.

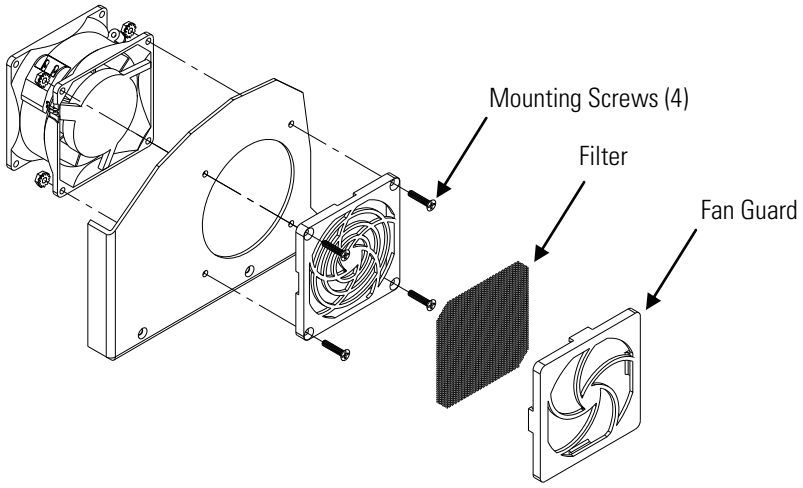


Figure 4–1. Replacing the Fan

DC Power Supply Replacement

Use the following procedure to replace the DC power supply (Figure 4–2).

Equipment Required:

DC power supply

Phillips 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.

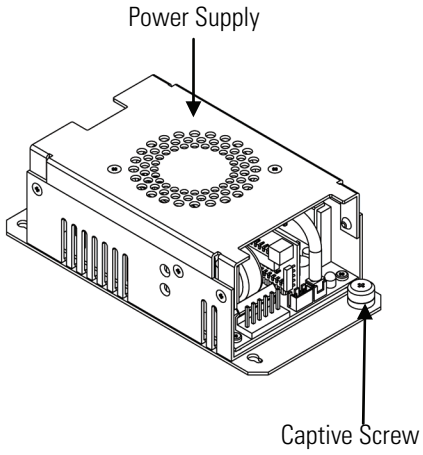


Figure 4–2. Replacing the DC Power Supply

Solenoid Valve Replacement

Use the following procedure to replace a solenoid valve.

Equipment Required:

Solenoid valve

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

Phillips 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.

1. Disconnect pneumatic and electrical connections from the solenoid and mark as appropriate to facilitate reassembly.

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

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

Permeation Oven Replacement

Use the following procedure to replace the permeation oven.

Equipment Required:

Permeation oven

Flat-blade screwdriver

Wrenches, 1/4-inch and 7/16-inch

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

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

2. Disconnect all electrical connections.

3. Disconnect the gas fittings.

4. Loosen captive fastener on permeation/pressure transducer bracket and slide off keyhole pins (Figure 4–3).

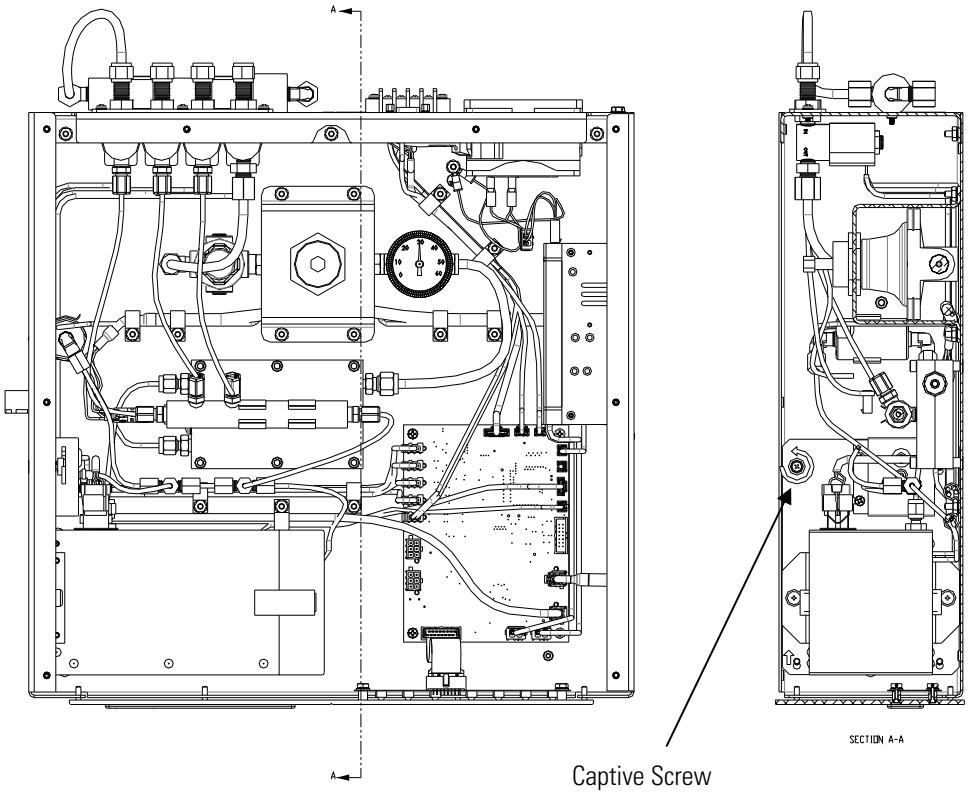


Figure 4–3. Permeation Oven Removal

5. Remove the two screws holding the oven to the floor plate and remove the oven.

6. Remove oven glass chamber from oven and install in new oven.
   a. Release the latches on the sides of the oven cover and remove cover.
   b. Remove glass chamber assembly by loosening (not removing) knurled screw, located at the top of the chamber, and gently pulling assembly upward. Completely remove assembly from oven (Figure 4–4).
   c. Separate glass chamber from top assembly by twisting and gently pulling glass away from top (Figure 4–4). Keep glass clean by using Kimwipes or similar material to handle glass.
   d. Place permeation tube in chamber.

e. Attach glass chamber to top assembly by gently pushing together with a slight twisting motion (Figure 4–4).

f. Replace glass chamber assembly into oven until top of assembly is flush or slightly below oven top (Figure 4–4).

g. Tighten knurled screw finger tight. Do not use tools to tighten.

h. Replace oven cover, being careful to place tubing and wire in slot of cover.

7. Install the new oven by following the previous steps in reverse.

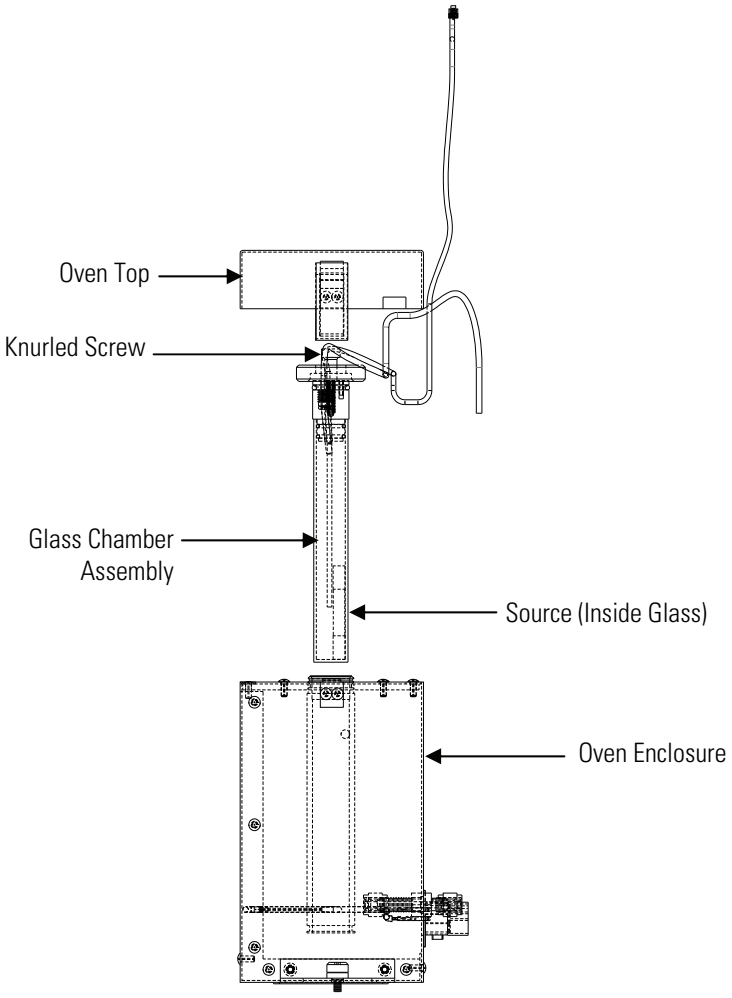


Figure 4–4. Removing and Replacing the Glass Chamber Assembly

Pressure Transducer Assembly Replacement

Use the following procedure to replace the pressure transducer assembly (Figure 4–5).

Equipment Required:

Pressure transducer assembly

#2 Phillips 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.

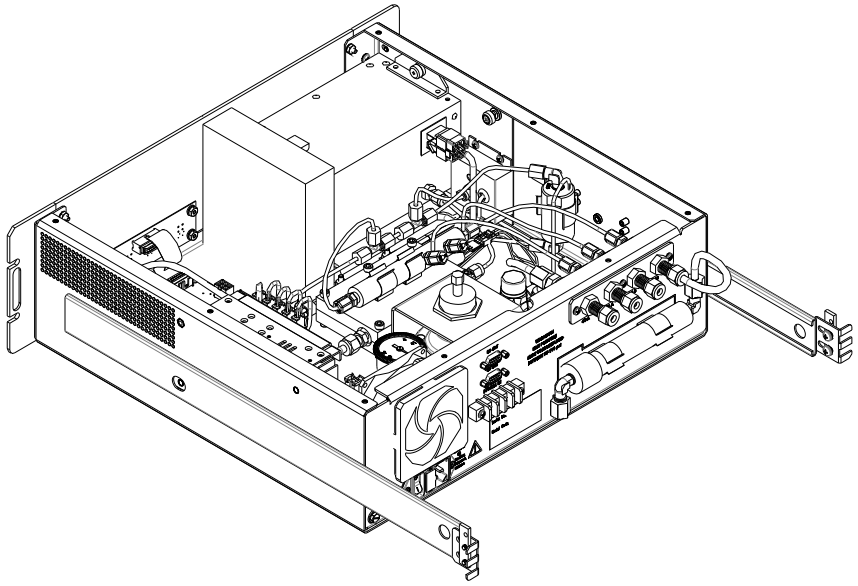


Figure 4–5. Replacing the Pressure Transducer Assembly

Plumbing Flow Splitter Assembly Replacement

Use the following procedure to replace the Plumbing Flow Splitter (Figure 4–6).

Equipment Required:

Plumbing flow splitter assembly

Allen head wrench, 5/32-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. This replacement requires the shut down of the zero air, which also requires the perm oven temperature to be reduced to ambient.

2. Unplug the permeation oven 4-pin connector on J3 on the measurement interface board.

3. Once the oven has cooled, shut off zero air supply.

4. Remove the kynar manifold from the retaining clips.

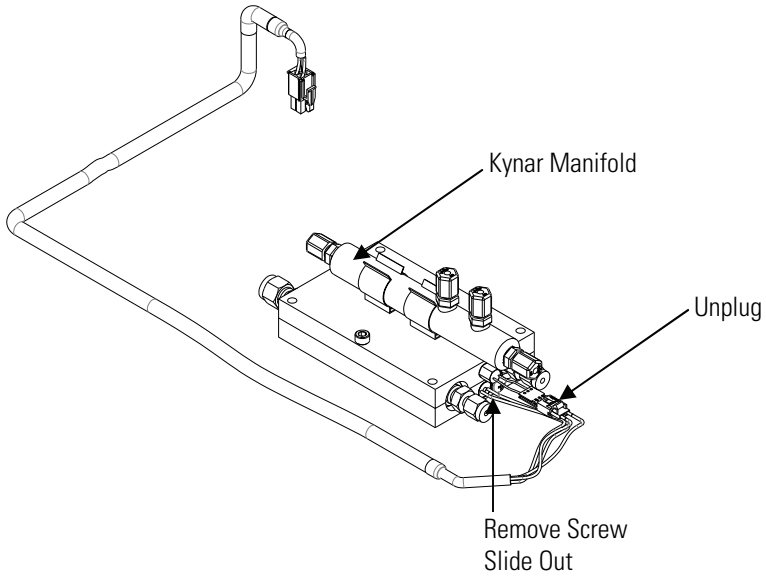


Figure 4–6. Flow Splitter Assembly

5. Disconnect the 1/4-inch “air in” nut, and the two 1/8-inch exit tubes. It may be necessary to label these two tubes to ensure they are reconnected properly later.

6. Remove the two center cap head screws that hold the top half of the heated plate to the base.

7. Move the top plate aside, ensuring that the thermistor leads are not bent or damaged.

8. The capillary assembly should lift out of the bottom half of the aluminum base.

9. Replace the assembly.

10. Replace the top aluminum plate.

11. Reattach the 1/4-inch and 2 1/8-inch tubes ensuring they are tight. Replace the two retaining screws.

12. Place the kynar manifold back in the clips.

Note To ensure proper function, it is critical that the any pneumatic connection that is disconnected or reconnected be leak tight. ▲

13. Turn on supply zero.

14. Ensure the J3 permeation oven connector is reattached to the measurement interface board.

Note When a thermistor is unplugged, the power on the model 84*i* will have to be cycled to have the heater turn back on. This is a failsafe to ensure that an open-loop thermistor does not cause a run-away condition. ▲

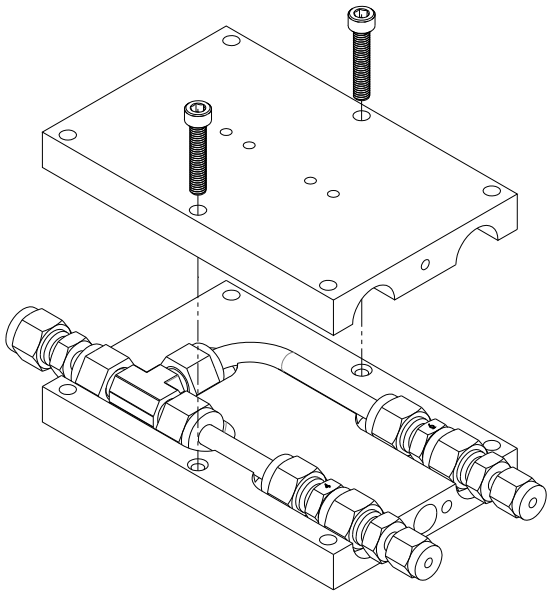


Figure 4–7. Capillary Block Assembly

Precision Regulator Assembly Replacement

Use the following procedure to replace the precision regulator assembly (Figure 4–8)

Equipment Required:

Precision regulator assembly

Nut driver, 11/32-inch

Open ended wrench, 9/16-inch

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

1. Note/record the pressure on the old assembly before proceeding, as the pressure on the new assembly may need to be adjusted to the factory specific pressure of the original assembly.

2. This replacement requires the shut down of the zero air, which also requires the perm oven temperature to be reduced to ambient.

3. Unplug the permeation oven 4-pin connector on J3 on the measurement interface board.

4. Once the oven has cooled, shut off zero air supply.

5. Disconnect the two brass 1/4-inch nuts from the inlet and outlet of the assembly.

6. Using a nut driver, remove the four nuts which retain the assembly to the floor plate.

7. Replace the assembly.

8. Secure the mounting flange to the floor plate with the 4 mounting nuts.

9. Reconnect the inlet and outlet brass nuts.

Note To ensure proper function, it is critical that any pneumatic connection that is disconnected or reconnected be leak tight. ▲

10. Turn on supply zero.

11. Ensure the J3 permeation oven connector is reattached to the measurement interface board.

12. Once the zero air is flowing through the system again, loosen the locking nut on the precision regulator.

13. Adjust the top hex knob such that the original pressure from the factory setting is re-established.

14. Tighten the locking nut.

Note After pneumatic assembly replacement, the concentration output may vary slightly due to variations in the pressure gauge. ▲

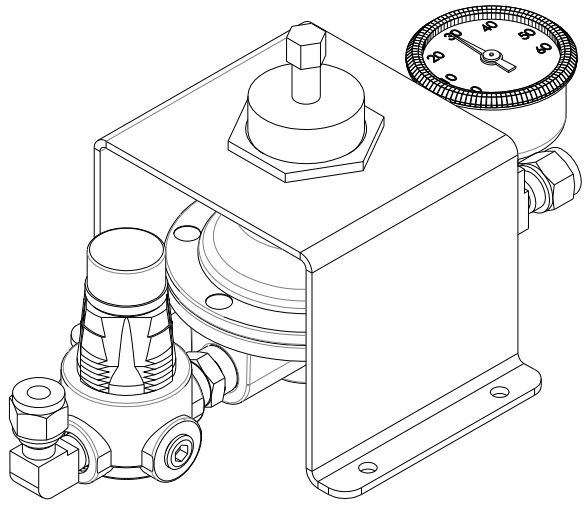


Figure 4–8. Pneumatic Assembly

Measurement Interface Board Replacement

Use the following procedure to replace the measurement interface board (Figure 4–9)

Equipment Required:

Measurement interface board

#2 Phillips head 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. This replacement requires the shut down of the zero air, which also requires the perm oven temperature to be reduced to ambient.

2. Unplug the permeation oven 4-pin connector on J3 on the measurement interface board.

3. Once the oven has cooled, shut off zero air supply.

4. Turn off the power to the 84*i* and unplug the power cord.

5. Remove all the connectors to the measurement interface board, noting or labeling the cables to ensure the proper re-attachment after the replacement.

6. Remove the four screws which hold the measurement interface board to the floor plate.

7. Remove the old measurement interface board and replace with the new one.

8. Reconnect the cables.

9. Plug the model 84*i* back in.

10. It may be necessary to cycle the power on the Model 81*i*, so that the 80*i* can update the firmware on the new measurement interface board to establish proper communication.

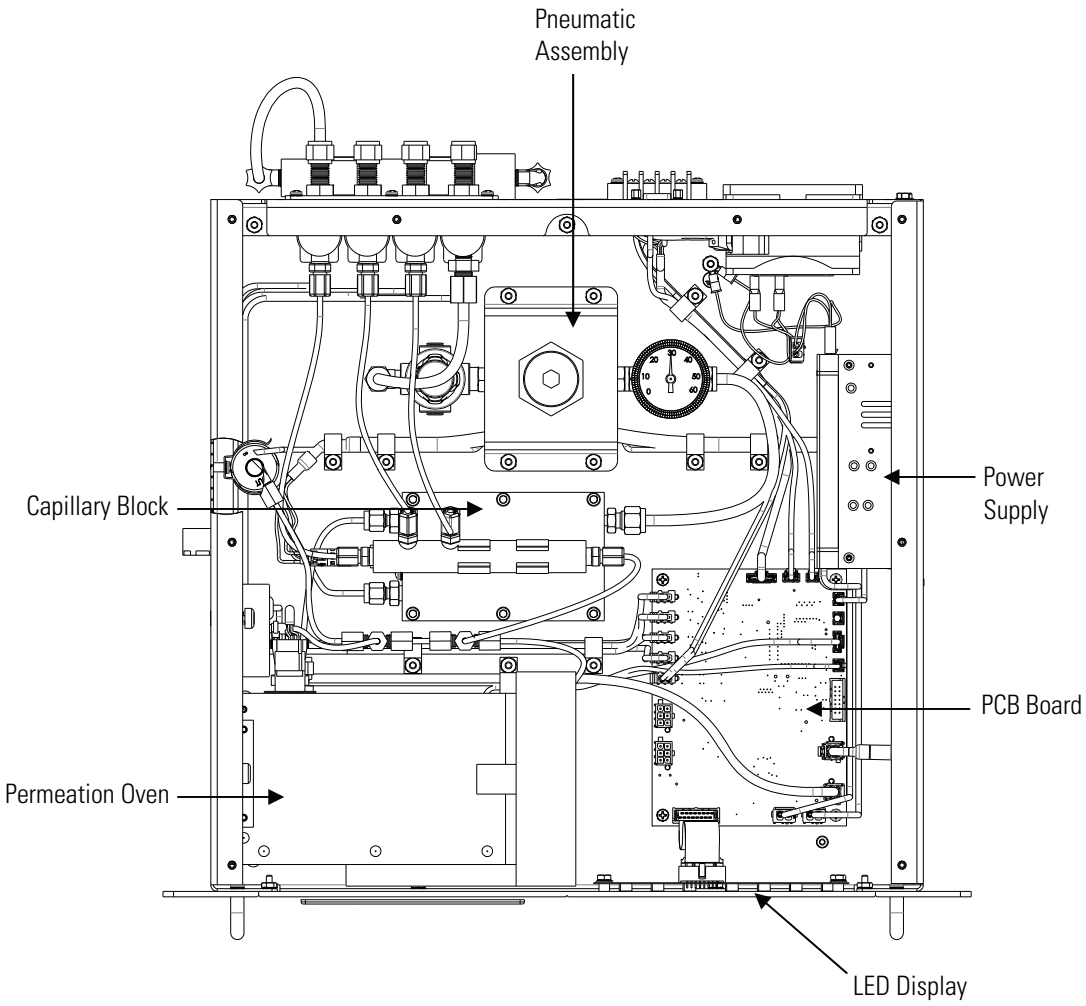


Figure 4–9. Model 84*i* Component Layout

LED PCB Replacement

Use the following procedure to replace the LED PCB (Figure 4–9).

Equipment Required:

LED PCB

Open ended wrench, 5/16-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. Remove the ribbon cable from the back of the LED PCB.
2. Remove the 4 nuts which hold the LED PCB to the front panel.
3. Replace the LED PCB.
4. Re-mount the LED PCB with the four nuts.
5. Reconnect the ribbon cable to the back of the LED PCB.

Capillary Block Heater Assembly Replacement

Use the following procedure to replace the capillary block heater assembly.

Equipment Required:

Capillary block heater assembly

Allen head wrench, 5/32-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. This replacement requires the shut down of the zero air, which also requires the perm oven temperature to be reduced to ambient.

2. Unplug the capillary heater 4-pin connector on J10 on the measurement interface board.

3. Remove the kynar manifold from the retaining clips.

4. Remove the four corner screws of the aluminum block; leave the 2 center screws in so that the assembly stays together.

5. Disconnect the 2-pin thermistor connector at the block, and remove the old thermistor from the aluminum block.

6. Remove the heater retainer screw from the bottom half of the aluminum block, and slide out the old heater cartridge.

7. Insert the new heater into the bottom aluminum block and replace the retaining screw.

8. Thread the new Thermistor into the top half of the aluminum block and reattach the 2-pin connector.

9. Mount the aluminum block to the floor plate using the four corner screws.

10. Connect the new 4-pin wire cable assembly to J10.

11. Replace the kynar manifold to the retainer clips.

Note When a thermistor is unplugged, the power on the model 84*i* will have to be cycled to have the heater turn back on. This is a failsafe to ensure that an open-loop thermistor does not cause a run-away condition. ▲

Service Locations

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.thermoscientific.com/aqi.

1-866-282-0430 Toll Free

1-508-520-0430 International

Appendix A
Warranty

Seller warrants that the Products will operate or perform substantially in conformance with Seller's published specifications and be free from defects in material and workmanship, when subjected to normal, proper and intended usage by properly trained personnel, for the period of time set forth in the product documentation, published specifications or package inserts. If a period of time is not specified in Seller's product documentation, published specifications or package inserts, the warranty period shall be one (1) year from the date of shipment to Buyer for equipment and ninety (90) days for all other products (the "Warranty Period"). Seller agrees during the Warranty Period, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with said published specifications; provided that (a) Buyer shall promptly notify Seller in writing upon the discovery of any defect, which notice shall include the product model and serial number (if applicable) and details of the warranty claim; (b) after Seller's review, Seller will provide Buyer with service data and/or a Return Material Authorization ("RMA"), which may include biohazard decontamination procedures and other product-specific handling instructions; and (c) then, if applicable, Buyer may return the defective Products to Seller with all costs prepaid by Buyer. Replacement parts may be new or refurbished, at the election of Seller. All replaced parts shall become the property of Seller. Shipment to Buyer of repaired or replacement Products shall be made in accordance with the Delivery provisions of the Seller's Terms and Conditions of Sale. Consumables, including but not limited to lamps, fuses, batteries, bulbs and other such expendable items, are expressly excluded from the warranty under this warranty.

Notwithstanding the foregoing, Products supplied by Seller that are obtained by Seller from an original manufacturer or third party supplier are not warranted by Seller, but Seller agrees to assign to Buyer any warranty rights in such Product that Seller may have from the original manufacturer or third party supplier, to the extent such assignment is allowed by such original manufacturer or third party supplier.

In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of (i) normal wear and tear, (ii) accident, disaster or event of force majeure, (iii) misuse, fault or negligence of or by Buyer, (iv) use of the Products in a manner for which

they were not designed, (v) causes external to the Products such as, but not limited to, power failure or electrical power surges, (vi) improper storage and handling of the Products or (vii) use of the Products in combination with equipment or software not supplied by Seller. If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates. If Seller provides repair services or replacement parts that are not covered by the warranty provided in this warranty, Buyer shall pay Seller therefor at Seller's then prevailing time and materials rates. ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER'S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS.

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

Appendix B
C-Link Protocol Commands

This appendix provides a description of the C-Link commands associated with the Model 84*i* Hg Permeation Source.

The following commands are described in alphabetical order.

---

alarm capillary temp min
alarm capillary temp max
These commands report the capillary temperature alarm minimum and maximum value settings. The following example reports that the capillary temperature alarm minimum is 49.5 °C.

```
Send:         alarm capillary temp min
Receive:      alarm capillary temp min 49.5 deg C
```

set alarm capillary temp min *value*
set alarm capillary temp max *value*
These commands set the capillary temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing capillary temperature alarm limits in °C. The following example sets the capillary temperature alarm minimum to 48 °C.

```
Send:         set alarm capillary temp min 48
Receive:      set alarm capillary temp min 48 ok
```

---

alarm perm gas min
alarm perm gas max
These commands report the permeation gas temperature alarm minimum and maximum value settings. The following example reports that the permeation gas temperature alarm minimum is 99.0 °C.

```
Send:         alarm perm gas min
Receive:      alarm perm gas min 99.0 deg C
```

set alarm perm gas min *value*
set alarm perm gas max *value*
These commands set the permeation gas temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing permeation gas temperature alarm limits in °C. The following example sets the permeation gas temperature alarm minimum to 99.5 °C.

```
Send:         set alarm perm gas min 99.5
Receive:      set alarm perm gas min 99.5 ok
```

---

alarm perm heater min
alarm perm heater max
These commands report the permeation heater temperature alarm minimum and maximum value settings. The following example reports that the permeation heater temperature alarm minimum is 99.0 °C.

```
Send:         alarm perm heater min
Receive:      alarm perm heater min 99.0 deg C
```

set alarm perm heater min *value*
set alarm perm heater max *value*
These commands set the permeation heater temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing permeation heater temperature alarm limits in °C. The following example sets the permeation heater temperature alarm minimum to 99.5 °C.

```
Send:         set alarm perm heater min 99.5
Receive:      set alarm perm heater min 99.5 ok
```

---

alarm pres 84i min
alarm pres 84i max
These commands report the 84*i* pressure alarm minimum and maximum value settings. The following example reports that the 84*i* pressure alarm maximum is 999.9 mmHg.

```
Send:         alarm pres 84i max
Receive:      alarm pres 84i max 999.9 mmHg
```

set alarm pres 84i min *value*
set alarm pres 84i max *value*
These commands set the 84*i* pressure alarm minimum and maximum values to *value*, where *value* is a floating-point number representing the 84*i* pressure alarm limits in mmHg. The following example sets the 84*i* pressure alarm maximum to 780 mmHg.

```
Send:         set alarm pres 84i max 780.0
Receive:      set alarm pres 84i max 780.0 ok
```

---

capillary setpoint
This command reports the setpoint for the capillary heater. The following example reports that the setpoint for the capillary heater is 50 °C.

```
Send:         capillary setpoint
Receive:      capillary setpoint 50.00 deg C
```

set capillary setpoint *value*
This command sets the setpoint for the capillary heater to *value*, where *value* is a floating-point number representing the setpoint for the capillary heater in degrees C. The following example sets the capillary setpoint to 50.01 °C.

```
Send:         set capillary setpoint 50.01
Receive:      set capillary setpoint 50.01 ok
```

---

connect 84i
This command reports the chosen span bulkhead selection for the 84*i*. The following example reports the 84*i* connection type is A.

```
Send:         connect 84i
Receive:      connect 84i OFF
```

The following example reports the 84*i* connection type is B.

```
Send:         connect 84i
Receive:      connect 84i ON
```

set connect 84i *X*
This command sets the connection type for the 84*i* to *X*, where *X* is either 0 (A) or 1 (B). The following example sets the 84*i* connection type to B.

```
Send:         set connect 84i 1
Receive:      set connect 84i 1 ok
```

The following example sets the 84*i* connection type to A.

```
Send:         set connect 84i 0
Receive:      set connect 84i 0 ok
```

---

diag volt
This command reports the diagnostic voltages for the 84*i* in the following order: 3.3v, 5V, 15V, -15V, 24V.

```
Send:         diag volt 84i
Receive:      diag volt 84i 3.321 4.998 14.975 -14.876 24.059
```

---

flow 84i
This command reports flow state for the 84*i* (“OK”, “FAIL”).

```
Send:         flow 84i
Receive:      flow 84i OK
```

---

perm gen ratio
This command reports the ratio of the permeation span to the instrument span.

```
Send:          perm gen ratio
Receive:       perm gen ratio 1.001
```

---

perm oven heater
This command reports the status of the permeation oven heater control in the 84*i* (0=Off, 1=On). The following example reports that the permeation oven heater is 1 (On).

```
Send:          perm oven heater
Receive:       perm oven heater 1
```

set perm oven heater *X*
This command turns On/Off the permeation oven heater, where *X* is either 0 (Off) or 1 (On). The following example sets the permeation oven heater to 1 (On).

```
Send:          set perm oven heater 1
Receive:       set perm oven heater 1 ok
```

---

perm oven setpoint
This command reports the value of the setpoint for the permeation oven. The following example reports that the permeation oven setpoint is 100 °C.

```
Send:          perm oven setpoint
Receive:       perm oven setpoint 100.00
```

set perm oven setpoint *xxxx*
This command sets the setpoint for the permeation oven to *xxxx*, where *xxxx* is a floating-point number representing the setpoint for the permeation oven in degrees C. The following example sets the permeation oven setpoint to 99.99 °C.

```
Send:          set perm oven setpoint 99.99
Receive:       set perm oven setpoint 99.99 ok
```

---

set perm span
This command sets the gas mode of the instrument to Permeation Span mode.

```
Send:          set perm span
Receive:       set perm span ok
```

---

pres 84i
This command reports the 84*i* pressure value. The following example reports that the pressure is 761.1 mmHg.

```
Send:          pres 84i
Receive:       pres 84i 761.1 mmHg
```

temp 84i ambient
This command reports the ambient temperature in the 84*i*. The following example reports that the ambient temperature is 84.2 °C.

```
Send:         temp 84i ambient
Receive:      temp 84i ambient 84.2 deg C
```

temp capillary
This command reports the capillary block temperature in the 84*i*. The following example reports that the capillary temperature is 50.02 °C.

```
Send:         temp capillary
Receive:      temp capillary 50.02 deg C
```

temp perm gas
This command reports the permeation gas temperature in the 84*i*. The following example reports that the permeation gas temperature is 100.03 °C.

```
Send:         temp perm gas
Receive:      temp perm gas 100.03 deg C
```

temp perm heater
This command reports the permeation heater temperature in the 84*i*. The following example reports that the permeation heater temperature is 94.94 °C.

```
Send:         temp perm heater
Receive:      temp perm heater 99.94 deg C
```

test option permeation
This command reports status of the permeation option (0=Off, 1=On). The following example reports that the permeation option is 1 (On).

```
Send:         test option permeation
Receive:      test option permeation 1
```

set test option permeation *x*
This command sets the permeation option to *x*, where *x* is either 0 (Off) or 1 (On). The following example sets the permeation option to 1 (On).

```
Send:         set test option permeation 1
Receive:      set test option permeation 1 ok
```

flags
This reports 8 hexadecimal digits (or flags) that represent status of the pressure and temperature compensation, gas mode, 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 following example, the instrument is reporting that the password lock is ON, temperature compensation is OFF, pressure compensation is ON, measure mode is AUTO, gas mode is ZERO, converter power is ON, eductor power is OFF, umbilical 2 power is OFF, umbilical 1 power is OFF, probe power is OFF, and there are no alarms.

```
Send:          flags
Receive:       flags 28300000
```

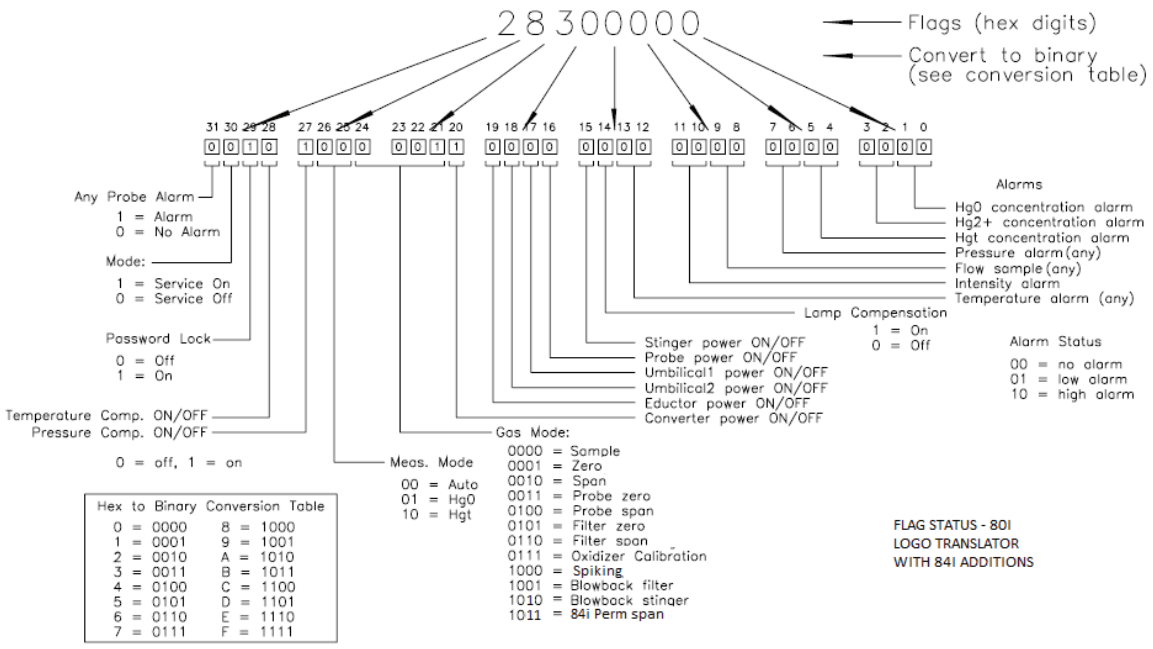


Figure B–1. Flag Status

Appendix C
MODBUS Protocol

This section describes the updates that apply to the "MODBUS Protocol" appendix in the Model 80*i*.

In the following Table C–1 through Table C–3 list the MODBUS addresses supported for the Model 84*i*.

Table C–1. Read Coils for 84*i*

Coil Number	Variable
53	PERMSPAN MODE
54	84i CONNECTION A
55	84i CONNECTION B
56	84i GAS TEMP
57	84i OVEN TEMP
58	84i CAPILLARY TEMP
59	84i FLOW
60	84i PRESSURE
61	84i STATUS

Table C–2. Read Registers for 84*i*

Register Number	Variable
109&110	PERM-GEN RATIO
111&112	PERM OVEN GAS TEMP
113&114	PERM OVEN HEATER TEMP
115&116	CAPILLARY TEMP
117&118	84i PRESSURE

Table C–3. Write Coils for 84*i*

Coil Number	Variable
134	PERMEATION SPAN MODE
135	SPARE
136	84i CONNECTION B
137	Set Hg^0 Span
138	Set Hg^t Span