



ThermoQuest

Finnigan
Polaris/GCQ Plus[™]



Hardware Manual

Revision C

PN 119633

Written by Jack Mitchell. Edited by Kendall Johns.

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Rev. C
119633

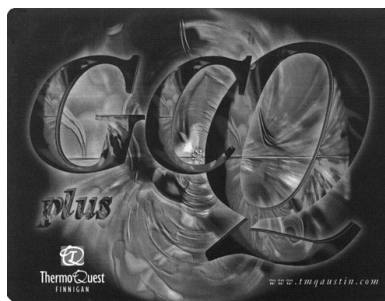
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EN 55011	(1991)	Group 1		Class A
EN 50082-1	(1992)	IEC 801-2	(1991)	Level 3
EN 50082-1	(1992)	IEC 801-3	(1984)	Level 2
EN 50082-1	(1992)	IEC 801-4	(1988)	Level 2
EN 50082-1	(1992)	IEC 801-5	(1993)	Class 3

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Safety Compliance

IEC 1010-1 1990 plus Amendment 1992

EN 61010-1 1993

Please be aware that any changes you make to your system may void compliance with one or more of these EMC or safety standards.

Changes to your system include replacing a part. Thus, to ensure continued compliance with EMC and safety standards, replacement parts should be ordered from ThermoQuest or one of its authorized representatives.

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Read This First

The GCQ *Plus* Hardware Manual contains instructions for cleaning, maintaining, and replacing parts as recommended by the GCQ *Plus* Diagnostics, a ThermoQuest Technical Support Engineer, or a ThermoQuest Field Engineer.

This manual is written primarily for users with limited or no prior experience using the GCQ *Plus* system.

This guide is organized as follows:

Chapter 1: Operating the GCQ Plus discusses basic procedures for operating the GCQ *Plus* system.

Chapter 2: Vacuum System and Gas Inlets defines the components of the Vacuum System.

Chapter 3: EI/CI Ion Source presents a description of the EI/CI ion source. The ion source is the site of ion formation.

Chapter 4: Mass Analyzer System discusses the mass analyzer, also called the quadrupole ion trap. The mass analyzer is the site of ion storage and mass analysis.

Chapter 5: Ion Detection System defines the components of the ion detection system. The ion detection system includes the electron multiplier and conversion dynode, which are used to detect ions leaving the mass analyzer.

Chapter 6: Troubleshooting explains procedures which will help users isolate, identify, and rectify problems.

Chapter 7: Electronics describes the location of fuses and PCBs and contains instructions on replacing PCBs, fuses, and other assemblies.

Chapter 8: Maintaining the GCQ Plus presents a table of recommended intervals for routine maintenance and cleaning, as well as detailed instructions for disassembling, cleaning, inspecting, and reassembling the ion source, mass analyzer, ion detection system, diffusion pump, and rotary-vane pump or turbomolecular pump.

Appendix A: Spare Parts contains a list of replacement parts.

Appendix B: Functional Block Diagrams contains a set of functional block diagrams for the GCQ *Plus* system and internal sub-systems.

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Your comments help us correct errors and improve the usability of our documents. Thank you.

Abbreviations

The following abbreviations are used in this manual and the online Help:

A	ampere
ac	alternating current
ADC	analog-to-digital converter
AP	acquisition processor
APCI	atmospheric pressure chemical ionization
API	atmospheric pressure ionization
ASCII	American Standard Code for Information Interchange
b	bit
B	byte (32 b)
baud rate	data transmission speed in events per second
°C	degrees Celsius
cfm	cubic feet per minute
CD	compact disc
CD-ROM	compact disc read-only memory
CI	chemical ionization
CIP	Carriage and Insurance Paid To
cm	centimeter
cm ³	cubic centimeter
CPU	central processing unit (of a computer)
CRM	consecutive reaction monitoring
CSE	Customer Service Engineer
<Ctrl>	control key on the computer keyboard
<i>d</i>	depth
DAC	digital-to-analog converter
dc	direct current
DDS	direct digital synthesizer
DEP™	direct exposure probe
DS	data system
DSP	digital signal processor
EI	electron ionization

<Enter>	<Enter> key on the computer keyboard
ESD	electrostatic discharge
eV	electron volt
f	femto (10^{-15})
°F	degrees Fahrenheit
FOB	Free on Board
ft	foot
FTP	file transfer protocol
g	gram
G	giga (10^9)
GC	gas chromatograph
GC/MS	gas chromatograph / mass spectrometer
GND	electrical ground
GPIO	general-purpose interface bus
GUI	graphical user interface
<i>h</i>	height
h	hour
HV	high voltage
Hz	hertz (cycles per second)
ICIS™	Interactive Chemical Information System
ICL™	Instrument Control Language
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
in.	inch
I/O	input/output
k	kilo (10^3 , 1000)
K	kilo (2^{10} , 1024)
K	Kelvin
kg	kilogram
kPa	kilopascal
<i>l</i>	length
L	liter
LAN	local area network

lb	pound
LED	light-emitting diode
m	meter
m	milli (10^{-3})
M	mega (10^6)
M+	molecular ion
μ	micro (10^{-6})
min	minute
mL	milliliter
mm	millimeter
MS	scan power: MS ¹
MS/MS	scan power: MS ²
MS ⁿ	scan power: MS ⁿ , n = 1 through 10
<i>m/z</i>	mass-to-charge ratio
n	nano (10^{-9})
NCBI	National Center for Biotechnology Information (USA)
Ω	ohm
p	pico (10^{-12})
Pa	pascal
PCB	printed circuit board
PID	proportional / integral / differential
PN	part number
P/P	peak-to-peak voltage
ppm	parts per million
psig	pounds per square inch, gauge
RAM	random access memory
<Return>	<Return> key on the computer keyboard
RF	radio frequency
RMS	root mean square
ROM	read-only memory
RS-232	industry standard for serial communications
s	second
SCSI	small computer system interface

SIM	selected ion monitoring
solids probe	direct insertion probe
SRM	selected reaction monitoring
SSQ [®]	single stage quadrupole
TIC	total ion current
TCP/IP	transmission control protocol / Internet protocol
Torr	torr
TSQ [®]	triple stage quadrupole
u	atomic mass unit
URL	uniform resource locator
V	volt
V ac	volts alternating current
V dc	volts direct current
VGA	Video Graphics Array
w	width
W	Watt
WWW	World Wide Web

Note: Exponents are written as superscripts. In the corresponding online Help, however, exponents are written with a caret (^) or with *e* notation because of design constraints in the online Help.

For example:

MS ⁿ (in this manual)	MS^n (in the online Help)
----------------------------------	---------------------------

10 ⁵ (in this manual)	10^5 (in the online Help)
----------------------------------	---------------------------

Typographical Conventions

Typographical conventions have been established for the following:

- Data Input
- Notes, Cautions, and Warnings
- Topic headings

Data Input

The following conventions indicate data input and output through the computer:

- Prompts and messages displayed on the screen are represented in this manual by capitalizing the first letter of each word and italicizing each word.
- Input that you enter from the keyboard or buttons that you click with the mouse or pointer are represented in **boldface letters**. Cross-references to other topics or manuals also appear in boldface.
- For brevity, we say “Choose **File | Directories**” rather than “pull down the File menu and choose directories.”
- Any command enclosed in angle brackets represents a single keystroke. For example, “press <F1>” means “press the key labeled F1.”
- Any command that requires pressing two or more keys simultaneously is shown with a hyphen connecting the keys. For example, “press <Shift>-<F1>” means “press and hold Shift, then press F1.”

Notes, Cautions, and Warnings

Notes, Cautions, and WARNINGS are displayed in boxes like the one below:

Note: Boxes like this one are used to display important information.

A **Note** contains information that can affect the quality of your operation. In addition, notes often contain information you may need if you are having trouble.

A **Caution** contains information necessary to protect your instrument from damage.

A **WARNING** describes hazards to human beings.

Topic headings

The following headings are used to show the organization of topics within a chapter:

Chapter 1

Chapter Name

1.1 First Level Topics

Second Level Topics

Third Level Topics

How to Use This Document Set

The **GCQ Plus Document Set** (PN 119638) serves as your library for information about the GCQ Plus hardware and software. If one of the manuals is missing from your set, use this list to notify customer service for a replacement.

ThermoQuest part numbers (PN) are provided for each book.

Preinstallation Kit (PN 119637)

This kit contains the **GCQ Plus Preinstallation Guide** and an online **Preinstallation Help File**. Use these items to prepare your site for the arrival of your GCQ Plus instruments.

Getting Connected (PN 119632)

This guide contains all the information you need to connect various configurations with the GCQ Plus mass spectrometer. This information is intended for general reference, or to help you reconnect your system after moving or cleaning.

Getting Started with Xcalibur 1.0 (PN 119636)

This guide contains procedures for elementary operations using the GCQ Plus GC/MS system with the Xcalibur 1.0 Data System. This includes starting the system, preparing for daily operation, performing injections, and analyzing data.

GCQ Plus Hardware Manual (PN 119633)

This guide contains descriptions of principal hardware components of the GCQ Plus mass spectrometer. It also includes procedures for cleaning and maintaining the mass spectrometer.

Getting Productive with Xcalibur 1.0: Quantitative Analysis (PN 119634)

This guide contains procedures for performing automated acquisitions and quantitative analyses. This includes creating calibration curves and reporting.

Getting Productive with Xcalibur 1.0: Qualitative Analysis (PN 119635)

This guide contains procedures for performing automated acquisitions and qualitative analyses. This guide also introduces various interactive data processing operations, such as spectrum refinement and library building.

Xcalibur Online Help

This help file describes the operation of all the data system programs used with the GCQ Plus system. It contains information on acquiring data, processing data, tuning, and calibrating.

Related Documentation



Finnigan Corporation. *Introduction to Mass Spectrometry and Glossary of Mass Spectrometry Terms*; San Jose, CA, 1989.



Price, Phil. Standard Definitions of Terms Relating to Mass Spectrometry, *J. Am. Soc. Mass Spectrom.* **1991**, 2, 336-348.



Handbook of Chemistry and Physics, CRC Press Inc., Boca Raton, FL, 1995.



Dodd, Janet. *The ACS Style Guide*, 2d Ed., 1997, American Chemical Society.



ThermoQuest Corporation. *Online Glossary of GCQ Terms*; Austin, TX, 1998.

Chapter 1

Operating the GCQ Plus

This chapter discusses basic procedures for operating the *GCQ Plus* system.

You will find information on the following main topics:

- Starting Up and Shutting Down
- Interfacing to the GC
- Interfacing to the Solids Probe
- Removing and Reinstalling the GCQ Plus Covers
- Removing the Vacuum Manifold Top Cover Plate

1.1 Starting Up and Shutting Down

This section contains instructions for starting, shutting down, and placing the system in standby.

You do not need to shut down the GCQ *Plus* system completely if it will be idle for only a short period of time, such as overnight or over a weekend. Turning the system on and off creates electrical surges and changes in temperature that could shorten the life of delicate components. When you are not operating the system for short periods of time (less than two weeks), you can leave the system in standby mode. Shut down and vent the system if you are performing a maintenance procedure or plan to leave the system idle for more than two weeks.

Shutting Down the System in an Emergency

If you need to turn off the system quickly, switch the main circuit breaker OFF (O). This switch is located on the back of the GCQ *Plus*. This turns off all power to the GCQ *Plus*, including the vacuum pumps. This is equivalent to unplugging the GCQ *Plus* power cord from the wall outlet. Although removing power abruptly will not harm anything in the system, this is not the recommended shutdown procedure, except in an emergency. Refer to page 1-3 for the recommended procedure.

To turn off the GC, autosampler, and computer in an emergency, use the on/off switches on each component.

Placing the System in Standby

The standby mode is useful if the instrument will not be used for short periods of time (less than two weeks). Placing the system in standby puts less stress on the components than a complete shutdown.

1. Wait until data acquisition, if any, is complete.
2. Open the Tune window. Refer to Xcalibur online help for instructions.
3. Verify that the CI reagent and calibration gases are off. If necessary, turn the gases off by clicking on their respective buttons.
4. Choose **Instrument | System Off** to turn off voltages to the EI/CI ion source, ion source lenses, mass analyzer, and ion detection system.

5. Leave the GC carrier gas flow and the septum purge on, and turn off the split vent. Set the GC column oven temperature to 50° C, or to the column manufacturer's specifications.

Note: You can set the GC column oven temperatures through the data system by selecting (or creating) and downloading a GC method to the GC. Refer to **GC Instrument Setup** in the Xcalibur online help. You can also set the GC column oven temperature from the GC front panel keypad. For instructions on how to operate the GC from the front panel, refer to the manual that came with the GC.

6. Verify that the transfer line temperature is within the standard operating range of 220 to 280° C.
7. Leave the GCQ Plus, GC, autosampler, and data system on.

Shutting Down the System Completely

Note: If your system does not have an optional inlet valve and you are shutting down the system to install a CI ion volume (that is, you are changing from EI operation to CI operation), first tune the GCQ Plus for EI operation. To tune for EI operation, refer to the online help.

1. If you plan to turn off the GC, download a GC method to cool the GC oven and injector to room temperature. Refer to **GC Instrument Setup** in the Xcalibur online help, or use the controls on the GC front panel. Refer to the manual that came with the GC.
2. Follow the instructions in the online help to open the Xcalibur Tune window.

WARNING: The GC oven, injector, transfer line, EI/CI ion source, and diffusion pump may be very hot and can cause severe burns if they are touched before they are cool. Allow heated components to cool before servicing them.

3. Choose **Instrument | Shutdown** to start the automatic shutdown procedure. When you choose Shutdown, the following actions occur:
 - The Shut Down dialog box appears.
 - The calibration gas and CI reagent gas solenoid valves are closed.
 - Voltages are turned off to the EI/CI ion source, mass analyzer, and ion detection system.
 - The heaters for the ion source and transfer line are turned off.
 - The diffusion pump or optional turbomolecular pump is turned off.
 - The program counts down twenty minutes for the diffusion pump to cool or ten minutes for the optional turbomolecular pump to spin down. The amount of time left in the shutdown procedure is displayed in the Shut Down dialog box.

Note: To terminate the automatic shutdown procedure, click on **Restart** in the Shut Down dialog box. Then, choose **Startup** from the Instrument menu

4. When the program is finished, a dialog box is displayed stating that it is OK to turn off the main power to the GCQ Plus.
5. Click **OK**. Switch the main circuit breaker of the GCQ Plus OFF (0). When you do this, the following happens:
 - The rotary-vane pump is turned off.
 - Eight seconds after the rotary-vane pump is turned off, the vent valve is opened and the vacuum manifold is vented to helium. After three minutes, the vent valve is closed.
6. Unplug the GCQ Plus power cord.

Note: If you are planning to perform system maintenance on the GCQ Plus only (for example, to clean the EI/CI ion source or mass analyzer), you do not need to turn off the GC, data system, and autosampler. In this case, the shutdown procedure is complete after step 6 above. However, if you do not plan to operate your system for an extended period of time, we recommend that you turn off the GC, data system, and autosampler as described in steps 7 and 8.

7. Wait for the GC injector, column oven, and transfer line to cool to room temperature.

8. Turn off:

- the GC carrier gas by following the procedure in the manual that came with your GC
- the helium supply at the tank
- the GC by using the main power on/off switch on the GC
- the data system by closing all programs and choosing Shut Down from the Windows NT Start menu
- the (optional) autosampler by using the main power on/off switch

Starting Up the System

Use this procedure to start the GCQ *Plus* system after it has been shut down completely. It consists of the following steps:

- Starting Up the GC
- Starting Up the Data System
- Starting Up the GCQ Plus
- Starting Up the Autosampler
- Setting Up Conditions for Operation

Starting Up the GC

1. Ensure that a capillary column is installed in the GC column oven and transfer line. Ensure that the transfer line is properly installed in both the GC and the GCQ *Plus*. Turn on the GC using the main power on/off switch.
2. Ensure that the helium tank head pressure is 400 to 700 kPa (60 to 100 psi). Set the carrier gas flow to a good beginning value, such as 40 cm/s or 1 mL/min. Refer to the GC's operating manual for instructions.

Starting Up the Data System

1. Turn on the monitor, computer, and (optional) printer.
2. Follow the Windows NT startup procedure. Press <Ctrl>-<Alt>- to log on when you are prompted to do so. Enter your password (if you have one) and click **OK** to complete the startup procedure. This may take a few minutes.

Starting Up the GCQ Plus

1. Verify that the main circuit breaker on the rear of the GCQ Plus is off.
2. Plug in the power cord for the GCQ Plus.
3. Switch the main circuit breaker ON (I). When you do this, the following occurs:
 - The rotary-vane pump turns on. The left vacuum LED on the front panel flashes to indicate that the vacuum system is on but not fully operational.
 - After the foreline pressure reaches the proper operating pressure, the diffusion pump (or optional turbomolecular pump) turns on. The EI/CI ion source, mass analyzer, and ion detection system remain off.
 - After 30 minutes, the vacuum system should be fully operational. When this occurs the blue (left) VACUUM LED turns off and the green (right) VACUUM LED lights up.

Note: The green VACUUM LED may not light after 30 minutes unless you start the GCQ Plus data system software and initiate the instrument.

4. Start the Xcalibur program to initialize the instrument.
Click **Start | Programs | Xcalibur | Xcalibur**.
5. Verify that the green vacuum LED is lit. If it is not, you should check the system for leaks. Steps for leak-checking can be found in **Chapter 6: Troubleshooting**.

Starting Up the Autosampler

To start up the autosampler, move the main power switch to the ON position. Procedures for placing sample vials, preparing solvent and waste bottles, installing syringes, etc., will be found in the manual that came with the autosampler.

Setting Up Conditions for Operation

1. Allow the system to pump down for at least one hour after you start the system to remove any air and water vapor from the vacuum manifold.
2. Verify that vacuum manifold pressure is low enough for proper operation:
 - If you have an ion gauge, check the pressure in the vacuum manifold as described in the online help. If the pressure is above 1.0×10^{-4} Torr, do not turn on the filament or electron multiplier. If necessary, allow additional pumping time. Check the air/water spectrum as described in the online help.
 - If you do not have an ion gauge, check the air/water spectrum to determine the amount of air and water in the manifold as described in the online help. Turn off the filament and electron multiplier if the air/water spectrum indicates large amounts of air and water. If necessary, recheck the air/water spectrum after additional pumping time.
3. Verify that the GC injector, column oven, transfer line, and ion source have come to thermal equilibrium, as detailed below. Typical operating temperatures are:
 - 50 to 350° C for the GC injector
 - 50 to 350° C for the column oven
 - 200 to 350° C for the transfer line
 - 150 to 225° C for the EI/CI ion source

Check the GC injector and column oven temperatures from the GC front panel. You can set the GC injector and column oven temperatures from the GC Method Editor or from the GC front panel keypad. Check the transfer line and ion source temperatures from the Status view in the **Tune** window.
4. Tune the GCQ Plus for EI or CI operation, as described in the online help.
5. Check the disk space, helium supply, and cooling fan operation, and print out a copy of the Status report as described in the Xcalibur online help.
6. Analyze a standard test sample to verify that the column is installed properly, the instrument parameters are set correctly, and the instrument is functioning properly.

1.2 Interfacing to the GC

This section provides instructions on interfacing the GCQ *Plus* to a gas chromatograph.

Installing a Capillary Column

This procedure describes how to install the end of the capillary column in the transfer line of the GCQ *Plus*. Other instructions on the setup and use of the GC may be found in the user's manual that came with your GC. In addition, instructions on hooking up the various cables to the GC can be found in **Getting Connected** (PN 119632).

WARNING: The GCQ *Plus* system must be completely shut down before installing a capillary column. In addition, the transfer line may be too hot to touch. Allow it to cool to a safe temperature before removing it.

Supplies: Methanol, Kimwipes or other lint-free industrial tissue, scribing tool, magnifying glass, 5/16-in. open-end wrench, two 7/16-in. open-end wrenches, 0.4 mm ID graphite/Vespel ferrule (PN A0101-18100).

Frequency: As needed

1. Shut down the system (page 1-2).
2. Slide the GC away from the MS detector.
3. Loosen the vacuum seal nut on the transfer line flange. Withdraw the transfer line from the MS detector until the brown Vespel tip is visible.
4. Unwind two coils of the MS detector end of the column.
5. Slide a 1/16 in. Swagelok®-type transfer line nut onto the column.
6. Slide a graphite/Vespel ferrule, flat side first, onto the column.
7. Wipe the first 250 mm (10 in.) of the column with a tissue soaked in methanol.
8. Feed the column from the inside of the GC, out through the hole in the GC wall, and into the transfer line.
 - a. Tighten the nut by hand onto the end of the transfer line.
 - b. Continue inserting the column until the end of the column is approximately 100 mm (4 in.) beyond the tip of the transfer line.
9. Score the column with a scribing tool approximately 50 mm (2 in.) from

the end of the column. Break the column at the score mark. Do this carefully to ensure a smooth, square cut.

10. Inspect the end of the column with a magnifying glass. Verify that the cut is square and smooth. Recut if necessary.
11. Withdraw the column until the end of the column is approximately 1 mm beyond the tip of the transfer line.
12. Use 5/16-in and 7/16-in. open-ended wrenches to tighten the nut until the column is secure. Use two 7/16-in. open-end wrenches to tighten the 1/8-in. nut so the union is tight on the transfer line.
13. Insert the transfer line into the MS detector until the tip of the transfer line is seated in the ion source block. Tighten the vacuum seal nut by hand. The transfer line tip must seal tightly against the source block for optimum performance.
14. Position the GC so that the opening in the side of the GC is aligned with the transfer line. Carefully slide the GC toward the MS detector, with the transfer line entering the opening in the wall of the GC, until the GC is flush with the spacer on the MS detector.

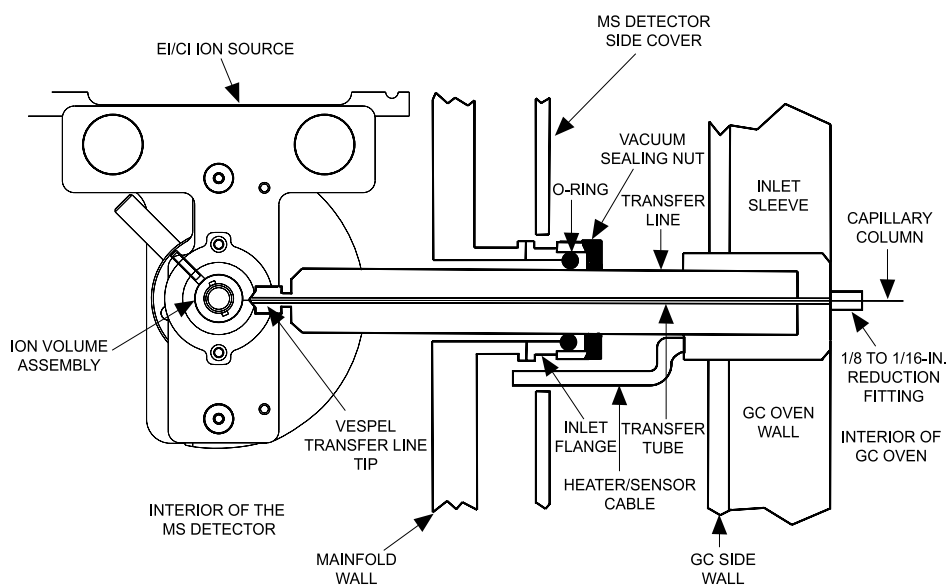


Figure 1-1. Capillary Column Inserted into Transfer Line

Moving the GC away from the GCQ Plus

1. Open the GC oven door and ensure that the capillary column is sufficiently slack to move the GC without damaging the column. If necessary, undo one coil of the column. Close the GC oven door.
2. Move the GC away from the GCQ *Plus* a sufficient distance to access the right side of the GCQ *Plus*.

Note: If the distance between the GC and the GCQ *Plus* is not sufficient, pull the GC column out of the transfer line and move the GC chassis farther away. Removing the column reduces the risk of accidental damage.

Inserting the Transfer Line

1. Align the opening in the side of the GC with the transfer line.
2. Carefully slide the GC toward the GCQ *Plus*, with the transfer line entering the opening in the side of the GC, until the GC is flush with the spacer on the GCQ *Plus*.

1.3 Interfacing to the Solids Probe

The solids probe is an optional inlet for the GCQ *Plus* that allows you to introduce solid and liquid samples directly into the ion source. This is useful for compounds that are thermally labile, highly active, or have physical characteristics that would prohibit or limit their ability to be analyzed using gas chromatography.

Inserting the solids probe is essentially the same procedure as changing ion volumes. This can be done quickly and easily with the inlet valve, without having to vent the system to atmosphere. No other modification of the instrument is necessary; the GC can remain installed in the mass spectrometer, which remains under vacuum, so that there is an absolute minimum of time necessary to configure the system for solid probe analysis.

The **DPC and Sample Probes User Guide** (PN 119327) contains procedures for interfacing the GCQ *Plus* to the sample probe.

1.4 Removing and Reinstalling the GCQ Plus Covers

Before you remove any of the GCQ *Plus* covers, shut down and vent the system (page 1-3).

Removing and Reinstalling the GCQ Plus Top Cover

Note: Removing the top cover may be difficult the first time as there are styrofoam blocks holding the vacuum manifold in place during shipping.

To remove the top cover:

1. Loosen the fastener on the rear of the GCQ *Plus* that attaches the top cover of the GCQ *Plus*.
2. Slide the top cover back about 1.25 cm (0.5 in.).
3. Lift the front of the top cover up about 7.5 cm (3 in.) to clear the tabs at the front of the top cover.
4. Lift the rear of the top cover until it is higher than the front of the top cover. Then, with one hand holding the front of the top cover and the other hand holding the rear, lift the top cover up and away from the GCQ *Plus*.

Reverse these steps to reinstall the GCQ *Plus* top cover.

Removing and Reinstalling the GCQ Plus Side Covers

To remove a side cover:

1. Remove the top cover (page 1-12).
2. Remove the screw that secures the cover to the chassis. The screw is near the front of the instrument.
3. Slide the cover back 1.2 cm (0.5 in.) and lift it away from the GCQ *Plus*.

To reinstall a side cover:

1. Insert the bottom of the side cover inside the ridge on the bottom side of the GCQ *Plus*.
2. Push the top of the side cover toward the instrument until it is flush with the chassis.
3. Slide the side cover forward until it is flush with the cover.
4. Reinstall the screw that secures the side cover to the chassis of the GCQ *Plus*.

Removing and Reinstalling the GCQ Plus Front Cover

To remove the front cover:

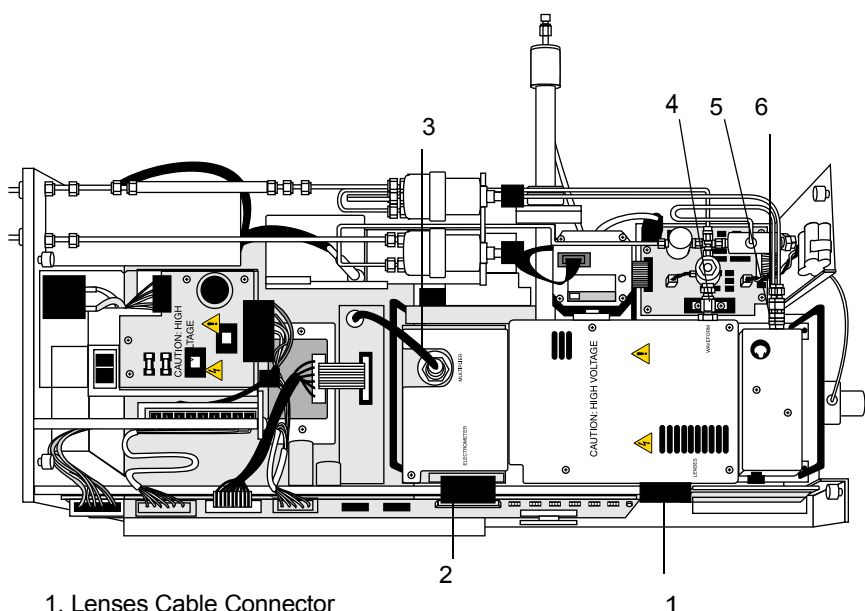
1. Remove the top cover (page 1-12).
2. If your instrument has an inlet valve, remove the inlet valve lever by pulling it free from the inlet valve.
3. Loosen the two fasteners that hold the front cover to the GCQ *Plus* chassis. They are at the top front edge.
4. Pull the top of the front cover far enough forward to reach the Front Panel PCB electrical cable, and disconnect it.
5. Lift the front cover up and away from the GCQ *Plus*.

Reverse these steps to reinstall the front cover.

1.5 Removing the Vacuum Manifold Top Cover Plate

Remove the vacuum manifold top cover plate to perform many of the maintenance procedures described in this manual, such as accessing the EI/CI ion source, mass analyzer, electron multiplier, and conversion dynode. Before you remove the top cover plate, shut down and vent the system (page 1-3).

Four cables and a gas line (one additional gas line if you have the CI option) are connected to the top cover plate.



1. Lenses Cable Connector
2. Electrometer Cable Connector
3. Electron Multiplier Connector
4. Waveform Cable Connector
5. Helium Buffer Gas Quick-Connect Fitting (top)
6. CI Reagent Gas Line Quick-Connect Fitting (bottom)

Figure 1-2. Electrical and Gas Line Connections to the Vacuum Manifold Top Cover Plate

CAUTION: Follow this procedure carefully to avoid damaging the transfer line tip, column, and ion source components.

1. Pull the transfer line away from the ion source so that the tip of the transfer line clears the ion source block, as described below. There is no need to remove the GC capillary column from the transfer line.
 - a. Open the GC oven door and ensure that the capillary column is sufficiently slack to move the GC without damaging the column. If necessary, undo one coil of the capillary column. Close the GC oven door.
 - b. Move the GC away from the GCQ Plus far enough so that you can access the vacuum-sealing nut on the transfer line inlet flange.
 - c. Loosen the vacuum-sealing nut on the transfer line inlet flange by turning it counterclockwise. See the figure on page 1-9 for the location of the vacuum-sealing nut.

WARNING: The transfer line may be hot. Wait until it is cool before proceeding.

- d. Pull the transfer line out of the GCQ Plus about 5 cm (2 in.).
2. Disconnect the following:
 - the lens cable from the connector labeled LENSES on the Analyzer PCB, which is located on the manifold top cover plate
 - the electrometer cable from the connector labeled ELECTROMETER on the Analyzer PCB
 - the electron multiplier cable (the coaxial cable) from the feedthrough labeled MULTIPLIER
 - the waveform cable from the feedthrough labeled WAVEFORM
3. Disconnect the helium damping gas line (upper gas line) and the CI reagent gas line (lower gas line) from the quick-connect fitting:
 - a. Pull the knurled ring on the quick-release fitting away from the gas line (to the left) and hold it there.
 - b. Pull the gas line away from the fitting (to the right).
 - c. Release the knurled ring after you disconnect the gas line.

4. Lift the top cover plate straight up by its two handles. Take care not to damage the parts on the underside of the cover plate. If the top cover plate catches, put it down again. Ensure that the transfer line is withdrawn a sufficient distance from the ion source. Place the cover plate upside down (supported on its handles) on a flat surface.
5. Cover the opening in the top of the vacuum manifold with the protective plastic cover that is supplied with the GCQ Plus.

Reinstalling the Vacuum Manifold Top Cover Plate

1. Remove the protective cover from the opening in the top of the vacuum manifold.
2. Check the O-ring (PN A0107-10406) for signs of wear. Replace it if necessary.
3. Wipe the O-ring and the top cover sealing surface with a lint-free cloth dampened with hexane. Blow-dry the O-ring (with a hand-held hair dryer) and inspect it for contaminants.
4. Remove contamination from the inner walls of the manifold by wiping them with a lint-free cloth soaked in methanol. Use a cotton-tipped applicator soaked in methanol to clean around inlets and feedthroughs. Use a blow-dryer to evaporate the methanol from the inner walls of the vacuum manifold.
5. Clean the conversion dynode and electron multiplier with clean, dry gas. Do not use liquids to clean the ion detection system parts.
6. Carefully lift the top cover plate by its two handles and turn it over. Insert the guide pins on the underside of the top cover plate into the guide holes on the vacuum manifold so that the electron multiplier is over the conversion dynode. Lower the cover plate onto the opening in the vacuum manifold. Take care not to damage the transfer line or the parts on the underside of the cover plate. Ensure that the cover plate is seated properly on the vacuum manifold.
7. Insert the transfer line into the vacuum manifold so that the tip of the transfer line seats in the sample inlet aperture of the ion source block.
 - a. Insert the transfer line carefully so that you do not hit the lens leads with the transfer line tip.
 - b. Tighten the vacuum-sealing nut on the transfer line inlet flange by turning it clockwise by hand.

8. Reconnect the CI reagent gas line (the lower gas line) and the helium damping gas line (upper gas line).
9. Reconnect the waveform, electron multiplier, electrometer, and lens cables.
10. Insert the transfer line into the GC:
 - a. Position the GC so that the opening in the side of the GC is aligned with the transfer line.
 - b. Carefully slide the GC toward the GCQ Plus, with the transfer line entering the opening in the side of the GC, until the GC is flush with the spacer on the GCQ Plus.

Chapter 2

Vacuum System and Gas Inlets

This chapter defines the components of the Vacuum System which maintain the low pressure necessary for the EI/CI ion source, the ion trap mass analyzer, and the ion detection system to operate properly. The vacuum manifold is evacuated by the diffusion pump (or optional turbomolecular pump) and the rotary-vane pump.

You will find information for the following main topics:

- Vacuum Manifold
- Diffusion Pump
- Turbomolecular Pump (optional)
- Rotary-Vane Pump
- Convectron Gauge
- Ion Gauge
- Gas Inlets

2.1 Vacuum Manifold

The heart of the GCQ *Plus* is the EI/CI ion source, the ion trap mass analyzer, and the ion detection system. These components are attached to the top cover plate of the vacuum manifold (see Figure 2-1, below). The top cover plate fits onto the vacuum manifold.

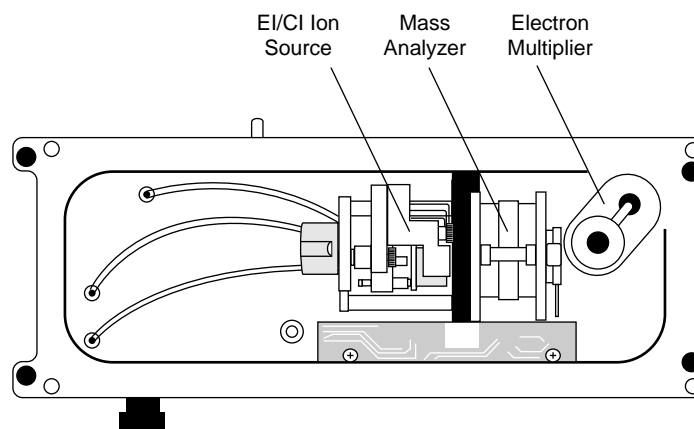


Figure 2-1. Top Cover Plate of the Vacuum Manifold (underside)

2.2 Diffusion Pump

The diffusion pump provides the high vacuum for the GCQ *Plus*. It mounts to the underside of the vacuum manifold with four captive screws. The pump is rated at 100 L/s (helium), and pump-down time is about 20 to 30 minutes. Under normal operating conditions the pump provides a vacuum of approximately 10^{-3} Pa (10^{-5} Torr). The pump is air-cooled by a fan that is built in to the pump housing.

Any contaminants that might leak from the diffusion pump condense on a thermoelectrically cooled Peltier baffle located below the intake of the diffusion pump. Thus, the pump oil is prevented from entering the vacuum manifold.

Power to and regulation of the diffusion pump is provided by the Diffusion Pump Control PCB. Power for the diffusion pump is turned on and off by the main circuit breaker and not by the service switch.

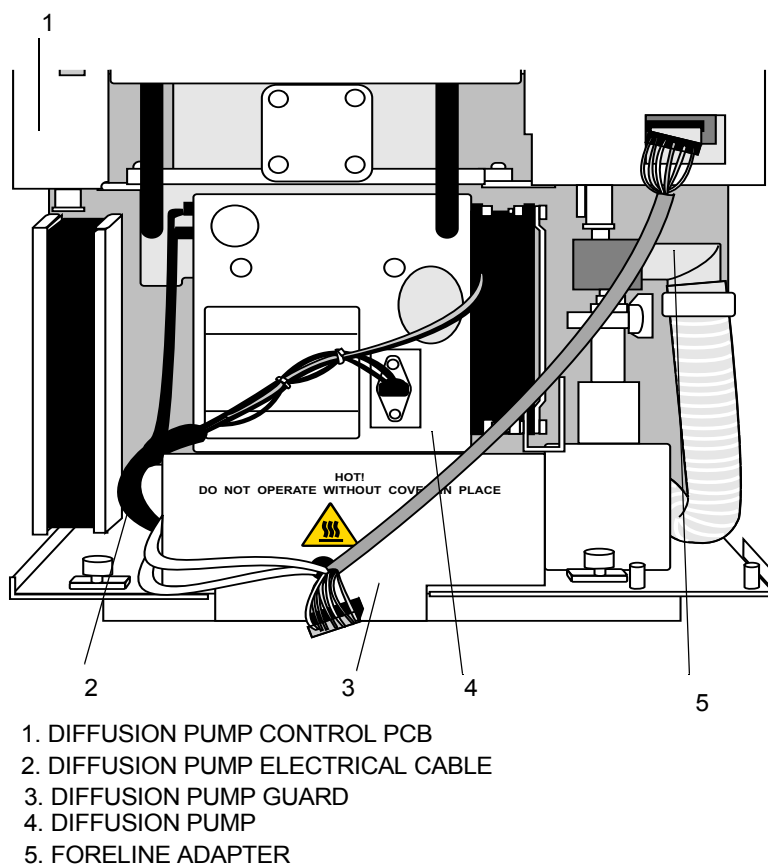


Figure 2-2. Front View of the Diffusion Pump

2.3 Turbomolecular Pump

The turbomolecular pump is an optional high-vacuum pump available with the GCQ *Plus* as an upgrade to the standard diffusion pump. The turbomolecular pump is rated at 230 L/s (helium). The operation of the pump is purely mechanical. It does not use oil to create a high vacuum. The turbomolecular pump has the advantage of being able to reach high vacuum faster than a diffusion pump.

The turbomolecular pump does not require any routine maintenance. It contains sufficient lubricant to supply the bearings for the life of the unit.

2.4 Rotary-Vane Pump

The rotary-vane pump is a two-stage forepump that establishes the vacuum necessary for the proper operation of the diffusion pump or turbomolecular pump. The rotary-vane pump is also used to evacuate the optional inlet valve. The pump has a maximum displacement of 7 m³/h and maintains a minimum pressure of 2×10^{-3} mbar.

The rotary-vane pump is connected to the high-vacuum pump by a short section of 0.75 in. ID Tygon tubing. The power cord of the rotary-vane pump is plugged into the rear of the MS Detector in the outlet labeled MECH PUMP. This outlet supplies power to the pump and is controlled by the main circuit breaker and not by the service switch.

CAUTION: Always plug the rotary-vane pump power cord into the outlet on the rear of the MS detector. Never plug it into a wall outlet.

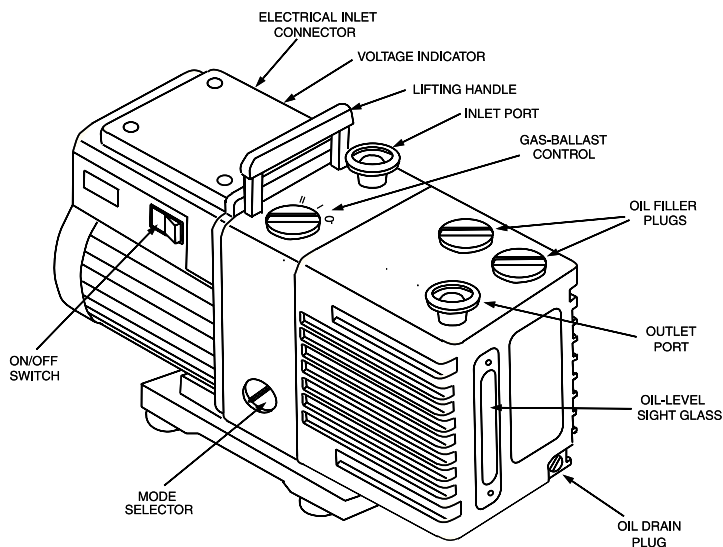


Figure 2-3. Rotary-Vane Pump

2.5 Convectron Gauge

The Convectron gauge measures the pressure in the foreline, which connects the high-vacuum pump and the rotary-vane pump. The foreline pressure, as measured by the Convectron gauge, is monitored by the Vent Control PCB. The Vent Control PCB detects whether the foreline pressure is too high for the proper operation of the high vacuum pump. Power to the high-vacuum pump is removed if the foreline pressure is too high.

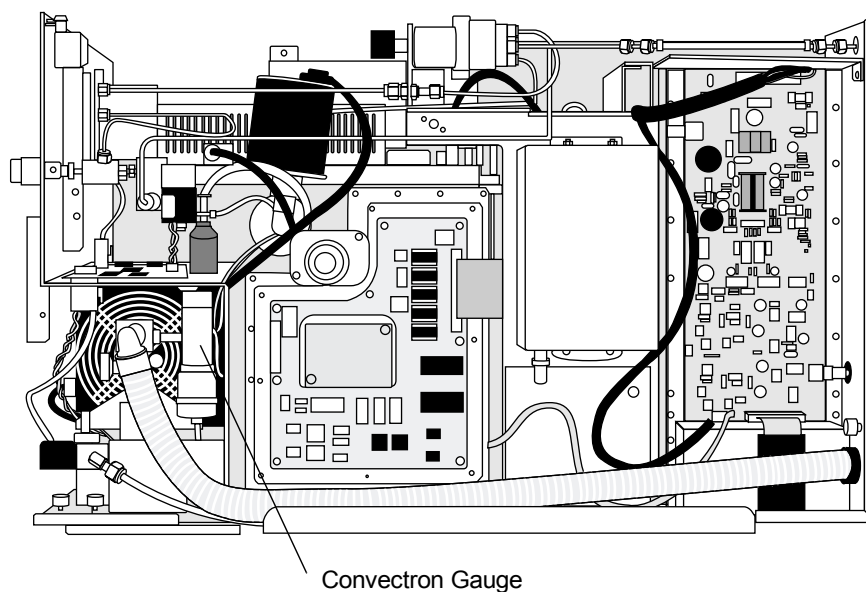


Figure 2-4. Right Side View, Showing Convectron Gauge

2.6 Ion Gauge

The ion gauge is an optional gauge that measures the pressure in the mass analyzer region (high vacuum region) of the vacuum manifold. The ion gauge produces energetic electrons that cause the ionization of molecules. Positive ions formed in the ion gauge are attracted to a collector. The collector current is related to the pressure in the vacuum manifold.

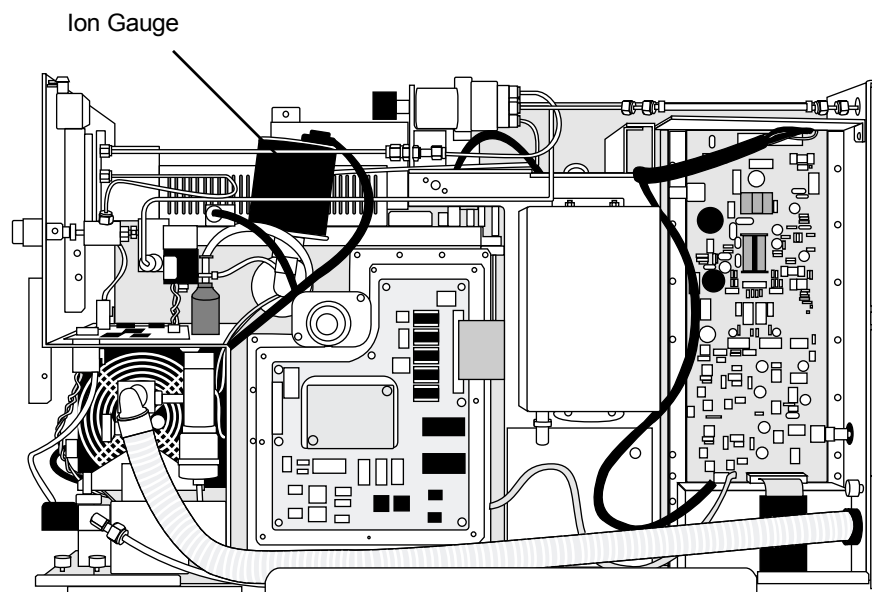


Figure 2-5. Right Side View, Showing Optional Ion Gauge

2.7 Gas Inlets

The GCQ *Plus* vacuum manifold has five gas inlets, which include the following:

- Vent Gas Valve
- MS Buffer Gas Valve
- Calibration Compound Valve
- CI Reagent Gas Valve
- Gas Inlet Adapter

Vent Gas Valve

The vent gas valve assembly allows the vacuum manifold to be vented to a clean, inert, dry gas such as helium. The vent gas valve assembly includes a solenoid-operated vent valve. It is controlled by the Vent Control PCB. In the standard operational mode, the vent valve is closed, and opened when the solenoid is energized.

Helium enters the MS detector through a fitting on the rear of the MS detector. It then passes through 1/8-in. stainless steel tubing to a 0 to 10 psi pressure regulator. At the pressure regulator, the flow of helium splits in two directions: to the vent valve and to the MS buffer gas capillary restrictor.

The vacuum manifold vents during the automatic shutdown procedure and when power is removed from the system. A battery backup on the Vent Control PCB provides power to the vent valve during a power failure. If power is not restored to the instrument after 8 seconds, the vent valve is opened and the manifold vents to helium. The vent valve closes after 3 minutes. The system recharges the battery backup when power is restored.

Note: The system must be vented to helium. Venting your system to atmosphere will allow atmospheric water vapor (and perhaps contaminants) into the manifold. Evacuating water vapor from the system requires extended pumping time.

MS Buffer Gas Valve

The MS buffer gas valve assembly controls the flow of helium into the ion trap mass analyzer cavity. The flow of helium is regulated by a capillary restrictor, connected to a 5 psi pressure regulator on the helium line. The helium enters the mass analyzer through a nipple on the entrance endcap electrode. Helium in the mass analyzer cavity dampens ionic motion and improves the performance of the MS detector.

Calibration Compound Valve

The calibration compound valve controls the flow of calibration compound into the EI/CI ion source. The calibration compound valve assembly includes a metering valve and a solenoid-operated valve. The assembly is mounted on the top cover plate of the vacuum manifold. The valve permits calibration compound to enter the ion source through 1/8 in. OD tubing.

CI Reagent Gas Valve

The CI reagent gas valve assembly controls the flow of CI reagent gas into the EI/CI ion source. The CI reagent gas valve assembly includes a 5 psi pressure regulator, a solenoid-operated valve, and a needle valve. CI reagent gas enters the ion source as follows: Reagent gas enters the rear of the instrument through a fitting, flows through the regulator, solenoid-operated valve, the needle valve, and then passes through an inlet in the top cover plate of the vacuum manifold. The CI reagent gas then passes from the inlet to the gas inlet adapter of the ion source through 1/8 in. OD tubing. The CI reagent gas solenoid valve is turned on and off through the data system.

The flow of CI reagent gas into the ion source is adjusted manually with the needle valve, which is located on the front of the instrument. You adjust the flow until the mass spectrum of the CI reagent gas ions indicates the proper CI reagent gas pressure in the ion source.

Gas Inlet Adapter

The calibration compound and CI reagent gas enter the EI/CI ion source through a gas inlet adapter. The gas inlet adapter is a block with openings for the calibration compound and CI reagent gas lines on one side, and an opening for the gases to enter the ion source block on the opposite side. The gas inlet adapter is secured to the ion source block by a thumb screw. The gas inlet adapter allows you to easily connect and disconnect the calibration compound and CI reagent gas lines from the ion source.

Chapter 3

EI/CI Ion Source

This chapter describes the EI/CI ion source. You will find information on the following main topics:

- Ion Source Components
- Inlet Valve (Optional)

The EI/CI ion source generates a beam of electrons, provides a site for these electrons to interact with sample or reagent gas molecules to form ions, and then focuses the ions into the mass analyzer for mass analysis.

The inlet valve is an optional vacuum lock that allows you to quickly remove or install an ion volume into the EI/CI ion source of the MS detector without venting the vacuum manifold.

3.1 Ion Source Components

The EI/CI ion source includes the following components:

- Back Plane
- Wave Spring
- Magnets and Magnet Support
- Lenses
- Ion Source Block Assembly
- Filament Assembly
- Ion Volume Assembly

Back Plane

The back plane serves as a support to which the other components of the ion source are attached. The back plane is toward the front of the instrument.

Wave Spring

The wave spring applies a constant force between the back plane and the spring base. The wave spring provides the tension for the ion source to be spring loaded in the vacuum manifold. Spring loading allows the ion source to be automatically positioned correctly with respect to the transfer line. The spring base holds the remainder of the ion source components. It is aligned to the back plane by two posts and is held in place by two thumb screws. The thumb screws function as forward stops for the spring base.

Magnets and Magnet Support

Two permanent magnets focus the filament electrons into a beam and cause the beam to spiral through the ion volume, ensuring optimization of the sample. The magnet support holds the two magnets in the proper position above and below the ion source block.

Lenses

The ion source lenses transmit the ions formed in the ion volume to the mass analyzer. The lenses are stainless steel plates and tubes to which voltages are applied. The three ion source lenses are designated L1, L2, and L3, with L1 being nearest to the ion volume.

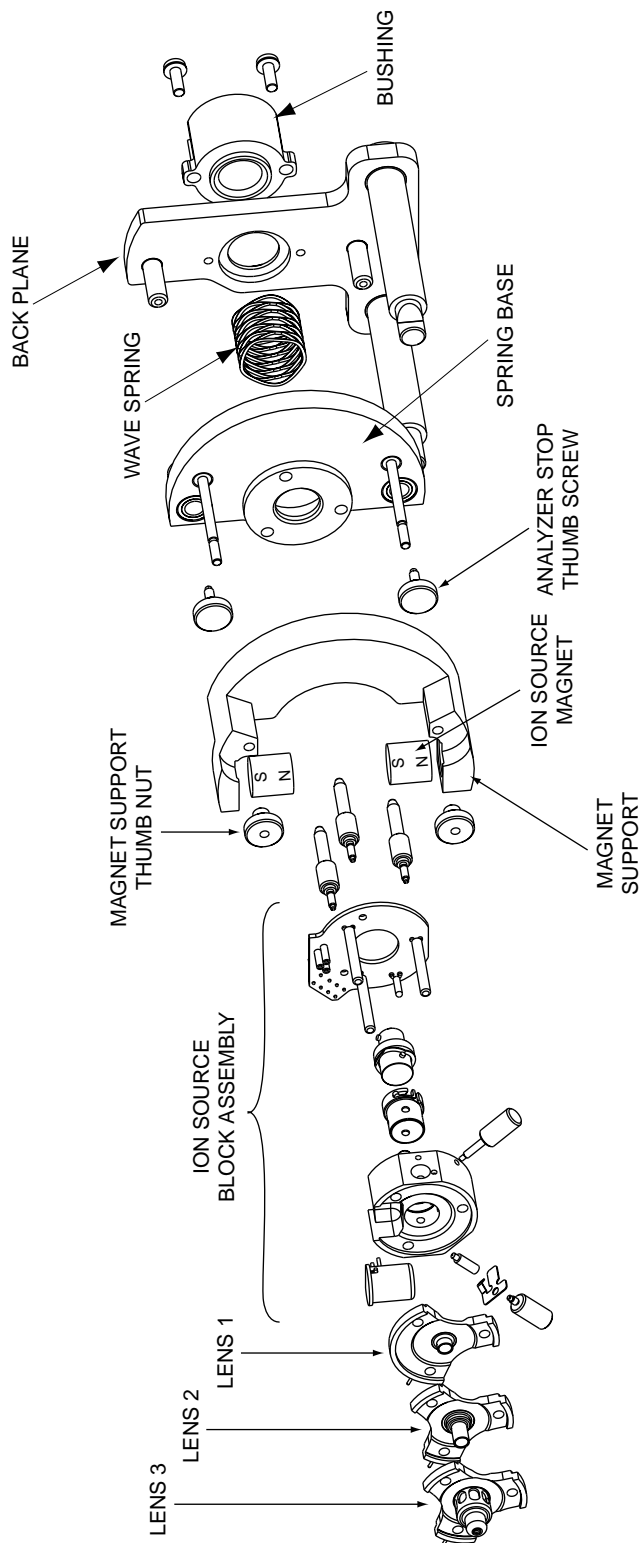


Figure 3-1. Exploded View of the EI/CI Ion Source

Ion Source Block Assembly

The ion source block assembly includes the ion source block, gas inlet adapter, ion source block PCB, three spring-base studs, three cartridge heaters, and a platinum probe temperature sensor. During normal operation, the ion source block holds an ion volume in its center. The ion volume is aligned in the ion source block by the ion volume key thumb screw. It is secured by the ion volume pin and ion volume spring. Samples are introduced from a GC capillary column through the sample inlet aperture on the side of the ion source block. The calibration compound or chemical ionization reagent enters the ion volume through the gas inlet adapter. The gas inlet adapter attaches to the ion source block by a thumb screw.

Three cartridge heaters and a platinum probe temperature sensor are mounted on the ion source block PCB. The cartridge heaters pass through the ion source block and heat the ion source block as well as heat, align, and support the three ion source lenses. The platinum probe temperature sensor monitors the temperature of the ion source block. The ion source block PCB supplies voltages to the filament, electron lens, and cartridge heaters, and it passes signals from the temperature sensor.

The spring-base studs hold the ion source block PCB to the ion source block. The spring-base studs insert into the spring base and position the ion source block between the two permanent magnets.

Filament Assembly

The filament assembly contains the filament, reflector, and electron lens. The filament assembly is positioned in a recess at the bottom of the ion source block and plugs into three sockets on the ion source block PCB. The filament is a rhenium wire that is electrically heated to produce electrons by thermionic emission. The reflector repels electrons emitted by the filament toward the ion volume. The filament and its reflector are maintained at negative potential relative to the ion volume, usually -70V. The electrons emitted by the filament are accelerated into the ion volume.

The electron lens, the metal cylinder around the filament wire, prevents positive ions from traveling up the electron beam, extending the life of the filament. The electron lens is located in the filament assembly between the filament and the ion volume. The voltage applied to the electron lens affects the flux of electrons that enter the ion volume.

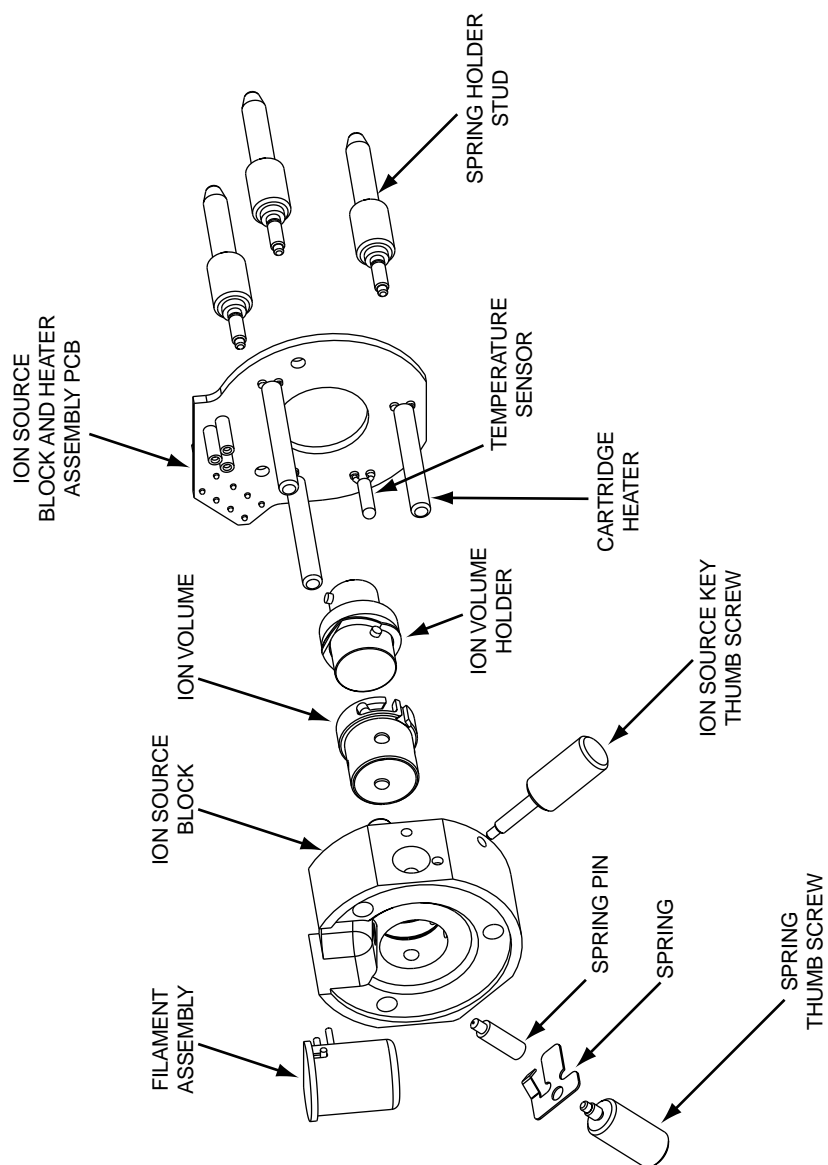


Figure 3-2. Exploded View of the Ion Source Block Assembly

Ion Volume Assembly

The ion volume assembly consists of an ion volume attached to an ion volume holder. The ion volume, located in the center of the EI/CI ion source, is the site where the molecules interact with energetic electrons to form ions. Different ion volumes are needed for EI and CI modes of operation. The EI and CI ion volumes are shown in Figure 3-3, below.

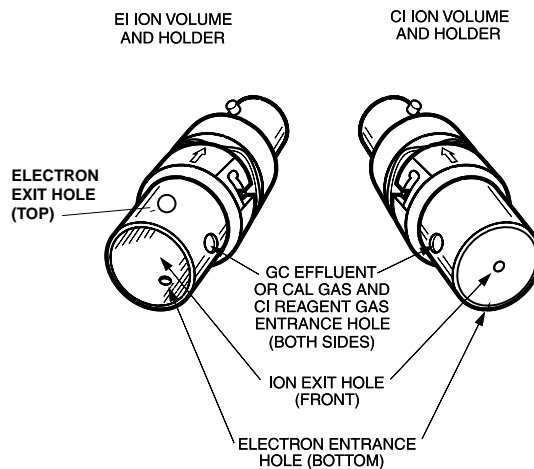


Figure 3-3. EI and CI Ion Volume Assemblies

3.2 Inlet Valve (Optional)

The inlet valve is mounted onto the front port of the vacuum manifold. It is a vacuum sealed valve through which you can insert and remove the ion volume assembly with an I/R (insertion/removal) tool.

The inlet valve includes the following components:

- Entry housing
- Ball valve and lever
- Inlet Valve Sleeve and Plug

Two tools accompany your GCQ *Plus*. They are used to remove the ion volume assembly. They are:

- I/R tool
- Guide bar

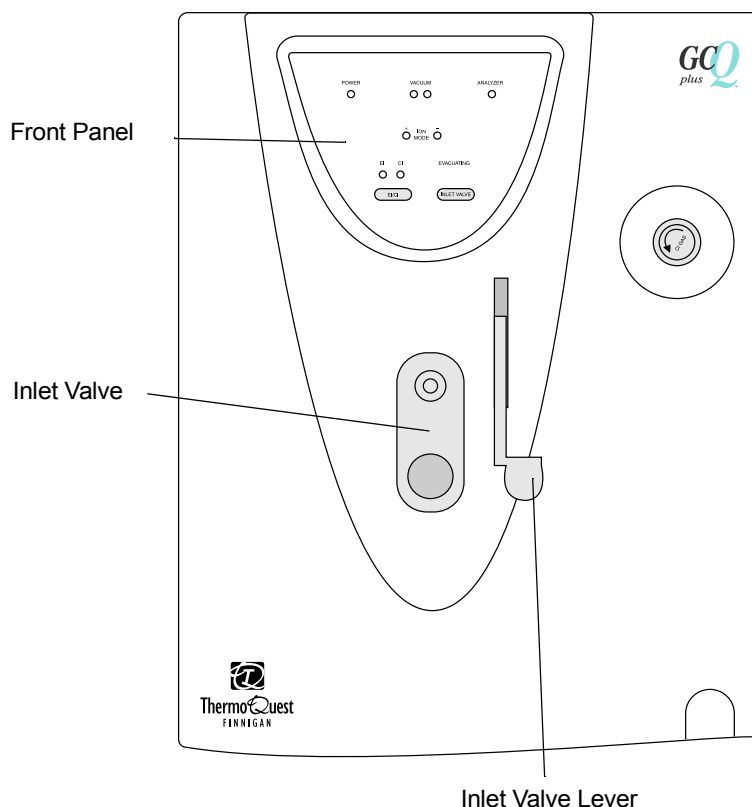


Figure 3-4. Front View

Entry Housing

The inlet valve entry housing is an aluminum chamber mounted on the vacuum manifold. The inlet valve entry housing has openings for the I/R tool and guide bar.

Ball Valve and Lever

The ball valve consists of a ball with a hole through it that is attached to a shaft. It is positioned next to the opening between the vacuum manifold and the inlet valve block. The valve is open when the hole in the ball is aligned with the opening between the vacuum manifold and the inlet valve. You open and close the ball valve with the inlet valve lever. When the lever is up, the ball valve is open. The ball valve is closed when the lever is in the down position.

Inlet Valve Seals

The inlet valve seals form a vacuum-tight seal over the shaft of the I/R tool when the I/R tool is inserted into the inlet valve. There are two seals, one in front of the ball valve and one behind it. You should replace the inlet valve seals periodically. Instructions for replacing the seals are in **Chapter 8: Maintaining the GCQ Plus**.

Inlet Valve Plug

The inlet valve plug seals the opening of the inlet valve when it is not in use. You can insert and remove the plug by hand.

I/R Tool

You insert and remove ion volumes with the I/R tool. The I/R tool consists of a shaft, handle, and guide ball. See Figure 3-5. The tip of the shaft has guides that hold the bayonet pins on the ion volume assembly. When you turn the rear portion of the handle of the I/R tool, the guides in the shaft move over the bayonet pins on the ion volume assembly between the hold and release positions. The guide ball is located on the end of a pin that is attached to the front portion of the handle. The guide ball inserts in a hole near the end of the guide bar and rolls along a track in the guide bar when you insert or remove the I/R tool. The guide ball also prevents you from lifting the I/R tool away from the guide bar when the I/R tool is not in the proper position. You will read more about how to use these tools in **Chapter 8: Maintaining the GCQ Plus**.

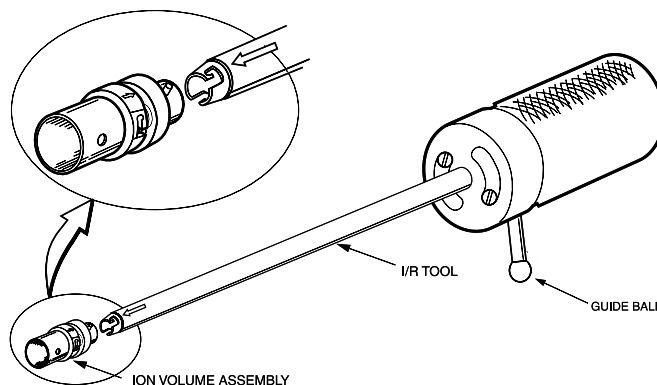


Figure 3-5. I/R Tool, Showing Arrows For Proper Ion Volume Placement

Guide Bar

The inlet valve guide bar is used to align and guide the I/R tool through the inlet valve and into the ion source. The inlet valve guide bar detaches for storage when it is not in use.

Chapter 4

Mass Analyzer System

The mass analyzer, also called the quadrupole ion trap, is the site of ion storage and mass analysis.

You will find information on the following main topics:

- Mass Analyzer Components
- Mass Analyzer Operation

4.1 Mass Analyzer Components

The mass analyzer is located on the mounting bracket opposite the EI/CI ion source. Figure 4-1 on page 4-3 shows a detailed view of the mass analyzer.

The mass analyzer contains three stainless steel electrodes which collectively form a cavity in which ion storage and mass analysis occur. The entrance endcap electrode and exit endcap electrode both have a small hole in their centers to permit the passage of ions into and out of the mass analyzer cavity. The ring electrode is located between the endcap electrodes. Ions produced in the EI/CI ion source enter the mass analyzer cavity through the entrance endcap electrode. Helium damping gas also enters the mass analyzer cavity through a nipple on the entrance endcap electrode. Ions can be ejected through either endcap electrode during mass analysis. Ions that are ejected through the exit endcap electrode are focused by the exit lens towards the ion detection system.

The entrance endcap electrode, exit endcap electrode, and central ring electrode are separated by two silicon nitride spacer rings. The spacer rings position the electrodes at the proper separation and also serve as electrical insulators. Two nonconducting posts pass through both endcap electrodes and screw into the mounting bracket. A spring washer and nut on the end of each post apply a force to the exit endcap electrode that holds the electrodes and spacers in place.

A dc offset voltage is applied to the mass analyzer electrodes to help draw ions in from the ion source. Typically, the magnitude of the DC offset voltage is -10 V for positive ion polarity mode and +10 V for negative ion polarity mode.

Various ac voltages are applied to the ring and endcap electrodes to trap and eject ions according to their mass-to-charge ratios.

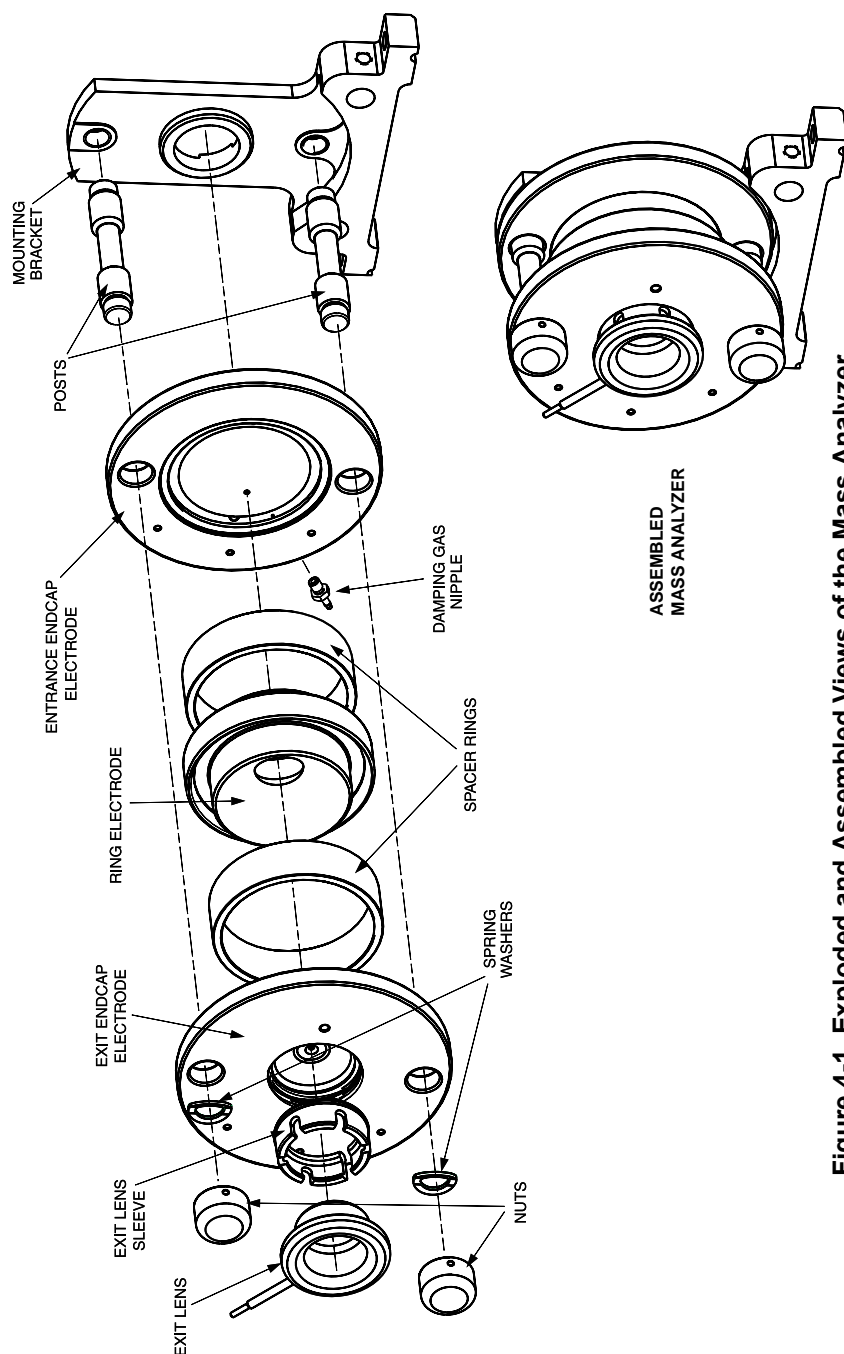


Figure 4-1. Exploded and Assembled Views of the Mass Analyzer

4.2 Mass Analyzer Operation

Mass analyzer operations can be broken down into four steps:

- Ion storage
- Ion Isolation (SIM, MS/MS)
- Collision induced dissociation (MS/MS)
- Mass analysis

Sample ions formed in the ion source are trapped in the mass analyzer if the ions have mass-to-charge ratios greater than the minimum storage mass, and the ions are not rejected by the ionization waveform voltage.

Ion Storage

After an optimum number of ions have been trapped, the ionization waveform voltage is turned off. The main RF storage voltage remains on.

Ion Isolation

For SIM and MS/MS analyses, the isolation waveform voltage is applied to the endcap electrodes. All ions are ejected except those of the selected mass or narrow range of masses.

Collision Induced Dissociation

For MS/MS analyses, the resonance excitation RF voltage applied to the endcap electrodes causes collision induced dissociation. Product ions with masses greater than the minimum storage mass are stored. The minimum storage mass during collision induced dissociation is typically one-quarter of the parent ion mass, for a resonance excitation q of 0.225.

Mass Analysis

Sample ions or product ions are separated by mass. The RF voltage applied to the ring electrode is ramped from low to high voltage, and the resonance ejection RF voltage is applied to the endcap electrodes to facilitate ejection. As the main RF voltage increases, ions of greater mass-to-charge ratios become unstable and are ejected from the mass analyzer. These ions are focused by the exit lens toward the ion detection system and detected.

Chapter 5

Ion Detection System

The GCQ *Plus* is equipped with a high sensitivity, off-axis ion detection system that produces a high signal-to-noise ratio. The ion detection system includes a 15-kV conversion dynode and a continuous-dynode electron multiplier. It is located behind the mass analyzer.

You will find information for the following main topics:

- Conversion Dynode
- Electron Multiplier

5.1 Conversion Dynode

The conversion dynode is a concave metal surface that is located at a right angle to the ion beam. A potential of +15 kV for negative ion detection or -15 kV for positive ion detection is applied to the conversion dynode. When an ion strikes the surface of the conversion dynode, one or more secondary particles are produced. These secondary particles can include positive ions, negative ions, electrons, and neutrals. When positive ions strike a negatively charged conversion dynode, the secondary particles of interest are negative ions and electrons. When negative ions strike a positively charged conversion dynode, the secondary particles of interest are protons and positive ions. These secondary particles are focused by the curved surface of the conversion dynode and accelerated by a voltage gradient into the electron multiplier.

The ion detection system of the GCQ *Plus* detector increases signal and decreases noise. The high voltage applied to the conversion dynode results in a high conversion efficiency and increased signal. That is, for each ion striking the conversion dynode, many secondary particles are produced. The increase in conversion efficiency is more pronounced for more massive ions than for less massive ions. This mass dependent gain factor minimizes detector noise due to the ionization of air and water, because these ions are of low mass.

Because of the off-axis orientation of the ion detection system relative to the mass analyzer, neutral molecules from the mass analyzer tend not to strike the conversion dynode or electron multiplier. Thus, neutral noise is also reduced.

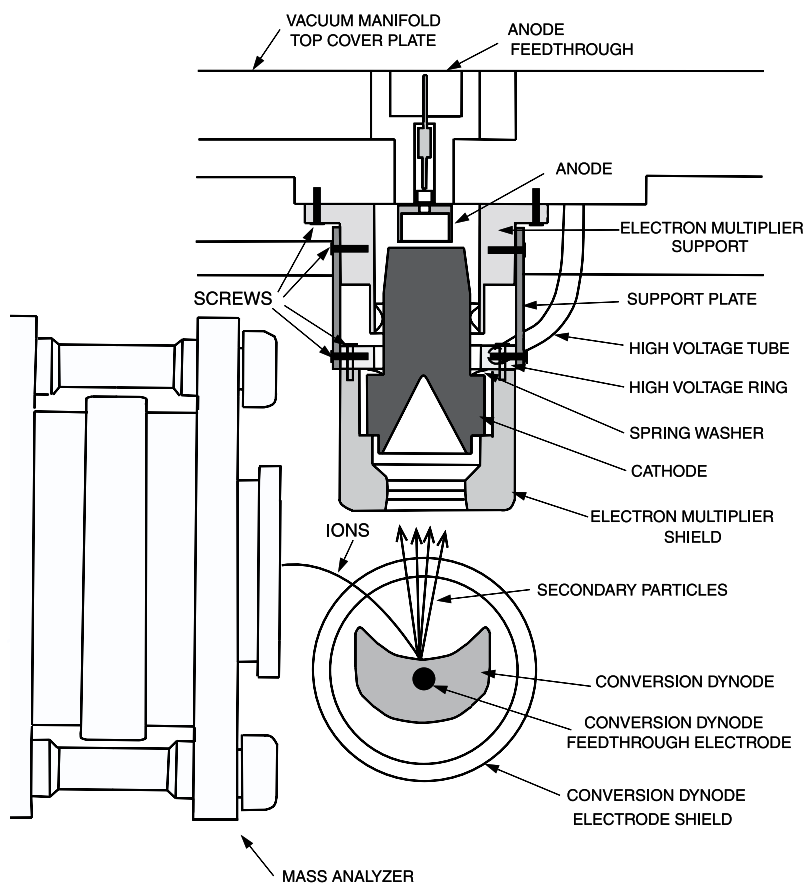


Figure 5-1. Cross-Sectional View of the Ion Detection System

5.2 Electron Multiplier

The electron multiplier is mounted on the top cover plate of the vacuum manifold next to the mass analyzer. The electron multiplier includes a cathode and an anode. The cathode of the electron multiplier is a lead oxide funnel-like resistor. A potential of up to -3 kV is applied to the cathode by the high voltage ring. The exit end of the cathode (at the anode) is near ground potential. The cathode is held in place by the high voltage ring, two support plates, the electron multiplier support, and the electron multiplier shield. A wave washer applies a force to the cathode to hold it in contact with the electron multiplier shield. The electron multiplier support is attached to the top cover plate of the vacuum manifold by two screws.

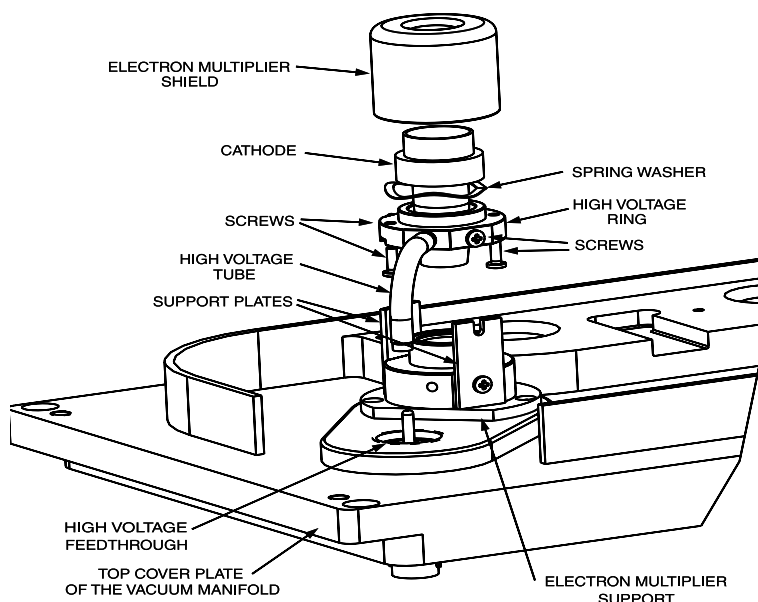


Figure 5-2. Exploded View of the Electron Multiplier, Showing the Cathode

Secondary particles from the conversion dynode strike near the inner walls of the electron multiplier cathode with sufficient energy to eject electrons. The ejected electrons are accelerated farther into the cathode, drawn by the increasingly positive potential gradient. Due to the funnel shape of the cathode, the ejected electrons do not travel far before they again strike the inner surface of the cathode, thereby causing the emission of more electrons. Thus, a cascade of electrons is created that finally results in a measurable current at the end of the cathode where the electrons are collected by the electron multiplier anode. The current collected by the anode is proportional to the number of secondary particles striking the cathode.

The electron multiplier anode collects electrons produced by the cathode. It is a cup located at the exit end of the cathode and screws into the anode feedthrough in the top cover plate.

Typically, the electron multiplier has a gain of about 10^5 . If the current of ions and electrons entering the electron multiplier from the conversion dynode is 10^{-12} A, and the gain of the electron multiplier is 10^5 , then a current of 10^{-7} A leaves the electron multiplier via the anode. This current is converted to a voltage by the electrometer circuit and recorded by the data system.

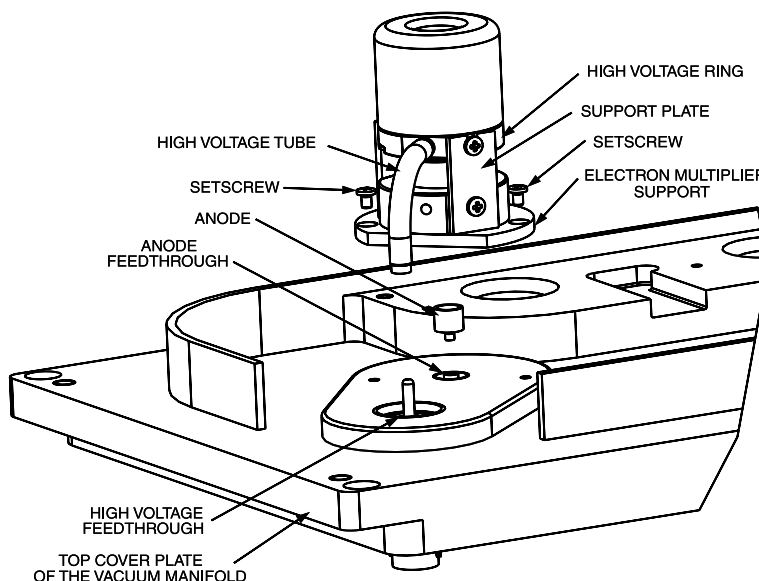


Figure 5-3. Exploded View of the Electron Multiplier, Showing the Anode

Chapter 6

Troubleshooting

Troubleshooting procedures help users isolate, identify, and rectify problems with the GCQ *Plus* MS Detector. From an overview, you will follow a branching structure to isolate the exact problem.

Typically, you start by selecting a general symptom. Next, identify the possible problem and remedy it with one of the solutions listed. You will find information for the following topics:

- GCQ Diagnostics
- Communication Problems
- High Vacuum Problems
- Heated Zone Problems
- Filament and Lens Control Problems
- Ion Trap Control Problems
- Tuning Problems
- Sensitivity Problems
- Stability Problems
- Linearity Problems
- Contamination Problems

6.1 GCQ Diagnostics

Use the Diagnostics program to check the state of the instrument any time you are having trouble. GCQ Diagnostics tests the major electronic circuits within the GCQ *Plus* and reports whether the circuits pass or fail. If there is a problem with the electronics, GCQ Diagnostics can usually locate it. You can then correct the problem yourself by replacing a faulty PCB or assembly. GCQ Diagnostics only diagnoses problems that are electrical in nature and does not detect problems in sensitivity due to misalignment, dirty components, or improper tuning. Therefore, it is important to have someone who is familiar with system operation and basic hardware theory run GCQ Diagnostics and isolate any problems.

Before running the GCQ Diagnostics, refer to the flowchart in Figure 6-1 below. Use Xcalibur online help for instructions on running GCQ Diagnostics.

Figure 6-1 lists a logical flow of questions and answers to be evaluated before using the Xcalibur software.

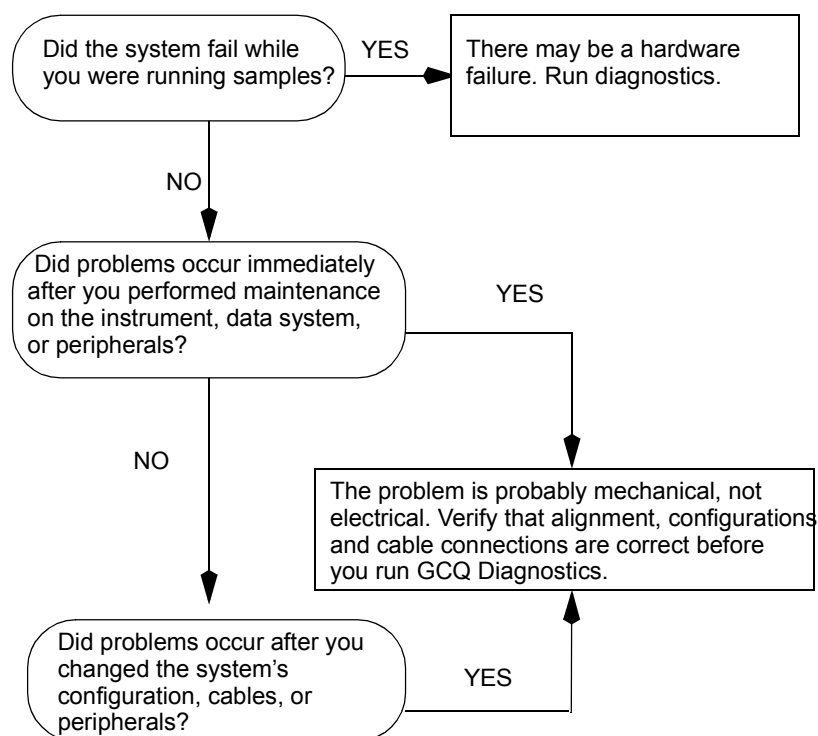


Figure 6-1. Diagnostics Flowchart

6.2 Communication Problems

The communication problems described in this section involve the links between the data system and the mass spectrometer, the gas chromatograph, and the autosampler. This section does not address communication issues with other peripheral devices.

The term “Communication” refers to:

- the transfer of analytical data between the mass spectrometer and the data system
- the current status of the mass spectrometer, gas chromatograph and autosampler
- instrument readbacks
- instrument control, method downloading and uploading, start, stop and pause features
- error messages

The flow of digital information is bi-directional; the data system downloads analytical methods to the instrument and issues start and stop, shutdown, startup, and initialize commands. The GCQ *Plus* reports its readiness state and current tasks, various voltages, heated zones, and pressure readings. It also delivers a steady stream of mass spectral data during acquisition.

Some communication problems are due to mechanical faults—for instance, a cable may be unplugged, or a device may be turned off. In other cases, the instrument method could be incorrect for proper operation of the GCQ *Plus*. Less common communication problems are due to defective electronic hardware components. Communication problems may be detected from an error message delivered by the data system, or they may be noticed from the failure to perform some expected task. Most communication problems can be addressed by the user; however, advanced electronic troubleshooting is best left to trained and qualified QuestCare Field Service Engineers.

Symptom	Possible Problem	Solution
Data system cannot initialize communication with GCQ <i>Plus</i>	The software is not configured correctly.	Select the GCQ <i>Plus</i> from the Instrument Configuration window.
	Computer Bios Interrupt conflicts are present.	Check computer Bios settings. Contact QuestCare for details.
Data system cannot initialize communication with GCQ <i>Plus</i>	The communication cable is unplugged.	Verify that the communication cable is connected.
	The Control DSP board inside the data system is faulty.	Reseat Control DSP. Replace if necessary.
	The communication circuits on the instrument main board are faulty.	Check connections to Main System PCB. Replace if necessary.
	The data system mother board is faulty.	Check connections to mother board, replace if necessary.
Computer loses communication with GCQ <i>Plus</i> intermittently	The Control DSP board inside the data system is faulty.	Reseat Control DSP. Replace if necessary.
	The communication circuits on the instrument main board are faulty.	Check connections to Main System PCB. Replace if necessary.
	The data system mother board is faulty.	Check connections to mother board, replace if necessary.
Cannot Download Methods to GCQ <i>Plus</i>	The software is not properly configured.	Verify correct settings in Instrument Configuration.
Acquisition does not begin as expected	The GCQ <i>Plus</i> start mode is not properly configured.	Verify that instrument is configured properly. Refer to Xcalibur online help.
	The GCQ Instrument Setup file has incorrect settings.	Check start time in GCQ Instrument Setup file.
	The forepressure is too high due to solvent peak.	Reduce injection volume. See section on Vacuum Problems (page 6-10).

Symptom	Possible Problem	Solution
Acquisition does not begin as expected	The Main System PCB jumper settings are incorrect.	Refer to Getting Connected for settings.
	The GC-MS remote start cable is disconnected.	Connect remote start cable. Refer to Getting Connected .
	The GC did not start.	Verify GC methods and configuration. Verify connection between autosampler and GC.
	The autosampler did not start.	Verify autosampler methods and configuration. Verify that the sample is present.
Unstable instrument readback	The Heated Zone setpoint is not attained.	Refer to section on Heated Zone Problems.
	There is a faulty cable connection.	Check connections to Main System PCB.
	The Control DSP is faulty.	Reseat DSP; replace if necessary.
	The Main System PCB is faulty.	Check connections to Main System PCB; replace if necessary.
	There is a Waveform Amplifier PCB voltage or communication malfunction.	Check connections to PCB, replace if necessary.
Acquisition terminates unexpectedly	There is an RF Amplifier PCB communication or voltage malfunction.	Check connections to PCB, replace if necessary.
	The end Run time in the GCQ Instrument Setup file is incorrect.	Check the Instrument Setup files for the GC and the MS.
	The data system is out of disk space.	Check disk space; back up and remove files.
Cannot initialize GC	There is a faulty Control or Acquisition DSP.	Reseat Control and Acquisition DSPs; replace if necessary.
	The GC is not turned on.	Turn on the GC.
	The GC is not configured properly in Xcalibur software.	Check Instrument Configuration.

Symptom	Possible Problem	Solution
	The cable between COM1 and GC is disconnected.	Verify connection.
	COM1 is not configured properly.	Verify COM port configuration.
	GC communications malfunction.	Contact QuestCare.
Cannot download methods to GC	There is a discrepancy between method and configuration.	Verify consistency between method and instrument configuration.
	COM1 is not configured properly.	Verify COM port configuration
	GC communications malfunction.	Contact QuestCare.
Cannot initialize Autosampler	Autosampler not turned on.	Turn on Autosampler.
	Autosampler not configured properly in Xcalibur software.	Check Instrument Configuration
	Disconnected cable between COM2 and autosampler.	Verify connection.
	COM2 not configured properly.	Verify COM port configuration.
	Autosampler communications malfunction.	Contact QuestCare.
Cannot download methods to Autosampler	Discrepancy between method and configuration.	Verify consistency between method and instrument configuration.
	COM2 not configured properly.	Verify COM port configuration
	Autosampler communications malfunction.	Contact QuestCare.

6.3 Power Supply Problems

Most power supply problems are detected by the Diagnostics program. Power supply problems often involve a blown fuse, faulty electronic component, or even something as simple as a disconnected cable. Use extreme care when you replace a fuse or electronic component. Place the GCQ *Plus* in service mode as soon as you remove the top cover to reduce the incidence of electrical shock. The service mode turns off all power to the instrument, except for that required to maintain a vacuum.

Note: Only qualified personnel should replace large assemblies such as the power module and PCBs.

Symptom	Possible Problem	Solution
Mass Spectrometer Will Not Turn On	Disconnected Power Cord.	Verify that the Power Cord is plugged in.
	No voltage coming from the electrical outlet.	Verify that the electrical outlet is operational.
	Improper Voltage at the electrical outlet.	Verify that the outlet is using the correct voltage for your system.
	Faulty circuit breaker on GCQ <i>Plus</i> .	Replace circuit breaker.
	Faulty Power Supply.	Replace Power Supply.
Mass Spectrometer turns on, but circuit breaker trips	Faulty Power Supply.	Replace Power Supply.
	Forepump causes circuit breaker to trip.	Check forepump; replace if necessary.
Mass Spectrometer Turns on, but there are no voltages available	There is no 5, 15, 150, 35, or 36 Volt power.	Check fuse on Main System PCB; replace if necessary. Check Power Supply; replace if necessary.
Mass Spectrometer Turns on, but there are no voltages available	There is no 28 volt.	Check fuse on RF Amplifier; replace if necessary. If fuse blows again after replacement, replace RF Amplifier.

Symptom	Possible Problem	Solution
	There is no 28 volt current.	Check connections to RF Amplifier, RF Control PCB, coil, and RF Feedthrough.
Fuses continue to open (any voltage)	Problem with Main System PCB or short circuits to ground.	Replace Main System PCB.
	Short in reagent gas, calibration gas, or vacuum interlock solenoid (24 V).	Replace solenoid.
	There is a short circuit in the Source Heater PCB (24V AC).	Inspect source assembly for improper connection or installation; replace if necessary.
		Replace Main System PCB.
	There is a short circuit in filament control (150 Volt).	Verify that the filament assembly is correctly installed; check for short circuits to ground.
	The filament assembly is conducting to ground (150 Volt).	Verify that the filament assembly is correctly installed; check for short circuits to ground.
	The Source Heater PCB is short circuiting due to contamination or rhenium deposition (150 Volt).	Remove rhenium deposits from the Source Heater PCB. Replace the Source Heater PCB if necessary.
Fuses continue to open (any voltage)	Lenses are short circuiting to ground.	Check lens insulators for wear or conducting path. Replace as necessary. Check the wiring between the source and vacuum manifold top cover plate for insulator wear or short circuits. Replace components as necessary. Check analyzer assembly bracket for insulation wear; replace if necessary.

Symptom	Possible Problem	Solution
28 Volt current is below acceptable range	The RF Amplifier is improperly adjusted.	Adjust R32 on RF Amplifier. Monitor the 28 volt current while adjusting. The current should be 0.8 to 1.2 amps.
	The RF pathway to ion trap has a fault.	Check connection sequences between RF Amplifier, Low Pass Filter, RF coil, RF Detector, RF Feedthrough, and ion trap ring electrode.
28 Volt current is higher than acceptable range	The RF Amplifier overheated.	Check fans on back of GCQ Plus; clean or replace as necessary. Verify adequate ventilation around GCQ Plus. Verify that lab temperature is within operating limits of GCQ Plus.
	The RF Amplifier is improperly adjusted.	Adjust R32 of the RF Amplifier.
	The RF Amplifier is faulty.	Replace the RF Amplifier.
	The RF Control assembly is faulty.	Check capacitor plate for high-voltage arcing; replace if necessary.
28 Volt current is higher than acceptable range	There is a short circuit to ground in RF Feedthrough.	Replace RF Feedthrough.
	There is a short circuit in the RF coil.	Replace the RF coil.
Alternating flashing green and blue LEDs on GCQ Plus front panel	The system is in fault mode because the line voltage is out of tolerance.	Cycle the main circuit breaker on the GCQ Plus to clear the fault mode. Verify input voltage tolerances.

6.4 High Vacuum Problems

The GCQ *Plus* vacuum manifold has two main components: the forepump (or roughing pump) and the high-vacuum pump (Diffusion Pump or Turbomolecular Pump). GCQ Diagnostics can detect vacuum problems; flashing LEDs on the front panel can indicate problems as well. Vacuum problems can also manifest themselves as artifacts during an acquisition. Typical forepressure readbacks are 30-40 mTorr (in EI mode), and typical manifold pressure (ion gauge readback) is $2-6 \times 10^{-5}$ Torr. For CI mode, forepressure is usually 60-90 mTorr, with manifold pressures no greater than 9×10^{-4} Torr. The pressure setpoints for EI and CI are different, and you must select the ionization mode by pushing in the EI/CI button on the front panel of the GCQ *Plus*. Alternating green flashing LEDs indicate that the forepressure is too high. This may also be a temporary condition after the vacuum interlock is used. Alternating green and blue flashing LEDs indicate a fault condition.

Symptom	Possible Problem	Solution
Forepump will not turn on	The forepump is off.	Check the forepump switch.
	The forepump power cable from the GCQ <i>Plus</i> is not connected.	Connect the power cable.
	The forepump is configured for incorrect voltage.	Configure the forepump for proper voltage.
	The forepump is faulty.	Replace the forepump.
Forepump turns on but will not pump down	The oil level in the forepump is insufficient.	Check oil level; add if necessary.
	The foreline is leaking.	Replace the foreline.
	The foreline connections leak.	Check foreline adapter clamps and seals at forepump and manifold high vacuum pump.
	The forepump is faulty.	Replace the forepump.
Diffusion Pump or Turbo Pump will not turn on	The forepressure is not low enough.	Check the forepump and foreline plumbing for leaks and proper operation.

Symptom	Possible Problem	Solution
Diffusion Pump or Turbo Pump will not turn on	Ready is not transmitted by the Vent Control PCB.	Check cable connections between vent control PCB and diffusion / turbo pump controller PCB; replace PCB if necessary.
	The laboratory environment is too hot.	Bring laboratory environment to within GCQ <i>Plus</i> specifications.
	The thermal snap switch on diffusion pump inhibiting ready.	Replace the thermal snap switch.
	Line voltage is out of tolerance.	Check line voltage; correct as necessary.
	The Diffusion / Turbo Pump PCB is faulty.	Replace the PCB.
	The Diffusion pump is overheated.	Reset by cycling main circuit breaker.
		Check cooling fans for proper operation.
Diffusion pump turns on but will not create an acceptable high vacuum		Verify correct air circulation around GCQ <i>Plus</i> .
		Adjust diffusion pump duty cycle.
	Gross leaks are present in the manifold.	Check manifold transfer line, vacuum interlock, and top cover assembly for gross leaks.
	The diffusion pump oil level is insufficient.	Clean and recharge diffusion pump.
	The diffusion pump heater is not heating.	Replace diffusion pump heater.
	The Peltier cooling baffle is not cooling sufficiently.	Replace the diffusion pump.

Symptom	Possible Problem	Solution
Diffusion pump shuts off during operation	The laboratory is too hot.	Bring laboratory environment within GCQ <i>Plus</i> specifications.
	There is not enough oil in the pump.	Add diffusion pump fluid.
	The diffusion pump duty cycle is too high.	Adjust diffusion pump duty cycle.
	The foreline pressure is too high. (There are alternating green flashing lights).	Shut down GCQ <i>Plus</i> and determine source of high foreline pressure; remedy.
Turbo Pump shuts off during operation	The foreline pressure is too high. (There are alternating green flashing lights).	Shut down GCQ <i>Plus</i> and determine source of high foreline pressure; remedy.
	The pump is turned off at the controller.	Check switch to make sure it is turned on.
	The cable connection between the controller and turbo pump is faulty.	Check connections.
	The Turbo pump controller is faulty.	Replace or repair as necessary.
	The Turbo pump is faulty.	Replace the Turbo pump.
Diffusion Pump overheats (GCQ in fault mode - green and blue LEDs on front panel flash alternately)	The pump ventilation is inadequate.	Check fans and air circulation.
	The line voltage is incorrect or out of tolerance.	Verify voltages are within acceptable tolerance; correct as necessary.
	The diffusion pump duty cycle is too high.	Adjust duty cycle.

Symptom	Possible Problem	Solution
Catastrophic ventilation occurs	A gross leak is present.	Check for leaks.
	The system was vented through the vacuum interlock opening, there was a GC column break at the transfer line, the foreline was cut, or other emergency.	Shut off power to GCQ immediately. Allow system to vent with helium and cool to room temperature. Perform corrective action as necessary.

6.5 Heated Zone Problems

The ion source and transfer line are the heated zones within the GCQ *Plus*. Often, a heated zone problem is the result of downloading a method to the GCQ *Plus* that has a different setpoint from the current setting, causing a delay while the heated zone heats or cools. Component failures are less common, but can occur. These are usually related to open circuits in heater cartridges or faulty temperature sensors. Heated zones in the gas chromatograph are not discussed in this manual.

Symptom	Possible Problem	Solution
Source Heater will not heat	The ion source heater cartridge is not connected.	Check connection between main board and analyzer PCB. Check the connection between the manifold top cover and the source assembly.
	The 24 Volt AC power supply is not operable.	Check fuse F5 on the Main System PCB and replace it if necessary.
	The heater cartridge is defective.	Vent the system and check that the resistance of the heater circuit $\approx 28 \Omega$. Replace the source heater PCB if necessary.
	The source temperature sensor (RTD) is defective.	Vent the system and check the resistance of the RTD (108Ω at 20°C , 176Ω at 200°C). Replace the source heater PCB if necessary.
	There is a problem with the main system PCB.	Contact QuestCare.
Source Heater overheats	The source temperature sensor (RTD) is defective.	Vent the system and check the resistance of the RTD (108Ω at 20°C , 176Ω at 200°C). Replace the source heater PCB if necessary.
Source Heater overheats	There is a problem with the Main System PCB.	Contact QuestCare.

Symptom	Possible Problem	Solution
Transfer Line will not heat	Transfer line heater elements are defective.	Place the GCQ <i>Plus</i> in service mode and unplug the transfer line connector. Measure the heater resistance at the following pins: <ul style="list-style-type: none"> • 2-3 \cong 360 Ω • 2-4 \cong 180 Ω • 3-4 \cong 180 Ω Replace the transfer line if resistance is incorrect.
	The transfer line temperature sensor (RTD) is defective.	Measure resistance of RTD across pins 5-6 (108 Ω at 20°C, 204 Ω at 275°C). Replace transfer line if necessary.
	There is a problem with the Main System PCB.	Contact QuestCare.
Transfer Line overheats	The transfer line temperature sensor is defective.	Measure resistance of RTD across pins 5-6 (108 Ω at 20°C, 204 Ω at 275°C). Replace transfer line if necessary.
	There is a problem with the Main System PCB.	Contact QuestCare.

6.6 Filament and Lens Control Problems

The lifetime of a filament depends on its exposure to oxygen and solvent vapors. The design of the filament assembly protects the filament and increases its lifetime. Typically, a filament will last many months. GCQ Diagnostics tests the filament for continuity and current regulation. Additionally, Xcalibur software tests the filament for continuity before each acquisition, so that an open filament condition will stop an autosampler sequence and generate an error message.

GCQ Diagnostics tests the lenses of the GCQ Plus. A flat line, which represents voltage readback versus the predicted voltage ramp, indicates a lens or other control fault. Contamination causes deterioration of lens performance over time; the amount of time depends on what type of sample and ionization mode you are using. Be careful to handle the lenses with care, and do not use harsh cleaning techniques, which could thin or abrade the anodized aluminum layer. Damaged lenses cause short circuits, which in turn can cause damage to the lens drivers.

Symptom	Problem	Solution
Diagnostics indicate filament is open	The filament is open.	Vent the system and remove the filament. Normal resistance $\cong 1.0 \Omega$. Replace if open.
Inspection shows filament is good, but diagnostics still indicate filament is open	There is a fault in the Source Heater PCB.	Replace the source heater PCB.
	The connection between the source assembly and top cover is inadequate.	Check the connection between the manifold top cover and the source assembly.
	There is a problem with the Main System PCB.	Contact QuestCare.
Emission current is unstable	The filament is near the end of its life span.	Replace the filament.
	There is a fault in the Source Heater PCB.	Replace the Source Heater PCB.
Emission current is unstable	There is a problem with the Main System PCB.	Contact QuestCare.

Symptom	Problem	Solution
Short filament lifetime	There is an air leak contributing to short filament lifetime.	Check for leaks; repair if any are found.
	The filament is on during solvent peak.	Increase acquisition delay time until solvent peak has passed.
	An excessively high emission current is in use.	Use lower emission current.
Diagnostics indicate flat response for Lens 1 or 3	Lens 1 has a short circuit to the source block or lens 3 has a short circuit to the analyzer bracket.	If the anodized aluminum insulating surface is abraded, replace the lens. If there is a burr on the ion source or the mounting bracket, repair or replace the affected part.
	The power supply to the lens has a fault.	Check Fuses F2 and F3 on main system PCB; replace if necessary.
	There is a fault with the lens drivers (PA42, PN A0001-05560).	Replace PA42 lens driver (U14 for lens 1, U18 for lens 3) on main system PCB.
Autotune sets Lens 1 or Lens 3 to very low or very high voltages	Lenses are contaminated.	Clean the lenses.
	There is a fault with the connection between the ion source and the top cover electrical feedthroughs.	Replace the connector.
Diagnostics indicate flat response for Lens 2	The power supply to the lens has a fault.	Check fuses F2 and F3 on main system PCB; replace if necessary.
	There is a problem with the lens driver (PA85) on the main system PCB.	Contact QuestCare.
Autotune sets Lens 2 to very low voltage	Lenses are contaminated.	Clean the lenses.
	There is a problem with lens 1 or 3.	See troubleshooting section for lenses 1 and 3, above.

6.7 Ion Trap Control Problems

Several electronic modules and interconnecting cables control the ion trap. Problems with these modules or cables in the RF Signal path can cause ion trap control problems. Begin troubleshooting ion trap control problems by using GCQ Diagnostics. The Data obtained from GCQ Diagnostics will help you identify whether the fault is due to a power supply problem, a break in the signal path, or a faulty component. Figure 6-1, Diagnostics Flowchart, on page 6-2, is an excellent resource to begin troubleshooting ion trap control problems. If the symptom is observed after performing work on the instrument, it points to mechanical issues; if the symptom arises suddenly during operation of the instrument, it indicates a fault condition.

Users with electronics knowledge will be able to perform some repairs on the RF circuitry. However, board-level repairs and adjustments, as well as replacement of major assemblies, are best handled by QuestCare service engineers.

Symptom	Possible Problem	Solution
RF Dip Calibration shows random noise instead of a smooth RF Dip	There is a loose cable.	Check the following cables: <ul style="list-style-type: none"> • Data system cable (PN 96000-63022) • Cable from RF amplifier to low pass filter (PN 96000-63010) • Cable from low pass filter to high voltage coil (PN 96000-63012)
	Analyzer ring electrode is not contacting RF feedthrough spring pin (PN A0004-33016).	Vent the system and check the spring pin for correct action.
	There is a breakdown in the high voltage RF feedthrough (PN 97000-60169).	Replace RF feedthrough.
	There is a fault with RF amplifier power supply (28 Volt power supply).	Check the fuse on the RF amplifier PCB; replace if necessary.

Symptom	Possible Problem	Solution
RF Dip Calibration shows random noise instead of a smooth RF Dip	The RF amplifier is faulty.	Replace the RF amplifier.
	There may be a problem with the RF control PCB, low pass filter PCB, or the high voltage coil.	Contact QuestCare for assistance.
RF Dip is present, but cannot be centered	There is a fault with the high voltage coil or the RF control PCB.	Contact QuestCare for assistance.
	There is high voltage arcing within the ion trap.	Vent the system and disassemble the ion trap. Check for burn marks or evidence of arcing. Clean components if necessary. Replace the components if problems persist.
The Detected RF line (RF Gain Calibration screen) shows flattening	The RF amplifier gain is not adjusted.	Adjust R32 on RF amplifier to make the RF Gain linear.
	High voltage arcing is present.	Check coil, RF capacitor plate, RF feedthrough, and ion trap assembly for evidence of high voltage arcing (discoloration or burn marks). Replace affected parts as necessary.
The Detected RF line is straight to a certain mass, then shows artifact	High voltage arcing is present.	Check coil, RF capacitor plate, RF feedthrough, and ion trap assembly for evidence of high voltage arcing (discoloration or burn marks). Replace affected parts as necessary.

Symptom	Possible Problem	Solution
The Detected RF and RF Mod lines are erratic	There is a loose cable.	Check the following cables: <ul style="list-style-type: none"> • Data system cable (PN 96000-63022) • Cable from RF amplifier to low pass filter (PN 96000-63010) • Cable from low pass filter to high voltage coil (PN 96000-63012)
	There is a problem with the RF control PCB, low pass filter PCB, the RF amplifier PCB, or the high voltage coil.	Contact QuestCare.
	High voltage arcing is present.	Check coil, RF capacitor plate, RF feedthrough, and ion trap assembly for evidence of high voltage arcing (discoloration or burn marks). Replace affected parts as necessary.

6.8 Tuning Problems

You can use the advanced ion trap and lens control features to tune the GCQ Plus as necessary. However, this broad range of control can also result in some confusion; often a perceived tuning problem is the result of a simple misadjustment of a manual control parameter, or the presence of too much or not enough calibration gas. You should suspect a tuning problem when Autotune fails. The five sections of Autotune perform different tasks, and symptoms or error messages in the individual sections of Autotune indicate very different problems. Often, a symptom observed in Autotune can be cross-referenced to an indicator in the GCQ Diagnostics, which further narrows the list of possible problems.

Symptom	Possible Problem	Solution
Error Message: Cannot find Calibration Gas	Calibration gas flow is insufficient.	Check that the calibration gas valve is open 4 to 6 turns counterclockwise from fully closed position. Increase flow if necessary.
	The calibration gas vial is empty.	Add 100 uL of FC-43 Calibration compound.
	There is a mechanical problem with the ion source or lenses.	Verify correct orientation and cleanliness of ion volume. Verify cleanliness and correct operation of lenses.
	There is a problem with ion trap control.	See Ion Trap Control Problems on page 6-18.
	Tune File settings are out of usable range.	Restore default Tune settings and Calibration settings. Run Autotune.
Multiplier Gain Calibration Fails	The multiplier is near the end of its lifetime.	Replace the multiplier.
	The filament is the source of too much background noise.	See Filament and Lens Control Problems on page 6-16.
Multiplier Gain Calibration fails	Water background in the manifold is elevated.	Check Air/Water spectrum. Remedy leaks or sources of water contamination in carrier gas.

Symptom	Possible Problem	Solution
	Multiplier anode is loose.	Inspect and tighten the anode.
	The background contamination of the manifold is elevated.	Find source of contamination and remedy. Allow the system to remain under vacuum until contamination has pumped away. Vent the system. Disassemble and clean the manifold.
	The multiplier power supply is faulty.	Replace multiplier power supply.
	The multiplier anode is contaminated.	Clean the anode.
Lens Tune Fails	There is a mechanical or electronic control problem with the lenses.	Run Ionization Lens Test in Diagnostics. Refer to Filament and Lens Control Problems on page 6-16.
	The lenses are contaminated.	Clean the lenses.
	The instrument is unable to isolate the mass for lens tuning due to incorrect Mass and/or Waveform Calibration.	Run Mass Calibration and Waveform Calibration in Autotune.
Mass Calibration Problems	There is insufficient calibration gas present.	See previous section on calibration gas problems on page 6-21.
	There is a mechanical or electronic control problem with the lenses.	Run Ionization Lens Test in Diagnostics. Refer to Filament and Lens Control Problems on page 6-16.
	The lenses are contaminated.	Clean the lenses.
Mass Calibration problems	There is an ion trap control problem.	See Ion Trap Control Problems on page 6-18.
Error Message: Cannot perform resonance ejection calibration	There is insufficient calibration gas.	See previous section on calibration gas problems on page 6-21.

Symptom	Possible Problem	Solution
	There is a problem with the electron multiplier.	See Multiplier Gain Calibration fails, page 6-21.
	There is an ion trap control problem.	See Ion Trap Control Problems on page 6-18.
Error Message: Cannot perform waveform calibration	The amount of calibration gas is insufficient.	See previous section on calibration gas problems on page 6-21.
	There is an ion trap control problem.	See Ion Trap Control Problems on page 6-18.
	The waveform DDS PCB is faulty.	Replace the waveform DDS PCB.
	There is poor high mass response.	See Poor High Mass Response, below.
Poor High Mass Response	There is insufficient calibration gas.	See previous section on calibration gas problems on page 6-21.
	The ion volume is contaminated.	Clean the ion volume.
	The lenses are contaminated.	Clean the lenses.
	There is a problem with filament or lens control.	See Filament and Lens Control Problems on page 6-16.
	The ion trap electrodes and/or spacers are contaminated.	Clean the ion trap components.
	There is a multiplier problem.	See page 6-21, Multiplier Gain Calibration Fails.
	The conversion dynode is faulty.	Contact QuestCare.
Poor High Mass response	There is an ion trap control problem.	See Ion Trap Control Problems on page 6-18.
	Reagent gas is leaking into the analyzer, suppressing EI signal.	Check operation of reagent gas solenoid and metering valve. Repair or replace if necessary.

Symptom	Possible Problem	Solution
Weak Signal	The multiplier is set too low.	Run Multiplier Gain.
	The ion volume is absent or incorrectly positioned.	Verify that the ion volume is positioned correctly.
	There is a filament or lens control problem.	See Filament and Lens Control Problems on page 6-16.
	The multiplier is faulty.	See Multiplier Gain Calibration fails, page 6-21.
Incorrect relative spectral abundances for calibration gas	Calibration gas self-CI occurs.	Reduce flow of calibration gas.
	Low mass ions are insufficient.	Adjust the high mass slider bar. Adjust lens voltage and/or trap offset voltage.
	High mass ions are insufficient.	Adjust the high mass slider bar. Adjust lens voltage and/or trap offset voltage.
	Calibration gas ions are spurious due to reagent gas leak.	Check for proper operation of reagent gas solenoid and metering valves.

6.9 Sensitivity Problems

When you observe a drop in instrument sensitivity, you should determine if the sensitivity drop was sudden or if it occurred gradually. A sudden loss of sensitivity can be the result of sudden component failure or an unnoticed change in the analytical method. Simple errors such as a plugged autosampler syringe or too low sample level in the sample vial can give the appearance of instrument failure.

Gradual drops in sensitivity are usually the result of source or lens contamination, and are easily remedied by cleaning the ion volume or lenses. Some components of the GCQ *Plus* that influence sensitivity, such as the electron multiplier, have definitive lifetimes, and eventually you will have to replace them. Improper GC maintenance is another cause of diminished sensitivity. It is important to establish a routine maintenance program for the GC. See your GC operator's manual for more information on establishing a maintenance program.

Symptom	Possible Problem	Solution
Low total ion current signal in chromatogram	The instrument is out of tune, or tune file is incorrect.	Select correct tune file for the method or run Autotune.
	The ion volume is contaminated.	Clean the ion volume.
	The ion volume is incorrectly positioned.	Position the ion volume properly.
	Emission current is set too low.	Check emission current settings in Manual Tune Options .
	There is a problem with filament or lens control.	See Filament and Lens Control Problems on page 6-16.
	The source heater PCB is faulty, allowing emission current to leak to ground.	Replace the source heater PCB.
	Reagent gas is leaking into the analyzer, suppressing EI signal.	Check operation of reagent gas solenoid and metering valve. Repair or replace if necessary.

Symptom	Possible Problem	Solution
Poor compound sensitivity	Insufficient sample delivery due to plugged syringe needle.	Clean or replace syringe.
	The injection port liner is contaminated.	Clean or replace injection port liner.
	The injector or septum is leaking.	Replace septum and perform leak check on GC.
	The capillary column is at the end of its life span.	Replace capillary column.
	Method development problems are present.	Contact QuestCare.
Sensitivity is unstable or shows decrease with repeated injections	The ion volume or lenses are contaminated.	Clean the ion volume and lenses.
	There is a problem with the filament emission current control.	See Filament and Lens Control Problems on page 6-16.
	The multiplier is faulty.	See Multiplier Gain Calibration fails, page 6-21.
	The injection port liner or capillary column are contaminated.	Replace the injection port liner and trim the capillary column.

6.10 Stability Problems

Good operating conditions for the mass spectrometer, gas chromatograph, and autosampler contribute to instrument stability. Sample preparation, spiking errors, sample injection errors, and lack of routine maintenance on the instruments can cause perceived stability problems. When hardware problems affect instrument stability, you should investigate simple remedies first, such as cleaning the ion volume and lenses, or checking for air leaks. Usually, a hardware fault that affects sensitivity will show other symptoms that are addressed elsewhere in the troubleshooting guide.

Symptom	Possible Problem	Solution
Mass Assignment is unstable	There is a problem with ion trap control.	See Ion Trap Control Problems on page 6-18.
Signal response is unstable or shows unexpected drop-out	There is a problem with filament or lens control.	See Filament and Lens Control Problems on page 6-16.
	There is an air leak.	Run Air/Water spectrum; check for leaks.
	There is a high vacuum problem.	See High Vacuum Problems, page 6-10.
	There is a communication problem.	See Communication Problems, page 6-3.

6.11 Linearity Problems

Poor operating conditions for the instrument can cause linearity problems. A well-maintained instrument will provide good linear response over a wide range of concentration for most compounds, but like any instrument, the GCQ *Plus* has a saturation point. The Automatic Gain Control feature allows the range of linear response to widen. At minimum injection time (60 μ sec), the multiplier remains linear at higher concentrations. Certain compounds do not give desired linear response due to chromatographic activity. Perform routine injector and column maintenance to minimize linearity problems. Usually, a hardware fault that affects linearity will show other symptoms that are addressed elsewhere in the troubleshooting guide

Symptom	Possible Problem	Solution
Calibration plots not sufficiently linear	There are dilution errors in preparing calibration samples.	Recheck preparation technique.
	High-end standards are too concentrated for the ion trap.	Use split injection technique to decrease amount of sample.
	Ion volume and lenses are dirty.	Clean ion volume and lenses.
	Multiplier settings are incorrect.	Run autotune.
	Injection port liner or capillary column is dirty.	Change the injection port liner and trim the capillary column.
	The capillary column is bad.	Replace capillary column.

6.12 Contamination Problems

The high sensitivity of the ion trap (relative to a quadrupole mass filter detector) often causes new users to confuse background with a contamination problem. Chemical noise is always present. The Automatic Gain Control will amplify whatever signal is present, even if it is column or septum bleed, until there is a nominal signal. Additionally, the spectra shown in Tune and Real-Time Display are auto-normalized, which can make the background appear high-level, when in fact it is not.

Certain sources of chemical noise do present in predictable fashion, such as septum bleed after a series of injections, or vial sample bleed which occurs if more than one injection is made from a sample vial. Some sample vial septa will even contaminate the autosampler wash solvent. GC columns can bleed and show elevated background, especially at higher temperature - the thicker the film, the greater the background level. Siloxane peaks that appear in a chromatogram at regular intervals result from focusing at the head of the column or in the injector. This type of contamination usually enters the system through sample injection, or from septum bleed, or from damage to the head of the capillary column.

Other possible sources of background spectra include hydrocarbon contamination in the carrier gas, diffusion pump oil, and solvents used to clean instrument parts. Wear cotton gloves when you handle ion source and mass analyzer components. Assure that carrier gas filter, carrier gas lines, and gas regulators are free of contamination and leaks.

Symptom	Possible Problem	Solution
Excessive diffusion pump oil manifest in spectrum (m/z 446)	The vacuum interlock valve has recently been used.	Allow vacuum system to stabilize.
	The system has been idle for a long period of time, resulting in condensation of diffusion pump oil on filament assembly.	Turn on filament and analyzer; allow system to stabilize until contamination vaporizes.
	There is an air leak in the manifold or the foreline, resulting in diffusion pump oil backstreaming.	Check for air leaks and remedy.
	Diffusion pump duty cycle is set too high.	See High Vacuum Problems on page 6-10.

Symptom	Possible Problem	Solution
There is excessive diffusion pump oil breakdown products manifest in spectrum (m/z 262, 170, 141, 121)	Diffusion pump oil has been subjected to oxidation due to an air leak.	Check for air leaks and remedy.
	Diffusion pump oil has been subjected to thermal degradation due to excessive diffusion pump power.	Adjust diffusion pump duty cycle.
There is excessive chemical background due to column bleed (m/z 429, 355, 281)	Capillary column has not been properly conditioned.	Condition the capillary column.
	Capillary column is damaged as a result of exposure to oxygen.	Find the source of the oxygen in the carrier gas or air leak. Recondition or replace the capillary column.
There is excessive injection port septum bleed (Typical m/z 209, 429, 355, 281).	The septum is worn out or damaged.	Replace the septum.
	Small pieces of septum are in the injection port liner.	Replace the injection port liner, condition the capillary column.
There is phthalate background manifest in chromatograms (m/z 149, 167, 279)	Phthalate contamination has occurred due to sample handling or solvent contamination. Phthalates may be observed from packaging materials.	Isolate source of phthalates and remedy.
There is excessive hydrocarbon contamination manifest in chromatograms (Typical ions are m/z 43, 57, 71, 85, 99...)	Hydrocarbon contamination can come from sample handling and preparation, solvent contamination, mechanical pump oil, fingerprints, and injection port septum and liners.	Isolate source of hydrocarbon contamination and remedy.
	Carrier gas tubing is contaminated.	Replace carrier gas tubing. Change carrier gas filters.

Symptom	Possible Problem	Solution
There is chemical background due to Teflon™ (PTFE) tubing (m/z 131, 181, 231, 281, 331...)	PTFE tubing inside the analyzer assembly has become exposed to harsh chemicals or is aged.	Replace PTFE tubing in analyzer assembly.
There is chemical background due to rhenium oxide (m/z 185/187, 201/203, 217/219, 233/235, 250/252)	These series of rhenium oxide ions come from oxidation of the rhenium filament wire due to the introduction of air into the ion source while the filament is on.	Check for air leaks and remedy.
Spectra are observed due to residual cleaning solvents: <ul style="list-style-type: none">• Methanol (m/z 31)• Acetone (m/z 43, 58)• Dichloromethane (m/z 84/83)• Hexane (m/z 85)• Toluene (m/z 91, 92)• Xylene (m/z 105, 106)• Trichloroethane (m/z 151, 153)	<p>There is residual solvent from a cleaning procedure or laboratory background contamination.</p> <p>The observed compounds have been introduced through sample injection. Ultimate source is either a sample solvent or the autosampler rinsing solvent.</p>	<p>When you finish performing a cleaning procedure, allow cleaned components to dry thoroughly. Warm parts in the GC oven to drive off residual solvent.</p> <p>Optimize GC method to separate solvent peak from area of interest in the chromatogram.</p>

Chapter 7

Electronics

This chapter contains the instructions for replacing GCQ *Plus* electronics. Most of the electronics lie just under the outside covers of the GCQ *Plus*, making them easily accessible.

You will find information for the following main topics:

- Fuses
- Replaceable PCBs and Assemblies
- Data System PCBs

7.1 Fuses

Fuses protect the various circuits by opening the circuits whenever overcurrent occurs. Most of the fuses in the GCQ *Plus* are located on the Main System PCB. However, there are several fuses located on the Diffusion Pump Control PCB, keep alive power supply, RF Amplifier PCB, and Power Module. The function and current rating of the various fuses are listed in Table 7-1.

CAUTION: Use only the fuses specified in Table 7-1 or in the Replaceable Parts chapter. Never replace a fuse with a fuse of a different type, voltage, or current rating.

Table 7-1. GCQ Plus Fuses

Location	Fuse	Circuit	Description	PN
Main System PCB	F1	Filament Power	3.15 A, SB, 5 x 20 mm, 250 V	A0006-10510
Main System PCB	F2	Dynode and Multiplier supplies	0.25 A, SB, 5 x 20 mm, 250 V	A0006-11204
Main System PCB	F3	Lens Drivers	0.16 A, SB, 5 x 20 mm, 250 V	A0006-01700
Main System PCB	F4	Lens Drivers	0.16 A, SB, 5 x 20 mm, 250 V	A0006-01700
Main System PCB	F5	Ion Source Heater and CI Gas Solenoid	2.5 A, T-F, 5 x 20 mm, 250 V	A0006-11202
Main System PCB	F6	Filament Control	0.315 A, SB, 5 x 20 mm, 250 V	A0006-04550
Main System PCB	F7	Filament Control	0.315 A, SB, 5 x 20 mm, 250 V	A0006-04550
Main System PCB	F8	RF control	0.4 A, SB, 5 x 20 mm, 250 V	A0006-05080
Main System PCB	F9	RF control	0.4 A, SB, 5 x 20 mm, 250 V	A0006-05080
Main System PCB	F10	Transfer line heater	0.8 A, 5 x 20 mm, 250 V	A0006-06075
Main System PCB	F11	Transfer line heater	1.6 A, 5 x 20 mm, 250 V	A0006-08650
Diffusion Pump Control PCB	F1	Diffusion pump	3.15 A, SB, 5 x 20 mm, 250 V	A0006-10510
Keep alive power supply	F1	12 V	2.0 A, Quick Act, 5 x 20 mm, 250 V	A0006-08806
RF Amplifier PCB	F1	36 V	1.0 A, Quick Act, 5 x 20 mm, 250 V	A0006-07610

Table 7-1. GCQ Plus Fuses (Continued)

Location	Fuse	Circuit	Description	PN
RF Amplifier PCB	F2	28 V	0.5 A, Quick Act, 5 x 20 mm, 250 V	A0006-07608
Voltage Select PCB	F1	Transformer	1.6 A, 5 x 20 mm, 250 V	76703-0516
Voltage Select PCB	F2	Transformer	1.6 A, 5 x 20 mm, 250 V	76703-0516

Replacing a Fuse

Replace a fuse when indicated by the GCQ Diagnostics, by ThermoQuest Technical Support, or by a ThermoQuest Customer Support Engineer.

CAUTION: To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before replacing fuses.

Replacing a fuse on the Main System PCB

To replace a fuse on the main system PCB:

Supplies: Phillips screwdriver

1. Shut down and vent the GCQ *Plus* system (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. If you have a Finnigan GCQ GC or a CE 8000 Top GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and left side covers of the GCQ *Plus* (page 1-12).
4. Remove the RF shield/safety cover on the Main System PCB by disconnecting the three fasteners on top of the cover, disconnecting the ground wires at the cover's front top and bottom, and lifting it up and away from the PCB.

CAUTION: To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

5. Locate and replace the defective fuse on the Main System PCB with a fuse of the same type, voltage, and current rating. See Table 7-1 on page 7-2 for a list of the proper fuses. Figure 7-1 on page 7-5 demonstrates how to replace the fuse.
6. Reinstall the cover on the Main System PCB.
7. Reinstall the left side and top covers of the GCQ *Plus*.
8. If you have a Finnigan GCQ GC or a CE 8000 Top GC, insert the transfer line into the GC (page 1-10).
9. Restart your system (page 1-5).
10. Run GCQ Diagnostics to verify that your system is operational.

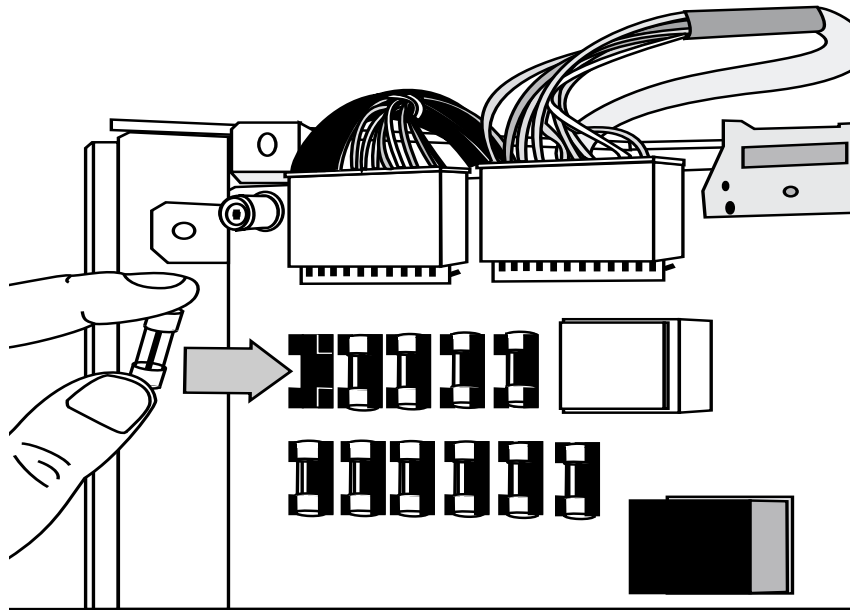


Figure 7-1. Replacing a Fuse on the Main System PCB

Replacing a Fuse on the Diffusion Pump Control PCB

To replace a fuse on the diffusion pump control PCB:

Supplies: Phillips screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. If you have a Finnigan GCQ GC or a CE 8000 Top GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and left side covers of the GCQ *Plus* (page 1-13).
4. Remove the cover to the Diffusion Pump Control PCB. Figure 7-2 shows the location of the Diffusion Pump Control PCB.
5. Replace the defective fuse on the Diffusion Pump Control PCB with a fuse of the same type, voltage, and current rating. Refer to Table 7-1 on page 7-2 for a list of replacement fuses.
6. Reinstall the cover on the Diffusion Pump Control PCB.
7. Reinstall the left side and top covers of the GCQ *Plus*.
8. If you have a Finnigan GCQ GC or a CE 8000 Top GC, insert the transfer line into the GC (page 1-10).
9. Restart your system (page 1-5).
10. Run GCQ Diagnostics to verify that your system is operational.

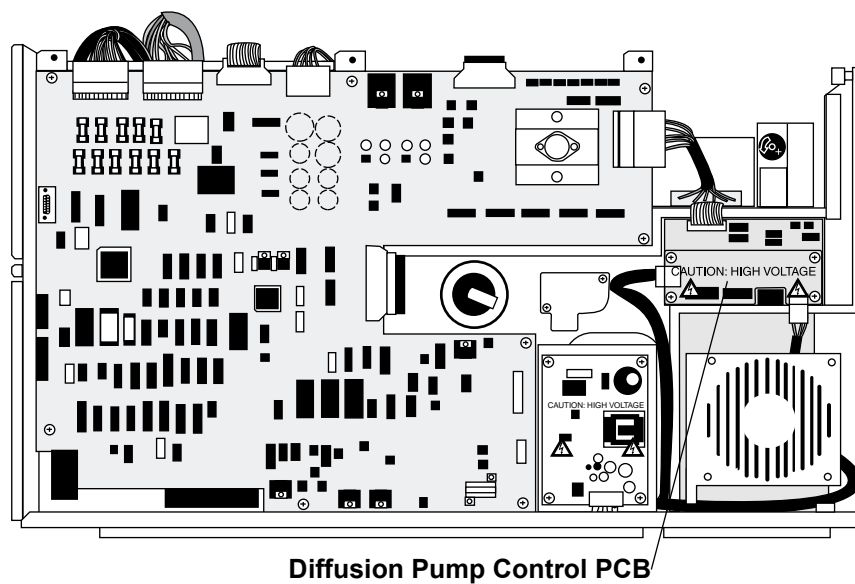


Figure 7-2. Left Side of GCQ Plus with Covers Removed, Showing Diffusion Pump Control PCB

Replacing a Fuse on the Keep Alive Power Supply PCB

To replace a fuse on the keep alive power supply PCB:

Supplies: Phillips screwdriver

1. Shut down and vent the GCQ *Plus* system (page 1-3).
2. If you have a Finnigan GCQ GC or a CE 8000 Top GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and left side covers of the GCQ *Plus* (page 1-13).
4. Remove the cover to the keep alive power supply. Figure 7-3 shows the location of the keep alive power supply.

CAUTION: To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

5. Locate and replace the defective fuse on the keep alive power supply with a fuse of the same type, voltage, and current rating. Refer to Table 7-1 on page 7-2 for a list of replacement fuses.
6. Reinstall the cover of the keep alive power supply.
7. Reinstall the top and left side covers of the GCQ *Plus*.
8. If you have a Finnigan GCQ GC or CE 8000 Top GC, insert the transfer line into the GC (page 1-10).
9. Restart your system (page 1-5).
10. Run GCQ Diagnostics to verify that your system is operational.

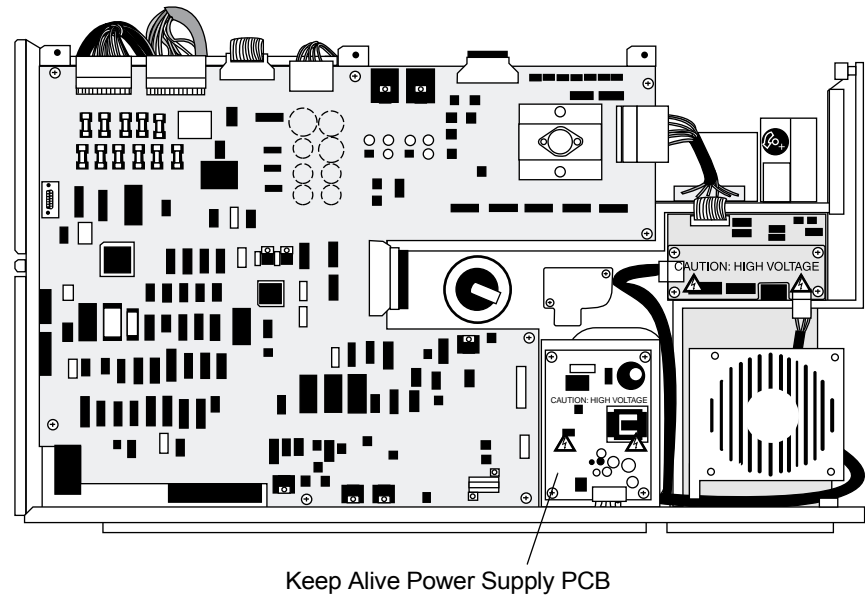


Figure 7-3. Left Side of GCQ Plus with Covers Removed, Showing the Keep Alive Power Supply PCB

Replacing a Fuse on the RF Amplifier PCB

To replace a fuse on the RF amplifier PCB:

Supplies: Phillips Screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).
2. If you have a Finnigan GCQ GC or a CE 8000 Top GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and left side covers of the GCQ *Plus* (page 1-13).
4. Remove the metal cover of the RF Amplifier PCB. Figure 7-4 shows the location of the RF Amplifier PCB.
5. Locate and replace the defective fuse on the RF Amplifier PCB with a fuse of the same type, voltage, and current rating. See Table 7-1 on page 7-2 for a list of replacement fuses.
6. Replace the metal cover of the RF Amplifier PCB.
7. If you have a TRACE GC 2000 or an HP 5890 GC, insert the transfer line into the GC (page 1-10).
8. Reinstall the right side and top covers of the GCQ *Plus*.
9. Restart your system (page 1-5).
10. Run GCQ Diagnostics to verify that your system is operational.

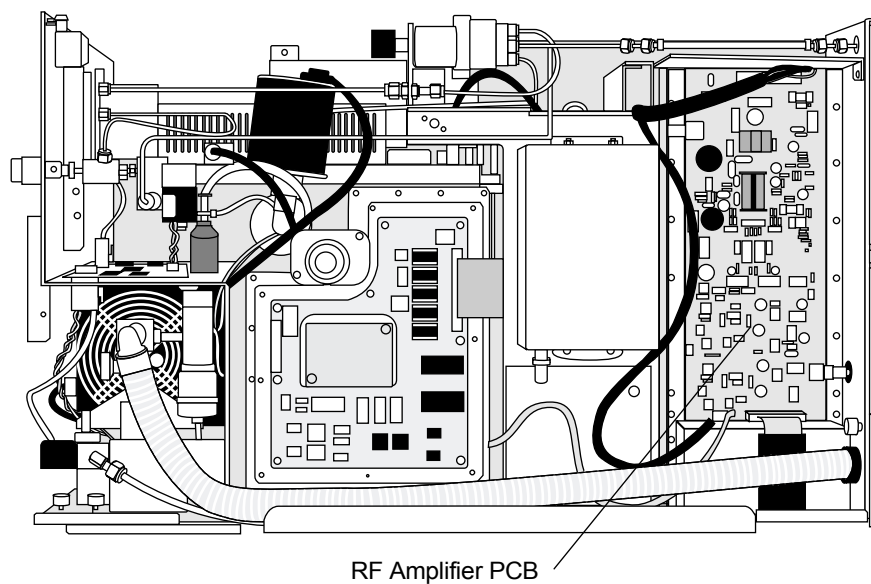


Figure 7-4. Right Side of GCQ Plus with Cover Removed, Showing the RF Amplifier PCB

Replacing a Fuse on the Voltage Select PCB

To replace a fuse on the voltage select PCB:

Supplies: Phillips Screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).
2. Remove the top and left side covers of the GCQ *Plus* (page 1-12).
3. Remove the cover of the Voltage Select PCB. Figure 7-5 on page 7-13 shows the location of the Vent Control PCB.

CAUTION: To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

4. Locate and replace the defective fuse on the Voltage Select PCB with a fuse of the same type, voltage, and current rating. For a list of proper fuses, see Table 7-1 on page 7-2.
5. Replace the cover on the Voltage Select PCB.
6. Reinstall the top cover of the GCQ *Plus*.
7. Restart your system (page 1-5).
8. Run GCQ Diagnostics to verify that your system is operational.

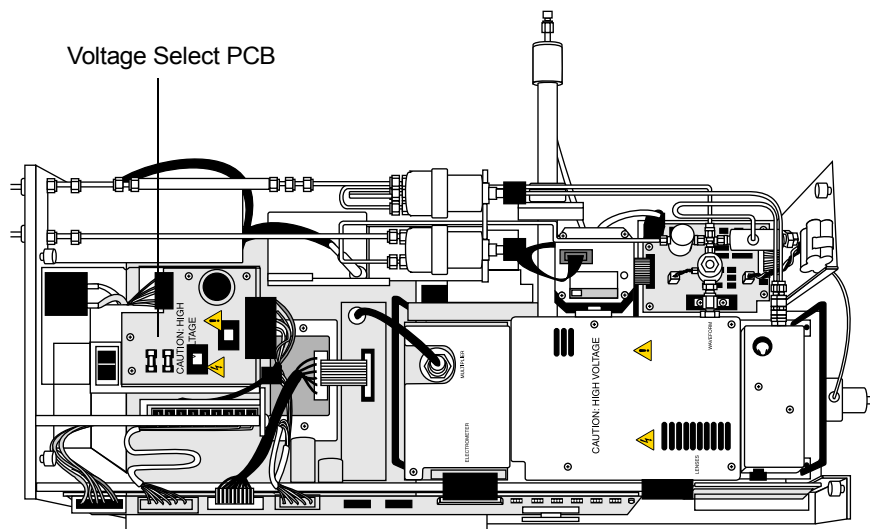


Figure 7-5. Top of GCQ Plus, Showing the Voltage Select PCB

7.2 Replaceable PCBs and Assemblies

This section contains instructions for replacing the following:

- PCBs and Assemblies Accessible from the Top of the Instrument
- PCBs and Assemblies Accessible from the Left Side of the Instrument
- PCBs and Assemblies Accessible from the Right Side of the Instrument

PCBs and Assemblies Accessible from the Top of the Instrument

Replace PCBs when indicated by GCQ Diagnostics. The following PCBs and assemblies are accessible from the top of the GCQ *Plus*, and are shown in Figure 7-6.

- Analyzer PCB
- Vent Control PCB
- Battery pack
- Ion gauge
- Gas inlet assembly
- CI reagent gas pressure regulator
- Helium gas pressure regulator
- Vent valve solenoid

CAUTION: To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

Note: If you are replacing a PCB, be sure to retain the packaging materials to return the defective part to ThermoQuest Austin.

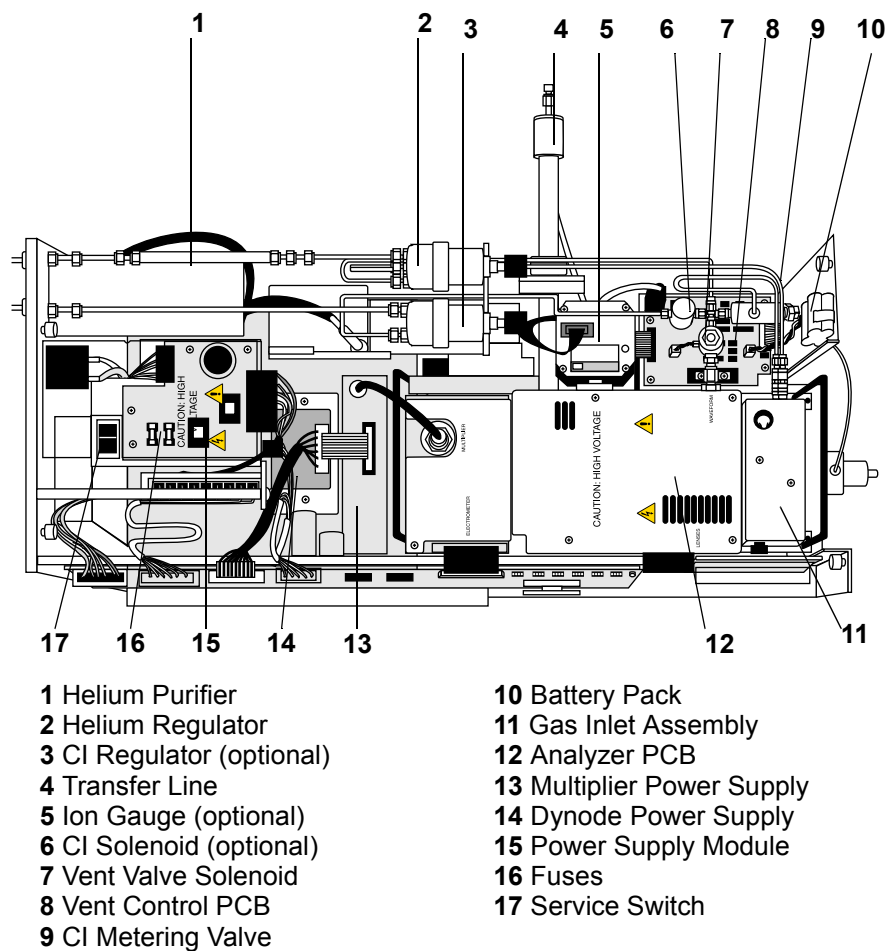


Figure 7-6. Replaceable Parts Accessible from the Top of the GCQ Plus

Removing the Analyzer PCB

To remove the Analyzer PCB:

Supplies: Phillips Screwdriver

1. Shut down and vent the GCQ Plus (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. Remove the top cover of the GCQ Plus (page 1-12).
3. Disconnect the electrical cables from the connectors labeled LENSES, ELECTROMETER, MULTIPLIER, and WAVEFORM on the metal cover of the Analyzer PCB. Remove the cover.
4. Disconnect the electrical cable that comes from the calibration gas valve assembly.
5. Unscrew and remove the six standoffs and two screws that hold the Analyzer PCB to the vacuum manifold top cover plate. Unseat and remove the PCB. See Figure 7-7 for the location of the Analyzer PCB.

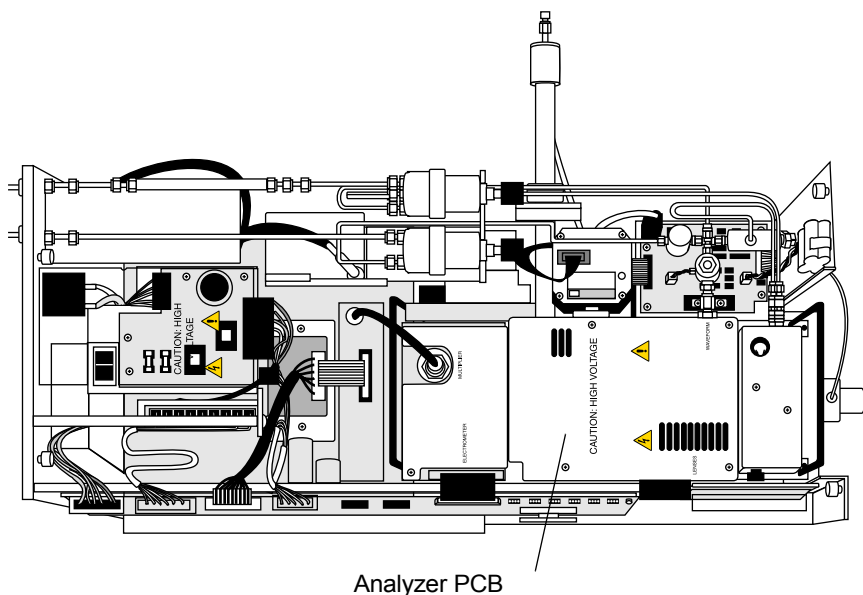


Figure 7-7. GCQ Plus with Top Cover Removed, Showing the Analyzer PCB

Reinstalling the Analyzer PCB

To replace the Analyzer PCB:

Supplies: Phillips Screwdriver, Analyzer PCB (PN 96000-61020)

1. Position the new Analyzer PCB on the vacuum manifold top cover plate. Align the two holes in the corners of the PCB with the guide pins on the vacuum manifold top cover plate. Carefully seat the Analyzer PCB into the eight-pin feedthroughs on the top cover plate.
2. Reinstall the two screws and six standoffs that hold the Analyzer PCB to the vacuum manifold top cover plate.
3. Reconnect the electrical cable that comes from the calibration gas valve assembly. Position the metal cover on the Analyzer PCB. Reinstall the six screws that hold the cover to the standoffs.
4. Reconnect the electrical cables to the connectors labeled LENSES, ELECTROMETER, MULTIPLIER, and WAVEFORM on the cover of the Analyzer PCB.
5. Reinstall the top cover of the GCQ Plus.
6. Restart your system (page 1-5).
7. Run GCQ Diagnostics to verify that your system is operational.

Removing the Vent Control PCB

To remove the Vent Control PCB:

Supplies: Phillips Screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. Remove the top cover of the GCQ *Plus* (page 1-12).
3. Disconnect the following:
 - The electrical cable (at P3) that comes from the battery pack
 - The electrical cable (at J1) that comes from the Front Panel PCB
 - The electrical cable (at P2) that comes from the vent valve solenoid
 - The electrical cable (at P1) that comes from the Main System PCB
 - The electrical cable that comes from the inlet valve solenoid on the underside of the PCB (if you have the inlet valve option)
 - The electrical cable (from the connector on the underside of the PCB) that comes from the convectron gauge
4. Remove the Vent Control PCB. Figure 7-8 shows the location of the Vent Control PCB.

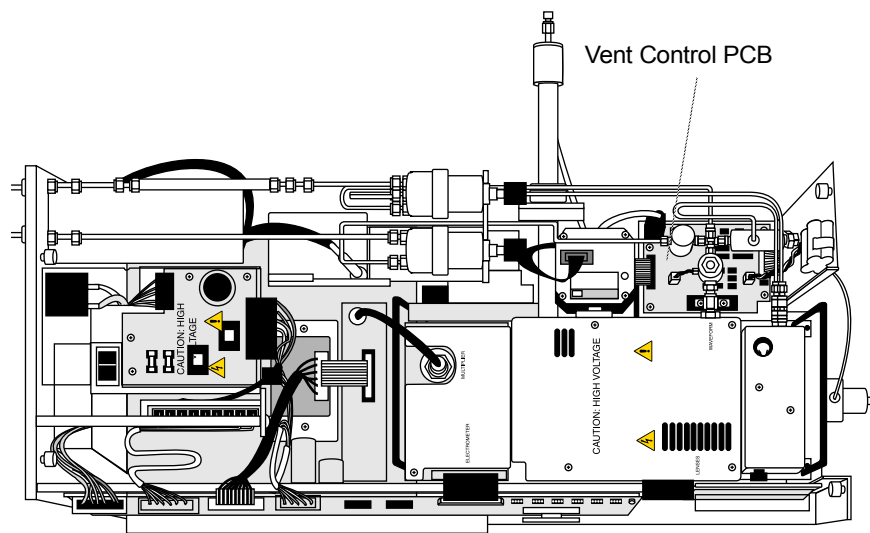


Figure 7-8. GCQ Plus with Top Cover Removed

Reinstalling the Vent Control PCB

To replace the Vent Control PCB:

Supplies: Phillips Screwdriver, Vent Control PCB (PN 96000-61040)

1. Install the new Vent Control PCB.
2. Reinstall the electrical cables.
3. Reinstall the top cover of the GCQ Plus.
4. Restart your system (page 1-5).
5. Run GCQ Diagnostics to verify that your system is operational.

Replacing the Battery Pack

To replace the battery pack:

Supplies: Battery Pack (PN 96000-98018)

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. Remove the top cover of the GCQ *Plus* (page 1-12).
3. Remove the battery pack. See Figure 7-9 for the location of the battery pack.
4. Reconnect the electrical cable from the battery pack to the Vent Control PCB.
5. Reinstall the top cover of the GCQ *Plus*.
6. Restart your system (page 1-5).
7. Run GCQ Diagnostics to verify that your system is operational.

Replacing the Optional Ion Gauge

To replace the ion gauge:

Supplies: Phillips Screwdriver, ion gauge (PN A0105-01520)

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. Remove the top cover of the GCQ *Plus* (page 1-12).
3. Disconnect the electrical cable on the ion gauge that comes from the Main System PCB.

4. Remove the two screws that hold the ion gauge collar to the vacuum manifold. See Figure 7-9 on page 7-21 for the location of the ion gauge. While holding the ion gauge, remove the whole flange collar. Tilt the ion gauge outward and remove it, taking care that the O-ring does not fall down into the instrument chassis. If you have to touch the O-ring, wear clean lint-free gloves.
5. Install the new ion gauge. Reinstall the two screws that hold the ion gauge to the vacuum manifold.
6. Reconnect the electrical cable that comes from the Main System PCB.
7. Reinstall the top cover of the GCQ Plus.
8. Restart your system (page 1-5).

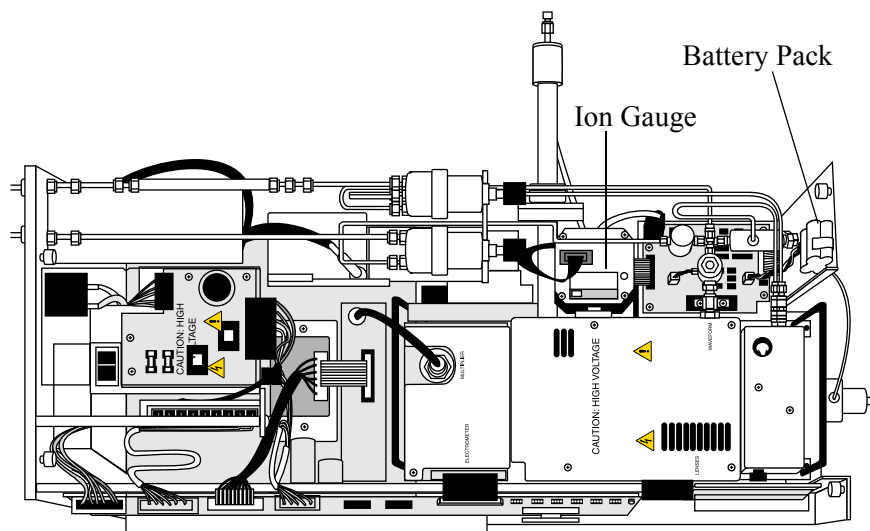


Figure 7-9. GCQ Plus with Top Cover Removed, Showing the Ion Gauge and Battery Pack

Removing the Gas Inlet Assembly

To remove the gas inlet assembly:

Supplies: Phillips Screwdriver, 7/16-in. open-ended wrench

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.
--

2. Remove the top cover of the GCQ *Plus* (page 1-12).
3. Disconnect the helium damping and CI reagent gas lines:
 - a. With your left hand, pull the knurled ring on the quick-release fitting to the left (away from the gas line) and hold it there.
 - b. With your right hand, disconnect the gas line by pulling it to the right (away from the fitting).
 - c. Release the knurled ring.
4. Remove the cover of the Analyzer PCB. Disconnect the electrical cable to the Analyzer PCB.
5. Remove the gas inlet assembly cover plate. See Figure 7-10 for the location of the gas inlet assembly.
6. Disconnect the CI reagent gas and helium gas lines from the manifold side of the quick-connect fittings. Disconnect the calibration compound gas line from the fitting near the CI reagent gas and helium gas line fittings. Leave the tubing in place.
7. Remove the calibration gas inlet assembly from the vacuum manifold top cover plate.

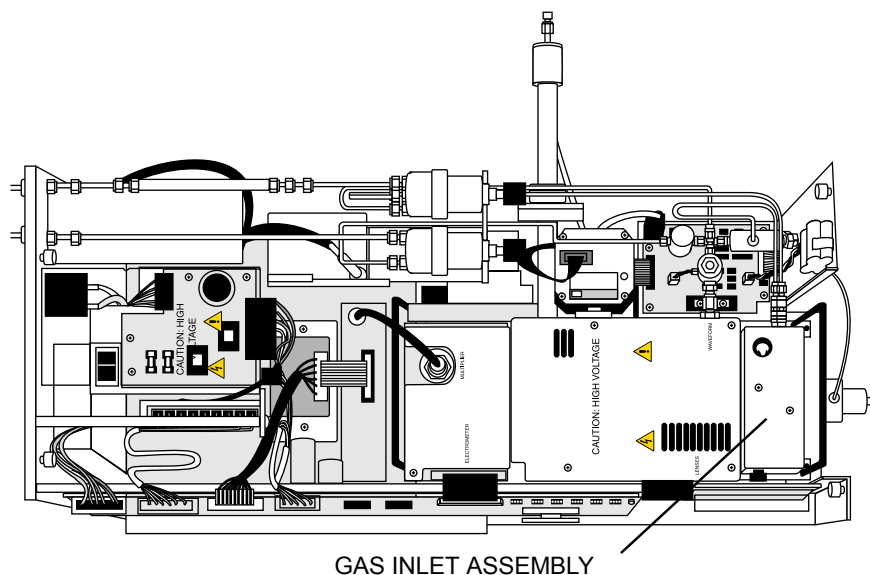


Figure 7-10. GCQ Plus with Top Cover Removed, Showing the Location of Gas Inlet Assembly

Reinstalling the Gas Inlet Assembly

To replace the gas inlet assembly:

Supplies: Phillips Screwdriver, 7/16-in. open-ended wrench, gas inlet assembly (PN 96000-62061)

1. Install the gas inlet assembly on the vacuum manifold top cover plate.
2. Reconnect the calibration compound, optional CI reagent gas, and helium gas lines to their fittings.
3. Replace the gas inlet assembly cover plate.
4. Reconnect the electrical cable to the Analyzer PCB.
5. Reconnect the optional CI reagent and helium damping gas lines.
6. Reinstall the top cover of the GCQ Plus.
7. Restart your system (page 1-5).

Replacing the CI Reagent Gas Pressure Regulator

To replace the CI gas pressure regulator:

Supplies: 7/16-in. and 11/16-in open-ended wrenches, CI reagent gas pressure regulator (PN A0105-03520).

Note: It is not necessary to shut down and vent your system to replace the CI reagent gas pressure regulator. However, ensure that the CI reagent gas solenoid valve is closed before servicing the CI reagent gas pressure regulator

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. Remove the top cover of the GCQ *Plus* (page 1-12).
3. Disconnect the two gas line fittings to the CI reagent gas pressure regulator. See Figure 7-11 for the location of the CI and Helium regulators.
4. Loosen the nut that holds the CI reagent gas pressure regulator to the GCQ *Plus* chassis. Remove the pressure regulator and replace it with a new one. Tighten the nut that holds the CI reagent gas pressure regulator to the GCQ *Plus* chassis.
5. Reconnect the gas line fittings to the CI reagent gas pressure regulator.
6. Reinstall the top cover of the GCQ *Plus*.
7. Restart your system (page 1-5).

Replacing the Helium Gas Pressure Regulator

To replace the helium pressure regulator:

Supplies: 7/16-in. and 11/16-in open-ended wrenches, helium gas pressure regulator (PN A0105-03010)

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. Remove the top cover of the GCQ *Plus* (page 1-12).

3. Disconnect the gas line fittings to the helium gas pressure regulator. Figure 7-11 shows gas lines.
4. Loosen the nut that holds the helium gas pressure regulator to the GCQ *Plus* chassis. Remove the pressure regulator and replace it with a new one. Tighten the nut that holds the helium gas pressure regulator to the GCQ *Plus* chassis.
5. Reconnect the gas line fittings to the helium gas pressure regulator.
6. Purge the regulator of air and water by pressurizing the supply line with helium, then gently pressing the tip of the male end of the helium quick-connect with the flat side of a screwdriver blade. Allow helium to purge for several minutes.
7. Reinstall the top cover of the GCQ *Plus*.
8. Restart your system (page 1-5).

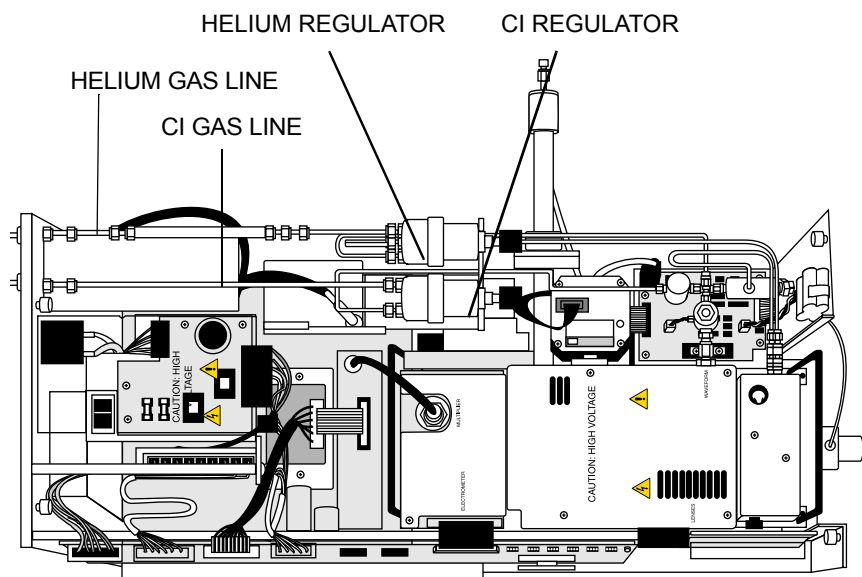


Figure 7-11. CI and Helium Regulators

Replacing the Vent Valve Solenoid

To replace the vent valve solenoid:

Supplies: Vent valve solenoid (PN 96000-60059), 7/16-in. open-ended wrench

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. Remove the top cover of the GCQ *Plus* (page 1-12).
3. Disconnect the electrical cable to the Vent Control PCB (at P2).
4. Disconnect the two gas line fittings to the vent valve solenoid. Remove the solenoid and replace it with a new one. See Figure 7-12 for the location of the vent valve solenoid.
5. Reconnect the two gas line fittings to the vent valve solenoid. Reconnect the electrical cable to the Vent Control PCB (at P2).
6. Reinstall the top cover of the GCQ *Plus*.
7. Restart your system (page 1-5).
8. Run GCQ Diagnostics to verify that your system is operational.

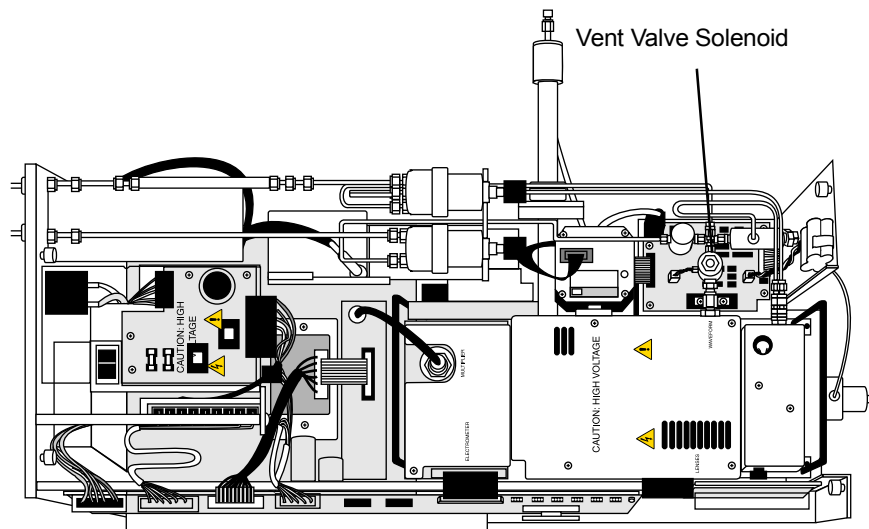


Figure 7-12. GCQ Plus with Top Cover Removed, Showing Vent Valve Solenoid

PCBs and Assemblies Accessible from the Left Side of the Instrument

Replace PCBs as indicated by GCQ Diagnostics. The components which are accessible from the left side of the GCQ *Plus* or require removal of the left side cover for replacement and are shown in Figure 7-13:

- Main System PCB
- Diffusion or Turbo Pump Control PCB
- Keep Alive Power Supply
- Electron Multiplier and Conversion Dynode Power Supplies
- Transfer line (systems with a Finnigan GCQ GC or CE 8000 Top GC)

Note: If you are replacing a PCB, retain the packing materials to return the defective part to ThermoQuest in Austin.

CAUTION: Prevent damage to the electronics by attaching an electrostatic discharge (ESD) strap to your wrist before continuing.

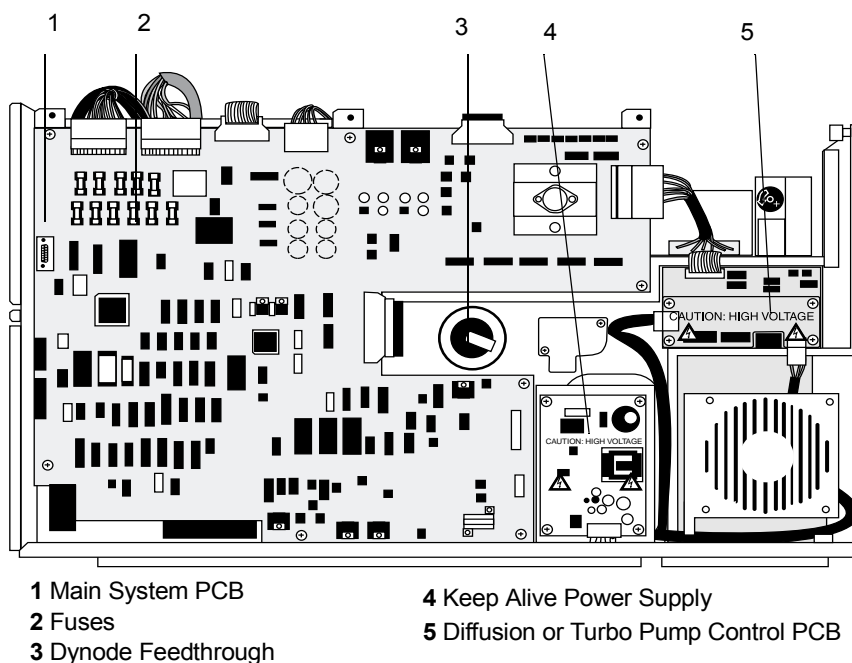


Figure 7-13. Left Side View

Removing the Main System PCB

To remove the main system PCB:

Supplies: Phillips Screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.
--

2. If you have a Finnigan GCQ GC, or CE 8000 Top GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and left side covers of the GCQ *Plus* (page 1-12).
4. Remove the cover on the Main System PCB:
 - a. Pull out the three fasteners on top of the cover
 - b. Disconnect the two ground wires from the cover
 - c. Lift the cover up and away from the PCB.
5. Disconnect all cables to the Main System PCB Figure 7-14 shows the PCB with the cover removed. The following cables are connected to the Main System PCB:
 - Transformer (P1)
 - Switching power supply (P2)
 - Conversion dynode/electron multiplier power supplies (P3)
 - Transfer line (P4)
 - Electrometer (P5)
 - RF Control PCB (P8)
 - Analyzer (P6)
 - Vent Control PCB and Diffusion/turbomolecular Control PCB (P9)
 - Ion gauge (P10) (if you have this option)
 - RF Amplifier PCB/Waveform Amplifier PCB (P11)
6. Disconnect the data system cable from the rear of the GCQ *Plus*. Disconnect any cable connected to the REMOTE port.

7. Loosen the eight fasteners that hold the Main System PCB to the GCQ *Plus* chassis.
8. Slide the Main System PCB toward the front of the GCQ *Plus* by 1.25 cm (0.5 in.) so that it clears the data system cable connector. Carefully lift the Main System PCB up and away from the GCQ *Plus*.

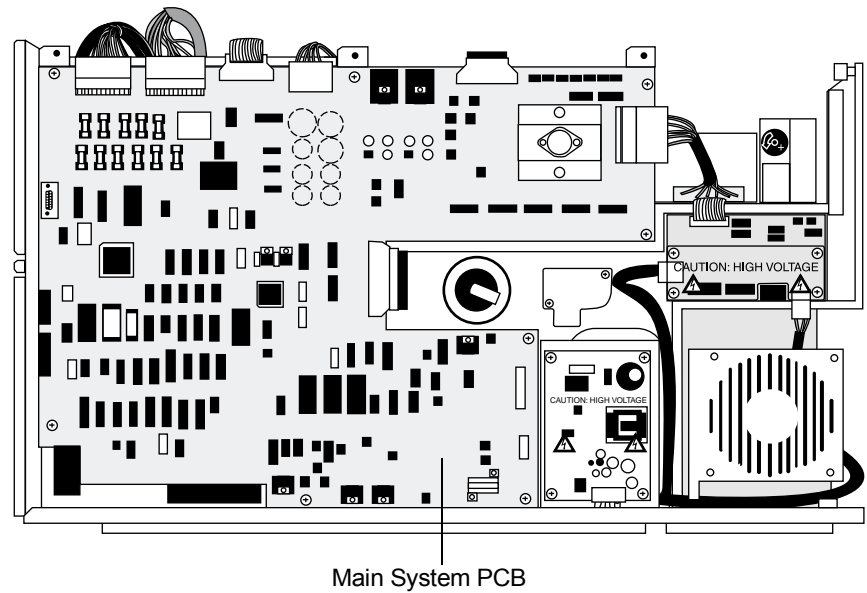


Figure 7-14. Left Side View, Showing Main System PCB.

Replacing the Main System PCB

To replace the main system PCB:

Supplies: Phillips Screwdriver, Main System PCB (PN 96000-61160)

1. Install the new Main System PCB.
2. Reconnect the data system cable and remote start cable.
3. Reconnect the cables to the Main System PCB.
4. Reinstall the cover on the Main System PCB.
5. Reinstall the left side and top covers of the GCQ *Plus*.
6. If you have a Finnigan GCQ GC, or CE 8000 Top GC, insert the transfer line into the GC (page 1-10).
7. Restart your system (page 1-5).
8. Run GCQ Diagnostics to verify that your system is operational.

Removing the Diffusion Pump Control PCB

To remove the diffusion pump control PCB:

Supplies: Phillips Screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. If you have a Finnigan GCQ GC, or CE 8000 Top GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and left side covers of the GCQ *Plus* (page 1-12). Note the exposed the Diffusion Pump Control PCB (Figure 7-15).
4. Disconnect the following:
 - the electrical cable (at J1) to the Main System PCB and Vent Control PCB
 - the electrical cable (at P2) to the keep alive power supply
 - the electrical cable (at P1) to the diffusion pump and main ac power
5. Remove the two screws underneath the PCB (above the fan) that hold the

sheet metal back for the Diffusion Pump Control PCB.

6. Remove the Diffusion Pump Control PCB and sheet metal mounting assembly from the GCQ *Plus* chassis.

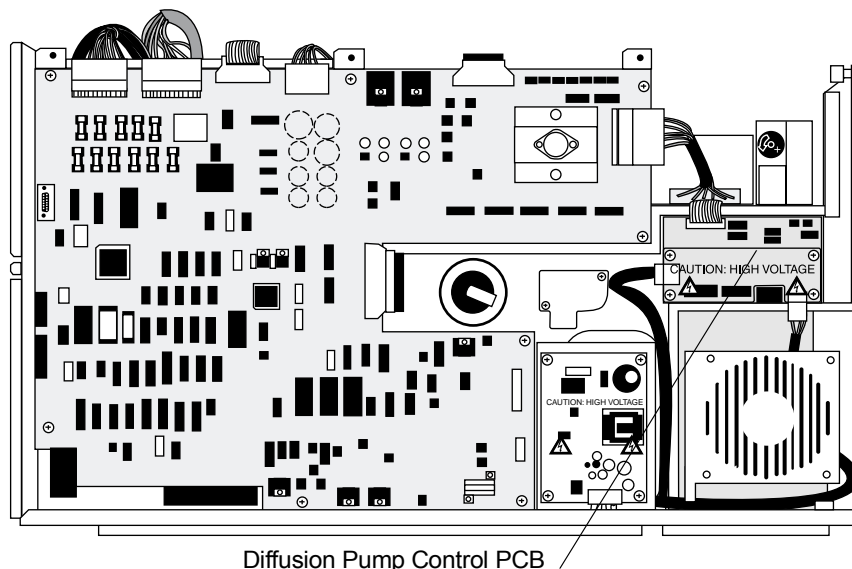


Figure 7-15. Left Side View, Showing Diffusion Pump Controller

Reinstalling the Diffusion Pump Control PCB

To replace the diffusion pump control PCB:

Supplies: Phillips Screwdriver, Diffusion Pump Control PCB (PN: 96000-60177[110V] or 96000-60277 [220V])

1. Install the new Diffusion Pump Control PCB.
2. Reinstall the two screws under the PCB that secure the sheet metal to the mounting assembly.
3. Reconnect the electrical cables.
4. Reinstall the left side and top covers of the GCQ *Plus*.
5. If you have a Finnigan GCQ GC or CE 8000 Top GC, insert the transfer line into the GC (page 1-10).
6. Restart your system as described on page 1-5.

Removing the Turbomolecular Pump Control PCB

To remove the turbo pump control PCB:

Supplies: Phillips Screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. If you have a Finnigan GCQ GC, or CE 8000 Top GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and left side covers of the GCQ *Plus* (page 1-12).
4. Remove the cover to the Turbomolecular Pump Control PCB. See Figure 7-16 for the location of the Turbomolecular Pump Control PCB.
5. Disconnect the following:
 - electrical cable (at P2) to the Main System PCB and Vent Control PCB
 - electrical cable (at P1) to the keep alive power supply
 - electrical cable (at P3) to the turbomolecular pump controller
6. Unscrew and remove the four standoffs. Remove the Turbomolecular Pump Control PCB.

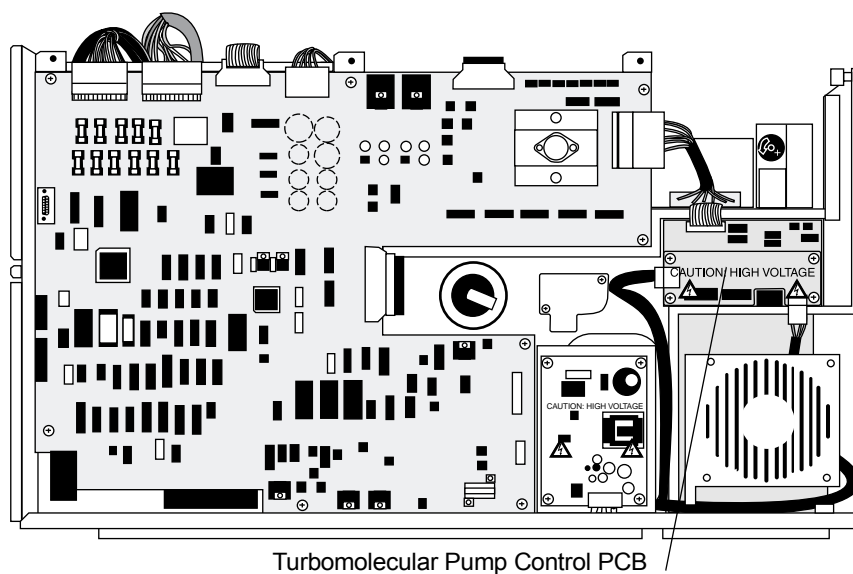


Figure 7-16. Left Side View, Showing Turbo Pump Control PCB

Reinstalling the Turbomolecular Pump Control PCB

To replace the turbo pump control PCB:

Supplies: Phillips Screwdriver, Turbomolecular Pump Control PCB (PN 119560-0001)

1. Install the Turbomolecular Pump PCB. Install the two standoffs and two screws.
2. Reconnect the electrical cables.
3. Reinstall the cover over the Turbomolecular Pump Control PCB.
4. Reinstall the left side and top covers of the GCQ Plus.
5. If you have a Finnigan GCQ GC or CE 8000 Top GC, insert the transfer line (page 1-10).
6. Restart your system (page 1-5).

Removing the Keep Alive Power Supply

To remove the keep alive power supply:

Supplies: Phillips Screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.
--

2. If you have a Finnigan GCQ GC, or CE 8000 Top GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and left side covers of the GCQ *Plus* (page 1-12).
4. Remove the cover to the keep alive power supply. Figure 7-17 shows the location of the Keep Alive Power Supply.
5. Disconnect the electrical cable that comes from the Diffusion/Turbomolecular Pump Control PCB.
6. Unscrew and remove the four standoffs. Remove the keep alive power supply.

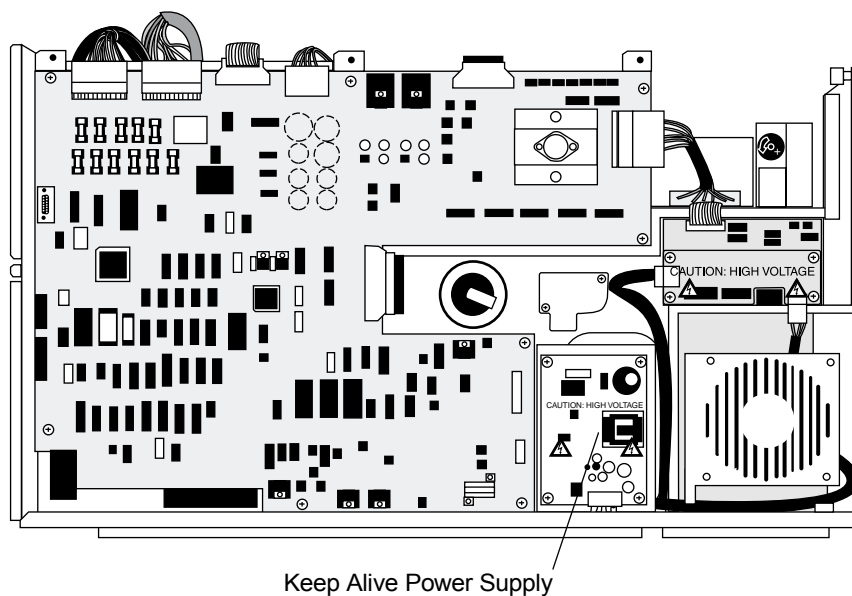


Figure 7-17. Left Side View, Showing Keep Alive Power Supply PCB

Reinstalling the Keep Alive Power Supply

To replace the keep alive power supply:

Supplies: Keep Alive Power Supply (PN A0012-24210), Phillips screwdriver

1. Install the new Keep Alive Power Supply. Reinstall the four standoffs to hold the keep alive power supply to the vacuum manifold.
2. Reconnect the electrical cable that comes from the Diffusion/Turbomolecular Pump Control PCB.
3. Reinstall the keep alive power supply cover.
4. Reinstall the left side and top covers of the GCQ Plus.
5. If you have a Finnigan GCQ GC or CE 8000 Top GC, insert the transfer line into the GC (page 1-10).
6. Restart your system. See instructions on page 1-5.
7. Run GCQ Diagnostics to verify that your system is operational.

Removing the Conversion Dynode and Electron Multiplier Power Supplies

To remove the conversion dynode and electron multiplier power supplies:

Supplies: Phillips Screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. If you have a Finnigan GCQ GC, or CE 8000 Top GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and left side covers of the GCQ *Plus* (page 1-12).
4. Disconnect the electrical cable that connects the Main System PCB (P4 connector) to the Power Module.
5. Disconnect the (black) conversion dynode high voltage cable at the conversion dynode feedthrough by pulling it free from the feedthrough.
6. Disconnect the electrical cable that comes from the Main System PCB (P3 connector) from the top of the electron multiplier and conversion dynode power supplies.
7. Remove the electron multiplier and conversion dynode power supplies from the GCQ *Plus*.

Reinstalling the Conversion Dynode and Electron Multiplier Power Supplies

To replace the conversion dynode and electron multiplier power supplies:

Supplies: Phillips Screwdriver, electron multiplier/conversion dynode power supply unit (PN 96000-60078)

1. Install the new electron multiplier and conversion dynode power supplies.
2. Connect the electrical cable that comes from the Main System PCB (P3 connector) to the electron multiplier and conversion dynode power supplies.
3. Connect the (black) conversion dynode high voltage cable to the conversion dynode feedthrough.
4. Connect the electrical cable that comes from the Main System PCB (P4 connector) to the Power Module.
5. Reinstall the left side and top covers of the GCQ *Plus* (page 1-12).
6. Insert the transfer line into the GC (page 1-10).
7. Restart your system (page 1-5).
8. Run GCQ Diagnostics to verify that your system is operational.

Replacing the Transfer Line on Systems with a Finnigan GCQ GC or CE 8000 Top GC

To replace a transfer line with a Finnigan GCQ GC or 8000 Top GC:

Supplies: Phillips Screwdriver, open-end wrench, Transfer Line
(PN 96000-60064 [GCQ GC] or 96000-60065 [CE 8000 Top])

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. Move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and left side covers of the GCQ *Plus* (page 1-12).
4. Loosen the swagelok nut on the GC end of the transfer line. Withdraw the capillary column from the transfer line.
5. Disconnect the transfer line heater/sensor cable.
6. Loosen the vacuum seal nut that secures the transfer line to the inlet flange. Withdraw the transfer line from the vacuum manifold.
7. Install the capillary column into the new transfer line (page 1-8).
8. Insert the transfer line into the GCQ *Plus* until the tip of the transfer line seats in the ion source block. Tighten the vacuum seal nut.
9. Reconnect the transfer line heater/sensor cable.
10. Reinstall the left side and top covers of the GCQ *Plus* (page 1-12).
11. Insert the transfer line into the GC (page 1-10).
12. Restart your system (page 1-5), then run GCQ Diagnostics to verify that your system is operational.

PCBs and Assemblies Accessible from the Right Side of the Instrument

The following components are accessible from the right side of the GCQ *Plus* or require the removal of the right side cover for replacement.

- Power Module
- RF Amplifier PCB
- Waveform Amplifier PCB
- RF Control PCB
- Low Pass Filter PCB
- Convectron gauge (and foreline adapter)
- Transfer line (TRACE GC 2000 or a Hewlett-Packard GC)

CAUTION: To prevent damage from static discharge, wear an ESD (electrostatic discharge) strap on your wrist.

Note: Reuse packing materials to return defective PCBs to ThermoQuest.

Figure 7-18 shows some of the parts replaceable from the right side of the GCQ *Plus*. The power module is shown in Figure 7-19 on page 7-41. The transfer line is shown in Figure 7-25 on page 7-53.

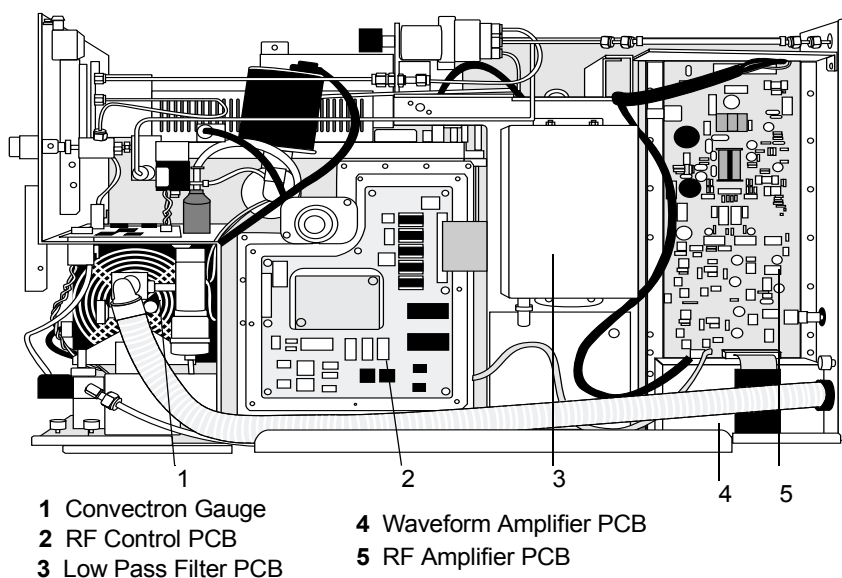


Figure 7-18. GCQ Plus with Right Cover Removed

Replacing the Power Module

To replace the power module:

Supplies: Phillips screwdriver, Power module (PN 96000-60062 [110 V] or 96000-60070 [220 V])

WARNING: Disconnect the power cord before proceeding.

1. Shut down and vent the GCQ *Plus* (page 1-3).
2. If you have a TRACE GC 2000 or a Hewlett-Packard GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and right side covers (page 1-12).
4. Disconnect the following:
 - a. the electrical lead to the fan at the rear of the instrument. The connector is located in the left, rear area of the Power Module.
 - b. the two electrical cables to the Main System PCB at connectors P1 and P2 on the Main System PCB
 - c. the cable that comes from the Main System PCB (P4 connector) from the front of the Power Module
 - d. the electrical cable that comes from the Power Module to the RF Amplifier PCB at the Amplifier end (connector J3)
 - e. the electrical cable that comes from the Power Module to the Waveform Amplifier PCB at the Amplifier end (connector J1)
5. Remove the Power Module (shown in Figure 7-19) by its handle. Replace it with a new one.
6. Reconnect the cables that you disconnected in step 4.
7. Reinstall the right side and top covers of the GCQ *Plus* (page 1-12).
8. If you have a TRACE GC 2000 or a Hewlett-Packard GC, insert the transfer line into the GC (page 1-10).
9. Restart your system (page 1-5).
10. Run GCQ Diagnostics to verify that your system is operational.

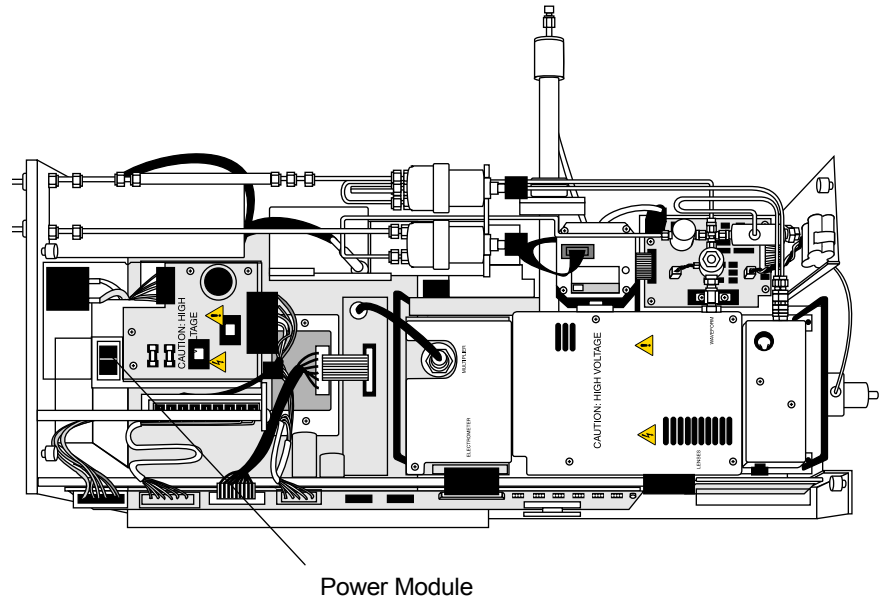


Figure 7-19. GCQ Plus with Top Cover Removed, Showing the Power Module

Removing the RF Amplifier PCB

To remove the RF amplifier PCB:

Supplies: Phillips screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.
--

2. If you have a TRACE GC 2000 or a Hewlett-Packard GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and right side covers (page 1-12). The RF Amplifier PCB is exposed (Figure 7-20).
4. Disconnect the following connections to the RF Amplifier PCB:
 - the electrical cable (at J3) that comes from the Power Module
 - the cable (at P1) that comes from the RF Control PCB
 - the cable (at P2) that comes from the Waveform Amplifier PCB
 - the coaxial cable (top) that comes from the Low Pass Filter PCB
 - the yellow Main RF coaxial cable from the rear of the GCQ *Plus*
5. Remove the metal cover to expose the RF Amplifier PCB.
6. Remove the RF Amplifier PCB and its heat sink as a unit.

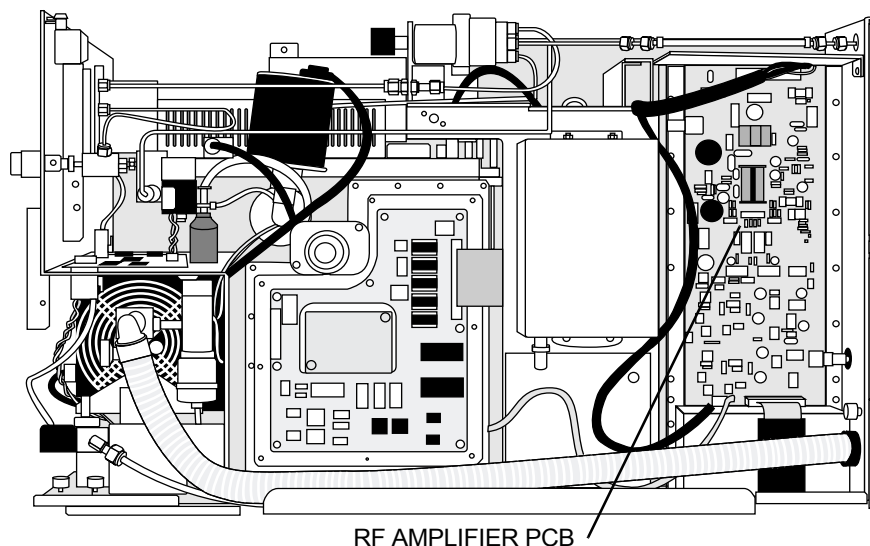


Figure 7-20. RF Amplifier PCB

Reinstalling the RF Amplifier PCB

To replace the RF amplifier PCB:

Supplies: Phillips screwdriver, RF Amplifier PCB (PN 96000-61090)

1. Install the new RF Amplifier PCB.
2. Reinstall the metal cover over the RF Amplifier PCB.
3. Reconnect the cables you disconnected when removing the PCB.
4. Reinstall the right side and top covers of the GCQ Plus (page 1-12).
5. If you have a TRACE GC 2000 or a Hewlett-Packard GC, insert the transfer line into the GC (page 1-10).
6. Restart your system (page 1-5).
7. Run GCQ Diagnostics to verify that your system is operational.

Removing the Waveform Amplifier PCB

To remove the waveform amplifier PCB:

Supplies: Phillips screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.
--

2. If you have a TRACE GC 2000 or a Hewlett-Packard GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and right side covers (page 1-12).
4. Loosen the fastener that holds the hose clamp bracket to the GCQ *Plus* chassis. Remove the hose clamp screw that connects to the hose bracket ground wire. Pull the hose and hose clamp bracket away from the instrument chassis.
5. Disconnect the following:
 - the electrical cable (at P1) that comes from the Main System PCB and RF Amplifier PCB
 - the electrical cable (at J1) that comes from the Power Module
 - the black coaxial cable that comes from the Analyzer PCB
 - the red and blue coaxial cables from the BNC connectors labeled *Aux RF* and *Waveform* on the back of the GCQ *Plus*
6. Remove the metal cover of the Waveform Amplifier PCB, which is shown in Figure 7-21.
7. Remove the Waveform Amplifier and its heat sink as a unit.

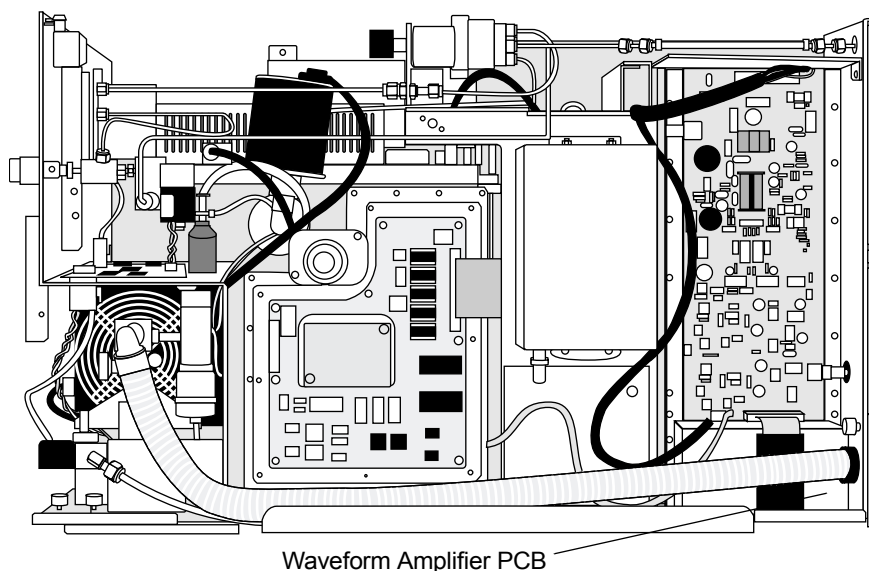


Figure 7-21. Right Side View, Showing the Waveform Amplifier PCB.

Reinstalling the Waveform Amplifier PCB

To replace the waveform amplifier PCB:

Supplies: Waveform Amplifier PCB (PN 96000-61110), Phillips Screwdriver

1. Install the new Waveform Amplifier PCB and heat sink.
2. Reinstall the metal cover over the Waveform Amplifier PCB.
3. Reconnect the cables that you disconnected when removing the PCB.
4. Reinstall the hose clamp bracket onto the GCQ *Plus* chassis in its original position, then tighten the fastener.
5. Reinstall the right side and top covers of the GCQ *Plus*.
6. If you have a TRACE GC 2000 or a Hewlett-Packard GC, insert the transfer line into the GC (page 1-10).
7. Restart your system (page 1-5).

Removing the RF Control PCB and Housing

To remove the RF control PCB and housing:

Supplies: Phillips screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.
--

2. If you have a TRACE GC 2000 or a Hewlett-Packard GC move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and right side covers (page 1-12).
4. Disconnect the cable that comes from the RF Amplifier PCB.
5. Remove the front cover of the RF Control PCB. There are nine screws. Figure 7-22 shows the location of the RF Amplifier PCB.
6. Disconnect (at P1) the cable that comes from the Main System PCB.
7. Remove the 21 screws that hold the RF Control PCB housing to the vacuum manifold. Remove the RF Control PCB and its housing as a unit. Reinstall the cover plate on the housing.

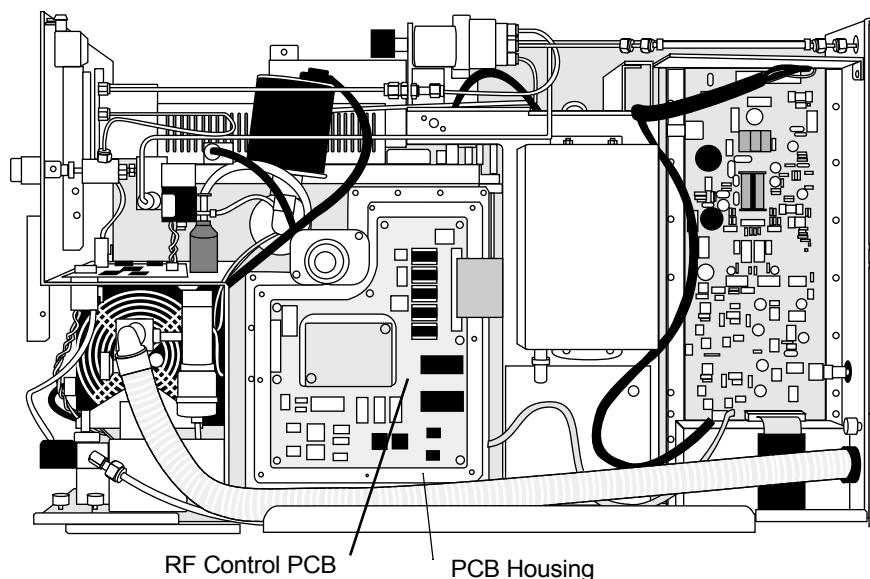


Figure 7-22. Right Side of GCQ Plus Showing RF Control PCB

Reinstalling the RF Control PCB and Housing

To replace the RF control PCB and housing:

Supplies: Phillips Screwdriver, RF Control PCB (PN 96000-60074)

1. Position the new RF Control PCB and its housing against the vacuum manifold where the old assembly was located. Reinstall the 21 screws that hold the RF Control PCB housing to the vacuum manifold.
2. Remove the front cover of the RF Control PCB housing.
3. Reconnect the cable that comes from the Main System PCB.
4. Position the front cover over the RF Control PCB. Reinstall the eight screws that hold the front cover to the RF Control PCB housing.
5. Reconnect the cable that comes from the RF Amplifier PCB.
6. Reinstall the right side and top covers of the GCQ Plus.
7. If you have a TRACE GC 2000 or a Hewlett-Packard GC, insert the transfer line into the GC (page 1-10).
8. Restart your system (page 1-5).

Removing the Low Pass Filter PCB

To remove the low pass filter PCB:

Supplies: Phillips screwdriver

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. If you have a TRACE GC 2000 or a Hewlett-Packard GC move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and right side covers (page 1-12).
4. Disconnect the two coaxial cables from the BNC connectors that are located on the top and bottom of the Low Pass Filter PCB.
5. Remove the metal cover of the Low Pass Filter PCB. Figure 7-23 shows the location of the Low Pass Filter PCB.
6. Remove the Low Pass Filter PCB.

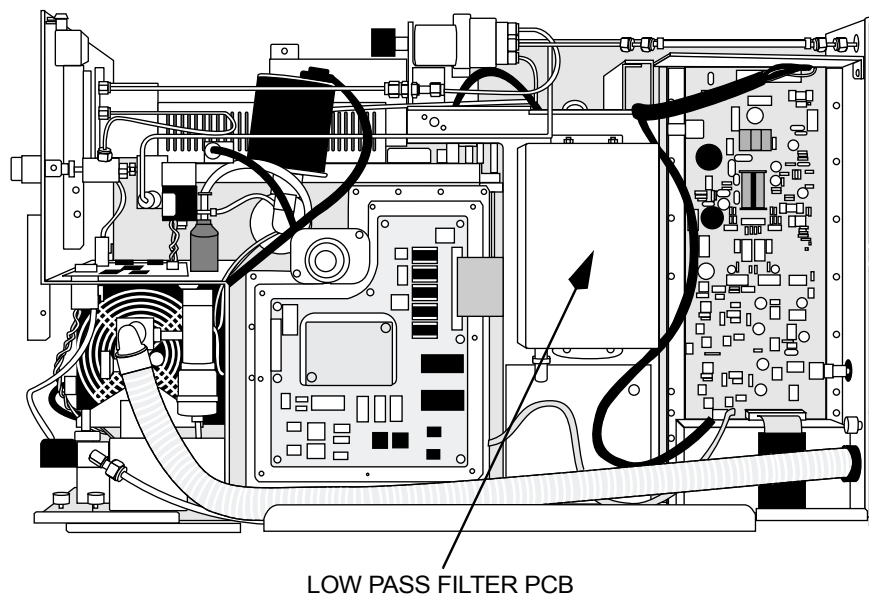


Figure 7-23. Low Pass Filter PCB

Reinstalling the Low Pass Filter PCB

To replace the low pass filter PCB:

Supplies: Phillips screwdriver, Low Pass Filter PCB (PN 96000-61080)

1. Install the new Low Pass Filter PCB.
2. Replace the metal cover of the Low Pass Filter PCB.
3. Reconnect the two coaxial cables.
4. Reinstall the right side and top covers of the GCQ *Plus*.
5. If you have a TRACE GC 2000 or a Hewlett-Packard GC, insert the transfer line into the GC (page 1-10).
6. Restart your system (page 1-5).
7. Run GCQ Diagnostics to verify that your system is operational.

Removing the Convectron Gauge and Foreline Adapter

To remove the convectron gauge and foreline adapter:

Supplies: Phillips screwdriver, 7/16 open-end wrench

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. If you have a TRACE GC 2000 or a Hewlett-Packard GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and right side covers (page 1-12).
4. Loosen the clamping ring that holds the foreline vacuum hose to the foreline adapter. Disconnect the foreline vacuum hose from the foreline adapter. Figure 7-24 shows the location of the foreline vacuum hose.
5. Disconnect the cable that comes from the convectron gauge to the Vent Control PCB from the underside of the Vent Control PCB.
6. If you have an inlet valve, disconnect the cable that comes from the inlet valve solenoid from the underside of the Vent Control PCB. Disconnect the vacuum line to the inlet valve solenoid.
7. Loosen the foreline adapter clamp that holds the foreline adapter to the backing flange of the diffusion or turbomolecular pump.
8. Slide the convectron gauge and foreline adapter (as a unit) out and away from the GCQ *Plus*.

Replacing the Convectron Gauge and Foreline Adapter

To replace the convectron gauge and foreline adapter:

Supplies: Phillips screwdriver, convectron gauge/foreline adapter

1. Install the new convectron gauge and foreline adapter so that the foreline adapter is over the backing flange of the diffusion pump or turbomolecular pump.
2. Tighten the foreline adapter clamp.

3. If you have an inlet valve, follow these steps:
 - a. Reconnect the vacuum line to the inlet valve solenoid.
 - b. Reconnect to the underside of the Vent Control PCB the cable that comes from the inlet valve solenoid.
 - c. Reconnect the cable that comes from the convectron gauge to the Vent Control PCB.
 - d. Reinstall the foreline vacuum hose on the foreline adapter. With a screwdriver, tighten the clamping ring that holds the foreline vacuum hose to the foreline adapter.
4. Reinstall the right side and top covers of the GCQ *Plus*.
5. If you have a TRACE GC 2000 or a Hewlett-Packard GC, insert the transfer line into the GC (page 1-10).
6. Restart your system (page 1-5).
7. Run GCQ Diagnostics to verify that your system is operational.

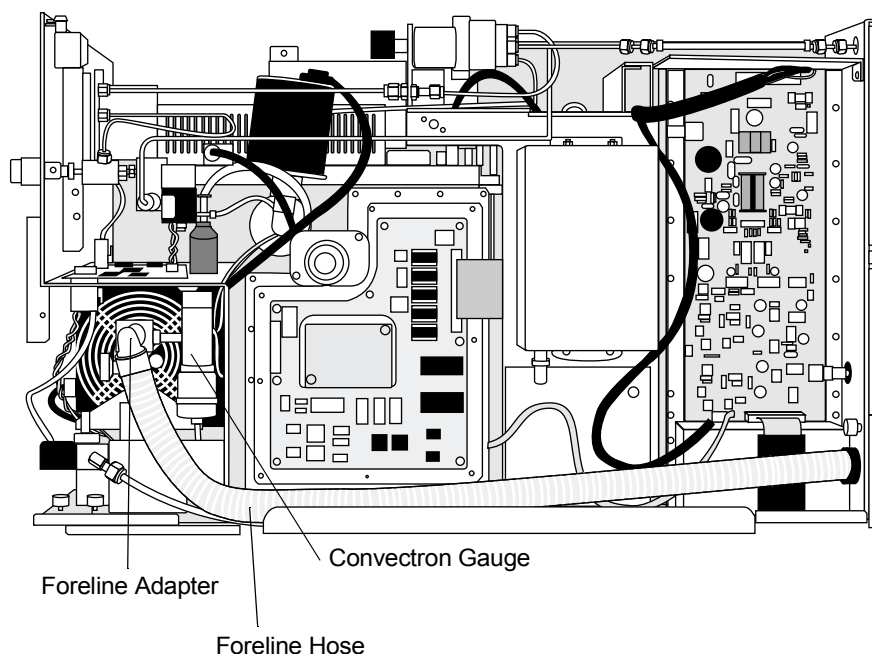


Figure 7-24. Right Side of the GCQ Plus Showing the Foreline Adapter, Foreline Hose, and Convectron Gauge

Removing the Transfer Line on Systems With a TRACE GC 2000 or a Hewlett-Packard GC

To remove the transfer line on a system with a TRACE GC 2000 or HP GC:

Supplies: Phillips screwdriver, 5/16-in. open-ended wrench, two 7/16 in. open-ended wrenches

1. Shut down and vent the GCQ *Plus* (page 1-3).

WARNING: Disconnect the power cord before proceeding.

2. If you have a TRACE GC 2000 or a Hewlett-Packard GC, move the GC away from the GCQ *Plus* (page 1-10).
3. Remove the top and right side covers (page 1-12).
4. Loosen the swagelok nut on the GC end of the transfer line until you can move the capillary column. Withdraw the capillary column from the transfer line.
5. Disconnect the transfer line heater/sensor cable.
6. Loosen the vacuum sealing nut that secures the transfer line to the inlet flange.
7. Withdraw the transfer line from the vacuum manifold.
8. Check the O-rings for wear. Replace if necessary.

Figure 7-25 shows a detailed view of the Transfer Line and its orientation to the gas chromatograph.

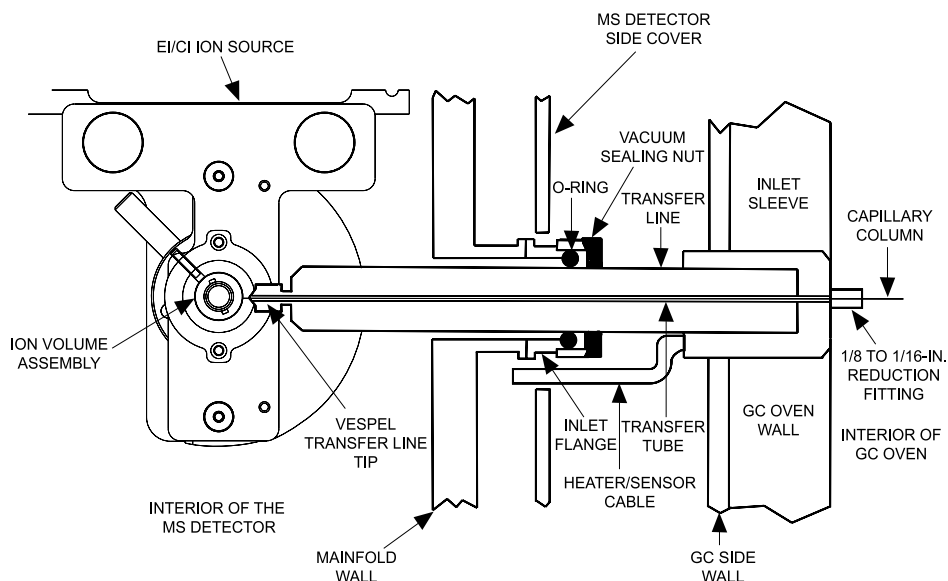


Figure 7-25. Detailed View of Transfer Line

Reinstalling the Transfer Line on Systems With a TRACE GC 2000 or Hewlett-Packard GC

To replace the transfer line on a system with a TRACE GC 2000 or HP GC:

Supplies: Phillips screwdriver, 5/16-in. open-end wrench, two 7/16-in. open-ended wrenches, transfer line (PN 96000-60066 [TRACE GC 2000] or 96000-60065 [HP 5890 GC])

1. Install the capillary column into the new transfer line (page 1-8).
2. Insert the transfer line into the GCQ *Plus* until the tip of the transfer line seats in the ion source block. Tighten the vacuum sealing nut.
3. Reconnect the transfer line heater/sensor cable.
4. Reinstall the right side and top covers of the GCQ *Plus*.
5. Insert the transfer line into the GC (page 1-10).
6. Restart your system (page 1-5).
7. Run GCQ Diagnostics to verify that your system is operational.

7.3 Data System PCBs

The Acquisition DSP PCB, Control DSP PCB, and Waveform DDS PCB reside in your GCQ *Plus* data system (personal computer) of your system. You can replace these PCBs as follows:

1. Shut down the computer as follows:
 - a. In Windows NT, choose **Start | Shut Down**. The Shut Down Windows dialog box appears.
 - b. Select Shut down the computer, then click **OK** to begin the Windows NT shutdown procedure.
 - c. When the Windows NT shutdown procedure tells you that it is safe to turn off the computer, turn off the computer and monitor by using the front-panel on/off switches.
2. Disconnect the monitor from the personal computer.
3. Remove the screws on the personal computer that attach the cover to the chassis, then remove the cover.

CAUTION: To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

4. Locate the Acquisition DSP PCB (PN 119700-61260), Control DSP PCB (PN 119700-61270), or Waveform DDS PCB (PN 97000-61280) on the ISA/PCI bus. The name of the PCB is written on each PCB. Disconnect all electrical cables to the PCB that you want to replace (including the ones on the rear of the personal computer).
5. Remove the single screw that secures the PCB to the card cage. Remove the PCB from the card cage.
6. Seat the new PCB in the ISA/PCI bus. Insert and tighten the screw that holds the PCB to the card cage.
7. Reconnect all electrical cables to the PCB that you replaced.
8. Reinstall the personal computer cover. With a screwdriver, reinstall the two screws and two knurled knobs in the rear of the personal computer that attach the top cover to the chassis. Connect the monitor to the PC.
9. Restart the computer.

Chapter 8

Maintaining the GCQ Plus

This chapter contains a maintenance schedule as well as detailed instructions for maintaining specific parts.

You will find information on the following main topics:

- Recommended Maintenance Schedule
- Cleaning the GCQ Plus
- Ion Source Components
- Mass Analyzer Components
- Diffusion Pump
- Rotary-Vane Pump

8.1 Recommended Maintenance Schedule

You can ensure peak performance of your GCQ *Plus* by performing regular, periodic maintenance on the instrument. The recommended maintenance schedule shown in Table 8-1 is based on running multiple samples in an 8-hour day. You may need to adapt the schedule to your needs depending on the number of analyses per day and how clean the samples are. We recommend that you keep a record of system maintenance and performance.

Table 8-1 lists a recommended maintenance schedule for the GCQ *Plus*.

Table 8-1. Recommended Maintenance Schedule

Frequency	Component	Task
Every Month	Cooling Fan	Check for proper operation
	Rotary-Vane Pump	Check oil level; add oil when needed
Every 6 months	Diffusion Pump	Check oil level; add oil when needed
Annually	Rotary-Vane Pump Inlet Filter	Clean, replace if needed
Every 2.5 Years	Diffusion Pump	Replace oil
As needed	Calibration Compound	Add
	EI/CI Ion Source	Clean
	Electron Multiplier anode	Clean
	Electron Multiplier cathode	Clean
	Filament	Replace when GCQ Diagnostics indicates it is open
	GC Capillary Column	Replace
	Inlet Valve Seals	Replace
As needed	Ion Source Lenses	Clean

Frequency	Component	Task
	Ion Volume	Clean
	Mass Analyzer	Clean
	Rotary-Vane Pump Oil	Purge when cloudy. Change if still cloudy after purging or every 3000 hours of operation.
	Transfer line O-ring	Check each time transfer line is cleaned.
	Transfer line seal	Inspect and clean

WARNING: As with all chemicals, store and handle solvents and reagents according to standard safety procedures, and dispose according to local and federal regulations.

8.2 Cleaning the GCQ Plus

A large part of maintaining your GCQ *Plus* is making sure that its components are clean. This section includes information on cleaning parts, cleaning frequency, and lists the tools and supplies you will need to clean the GCQ *Plus* components.

Cleaning Frequency

How often you clean the GCQ *Plus* depends on the types and amounts of samples and solvents you introduce into the instrument. In general, the closer an ion source or mass analyzer part is to the sample introduction point, the more rapidly it becomes dirty. Therefore, you will clean the ion source more often than other parts.

Because the ion volume (which is the site of ion formation) is exposed directly to samples introduced into the GCQ *Plus*, *you will clean it more frequently than other parts*. If you have an optional inlet valve, ion volumes can be removed, cleaned, and replaced without venting the instrument. See page 8-12 for instructions on removing the ion volume through the optional inlet valve.

The ion source lenses (especially L1) also come in contact with samples introduced in to the GCQ *Plus*. Clean the lenses periodically, but not as often as the ion volume. The lenses should be cleaned if cleaning the ion volume does not restore adequate signal. You should periodically clean the entire EI/CI ion source to restore original performance. Under normal operation, this should not be necessary more than every six months. Because the ion source is separate from the ion trap mass analyzer, the ion trap mass analyzer requires very infrequent cleaning. Under normal operation, you should not have to do this more than once every two years.

When your instrument is clean and in good working order, perform benchmark tests and record the results. A good benchmark is a mixture of decafluorobenzophenone, hexachlorobenzene, and methyl stearate included with the instrument. When the tested performance of your system decreases significantly from your benchmark test results, clean the parts of the GCQ *Plus* in the following order:

1. Clean the ion volume (page 8-19).
2. Clean the EI/CI ion source (page 8-28).
3. Clean the mass analyzer (page 8-41).

Note: If you just want to change or clean the ion volumes and the instrument is equipped with an inlet valve, there is no need to shut down the system.

Figure 8-1 illustrates the sequence in which to perform routine maintenance on the GCQ Plus:

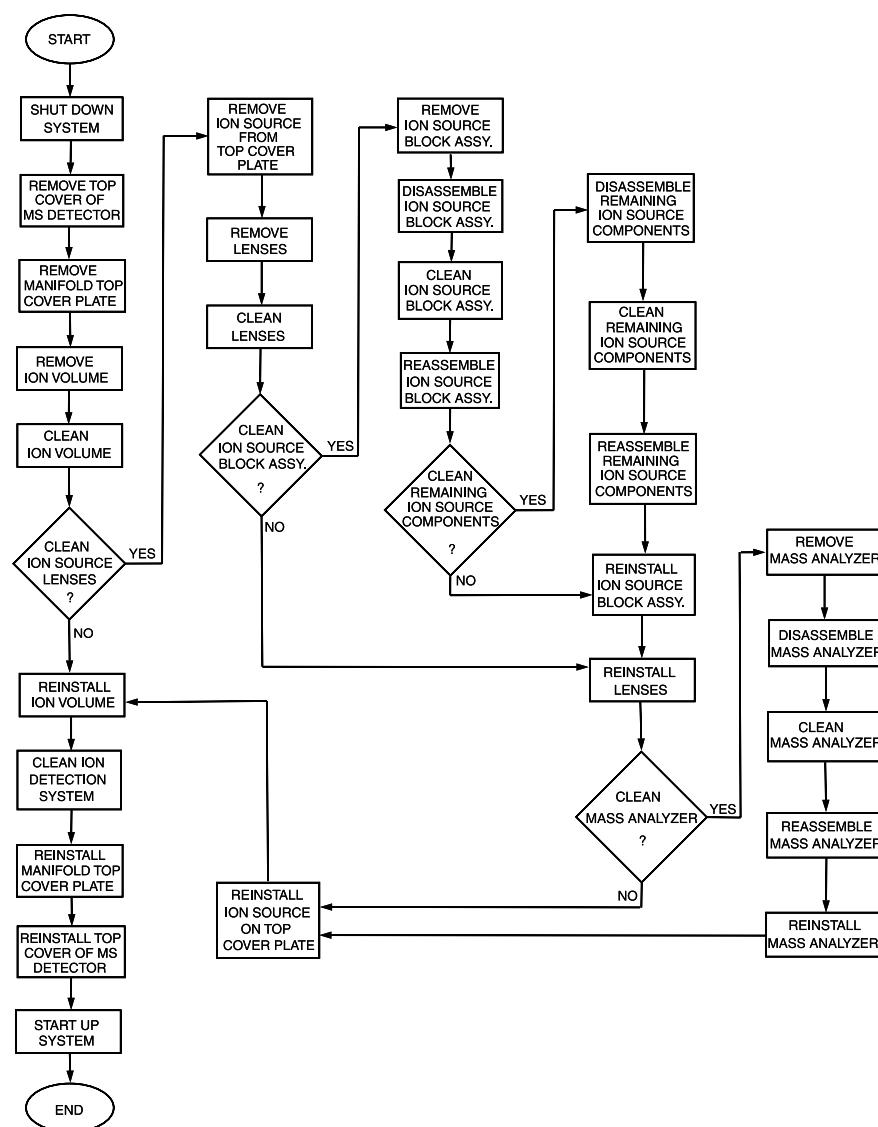


Figure 8-1. Sequence of Routine Maintenance

Necessary Maintenance Supplies

The GCQ *Plus* requires just a few tools for maintenance. You can remove and disassemble many parts by hand. Make sure you have the materials listed in Table 8-2 for cleaning and maintaining the ion source, mass analyzer, and ion detection system. Items listed without part numbers may be purchased at your local hardware store or from other vendors.

Table 8-2. Recommended Maintenance Supplies

Description	Part Number
Wrench, 9/64-in., hex socket (Allen)	
Wrench, 9/16-in., socket	
Wrench, 7/16-in., open end	
Wrench, 9/16-in., open end	
Wrench, 11/16-in., open end	
Screwdrivers, set, ball point, Allen	A0025-03025
Screwdriver, slot head	
Screwdriver, Phillips	
Ultrasonic cleaner	
Beaker, 450 mL	
Gloves, nylon, lint free	A0301-09700
Kimwipes or other lint-free industrial tissue	
Applicators, cotton-tipped	A0301-02000
Soft toothbrush	
Aluminum oxide abrasive, number 600	32000-60340
Detergent (Alconox, Micro or equivalent)	
Clean, dry, compressed gas	
De-ionized water	
Tap water	

Table 8-2. Recommended Maintenance Supplies (Continued)

Description	Part Number
Glycerol, reagent grade	
Methanol, reagent grade	
Acetone, reagent grade	
Protective cover, clear plastic	96000-20130
Dremel rotary tool or equivalent	

Cleaning Parts

The GCQ *Plus* has parts made up of different types of materials. This section covers the following procedures:

- Cleaning Stainless Steel Parts
- Cleaning Anodized Aluminum and Gold-Plated Parts

Cleaning Stainless Steel Parts

Stainless steel parts include:

- Ion volume and ion volume holder
- Ion source block and lenses
- Exit lens

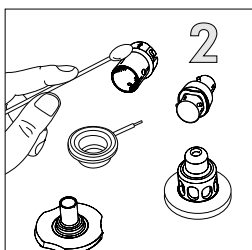
CAUTION: Do not use this procedure to clean anodized aluminum parts, such as the lens spacers, or gold plated parts, such as the ion source thumb screws. Cleaning anodized aluminum or gold-plated parts with abrasive cleansers is not recommended. Abrasives wear away protective layers.

CAUTION: Do not use this procedure to clean the inside surfaces of the endcap electrodes or ring electrode. Follow the procedure on page 8-41 to clean the mass analyzer.

To clean anodized aluminum and gold-plated parts:

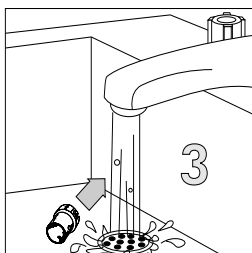
CAUTION: Always wear impermeable laboratory gloves and eye protection when performing cleaning procedures.

1. Gather the necessary supplies listed in Table 8-2 on page 8-6.
2. Use a slurry of number 600 aluminum oxide in glycerol and a cleaning brush or cotton-tipped applicator to remove contamination from all the surfaces you are cleaning. Contamination appears as dark or discolored areas, but often is not visible. The heaviest contamination is usually found around the apertures - for example, the electron entrance hole on an ion volume and the surface of the ion volume opposite the filament hole. Clean each part thoroughly, even if no contamination is visible. Use the wooden end of an applicator cut at an angle to clean the inside corners.

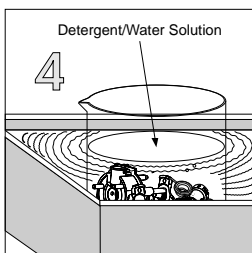


You can use a Dremel tool with the polishing swab at its lowest speed to increase cleaning efficiency, as well as decrease the time required to clean the items. Use care when using the Dremel tool as it is an electrical appliance. Be sure to keep the tool away from possible hazards such as standing water.

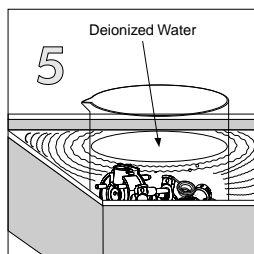
3. Rinse each item under running water. Use a clean applicator to remove the aluminum oxide slurry. Do not let the slurry dry on the metal; dried aluminum oxide is difficult to remove.



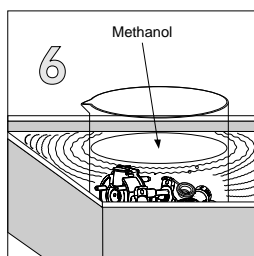
4. Place the parts in a beaker containing a solution of detergent in warm water. Place the beaker and its contents in an ultrasonic bath for 5 minutes, then rinse the parts with tap water to remove the detergent.



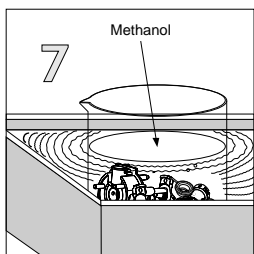
Note: Lenses should not be placed in an ultrasonic bath for more than one minute at a time. Basic solutions such as detergent can damage the anodized coating if exposed too long.



5. Using clean tools, place the parts in a beaker containing deionized water, and then place the beaker and its contents in an ultrasonic bath for 5 minutes (if the water is cloudy after sonication is complete, decant off the water, add fresh water, and place the beaker and its contents in a ultrasonic bath again for 5 minutes). Repeat until the water is clear.

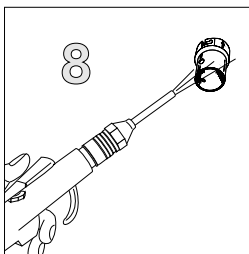


6. Rinse the parts with methanol.

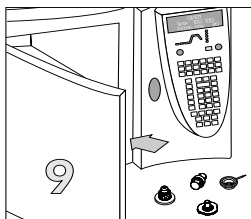


7. Place the parts in a beaker containing fresh methanol, then place the beaker and its contents in an ultrasonic bath for 5 minutes.

Note: After the parts are clean, wear clean, lint-free nylon or cotton gloves when you handle the clean parts.



8. Remove the parts from the beaker. Blow off the methanol from the parts with a clean, dry gas

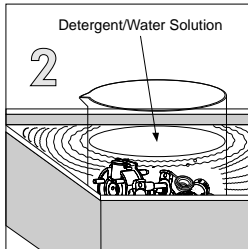


9. Dry the parts in an oven, set at 100° C, for 30 minutes. Allow the parts to cool before putting them back together.

Cleaning Anodized Aluminum and Gold-Plated Parts

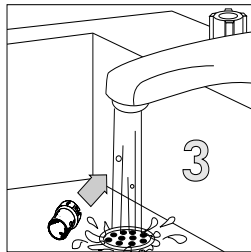
To clean anodized aluminum and gold-plated parts:

1. Place the parts in a beaker so that no two parts are touching. Cover the parts with a solution of detergent in warm water.
2. Place the beaker and its contents in an ultrasonic bath for about 1 minute. Remove any remaining deposits with a soft toothbrush and a solution of detergent in warm water

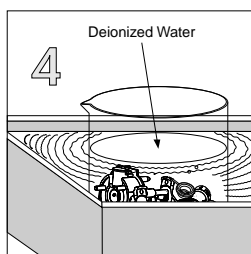


CAUTION: Highly basic solutions can damage anodized aluminum.

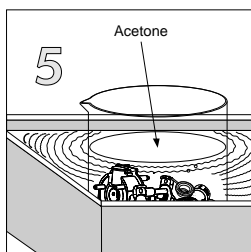
3. Rinse the parts with fresh water.

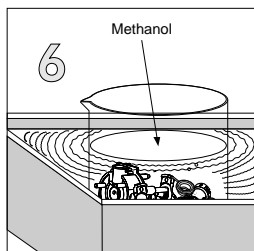


4. Place the parts in a beaker containing deionized water, and then place the beaker in an ultrasonic bath for 5 minutes.



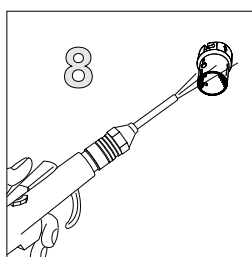
5. Rinse the parts with acetone, then place the parts in a beaker containing fresh acetone. Place the beaker and its contents in an ultrasonic bath for 5 to 10 minutes.



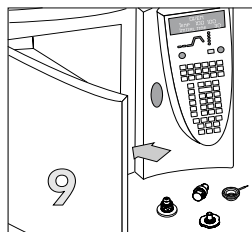


6. Rinse the parts with methanol, then place the parts in a beaker containing fresh methanol. Place the beaker and its contents in an ultrasonic bath for 5 to 10 minutes.

7. Remove the parts from the beaker.



8. Blow off the methanol from the parts with a clean, dry gas.



9. Dry the parts in an oven set at 100° C for 30 minutes. Allow the parts to cool before you reassemble them.

8.3 Ion Source Components

The ion source consists of the ion volume, the site of ion formation, and the ion source lenses which transmit these ions to the ion trap mass analyzer. Because the ion volume is exposed directly to samples introduced into the GCQ Plus, it requires the most frequent cleaning.

Ion Volume Assembly

The Ion Volume is the site where molecules interact with energetic electrons to form ions. How often you clean the ion volume assembly will depend on what types of samples you are running.

Removing the Ion Volume Assembly from Systems with an Inlet Valve

To remove the ion volume assembly using the inlet valve:

Supplies: I/R tool, I/R tool Guide Bar, gloves

Frequency: As needed

Use the optional inlet valve to conveniently remove, clean, and replace ion volumes without venting the instrument.

1. Turn off the voltages for the ion source, mass analyzer, and ion detection system as follows:
 - a. Run the Tune program from the GCQ Software.
 - b. Choose **Instrument | System Off**.
2. Insert the guide bar for the I/R tool into the opening near the bottom of the inlet valve with the track in the guide bar facing to the left. Push the guide bar in as far as it will go, then rotate it to the right by 90° to lock the guide bar in the inlet valve.



Figure 8-2. Guide Bar for I/R Tool

CAUTION: Make sure the voltages to the EI/CI ion source, mass analyzer, and ion detection system are off before you insert the I/R tool into the ion source.

3. Push the inlet valve lever all the way down, then remove the plug from the opening of the inlet valve
4. Turn the rear portion of the handle on the I/R tool to the release position (see Figure 8-3) by lining up the line on the rear portion of the handle with the release icon on the front portion of the handle.



Figure 8-3. I/R Tool In Release Position

5. Insert the guide ball on the I/R tool into the guide ball opening, then insert the guide bar into the inlet valve until the guide ball is at the first step in the guide bar.
6. Evacuate the inlet valve by pressing the Inlet Valve button on the front panel of the MS Detector. The blue front panel LED labeled Evacuating flashes on and off while the inlet valve is evacuating.
7. Open the ball valve by placing the inlet valve lever in the up position after the front panel LED labeled EVACUATING turns off (approximately 40 seconds).

Note: If both the VACUUM and EVACUATING lights flash, this simply indicates a temporary rise in forepressure and is not a cause for alarm.

8. Monitor the foreline pressure while opening the inlet valve. The pressure should not surge beyond 150 mtorr in the EI mode or 350 mtorr in the CI mode. If this occurs, replace the inlet valve seals.

9. Slide the I/R tool into the vacuum manifold until the tip of the I/R tool is fully inserted in the ion volume holder.
10. Turn the rear portion of the handle on the I/R tool counterclockwise to the hold position (Figure 8-4). In the hold position, the line on the rear portion of the handle is aligned with the hold icon on the forward portion of the handle. You will hear a “click” when the handle is fully engaged.



Figure 8-4. I/R Tool in Hold Position

11. Withdraw the I/R tool, with the ion volume assembly attached, until the guide ball reaches the step in the guide bar. Close the ball valve by placing the inlet valve lever in the down position.

CAUTION: Do not withdraw the I/R tool beyond the point where the guide ball reaches the step in the guide bar until the ball valve has been closed. Otherwise, the system is vented to the atmosphere.

12. Withdraw the I/R tool completely from the inlet valve. Disengage the I/R tool from the guide bar by withdrawing the guide ball on the I/R tool through the guide ball opening in the guide bar.

WARNING: Let the ion volume cool before touching it.

13. Use clean gloves to press the ion volume assembly into the tip of the I/R tool and rotate the ion volume assembly to clear the bayonet pins from the pin guides.

Cleaning the Ion Volume Assembly

To clean the ion volume assembly:

Supplies: Cleaning Supplies, gloves

Frequency: As needed

Note: Wear gloves. Use clean, lint-free, nylon or cotton gloves when you handle parts of the EI/CI ion source.

1. Disassemble the ion volume assembly.

Press and hold the ion volume against the ion volume holder to compress the spring washer on the ion volume holder while twisting the two pieces in opposite directions. The bayonet pins slide out of the bayonet pin guide entrance to release the ion volume.

2. Clean the ion volume assembly (page 8-7).

Replacing the Ion Volume Assembly in Systems with an Inlet Valve

To replace the ion volume assembly using the inlet valve:

Supplies: I/R tool, gloves

Frequency: After removing the ion volume

Note: Wear clean, lint-free gloves when you handle EI/CI ion source parts.

1. Place the ion volume assembly into the bayonet lock on the tip of the I/R tool with the arrows on the ion volume and on the tip of the I/R tool facing each other, as illustrated in Figure 8-5.

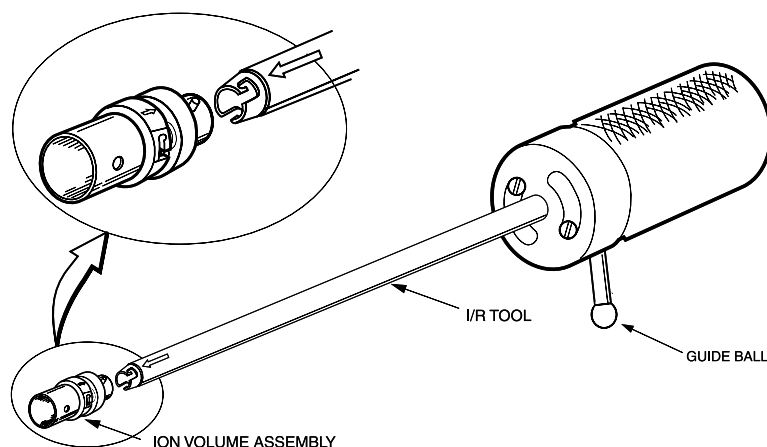


Figure 8-5. Placing the Ion Volume Assembly on the I/R Tool

CAUTION: The arrows on the I/R tool and ion volume assembly must be aligned to avoid damage to the source assembly.

2. Turn the rear portion of the handle on the I/R tool to the hold position. In the hold position, the line on the rear portion of the handle is aligned with the hold icon on the forward portion of the handle.
3. Insert the guide ball on the I/R tool into the guide ball opening near the end of the guide bar.
4. Insert the I/R tool, with the ion volume assembly attached, into the inlet valve until the guide ball is at the first step in the guide bar.
5. Evacuate the inlet valve by pressing the INLET VALVE button on the front panel of the MS detector. The blue front panel LED labeled EVACUATING flashes on and off while the inlet valve is evacuating.
6. After the EVACUATING LED turns off, open the ball valve by placing the inlet valve lever in the up position.

CAUTION: Make sure the voltages to the EI/CI ion source, mass analyzer, and ion detection system are off before you insert the I/R tool into the ion source.

7. Slide the I/R tool into the vacuum manifold until the ion volume is inserted in the ion source block. You will hear a click when it is inserted.
8. Turn the rear portion of the handle on the I/R tool clockwise to the release

position. In the release position, the line on the rear portion of the handle is aligned with the release icon on the forward position of the handle.

9. Check to make sure that the ion volume assembly is fully seated into the EI/CI source block:
 - a. Withdraw the I/R tool away from the ion volume and turn the I/R tool handle to the hold position.
 - b. Slide the I/R tool back into the vacuum manifold until the end of the I/R tool just touches the ion volume assembly. The I/R tool should not go in completely.
10. Withdraw the I/R tool until the guide ball reaches the step in the guide bar.

CAUTION: Do not withdraw the I/R tool beyond the point where the guide ball reaches the step in the guide bar until the ball valve has been closed. Otherwise, the system is vented to the atmosphere. See Figure 8-5 on page 8-16 for correct placement of the ion volume assembly.

11. Close the ball valve by placing the inlet valve lever in the down position.
12. Withdraw the I/R tool completely from the inlet valve. Disengage the I/R tool from the guide bar by withdrawing the guide ball on the I/R tool through the guide ball opening in the guide bar.
13. Remove the guide bar by turning it to the left by 90° and then pulling it free from the inlet valve.
14. Insert the inlet valve plug into the opening in the inlet valve.

Removing the Ion Volume from Systems Without an Inlet Valve

To remove the ion volume:

Supplies: Ion volume tool (PN 96000-20173)

Frequency: As needed

1. Shut down the GCQ Plus (page 1-3).
2. Remove the top cover (page 1-12).
3. Remove the vacuum manifold top cover plate (page 1-14).
4. Insert the ion volume tool onto the ion volume holder through the opening in the ion source PCB.

5. Turn the ion volume tool handle 90° to the left to engage the ion volume holder.
6. Use the ion volume tool to pull the ion volume assembly straight back and through the opening in the ion source PCB.

Cleaning the Ion Volume Assembly

To clean the ion volume assembly:

Supplies: Cleaning Supplies, gloves

Frequency: As needed

Note: Wear clean, lint-free, nylon or cotton gloves when you handle parts of the EI/CI ion source.

1. Disassemble the ion volume assembly:

Press and hold the ion volume against the ion volume while twisting the two pieces in opposite directions. The bayonet pins slide out of the bayonet pin guide entrance, releasing the ion volume.

2. Clean the ion volume assembly (page 8-7).

Reinstalling the Ion Volume into Systems Without an Inlet Valve

To replace the ion volume assembly:

Supplies: Ion volume tool, gloves

Frequency: After removing the ion volume

1. Insert the ion volume holder onto the end of the ion volume tool as shown in Figure 8-6.
2. Use the ion volume tool to push the ion volume assembly straight back through the opening in the ion source PCB. Turn the ion volume tool handle 90° to the left to disengage the ion volume.
3. Reinstall the top cover plate of the vacuum manifold.
4. Reinstall the top cover of the GCQ Plus. Start up the system (page 1-5).

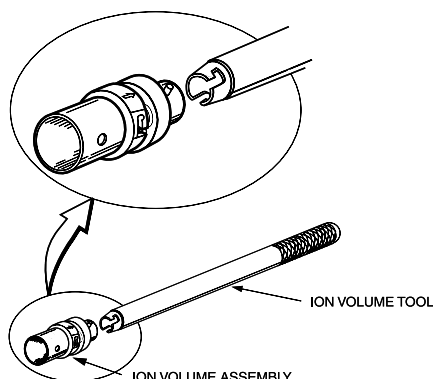


Figure 8-6. Inserting the Ion volume On the Ion Volume Tool

Inlet Valve

Maintenance procedures such as replacing inlet valve seals and removing the diffusion pump require you to remove the inlet valve.

Removing the Inlet Valve

To remove the inlet valve:

Supplies: Phillips Screwdriver, 7/16 in. open-ended wrench, 5/32 in. Allen wrench

Frequency: As needed

1. Shut down and vent the GCQ Plus (page 1-3).
2. Remove the GCQ Plus top and front covers (page 1-12).
3. Disconnect the vacuum line to the inlet valve.
4. Remove the two screws that hold the inlet valve cover to the inlet valve entry housing. Remove the cover.
5. Remove the four hex-socket screws that hold the inlet valve entry housing to the vacuum manifold.
6. Remove the inlet valve from the vacuum manifold. Ensure that the entry housing, ball valve, and O-ring remain intact. Place the inlet valve on a clean surface.

Reinstalling the Inlet Valve

To replace the inlet valve:

Supplies: Phillips Screwdriver, 7/16 in. open-ended wrench, 5/32 in. Allen wrench

Frequency: As needed

1. Insert the inlet valve into the front port of the vacuum manifold. Ensure that the entry housing, ball valve, and O-ring remain intact. Check the O-ring for wear. Replace if necessary.
2. Reinstall the four hex-socket screws that hold the inlet valve entry housing to the vacuum manifold.
3. Position the inlet valve cover over the entry housing. Reinstall the two screws that hold the cover to the entry housing.
4. Reconnect the vacuum line to the inlet valve.
5. Reinstall the front cover of the GCQ Plus (page 1-13).
6. Reinstall the inlet valve lever.
7. Reinstall the top cover of the GCQ Plus.
8. Restart the system.

WARNING: Toxic residues from mass spectrometer samples are likely to be concentrated in the pump oil. Dispose of spent pump oil according to local and federal regulations.

Replacing the Inlet Valve Seals

To replace the inlet valve seals:

Supplies: Two inlet valve seals (PN 76412-0105).

Frequency: As needed

1. Shut down and vent the GCQ Plus (page 1-3).

WARNING: Unplug the GCQ Plus power cord before you proceed.

2. Remove the GCQ Plus top and front cover (page 1-12).
3. Remove the inlet valve (page 8-20).
4. Replace the front and rear O-rings.
5. Reinstall the inlet valve (page 8-20).
6. Reinstall the top and front covers of the GCQ Plus.
7. Restart the system (page 1-5).

Ion Source Lenses

In many cases, if cleaning a dirty ion volume does not restore the instrument to its normal operating parameters, cleaning the ion source lenses will. It is seldom necessary to clean the entire ion source.

The ion source has three lenses (L1, L2, and L3) that are surrounded by an anodized aluminum spacer. The electrical connection to the lens is made through a stainless steel pin protruding from the edge of the spacer. A small three-pin connector attaches to these pins and carries the voltage from the electrical feedthrough to the lens. Each lens spacer has three holes that allow the lens to slide over the three cartridge heaters. These holes align the lenses.

Removing the Ion Source Lenses

To remove the ion source lenses:

Supplies: Allen Wrench

Frequency: As needed

1. Remove the ion source (page 8-25).
2. Pull L3 straight away from the ion source block to pull the lens off the cartridge heaters. Place the lens on a clean surface.
3. Repeat these steps to remove L2 and L1.

Cleaning the Lenses

To clean the lenses:

Supplies: Gloves, cleaning supplies listed on page 8-6.

Frequency: As needed

The lenses are selectively plated and require two different cleaning procedures. Do not use abrasives on the anodized aluminum portion of the lenses.

Instructions for cleaning the stainless steel portion of the lenses are on page 8-7. Pay particular attention to the areas inside the tube and around the hole in each lens.

Instructions for cleaning anodized aluminum parts are on page 8-10. Use this procedure to clean the lenses.

Reinstalling the Lenses

To replace the lenses:

Supplies: Gloves

Frequency: As needed

Note: Wear clean, lint-free, nylon or cotton gloves when you handle parts of the EI/CI ion source.

1. Place the ion source on a clean surface with the backplane down and the ion source block up.
2. Reinstall lens L1. Place L1 onto the ion source block so that the cartridge heaters pass through the holes in the lens spacer. Be sure to orient the electrical connection pin of the lenses toward the same side of the ion source as the 8-pin connector on the ion source block PCB.
3. Reinstall L2 and L3 in the same manner as L1.
4. Reinstall the ion source (page 8-28).

Ion Source

If cleaning the ion volume and the ion source lenses does not restore system performance, you may need to clean the entire EI/CI ion source. Normally this is not necessary more than once every six months.

Removing the Ion Source

To remove the ion source:

Supplies: Allen wrench, gloves

Frequency: As needed

1. Shut down and vent the GCQ Plus (page 1-3).

WARNING: Unplug the GCQ power cord before you proceed.

2. Remove the vacuum manifold top cover plate (page 1-14).

Note: Wear clean, lint-free, nylon or cotton gloves when you handle parts of the EI/CI ion source.

3. Disconnect the 8-pin Vespel connector from the ion source block PCB and the 3-pin Vespel connector from the lenses. Be careful not to pull the connector by the wires.
4. Disconnect the gas lines to the ion source by removing the gas inlet adapter from the ion source block. The gas inlet adapter is attached to the ion source block by a knurled thumb screw. Turn the thumb screw counter clockwise until the gas inlet adapter detaches from the ion source block.
5. Hold the ion source with one hand. Loosen the two 10-32 x 1/4-in. socket-head screws that hold the ion source to the mounting bracket. Do not confuse these screws with the two that hold the mounting bracket to the top cover plate.
6. Slide the ion source straight away from the mounting bracket.
7. Place the ion source on a clean surface with the back plane down and lens L3 face up.

Disassembling the Ion Source

To disassemble the ion source:

Supplies: Gloves

Frequency: As needed

1. Pull L3 straight away from the ion source block to pull the lens off the cartridge heaters. Place the lens on a clean surface. Repeat these steps to remove L2 and L1.
2. Hold the ion source block on its flat sides with your thumb and index finger. Pull the ion source block assembly free of the spring base.
3. Pull the filament assembly straight away from the three filament connectors on the ion source block.
4. Remove the ion volume key thumb screw from the ion source block.
5. Remove the spring thumb screw, spring, and pin from the ion source block.
6. Turn the ion source block over and remove the three spring base studs. Be careful not to damage the leads on the Ion Source Block PCB.
7. Gently pull the Ion Source Block PCB from the ion source block by sliding the three cartridge heaters and temperature sensor from the ion source block. Do not bend or twist the cartridge heaters or the temperature sensor. Place the Ion Source block PCB on a clean surface with the cartridge heaters and temperature sensor face up.
8. To reassemble the ion source block assembly, reverse steps 1 through 7.

Figure 8-7 shows an exploded view of the EI/CI ion source:

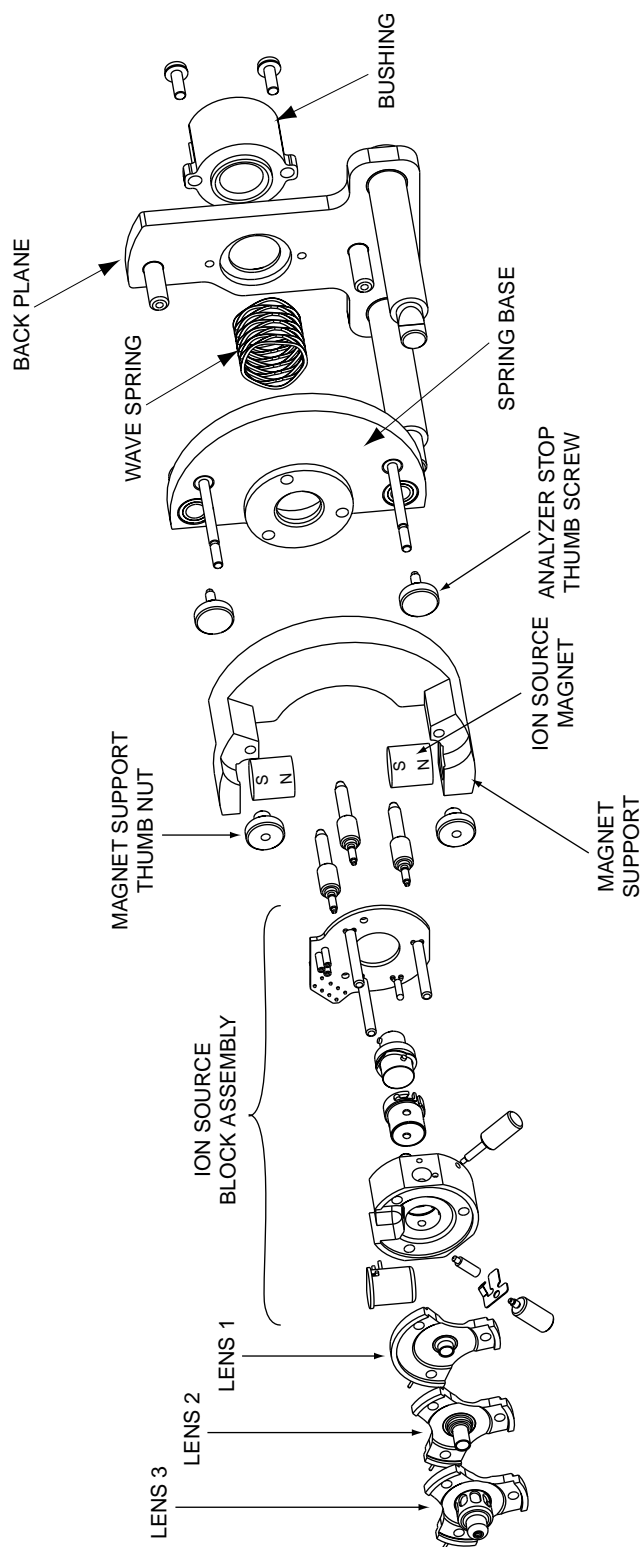


Figure 8-7. Exploded View of the EI/CI Ion Source

Cleaning the Entire Ion Source

To clean the ion source:

Supplies: Cleaning supplies (page 8-6).

Frequency: As needed

1. Disassemble the ion source block.
2. Clean each component (page 8-7).
3. Reassemble the ion source, then reinstall it onto the top cover plate.

Reinstalling the Ion Source

To replace the ion source:

Supplies: Allen wrench, Phillips screwdriver

Frequency: As needed

Note: If you have a Finnigan GCQ GC or CE 8000 Top GC, the gas inlet adapter attaches to the side of the ion source that is opposite the 8-pin feedthrough. If you have a TRACE GC 2000 or a Hewlett-Packard GC, the gas inlet adapter attaches to the same side of the ion source as the 8-pin feedthrough.

1. Slide the two back plane posts on the ion source straight into the mounting bracket. The mounting bracket is mounted to the top cover plate. Tighten the two 10-32 x 1/4-in. socket-head setscrews that hold the ion source to the mounting bracket.
2. Reconnect the ion source electrical leads to the connector on the back plane of the ion source.
3. Reconnect the gas lines to the ion source:
 - a. Insert the gas inlet adapter into the ion source block on the appropriate side. Refer to the note above.
 - b. Tighten the knurled thumb screw to secure the gas inlet adapter to the ion source block.
4. Replace the vacuum manifold top cover plate.
5. Replace the top cover.
6. Restart the GCQ Plus.

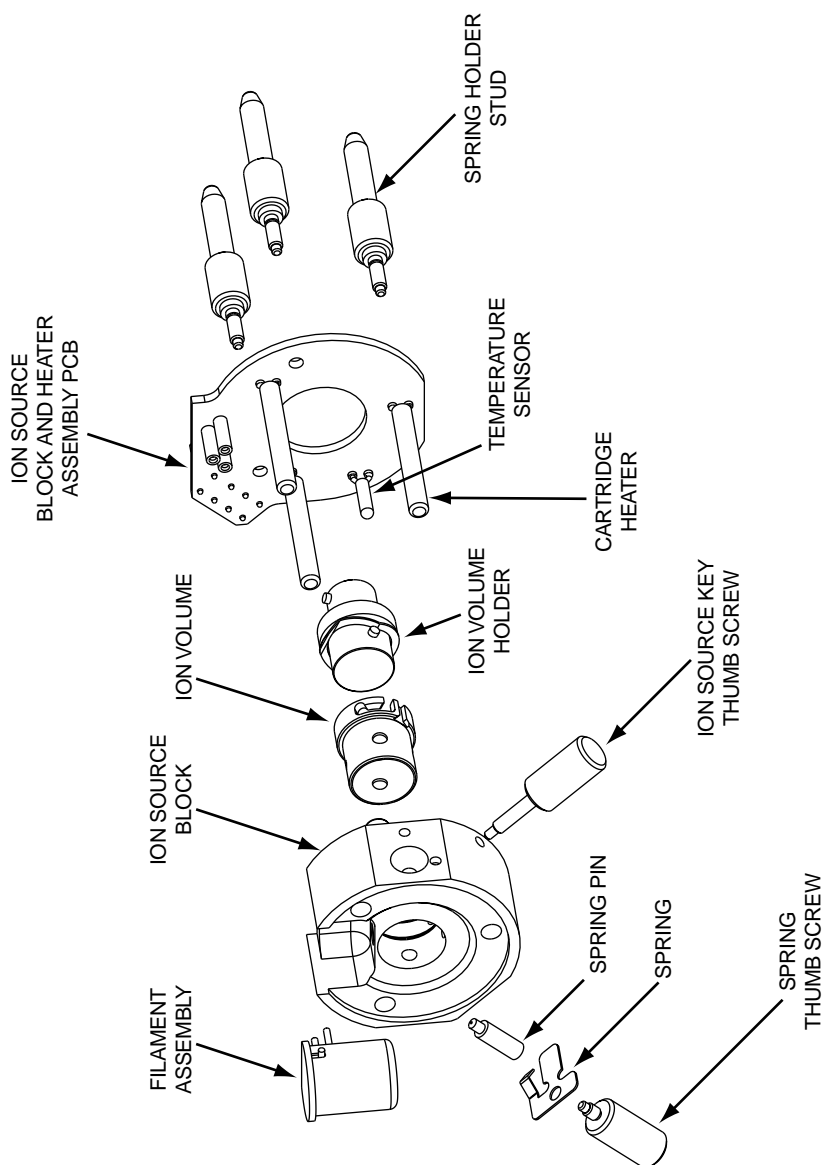


Figure 8-8. Exploded View of the EI/CI Ion Source Block Assembly

Ion Detection System

The ion detection system, conversion dynode, and electron multiplier must be kept clean and free of dust.

Cleaning The Ion Detection System

You should clean the conversion dynode and electron multiplier whenever you remove the vacuum manifold top cover plate with clean, dry gas.

Remember:

- Do not use liquids to clean the ion detection system parts.
- Always cover the opening in the top of the vacuum manifold with the protective cover (supplied with the GCQ Plus) whenever you remove the vacuum manifold top cover plate.

Replacing the Cathode

To replace the cathode:

Supplies: Phillips Screwdriver, cathode (PN A0022-02400)

Frequency: As needed

1. Shut down and vent the GCQ Plus (page 1-3).

WARNING: Unplug the GCQ Plus power cord before you proceed.

2. Remove the GCQ Plus top cover (page 1-12).
3. Remove the vacuum manifold top cover plate (page 1-14).
4. Loosen (but do not remove) the two screws that secure the support plates to the high voltage ring. Figure 8-9 shows a detailed view of the electron multiplier.
5. Detach the high voltage tube from the high voltage feedthrough and remove the electron multiplier. The electron multiplier support and the support plates should remain attached to the top cover plate.
6. Remove the two screws that secure the electron multiplier shield to the high voltage ring.

7. Insert the narrow end of a new cathode first through the spring washer and then through the high voltage ring.
8. Place the electron multiplier shield over the wide end of the cathode so that the screw holes in the electron multiplier shield are aligned with the screw holes in the high voltage ring.
9. Hold the high voltage ring and electron multiplier shield together to compress the spring washer. Secure the high voltage ring to the electron multiplier shield by using the two Phillips-head screws. The cathode should be held in place between the high voltage ring and the electron multiplier shield. The spring washer should apply a force to the cathode to keep it in contact with the electron multiplier shield.
10. Reattach the high voltage ring to the support plates by inserting the two screws in the sides of the high voltage ring into the notches in the two support plates. Insert the end of the high voltage tube in the electron multiplier feedthrough in the top cover plate. Tighten the two Phillips-head screws that secure the high voltage ring to the two support plates.
11. Reinstall the top cover plate of the vacuum manifold over the opening in the vacuum manifold.
12. Reinstall the GCQ *Plus* top cover.
13. Restart the system.

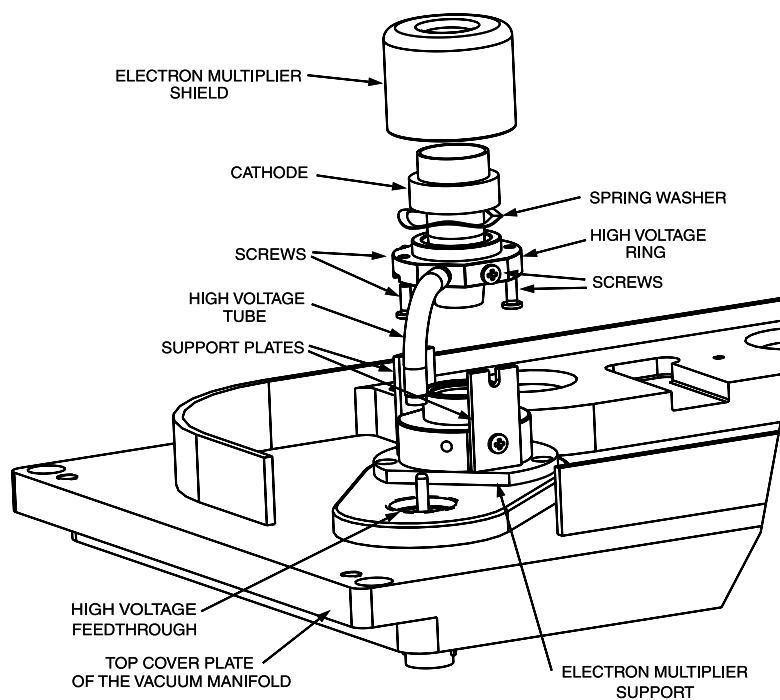


Figure 8-9. Exploded View of the Electron Multiplier, Showing the Cathode

Cleaning or Replacing the Anode

To clean or replace the the electron multiplier anode:

Supplies: Phillips Screwdriver, Anode (PN 96000-20076), gloves

Frequency: As needed

Note: Wear clean, lint-free nylon or cotton gloves when you handle parts of the electron multiplier.

1. Shut down and vent the GCQ Plus (page 1-3).

WARNING: Unplug the GCQ Plus power cord before you proceed.

2. Remove the GCQ Plus top cover (page 1-12).
3. Remove the vacuum manifold top cover plate (page 1-14).
4. Prepare a clean work area by covering the area with lint-free paper.

CAUTION: Be careful not to damage the surface of the electron multiplier shield. The electron multiplier shield has been electropolished to prevent field emission.

5. Remove the two socket-head setscrews that hold the electron multiplier support to the vacuum manifold top cover plate.
6. Detach the high voltage tube from the high voltage feedthrough in the top cover plate and remove the electron multiplier assembly as a unit. Place it on a clean surface (the anode remains in the anode feedthrough in the top cover plate).
7. Remove the anode from the anode feedthrough by unscrewing it (turn it counterclockwise) by hand. Place it on a clean surface. Figure 8-10 shows an exploded view of the electron multiplier with the anode.
8. Clean the anode by following the instructions for cleaning stainless steel parts (page 8-7).
9. Reinstall the anode in the anode feedthrough in by screwing it (turn it clockwise) by hand.

Note: Make sure that the anode is centered in the cavity.

10. Reinstall the electron multiplier on the top cover plate. Ensure that the high voltage tube is properly inserted in the high voltage feedthrough.
11. Reinstall the two socket-head setscrews that secure the electron multiplier support to the top cover plate. Tighten the setscrews with an Allen wrench or ball driver.

Note: The two socket-head setscrews are vented, meaning they have a hole in them to allow gas to escape from the threads. Do not substitute non-vented setscrews.

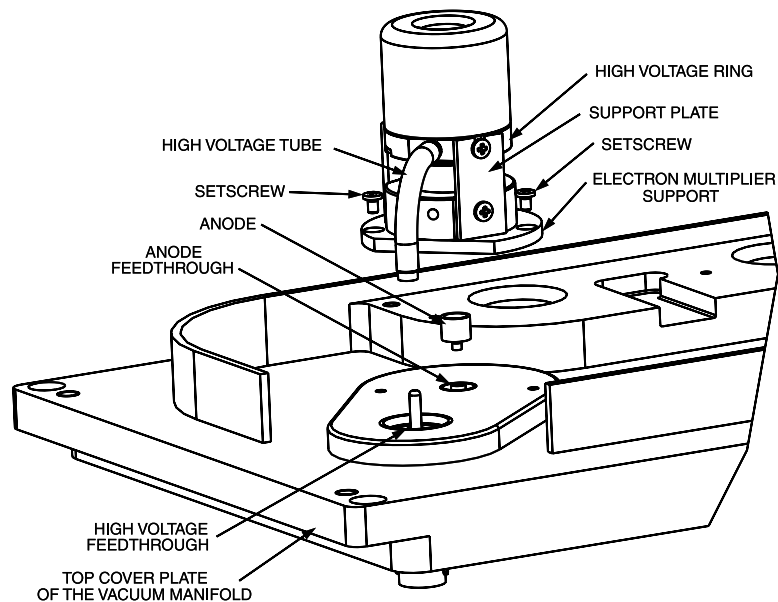


Figure 8-10. Exploded View of the Electron Multiplier, Showing the Anode

Ion Source Filament

The number of ions produced in the EI/CI ion source is roughly proportional to the filament emission current. Lack of ion production is a sign that the filament has failed. If the measured emission current is substantially less than the value that the emission current is set to, or if the measured emission current is decreasing over time, then the filament has failed or is failing (the LED labeled 'F OPN' on the Main System PCB is illuminated whenever the filament circuit is open).

Replacing the Filament

To replace the ion source filament:

Supplies: Gloves, Allen Wrench, Filament (PN 119701-60287)

Frequency: As needed

1. Prepare a clean work area by covering the area with lint-free paper.
2. Shut down and vent the GCQ Plus (page 1-3).

WARNING: Unplug the GCQ Plus before you proceed.

3. Remove the GCQ Plus top cover, then remove the vacuum manifold top cover plate (page 1-14).

Note: Wear clean, lint-free nylon or cotton gloves when you handle parts of the EI/CI ion source.

4. Remove the ion source from the top cover plate (page 8-28). Place the ion source on a clean surface with the bushing on the back plane down and lens L3 face up.
5. Remove the ion source lenses (page 8-23).
6. Remove the old filament assembly.
 - a. Hold down the ion source block by using your thumb and index finger to grasp its flat sides.
 - b. Pull the filament assembly straight away from the three filament assembly connectors on the Ion Source Block PCB.

7. Inspect and install a new filament assembly.
 - a. Verify that the filament wire is centered in the electron lens hole. See Figure 8-11 for a view of a centered wire. Hold down the ion source block by using your thumb and index finger to grasp its flat sides.
 - b. Align the electrical leads on the filament assembly with the three connectors on the Ion Source Block PCB and then gently press the filament leads into the connectors.

Note: Now is a good time to clean the ion volume, ion source lenses, and the source block.

8. Reinstall the lenses (page 8-24).
9. Reinstall the ion source onto the mounting bracket (page 8-28).
10. Reinstall the vacuum manifold top cover plate (page 1-16).
11. Reinstall the top cover of the GCQ Plus.
12. Restart the system.

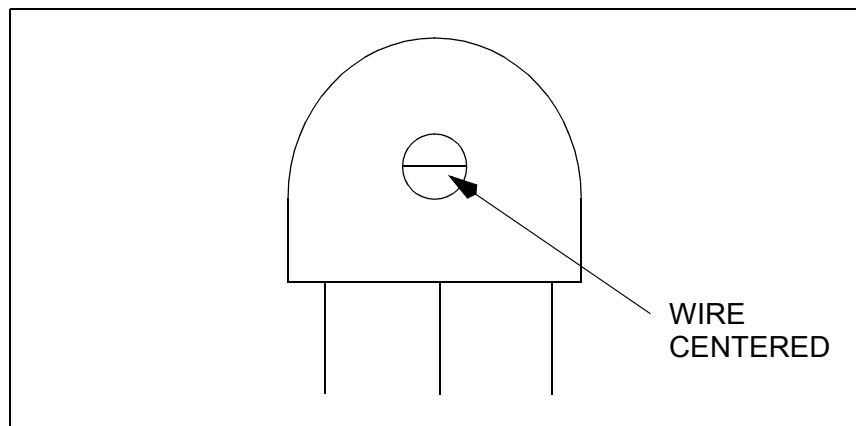


Figure 8-11. Ion Source Filament (Picture enlarged to show detail.)

Calibration Compound

The calibration compound chamber is located on the top cover plate of the vacuum manifold. Check the level of calibration compound whenever you remove the top cover of the MS detector. The level should be about 0.1 mL.

Adding Calibration Compound

To add calibration compound:

Supplies: 9/16-in. wrench, syringe, PFTBA calibration compound
(PN 50010-30059)

Frequency: As needed

Note: It may be difficult to see the level of the calibration compound because most of the 0.1 mL is absorbed into the glass frit.

1. Ensure that the calibration compound valve is closed, and that the calibration compound button in the GCQ Tune window is off.
2. Remove the top cover of the GCQ *Plus* (page 1-12).
3. Remove the nut for the calibration compound chamber. Slide the vial down, away from the calibration compound valve fitting, with the ferrule and nut attached. Remove the ferrule and nut.
4. Use a syringe to transfer 0.1 mL of PFTBA calibration compound into the calibration compound chamber. The syringe needle should be near the bottom of the chamber before you expel the calibration compound.
5. Hold the vial vertically. Place the nut on the neck of the vial, then place the 1/4-in. ferrule over the neck of the vial and into the nut.
6. Connect the vial to the calibration compound valve fitting with the nut and ferrule.
7. Reinstall the top cover of the GCQ *Plus*.

8.4 Mass Analyzer Components

A clean mass analyzer is essential for good quality spectra. The mass analyzer requires cleaning less often than the ion volume and the ion source lenses. The frequency of cleaning depends on the type and quantity of the compounds that you analyze. Under normal use the mass analyzer does not require cleaning more than every two years. Cleaning the mass analyzer involves the following steps:

- Removing the Mass Analyzer
- Disassembling the Mass Analyzer
- Cleaning the Mass Analyzer Components
- Reassembling the Mass Analyzer
- Reinstalling the Mass Analyzer

Removing the Mass Analyzer

To remove the mass analyzer:

Supplies: Allen Wrench, Gloves

Frequency: As needed

1. Disconnect the electrical leads to the exit lens, exit endcap electrode, and entrance endcap electrode.
2. Disconnect the damping gas line from the nipple on the entrance endcap electrode.
3. Loosen the two 10-32 x 1/4-in. socket-head setscrews that hold the mounting bracket to the top cover plate of the vacuum manifold.
4. Hold the mass analyzer with one hand. With the other hand, hold the mounting bracket. Lift the mass analyzer and mounting bracket straight away from the top cover plate. Place it on a clean surface with the mounting bracket down and the mass analyzer up.

Disassembling the Mass Analyzer

To disassemble the mass analyzer:

Supplies: Allen Wrench, gloves

Frequency: As needed

Note: Wear clean lint-free gloves when handling Mass Analyzer components.
--

1. Prepare a clean work area by covering the area with lint-free paper. Place each part on the paper as you remove it.
2. Pull the exit lens out of the exit lens sleeve.
3. Pull the exit lens sleeve out of the recess in the exit endcap electrode.
4. Unscrew and remove the two nuts from the posts, then remove the two spring washers.
5. Remove the exit endcap electrode from the posts.
6. Remove the two spacer rings and the ring electrode.
7. Remove the entrance endcap electrode from the posts.
8. Unscrew and remove the two posts from the mounting bracket.

Figure 8-12 shows a detailed view of the mass analyzer:

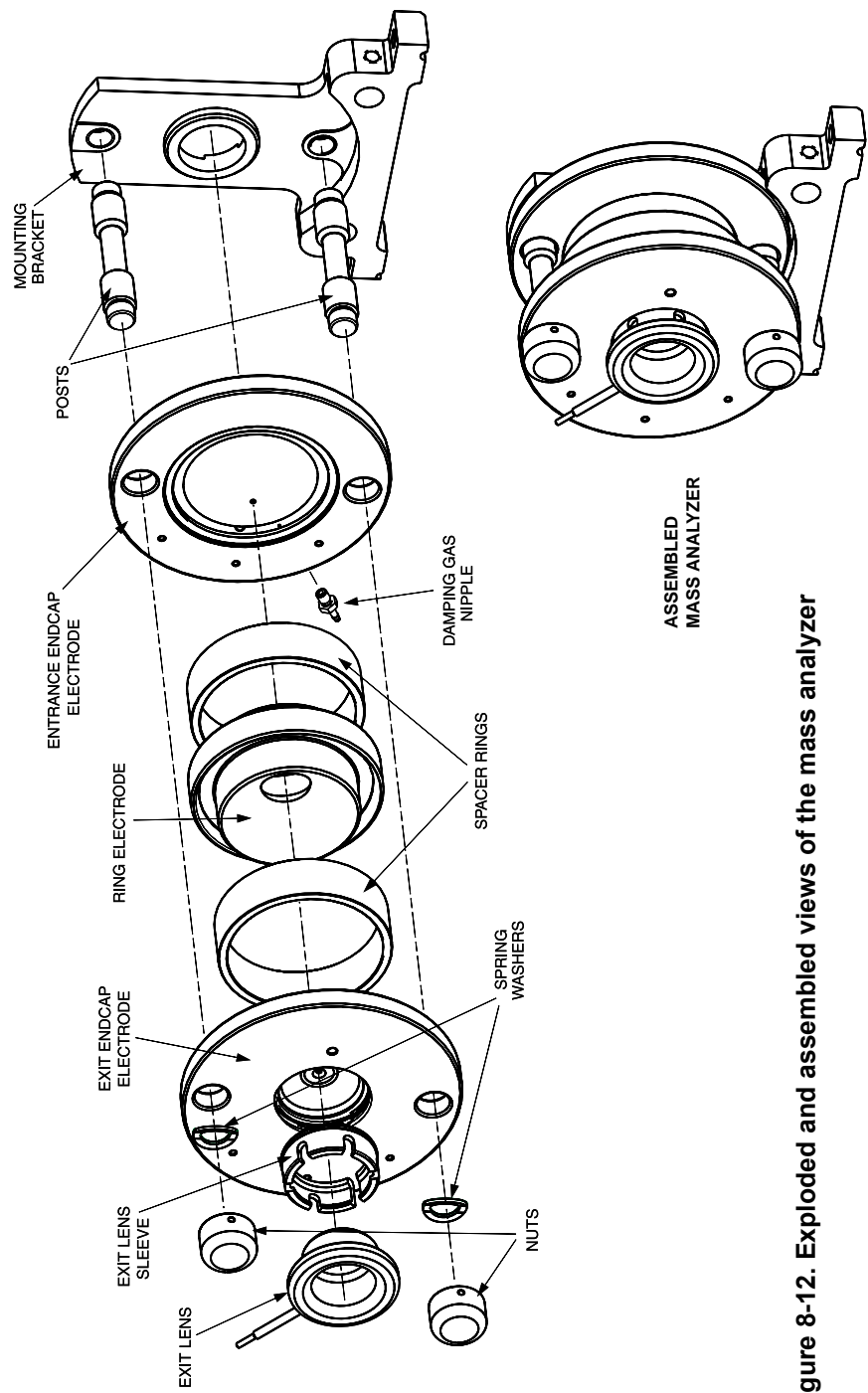


Figure 8-12. Exploded and assembled views of the mass analyzer

Cleaning the Mass Analyzer Components

To clean the components of the mass analyzer:

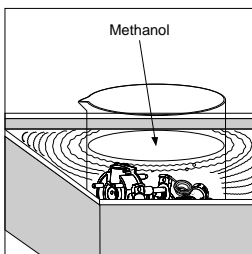
Supplies: Gloves, beaker, ultrasonic bath, methanol

Frequency: As needed

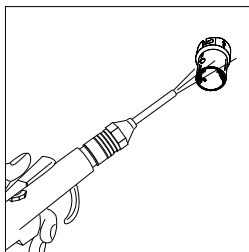
Note: Wear clean, lint-free nylon or cotton gloves when you handle components of the mass analyzer.

It is not necessary to clean the inside surfaces of the mass analyzer with aluminum oxide. In fact, this could damage the inside surfaces. However, after use, a black ion burn may form around the ion entrance hole in the entrance endcap electrode. This can easily be removed using the procedure for cleaning stainless steel parts on page 8-7.

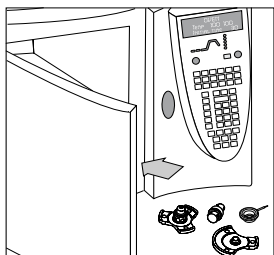
Clean the endcap electrodes, ring electrode, spacer rings, posts, nuts, exit lens, and exit lens sleeve as follows:



1. Place the parts in the beaker and cover the parts with methanol.
2. Place the beaker in an ultrasonic bath for about 10 minutes.
3. Pour the methanol out of the beaker. Rinse parts with fresh methanol.



4. Remove the parts from the beaker. Blow the methanol off of the parts with clean, dry gas.



5. Dry the parts in an oven set at 100° C for 30 minutes. Allow the parts to cool before reassembling.

Note: If you want to clean the mounting bracket, follow the procedure **Cleaning Anodized Aluminum and Gold-Plated Parts** on page 8-10.

Reassembling the Mass Analyzer

To reassemble the mass analyzer:

Supplies: Allen wrench, gloves

Frequency: After disassembling and cleaning the mass analyzer

1. Lay the mounting bracket flat-side down on a clean surface.
2. Reinstall the two posts onto the mounting bracket.
3. Reinstall the entrance endcap electrode onto the posts. The entrance endcap electrode has the damping gas nipple. Place the electrode with the convex surface facing away from the mounting bracket. The electrical-lead pin should point toward the side of the top cover plate where the 8-pin feedthroughs are located.

CAUTION: Handle the spacer rings carefully. Do not scrape the spacer rings against any metal surfaces. Metal deposits on the surface of the spacer rings may cause the RF voltage to arc across the spacer rings to the endcaps.

4. Place a spacer ring into the groove in the entrance endcap electrode.
5. Reinstall the ring electrode onto the spacer ring so that the spacer ring is held securely between the electrodes. The orientation of the ring electrode is not important.
6. Reinstall the second spacer ring into the groove in the ring electrode.
7. Reinstall the exit endcap electrode on the posts so that the spacer ring is held in place between the ring electrode and the exit endcap electrode. Place the electrode so that the convex surface faces the spacer ring. The electrical lead pin should point toward the side of the cover plate that the 8-pin feedthroughs are located.
8. Inspect the mass analyzer assembly for proper alignment of parts.
9. Reinstall the two spring washers on the posts so that the convex side of the washer is toward the exit endcap electrode.
10. Reinstall the two nuts on the posts and tighten them by hand. Insert the exit lens sleeve into the recess in the exit endcap electrode.
11. Insert the exit lens into the exit lens sleeve so that the lead pin on the exit lens points in the same direction as the lead pin on the exit endcap electrode.

Reinstalling the Mass Analyzer

To replace the mass analyzer:

Supplies: Allen wrench, gloves

Frequency: After removing the Mass Analyzer

1. Place the mounting bracket and mass analyzer onto the top cover plate so that the mounting bracket is flush with the ledge on the top cover plate.
2. Slide the mounting bracket along the ledge toward the 8-pin feedthrough as far as it will go.
3. Hold the mounting bracket and mass analyzer in place with one hand. Tighten the two socket-head setscrews that hold the mounting bracket to the top cover plate.
4. Reconnect the damping gas line to the entrance endcap electrode.
5. Reconnect the electrical lead to the entrance endcap electrode.
6. Reconnect the electrical leads to the exit lens and exit endcap electrode.

8.5 Diffusion Pump

You should replace the diffusion pump oil after every two and a half years of operation. Replacing the oil in the diffusion pump includes the following procedures:

- Removing the Diffusion Pump
- Changing the Diffusion Pump Oil
- Reinstalling the Diffusion Pump

WARNING: The GC oven, injector, transfer line, EI/CI ion source, and diffusion pump can be very hot and can cause severe burns if they are touched. Allow heated parts to cool before servicing them.

Removing the Diffusion Pump

To remove the diffusion pump:

Supplies: Phillips Screwdriver, 5/16-inch box nut driver, 1/2-inch socket wrench or 1/2-in. open-ended wrench

Frequency: As needed

1. Shut down and vent the GCQ Plus (page 1-3).

WARNING: Unplug the GCQ Plus power cord before you proceed.

2. Remove the GCQ Plus top cover, then remove the vacuum manifold top cover plate (page 1-14).
3. Remove the GCQ Plus front and side covers. If your instrument has an inlet valve, remove the inlet valve (page 8-20).
4. Remove the diffusion pump guard, shown in Figure 8-13. If your instrument has an inlet valve, disconnect the evacuation solenoid wires from the vent control PCB.

5. Remove the cooling fan:
 - a. Disconnect the cooling fan electrical cable from the bottom of the fan housing.
 - b. Remove the three 5/16-inch hex nuts and remove the fan.
 - c. Remove the electrical connector from the fan housing to provide more room to work on the diffusion pump.
6. Disconnect the diffusion pump electrical cable from the diffusion pump control PCB.
7. Loosen the clamp that holds the foreline adapter to the backing flange of the diffusion pump. Disconnect the connection gauge with electrical wires from vent control PCB. Remove the foreline adapter from the pump.
8. Support the diffusion pump with one hand or with a suitably sized object. Then, use a 1/2-in. socket wrench (or open-end wrench) to loosen the four screws that hold the diffusion pump to the vacuum manifold.
9. Carefully lower the diffusion pump and remove it from the GCQ Plus.

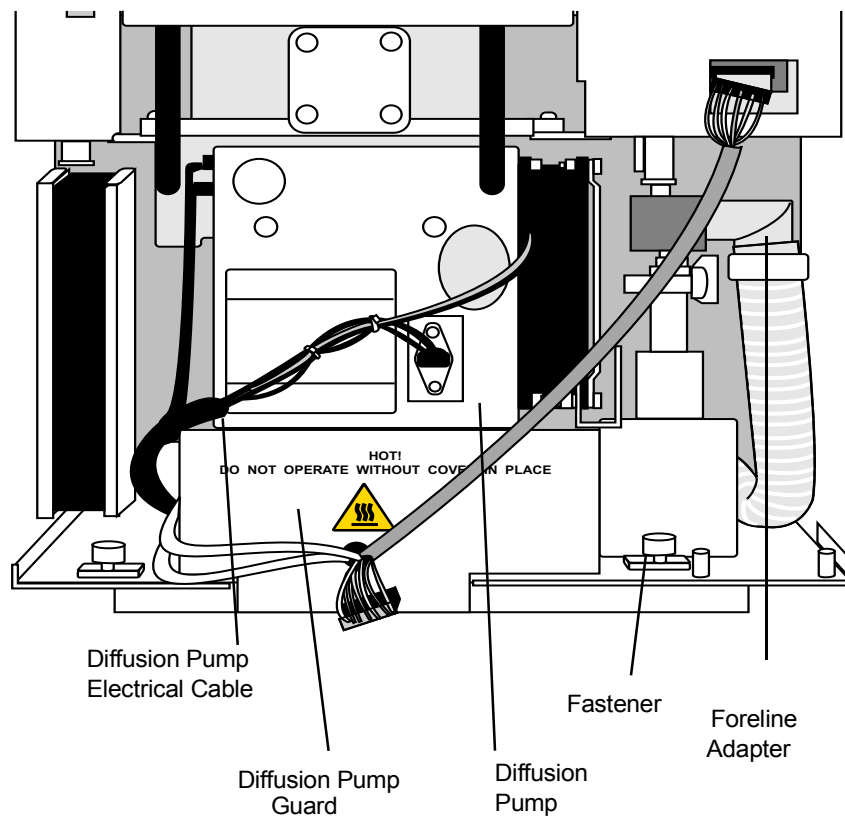


Figure 8-13. Front View of the GCQ Plus Showing the Diffusion Pump

WARNING: Toxic residues from mass spectrometer samples are likely to be concentrated in the pump oil. Spent pump oil must be disposed of in accordance with local and federal regulations.

Changing the Diffusion Pump Oil

To change the diffusion pump oil:

Supplies: Allen Wrench, Diffusion Pump Oil (PN A0301-14100)

Frequency: Every two and a half years

1. Loosen (but do not remove) the four screws securing the fan cowl. Wear gloves to withdraw the inlet baffle by removing the four fixing screws on the inlet flange. Place the inlet baffle assembly on a clean, lint-free surface. Do not disassemble the inlet baffle assembly. Handle the inlet baffle assembly carefully to avoid damage to the Peltier (thermoelectric device) wires. Figure 8-14 shows the location of these components.
2. Remove the transit spring and upper and lower jet assembly. Note the orientation of the parts. Place each part on a clean, lint-free surface.
3. Warm the diffusion pump and replacement oil by placing them in the GC oven at 50° C for 30 minutes.
4. Invert the pump and carefully pour the pump oil out through the top of the pump into a suitable container. Remove any oil that remains with a clean, lint-free tissue. Dispose of spent pump oil in accordance with local and federal regulations.
5. With the pump upright, pour the entire contents (20 mL) of one bottle of pump oil into the bottom of the pump through the pump inlet flange.
6. Reinstall the lower and upper jet assembly and transit spring.
7. Reinstall the inlet baffle assembly. Secure the inlet baffle assembly to the diffusion pump with the four screws. If you loosened the four screws that secure the fan cowl in step 1, tighten the four screws.

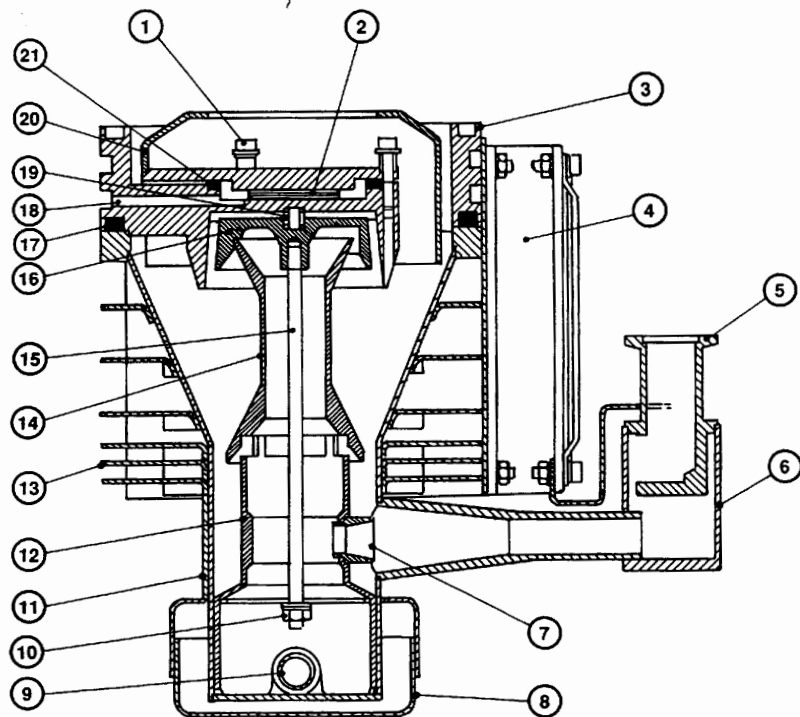
Reinstalling the Diffusion Pump

To replace the diffusion pump:

1. Place the diffusion pump in position under the opening in the vacuum manifold. Place a suitably sized object under the diffusion pump, or support it with one hand, to hold it in contact (or near contact) with the vacuum manifold, and install the four screws that hold it in place.

CAUTION: Be careful not to cross-thread the screws.

2. Reconnect the diffusion pump to the foreline adapter with the foreline adapter clamp. Tighten the clamp by hand.
3. Reconnect convectron wire to the Vent Control PCB.
4. Reconnect the diffusion pump electrical leads to the Diffusion Pump Control PCB.
5. Reinstall the cooling fan.
6. Reinstall the diffusion pump guard.
7. Reconnect the evacuation solenoid wires to vent control PCB
8. If you have an inlet valve, reinstall the inlet valve.
9. Reinstall the GCQ *Plus* front cover, side covers, and top cover.
10. Restart the system (page 1-5).



- | | | |
|--------------------------|---------------------|---|
| 1. Screw (3 off) | 8. Radiation shield | 15. Tie-rod |
| 2. Thermoelectric device | 9. Heater | 16. Top-jet cap |
| 3. Inlet-flange | 10. Nut and washer | 17. Pump body 'O' ring |
| 4. Cooling-fan | 11. Pump body | 18. Thermoelectric device cable leadthrough |
| 5. Backing flange | 12. Lower jet-stage | 19. Transit spring |
| 6. Backing condenser | 13. Cooling-fins | 20. Inlet-baffle assembly |
| 7. Ejector-stage | 14. Upper jet-stage | 21. Inlet-baffle 'O' ring |

Figure 8-14. Cross-Section of Diffusion Pump

8.6 Rotary-Vane Pump

Inspect the rotary-vane pump oil through the oil-level sight glass. The pump oil is a light amber color and clear. If the oil is cloudy or discolored, purge the oil to decontaminate the oil of dissolved solvents. If the pump oil is still cloudy or discolored, you must change it. In any case, you must change the pump oil after each 3000 hours (about 4 months) of operation. Figure 8-15 shows a detailed view of the Rotary-Vane Pump.

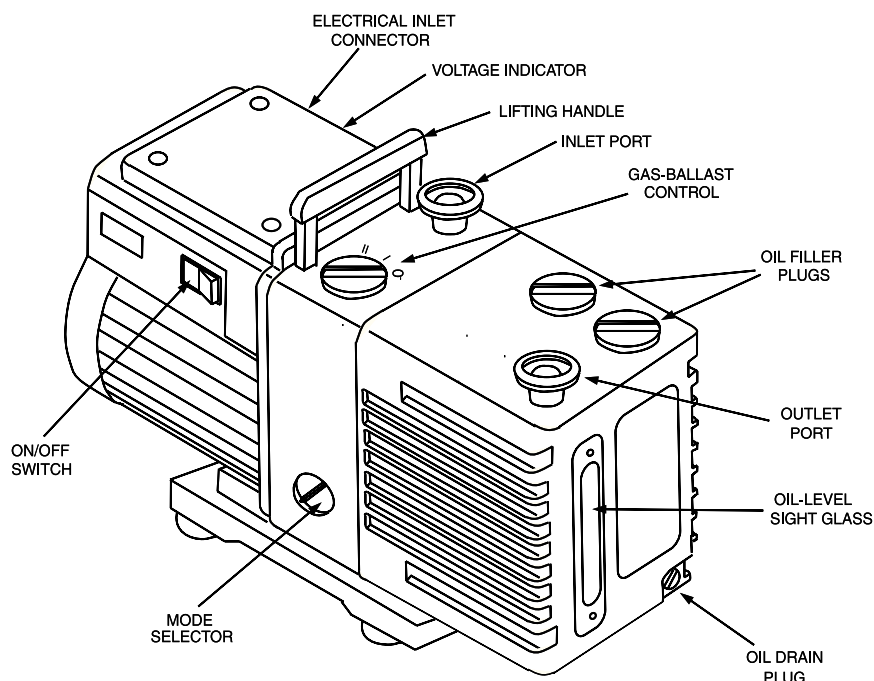


Figure 8-15. Rotary-Vane Pump

During normal operation, oil must always be visible in the oil-level sight glass between the MIN and MAX marks. Check the oil level. If the oil level is below the MIN mark, add oil (page 8-51).

Note: During normal operation the mode selector switch is set to high vacuum mode (turned fully clockwise) and the gas-ballast control is closed (position 0).

Purging (or decontaminating) the oil in the rotary-vane pump removes dissolved gases and low-boiling-point liquids from the pump oil. Purge the pump oil if it is cloudy or discolored. You can purge the pump oil without interrupting system operation. However, do not purge the pump during an acquisition, or while the electron multiplier or filament are on.

Purging the Rotary-Vane Pump Oil

To purge the rotary-vane pump oil:

Supplies: None

Frequency: Whenever the oil gets cloudy

1. Set the gas-ballast control to the low flow position (position I).
2. Allow the pump to operate for 10 minutes or until the oil is clear. If the oil remains cloudy or discolored after 10 minutes, replace the oil.
3. Set the gas-ballast control to the closed position (position 0).

Adding Oil to the Rotary-Vane Pump

To add oil to the rotary-vane pump:

Supplies: Rotary-Vane Pump Oil (PN A0301-15101)

Frequency: As needed

CAUTION: You must shut down and unplug the GCQ Plus system and the rotary-vane pump before you can add oil to the rotary-vane pump.

Note: The pump oil level must be between the MIN and MAX marks on the oil-level sight-glass for the pump to operate properly.

1. Shut down and unplug the GCQ Plus system (page 1-3).
2. Remove one of the oil filler plugs.

CAUTION: Use only factory-approved rotary-vane pump oil.

3. Add fresh oil into the reservoir until the oil is half way between the MIN and MAX level marks. If the oil level goes above the MAX level mark, remove the drain plug and drain the excess oil from the reservoir.
4. Refit the oil filler plug.
5. Plug in and restart the system (page 1-5).

Changing the Rotary-Vane Pump Oil

To change the rotary-vane pump oil:

Supplies: Rotary-Vane Pump Oil (PN A0301-15101)

Frequency: Every 3000 hours (about 4 months) of operation, or sooner if purging the pump oil fails to decontaminate the oil.

Note: For best results, change the oil while the rotary-vane pump is still warm from operation. Be careful as the oil can be very hot if the pump was recently operated.

1. Shut down and unplug the GCQ *Plus* system (page 1-3).
2. Disconnect the foreline vacuum hose from the pump. Place the rotary-vane pump on a bench.
3. Remove one of the oil filler plugs. Remove the drain plug, and allow the oil to drain into a suitable container. Dispose of the spent oil properly. Reinstall the oil drain plug.
4. Add fresh oil into the reservoir until the oil level is half way between the MIN and MAX level marks. If the oil level goes above the MAX level mark, remove the drain plug and drain the excess oil from the reservoir.
5. Reinstall the oil filler plug.
6. Return the rotary-vane pump to its former position on the floor and reconnect the foreline vacuum hose to the rotary-vane pump.
7. Plug in and restart the system (page 1-5).

8.7 Turbomolecular Pump

The turbomolecular pump does not require any routine maintenance. The pump contains sufficient lubricant to supply the bearings for life.

Appendix A

Spare Parts

This appendix contains part numbers for spare parts and consumables for the autosampler (optional), gas chromatograph, transfer line, *GCQ Plus*, data system, and manuals. To ensure proper results in servicing the *GCQ Plus* system, order only the parts listed or their equivalent.

The following is a list of spare parts available for your system. To order spare parts, contact ThermoQuest Austin at (512) 251-1494. Please have your *GCQ Plus* serial number ready when calling.

Autosampler, CTC A200S

Base plate, white	94022-10073
Base/body subassembly	A0950-00929
Cable, 25 pin connector, 10 ft	A0302-01950
Cable, inlet interface, autosampler, diagnostic	55000-63221
Caps, crimp, 0.7 mL vials	A0301-07560
Clamp	96200-10007
Connector, power plug, 2P3W	A0004-00345
Crimper, 5.0 mL, 20 mm	A0301-08701
Crossrail subassembly, autosampler	A0950-00930
Foam, acoustic, 1/2 in	A0301-09202
Fuse, 0.375 A, 220 V ac (package of 5)	A0006-30050
Fuse, 0.5 A, 220 V ac, 5 x 20 mm, SB	A0006-11105
Fuse, 0.63 A, 110 V ac	A0006-30051
Fuse, 1.0 A, 110 V ac, 5 x 20 mm, SB	A0006-11101
Gauge setting	96200-10008
Head/injector subassembly	A0950-00932
Manual, CTC Operating/Service	A0920-06032
Manual, Setup Guide,	55000-97030
PCB, Processor	A0950-01058
Stop, eccentric	96200-20003
Syringe, 10 µL, Hamilton	A0950-00904
Thumb nut, 10-32, steel	A0301-24147
Kit, autosampler waste bottle	A0301-23025
Kit, battery/capacitor	70001-62021
Battery, lithium, 3 V (2 ea)	A0301-05325

Capacitor, ceramic, 0.47 μ f, 50 V, 20% (1 ea)	A0002-24100
Kit, 0.7 mL samples	70001-60203
Crimper, 0.7 mL vial, 8 mm	A0301-08700
Sample tray, 10 x 20, 0.7 mL vials	A0301-24151
Setup guide	55000-97030
Vials/caps kit, 0.7 mL	A0301-23056
Kit, 2.0 mL samples	70001-60202
Sample tray assembly, 2 mL vial	A0301-24150
Setup guide	55000-97030
Vials/caps, 2 mL (package of 500)	A00301-23055

Gas Chromatograph

Cable, RS-232 (from GC to data system)	A0302-00005
Display, front panel	A0611-60150
Fan, cooling	A0007-00500
Injector, split/splitless, body	A0201-00020
Keypad assembly, front panel	A0950-00576
Motor, oven blower	A0013-00020
PCB, Central Processor	A0009-00003
PCB, Power Supply	A0009-00002
PCB, Temperature Control	A0009-00001
Septum, 9.5 mm	A0301-16990
Trap, hydrocarbon	A0201-00001
Valve, needle, septum purge	A0301-00001
Valve, needle, vent flow	A0110-00015

Gas Chromatograph

Valve, solenoid, cryogenic	A0110-00005
Valve, solenoid, split/splitless	A0111-00010

Transfer Lines

Transfer line assembly (TRACE GC 2000)	96000-60066
Transfer line assembly (CE 8000 Top GC)	96000-60065
Transfer line assembly (Finnigan GCQ GC)	96000-60064
Transfer line assembly (Hewlett-Packard GC)	96000-60065
Transfer line tip, Vespel	96000-20026

El/CI Ion Source

Ion Source Assembly	119720-60047
Back plane	119714-20030
Spring base	119713-20037
Block, ion source	96000-20006
Filament assembly	119701-60287
Ion volume holder	70001-20532
Ion volume, CI	96000-20066
Ion volume, EI	119710-20061
Lens, L1	119705-60043
Lens, L2 (ion gate)	119706-60044
Lens, L3	119707-60045
Magnet support	119712-20110
Magnet, ion source	70001-98195
PCB, Ion Source Block and heater assembly	96000-60087
Screw, 6-32 × 3/8 in., with a star washer	A0415-63206
Spring, wave	A0201-11597
Spring, ion volume	96000-20176
Stud, spring holder	70001-20549
Thumb nut, magnet support	70001-20545
Analyzer stop thumb screw	70001-20579
Spring thumb screw	70001-20565
Ion volume key thumb screw	70001-20566
Spring pin	70001-20533
Bushing (Probe guide)	96000-20113
PCB interconnect assembly	119700-1000
Gas inlet adapter	119715-60075

Mass Analyzer

Kit, mass analyzer	97000-62001
Electrode, ring, 0.707 cm	96000-20016
Electrode, end cap, entrance/exit	96000-20047
Exit lens	97000-20205
Nipple, helium	96000-20117
Nut	96000-20022
Post	96000-20083
Sleeve, exit lens	97000-20208
Spacer	96000-40001
Spring washer, 0.33 in. ID, 0.49 in. OD, stainless steel	A0474-11618

Ion Detection System

Anode, electron multiplier	96000-20076
Cathode, electron multiplier	A0022-02400
Electron multiplier assembly	96000-60036
Power supply, electron multiplier/conversion dynode	96000-60078
Conversion dynode kit	96000-62023
Dynode feedthrough (1 ea)	96000-20150
O-Ring, 1.37 in. ID, 0.103 in. thick, Viton (1 ea)	A0107-10400
Screw, pan, 6-32 \times 1/2 in., stainless steel (3 ea)	A0415-63208
Spring, coil, 1.358 in. ID, 0.083 in. (1 ea)	A0201-11680
Tube, shield, dynode (1 ea)	97000-20275

Vacuum System

Gas Inlet Assembly	96000-62061
Calibration compound chamber	10006-40010
FC-43 vial	50010-30059
Foreline adapter (diffusion pump)	96000-20142
Foreline adapter (turbo pump)	119416-0001
Fan, diffusion pump exhaust, 110 V	A0013-00506
Fan, diffusion pump exhaust, 220 V	A0013-00507
Fan, turbo pump inlet, 110 V	A0013-00506
Fan, turbo pump exhaust, 24 V	119563-0001
Fan, turbo pump inlet, 220 V	A0013-00507
Fan, main instrument rear	A0013-00250
CI Reagent Gas Pressure Regulator	A0105-03520
Helium Gas Pressure Regulator	A0105-03010
Gas purifier (helium line inside GCQ)	76461-0035
Convectron gauge	A0105-00501
Diffusion pump, 120 V ac	A0108-00448
Diffusion pump, 230 V ac	A0108-00450
Ferrule, 1/4-in., calibration compound chamber	95001-20310
Ion gauge	A0105-01520
O-ring, top cover	A0107-10406
Rotary-vane pump, RV5, 115 / 220 V ac	76505-3002
Rotary-vane pump, RV3, 115 / 220 V ac	119317-0001
Seal, Inlet Valve	76412-0105
Vent valve assembly	96000-60059

PCBs and Power Supplies

Battery pack, Ni-Cad 7.2 V	96000-98018
Front Panel PCB	119576-0001
Voltage Select PCB	96000-61060
Fuse, 1.6 A, 5 × 20 mm, 250 V, time lag (Voltage select PCB F1-F2)	76703-0516
PCB, Acquisition DSP	119700-61260
PCB, Analyzer	96000-61020
PCB, Control DSP	19700-61270
PCB, Diffusion Pump Control, 110 V	96000-60177
PCB, Diffusion Pump Control, 220 V	96000-60277
Fuse, 3.15 A, 5 × 20 mm, 250 V (Diffusion Pump Control PCB F1)	A0006-10510
PCB, Low Pass Filter	96000-61080
PCB, Main System	96000-61160
Fuse, 0.16 A, 5 × 20 mm, 250 V, time lag (F3-F4)	A0006-01700
Fuse, 0.25 A, 5 × 20 mm, 250 V, time lag (F2)	A0006-11204
Fuse, 0.315 A, 5 × 20 mm, 250 V, time lag (F6-F7)	A0006-04550
Fuse, 0.4 A, 5 × 20 mm, 250 V, time lag (F8-F9)	A0006-05080
Fuse, 0.8 A, 5 × 20 mm, 250 V, time lag (F10)	A0006-06075
Fuse, 1.6 A, 5 × 20 mm, 250 V, time lag (F11)	A0006-08650
Fuse, 2.5 A, 5 × 20 mm, 250 V (F5)	A0006-11202
Fuse, 3.15 A, 5 × 20 mm, 250 V, time lag (F1)	A0006-10510
PCB, RF Amplifier	96000-61090
PCB, RF Control	96000-61100
PCB, Ring dc Filter	96000-61130
PCB, Vent Control	96000-61040

PCB, Waveform / RF DDS	97000-61280
PCB, Waveform Amplifier	96000-61110
Power Module, 110 V ac	96000-60062
Power Module, 220 V ac	96000-60070
Power supply, keep-alive	A0012-24210
Fuse, 2.0 A, 5 × 20 mm, 250 V, quick act (keep alive power supply F1)	00006-08806
Power supply, electron multiplier/Conversion Dynode	96000-60078
Turbomolecular Pump Control PCB	119560-0001

RF Detector Assemblies

RF detector assembly	96000-60074
RF coil assembly	96000-60058
O-Ring, 1.37 in. ID, 0.103 in. thick, Viton (1 ea)	A0107-10400
RF Feedthrough (1 ea)	97000-60169
Screw, pan-head, 6-32 x 1/2, stainless steel (3 ea)	A0415-63208

Cables

Cable, rear cooling fan – Power Module	96000-63027
Cable, Control DSP PCB – Acquisition DSP PCB	96000-63029
Cable, Control DSP PCB – Waveform DDS PCB	96000-63030
Cable, data system – MS detector	96000-63022
Cable, transfer line - CI valve - keep alive power supply fan	96000-63004
Cable, Front Panel PCB – Vent Control PCB,	96000-63028
Cable, multiplier supply – electron multiplier	96000-63008
Cable, Low Pass Filter PCB – RF coil	96000-63012

Cable, rear cooling fan – Power Module	96000-63027
Cable, Main System PCB – Analyzer (dc ring filter) PCB	96000-63001
Cable, Main System PCB – Analyzer PCB (electrometer)	96000-63002
Cable, Vent Control PCB, diffusion pump control PCB, main system PCB	96000-63003
Cable, Main System PCB – electron multiplier/dynode supply	96000-63007
Cable, Main System PCB – ion gauge	96000-63009
Cable, Main System PCB – RF Amplifier/Waveform Amplifier PCB	96000-63011
Cable, Main System PCB – RF Control PCB	96000-63005
Cable, Main System PCB, power module PS-1	96000-63017
Cable, Main System PCB, power module PS-2	96000-63018
Cable, convectron gauge – Vent Control PCB	96000-63015
Cable, Power cord, 120 V ac, 20 A (USA)	96000-98034
Cable, Power cord, 230 V ac, 15 A (international)	96000-98036
Cable, power module - main system PCB	96000-63016
Cable, RF Amplifier PCB – Low Pass Filter PCB	96000-63010
Cable, RF Amplifier PCB - waveform amplifier PCB - power module	96000-63019
Cable, RF Control PCB – RF Amplifier PCB	96000-63013
Cable, Vent Control PCB – vent valve	96000-63014
Cable, Waveform Amplifier PCB – Analyzer PCB	96000-63006

Maintenance Kit

Kit, MS Detector Maintenance	96000-62013
Aluminum oxide sample (1 ea)	32000-60340
Applicators, cotton tip (2 packages)	A0301-02000
Electron multiplier assembly (1 ea)	96000-60036
Filament assembly (2 ea)	70001-60287
Gloves, cotton, medium (6 pair)	A0301-09710
O-ring, 11.475 in. ID \times 0.210 in. thick, conducting (1 ea)	A0107-10406
O-ring, 0.987 in. ID \times 3/32 in. thick, Viton (2 ea)	A0107-10401
O-ring, 0.984 in. ID \times 1/8 in. thick, Viton (1 ea)	A0107-11500
Oil, diffusion pump (2 bottles)	A0301-14100
Oil, rotary-vane pump (2 liter)	A0301-15101
Spring, ion volume (1 ea)	96000-20176

Spares Kit

Kit, MS Detector Spares	96000-62080
FC-43 vial (1 ea)	50010-30059
Ferrule, 1/8 in. to 0.4 mm, V/G (1 ea)	A0101-18115
Filament assembly	119701-60287
Fuse, 0.16 A, 5 \times 20 mm, 250 V ac (2 ea)	A0006-01700
Fuse, 0.25 A, 5 \times 20 mm, 250 V ac (2 ea)	A0006-11204
Fuse, 0.315 A, 5 \times 20 mm, 250 V ac (2 ea)	A0006-04550
Fuse, 0.4 A, 5 \times 20 mm, 250 V ac (2 ea)	A0006-05080
Fuse, 0.5 A, SB, 5 \times 20 mm, 250 V ac (2 ea)	A0006-07608
Fuse, 0.8 A, 5 \times 20 mm, 250 V ac (2 ea)	A0006-06075

Kit, MS Detector Spares	96000-62080
Fuse, 1.0 A, 5 × 20 mm, 250 V ac (2 ea)	A0006-07610
Fuse, 1.25 A, 5 × 20 mm, 250 V ac (2 ea)	A0006-07650
Fuse, 1.6 A, 5 × 20 mm, 250 V ac (2 ea)	76703-0516
Fuse, 1.6 A, 5 × 20 mm, 250 V ac (2 ea)	A0006-08650
Fuse, 2.5 A, 5 × 20 mm, 250 V ac (2 ea)	A0006-11202
Fuse, 3.15 A, 5 × 20 mm, 250 V ac (2 ea)	A0006-10510
O-ring, 0.987 in. ID, 3/32 in. thick, Viton (1 ea)	A0107-10401
Oil, diffusion pump	A0301-14100
Screw, set, socket, 10-32 × 3/8 in., stainless steel (3 ea)	A0451-90047
Tip, transfer line, Vespel (1 ea)	96000-20026
Tubing, fused silica, 0.05 mm ID (1 ea)	A0106-10496

Installation Kit

Kit, MS Detector Installation	96000-62011
Cable tie, 7 in. (1 ea)	00007-90500
Ferrule, Swagelok type, back, 1/8 in., brass (6 ea)	A0101-02500
Ferrule, Swagelok type, front, 1/8 in., brass (6 ea)	A0101-08500
Gloves, cotton, medium (6 pair)	A0301-09710
Ion volume holder (1 ea)	70001-20532
Ion volume, CI (1 ea)	96000-20066
Nut, Swagelok-type, 1/8 in., brass (6 ea)	A0101-15500
Oil, rotary-vane pump (1 liter)	A0301-15101
Plastic manifold cover (1 ea)	96000-20132
Tool, driver, allen, hex 3/32 in. (1 ea)	A0725-00030
Tool, ion volume (1 ea)	96000-20173
Trap, oxygen, moisture, hydrocarbon (1 ea)	A0950-01500
Tube, copper, 1/8 in. OD (10 ft)	A0301-22701
Vial, decafluorobenzophenone, 1 pg/ μ L, 10 pg/ μ L, 100 pg/ μ L (6 pk)	96000-98044
Vial, GCQ test mix (1 ea)	A0301-23057

Appendix B

Functional Block Diagrams

This appendix contains functional block diagrams for the *GCQ Plus* system and its subsystems.

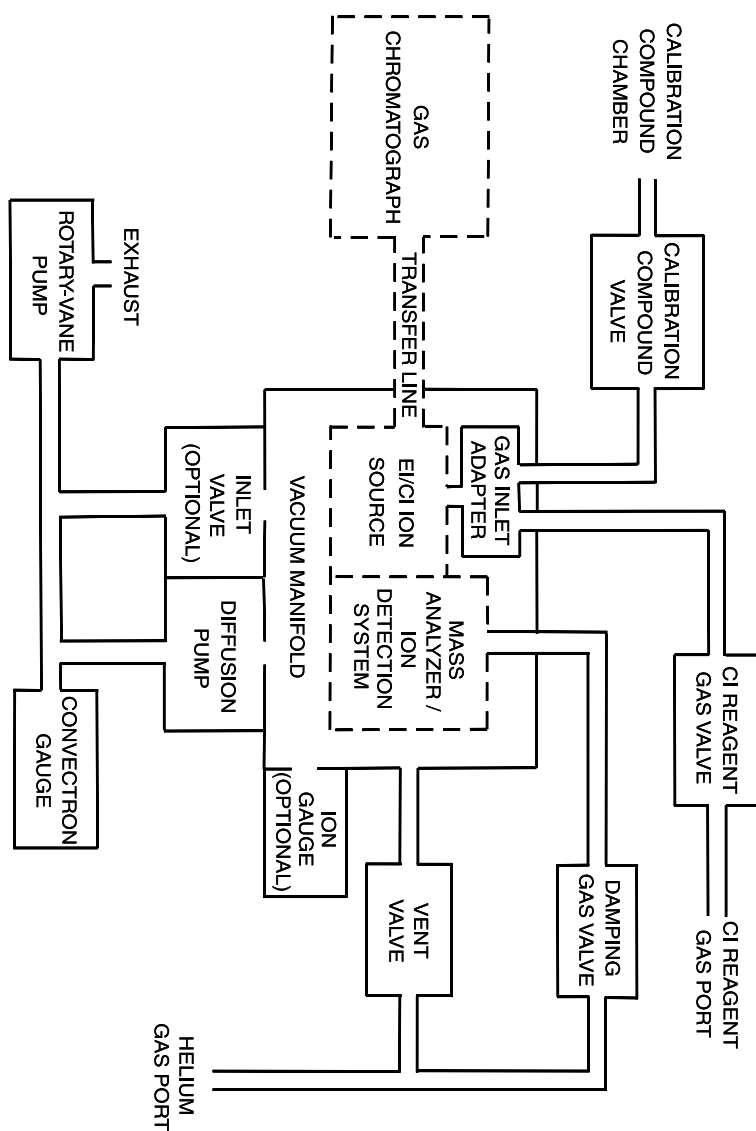


Figure B-1. The Vacuum System and Inlet Gases Hardware

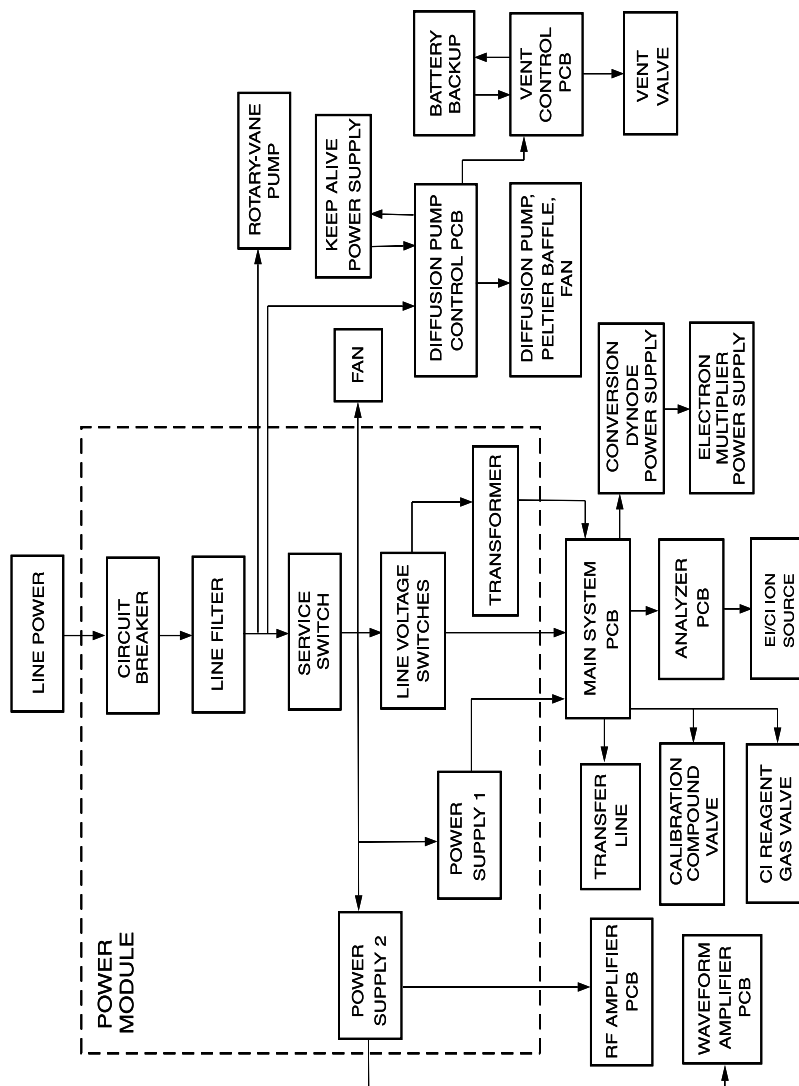


Figure B-2. The Power Module and Power Distributions

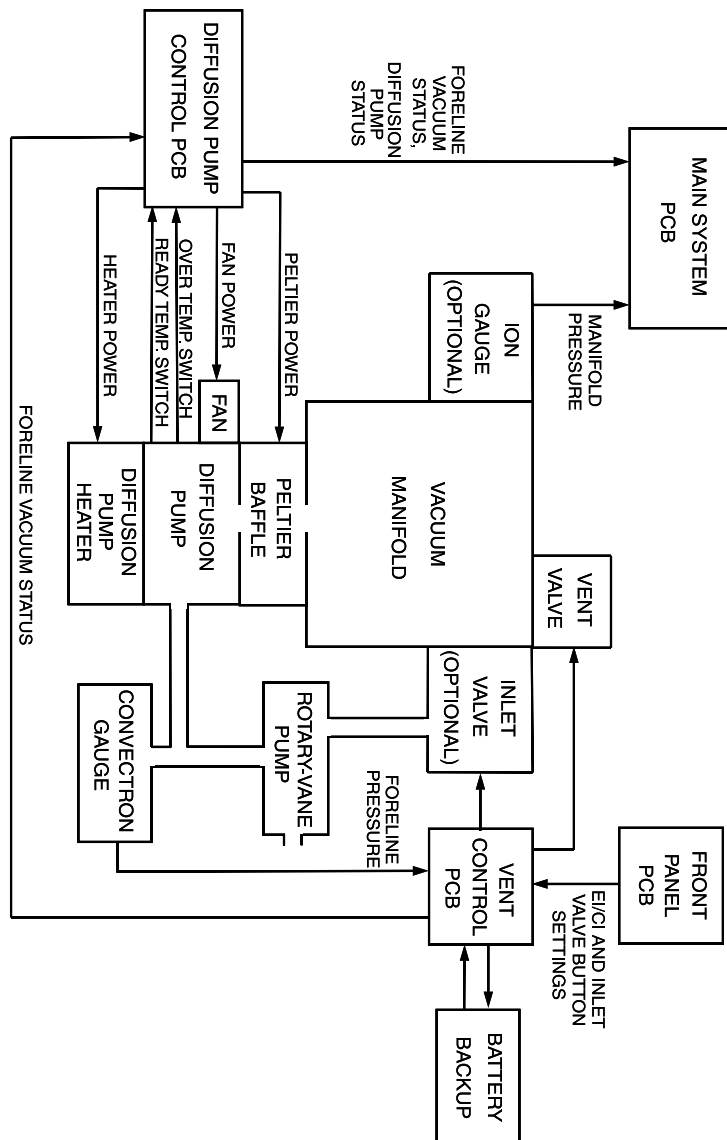


Figure B-3. Vacuum System Electronic Assemblies

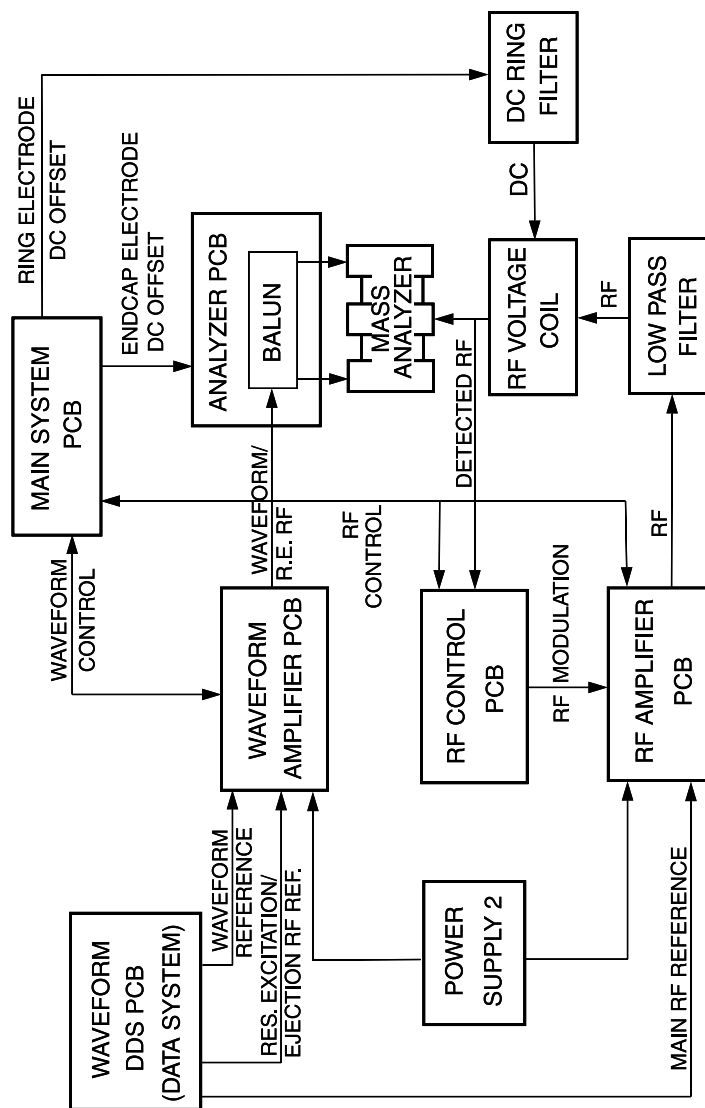


Figure B-4. RF/Waveform Generation Electronic Assemblies

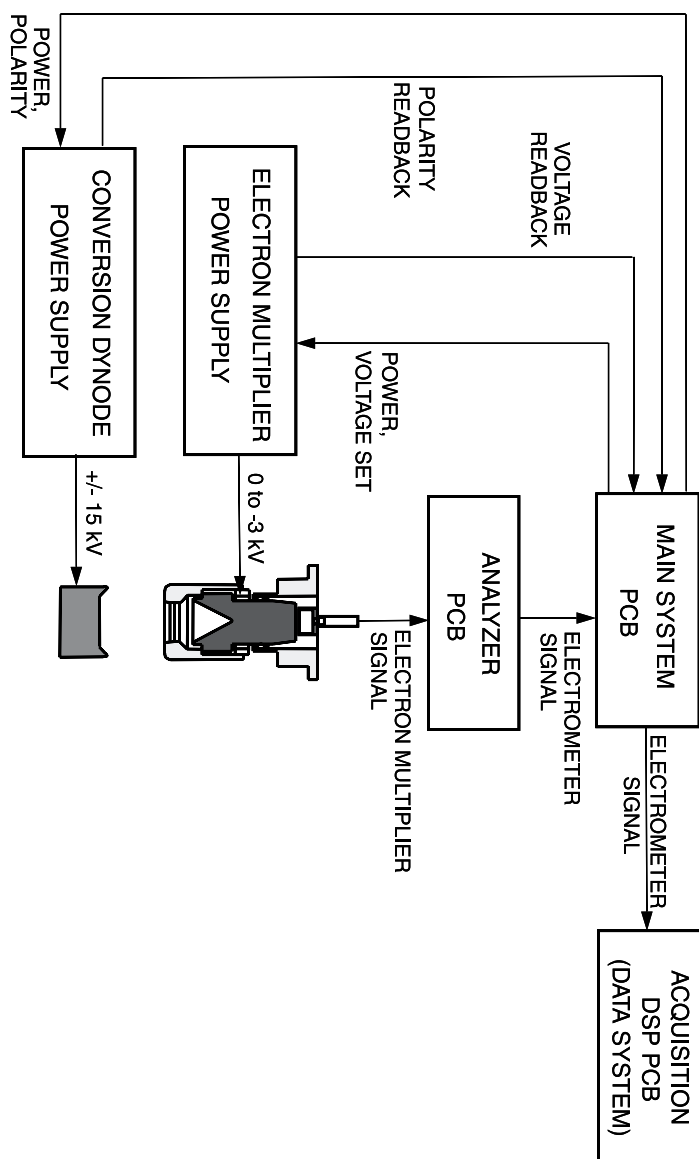


Figure B-5. Block Diagram of Ion Detection System

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