

# **DSQ II**

## **Hardware Manual**

120299-0002 Revision C

December 1, 2009

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## DSQ II Hardware Manual, 120299-0002, Revision C

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## Preface

This guide contains detailed instructions for operating, maintaining, and troubleshooting the DSQ II mass spectrometer.

## About Your System

Thermo Fisher Scientific systems provide the highest caliber gas chromatography/mass spectrometry (GC/MS) instrumentation available on today's market.

GC/MS represents a combination of two powerful analytical techniques: GC, which acts as a separation technique and MS, which acts as a detection technique. Complex mixtures of individual compounds can be injected into the GC, either manually or through the use of an optional autosampler, and then separated for presentation to the MS. The MS will then generate a mass spectrum of the GC eluent and its components, which can be used for qualitative identification, as well as accurate and precise quantification of the individual compounds present in the sample.

**IMPORTANT** Thermo Fisher Scientific systems are designed to optimize both the separation and detection capabilities of GC/MS techniques and combine them in a synergistic fashion to provide high performance analytical capabilities for both research and routine applications. More information on the use of this system can be found in related documentation sources and through the provided contact information.



**WARNING** Thermo Fisher Scientific systems operate safely and reliably under carefully controlled environmental conditions. If the equipment is used in manner not specified by the manufacturer, the protections provided by the equipment may be impaired. If you maintain a system outside the specifications listed in this guide, failures of many types, including personal injury or death, may occur. The repair of instrument failures caused by operation in a manner not specified by the manufacturer is specifically excluded from the Standard Warranty and service contract coverage.

## Power Ratings

Mass Spectrometer (MS)

- 120 V ac +6/-10%, 50/60 Hz, 15 A max
- 230 V ac  $\pm$ 10%, 50/60 Hz, 10 A max

Gas Chromatograph (GC)

- 120 V ac +6/-10%, 50/60 Hz, 20 A max
- 230 V ac  $\pm$ 10%, 50/60 Hz, 10 A max

Detailed instrument specifications are in the Product Specification or Product Brochure.

## Safety Alerts and Important Information

Make sure you follow the precautionary notices presented in this guide. Safety and other special notices appear in boxes and include the following:



**WARNING** This is the general warning safety symbol and safety alert word to prevent actions that *could* cause personal injury. It highlights hazards to humans or the environment. Each WARNING safety alert is preceded with this safety symbol and another appropriate safety symbol (see “[Safety Symbols and Signal Words](#)” on [page xv](#).) Then it is followed with an appropriate safety precautionary message. When you see a safety alert on your instrument or in the publications, please carefully follow the safety instructions before proceeding.

**CAUTION** This is the safety alert word to prevent actions that *may* cause personal injury or instrument damage. We use it to highlight information necessary to prevent personal injury or damage to software, loss of data, or invalid test results; or might contain information that is critical for optimal system performance. A CAUTION safety alert is always preceded with an appropriate safety symbol (see “[Safety Symbols and Signal Words](#)” on [page xv](#).) Then it is followed with an appropriate safety precautionary message. When you see a safety alert on your instrument or in the publications, please carefully follow the safety instructions before proceeding.

**IMPORTANT** Highlights information necessary to prevent damage to software, loss of data, or invalid test results; or might contain information that is critical for optimal performance of the system.

**Note** Emphasizes important information about a task.

**Tip** Helpful information that can make a task easier.

## Safety Symbols and Signal Words

All safety symbols are followed by **WARNING** or **CAUTION**, which indicates the degree of risk for personal injury and/or instrument damage. Cautions and warnings are following by a descriptor, such as **BURN HAZARD**. A **WARNING** is intended to prevent improper actions that *could* cause personal injury. Whereas, a **CAUTION** is intended to prevent improper actions that *may* cause personal injury and/or instrument damage. The following safety symbols may be found on your instrument and/or in this guide:



**BURN HAZARD.** This symbol indicates a hot surface that *could* or *may* cause burn injuries.



**ELECTRICAL SHOCK HAZARD.** This symbol indicates that an electrical shock *could* or *may* occur.



**FIRE HAZARD.** This symbol indicates a risk of fire or flammability, or that fire/flammability damage *could* or *may* occur.



**FLAMMABLE GAS HAZARD.** This symbol alerts you to gases that are compressed, liquefied or dissolved under pressure and can ignite on contact with an ignition source. This symbol indicates this risk *could* or *may* cause physical injury.



**GLOVES REQUIRED.** This symbol indicates that you must wear gloves when performing a task or else physical injury *could* or *may* occur.



**HAND AND CHEMICAL HAZARD.** This symbol indicates that chemical damage or physical injury *could* or *may* occur.



**INSTRUMENT DAMAGE.** This symbol indicates that damage to the instrument or module *may* occur. This damage may not be covered under the standard warranty.



**LIFTING HAZARD.** This symbol indicates two or more people are required to lift the object to prevent a physical injury that *could* or *may* occur.



**MATERIAL AND EYE HAZARD.** This symbol indicates that eye damage *could* or *may* occur.



**RADIOACTIVE.** This symbol indicates the presence of radioactive material *could* or *may* occur.



**READ MANUAL.** This symbol alerts you to carefully read your instrument's operational instructions before usage to ensure your safety and the instrument's operational ability. Failing to carefully read the instructions *could* or *may* put you at risk for a physical injury.



**TOXIC SUBSTANCES HAZARD.** This symbol indicates that exposure to a toxic substance *will*, *could*, or *may* cause personal injury or death.



This is the general warning symbol that the ISO 3864-2 standard refers to as the general warning signal to prevent personal injury. It is a triangle with an exclamation mark that precedes the **WARNING** safety alert word. In the vocabulary of ANSI Z535 signage, this symbol indicates a possible personal injury hazard exists if the instrument is improperly used or if unsafe actions occur. We use this symbol and another appropriate safety symbol to alert to an imminent or potential hazard that *could cause personal injury*.

## Contacting Us

There are several ways to contact Thermo Fisher Scientific.

### ❖ To contact Technical Support

Phone	800-532-4752
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## Related Documentation

In addition to this guide, Thermo Scientific provides the following documents for the DSQ II. These documents are also available on a “Print-By-Request” basis.

*DSQ II Document Set*, PN 120299

- *DSQ II Preinstallation Guide*, PN 120299-0001
- *DSQ II Hardware Manual*, PN 120299-0002
- *DSQ II User’s Guide*, PN 120299-0003
- *Instrument Help* is available from within the *Tune* software.

To suggest ways we can improve the documentation, use your browser to complete our [documentation survey](#).



# Basic Operations

This chapter describes basic operations of the TRACE GC Ultra and DSQ II.

## Contents

- “Installing a Column into the GC/MS System” on page 4
- “Removing a Column from the GC/MS System” on page 15
- “Starting Up the GC/MS System” on page 17
- “Shutting Down the GC/MS System” on page 18

## Getting the Right Tools

The following table contains the tools and parts you will need to install the DSQ II system. Some items are included with the system and some are not.

**Table 1.** DSQ II System Installation Tools

Tools Needed
Aluminum plug (PN 290 326 55)
Brass back ferrules, Swagelok (PN A0101-02500)
Brass front ferrules, Swagelok (PN A0101-08500)
Brass nuts, Swagelok (PN A0101-15500)
Cable, PC to DSQ II, 15 ft Ethernet crossover (PN 76396-0052)
Cable, Serial, PC to TRACE GC Ultra (PN 230 980 00)
Cable, GC to DSQ II remote start (PN 76396-0050)
Capillary column, TR5MS, 15 m, 0.25 mm i.d., 0.25 $\mu$ m (PN 76317-3015)
CI Ion Volume (PN 119650-0230), if applicable
Column measuring tool (PN 119640-0550)
Copper tubing, clean (PN 76381-0041, 1/8-in. o.d., 0.030-in. wall)
Digital voltmeter (Fluke model 77 or equivalent)
Dusting spray containing tetrafluoroethane (Falcon® Dust-Off®, MicroCare® MicroBlast™, or equivalent)
Flashlight, small hand-held
Flow meter, Thermo Scientific GFM Pro (PN 66002-010)
Forceps (PN 76360-0400)
Gas filter, helium (PN A0950-01600)
Gloves, clean, lint and powder-free (medium PN 23827-0008, large PN 23827-0009)
Hex nut driver, 5.5 mm
Injector ferrule for 0.25 mm column (PN 290 134 88)
Injector nut (PN 350 324 23)
Ion volume tool (PN 119270-0001)
I/R tool and guide bar, if applicable
Leak detector (Thermo Scientific GLD Pro PN 66002-001 or equivalent)
Magnifying glass
Methanol or other suitable solvent
Potentiometer adjustment tool

**Table 1.** DSQ II System Installation Tools, continued

Tools Needed
Power cords with appropriate plugs
Preinstallation Guide (PN 120299-0001)
Scoring wafer (or sapphire scribe) to cut capillary column
Screwdriver, flat blade
Screwdriver, Phillips #1
Screwdriver, Phillips #2
Syringe, 10 $\mu$ L, 70 mm needle (PN 3650-0103)
Tape measure
Teflon <sup>®</sup> thread tape
Tissue, lint-free
Tubing cutter
Test mix, octafluoronaphthalene and benzophenone (PN 120150-TEST)
Transfer line ferrule, 0.4 mm i.d. (PN A0101-18100)
Wrench, (adjustable) 12-in.
Wrench, (Allen) 1/16-in.
Wrench set, (Allen) 5, 2, 2.5, 3, 4, 5 mm (PN 3812-0100)
Wrench set, (open-ended) 5–17 mm
Wrench set, (open-ended) 1/4-in., 5/16-in., 7/16-in. (2), 9/16-in., 1/2-in.

## Installing a Column into the GC/MS System

To install a column, you will need:

- Capillary column, 5MS, 15 m, 0.25 mm i.d., 0.25  $\mu$ m
- Column Measuring Tool
- Gloves, clean, lint- and powder-free
- Injector ferrule, for 0.25 mm column
- Magnifying glass
- Methanol or other suitable solvent
- Scoring wafer (or sapphire scribe) to cut capillary column
- Leak detector (Thermo Scientific GLD Pro PN 66002-001 or equivalent)
- Flowmeter (Thermo Scientific GFM Pro flowmeter PN 66002-010 or equivalent)
- Tissue, lint-free
- Transfer line ferrule, 0.4 mm i.d.
- Wrench, open-ended, 5/16-in.
- Wrench, open-ended, 6 mm
- Wrenches (two), open-ended, 7/16-in.

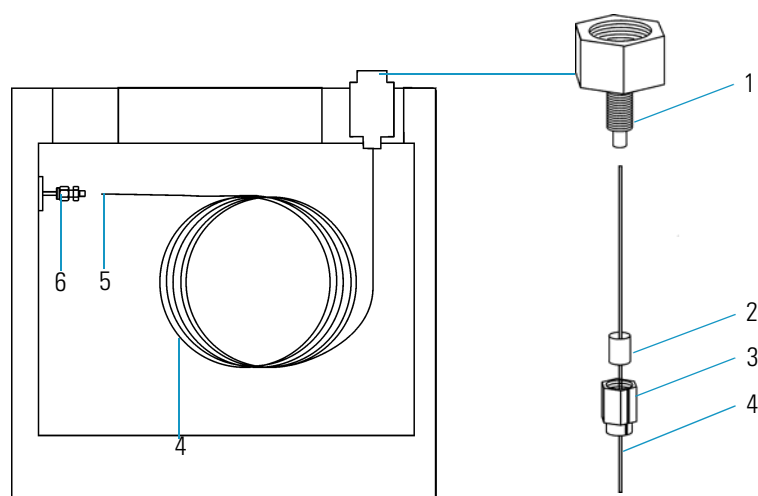
For information about setting up the TRACE GC Ultra or FOCUS GC, refer to the documentation supplied with the instrument.



**WARNING - BURN HAZARD:** The injector, oven, and transfer line may be hot. Allow them to cool to room temperature before touching them.

1. Connect the column to the injector that is inside the TRACE GC Ultra.

**Figure 1.** GC Injector (Front)



1	Injector	4	Column
2	Injector Ferrule	5	Column Outlet
3	Injector Nut	6	Transfer Line

- a. Unwind the column about a half turn for the inlet and two turns for the DSQ II.

**Note** Wear clean, lint- and powder-free gloves when you handle the column and injector ferrule.

- b. Wipe about 100 mm (4 in.) of the column with a tissue soaked in methanol.
- c. Insert the column through the injector nut and ferrule (open end up). Wipe the column again with a tissue soaked in methanol.
- d. Use a scoring wafer to score and break the column about 2.5 cm (1 in.) from the end. Use a magnifying glass to check for an even, flat cut. Repeat if necessary.

**Tip** Slide a septum on the column before the injector nut to make it easier to measure the proper distance between the nut and end of the column.

- e. Insert the column into the injector so that the end of the column is the proper distance (splitless = 64 mm, split = 40 mm, PTV = 30 mm) from the back of the injector nut.
  - f. Verify the position with the column measuring tool.
  - g. Use your fingers to tighten the injector nut and give it an additional quarter turn with the wrench.
  - h. Use a scoring wafer to score and break the column outlet about 2.5 cm (1 in.) from the end.
  - i. Power on the TRACE GC Ultra.
2. Set up the TRACE GC Ultra.
    - a. Set the oven and injector temperatures to 30 °C.
    - b. Set the injector flow to 1.0 mL/min.
    - c. Turn off vacuum compensation (under the Right or Left Carrier menu).
    - d. Dip the column outlet in a small vial of methanol. Bubbles indicate there is flow through the column.
    - e. Allow the column to purge for at least 10 minutes.
  3. Perform column characterization.
    - a. Raise the oven and injector temperatures to 50 °C and allow them to stabilize. Then confirm that the carrier gas is on.



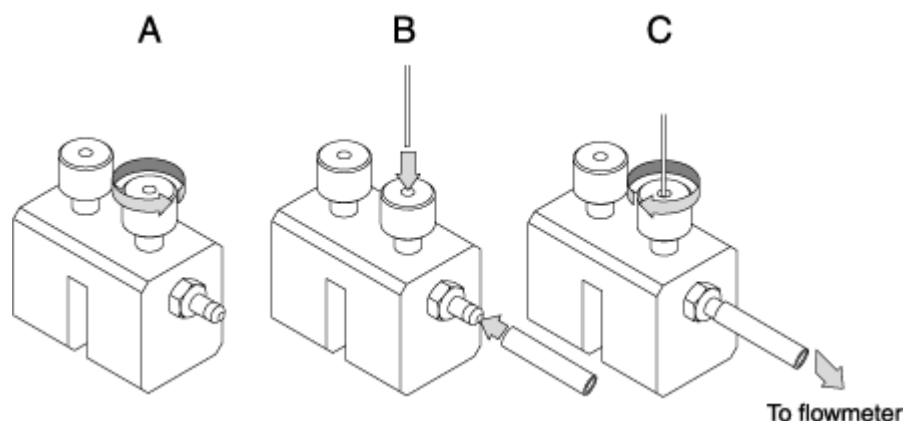
**CAUTION - INSTRUMENT DAMAGE:** Do not allow the clear plastic component to exceed 80 °C. Otherwise, it will melt and damage the instrument.

## 1 Basic Operations

### Installing a Column into the GC/MS System

- b. Carefully push the capillary column end into the flowmeter section of the column-flow meter connector, as shown in Figure 2.

**Figure 2.** Flow Measure



- c. Connect the flowmeter to the dedicated fitting on the column flow meter connector.

**Note** The available options (Right column or Left column) will differ depending on the configuration of your GC.

- d. Press **Column Eval** to open the following menu:

COLUMN INFORMATION	
Right column	
Left column	<

**Note** Make sure the Vacuum Compensation parameter is set to OFF in the Carrier menu, which is accessed by pressing the **Left Carrier** or **Right Carrier** button. Otherwise an accurate column evaluation cannot be performed.

- e. Scroll to the Right or Left column to evaluate and press **Enter**. The following menu appears if you select the left column and use the settings below to set the physical characteristics of the column.

LEFT <sup>1</sup> COLUMN INFO	
Length (m)	15.00
ID (mm)	0.25
Film th. (um)	0.25

1. These settings could also apply to a right column.

f. Select **Pre/post column? yes (Y) or no (N)**.

- If a pre-/post-column is not present, select **N**.
- If a pre-/post-column is present, select **Y**. You must set the length and nominal internal diameter of the pre-/post-column in the same valid ranges for the column. The following two lines are added to the menu.

Pre/post column?	Y
P/p col. L	10.00
P/p col. ID	0.530

g. According to the physical characteristics of the column, the system calculates and displays the relevant Column K-factor.

LEFT <sup>1</sup> COLUMN INFO	
Column K=	(0.8087)
Calc'd ID	(0.0000)
Run Column eval?	

1. These settings could also apply to a right column.

h. To evaluate the column, scroll to **Run column eval.?** and press **ENTER**.

The system will set the Column K factor by pressurizing the column to obtain a nominal carrier flow of 5 mL/min. The display shows the pressure.

i. Using the flowmeter, measure the carrier gas flow at the outlet of the column. Scroll to **Measured Flow** and set the value of the flow.

EVALUATING L COLUMN	
Pressure	(162)
Measured Flow:	4.90
Use <STOP> to abort	

**Note** To abort column evaluation, you can press **STOP**.

j. The following message will display if the operation was successful.

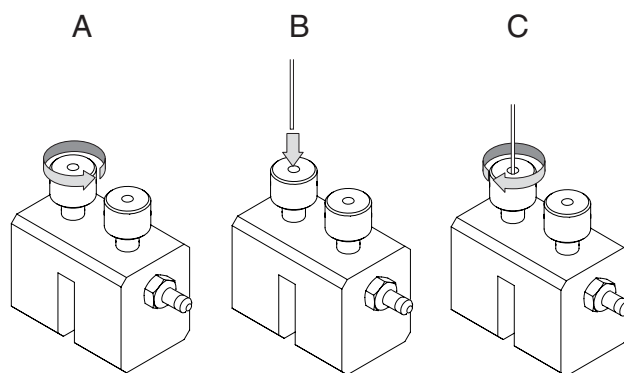
L. COL. EVALUATION
COMPLETED
Calc'd ID 0.242
K. 0.9020

- k. Expect a K-factor of about 0.7 – 0.9 for a 15 m, 0.25 mm i.d. column (1.3 – 2.0 for a 30 m, 0.25 mm i.d. column). If the column does not report a K-factor within this range or within 0.1 units of the previous stored value, check for a leak or broken column using the leak detector. The K-factor is a measured resistance for the column. A K-factor that is too low may indicate a leak in the system, while a K-factor that is too high may indicate a blockage.
4. Perform a column leak check.
  - a. Carefully push the capillary column end into the column section of the column-flow meter connector, as shown in [Figure 3](#).



**CAUTION - INSTRUMENT DAMAGE:** Do not allow the clear plastic component to exceed 80 °C. Otherwise, it will melt and damage the instrument.

**Figure 3.** Leak Check



- b. Press **Leak Check** to access the **Leak Check Columns** menu.

**Note** The available options (Right column or Left column) will differ depending on the configuration of your GC.

LEAK CHECK COLUMN	
Right column	
Left column	<
1. This item appears if the relevant channel is present and configured.	

- c. Scroll to a channel to open the left or right column's leak check menu.

L. COL. LEAK CHECK
Start Leak Check
Leak Check Settings



- d. Scroll to **Leak Check Settings**.

L. COL. SETT.	
Check Leak press	200
Sensitivity	5.0

- e. In the **Check at press** line, set the pressure at which the leak check will be performed. The value must be between 10 and 999 kPa (1.45 and 145 psi).
- f. In the **Sensitivity** line, set the maximum pressure drop that is allowed during the test. The value must be between 1 and 10 kPa (0.145 and 1.45 psi).
- g. Press **CLEAR** to exit the Leak Check Settings menu and return to the previous menu.

L. COL. LEAK CHECK	
Start leak check	
Leak Check settings	

- h. Select **Start leak check** to begin operation. The split and purge valves of the selected channel are automatically closed and the channel is pressurized with carrier gas to the leak check set point.

CHECKING L COLUMN	
Pressure	(200)
Elapsed time	0.90
Use <STOP> to abort	

**Note** To abort a leak check, you can press **STOP**.

- i. The system monitors the pressure for one minute. If the pressure does not drop more than the maximum allowed sensitivity value, then the leak check will pass.

R/L LEAK CHECK
COMPLETED
SUCCESSFULLY
Leak check passed.

If the leak check did not pass, you should use the leak detector to find and fix the leaks.

**Tip** Leaks can be caused by not tightening the fitting on the clear plastic component. We recommend that you check that fitting before looking elsewhere.

- j. Repeat the column evaluation and leak check until no leaks are indicated.

5. Disconnect the column from the clear plastic component.
6. Remove the clear plastic component, including its fittings, from the oven and set it aside.
7. Condition the column before inserting it into the DSQ II.



**CAUTION - INSTRUMENT DAMAGE:** The material released from the column (column bleed) during the conditioning will contaminate the ion source if the column is inserted into the transfer line. The ion source must then be cleaned.

- a. Raise the DSQ II temperature to the desired temperature (normally 220 °C).
- b. Run the slow temperature program that is recommended by the manufacturer. For example, hold the column at 40 °C for 15 minutes, then ramp at 10 °C/minute up to 10 °C above the maximum temperature you will operate the column (normally  $260 + 10\text{ °C} = 270\text{ °C}$ ). Hold the column at this temperature for two hours.



**CAUTION - INSTRUMENT DAMAGE:** Never exceed the manufacturer's maximum operating temperature.

8. Connect the column to the transfer line.
  - a. Shut down and vent the DSQ II (see [“Shutting Down the GC/MS System”](#) on [page 18](#)).
  - b. Lower the oven temperature to 30 °C and allow it to cool before continuing.



**WARNING - BURN HAZARD:** The injector, oven, and transfer line may be hot. Allow them to cool to room temperature before touching them.

- c. Unwind about one turn of the column from the column outlet end.

**Note** Wear clean, lint- and powder-free gloves when you handle the column and transfer line ferrule.

- d. Wipe about 300 mm (12 in.) of the column with a tissue soaked in methanol.
- e. Insert the column through the septa, transfer line nut, and ferrule. Wipe the column again with a tissue soaked in methanol.
- f. Use a scoring wafer to score and break the end of the column. Use a magnifying glass to check for an even, flat cut. Repeat if necessary.
- g. Insert the column into the transfer line using one of the following methods below.

## Method One

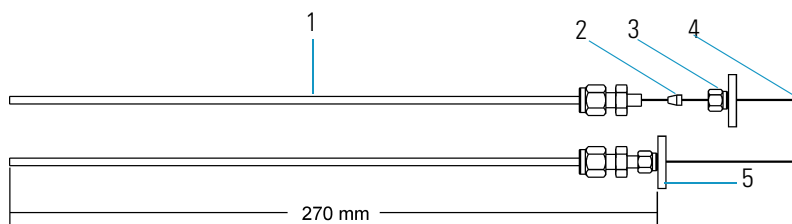
If you have a column measuring tool, follow these steps:

1. Screw the transfer line nut onto the column measuring tool.

**Tip** Slide a septum on the column before adding the transfer line nut to make it easier to measure the proper distance between the nut and the end of the column. You can also use a white marker to mark the position of the column and nut.

2. Push the column past the end of the column measuring tool and use a scoring wafer to score and break the end of the column. Use a magnifying glass to check for an even, flat cut. Repeat if necessary.

**Figure 4.** Column Measuring Tool

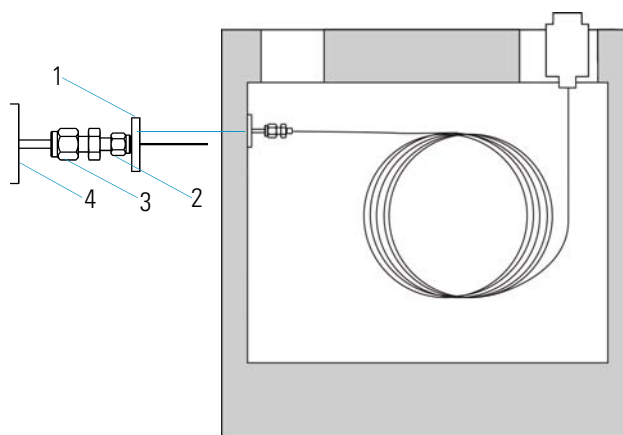


1	Column Measuring Tool*	4	Column
2	Transfer Line Ferrule	5	Septum
3	Transfer Line Nut		

\* The Column Measuring Tool is sold separately and can be purchased from Thermo Fisher Scientific.

3. Pull the column back so that it is flush with the end of the column measuring tool. Tighten the transfer line nut.
4. Slide the septum up to the back of the transfer line nut.
5. Remove the column, transfer line nut and ferrule from the column measuring tool.

**Figure 5.** Transfer Line (Front)



1	Septum	3	Transfer Line Union
2	Transfer Line Nut	4	Transfer Line

6. Insert the column into the transfer line. Be careful not to move the septum.
7. Tighten the transfer line nut and the transfer line union. For proper operation, the column must extend approximately 1 mm past the end of the transfer line.
8. Condition the transfer line ferrule. Graphite/vespel ferrules like the transfer line ferrule require conditioning to ensure a leak-tight seal.
  - a. Raise the oven temperature to the maximum temperature you will operate the column (normally 300 °C).
  - b. Wait 10 minutes.
  - c. Lower the oven temperature to 30 °C and allow it to cool before continuing.



**WARNING - BURN HAZARD:** The oven may be hot. Allow it to cool to room temperature before opening it. The injector will still be hot, so do not touch it.

- d. Re-tighten the transfer line nut and the transfer line union.
9. Set up the TRACE GC Ultra.
  - a. Make sure the column does not have any sharp bends and that it does not touch any metal objects or walls inside the oven.
  - b. Raise the oven temperature to the initial temperature you will use (normally 40 °C).

**Note** Turn on vacuum compensation (under the Right or Left Carrier menu).

## Method Two

If you have the optional inlet valve, follow these steps:

**Tip** Slide a septum on the column before the transfer line nut to make it easier to measure the proper distance between the nut and end of the column.

1. Remove the DSQ II front and top covers to get a better view of the column. You can also use a flashlight to light the interior of the source through the vacuum interlock if you do not wish to remove the covers.
2. Use the I/R tool to remove the ion volume, as described in “[Cleaning the Ion Volume Without an Inlet Valve](#)” on page 43.
3. Insert the column into the transfer line and use your fingers to tighten the transfer line nut.
4. Push the column in until you can see it through the inlet valve.
5. Pull the column back just far enough that you cannot see it.
6. Tighten the transfer line nut and transfer line union.
7. Use the I/R tool to replace the ion volume, as described in “[Cleaning the Ion Volume Without an Inlet Valve](#)” on page 43.
8. Condition the transfer line ferrule. Graphite/vespel ferrules like the transfer line ferrule require conditioning to ensure a leak-tight seal.
  - a. Raise the oven temperature to the maximum temperature you will operate the column (normally 300 °C).
  - b. Wait 10 minutes.
  - c. Lower the oven temperature to 30 °C and allow it to cool before continuing.



**WARNING - BURN HAZARD:** The oven may be hot. Allow it to cool to room temperature before opening it. The injector will still be hot, so do not touch it.

- d. Re-tighten the transfer line nut and the transfer line union.
9. Set up the TRACE GC Ultra.
    - a. Make sure the column does not have any sharp bends and that it does not touch any metal objects or walls inside the oven.
    - b. Raise the oven temperature to the initial temperature you will use (normally 40 °C).

**Note** Turn on vacuum compensation (under the Right or Left Carrier menu).

#### Method Three

If you do not have an inlet valve, follow these steps:

1. Remove the DSQ II front and top covers to get a better view of the column.
2. Remove the vacuum manifold cover, as described in “[Removing the Vacuum Manifold Cover](#)” on [page 32](#).
3. Remove the ion source, as described in “[Cleaning the Ion Source Components](#)” on [page 38](#).
4. Adjust the column so that it extends 1–2 mm past the end of the transfer line.
5. Tighten the transfer line nut and transfer line union.
6. Replace the ion source, as described in “[Cleaning the Ion Source Components](#)” on [page 38](#).
7. Replace the vacuum manifold cover.
8. Reattach the DSQ II front and top covers.
9. Condition the transfer line ferrule. Graphite/vespel ferrules like the transfer line ferrule require conditioning to ensure a leak-tight seal.
  - a. Raise the oven temperature to the maximum temperature you will operate the column (normally 300 °C).
  - b. Wait 10 minutes.
  - c. Lower the oven temperature to 30 °C and allow it to cool before continuing.



**WARNING - BURN HAZARD:** The oven may be hot. Allow it to cool to room temperature before opening it. The injector will still be hot, so do not touch it.

- d. Re-tighten the transfer line nut and the transfer line union.
10. Set up the TRACE GC Ultra.
    - a. Make sure the column does not have any sharp bends and that it does not touch any metal objects or walls inside the oven.
    - b. Raise the oven temperature to the initial temperature you will use (normally 40 °C).

**Note** Turn on vacuum compensation (under the Right or Left Carrier menu).

## Removing a Column from the GC/MS System

To remove a column from the GC/MS system, you will need:

- Gloves, clean, lint- and powder-free
- Wrench, open-ended, 5/16-in.
- Wrench, open-ended, 7/16-in.
- Wrench, open-ended, 6 mm

1. Shut down the DSQ II.

- Shut down and vent the DSQ II (see [“Shutting Down the GC/MS System”](#) on [page 18](#)). Lower the oven, injector, and transfer line temperatures to 30 °C and allow them to cool before continuing.



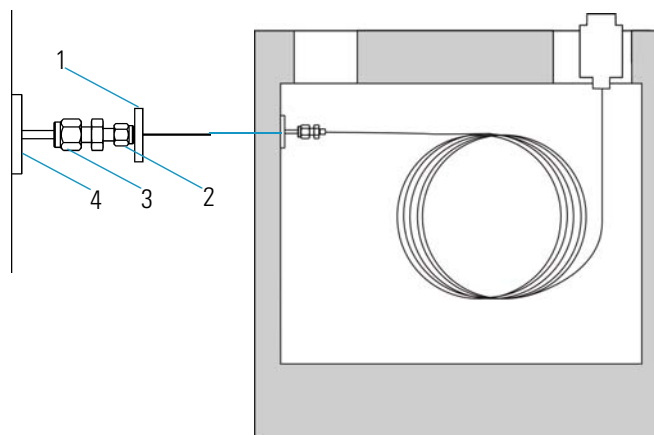
**WARNING - BURN HAZARD:** The oven, injector, and transfer line are hot. Allow them to cool to room temperature before touching them.

- Once the DSQ II is cooled down, power off the TRACE GC Ultra.

2. Remove the column from the transfer line.

- Unscrew the transfer line nut.
- Remove the column from the transfer line.

**Figure 6.** Transfer Line Components



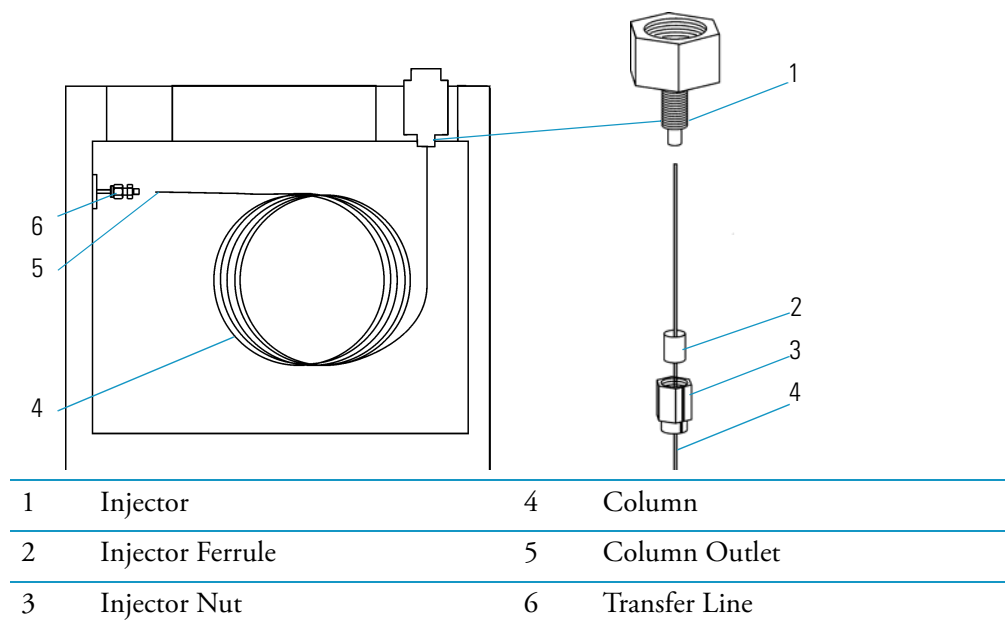
1	Septum	3	Transfer Line Union
2	Transfer Line Nut	4	Transfer Line

## 1 Basic Operations

### Removing a Column from the GC/MS System

3. Remove the column from the injector.
  - a. Unscrew the injector nut.
  - b. Remove the column from the injector.

**Figure 7.** TRACE GC ULtra Injector Components





## Starting Up the GC/MS System

To start up the GC/MS system:

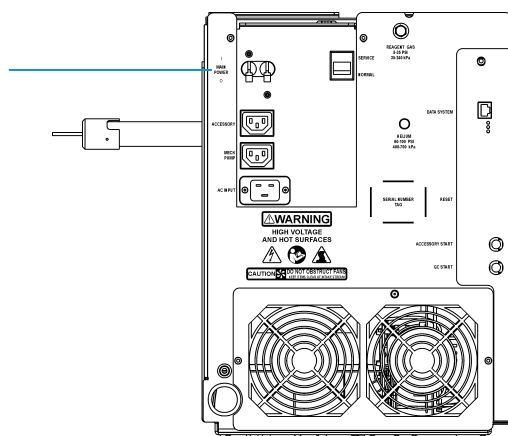
1. Set up the DSQ II.
  - a. Install the TRACE GC Ultra column (see “Installing a Column into the GC/MS System” on page 4).
  - b. Be sure the TRACE GC Ultra is powered on and there is carrier gas flowing through the column into the DSQ II.



**CAUTION - INSTRUMENT DAMAGE:** If you turn on the DSQ II without column flow, air is drawn through the column, which could damage the instrument. This large air leak may also require that you clean the ion source.

- c. Plug in the power cord for the DSQ II.
  - d. Plug the mechanical pump into the Mech Pump outlet on the back of the DSQ II.
2. Power on the DSQ II.

**Figure 8.** Main Circuit Breaker (Rear)



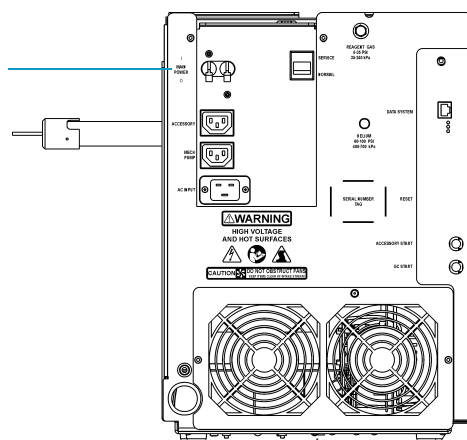
- a. Switch the main circuit breaker to ON (I), which will cause the rotary-vane pump to power on, the fore pressure to reach the proper operating pressure, and the turbomolecular pump to power on.
  - b. Set the transfer line to the desired operating temperature (normally 250 °C) by selecting <Aux>, <Temp>, <Enter> on the TRACE GC Ultra. Enter the temperature.
3. Open *Xcalibur* on the computer.
  - a. Check the heater status by clicking the Heaters tab in the DSQ II Status pane. If the ion source is not set to the right temperature (normally 200 °C), change it in *Tune*.
  - b. Check the status of the vacuum in the Vacuum tab of the DSQ II Status pane. Within 10 minutes of turning on the DSQ II, the vacuum should read OK. If it does not, see “Using Diagnostics” on page 121.
  - c. Allow the DSQ II to stabilize for 30 minutes before running samples.

## Shutting Down the GC/MS System

To shut down the GC/MS system:

1. Cool the TRACE GC Ultra. If you do not plan to change the column or perform maintenance on the GC, you do not have to lower the injector temperature, but you do need to lower the oven, injector, and transfer line temperatures to 30 °C.
2. Shut down the DSQ II.
  - a. From the Instrument Setup window of *Xcalibur*, click the **Tune** button to open the Tune window.
  - b. Select **Instrument | Shutdown** to begin the automatic shutdown process, which includes:
    - Displaying the *Xcalibur* Shut Down window
    - Turning off the calibration and CI reagent gas
    - Turning off the voltages to the ion source, quadrupole, and ion detector
    - Turning off the ion source heater
    - Turning off the turbomolecular pump
    - *Xcalibur* counting down ten minutes for the pump to slow down
    - *Xcalibur* waiting for the Ion Source to cool to < 175 °C to prevent oxidizing the hot parts when they are exposed to air
  - c. Wait for the transfer line to cool to < 175 °C.
3. Power off the DSQ II.
  - a. When *Xcalibur* indicates that it is okay to turn off the main power to the DSQ II, click OK.

**Figure 9.** Main Circuit Breaker (Rear)



- b. Switch the main circuit breaker to OFF (0), which turns off the rotary-vane pump. Approximately three seconds later, the vent valve opens and the vacuum manifold vents to atmospheric pressure. This takes approximately three to four minutes.
- c. Remove the DSQ II power cord from the wall socket.

**IMPORTANT** The process ends here if you are planning to perform system maintenance on the DSQ II alone (for example, to clean the ion source). You don't need to turn off the TRACE GC Ultra, data system, and autosampler.

- 4. Wait for the TRACE GC Ultra oven, injector, and transfer line to cool to room temperature.
- 5. Power off all the remaining instruments.
  - a. Power off the TRACE GC Ultra by switching the main circuit breaker to OFF (0).
  - b. Turn off the GC's helium supply at the tank.
  - c. Power off the autosampler (optional) by switching the main power switch to OFF.

## **1 Basic Operations**

### Shutting Down the GC/MS System

## Maintaining the DSQ II

This chapter describes how to perform maintenance on every component in the DSQ II. Keeping your DSQ II in good working condition increases laboratory productivity and helps you get the most out of the instrument.

### Contents

- "Components That Require Maintenance" on page 22
- "List of Tools" on page 22
- "Recommended Maintenance Schedule" on page 23
- "Running Benchmark Tests" on page 24
- "Preparing the DSQ II for Maintenance" on page 25
- "Cleaning the Ion Source Components" on page 38
- "Replacing the Electron Multiplier" on page 59
- "Maintaining the Turbomolecular Pump" on page 62
- "Maintaining the Rotary-Vane Pump" on page 62
- "Maintaining Components Outside the Vacuum Manifold" on page 70

## Components That Require Maintenance

There are only three main components of the DSQ II that require frequent maintenance, depending on the quantity and types of sample you are running. A frequently used instrument will, of course, require more maintenance than an instrument that is rarely used.

- Ion Source
- Ion Detector
- Rotary-Vane Pump

There are many more components in the DSQ II that do not require maintenance, but may need to be replaced in the event that there is a problem with the instrument. These components are described in "[Maintaining Components Outside the Vacuum Manifold](#)" on [page 70](#).

## List of Tools

To perform maintenance on a DSQ II system, you will need the following tools:

- • Gas, clean and dry
- • Gloves, clean, lint- and powder-free
- • Gloves, latex, impermeable
- • Lint-free cloth or paper
- • Nut driver, 5.5 mm
- • Protective eyewear
- • Screwdriver, Phillips #2
- • Screwdriver, flat blade
- • Wrench, adjustable
- • Wrench, Allen, 2 mm, 2.5 mm, 3 mm, 4 mm, 5/32-in., 5/64-in., 1/16-in.
- • Wrench, open-ended, 1/4-in., 5/16-in., 7/16-in. (two) 1/2-in., 9/16-in.
- • Wrench, socket, 1/2-in.

## Recommended Maintenance Schedule

To perform maintenance on the DSQ II, you will need to disassemble, clean, and replace particular components. Table 2 is a factory recommended maintenance schedule based on running multiple samples eight hours a day. You can adapt the schedule according to the cleanliness of your samples and the number of analyses you make per day. We recommend that you keep a maintenance log of the DSQ II service so that you can identify variations in normal operation, which will make maintenance even easier when the need arises.

**Table 2.** Recommended Maintenance Schedule

Procedure	Replace	1 Month	4 or 6 Months	As Needed*
Cleaning the Ion Source Components (see page 38), which may include:				✓
• Cleaning the Ion Volume with an Inlet Valve (see page 38)				✓
• Cleaning the Ion Volume Without an Inlet Valve (see page 43)				✓
• Cleaning the Ion Source, Lenses and Prefilter (see page 45)				✓
• Replacing the Ion Source Filament (see page 53)				✓
Replacing the Electron Multiplier (see page 59), which may include:	✓			✓
Maintaining the Turbomolecular Pump (see page 62)				✓
Maintaining the Rotary-Vane Pump (see page 62), which may include:	✓			
• Checking the Oil Level of a Rotary-Vane Pump (see page 63)		✓		
• Adding Oil to a Rotary Vane Pump (see page 64)				✓
• Purging Gas from the Oil in a Rotary-Vane Pump (see page 65)		✓		
• Changing the Oil in a Rotary-Vane Pump (see page 67)		**	✓**	
Maintaining Components Outside the Vacuum Manifold (see page 70)				✓

\* As Needed depends on how close the component is to the sample introduction point. For example, the Ion Volume is closer to the sample introduction point than any other component and requires the most frequent cleaning.

\*\* Perform every month if you use ammonia as a chemical ionization reagent gas.

## Running Benchmark Tests

To confirm that your instrument is clean and in good working order, we recommend you perform benchmark tests and record the results. For more information, refer to the *DSQ II User's Guide*.



**CAUTION - INSTRUMENT DAMAGE.** This section relates strictly to the parts and components listed in this chapter. Use caution when using these cleaning procedures for other parts. Some components can be damaged if exposed to abrasives, solvents, or heat.

1. Run a benchmark QC (quality control) test. A good benchmark test is the mixture of octafluoronaphthalene and benzophenone, which is included with the instrument.
2. Compare the results to previous results.
3. Clean the ion volume only when the tested performance of your system decreases significantly from your benchmark test results.
4. Run the benchmark test again and compare the results.
5. If the DSQ II is still not operating at optimal performance, clean the lenses, ion source assembly, and prefilter. The frequency in which you clean the DSQ II depends on the types and amounts of samples and solvents you introduce into the instrument. In general, the closer a component is to the sample introduction point, the faster it gets dirty. For example, you need to clean the ion volume more often than other parts because it is the first component to come in contact with the sample.



## Preparing the DSQ II for Maintenance

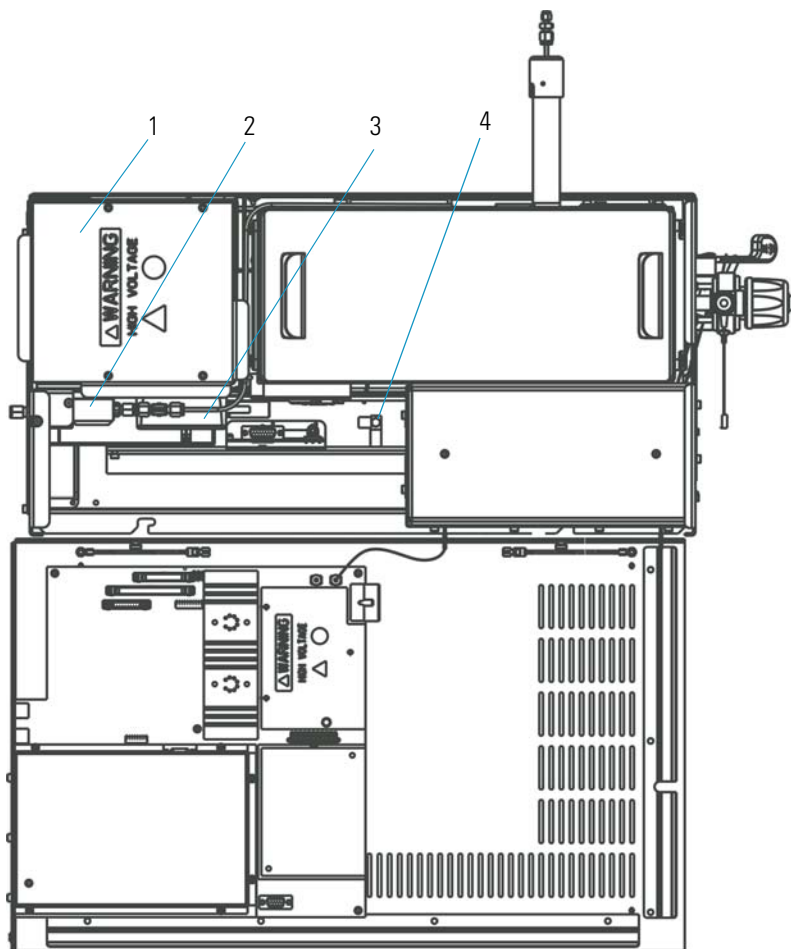
Before you can perform any maintenance on the DSQ II, you must shut down the system and remove the covers. The DSQ II covers overlap, so they must be removed in the order of front, top, right and left as you face the front of the instrument.

### Removing the Front and Top Covers

To remove the front and top covers, you will need a Phillips #2 screwdriver.

1. Cover the work area with a lint-free cloth.

**Figure 10.** Components Accessed by Removing the Top and Front Covers



1	Power Module	3	Calibration Gas Flow Module
2	CI Reagent Gas Flow Module (Upgrade Option)	4	Ion Gauge (Upgrade Option)

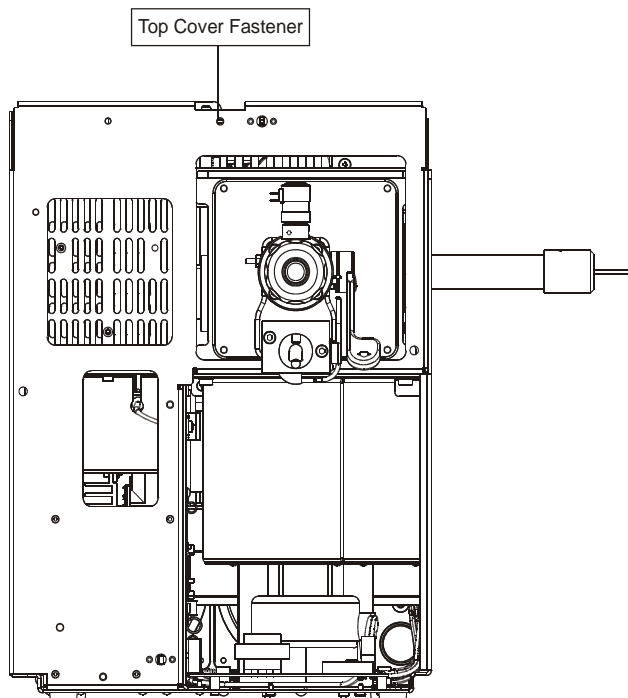
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock

3. Remove the front cover.
4. Loosen the fastener located on the front of the DSQ II that attaches the top cover to the chassis.

**Figure 11.** Removing the Top Cover Fastener



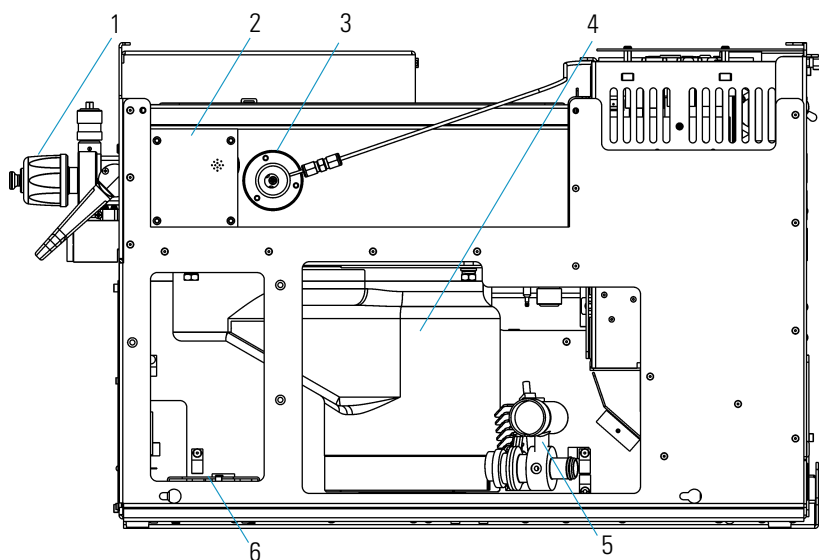
5. Slide the top cover forward about 2.5 cm (1-inch).
6. Lift the top cover up and away from the DSQ II.
7. Reverse these steps to reinstall the top cover.

## Removing the Right Cover

To remove the right cover, you will need a Phillips #2 screwdriver and a 2.5 mm Allen wrench.

1. Cover the work area with a lint-free cloth.

**Figure 12.** Components Accessed by Removing the Right Cover



1	Inlet Valve	4	High Vacuum Pump
2	Lens Interface Board	5	Fore Pressure Gauge and Foreline Adapter
3	Transfer Line	6	Turbomolecular Pump Power Supply

2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18.](#)

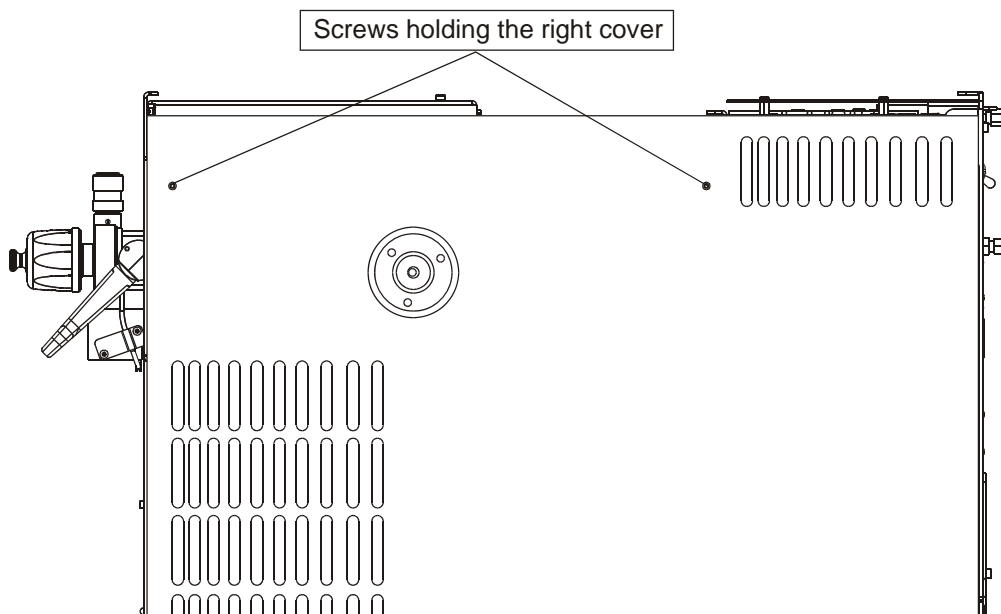


**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock

3. Remove the front and top covers, as described in ["Removing the Front and Top Covers" on page 25.](#)
4. Remove the capillary column, as described in ["Preparing the DSQ II for Maintenance" on page 25.](#)

5. Remove the two screws connecting the right cover to the chassis.

**Figure 13.** Removing the Screws Holding the Right Cover in Place



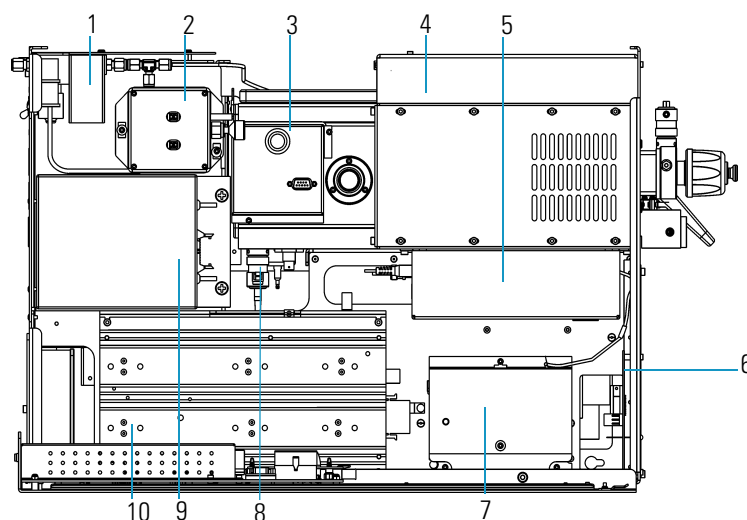
6. Slide the cover towards the back of the instrument and pull it away.
7. Reverse these steps to reinstall the right cover.

## Removing the Left Cover

To remove the left cover, you will need a Phillips #2 screwdriver.

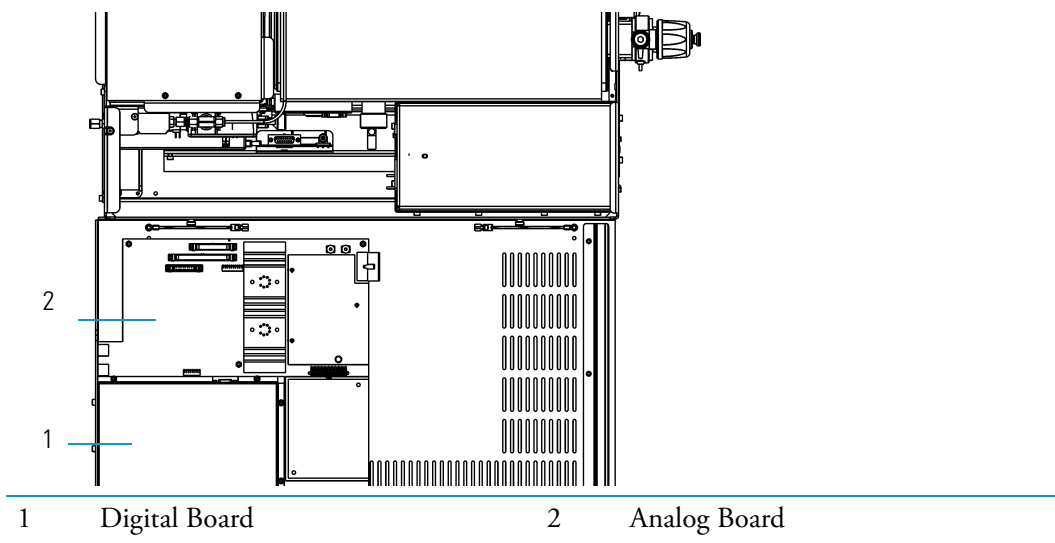
1. Cover the work area with a lint-free cloth.

**Figure 14.** Components Accessed by Removing the Left Cover



1	CI Reagent Gas Flow Module (optional)	6	Vacuum Control Board
2	Calibration Gas Flow Module	7	DC Driver
3	Electrometer Board	8	Vent Valve Solenoid
4	RF Detector Board	9	Conversion Dynode/Electron Multiplier Power Supply
5	Low Pass Filter Board	10	RF Generator Board

**Figure 15.** Components Accessed by Removing the Top and Left Covers



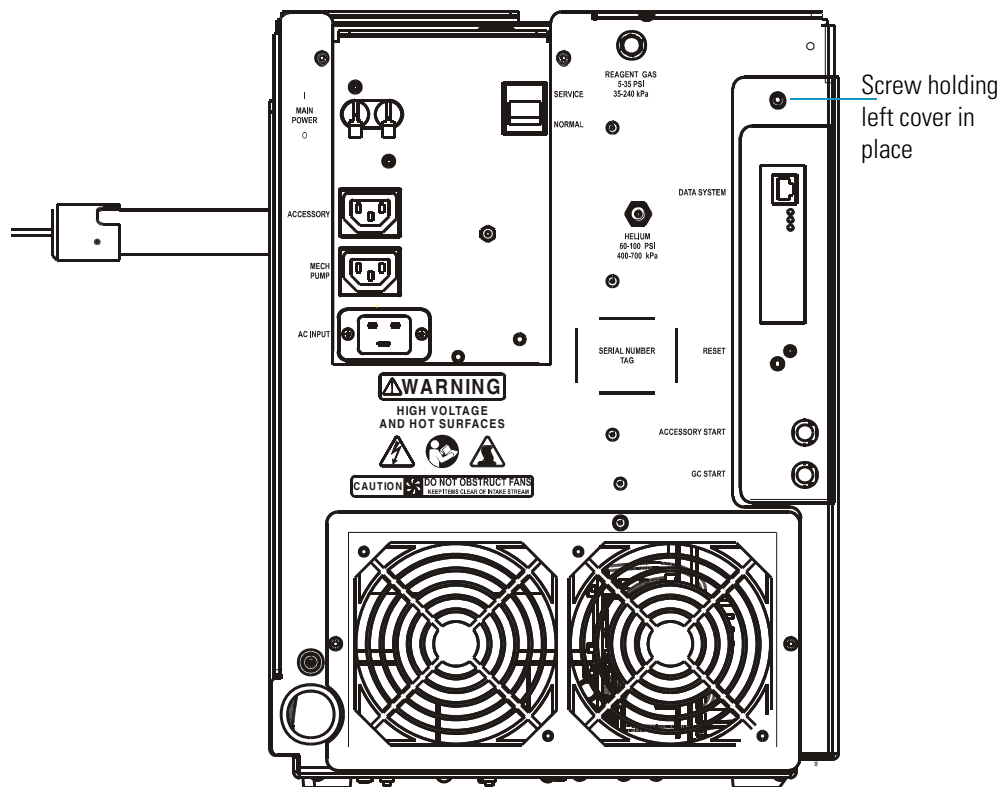
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock

3. Remove the front and top covers, as described in "[Removing the Front and Top Covers](#)" on page 25.
4. Remove the screw located on the back of the instrument that connects the left cover to the chassis.

**Figure 16.** Removing the Screw Holding the Left Cover in Place



5. Slide the cover toward the rear of the instrument until the tabs are at the end of the grooved slots and then pull the cover away.



**WARNING - INSTRUMENT DAMAGE.** The analog and digital boards are attached to interior side of the left cover, so that cover is significantly heavier than the right cover. Do not pull the cover too far away from the instrument when you open it or you could damage the cables leading from the boards to other parts of the instrument.

6. Reverse these steps to reinstall the left cover.

## Removing the Vacuum Manifold Cover

If you need to clean the ion source, prefilter, quadrupole, or ion detector, you will need to remove the vacuum manifold cover first.



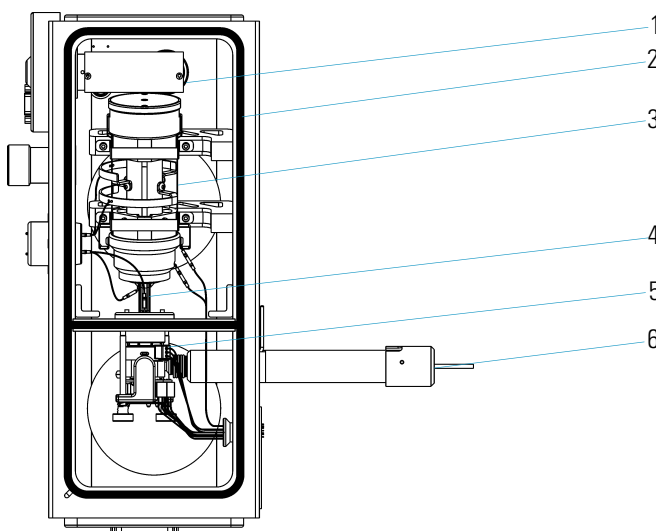
**CAUTION - INSTRUMENT DAMAGE.** Keep the vacuum manifold cover attached to the instrument while performing maintenance. Even small amounts of dust on the electron multiplier, conversion dynode, or quadrupole can cause excessive noise in your mass spectra.

To remove the vacuum manifold cover, you will need:

- Gas, clean and dry
- Gloves, clean, lint- and powder-free
- Lint-free cloth
- Screwdriver, Phillips #2
- Wrench, Allen, 2.5 mm

1. Cover the work area with a lint-free cloth.

**Figure 17.** Components Accessed By Removing the Vacuum Manifold Cover



1	Electron Multiplier	4	Prefilter
2	O-ring	5	Ion Source
3	Quadrupole	6	Transfer Line

2. Shut down and vent the DSQ II, as described in ["Preparing the DSQ II for Maintenance" on page 25](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock

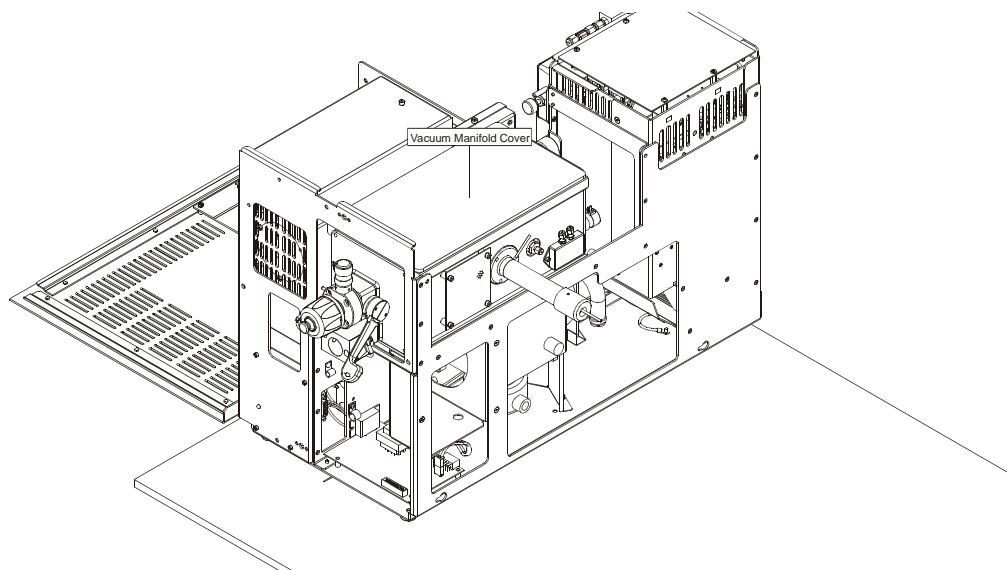


3. Remove the front and top covers, as described in ["Removing the Front and Top Covers"](#) on page 25.

**Tip** The cover will be easier to remove if you start by completely venting the instrument to atmospheric pressure for approximately four minutes.

4. Remove the vacuum manifold cover.

**Figure 18.** Removing the Vacuum Manifold Cover



5. Check the vacuum manifold cover for dust.
  - a. Verify the O-ring, which is the thin, black strip around the top of the vacuum manifold, for signs of wear and tear. Replace it if needed.
  - b. Verify that there are no particles on the O-ring. Wipe it off with a lint-free cloth if necessary.
6. Perform maintenance on the components of the vacuum manifold:
  - ["Cleaning the Ion Volume with an Inlet Valve"](#) on page 38 or ["Cleaning the Ion Volume Without an Inlet Valve"](#) on page 43
  - ["Cleaning the Ion Source, Lenses and Prefilter"](#) on page 45
  - ["Replacing the Ion Source Filament"](#) on page 53



**CAUTION - INSTRUMENT DAMAGE.** Do not allow dust or lint to get on the electron multiplier or ion trap. It can cause spectral noise or instrument damage.

7. Reattach the vacuum manifold cover.
8. Reattach the front and top covers of the DSQ II.
9. Restart the DSQ II.

## Cleaning Stainless Steel Components

To clean stainless steel components, you will need:

- Acetone, reagent grade (or other suitable polar solvent)
- Aluminum oxide abrasive, number 600
- Applicators, cotton-tipped
- Beaker, 450 mL
- De-ionized water
- Detergent (Alconox, Micro, or equivalent)
- Dremel rotary tool or equivalent (recommended)
- Foil, aluminum
- Forceps
- Gas, clean and dry (N<sub>2</sub> or He)
- Gloves, latex, impermeable
- Gloves, clean, lint- and powder-free
- Glycerol, reagent grade
- Lint-free cloth
- Protective eyewear
- Tap water
- Toothbrush, soft
- Ultrasonic cleaner



**CAUTION - INSTRUMENT DAMAGE.** Do NOT use this procedure to clean ceramic, aluminum, or gold-plated parts. Also, this procedure should not be used on the prefilter, electron multiplier, conversion dynode, quadrupole, or anode feedthrough.



**WARNING - MATERIAL AND EYE HAZARD.** Wear impermeable laboratory gloves and eye protection when cleaning components.

1. Remove contaminants from all the components you are cleaning.
  - a. Use a slurry of #600 aluminum oxide (PN 32000-60340) in glycerol and a cleaning brush or cotton-tipped applicator (PN A0301-02000) to clean each component. Contamination can be indicated by a dark or discolored area, but it is often invisible. The heaviest contamination is usually found around the apertures. For example, the electron entrance hole of the ion volume.
  - b. Clean each component thoroughly, even if no contamination is visible.
  - c. Cut the wooden end of an applicator at an angle and use it to clean the crevices of a component.

**Tip** To clean components faster, use a Dremel® tool with the polishing swab at its lowest speed. Keep the tool away from possible hazards, such as standing water or flammable solvents.

2. Rinse the components with clean water. Use a clean applicator or toothbrush to remove the aluminum oxide slurry. Do not let the slurry dry on the stainless steel because it is difficult to remove.
3. Sonicate the components in warm detergent.
  - a. Use forceps to place the components in a beaker of warm detergent.
  - b. Place the beaker and its contents in an ultrasonic bath for five minutes.
  - c. Rinse the components with tap water to remove the detergent.
4. Sonicate the components in deionized water.
  - a. Use forceps to place the components in a beaker of deionized water.
  - b. Place the beaker and its contents in an ultrasonic bath for five minutes.
  - c. If the water is cloudy after sonicating, pour out the water, add fresh water, and place the beaker and its contents in a ultrasonic bath again for five minutes. Repeat until the water is clear.
5. Sonicate the components in acetone.
  - a. Use forceps to place the components in a beaker of acetone.
  - b. Place the beaker and its contents in an ultrasonic bath for five minutes.
  - c. Use forceps to transfer the components to a beaker of fresh acetone.
  - d. Place the beaker and its contents in an ultrasonic bath for five minutes.
6. Blow clean, dry gas on the components to remove the acetone.
7. Use forceps to place the components in a beaker covered with aluminum foil. Dry the components in a 100 °C oven for 30 minutes. Allow the components to cool before reassembling them.

## Cleaning Non-Stainless Steel or Hybrid Components

To clean non-stainless steel or hybrid components, you will need:

- Acetone, reagent grade (or other suitable polar solvent, such as Methanol or Ethanol)
- Aluminum oxide abrasive, number 600
- Applicators, cotton-tipped
- Beaker, 450 mL
- De-ionized water
- Detergent (Alconox, Micro, or equivalent)
- Dremel rotary tool or equivalent (recommended)
- Forceps
- Gas, clean and dry (N<sub>2</sub> or He)
- Gloves, latex, impermeable
- Gloves, clean, lint- and powder-free
- Lint-free cloth
- Protective eyewear
- Tap water
- Toothbrush, soft



**WARNING - MATERIAL AND EYE HAZARD.** Wear impermeable laboratory gloves and eye protection when cleaning components.

1. Remove contamination from metal surfaces. It is only necessary to clean surfaces that come in contact with the ion beam. Do not clean non-metallic components.
  - a. Use a slurry of number 600 aluminum oxide (PN 32000-60340) in glycerol and a cleaning brush or cotton-tipped applicator (PN A0301-02000). Contamination may appear as a dark or discolored area, but often is not visible.
  - b. Clean each components thoroughly, even if no contamination is visible.
  - c. Use the wooden end of an applicator cut at an angle to clean the inside corners.

**Tip** To clean components faster, use a Dremel® tool with the polishing swab at its lowest speed. Keep the tool away from possible hazards, such as standing water or flammable solvents.

2. Rinse the components with clean water. Use a clean applicator or toothbrush to remove the aluminum oxide slurry. Do not let the slurry dry on the metal; dried aluminum oxide is difficult to remove.
3. Scrub all of the components with a warm detergent solution.
  - a. Scrub the components with a toothbrush or clean applicator. Do not soak or sonicate the components in detergent.

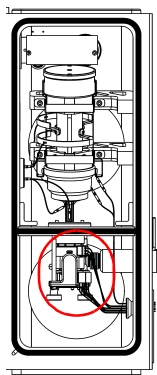
- b. Using forceps, rinse the components thoroughly with tap water to remove the detergent.



**CAUTION - INSTRUMENT DAMAGE.** Do not leave aluminum components like the heater ring in the detergent. It can potentially discolor the aluminum.

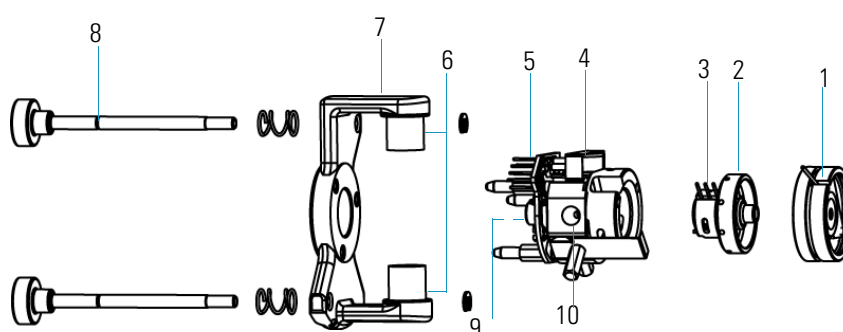
4. Rinse the components in deionized water. Using forceps, dip the components in a beaker of deionized water. Change the water if it becomes cloudy. Do not soak or sonicate the components.
5. Rinse the components with acetone. Using forceps, dip the components in a beaker of acetone. Change the acetone if it becomes cloudy. Do not soak or sonicate the components.
6. Blow dry the components immediately. Blow off the acetone from the components with a clean, dry gas.

## Cleaning the Ion Source Components



The ion source consists of an ion volume, lenses, and filament. The ion volume is directly exposed to any sample that is injected into the GC/MS, so it may need to be cleaned more frequently than any other component. The frequency can increase depending on the types and amounts of samples you typically run. Although you can clean the ion volume with or without an inlet valve, you can save a lot of time and effort by cleaning it with an inlet valve. Using the I/R tool allows you to easily access the ion volume by entering the vacuum manifold through the inlet valve without breaking vacuum, thus saving you from shutting down and disassembling the DSQ II.

**Figure 19.** Ion Source Components



1	Source Spacer and Prefilter Lens	6	Two Magnets
2	Lenses	7	Magnet Yoke
3	3-Pin Lens Connector	8	Two Thumbscrews
4	Filament	9	Ion Volume (Inside Ion Source)
5	8-Pin Connector	10	Ion Source

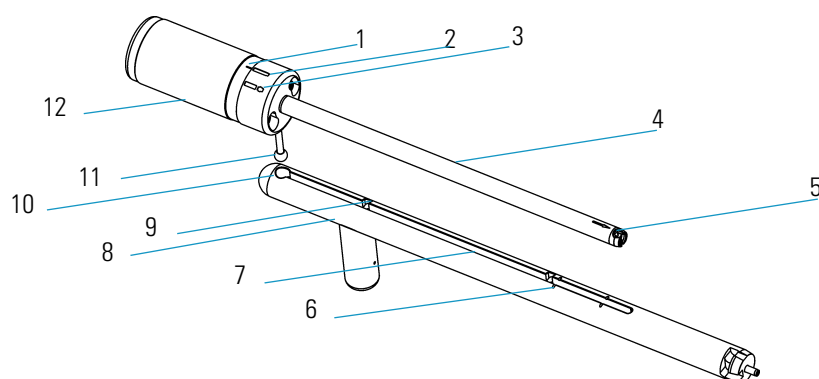
## Cleaning the Ion Volume with an Inlet Valve

To clean the ion volume with an inlet valve, you will need:

- Cleaning supplies for stainless steel parts
- Gloves, clean, lint- and powder-free
- Insertion/removal tool (I/R tool) and guide bar
- Lint-free cloth

1. Open *Xcalibur* and click **DSQ II** in the Status tab.
2. Click the **Insert/Remove Probe** button on the Status tab to open the Insert/Remove Probe window.
3. Prepare the inlet valve.
  - a. With the guide bar track facing left, insert the guide bar into the guide bar opening.

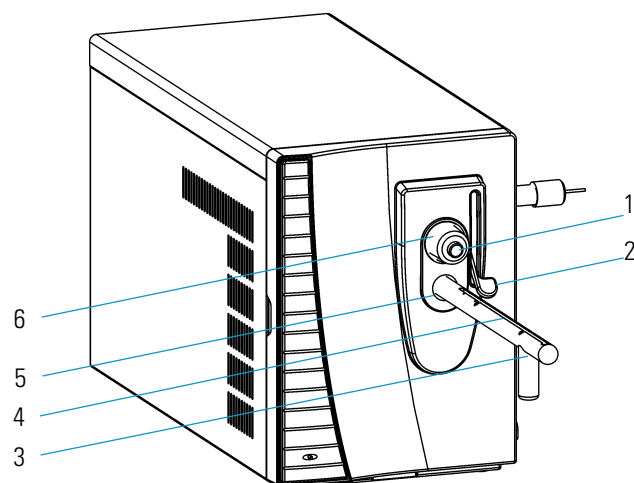
**Figure 20.** I/R Tool and Guide Bar Components




1	Alignment Line	7	Guide Bar Track
2	Hold Position	8	Guide Bar
3	Release Position	9	First Groove
4	I/R Tool	10	Guide Ball Hole
5	Bayonet Lock	11	Guide Ball
6	Second Groove	12	Handle

- b. Insert the guide bar into the DSQ II as far as it will go.

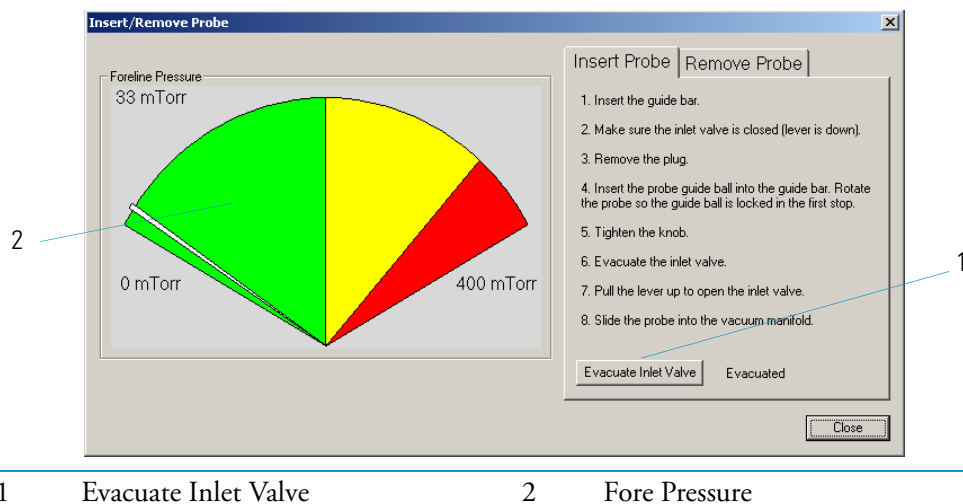
**Figure 21.** Inserting the Guide Bar



1	Inlet Valve Plug	4	Guide Bar Track
2	Inlet Valve Lever	5	Guide Bar Opening
3	Guide Bar	6	Inlet Valve Knob


- c. Rotate it 90° clockwise to lock it into the opening.
  - d. Make sure the inlet valve lever is closed (pointed down).
  - e. Remove the inlet valve plug.
4. Insert the I/R tool into the DSQ II.
- a. Turn the I/R tool to the release position, as indicated by the  icon, so that it can accept the ion volume.
  - b. Insert the guide ball into the guide ball hole.
  - c. Slide the I/R tool toward the instrument in the guide bar track until the guide ball is at the groove furthest from the instrument.
  - d. Turn the I/R tool to fit the guide ball into the groove, which will prevent the probe from being pulled forward when the inlet valve is evacuated. Otherwise, you could damage the instrument.
  - e. Tighten the inlet valve knob to ensure a leak-tight seal.
  - f. Open *Xcalibur* and go to the Insert Probe window to click the **Evacuate Inlet Valve** button.

**Figure 22.** Evacuating the Inlet Valve



- g. Monitor the fore pressure, which should not stay higher than 350 mTorr. If it does, you must adjust or replace the inlet valve seal, as described in "[Replacing the Inlet Valve Seal](#)" on page 93.
  - h. Once the inlet valve is evacuated, pull the lever up to open the inlet valve.
5. Remove the ion volume.
- a. Slide the I/R tool toward the instrument until the guide ball is slightly beyond the groove closest to the instrument.



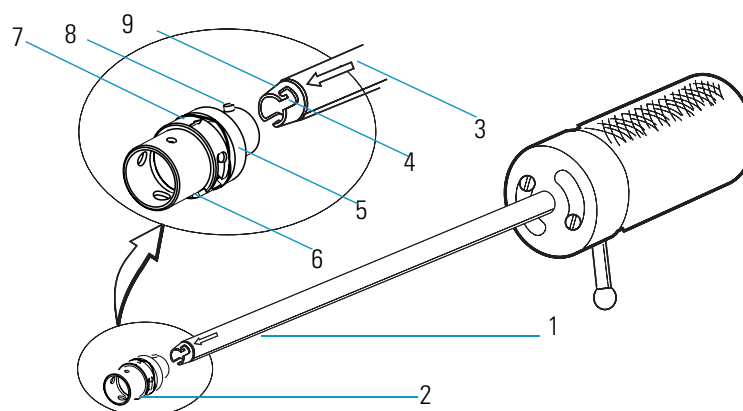
- b. Turn the I/R tool handle counter-clockwise toward the hold position, as indicated by the  icon.
  - c. Withdraw the tool until the guide ball fits in the groove furthest from the instrument.
  - d. Push the inlet valve lever down to close it.
  - e. Loosen the inlet valve knob.
  - f. Remove the I/R tool with the ion volume attached to it.
6. Clean the ion volume.



**WARNING - ELECTRICAL SHOCK HAZARD.** The ion volume may be very hot, so let it cool to room temperature before handling it.

- a. Press the ion volume forward into the tip of the I/R tool and rotate it to disconnect the bayonet pins from the pin guides.

**Figure 23.** Disconnecting the Ion Volume from the I/R Tool



1	I/R Tool	6	Spring Washer
2	Ion Volume	7	Ion Volume Alignment Arrow
3	I/R Tool Alignment Arrow	8	Bayonet Pins
4	Pin Guide	9	Bayonet Lock
5	Ion Volume Holder		




- b. Remove the ion volume from the I/R tool.
- c. Clean the ion volume, as described in "[Cleaning Stainless Steel Components](#)" on [page 34](#). If you are cleaning a CI ion volume, be sure to clean out the small electron entrance hole with a dental pick or old syringe needle. Aluminum oxide can get trapped in the hole, which can adversely affect sensitivity.

**Note** Wear clean, lint- and powder-free gloves when you handle any vacuum manifold components.

- d. Place the ion volume into the bayonet lock on the I/R tool. Make sure the alignment arrows on the ion volume and the I/R tool are facing each other.



**CAUTION - INSTRUMENT DAMAGE.** The arrows on the I/R tool and ion volume must be aligned to avoid damaging the ion source assembly.

7. Insert the I/R tool into the DSQ II with the ion volume attached.
  - a. Turn the I/R tool to the hold position .
  - b. Insert the guide ball into the guide ball hole.
  - c. Slide the I/R tool into the guide bar track until the guide ball is in the first groove.
  - d. Turn the I/R tool so the guide ball is in the first groove. This prevents the probe from being pulled forward when the inlet valve is evacuated.
  - e. Tighten the inlet valve knob to ensure a leak-tight seal.
  - f. In the *Xcalibur* Insert Probe window, click the **Evacuate Inlet Valve** button.
  - g. Monitor the foreline pressure, which should not stay higher than 350 mTorr. If it does, replace the inlet valve seal, as described in "[Replacing the Inlet Valve Seal](#)" on [page 93](#).
  - h. Once the inlet valve is evacuated, pull the lever up to open the inlet valve.
8. Reinstall the ion volume.
  - a. Slide the I/R tool into the DSQ II with the ion volume attached until the guide ball is slightly beyond the groove closest to the instrument.
  - b. Turn the I/R tool handle counter-clockwise toward the release position .
  - c. Withdraw the I/R tool about 2.5 cm (1 in.).
  - d. Turn the I/R tool handle to the hold position .
  - e. Slide the I/R tool toward the instrument until it feels like it cannot go in any further.
  - f. Withdraw the I/R tool until the guide ball reaches the groove furthest from the instrument.
  - g. Push the lever down to close the inlet valve.
  - h. Loosen the inlet valve knob.
  - i. Remove the I/R tool.

9. Restore the inlet valve.
  - a. Reattach the inlet valve plug. Keep the EI or CI label pointing upward to indicate which type of ion volume is installed in this instrument. If there is an EI/CI ion volume installed in this instrument, position the label so that EI and CI are left to right.
  - b. Remove the guide bar by rotating it 90° counter-clockwise and sliding it out of the guide bar opening.
10. Close the Insert/Remove Probe window.

## Cleaning the Ion Volume Without an Inlet Valve

To clean the ion volume without an inlet valve, you will need:

- Cleaning supplies for stainless steel parts
- Gloves, clean, lint- and powder-free
- Ion volume tool
- Lint-free cloth

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



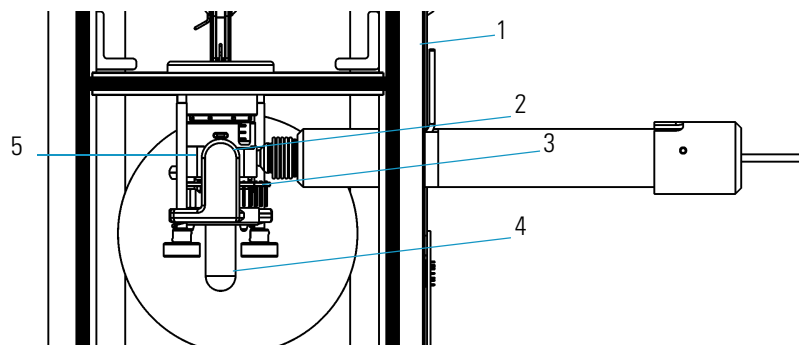
**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the front and top covers, as described in "[Removing the Front and Top Covers](#)" on page 25.
4. Remove the vacuum manifold cover, as described in "[Removing the Vacuum Manifold Cover](#)" on page 32.

**Note** Wear clean, lint- and powder-free gloves when handling any vacuum manifold components.

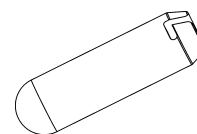
5. Remove the ion volume from the ion source.

**Figure 24.** Using the Ion Volume Tool to Remove the Ion Volume

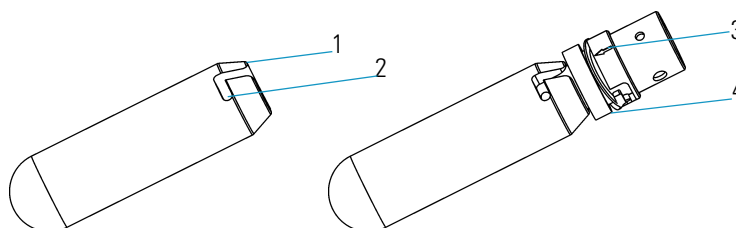


1	Vacuum Manifold	4	Ion Volume Tool
2	Magnet Yoke	5	Ion Source Block (Ion Volume inside)
3	Ion Source Board		

- a. Hook the ion volume tool (PN 119270-0001) onto the ion volume through the opening of the magnet yoke and white ion source board.
- b. Turn the ion volume tool 30° counter-clockwise to engage the ion volume.
- c. Pull the ion volume straight back and through the opening.
- d. Rotate the ion volume to disconnect it from the ion volume tool.



**Figure 25.** Removing the Ion Volume from the Ion Volume Tool



1	Ion Volume Tool	3	Ion Volume Arrow
2	Bayonet Pin Guide/Lock	4	Ion Volume

6. Clean the ion volume, as described in "[Cleaning Stainless Steel Components](#)" on page 34. If you are cleaning a CI ion volume, be sure to clean the small electron entrance hole with a dental pick or old syringe needle. Aluminum oxide can get trapped in this hole, which can adversely affect sensitivity.

7. Reinstall the ion volume.
  - a. Attach the ion volume to the end of the ion volume tool.
  - b. Align the ion volume arrow so it is facing up.
  - c. Push the ion volume tool through the magnet yoke until you hear the ion volume snap into place.
  - d. Turn the handle of the ion volume tool clockwise 30° to disengage the ion volume.
8. Reattach the vacuum manifold cover.
9. Reattach the front and top covers.
10. Restart the DSQ II.

## Cleaning the Ion Source, Lenses and Prefilter

To clean the ion source, lenses, and prefilter, you will need:

- Cleaning supplies for non-stainless steel or hybrid parts
- Cleaning supplies for stainless steel parts
- Forceps
- Gloves, clean, lint- and powder-free
- Lens alignment tool
- Lint-free cloth
- Wrench, Allen, 2.5 mm
- Wrench, Allen, 3.0 mm

If cleaning the ion volume does not restore system performance, try cleaning the ion source and prefilter. System performance is determined by your benchmark tests, as described in ["Preparing the DSQ II for Maintenance" on page 25](#). The ion source lenses (especially lens 1) come in direct contact with samples introduced into the DSQ II and need to be cleaned periodically (though not as often as the ion volume).

## Cleaning the Ion Source and Lenses

To clean the ion source and lenses:

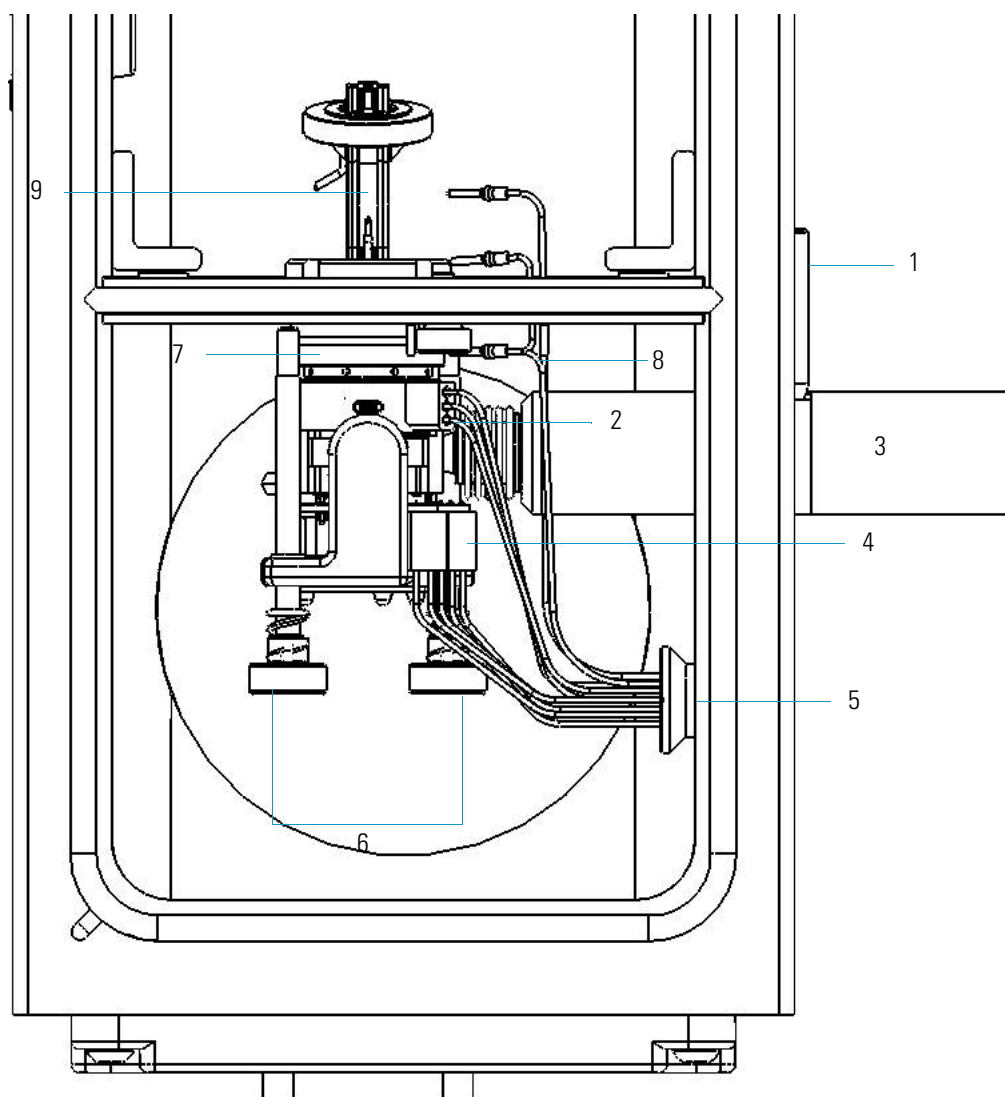
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the front and top covers, as described in "[Removing the Front and Top Covers](#)" on page 25.
4. Remove the vacuum manifold cover, as described in "[Removing the Vacuum Manifold Cover](#)" on page 32.
5. Disconnect the 3- and 8-pin connectors from the ion source. Do not disconnect them by pulling on the wires.
6. Loosen the two thumbscrews on the magnet yoke.
7. Slide the source spacer slightly to the left, while pulling it away from the prefilter. Once it is free, carefully slide it to the left so that it clears the end of the transfer line. Be careful not to damage the capillary column extending out of the transfer line.

**Figure 26.** Disconnecting the Ion Source and Surrounding Components from the DSQ III

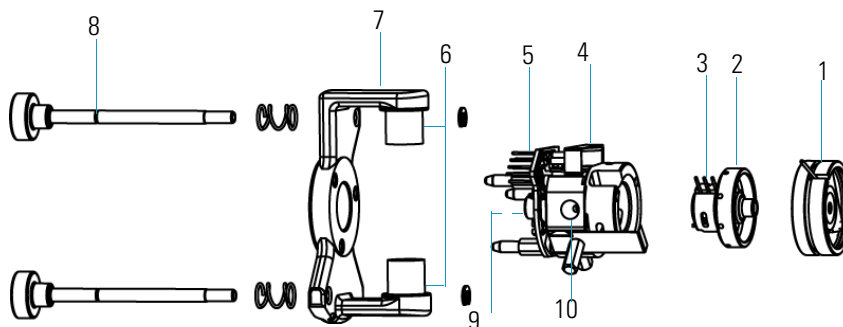


1	Vacuum Manifold	6	Two Thumbscrews
2	3-Pin Lens Connector	7	Source Spacer
3	Transfer Line	8	Source Spacer Connector
4	8-Pin Lens Connector	9	Prefilter
5	12-Pin Lens Connector		

**Note** Wear clean, lint- and powder-free gloves when you handle any vacuum manifold components.

8. Remove the components surrounding the ion source.

**Figure 27.** Removing the Components Surrounding the Ion Source

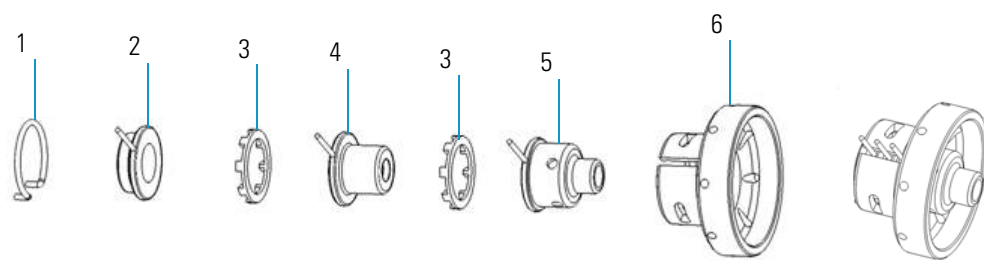


1	Source Spacer and Prefilter Lens	6	Two Magnets
2	Lens Stack	7	Magnet Yoke
3	3-Pin Lens Connector	8	Two Thumbscrews
4	Filament	9	Ion Volume (Inside Ion Source)
5	8-Pin Lens Connector	10	Ion Source

9. Remove the source spacer, which contains the prefilter entrance lens. Also, compress and remove the triangular spring clip that the source spacer uses to hold the prefilter lens in place.
10. Remove the lens stack.
11. Remove the magnet yoke, magnets, and thumbscrews as one unit and set them aside.
12. Disassemble the lens stack.



**Figure 28.** Disassembling the Lens Stack

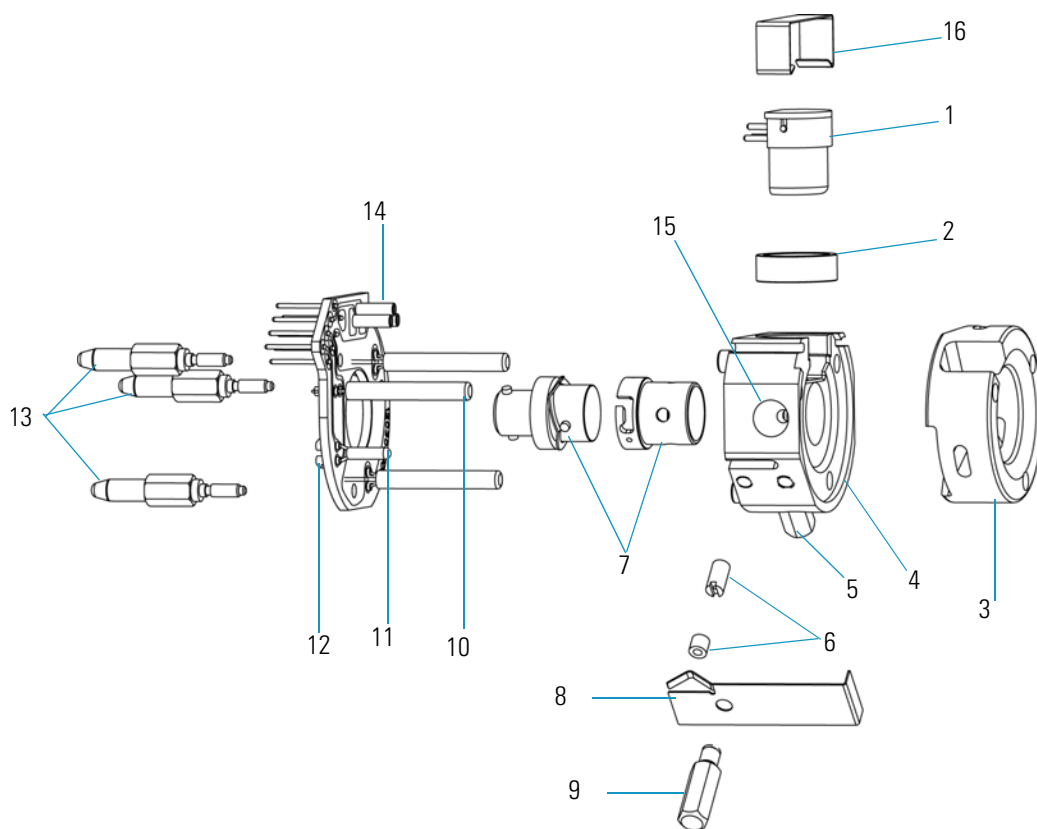


Disassembled				Assembled	
1	Lens Clip	4	Lens 2		
2	Lens 1	5	Lens 3		
3	Lens Spacer	6	Lens Holder		

- a. Remove the lens clip by pinching the ends with your fingers or forceps.
  - b. Remove the lenses and lens spacers from the ceramic lens holder.
13. Clean the exterior and interior surface of the lenses, as described in "[Cleaning Stainless Steel Components](#)" on page 34. Pay particular attention to the areas inside the tube and around the hole of each lens.
  14. Clean ONLY the ceramics with Aqua Regia, hydrogen flame, or muffle furnace at 600 °C.

15. Disassemble the ion source.

**Figure 29.** Ion Source Components



1	Filament	9	Spring Thumbscrew
2	Filament Spacer	10	Three Cartridge Heaters
3	Heater Ring	11	Temperature Sensor
4	Ion Source	12	Ion Source Board
5	Alignment Pin/Ion Volume Key Thumbscrew	13	Three Base-Studs
6	Ion Volume Pin/Set Screw & Ball Plunger	14	3-Pin Filament Connector
7	Ion Volume and Holder	15	Sample Inlet Aperture
8	Spring	16	Filament Retainer Clip

- a. Remove the base studs, but be careful not to damage the leads on the ion source board.



**CAUTION - INSTRUMENT DAMAGE.** Do not bend or twist the cartridge heaters or the temperature sensor.

- b. Gently pull the ion source board from the ion source by sliding the cartridge heaters and temperature sensor out of the ion source and pulling the filament straight away from the 3-pin filament connector that is located on the ion source board.
- c. Remove the filament retainer clip.
- d. Remove the filament and filament spacer.
- e. Remove the ion volume key thumbscrew.

**Note** It is not necessary to remove the ion volume pin. If it is removed, it should be reinserted just far enough so the ball will keep an ion volume from falling out. If the ball extends too far, the ion volume will be difficult to remove.

- f. Remove the spring and spring thumbscrew.
16. Clean the ion source components, as described in "[Cleaning Stainless Steel Components](#)" on page 34 and "[Cleaning Non-Stainless Steel or Hybrid Components](#)" on page 36. Pay particular attention to cleaning around the filament and the well on the opposite side of where the ion volume sits.
  17. Reassemble the ion source.
    - a. Reinstall the magnet yoke, magnets, and thumbscrews.
    - b. Reinsert the lenses.
    - c. Compress and install the triangular spring clip that the source spacer uses to hold the prefilter lens in place.
    - d. Reinstall the source spacer.
  18. Reassemble the lens stack.
    - a. Put the lenses and lens spacers back into the ceramic lens holder.
    - b. Reattach the lens clip by pinching the ends with your fingers or forceps.
  19. Insert the lens alignment tool (PN 120271-0001) through the magnet yoke and into the lenses to maintain alignment during assembly.
  20. Install the ion source into the DSQ II.
    - a. Slip the ion source over the end of the transfer line. Be careful not to damage the capillary column extending out of the transfer line.
    - b. Push the source spacer to the right until it snaps into place.
    - c. Tighten the two thumbscrews.

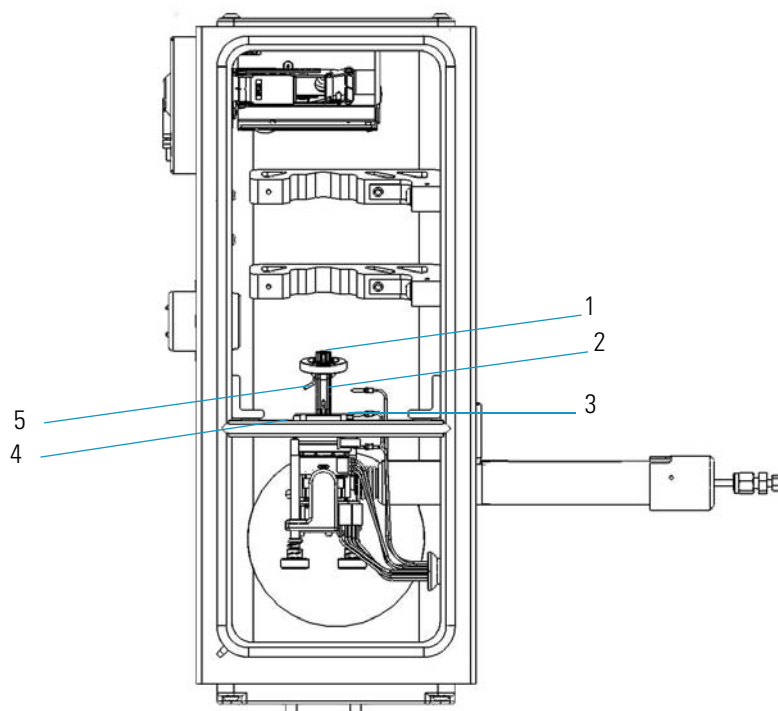
- d. Attach the 3- and 8-pin connectors.
- e. Move the ion source left and right to ensure it is snapped in place. If it does not move, it is in place. If the ion source is not in its groove properly, it could affect performance and your ability to insert or remove the ion volume with an inlet valve.
- f. Remove the lens alignment tool.
- g. Use the lens alignment tool to insert the ion volume. Make sure the arrow is facing up and the ion volume is all the way in, which is typically when the flat surface of the ion holder and heater board are exactly aligned. Any stainless steel that is outside the board plane reduces ionization.

## Cleaning the Prefilter

To clean the prefilter:

1. Remove the prefilter.

**Figure 30.** Removing the Prefilter



1	Prefilter	4	Prefilter Clamp
2	Top Prefilter Connector	5	Bottom Prefilter Connector
3	Four Prefilter Clamp Screws		

- a. Disconnect the top and bottom prefilter connectors from the prefilter.
  - b. Remove the ion source from its housing.
  - c. Loosen the thumbscrew locking the prefilter brackets in place and slide the ion volume holder to the left. Then remove the prefilter out the front of the instrument.
2. Clean the prefilter according to "[Cleaning Non-Stainless Steel or Hybrid Components](#)" on page 36.
3. Reinstall the prefilter.
  - a. Assemble the mounting bracket.
  - b. Clip the prefilter through the baffle wall.
  - c. Slide the lock bracket right and tighten the screw.
  - d. Reinstall the ion source and ensure it is aligned.
4. Reattach the vacuum manifold cover.
5. Reattach the front and top covers.
6. Restart the DSQ II.

## Replacing the Ion Source Filament

The number of ions produced in the ion source is almost proportional to the filament emission current. If you notice a decrease in ion production, the filament may be failing and needs to be replaced. Also, if the measured emission current is substantially less than the set emission current value, or if the measured emission current is decreasing, you may need to replace the filament because it has failed or is failing.

To replace the ion source filament, you will need clean, lint- and powder-free gloves and a lint-free cloth.

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



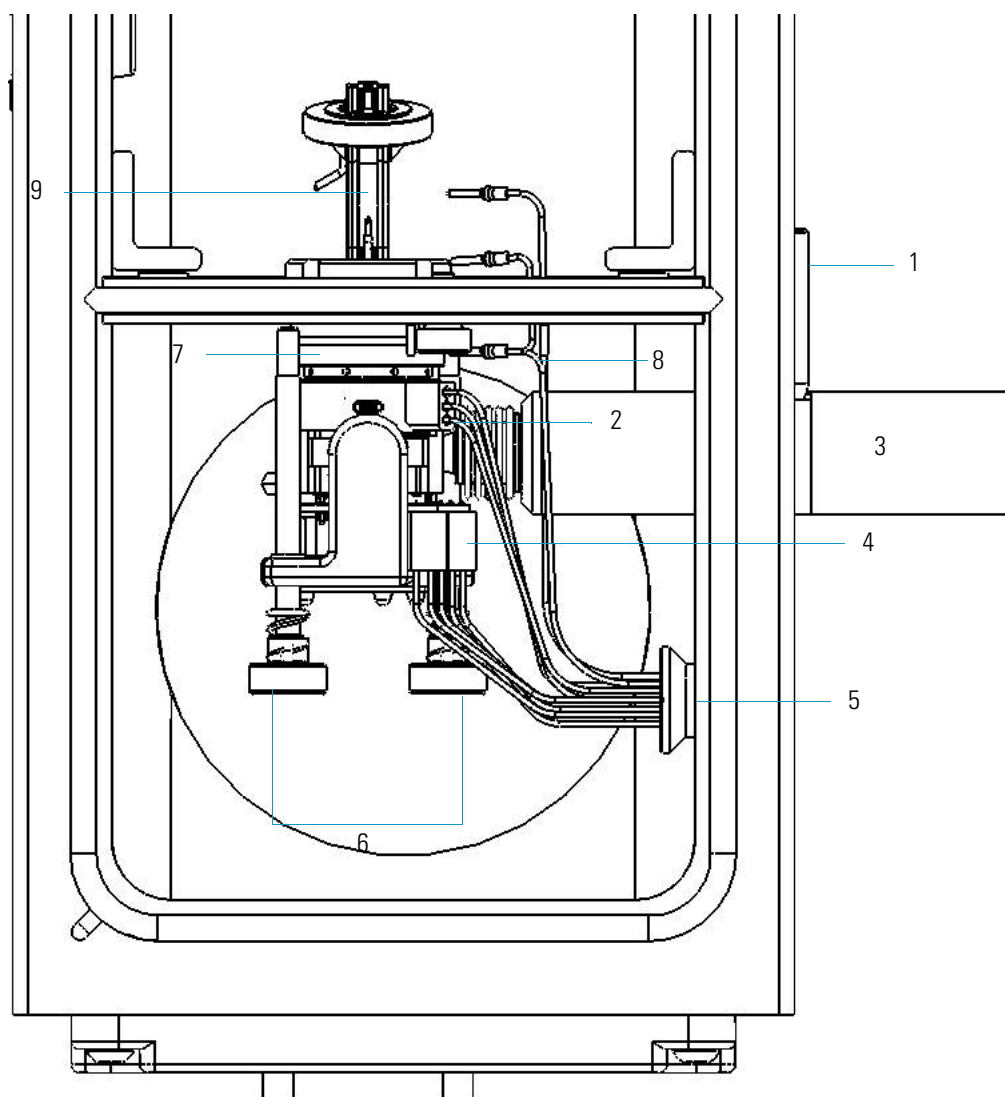
**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the front and top covers, as described in "[Removing the Front and Top Covers](#)" on page 25.
4. Remove the vacuum manifold cover, as described in "[Removing the Vacuum Manifold Cover](#)" on page 32).

**Note** Wear clean, lint- and powder-free gloves when you handle any vacuum manifold components.

5. Disconnect the 3- and 8-pin connectors from the ion source. Do not disconnect them by pulling on the wires.
6. Loosen the two thumbscrews on the magnet yoke.
7. Slide the source spacer slightly to the left, while pulling it away from the prefilter. Once it is free, carefully slide it to the left so that it clears the end of the transfer line. Be careful not to damage the capillary column extending out of the transfer line.

**Figure 31.** Disconnecting the Ion Source and Surrounding Components from the DSQ III

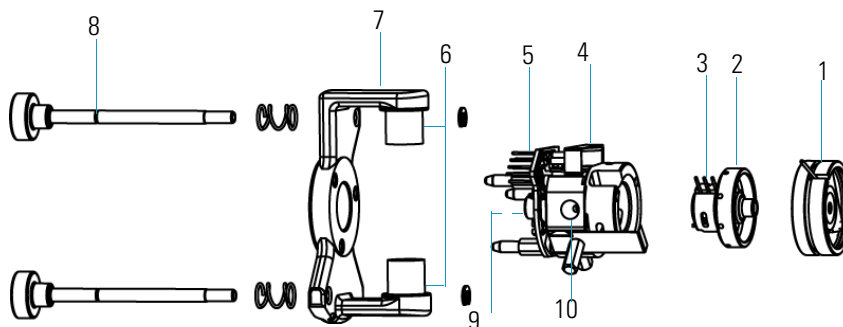


1	Vacuum Manifold	6	Two Thumbscrews
2	3-Pin Lens Connector	7	Source Spacer
3	Transfer Line	8	Source Spacer Connector
4	8-Pin Lens Connector	9	Prefilter
5	12-Pin Lens Connector		

**Note** Wear clean, lint- and powder-free gloves when you handle any vacuum manifold components.

8. Remove the components surrounding the ion source.

**Figure 32.** Removing the Components Surrounding the Ion Source



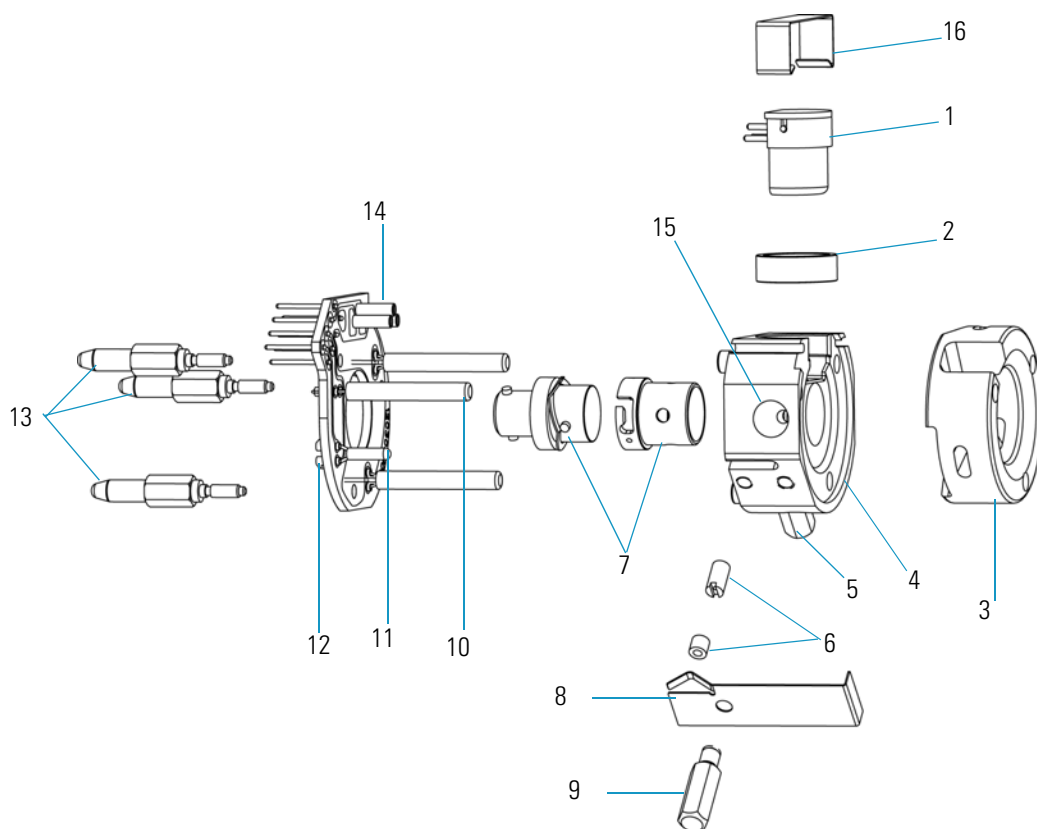
1	Source Spacer and Prefilter Lens	6	Two Magnets
2	Lens Stack	7	Magnet Yoke
3	3-Pin Lens Connector	8	Two Thumbscrews
4	Filament	9	Ion Volume (Inside Ion Source)
5	8-Pin Lens Connector	10	Ion Source

9. Remove the source spacer, which contains the prefilter entrance lens.
10. Remove the lens stack.
11. Remove the magnet yoke, magnets, and thumbscrews as one unit and set them aside.



12. Disassemble the ion source.

**Figure 33.** Ion Source Components



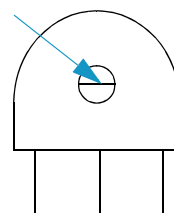
1	Filament	9	Spring Thumbscrew
2	Filament Spacer	10	Three Cartridge Heaters
3	Heater Ring	11	Temperature Sensor
4	Ion Source	12	Ion Source Board
5	Alignment Pin/Ion Volume Key Thumbscrew	13	Three Base-Studs
6	Ion Volume Pin/Set Screw & Ball Plunger	14	3-Pin Filament Connector
7	Ion Volume and Holder	15	Sample Inlet Aperture
8	Spring	16	Filament Retainer Clip

- a. Remove the base studs, but be careful not to damage the leads on the ion source board.



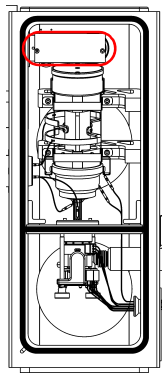
**CAUTION - INSTRUMENT DAMAGE.** Do not bend or twist the cartridge heaters or the temperature sensor.

- b. Gently pull the ion source board from the ion source by sliding the cartridge heaters and temperature sensor out of the ion source and pulling the filament away from the 3-pin filament connector located on the ion source board.
  - c. Remove the filament retainer clip.
  - d. Remove the filament.
13. Verify that the wire on the new filament is centered in the electron lens hole. If it is not, carefully use forceps to adjust the wire.
  14. Insert the filament into the ion source. Normally, there is a small gap (about 0.020 in.) between the filament and the connectors. The gap allows the ceramic filament spacer centering ring to properly position and align the electron lens hole with the ion volume.
  15. Ensure the bottom of the filament's outer shield does not touch the ion source.
  16. Reassemble the ion source and its surrounding components.
    - a. Insert the filament retainer clip.
    - b. Gently insert the ion source board into the ion source by sliding the cartridge heaters and temperature sensor into the ion source and pushing the filament into the 3-pin filament connector located on the ion source board.
    - c. Reattach the base studs, but be careful not to damage the leads on the ion source board.
    - d. Insert the lens stack.
    - e. Attach the source spacer to the ion source.
    - f. Reattach the magnet yoke, magnets, and thumbscrews.
  17. Reinstall the ion source and its surrounding components back into the DSQ II.
    - a. Slip the ion source over the end of the transfer line. Be careful not to damage the capillary column extending out of the transfer line.
    - b. Push the source spacer to the right until it snaps into place.
    - c. Tighten the two thumbscrews completely.
    - d. Attach the 3- and 8-pin connectors.
    - e. Move the ion source left and right to ensure it is snapped in place. If it does not move, it is in place. If the ion source is not in its groove properly, it could affect performance and your ability to insert or remove the ion volume with an inlet valve.



18. Reattach the vacuum manifold cover.
19. Reattach the front and top covers.
20. Restart the DSQ II.

## Replacing the Electron Multiplier



The electron multiplier consists of a conversion dynode and cathode. It must be kept clean and free of dust because even the smallest amount of lint can cause spectral noise or static discharge, which could lead to power supply failure. Always clean the conversion dynode and electron multiplier with clean dry gas, never liquids or abrasives, each time you remove the vacuum manifold cover. Attach the vacuum manifold cover when you temporarily step away from the instrument to prevent dust from accidentally contaminating the system.

**CAUTION - INSTRUMENT DAMAGE.** If you notice an ion burn on the surface of the conversion dynode, clean it with Alox/water. Normally, it will not adversely affect the performance of the instrument.

You may need to replace the electron multiplier if AutoTune is consistently setting the voltage to 1800 V or higher. To replace the electron multiplier, you will need:

- Cathode (PN A0022-14633)
- Forceps
- Gloves, clean, lint- and powder-free
- Lint-free cloth
- Screwdriver, Flat
- Screwdriver, Phillips #1
- Wrench, Allen, 2.5 mm
- Wrench, Allen, 3 mm

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



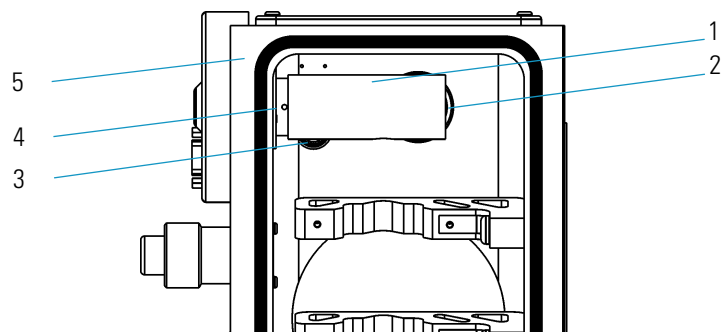
**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the front and left covers, as described in "[Removing the Front and Top Covers](#)" on page 25 and "[Removing the Left Cover](#)" on page 29
4. Remove the vacuum manifold cover, as described in "[Removing the Vacuum Manifold Cover](#)" on page 32.

**Note** Wear clean, lint- and powder-free gloves when you handle any vacuum manifold components.

5. Remove the ion detector.

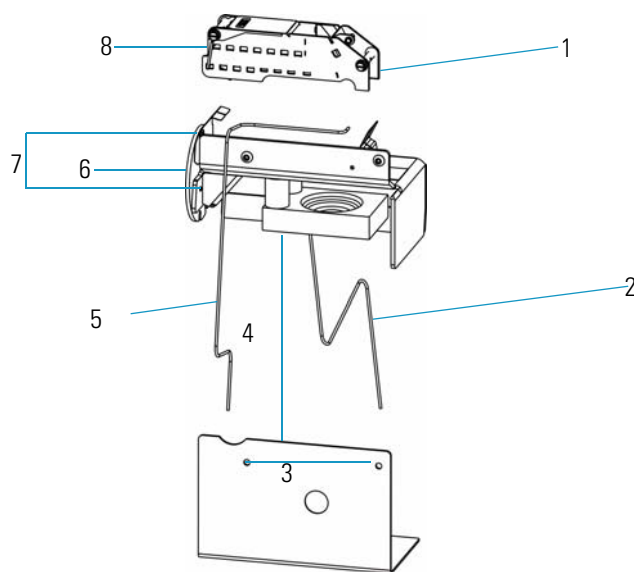
**Figure 34.** Removing the Ion Detector



1	Ion Detector	4	Two Screws on Ion Detector
2	Conversion Dynode Connector	5	Vacuum Manifold
3	Electron Multiplier Connector		

- Disconnect the conversion dynode and electron multiplier connectors from the connectors on the bottom of the vacuum manifold.
  - Remove the two screws holding the ion detector to the vacuum manifold.
6. Disassemble the ion detector and remove the multiplier.

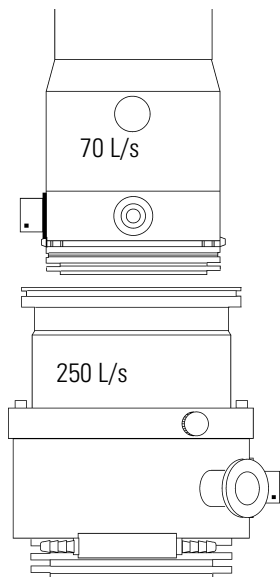
**Figure 35.** Ion Detector Components



1	Electron Multiplier Cathode	5	Electron Multiplier Wire
2	Conversion Dynode Wire	6	Base
3	Two Screws for Shield	7	Two Screws for the Base
4	Shield and Conversion Dynode	8	Electron Multiplier Anode

- a. Remove the two screws that hold the shield in place.
  - b. Remove the two screws that hold the base in place.
  - c. Disconnect the electron multiplier wire.
  - d. Remove the old electron multiplier by gently pressing on the cathode springs while pulling up on the electron multiplier.
7. Lock the new electron multiplier in place with springs and clip.
  8. Use the two base screws to reattach the ion detector base to the manifold wall. Ensure the conversion dynode connector wire is seated properly in the dynode and feedthrough.
  9. Reassemble the ion detector.
    - a. Attach the shield with the two screws that hold the shield in place.
    - b. Attach the new electron multiplier cathode with the spring clip. Insert the end nearest the manifold mount first, then push the other end into the clip.
    - c. Reconnect the electron multiplier connector.
  10. Reattach the front and top covers.
  11. Restart the DSQ II.

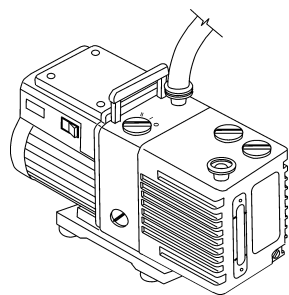
## Maintaining the Turbomolecular Pump



The DSQ II is equipped with either a 70 L/s turbomolecular pump, a 250 L/s turbomolecular pump, or a 200/200 L/s split-flow turbomolecular pump.

No maintenance is required. These pumps contain enough lubricant to support the bearings for life. The turbomolecular pump is located directly under the vacuum manifold and provides the high vacuum necessary for ion production.

## Maintaining the Rotary-Vane Pump



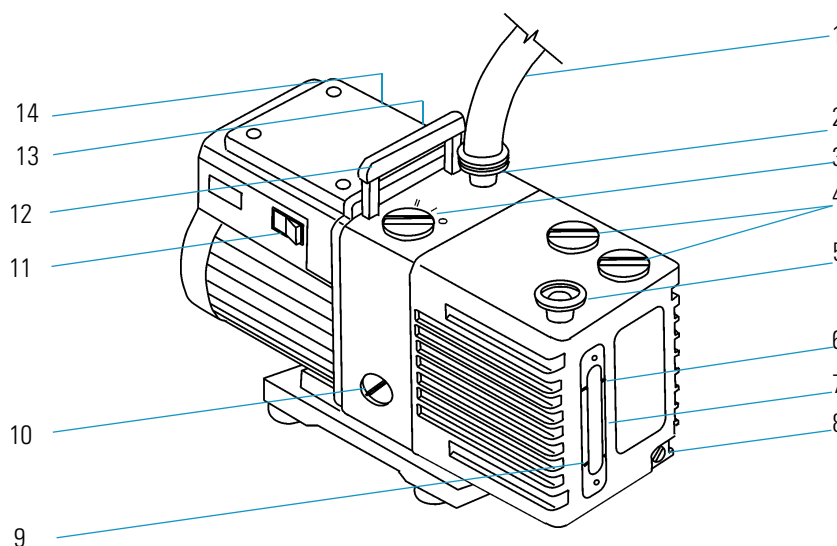
The rotary-vane pump is located under the DSQ II worktable. To maintain the rotary-vane pump, check, add, purge, and change the oil as needed.

## Checking the Oil Level of a Rotary-Vane Pump

To check the oil level (should be done on a monthly basis) of a rotary-vane pump:

1. Look in the oil-level sight-glass to see if the oil level is between the MIN and MAX marks.

**Figure 36.** Rotary-Vane Pump Components



1	Foreline Vacuum Hose	8	Drain Plug
2	Inlet Port	9	MIN (minimum level mark)
3	Gas-Ballast Control	10	Mode Selector
4	Oil Filler Plugs	11	On/Off Switch
5	Outlet Port	12	Handle
6	MAX (maximum level mark)	13	Voltage Indicator
7	Oil-Level Sight-glass	14	Electrical Inlet Connector

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

2. If the oil level is below the MIN mark, add oil, as described in ["Adding Oil to a Rotary Vane Pump"](#) on page 64.
3. Look for oil that is clear and light amber in color.
  - a. If the oil is cloudy or discolored, purge the oil to decontaminate dissolved solvents, as described in ["Purging Gas from the Oil in a Rotary-Vane Pump"](#) on page 65.
  - b. If the pump oil is still discolored, change it, as described in ["Changing the Oil in a Rotary-Vane Pump"](#) on page 67.

## Adding Oil to a Rotary Vane Pump

To add oil to the rotary-vane pump:

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18.](#)

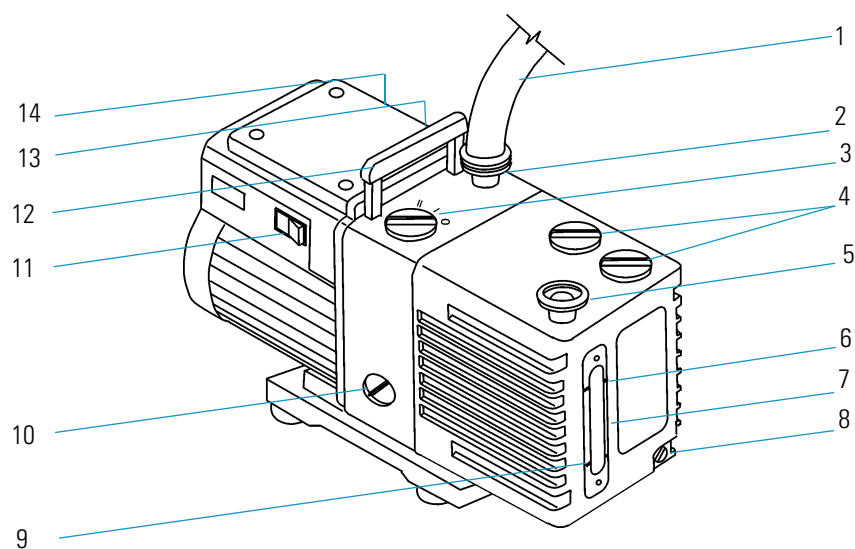


**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Add oil.

**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.

**Figure 37.** Rotary Vane Pump Components



1	Foreline Vacuum Hose	8	Drain Plug
2	Inlet Port	9	MIN (minimum level mark)
3	Gas-Ballast Control	10	Mode Selector
4	Oil Filler Plugs	11	On/Off Switch
5	Outlet Port	12	Handle
6	MAX (maximum level mark)	13	Voltage Indicator
7	Oil-Level Sight-glass	14	Electrical Inlet Connector



- a. Remove one of the oil filler plugs from the rotary-vane pump.
- b. Add fresh oil into the reservoir until the oil is half way between the MIN and MAX level marks.



**CAUTION - INSTRUMENT DAMAGE.** Use only factory-approved rotary-vane pump oil to avoid damaging the instrument or causing a fire.

- c. If the oil level goes above the MAX level mark, remove the drain plug and drain the excess oil into a suitable container.
  - d. Reattach the oil filler plug.
4. Plug the rotary-vane pump and DSQ II to the power source.
  5. Restart the DSQ II.
  6. Purge the rotary-vane pump for 10 minutes by using the gas ballast to remove excess gases from the new oil.

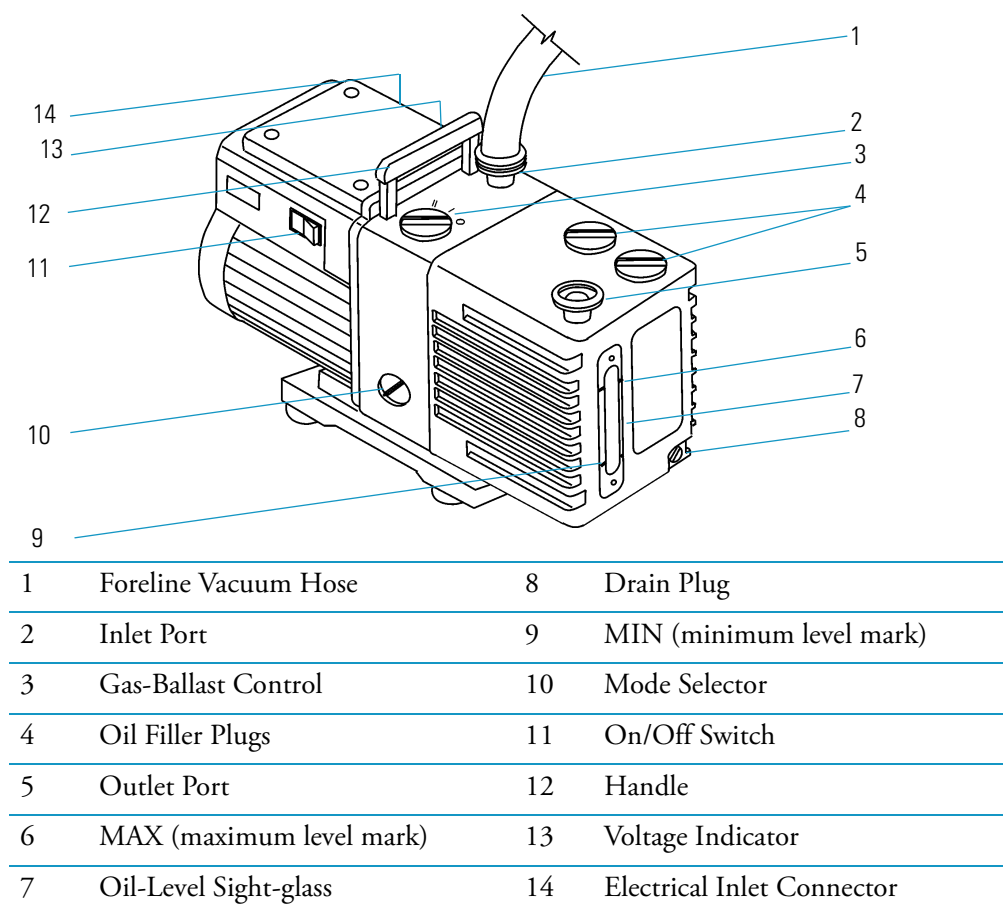
## Purging Gas from the Oil in a Rotary-Vane Pump

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

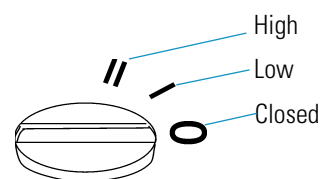
To purge oil from the rotary-vane pump:

1. Make sure you are not in the middle of an acquisition and the electron multiplier and filament are OFF. Use the *Xcalibur* Tune window to confirm these items are off.
2. Prepare the rotary-vane pump for purging.

**Figure 38.** Rotary Vane Pump Components



- Set the gas-ballast control to position I (means low flow).
- Leave it in that position for 10 minutes or until the oil is clear.
- If the oil remains cloudy or discolored after 10 minutes, change the oil, as described in "[Changing the Oil in a Rotary-Vane Pump](#)" on page 67.
- Set the gas-ballast control to position (0 means closed).



## Changing the Oil in a Rotary-Vane Pump

To change the rotary-vane pump oil, you will need:

- Gloves, latex, impermeable
- Rotary-vane pump oil (PN A0301-15101)
- Suitable container for removing spent oil

You should change the rotary vane pump oil every four months (about 3,000 hours of operation). If you use ammonia as a chemical ionization reagent gas you should change the oil every month. Ammonia is highly basic and quickly damages seals in the rotary-vane pump. Purging the oil with the gas ballast also helps remove dissolved ammonia from 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. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



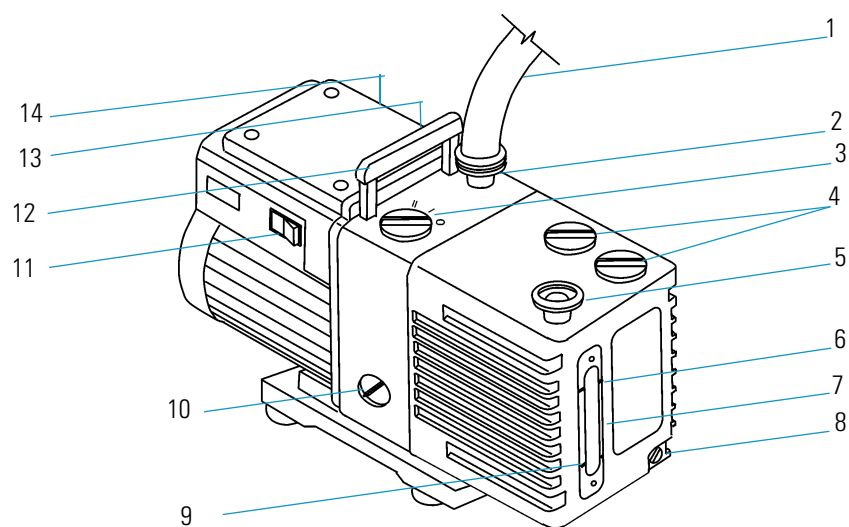
**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Unplug the rotary-vane pump.



**WARNING - ELECTRICAL SHOCK HAZARD.** Shut down and unplug the DSQ II and rotary-vane pump before adding oil.

**Figure 39.** Rotary- Vane Pump Components



1	Foreline Vacuum Hose	8	Drain Plug
2	Inlet Port	9	MIN (minimum level mark)
3	Gas-Ballast Control	10	Mode Selector
4	Oil Filler Plugs	11	On/Off Switch
5	Outlet Port	12	Handle
6	MAX (maximum level mark)	13	Voltage Indicator
7	Oil-Level Sight-glass	14	Electrical Inlet Connector

4. Disconnect the foreline vacuum hose.
5. Place the rotary-vane pump on a bench.



**WARNING - LIFTING HAZARD.** Use a proper lifting technique with the rotary-vane pump because it weighs approximately 22 kg (50 lbs).

6. Drain the old oil.



**WARNING - HAND AND CHEMICAL HAZARD.** Wear impermeable laboratory gloves when changing oil.

- a. Remove one of the oil filler plugs.
- b. Using gloves, remove the drain plug, and allow the oil to drain into a suitable container.
- c. Dispose of the spent oil according to local environmental regulations.
- d. Replace the drain plug.

7. Add fresh oil.



**WARNING - FIRE HAZARD.** Use only factory-approved rotary-vane pump oil. Using unapproved rotary-vane pump oil may result in a fire or explosion.

- a. Add oil to the oil filler plug opening halfway between the MIN and MAX level marks.
  - b. If the oil level goes above the MAX level mark, remove the drain plug and drain the excess oil from the pump.
8. Reassemble the rotary-vane pump.
- a. Reattach the oil filler plug.
  - b. Place the rotary-vane pump on the floor.
  - c. Reconnect the foreline vacuum hose.
9. Plug the rotary-vane pump into the mechanical pump outlet on the back of the DSQ II.
10. Restart the DSQ II.

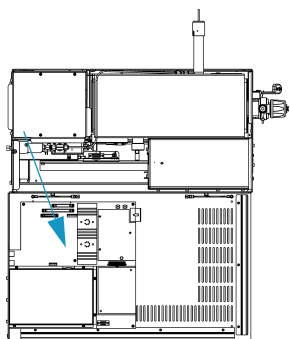
## Maintaining Components Outside the Vacuum Manifold

This section describes how to remove and replace fuses, boards, and other components located outside the vacuum manifold. You can find these components by removing the front, left, and right covers, or by looking on the rear of the DSQ II.

These components, which are listed below, do not require routine maintenance, but they may need to be replaced at a later date. You should only replace these parts when instructed by *Tune* diagnostics, technical support, or a field service engineer.

- "Replacing the Analog Board" on page 71
- "Replacing the Analog Board Fuse" on page 73
- "Replacing the Calibration Gas Flow Module" on page 75
- "Replacing the CI Reagent Gas Flow Module" on page 79
- "Replacing the Conversion Dynode/Electron Multiplier Power Supply" on page 81
- "Replacing the DC Driver" on page 83
- "Replacing the DC Driver Fuse" on page 85
- "Replacing the Digital Board" on page 87
- "Replacing the Electrometer Board" on page 89
- "Replacing the Foreline Pressure Gauge and Foreline Adapter" on page 91
- "Replacing the Inlet Valve Seal" on page 93
- "Replacing the Ion Gauge (Optional Upgrade)" on page 94
- "Replacing the Lens Interface Board" on page 96
- "Replacing the Low Pass Filter Board" on page 98
- "Replacing the Power Module" on page 101
- "Replacing the Power Module Fuses" on page 103
- "Replacing the Rear Cooling Fans" on page 104
- "Replacing the RF Detector Board" on page 107
- "Replacing the RF Generator Board" on page 109
- "Replacing the RF Generator Board Fuses" on page 110
- "Replacing the Transfer Line" on page 112
- "Replacing the Turbomolecular Pump Power Supply" on page 114
- "Replacing the Vacuum Control Board" on page 115
- "Replacing the Vent Valve Solenoid" on page 118

## Replacing the Analog Board



To replace the analog board, you need:

- New Analog board (PN 119590-0022)
- Nut driver, 5.5 mm
- Wrench, Allen, 2.5 mm
- Wrench, Allen, 3 mm

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.

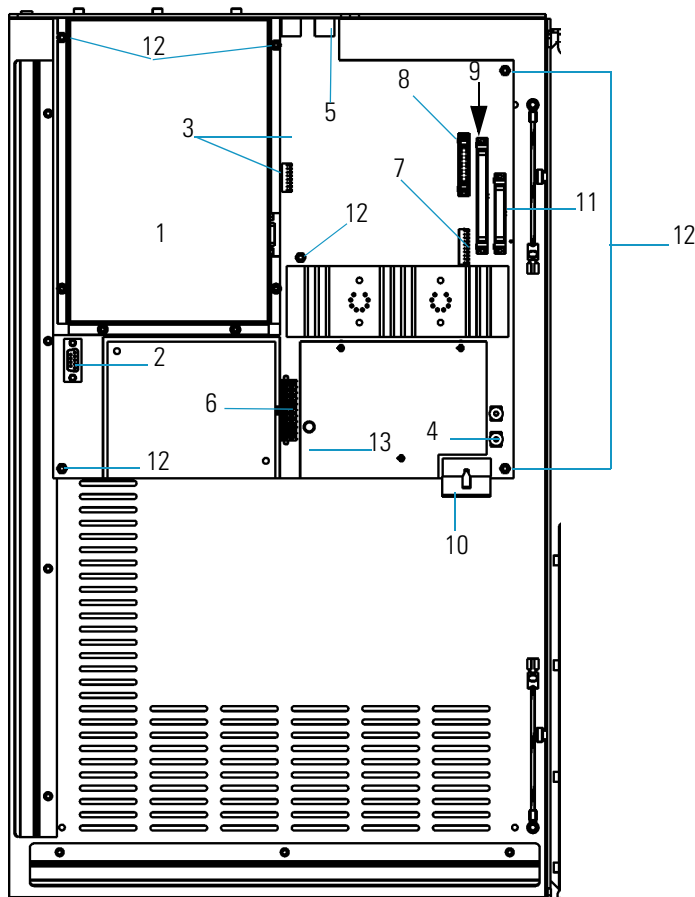


**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in "[Removing the Left Cover](#)" on page 29.

4. Remove the analog board.

**Figure 40.** Removing the Analog Board

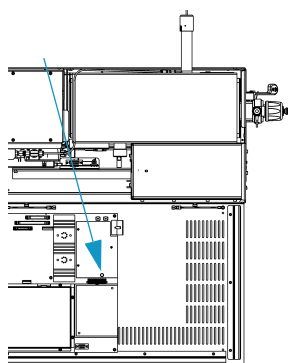


1	Digital Board	8	P7 Connector on Electron Multiplier/ Conversion Dynode Power Supply
2	J1 Connector on RF Control Board	9	P8 Connector on RF Generator Board
3	P4/P5 Connector on DC Driver	10	P9 Connector on Power Module
4	J3 Connector on Low Pass Filter Board	11	P10 Connector on Vacuum Control Board
5	J5 Connector on Analog Board	12	Nuts holding the Board in place
6	P2 Connector on Lens Interface Board	13	Analog Board (PN 119590-0022)
7	P6 Connector on CI Reagent Gas Flow Module		



- a. Remove the digital board, as described in ["Replacing the Digital Board" on page 87](#).
  - b. Disconnect cables from their connectors.
  - c. Remove the six nuts holding the analog board in place.
  - d. Remove the analog board.
5. Install the new analog board (PN 119590-0022).
    - a. Insert the new analog board.
    - b. Reattach the six nuts.
    - c. Reconnect the cables.
    - d. Reattach the digital board.
  6. Reattach the left cover of the DSQ II.
  7. Restart the DSQ II.

## Replacing the Analog Board Fuse



To replace the analog board fuse:

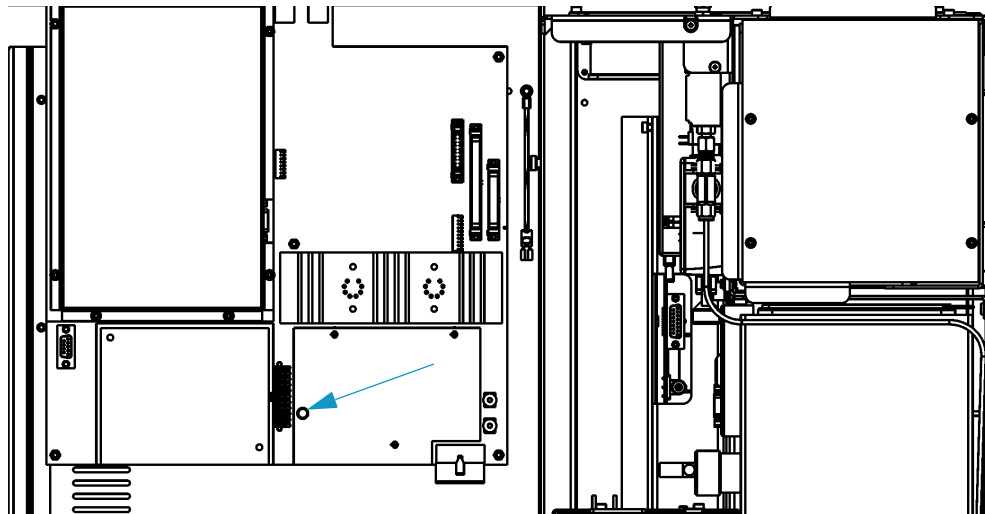
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in ["Removing the Left Cover" on page 29](#).
4. Replace the analog board fuse.

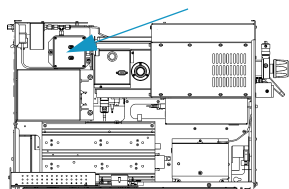
**Figure 41.** Replacing the Analog Board Fuse



**CAUTION - INSTRUMENT DAMAGE.** Only use a 125V fuse or else you could damage the instrument. Never replace DSQ II fuses with those of a different type, voltage, or current rating. Also, to avoid damaging the boards, you should always wear a properly grounded electrostatic discharge (ESD) strap on your wrist when replacing fuses.

- a. Disconnect the analog board fuse.
  - b. Connect the new analog board fuse (PN 76339-0008; 2 A, very fast microfuse, 125 V). It does not matter which way it is plugged in.
5. Reattach the left, top, and front covers of the DSQ II.
  6. Restart the DSQ II.

## Replacing the Calibration Gas Flow Module



To replace the calibration gas flow module, you will need:

- New Calibration Gas Flow Module (PN 119246-0001)
- FC-43 calibration compound (PN 50010-30059)
- Syringe
- Wrench, Allen, 3 mm
- Wrench, open-ended, 7/16-in.
- Wrench, open-ended, 9/16-in.

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

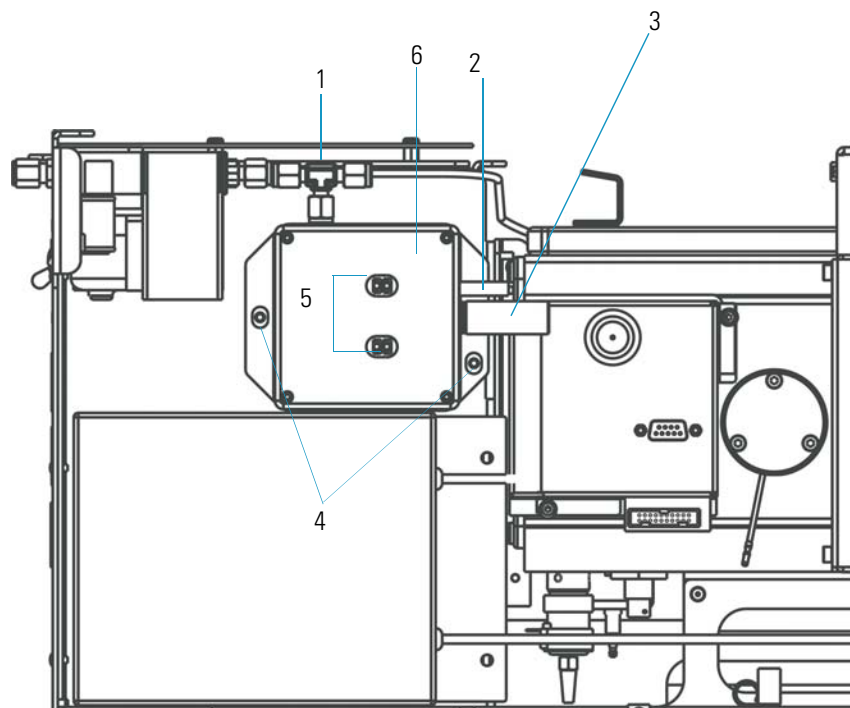
3. Remove the left cover, as described in "[Removing the Left Cover](#)" on page 29.
4. Turn off the CI reagent gas supply (if present).



**WARNING - FLAMMABLE GAS HAZARD.** CI reagent gases are often flammable or corrosive. You must vent the gas to a fume hood or other suitable exhaust. The CI reagent gas supply line must be leak tight.

5. Remove the calibration gas flow module.

**Figure 42.** Removing the Calibration Gas Flow Module



1	Gas Fittings	4	Two Screws
2	Foreline Adapter Tubing (not shown)	5	Two Twisted Pair Wires
3	Calibration Compound Vial	6	Calibration Gas Flow Module (PN 119246-0001)

- a. Disconnect the gas fittings.
  - b. Disconnect the foreline adapter tubing from the foreline adapter, which is located near the high vacuum pump.
  - c. Remove the two screws.
  - d. Remove the calibration gas flow module.
6. Install the new calibration gas flow module (PN 119246-0001).
    - a. Insert the new module.
    - b. Reattach the two screws.
    - c. Reattach the foreline adapter tubing to the foreline adapter.
    - d. Reconnect the gas fittings.

7. Add 200  $\mu$ L of calibration compound. See ["Refilling the Calibration Gas Flow Module" on page 77](#) for more information.
8. Test the gas fittings for leaks.
  - a. Use the DSQ II to check each fitting for leaks, as described in ["High Vacuum Symptoms" on page 135](#).



**CAUTION - INSTRUMENT DAMAGE.** Do not use liquid soap leak detectors (such as Snoop) to check for leaks. They will contaminate your system.

- b. Correct leaks by tightening or replacing the connections. Continue to check and correct leaks until all connections are leak-free.
9. Turn on the CI reagent gas supply (if present).
10. Reattach the right, left, top, and front covers of the DSQ II.
11. Restart the DSQ II.
12. Once the DSQ II has pumped down and is operational, check for vacuum leaks by reading the convectron gauge and ion gauge and running an automatic tune.

## Refilling the Calibration Gas Flow Module

Calibration compound is a liquid whose mass spectrum is used to tune and calibrate the DSQ II. The DSQ II uses FC-43 as its calibration compound. You cannot tell by sight whether calibration compound needs to be added. However, during an *Xcalibur* automatic tune, an error message displays "the intensity of calibration gas ions is too low."

There are many factors that can cause a shortage of calibration gas ions besides a decrease in calibration compound. As a rule, the DSQ II should never require adding calibration compound more than once a year.

To refill the calibration gas flow module, you will need:

- FC-43 calibration compound (PN 50010-30059)
- Screwdriver, Phillips #2
- Syringe
- Wrench, open-ended, 9/16-in.

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

## 2 Maintaining the DSQ II

### Maintaining Components Outside the Vacuum Manifold

3. Remove the right cover, as described in "[Removing the Right Cover](#)" on page 27.
4. Unscrew the calibration gas vial from the calibration gas flow module, which is located behind and to the left of the vacuum manifold.
5. Fill the calibration compound vial.
  - a. Fill a syringe with 200  $\mu$ L of calibration compound.
  - b. Insert the syringe into the calibration compound vial until you touch the white frit.
  - c. Inject the calibration compound onto the frit. The frit absorbs the calibration compound. If you see liquid pooled on top of the frit, remove the excess liquid according to local environmental regulations.



**CAUTION - INSTRUMENT DAMAGE.** Adding more than 200  $\mu$ L of calibration compound can damage the calibration gas flow module. Be sure liquid does not pour into the module when you install the vial.

6. Replace the cal gas vial by first tightening it by hand.
7. Reattach the covers on the DSQ II.
8. Restart the DSQ II.

## Replacing the CI Reagent Gas Flow Module

To replace the CI reagent gas flow module, you will need;

- New CI Reagent Gas Flow Module (PN 23331-0091)
- Leak detector (Thermo Scientific GLD Pro PN 66002-001 or equivalent)
- Screwdriver, Phillips #2
- Wrench, open-ended, 7/16-in.

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

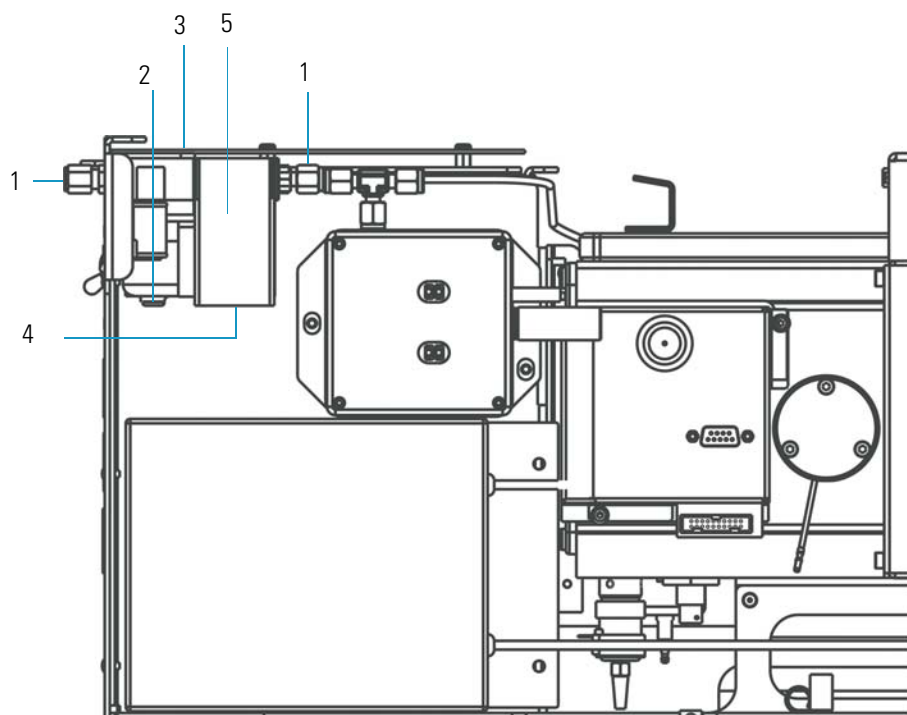
3. Remove the left cover, as described in "[Removing the Left Cover](#)" on page 29.
4. Turn off the CI reagent gas supply.



**WARNING - FLAMMABLE GAS HAZARD.** CI reagent gases are often flammable or corrosive. For safety reasons, you must vent the gas to a fume hood or other suitable exhaust and make sure the CI reagent gas supply line is leak-tight.

5. Remove the CI reagent gas flow module.

**Figure 43.** Removing the CI Reagent Gas Flow Module



1	Gas Fittings	4	Cable (not shown)
2	Foreline Adapter Tubing (not shown)	5	CI Reagent Gas Flow Module (PN 23331-0091)
3	Two Screws		

- a. Disconnect the cable.
  - b. Disconnect the two gas fittings.
  - c. Disconnect the foreline adapter tubing.
  - d. Remove the two screws holding the module in place.
6. Install the new CI reagent gas flow module.
- a. Insert the new module.
  - b. Reattach the screws.
  - c. Reattach the foreline adapter tubing.
  - d. Reconnect the gas fittings.
  - e. Reconnect the cable.



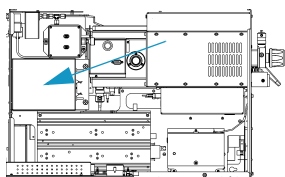
7. Test the gas fittings for leaks.
  - a. Turn on the CI reagent gas supply.
  - b. Use a leak detector to check for leaks on the high-pressure side of the CI reagent gas flow module.
  - c. Use the DSQ II to check for leaks on the low-pressure side of the CI reagent gas flow module, as described in ["High Vacuum Symptoms" on page 135](#).



**CAUTION - INSTRUMENT DAMAGE.** Do not use liquid soap leak detectors (such as Snoot) to check for leaks. They may contaminate your system.

- d. Correct leaks by tightening or replacing the connections. Continue to check and correct leaks until all connections are leak-free.
8. Reattach the left, top, and front covers of the DSQ II.
9. Restart the DSQ II.
10. Once the DSQ II has pumped down and is operational, check for vacuum leaks by reading the convectron gauge and ion gauge and running an automatic tune.

## Replacing the Conversion Dynode/Electron Multiplier Power Supply



To replace the conversion dynode/electron multiplier power supply, you will need a Phillips #2 screwdriver.

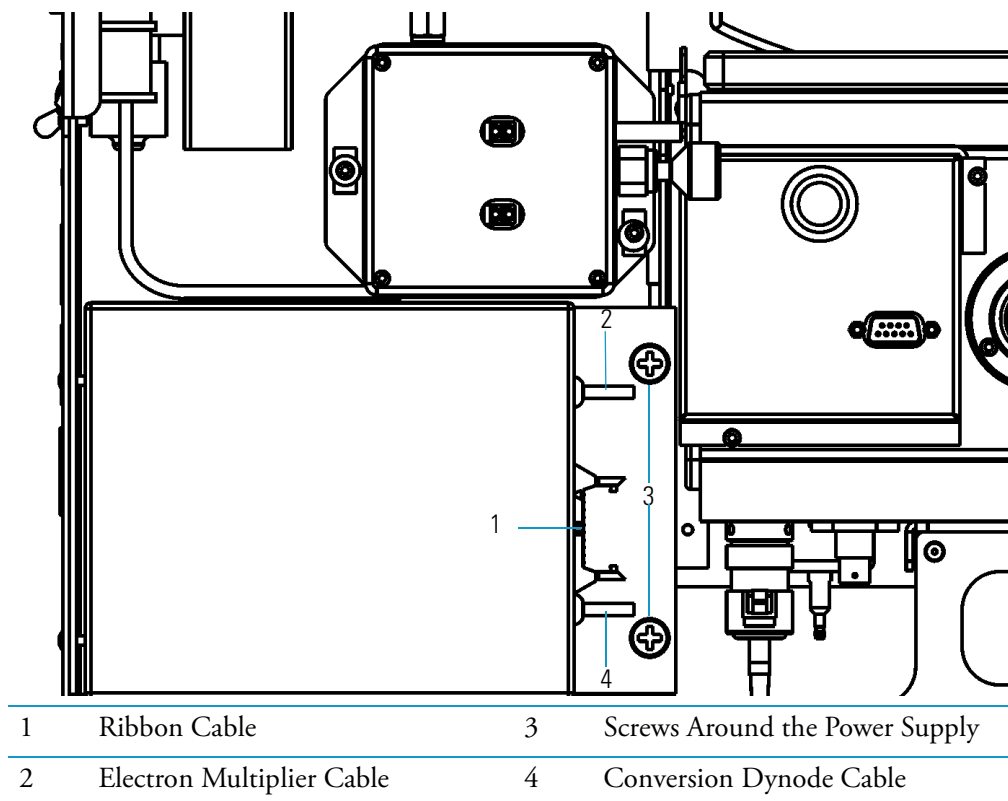
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in "[Removing the Left Cover](#)" on page 29.
4. Remove the conversion dynode/electron multiplier power supply.

**Figure 44.** Removing the Conversion Dynode/Electron Multiplier Power Supply



- a. Disconnect the ribbon cable.
  - b. Disconnect the electron multiplier cable and conversion dynode cable from the bottom of the vacuum manifold.
  - c. Remove the two large screws holding the power supply in place. There is double-sided tape holding the back of the power supply to the chassis. Pull the power supply out to break it loose from the tape.
5. Install the new conversion dynode/electron multiplier power supply (PN 119377-0001 or 119377-0002 with the PPINICI upgrade).
    - a. Insert the power supply.
    - b. Reattach the screws.
    - c. Reconnect the cables.
  6. Reattach the left, top, and front covers of the DSQ II.
  7. Restart the DSQ II.

## Replacing the DC Driver

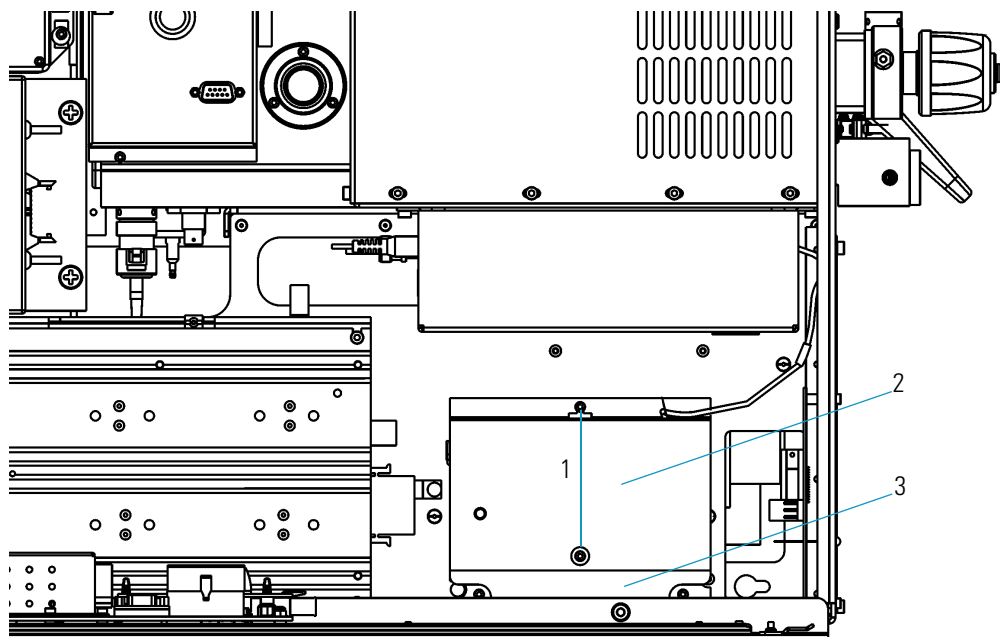
To replace the DC driver, you will need a 2.5 mm Allen wrench.

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in ["Removing the Left Cover" on page 29](#).
4. Remove the DC driver.

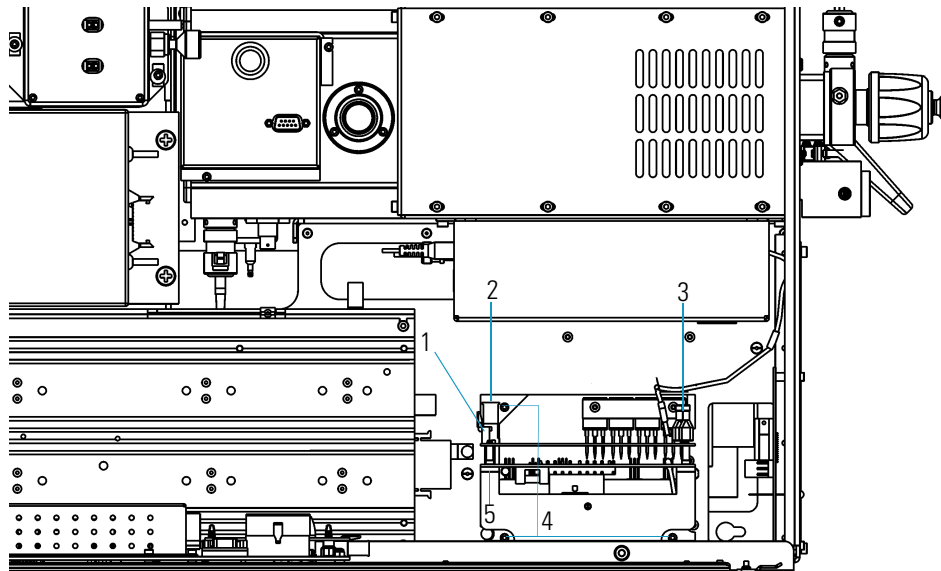


- |   |                                   |   |                            |
|---|-----------------------------------|---|----------------------------|
| 1 | Screws Around the DC Driver Cover | 3 | DC Driver (PN 120152-1000) |
| 2 | DC Driver Cover                   |   |                            |

- a. Remove the lower screw and only loosen the upper screw holding the DC driver cover in place.
- b. Slide the cover up off the upper screw to remove it.

- c. Remove the DC driver cover.

**Figure 45.** DC Driver with Cover Removed



1	Connector to J8 Cable (to Analog Board)	4	Three Screws Around the DC Driver
2	Connector to J2 Cable (to RF Detector Board)	5	Connector to P1 Cable (to Power Module)
3	Connectors to J3, J4, J7 Cables (to Low Pass Filter Board)		

- d. Disconnect the J2, J3, J4, J7, J8, and P1 cables.
  - e. Remove the three screws holding the DC driver in place.
5. Install the new DC driver.
    - a. Insert the new DC driver.
    - b. Reattach the screws.
    - c. Reconnect the cables. The green cable leading to the DC driver goes on the left terminal (J7), the black cable goes to J4, and the red cable goes to J3.
    - d. Reattach the DC driver cover.
    - e. Reattach the left, top, and front covers of the DSQ II.
    - f. Restart the DSQ II.

## Replacing the DC Driver Fuse

To replace the DC driver fuse, you will need a 2.5 mm Allen wrench.

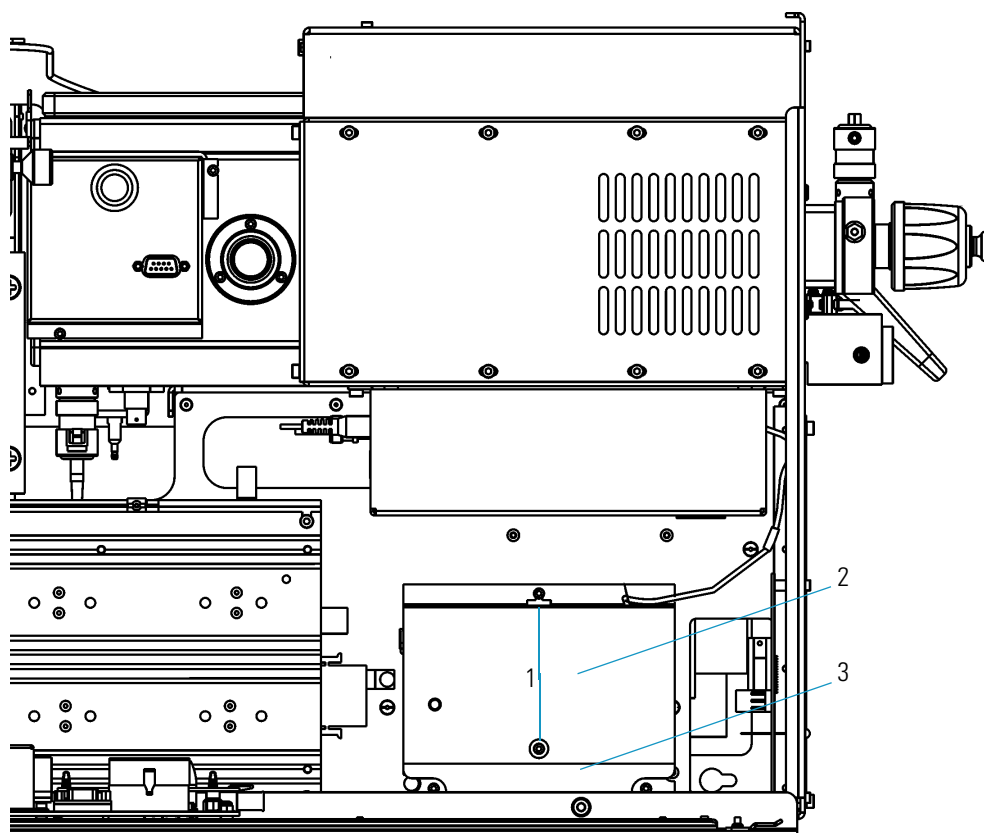
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in ["Removing the Left Cover" on page 29](#).
4. Remove the DC driver assembly cover.

**Figure 46.** Removing the DC Driver



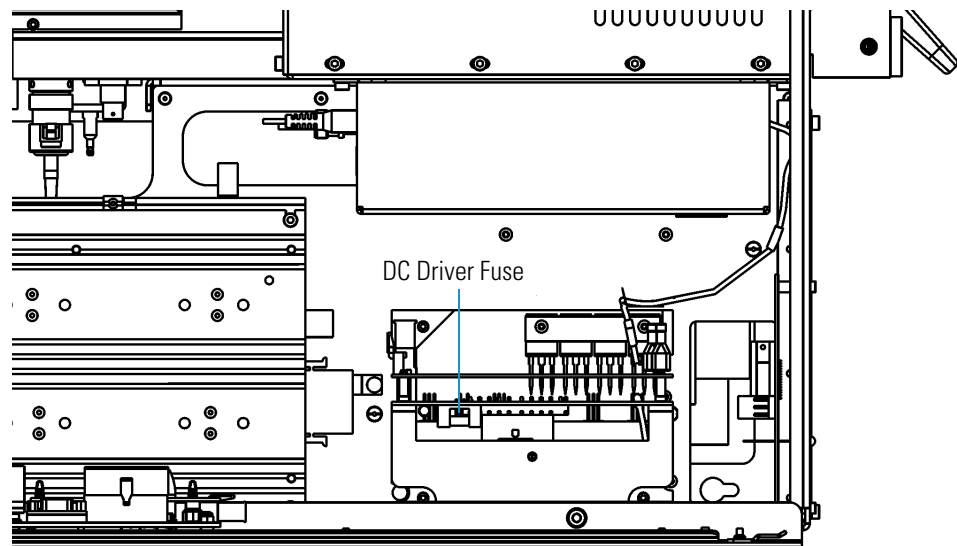
- |   |                                   |   |           |
|---|-----------------------------------|---|-----------|
| 1 | Screws Around the DC Driver Cover | 3 | DC Driver |
| 2 | DC Driver Cover                   |   |           |

## 2 Maintaining the DSQ II

### Maintaining Components Outside the Vacuum Manifold

- a. Remove the lower screw and only loosen the upper screw holding the DC driver cover in place.
  - b. Slide the cover up off the upper screw to remove it.
  - c. Remove the DC driver cover.
5. Remove the current DC driver fuse.
  6. Replace the DC driver fuse (PN 76703-0125; 1.25 A, SB, 5 x 20 mm, 250 V).

**Figure 47.** Replacing the DC Driver Fuse



**CAUTION - INSTRUMENT DAMAGE.** Only use a 125V fuse or else you could damage the instrument. Never replace DSQ II fuses with those of a different type, voltage, or current rating. Also, to avoid damaging the boards, you should always wear an electrostatic discharge (ESD) strap on your wrist when replacing fuses.

7. Reattach the DC driver cover and reattach the screw that holds the cover in place.
8. Reattach the left, top, and front covers of the DSQ II.
9. Restart the DSQ II.

## Replacing the Digital Board

To replace the digital board, you will need:

- New Digital board (PN 119590-0010)
- Nut driver, 5.5 mm
- Wrench, Allen, 2.5 mm
- Wrench, Allen, 3 mm

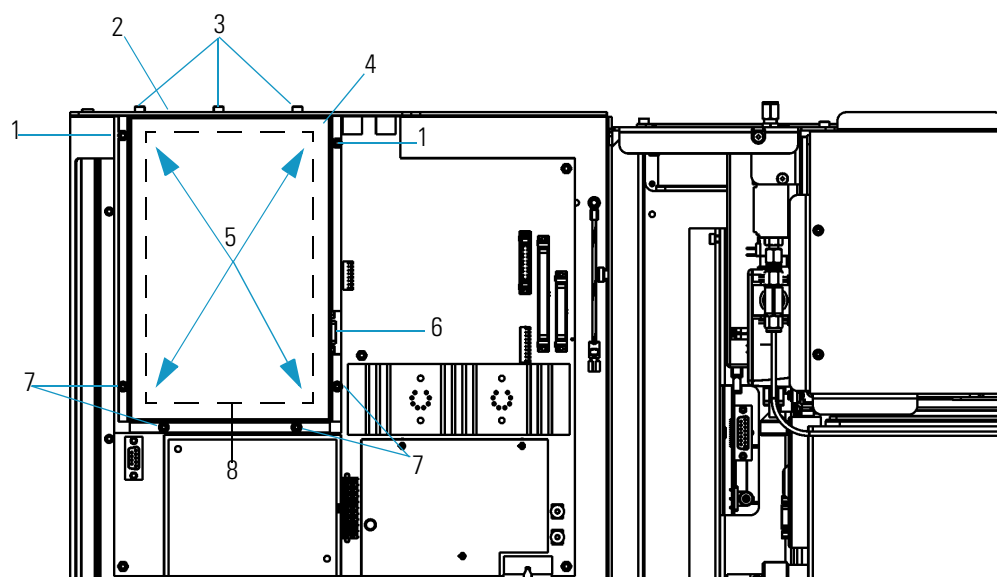
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in ["Removing the Left Cover" on page 29](#).
4. Remove the digital board.

**Figure 48.** Removing the Digital Board



1	Two Nuts Around the Digital Board Cover	5	Six Nuts Around the Digital Board
2	Connector to Ethernet Cable (to PC)	6	Connector to J3 Cable (to Electrometer Board)
3	Seven Screws Around the Digital Board Cover	7	Four Screws Around the Digital Board Cover
4	Digital Board Cover	8	Digital Board (PN 119590-0010)

## 2 Maintaining the DSQ II

### Maintaining Components Outside the Vacuum Manifold

- a. Disconnect the Ethernet cable and J3 cable.
  - b. Remove the seven screws and two nuts holding the digital board cover in place.
  - c. Remove the digital board cover.
  - d. Remove the six nuts holding the digital board in place.
  - e. Carefully remove the digital board.
5. Install the new digital board (PN 119590-0010).
  - a. Insert the new digital board.
  - b. Reattach the nuts.
  - c. Reattach the digital board cover.
  - d. Reattach the screws.
  - e. Reconnect the cables.
6. Reattach the left, top, and front covers of the DSQ II.
7. Restart the DSQ II.



## Replacing the Electrometer Board

To replace the electrometer board, you will need:

- New Electrometer board (PN 119590-0500)
- Screwdriver, Phillips #1
- Wrench, Allen, 3 mm
- Wrench, open-ended, 17 mm
- Wrench, open-ended, 9/16-in.

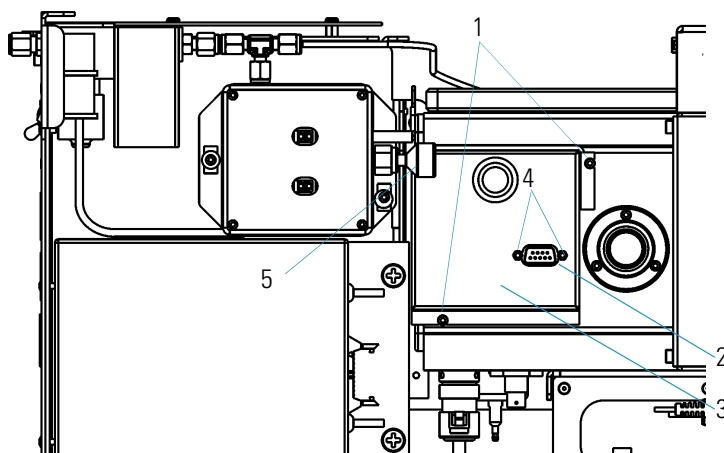
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in ["Removing the Left Cover" on page 29](#).
4. Remove the electrometer board.

**Figure 49.** Removing the Electrometer Board

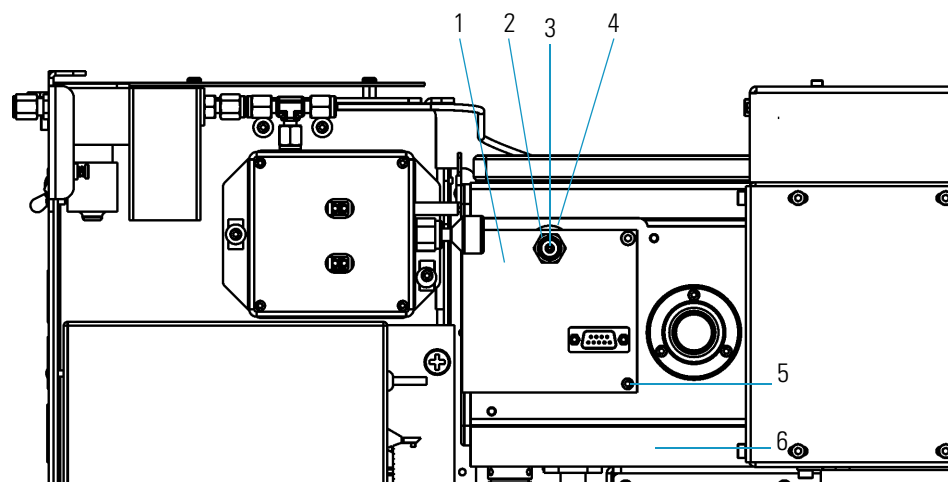


1	Two Screws Around the Electrometer Board Cover	4	Two Hex Bolts Around the Board Cover
2	Cable	5	Cal Gas Vial
3	Electrometer Board Cover		

- a. Disconnect the cable.
- b. Remove the calibration gas vial so you have space to remove the electrometer cover.
- c. Remove the two screws holding the electrometer board cover in place.

- d. Remove the electrometer board cover.

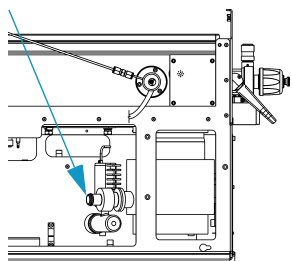
**Figure 50.** Electrometer Board with Cover Removed



1	Electrometer Board (PN 119590-0500)	4	Anode Feedthrough
2	Nut Holding Electrometer Board to Anode Feedthrough	5	Screw Holding Electrometer Board to Vacuum Manifold
3	Screw Holding Wire to Anode Feedthrough	6	Vacuum Manifold

- e. Remove the screw holding the wire to anode feedthrough.
  - f. Remove the nut holding the electrometer board to anode feedthrough.
  - g. Remove the screw holding the electrometer board to vacuum manifold and pull out the electrometer board.
5. Install the new electrometer board (PN 119590-0500).
    - a. Insert the new electrometer board.
    - b. Reattach the screws and nuts.
    - c. Reattach the electrometer board cover.
    - d. Reattach the screws to the cover.
    - e. Reattach the cal gas vial.
    - f. Reconnect the cable.
  6. Reattach the left, top, and front covers of the DSQ II.
  7. Restart the DSQ II.

## Replacing the Foreline Pressure Gauge and Foreline Adapter



To replace the foreline pressure gauge and foreline adapter, you will need:

- Foreline Pressure Gauge and Foreline Adapter (PN 119259-0002 for 250 L/s and split-flow turbomolecular pump systems or PN 119259-0003 for 70 L/s turbomolecular pump systems)
- Lint-free paper
- Screwdriver, flat blade
- Wrench, adjustable

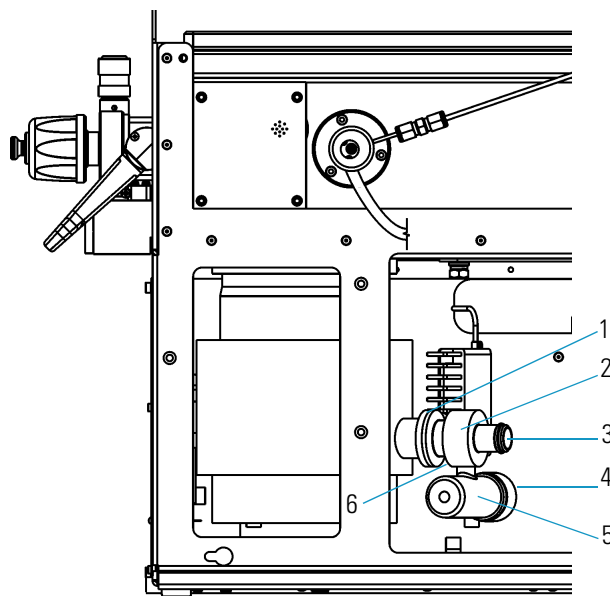
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18.](#)



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the right cover, as described in ["Removing the Right Cover" on page 27.](#)
4. Remove the foreline pressure gauge and foreline adapter.

**Figure 51.** Removing the Foreline Pressure Gauge and Foreline Adapter



1 Foreline Adapter Clamp and O-ring	4 Foreline Pressure Gauge Cable
2 Foreline Adapter	5 Foreline Pressure Gauge
3 Foreline Hose Clamp	6 Foreline Tubing

## 2 Maintaining the DSQ II

### Maintaining Components Outside the Vacuum Manifold

- a. Disconnect the foreline pressure gauge cable from the foreline pressure gauge.
  - b. Disconnect the foreline tubing from the gold fitting on the foreline adapter.
  - c. Remove the foreline adapter clamp.
  - d. Remove the foreline hose clamp.
  - e. Remove the current foreline pressure gauge and foreline adapter.
5. Install the new foreline pressure gauge (PN 119259-0002) and foreline adapter (PN 119259-0003).
  - a. Insert the new gauge and adapter.
  - b. Reattach the foreline hose and adapter clamps.
  - c. Reconnect the foreline tubing.
  - d. Reconnect the cable.
6. Reattach the right, top, and front covers of the DSQ II.
7. Restart the DSQ II.

## Replacing the Inlet Valve Seal

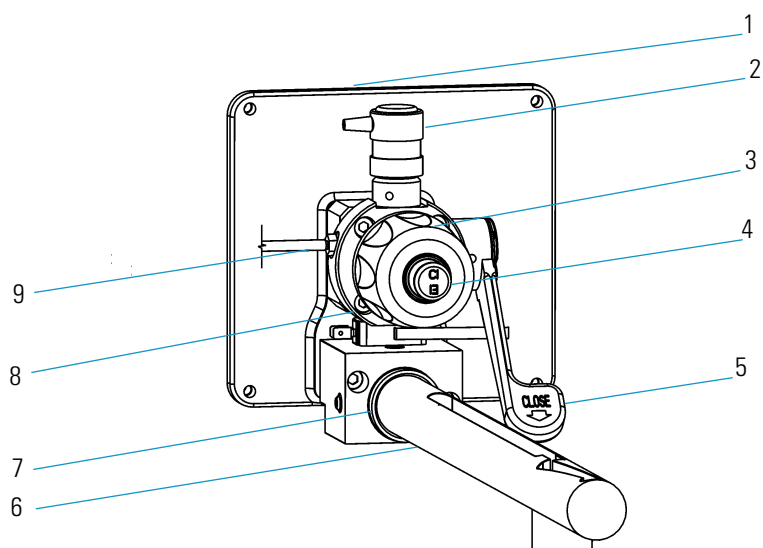
You may need to replace the inlet valve seal if the seal is leaking, as indicated by the *Xcalibur* Insert/Probe graph. It may also need to be replaced if nothing improves when you tighten the seal or if the seal is worn, thin, or cracked.

To replace an inlet valve seal, you will need:

- Inlet Valve Seal Kit, which includes an Inlet Valve Seal and Inlet Seal Removal Tool (PN 119265-0003)
- Lint-free cloth

1. Disassemble the inlet valve.

**Figure 52.** Inlet Valve Components

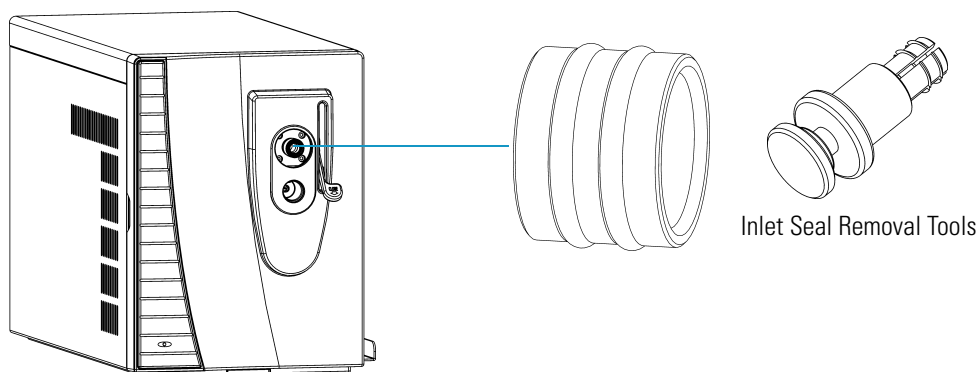


1	Vacuum Manifold	6	Guide Bar
2	Inlet Valve Solenoid	7	Guide Bar Entry
3	Inlet Valve Knob (Ferrule inside)	8	Four Hex Socket Screws
4	Inlet Valve Plug	9	Foreline Hose Connection
5	Inlet Valve Lever		

- Make sure the inlet valve is closed (pull down the inlet valve lever).
- Remove the inlet valve plug, knob, and ferrule.

2. Remove and replace the inlet valve seal.

**Figure 53.** Removing the Inlet Valve Seal



- a. Insert the inlet seal removal tool into the inlet valve.
- b. Press the button on the tool to engage the inlet valve seal.



**CAUTION - INSTRUMENT DAMAGE.** To avoid scratching the sealing surface, you should only use the supplied inlet seal removal tool to remove the seal.

- c. Pull out the inlet valve seal and discard it.
  - d. Insert a new inlet valve seal (PN 119265-0003).
3. Reassemble the inlet valve.
    - a. Put the ferrule, knob and plug back into the inlet valve opening.
    - b. The first time you use the inlet valve, you will need to tighten the inlet valve knob more than usual to prevent it from leaking.

## Replacing the Ion Gauge (Optional Upgrade)

To replace the ion gauge, you will need:

- Gloves, clean, lint- and powder-free
- Ion gauge (PN A0105-06003)
- Wrench, Allen, 3 mm

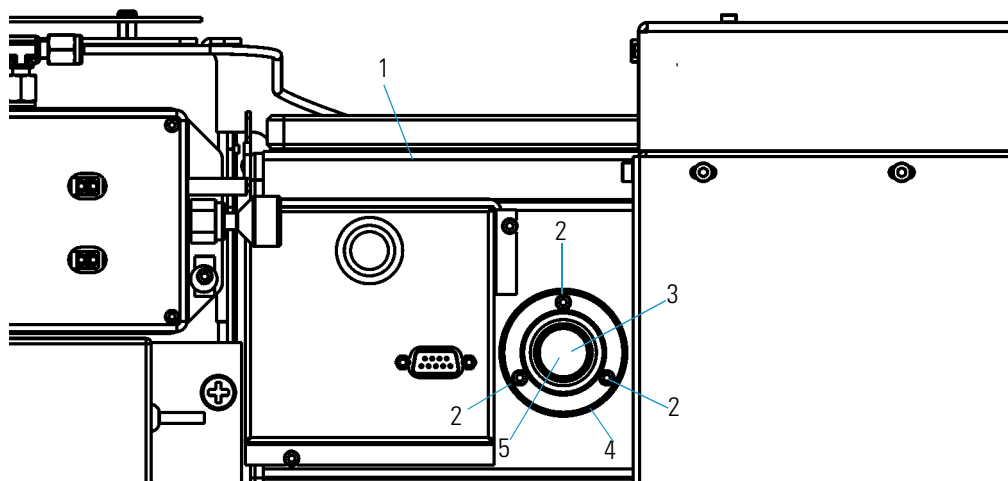
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in ["Removing the Left Cover"](#) on page 29.
4. Remove the current ion gauge.

**Figure 54.** Removing the Ion Gauge



1	Vacuum Manifold	4	Ion Gauge Collar (flange)
2	Three Screws Around the Ion Gauge Collar	5	Ion Gauge and O-ring
3	Cable (to Ion Gauge Control Board)		

- a. Disconnect the cable.
- b. Remove the three screws holding the ion gauge collar in place.
- c. Remove the ion gauge collar and ion gauge together.
- d. Pull the ion gauge out of the ion gauge collar. Wearing gloves, hold on to the O-ring.
5. Install the new ion gauge (PN A0105-06003).
  - a. Insert the new ion gauge into the ion gauge collar. Slip the O-ring over the end of the ion gauge.
  - b. Push the ion gauge all the way into the vacuum manifold. Turn it so the cable will point straight down.
  - c. Reattach the screws that hold the ion gauge collar in place.
  - d. Reconnect the cable.
6. Reattach the left, top, and front covers of the DSQ II.
7. Restart the DSQ II.
8. Once the DSQ II has pumped down and is operational, check for vacuum leaks by reading the convectron gauge and ion gauge pressures and running an automatic tune.

### Replacing the Lens Interface Board

To replace the lens interface, you will need a 3 mm Allen wrench.

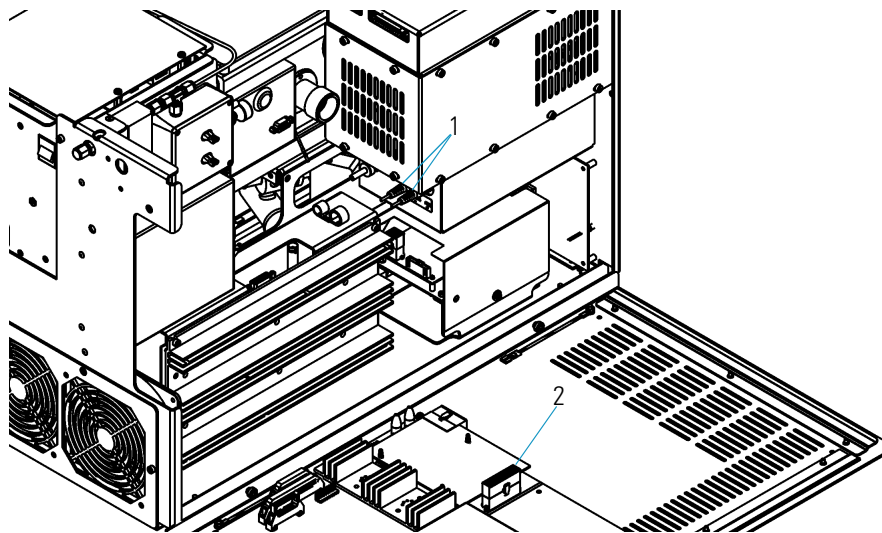
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the right and left covers, as described in "[Removing the Right Cover](#)" on page 27 and "[Removing the Left Cover](#)" on page 29.
4. Remove the lens interface board.

**Figure 55.** Disconnecting the Lens Interface Board Cables

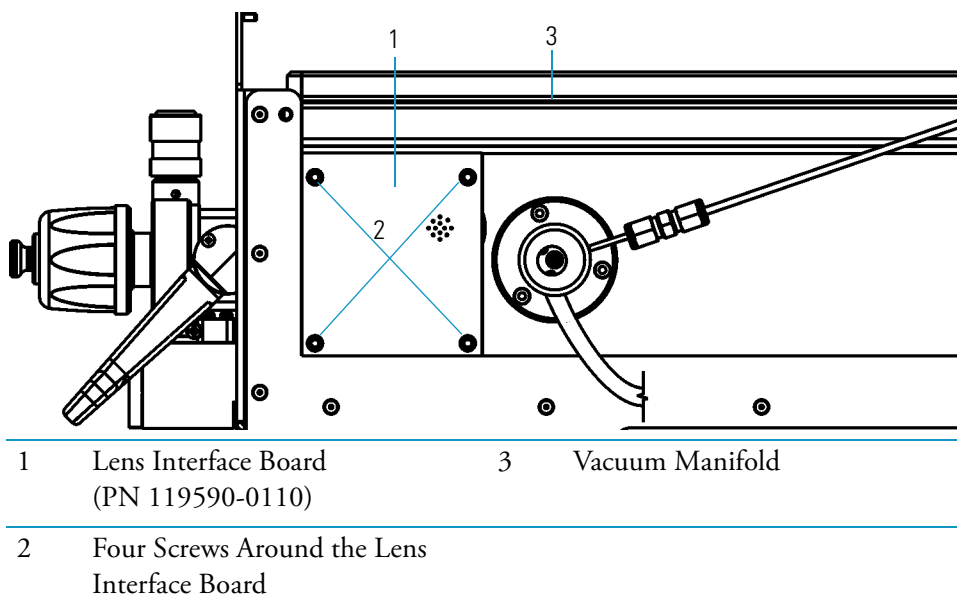


1	Cables to Low Pass Filter Board	2	Cable to Analog Board
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- a. Disconnect the cables to the low pass filter board.
- b. Disconnect the cable to the analog board.

**Figure 56.** Removing the Lens Interface Board



- c. Remove the four screws holding the lens interface board in place.
  - d. Remove the current lens interface board.
5. Install the new lens interface board (PN 119590-0110).
- a. Insert the new lens interface board.
  - b. Reattach the screws that hold the lens interface board in place.
  - c. Reconnect the cables.
6. Reattach the right, left, top, and front covers of the DSQ II.
7. Restart the DSQ II.

## Replacing the Low Pass Filter Board

To replace the low pass filter, you will need:

- Forceps
- New Low Pass Filter board
- Screwdriver, Phillips #2
- Wrench, Allen, 2.5 mm
- Wrench, Allen, 3 mm

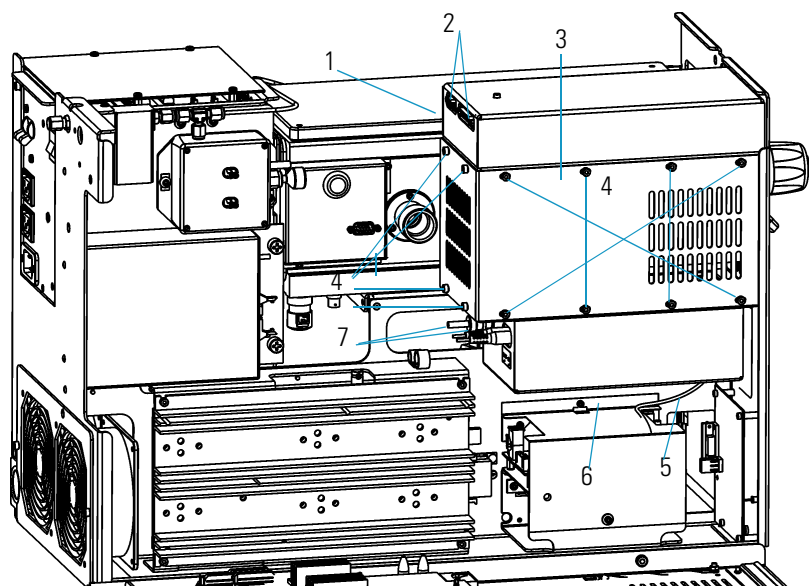
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18.](#)



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in ["Removing the Left Cover" on page 29.](#)
4. Disconnect the RF module.

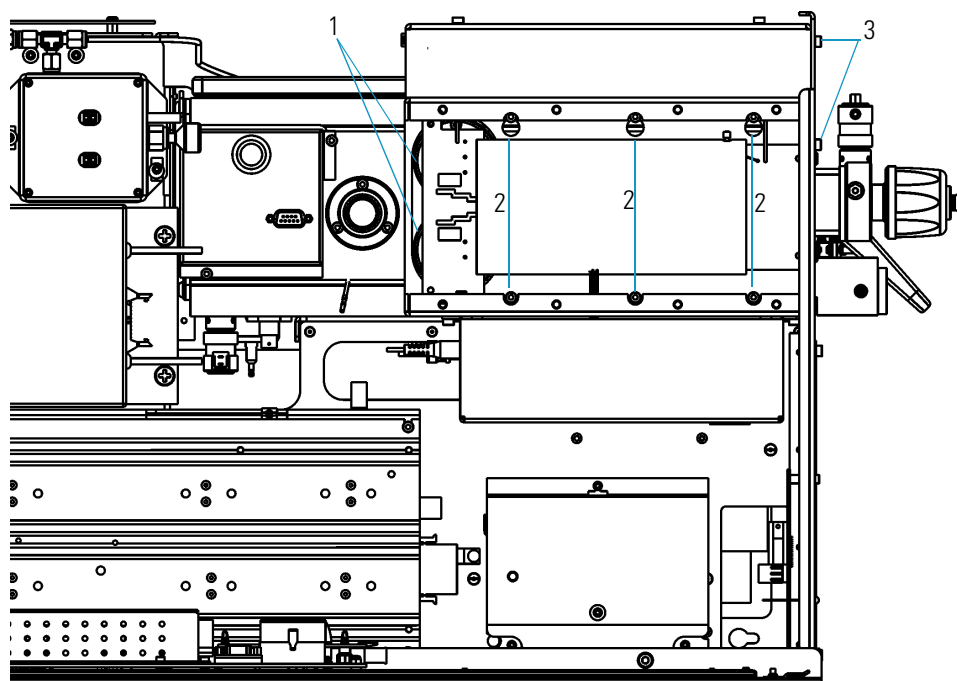
**Figure 57.** Removing the RF Module



1	RF Module	5	Three Cables to DC Driver
2	Two Cables to RF Detector Board	6	DC Driver
3	RF Coil Cover	7	Three Cables to Lens Interface and RF Generator Board
4	12 Screws Around the RF Coil Cover		

- a. Disconnect the five cables from the RF module.
  - b. Disconnect the three cables from the DC driver.
5. Remove the RF module.
- a. Remove the twelve screws holding the RF coil cover in place.
  - b. Remove the RF coil cover.

**Figure 58.** RF Module with RF Coil Cover Removed

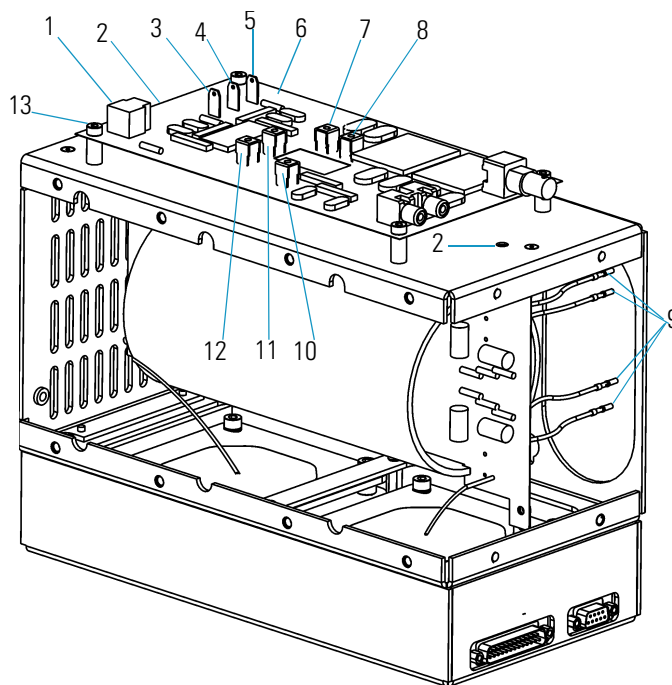


1	Four RF Feedthrough Connectors	3	Two Screws Around the RF Module
2	Six Screws Around the RF Module		

- c. Use forceps to disconnect the four RF feedthrough connectors.
- d. Remove the bottom three and loosen the top three screws holding the RF module in place.
- e. Remove the two screws holding the RF module to the front of the chassis.
- f. Lift the RF module up and out of its slots.

6. Remove the low pass filter board.

**Figure 59.** Removing the Low Pass Filter Board



1	Connector to J1 Cable	8	Connector to J6 Wire (gold)
2	Screws Around the Low Pass Filter Cover	9	Four RF Feedthrough Connections
3	Connector to P1 Cable (green)	10	Connector to J2 Wire (white)
4	Connector to P2 Cable (black)	11	Connector to J5 Wire (red)
5	Connector to P4 Cable (red)	12	Connector to J4 Wire (green)
6	Low Pass Filter Board (PN 119590-0480)	13	Four Screws Around the Low Pass Filter Board
7	Connector to J7 Wire (gold)		

- Turn the RF module over (setting it down on its top), and remove the two screws holding the low pass filter cover in place.
- Unscrew the connectors to the J2, J4, J5, J6, J7 wires.
- Disconnect the J1 cable.
- Disconnect the P1, P2, and P4 cables.
- Remove the four screws holding the low pass filter board in place.
- Remove the current low pass filter board.

7. Install the new low pass filter board (PN 119590-0480).
  - a. Insert the new low pass filter board.
  - b. Reattach the screws that connect the low pass filter to the chassis.
  - c. Slip the P1, P2, and P4 cables through the hole in the low pass filter cover. Be sure none of the wires touch each other.
  - d. Reconnect the J1 cable.
  - e. Reconnect the J2, J4, J5, J6, and J7 wires.
  - f. Reattach the screws that hold the low pass filter cover in place.
8. Reinstall the RF module.
  - a. Insert the RF module into its slot.
  - b. Reattach the screws that connect the RF module to the chassis.
  - c. Tighten the screws that hold the RF module in place.
  - d. Use forceps to reconnect the RF feedthrough connectors. The green RF feedthrough connectors connect to the pins closest to the front of the instrument, red to the pins closest to the back of the instrument. Be sure the wires do not touch each other or the board.
  - e. Reattach the RF coil cover.
  - f. Reattach the screws that hold the RF coil cover in place.
9. Reconnect the RF module. The green P1 cable to the DC driver goes on the left terminal (J7), the black P2 cable goes to J4, and the red P4 cable goes to J3.
  - a. Reconnect the cables to the DC driver.
  - b. Reconnect the cables to the RF module.
10. Reattach the left, top, and front covers of the DSQ II.
11. Restart the DSQ II.

## Replacing the Power Module

To replace the power module, you will need a 3 mm Allen wrench.

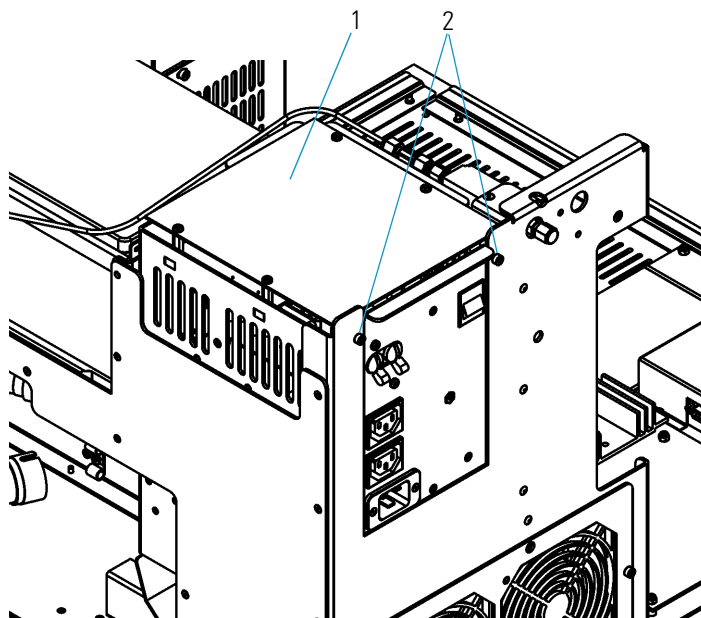
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the top and front covers, as described in ["Removing the Front and Top Covers"](#) on page 25.
4. Remove the current power module.

**Figure 60.** Removing the Power Module



- |   |                                      |
|---|--------------------------------------|
| 1 Power Module<br>(PN 119655-1115 or -1230) | 2 Two Screws Around the Power Module |
|---|--------------------------------------|

- a. Remove the two screws holding the power module in place.
  - b. Lift the power module straight up.
5. Install a new 115 V power module (PN 119655-1115) or 230 V power module (PN 119655-1230).



**CAUTION - INSTRUMENT DAMAGE.** The power module voltage setting (115 V or 230 V) must match the one that was removed. Otherwise, you could damage the instrument and rotary-vane pump. Do not attempt to change the voltage setting of the power module. It has been configured at the factory and cannot be changed in the field.

- a. Insert the new power module.
  - b. Reattach the screws that hold the power module in place.
6. Reattach the top and front covers of the DSQ II.
  7. Restart the DSQ II.

## Replacing the Power Module Fuses

To replace a power module fuse, you will need:

- Power Module Fuses F1, F2 (PN A0006-04550; 0.315 A, 5 x 20 mm, 250 V)
- Power Module Fuse F3 (PN A0006-06075; 800 mA, 5 x 20 mm, 250 V)
- Power Module In-line Fuses (PN A0006-10510; 3.15 A, SB, 5 x 20 mm, 250 V)
- Screwdriver, Phillips #2
- Wrench, Allen, 3 mm

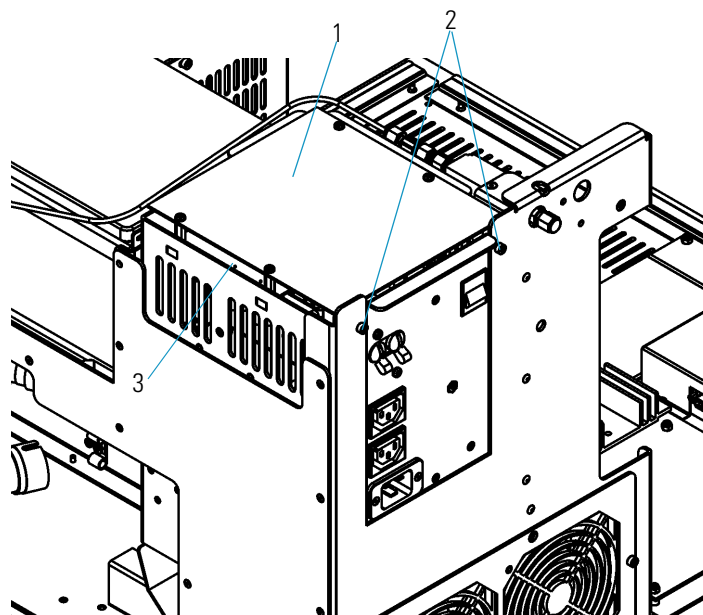
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the top and front covers, as described in ["Removing the Front and Top Covers" on page 25](#).
4. Remove the current power module.

**Figure 61.** Removing the Power Module



- |   |                                    |   |                    |
|---|------------------------------------|---|--------------------|
| 1 | Power Module                       | 3 | Power Module Cover |
| 2 | Two Screws Around the Power Module |   |                    |

- a. Remove the two screws holding the power module in place.
- b. Lift the power module straight up.

5. Replace the power module fuses.



**CAUTION - INSTRUMENT DAMAGE.** Only use a DSQ II fuse or else you could damage the instrument. Never replace DSQ II fuses with those of a different type, voltage, or current rating. Also, to avoid damaging the boards, you should always wear an electrostatic discharge (ESD) strap on your wrist when replacing fuses.

- a. Remove the power module cover.
  - b. Disconnect the power module fuses.
  - c. Connect the new fuses. It does not matter which way they are plugged in.
  - d. Reattach the power module cover.
6. Reinstall the power module by reattaching the screws that hold it in place.
  7. Reattach the top and front covers of the DSQ II.
  8. Restart the DSQ II.

## Replacing the Rear Cooling Fans

The rear cooling fans provide the necessary airflow to keep the DSQ II cool. The fans should be cleaned every four months by wiping them with a damp cloth. This helps prevent dust from accumulating inside the instrument.

To replace the rear cooling fans, you will need:

- New Rear Cooling Fan(s)
- Wrench, Allen, 3 mm
- Wrench, open-ended, 1/4-in.

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



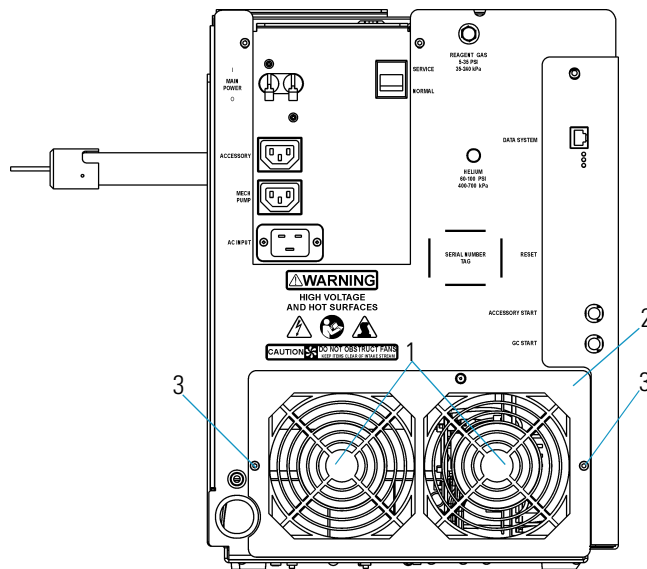
**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the front and top covers, as described in "[Removing the Front and Top Covers](#)" on page 25.



4. Remove the fan bracket.

**Figure 62.** Removing the Rear Cooling Fans

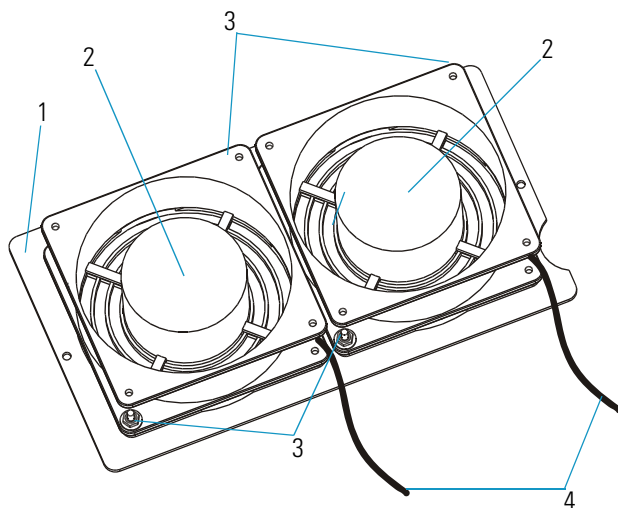


- |   |   |   |                                      |
|---|---|---|--------------------------------------|
| 1 | Two Rear Cooling Fans<br>(PN 119253-0001) | 3 | Two Screws Around the Fan<br>Bracket |
| 2 | Fan Bracket                               |   |                                      |

- a. Remove the two screws holding the fan bracket in place.
- b. Place the fan bracket on the table behind the instrument.

5. Remove the rear cooling fans from the fan bracket.

**Figure 63.** Removing the Fans from the Bracket



1	Fan Bracket	3	Four Nuts Around the Rear Cooling Fans
2	Two Rear Cooling Fans	4	Two Fan Cables

- a. Disconnect the two fan cables.
  - b. Remove the four nuts holding the rear cooling fans in place.
  - c. Remove the rear cooling fans.
6. Attach the new rear cooling fans to the fan bracket by reattaching the nuts. Make sure the airflow indicator arrows on the new rear cooling fans point into the DSQ II (away from the fan bracket) and the wires are pointing down.
  7. Reconnect the fan cables.
  8. Attach the two screws holding the fan bracket in place. Make sure the fan cables do not get pinched or touch the fan blades.
  9. Reattach the covers on the DSQ II.
  10. Restart the DSQ II.

## Replacing the RF Detector Board

To replace the RF detector board, you will need:

- New RF Detector board
- Wrench, Allen, 2.5 mm
- Wrench, Allen, 3 mm

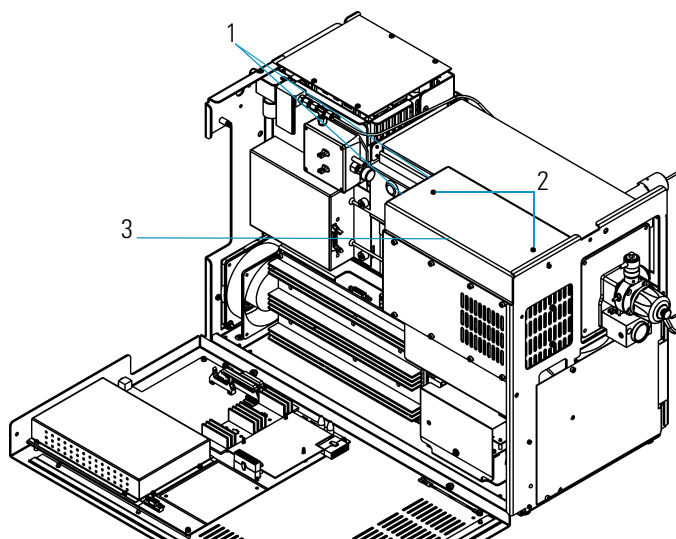
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in ["Removing the Left Cover" on page 29](#).
4. Remove the RF detector board.

**Figure 64.** Removing the RF Detector Board Cover

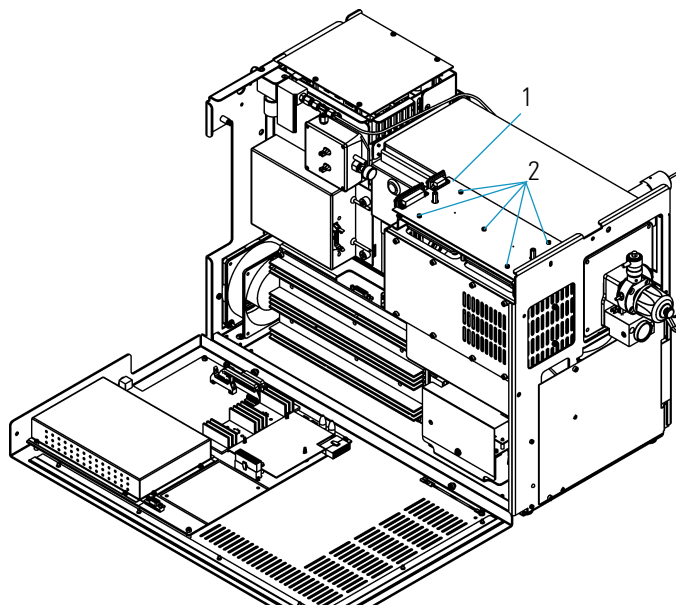


1	Two Cables	3	RF Detector Board Cover
2	Two Screws Around the RF Detector Board Cover		

- a. Disconnect the two cables.
- b. Remove the two screws holding the RF detector board cover in place.

- c. Remove the RF detector board cover.

**Figure 65.** Removing the RF Detector Board



1 RF Detector Board  
(PN 119590-0270)

2 Five Screws Around the RF  
Detector Board

- d. Remove the five screws holding the RF detector board in place.
  - e. Remove the RF detector board.
5. Install the new RF detector board (PN 119590-0270).
- a. Insert the RF detector board.
  - b. Reattach the screws that hold the RF detector board in place.
  - c. Reattach the cover.
  - d. Reattach the screws that hold the cover in place.
  - e. Reconnect the cables.
6. Reattach the left, top, and front covers of the DSQ II.
7. Restart the DSQ II.

## Replacing the RF Generator Board

To replace a RF generator board, you will need a 3 mm Allen wrench.

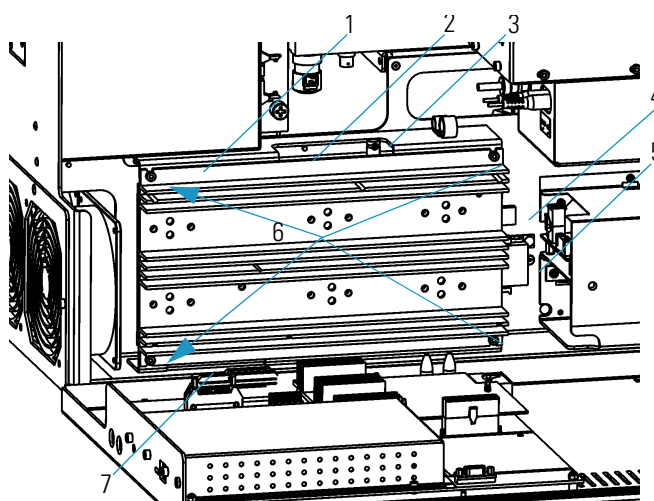
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in ["Removing the Left Cover" on page 29](#).
4. Remove the RF generator board.

**Figure 66.** Removing the RF Generator Board



1	RF Generator Board (PN 119590-0060)	5	Connector for J3 Cable (to Power Module)
2	Connector for P1 Cable (to RF Detector Board)	6	Four Screws Around the RF Generator Board
3	Connector for J1 Cable (to Low Pass Filter Board)	7	Connector for P2 Cable (to Analog Board)
4	Connector for J2 Cable (to Power Module)		

- a. Disconnect the P1, J1, J2 and J3 cables.
- b. Remove the top two screws and loosen the bottom two screws holding the RF generator board in place.

- c. Lift out the current RF generator board.
  - d. Disconnect the P2 cable.
5. Install the new RF generator board (PN 119590-0060).
  - a. Reconnect the P2 cable.
  - b. Insert the new RF Generator board.
  - c. Reattach the screws that hold the RF Generator board in place.
  - d. Reconnect the P1, J1, J2, and J3 cables.
6. Reattach the left, top, and front covers of the DSQ II.
7. Restart the DSQ II.

## Replacing the RF Generator Board Fuses

To replace an RF generator board fuse, you will need:

- RF Generator board Fuse F1 (PN A0006-07608; 0.5 A, Quick Act, 5 x 20 mm, 250 V)
- RF Generator board Fuse F2 (PN A0006-07610; 1.0 A, Quick Act, 5 x 20 mm, 250 V)
- Wrench, Allen, 3 mm

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.

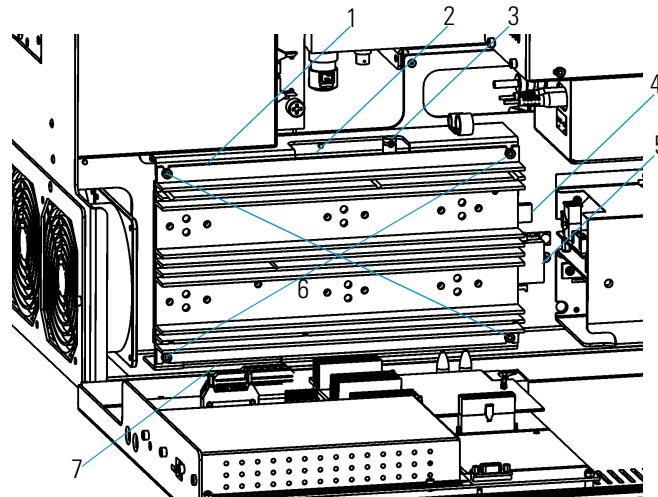


**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in "[Removing the Left Cover](#)" on page 29.

4. Remove the RF generator board.

**Figure 67.** Removing the RF Generator Board to Replace Fuses



1	RF Generator Board	5	Connector to J3 Cable (to Power Module)
2	Connector to P1 Cable (to RF Detector Board)	6	Four Screws Around the RF Generator Board
3	Connector to J1 Cable (to Low Pass Filter Board)	7	Connector to P2 Cable (to Analog Board)
4	Connector to J2 Cable (to Power Module)		

- a. Disconnect the P1, J1, J2, and J3 cables.
- b. Remove the top two screws and loosen the bottom two screws holding the RF generator board in place.
- c. Lift out the RF generator board.
- d. Disconnect the P2 cable.



**WARNING - ELECTRICAL SHOCK HAZARD.** Only use a DSQ II fuse or else you could damage the instrument. Never replace DSQ II fuses with those of a different type, voltage, or current rating. Also, to avoid damaging the boards, you should always wear a properly grounded electrostatic discharge (ESD) strap on your wrist when replacing fuses.

5. Replace the RF generator board fuses.
  - a. Disconnect the RF generator board fuses.
  - b. Connect the new RF generator board fuses. It does not matter which way they are plugged in.

## 2 Maintaining the DSQ II

### Maintaining Components Outside the Vacuum Manifold

6. Reinstall the RF generator board.
  - a. Reconnect the P2 cable.
  - b. Insert the RF generator board.
  - c. Reattach the screws that hold the RF generator board in place.
  - d. Reconnect the P1, J1, J2, and J3 cables.
7. Reattach the left, top, and front covers of the DSQ II.
8. Restart the DSQ II.

## Replacing the Transfer Line

To replace the transfer line, you will need:

- Gloves, clean, lint- and powder-free
- New Transfer line
- Wrench, Allen, 3 mm
- Wrench, open-ended, 5/16-in.
- Wrench, two, open-ended, 7/16-in.

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

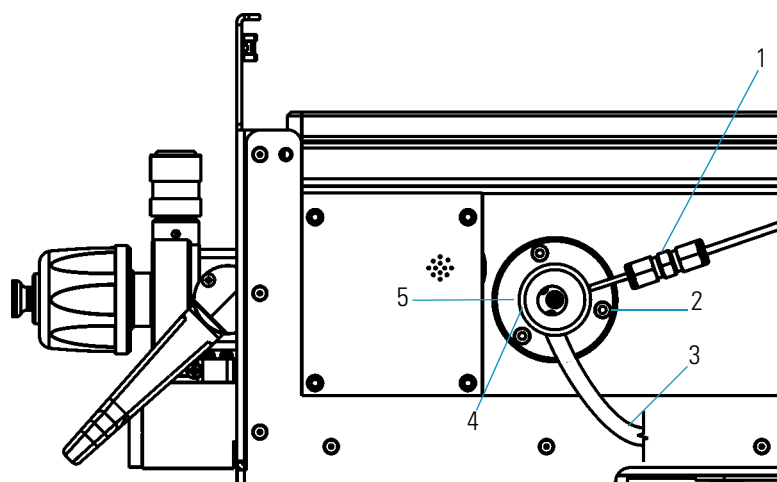
3. Remove the front, top and right covers, as described in "[Removing the Front and Top Covers](#)" on page 25 and "[Removing the Right Cover](#)" on page 27.
4. Shut down the TRACE GC.
5. Remove the transfer line.



**WARNING - BURN HAZARD.** The transfer line may be hot. Allow it to cool to room temperature before touching it.



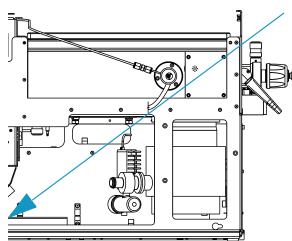
**Figure 68.** Removing the Transfer Line



1	Transfer Line Gas Fitting	4	Transfer Line (PN 119640-1050)
2	Three Screws Around the Transfer Line	5	O-ring (not shown)
3	Transfer Line Cable		

- a. Disconnect the transfer line cable from the left side of the GC.
  - b. Loosen the transfer line gas fitting.
  - c. Remove the three screws holding the transfer line in place.
  - d. Remove the transfer line.
6. Install the new transfer line (PN 119640-1050).
    - a. Insert the new transfer line.
    - b. Reattach the screws that hold the transfer line in place.
    - c. Tighten the transfer line gas fitting.
    - d. Reconnect the transfer line cable to the left side of the GC.
  7. Reattach the right, top, and front covers of the DSQ II.
  8. Restart the GC.
  9. Restart the DSQ II.
  10. Once the DSQ II has pumped down and is operational, check for vacuum leaks by reading the convectron gauge and ion gauge pressures and running an automatic tune.

## Replacing the Turbomolecular Pump Power Supply



To replace the turbomolecular pump power supply, you will need a #2 Phillips screwdriver.

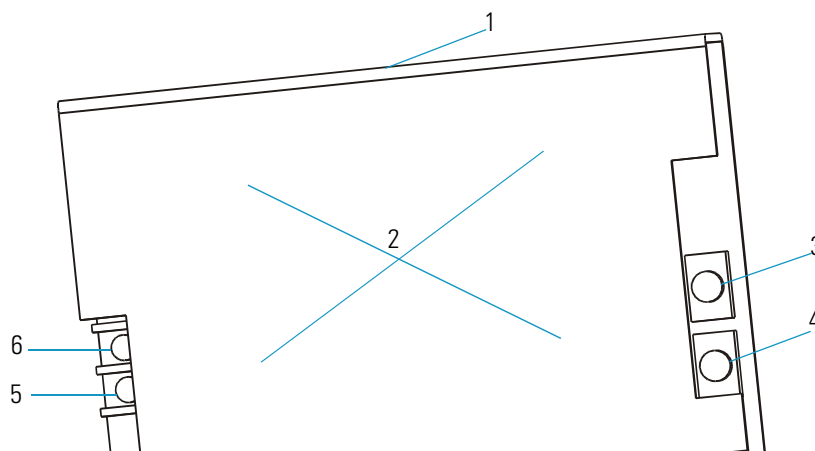
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the right cover, as described in ["Removing the Right Cover" on page 27](#).
4. Remove the turbomolecular pump power supply.

**Figure 69.** Removing the Turbomolecular Pump Power Supply



1	Turbomolecular Pump Power Supply (PN 76330-0230)	4	Connector to P2-2 Cable (+), red wire
2	Four Screws Around the Turbomolecular Pump Power Supply	5	Connector to P1-2L Cable, brown wire
3	Connector to P2-1 Cable (-), black wire	6	Connector to P1-2N Cable, blue wire

- a. Disconnect the four cables (items 3, 4, 5, and 6 in ).
- b. From the bottom of the DSQ II, remove the four screws holding the turbomolecular power supply in place.
- c. Remove the turbomolecular pump power supply.

5. Install the new turbomolecular pump power supply (PN 76330-0230).
  - a. Insert the new power supply.
  - b. Reattach the screws that hold the power supply to the bottom of the DSQ II.
  - c. Reconnect the P2-1, P2-2, and P1-2L cables.
6. Reattach the right, top, and front covers of the DSQ II.
7. Restart the DSQ II.

## Replacing the Vacuum Control Board

To replace the vacuum control board, you will need a 2.5 mm Allen wrench.

1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in "[Shutting Down the GC/MS System](#)" on page 18.

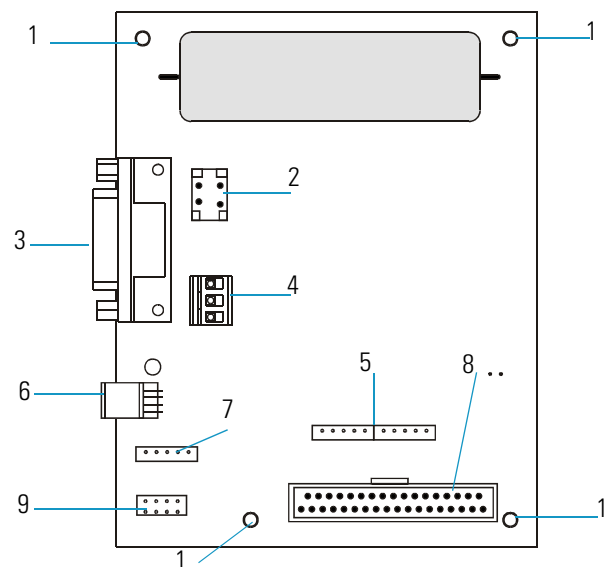


**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in "[Removing the Left Cover](#)" on page 29.

4. Remove the vacuum control board.

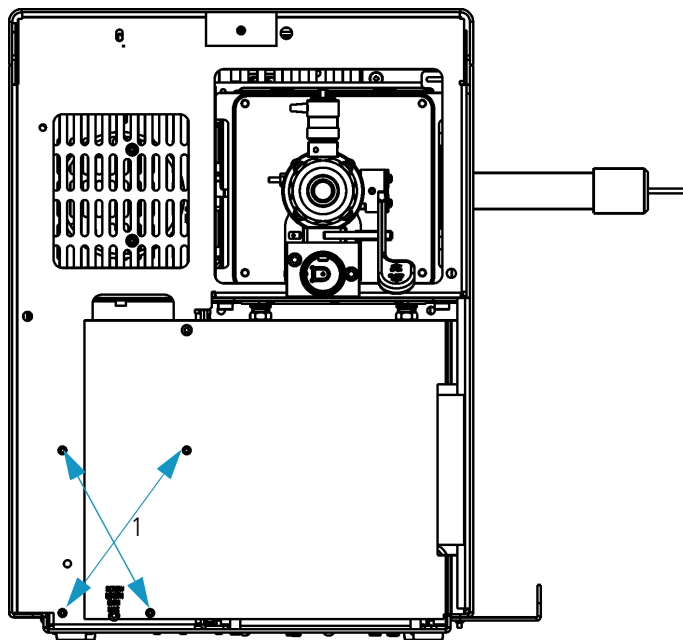
**Figure 70.** Removing the Vacuum Control Board



1	Four Screws Around the Vacuum Control Board	6	Connector to J3 Cable (to Turbomolecular Pump Power Supply)
2	Connector to J1 Cable (to Fore Pressure Gauge)	7	Connector to P2 Cable (to Inlet Valve Solenoid)
3	Connector to J2 Cable (to Turbomolecular Pump Controller)	8	Connector to P4 Cable (to Analog Board)
4	Connector to P1 Cable (to Power Module)	9	Connector to P5 Cable (to Calibration Gas Flow Module and Vent Valve Solenoid)
5	Connector to P2 Cable (to Ion Gauge Control Board)		

- a. Disconnect all the cables from the Vacuum Control board.

**Figure 71.** Removing the Vacuum Control Board Mounting Screws



---

1 Four Vacuum Control Board Mounting Screws

---

- b. Remove the four mounting screws holding the vacuum control board in place.
  - c. Remove the vacuum control board.
5. Install the new vacuum control board (PN 119590-0031).
    - a. Insert the new vacuum control board.
    - b. Reattach the screws that hold the vacuum control board in place.
    - c. Reconnect all the cable to the vacuum control board.
  6. Reattach the left, top, and front covers of the DSQ II.
  7. Restart the DSQ II.

## Replacing the Vent Valve Solenoid

To replace the vent valve solenoid, you will need a lint-free cloth and an adjustable wrench.

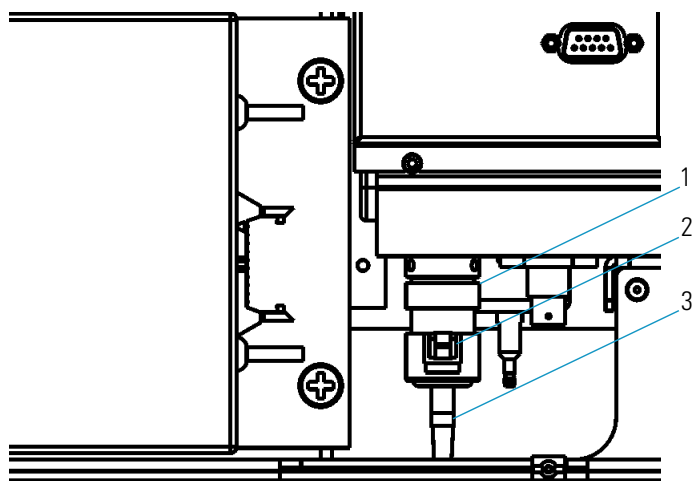
1. Cover the work area with a lint-free cloth.
2. Shut down and vent the DSQ II, as described in ["Shutting Down the GC/MS System" on page 18](#).



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

3. Remove the left cover, as described in ["Removing the Left Cover" on page 29](#).
4. Remove the vent valve solenoid.

**Figure 72.** Removing the Vent Valve Solenoid



1	Vent Valve Solenoid (PN 76461-1003)	3	Vent Valve Filter
2	Cable		

- a. Disconnect the cable.
- b. Unscrew the current vent valve solenoid and remove it.
- c. Unscrew the vent valve filter.

5. Install the new vent valve solenoid (PN 76461-1003). On the cable, the orientation of the two plugs does not matter.
  - a. Reattach the vent valve filter.
  - b. Attach the new vent valve solenoid.
  - c. Reconnect the cable.
6. Reattach the left, top, and front covers of the DSQ II.
7. Restart the DSQ II.
8. Once the DSQ II has pumped down and is operational, check for vacuum leaks by reading the convectron gauge and ion gauge pressures and running an automatic tune.

## **2 Maintaining the DSQ II**

### **Maintaining Components Outside the Vacuum Manifold**



# Troubleshooting

This chapter will enable you to identify any issues related to operating the DSQ II. Once you understand the symptom, cause, and solution to the issue, use [Chapter 2: Maintaining the DSQ II](#) to find out how to address it. This chapter is organized according to the type of symptoms you may experience when using the DSQ II. If you experience issues that are not addressed in this chapter, contact Technical Support.

## Contents

- “Communication Symptoms” on page 123
- “Contamination Symptoms” on page 127
- “Filament and Lens Control Symptoms” on page 130
- “Heated Zone Symptoms” on page 132
- “High Vacuum Symptoms” on page 135
- “Linearity Symptoms” on page 138
- “Power Supply Symptoms” on page 139
- “RF and DC Control Symptoms” on page 141
- “Sensitivity Symptoms” on page 144
- “Stability Symptoms” on page 148
- “Tuning Symptoms” on page 149

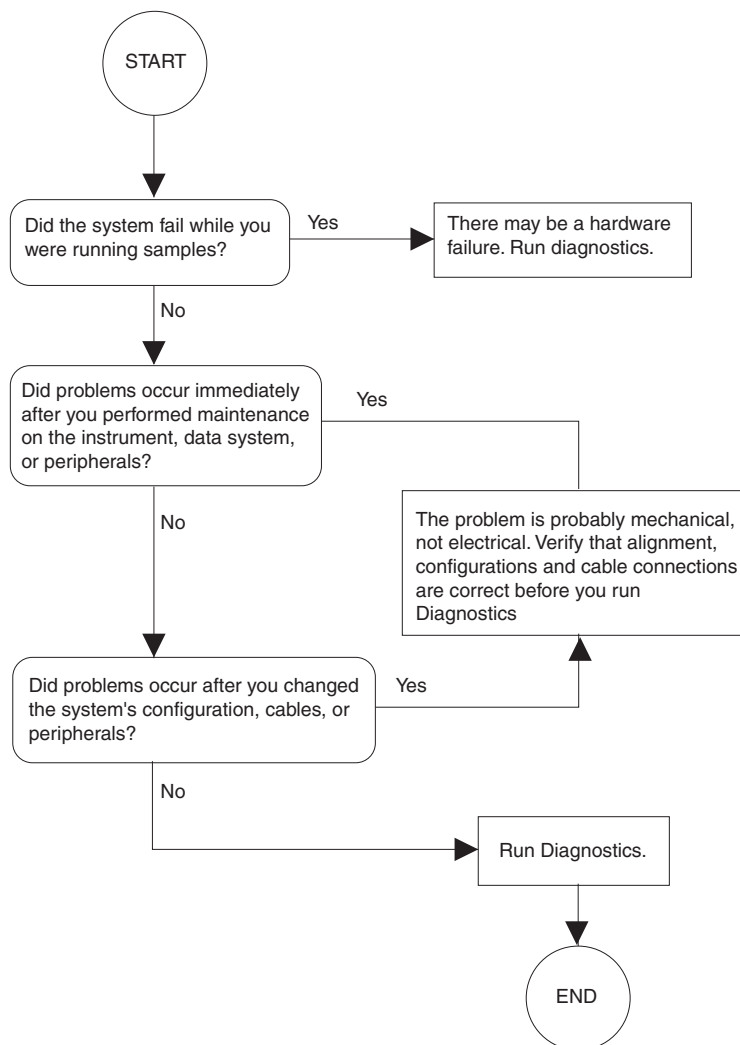
## Using Diagnostics

If your DSQ II is running poorly or suspiciously, *DSQ II Tune* diagnostics will most likely detect the problem and recommend a solution. Diagnostics tests electronic circuits and reports whether the circuits pass or fail.

However, problems in sensitivity due to misalignment, dirty components, or improper tuning are not detected by diagnostics.

Before running diagnostics, refer to the flowchart [Figure 73](#) to determine solutions outside of *DSQ II Tune* diagnostics.

**Figure 73.** Diagnostics Flowchart



## Running Tune Diagnostics

1. Open the Diagnostics window in *DSQ II Tune*.
  - a. Open *Xcalibur* and click **Instrument Setup**.
  - b. Click the **DSQ II** icon to open the Method Editor.
  - c. Click the **Tune** button.
  - d. Select **Diagnostics | Run Tests** to open the Diagnostics window.
2. Run diagnostics by clicking on the test you want to run.

## Communication Symptoms

Communication symptoms likely involve links between the data system and the DSQ II, GC, and autosampler. This section does not address communication issues with other devices. Communication symptoms may occur during:

- Data transfer between the DSQ II and the data system
- Error messages
- Instrument control, method downloading and uploading
- DSQ II, GC and autosampler current status readbacks
- Start, stop, pause and initialize functions

### How does the DSQ II communication work?

The flow of digital information in the DSQ II system is bi-directional; the data system downloads analytical methods to the instrument and activates functions to start, stop, shutdown, startup, and initialize. The DSQ II 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.

### Why does the DSQ II have communication symptoms?

Some communication symptoms are due to mechanical faults—for instance, a cable may be disconnected, or a device may be turned off. In other cases, an instrument method that is not compatible with the DSQ II. Less common communication symptoms are due to defective electronic hardware components.

### How do I detect communication symptoms?

Communication symptoms 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.

### Data system cannot initialize communication with DSQ II.

#### Possible Solutions

- Communication circuits on the digital board are faulty. Check connections to digital board. Replace if necessary.
- Digital board has locked up. Press the Reset button on the back of the instrument.
- Ethernet cable is disconnected. Verify that the ethernet cable is connected to the data system port on the DSQ II.

- The wrong type of ethernet cable is connected to the mass spectrometer. Use the supplied 10 Base-T Category 5 crossover cable. The length of the ethernet cable may be extended by plugging a standard Category 5 cable in series with the supplied crossover cable.
- Ethernet card in the PC is not configured or is faulty. Check TCP/IP configuration (compare to the settings in the *Readme.doc* file). Replace the card if necessary.
- Software is not configured correctly. Select the DSQ II from the Instrument Configuration window and configure the software.
- System is in service mode. Check if green power LED on front cover is flashing; return service switch to normal position if necessary.
- *Xcalibur* software has locked up. Use Task Manager to close HomePage, AcquServer, QuadTune, and QuadInst. You can also reboot the computer.

## **Computer intermittently loses communication with DSQ II.**

### **Possible Solutions**

- Ethernet cable is loose or damaged. Inspect cable and replace if necessary.
- Communication circuits on the digital board are faulty. Check connections to digital board. Replace if necessary.

## **Cannot download methods to DSQ II.**

### **Possible Solutions**

The software is not properly configured. Verify correct settings in Instrument Configuration.

## **Unable to start a GC temperature program even though all devices are ready. “NOT RDY - Waiting for Inhibit RDY Signal” displays on the TRACE GC Ultra status menu.**

### **Possible Solutions**

1. Check the GC and/or autosampler remote start cables for loose or faulty connections.
  - GC remote start cable (8-pin) connects to the GC (Generic/HS port) and DSQ II (GC Start port).
  - Autosampler remote start cable connects to the GC (Autosampler port) and autosampler controller (GC port). See the *TRACE GC Ultra Operating Manual* for more information.
2. Configure the Inhibit Ready parameter on the TRACE GC Ultra.

3. Configure the TRACE GC Ultra handshaking parameter to allow the GC to become ready to run a temperature program. Configure the TRACE GC Ultra as follows:
  - a. Press <CONFIG> to display the Configure menu.
  - b. Press the down arrow key to Handshaking and press <ENTER> to display the Config Handshaking menu.
  - c. Press the down arrow key to Inhibit ready in and press <ENTER> to display the Inhibit Ready menu.
  - d. Specify the Inhibit Ready parameter. The default setting is When High. This allows normal operation of the DSQ II. If the GC method has not been downloaded from *Xcalibur*, the GC may not have received a signal from the DSQ II allowing it to become ready. In this case, you can either send the GC method from *Xcalibur* or select When low or Do not inhibit as the Inhibit Ready parameter.

## Acquisition does not start as expected.

### Possible Solutions

- Autosampler did not start. Verify autosampler methods and configuration. Verify that the sample is present.
- Fore pressure is too high due to solvent peak. Reduce injection volume or extend filament/multiplier delay time until after solvent peak. See “[High Vacuum Symptoms](#)” on [page 135](#).
- TRACE GC Ultra did not start. Verify GC methods and configuration. Verify connection between autosampler and GC.
- Heated zone setpoint is not attained. Refer to “[Heated Zone Symptoms](#)” on [page 132](#).
- DSQ II Instrument Setup file has incorrect settings. Check start time in DSQ II Instrument Setup file.
- DSQ II start mode is not properly configured. Verify that instrument is configured properly. Refer to *Xcalibur* online help.
- Remote start cable to the GC is disconnected. Connect remote start cable.

## Unstable instrument readback.

### Possible Solutions

- There is a faulty cable connection. Check connections to the analog board in the DSQ II.
- The digital board is faulty. Reseat connector between Analog and Digital board; replace if necessary. See [“Replacing the Digital Board”](#) on [page 87](#).
- The analog board is faulty. Check connections to the Analog board; replace if necessary. See [“Replacing the Analog Board”](#) on [page 71](#).

## Acquisition terminates unexpectedly.

### Possible Solutions

- The End Run time in the DSQ II Instrument Setup file is incorrect. Check the Instrument Setup files for the GC and the DSQ II.
- The data system is out of disk space. Check disk space; back up and remove files.

## Cannot initialize GC.

### Possible Solutions

- The GC is not turned on. Turn on the GC.
- The GC is not configured properly in *Xcalibur* software. Check Instrument Configuration.
- The cable between COM1 and GC is disconnected. Verify connection.
- COM1 is not configured properly. Verify COM port configuration.
- GC communications malfunction. Contact Technical Support.

## Cannot download methods to GC.

### Possible Solutions

- 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 Technical Support.

## Cannot initialize Autosampler.

### Possible Solutions

- Autosampler not turned on. Turn on Autosampler.
- Autosampler not configured properly in *Xcalibur* software. Check Instrument Configuration
- Disconnected cable between GC and autosampler. Verify connection.
- Autosampler communications malfunction. Contact Technical Support.

## Cannot download methods to Autosampler.

### Possible Solutions

- Discrepancy between method and configuration. Verify consistency between method and instrument configuration.
- Autosampler communications malfunction. Contact Technical Support.

## Contamination Symptoms

Chemical noise is always present in the DSQ II. Additionally, the spectra shown in *DSQ II Tune* and Real-Time Display are auto-normalized, which can make the background appear high when it really is not.

Some chemical noise does present itself, such as septum bleed after a series of injections, vial sample bleed (which occurs if more than one injection is made from a sample vial), and Siloxane peaks that appear in the chromatogram at regular intervals from focusing at the head of the column or in the injector.

Other possible contamination sources include hydrocarbon contamination of the carrier gas, rotary-vane pump, or instrument cleaning solvents.

Always wear clean, lint- and powder-free gloves when handling parts inside the vacuum manifold, and assure that the carrier gas filter, carrier gas lines, and gas regulators are free of contamination and leaks.

## **Excessive chemical background due to column bleed ( $m/z$ 429, 355, 281).**

### **Possible Solutions**

- 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, as described in [“Preparing the DSQ II for Maintenance”](#) on [page 25](#).
- Capillary column is broken off in ion volume. Remove broken pieces from ion volume.

## **Excessive injection port septum bleed ( $m/z$ 207, 429, 355, 281).**

### **Possible Solutions**

- If the Baseline contains these masses, the septum is worn out or damaged. Replace the septum.
- If the Baseline contains these masses, small pieces of septum are in the injection port liner. Replace the injection port liner, condition the capillary column.
- If chromatographic peaks contain these masses, check the vial septa or use solvent to wash the vials.

## **Phthalate background manifests in chromatograms ( $m/z$ 149, 167, 279).**

### **Possible Solutions**

- Phthalate contamination has occurred due to sample handling or solvent contamination. Phthalates may be observed from packaging materials. Isolate the source of phthalates, such as vial lids or plastic solvent containers and remedy.

## **Excessive hydrocarbon contamination manifest in chromatograms ( $m/z$ 43, 57, 71, 85, 99...).**

### **Possible Solutions**

- Do not touch these parts without wearing gloves. Oil from your skin can contaminate the system.
- Carrier gas tubing is contaminated. Isolate source of hydrocarbon contamination and remedy.
- Replace carrier gas tubing.
- Change carrier gas filters.



## Chemical background due to rhenium oxide ( $m/z$ 185/187, 201/203, 217/219, 233/235, 250/252).

### Possible Solutions

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. See [“High Vacuum Symptoms”](#) on page 135.

## Spectra are observed due to solvents.

### Possible Solutions

- There is residual solvent from a cleaning procedure or laboratory background contamination. When you finish performing a cleaning procedure, allow cleaned components to dry thoroughly. Warm parts in the GC oven to dry off residual solvent.
- The observed compounds have been introduced through sample injection. Ultimate source is either a sample solvent or the autosampler rinsing solvent. Optimize GC method to separate solvent peak from area of interest in the chromatogram.

**Table 3.** Solvent Spectra

Solvents
Acetone ( $m/z$ 43, 58, 59)
Hexane ( $m/z$ 41, 43, 56, 57, 58, 85, 86)
Methanol ( $m/z$ 31, 32)
Methylene chloride ( $m/z$ 84/83)
Toluene ( $m/z$ 91, 92)
Trichloroethane ( $m/z$ 151, 153)
Xylene ( $m/z$ 105, 106)

## Filament and Lens Control Symptoms

The lifetime of a filament depends on its exposure to oxygen and solvent vapors. The filament assembly protects the filament and increases its lifetime for many months.

Tune diagnostics tests the filament for continuity and current regulation. Testing the filament for continuity before each acquisition ensures that an open filament condition will stop an autosampler sequence and generate an error message.

Diagnostics tests the lenses of the mass spectrometer. A flat line, which represents voltage readback versus the predicted voltage ramp, indicates a lens or other control fault.

Contamination causes lens performance to deteriorate 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. Damaged lenses cause short circuits, which in turn can cause damage to lens drivers.

### Diagnostics indicate filament is open.

#### Possible Solutions

Vent the system and remove the filament, as described in [“Cleaning the Ion Source, Lenses and Prefilter”](#) on [page 45](#). The resistance of a working filament is about 1.0  $\Omega$ . If the measured value is very large, replace the filament.

### Inspection indicates filament is good, but diagnostics still indicates filament is open.

#### Possible Solutions

- There is a fault in the ion source board. Replace the ion source board, as described in [“Cleaning the Ion Volume Without an Inlet Valve”](#) on [page 43](#).
- The cable connection between the analog and lens interface board is defective. Check the connection, as described in [“Replacing the Lens Interface Board”](#) on [page 96](#).
- There is a problem with the analog board. If necessary, replace the board, as described in [“Replacing the Analog Board”](#) on [page 71](#).

## Emission current is unstable.

### Possible Solutions

- The filament is near the end of its life span. Replace the filament, as described in [“Replacing the Ion Source Filament”](#) on page 53.
- There is a fault in the ion source board. Replace the ion source board, as described in [“Cleaning the Ion Source, Lenses and Prefilter”](#) on page 45.
- There is a problem with the analog board. If necessary, replace the analog board, as described in [“Replacing the Analog Board”](#) on page 71.

## Short filament lifetime.

### Possible Solutions

- Change the emission current setting to:
  - CEI – 25  $\mu$ A.
  - PCI – 50  $\mu$ A.
  - NCI – 50  $\mu$ A.
- There is an air leak contributing to short filament lifetime. Check for leaks; repair if any are found. See [“High Vacuum Symptoms”](#) on page 135.
- The filament is on during solvent peak. Increase filament/multiplier delay time until solvent peak has passed.
- High emission current is being used. Use lower emission current to extend lifetime.

## Diagnostics indicate flat lens response.

### Possible Solutions

- The power supply to the lens has a fault. Check regulator board in the power module; replace if necessary, see [“Replacing the Power Module”](#) on page 101.
- There is a fault with the lens drivers. Replace the analog board, as described in [“Replacing the Analog Board”](#) on page 71.

## Heated Zone Symptoms

The ion source and transfer line are heated zones related to the DSQ II. The ion source heater is controlled by the DSQ II and the transfer line heater is controlled by the Aux1 heated zone of the TRACE GC Ultra or FOCUS GC.

Often, a heated zone problem is the result of downloading a method to the DSQ II that has a different setpoint from the current setting, which causes 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. Refer to the GC documentation for information about heated zones.

### Excessive chromatographic peak tailing.

#### Possible Solutions

- Pressure check the inlet to see if there is a leak by pressurizing a sealed inlet to 250 kPa. If there is no leak, the pressure in the inlet will not fall more than < 10 kPa within the first minute. You can check the calibration of the K-factor by inserting the calibration column and making sure the K-factor readback is 1. If the K-factor calibration is okay, put the analytical column in and recheck the K-factor.
- The GC oven is not ramped to high enough temperature. Extend upper oven temperature.
- The GC column needs to be replaced or does not have the appropriate stationary phase for your application. Change GC column.
- The GC column does not extend 1 mm past the end of the transfer line tip. Insert the GC column in transfer line so it extends 1 mm past the end of the tip. If the end of the column is inside the tip, an excessive amount of GC effluent will contact the inside wall of the tip.
- Ion source and/or transfer line are not hot enough. Increase the transfer line temperature. It should be at least as hot as the highest GC oven temperature. Then try increasing the ion source temperature.
- Sample analyte is absorbing in the GC injector. Clean and deactivate the injection liner. You can also try liners made of different materials.

## Ion source heater will not heat.

### Possible Solutions

- The 24 V power supply is not operable. If necessary, replace power module, as described in [“Replacing the Power Module”](#) on [page 101](#).
- There is a problem with the analog board. Contact Technical Support.
- Cartridge heaters are not connected. Check connections between the analog and lens interface boards and lens interface board and ion source board.
- One or more heater cartridges on the ion source board is defective. Vent the system and check that the resistance of the heater circuit  $\approx 24\ \Omega$ . If necessary, replace the ion source board, as described in [“Cleaning the Ion Source, Lenses and Prefilter”](#) on [page 45](#).
- Ion source heater fuse (F1) is blown on the analog board. Replace the ion source heater fuse on the analog board, as described in [“Replacing the Analog Board Fuse”](#) on [page 73](#).
- Ion source temperature sensor (RTD) is defective. Vent the system and check the resistance of the RTD ( $108\ \Omega$  at  $20\ ^\circ\text{C}$ ,  $176\ \Omega$  at  $200\ ^\circ\text{C}$ ). If necessary, replace the ion source board, as described in [“Cleaning the Ion Source, Lenses and Prefilter”](#) on [page 45](#).

## Ion source heater overheats.

### Possible Solutions

- The ion source temperature sensor (RTD) is defective. Vent the system and check the resistance of the RTD ( $108\ \Omega$  at  $20\ ^\circ\text{C}$ ,  $176\ \Omega$  at  $200\ ^\circ\text{C}$ ). Replace the ion source board if necessary.
- There is a problem with the analog board. If necessary, replace the analog board, as described in [“Replacing the Analog Board”](#) on [page 71](#).

## Transfer line will not heat.

### Possible Solutions

- Aux1 zone of GC is not configured for the DSQ II transfer line. Configure Aux1 zone of the GC and set transfer line temperature in *Xcalibur's* Method Editor for the GC.
- Transfer line heater elements are defective. Turn off the GC. Unplug the transfer line connector. Measure the heater resistance between the following pins. Replace the transfer line if resistance is incorrect. See [“Replacing the Transfer Line”](#) on [page 112](#).

**Table 4.** Transfer Line Heater Resistance

PINS
2-3 $\approx$ 360 $\Omega$
2-4 $\approx$ 180 $\Omega$
3-4 $\approx$ 180 $\Omega$

- The transfer line temperature sensor (RTD) is defective. Measure resistance of RTD across pins 5-6 (108  $\Omega$  at 20 °C, 204  $\Omega$  at 275 °C). Replace transfer line if necessary.

## Transfer Line overheats.

### Possible Solutions

- The transfer line temperature sensor is defective. Turn off the GC. Unplug the transfer line connector. Measure resistance of RTD across pins 5-6 (108  $\Omega$  at 20 °C, 204  $\Omega$  at 275 °C). Replace transfer line if necessary. See [“Replacing the Transfer Line”](#) on [page 112](#).
- There is a problem with the Aux1 zone of the GC. Contact Technical Support.

## High Vacuum Symptoms

High Vacuum problems can manifest themselves in two ways. First, an intermittent vacuum condition (the vacuum pressure in the vacuum manifold fluctuates intermittently) can cause chromatographic signals to drop out, or, if the pressures exceed the maximum allowed pressures by *Xcalibur*, then the DSQ II can automatically shut down. Second, if the vacuum is consistent enough to where it does not exceed the maximum allowed pressure and avoids the *Xcalibur* automatic shutdown, non-reproducible false chromatographic peaks can be generated in the chromatogram.

Typical fore pressure readbacks are 30-40 mTorr (in EI mode), and typical manifold pressure (ion gauge readback) is  $1-5 \times 10^{-5}$  Torr. For CI mode, fore pressure is usually 60-90 mTorr, with manifold pressures no greater than  $9 \times 10^{-4}$  Torr.

Running a leak check as part of an automatic tune is a good way to check for leaks. You can also find vacuum leaks by spraying a gas around the vacuum manifold and looking for the characteristic ions in full-scan EI. Argon produces  $m/z$  40. Alternatively, compressed electronic dusting spray containing an HFC can be used. For example, Falcon<sup>®</sup> Dust-Off<sup>®</sup> and MicroCare<sup>®</sup> Micro-Blast<sup>™</sup> contain tetrafluoroethane, which produce ions at  $m/z$  69 and  $m/z$  83.

### Automatic Tune reports “Air leak has been detected”.

#### Possible Solutions

There may be an air leak. Use the procedure described above for finding the leak. The most common leaks are caused by:

- Tighten the transfer line nut or union
- Check the transfer line or inlet ferrules. Replace them if they are broken.
- Clean dust or debris from the top cover O-ring
- No helium flow from the GC. This causes the DSQ II to suck air through the column.

## **Rotary-vane pump will not turn on.**

### **Possible Solutions**

- The rotary-vane pump is off. Check the rotary-vane pump switch.
- The rotary-vane pump power cable from the DSQ II is not connected. Connect the power cable.
- The rotary-vane pump is configured for incorrect line voltage. Configure the rotary-vane pump for proper line voltage.
- The rotary-vane pump is faulty. Replace it.

## **Rotary-vane pump powers on, but will not pump down.**

### **Possible Solutions**

- The cable from the fore pressure gauge to the vacuum control board is faulty. Check the cable.
- The foreline is leaking. Check the clamps and connectors. Replace the foreline hose if a hole is found.
- A large leak is present. Check for leaks and correct.
- The oil level in the rotary-vane pump is insufficient. Check oil level; add more oil, as described in [“Adding Oil to a Rotary Vane Pump”](#) on [page 64](#).
- The rotary-vane pump is faulty. Replace the rotary-vane pump.
- The vacuum manifold top cover is leaking. Press down on the top cover to make sure it is seated properly.

## **Turbomolecular pump will not turn on.**

### **Possible Solutions**

- The fore pressure is not low enough. Check the rotary-vane pump and foreline plumbing for leaks and proper operation.
- Ready is not transmitted by the vacuum control board. Check cable connections between vacuum control board and turbomolecular pump controller; replace if necessary.
- The laboratory environment is too hot. Bring laboratory environment to within DSQ II specifications.
- Line voltage is out of tolerance. Check line voltage; correct as necessary.



## **Turbomolecular pump shuts off during operation.**

### **Possible Solutions**

- The fore pressure is too high. Check for leaks in the foreline.
- The cable connection between the turbomolecular pump and vacuum control board is faulty. Check connections.
- The turbomolecular pump controller is faulty. Replace or repair as necessary.
- The turbomolecular pump power supply is faulty. Replace or repair as necessary.
- The turbomolecular pump is faulty. Replace the turbomolecular pump.

## **Unexpected system vent occurs.**

### **Possible Solutions**

- A gross leak is present. Check for leaks.
- The system was vented through the inlet valve, there was a GC column break at the transfer line or the foreline was cut. Shut off the DSQ II main circuit breaker. Allow the system to vent and cool to room temperature.

## **Vacuum fault.**

### **Possible Solutions**

- A gross leak is present. Check for leaks in the transfer line, vent valve, high vacuum valve, and rotary-vane pump connection.
- The ion gauge must be on (if you have one) and the pressure below  $1 \times 10^{-3}$  Torr. Turn on ion gauge from *DSQ II Tune*.

## Linearity Symptoms

Linearity symptoms occur when a plot of intensity versus concentration of a known compound are not uniform throughout the curve, or vary from their expected peaks. Poor instrument operating conditions can cause linearity problems. Additionally, certain compounds do not give a desired linear response due to chromatographic activity.

A well-maintained instrument will provide good linear response over a wide range of concentration for most compounds. Like any instrument, however, the DSQ II has a saturation point.

Perform routine injector and column maintenance to minimize linearity problems. Usually, a hardware fault that affects linearity will show different symptoms than those that might be attributed to linearity.

### Calibration plots not sufficiently linear.

#### Possible Solutions

- Standards are too concentrated. Use split injection technique to decrease amount of sample, lower emission current to reduce sensitivity, or lower detector gain.
- Ion volume, lenses, or prefilter are dirty. Clean the ion volume, lenses, and prefilter, as described in [“Cleaning the Ion Source, Lenses and Prefilter”](#) on [page 45](#).
- Injection port liner or capillary column is dirty. Change the injection port liner and trim the capillary column.
- Capillary column stationary phase is too thin for high concentration samples. Use a higher capacity capillary column with a thicker stationary phase and/or use a split injection technique.
- The capillary column is bad. Replace capillary column.

## Power Supply Symptoms

*DSQ II Tune* diagnostics detects most power supply symptoms. Power supply problems often involve a blown fuse, faulty electronic components, or even something as simple as a disconnected cable. Use extreme care when you replace a fuse or electronic component.



**WARNING - ELECTRICAL SHOCK HAZARD.** Before proceeding, unplug the DSQ II to avoid an electrical shock.

### DSQ II will not turn on.

#### Possible Solutions

- Disconnected power cord. Verify that the power cord is plugged in.
- Voltage not 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 power module. Replace power module, as described in “[Replacing the Power Module](#)” on [page 101](#).

### DSQ II turns on, but trips the circuit breaker.

#### Possible Solutions

- Faulty power module. Replace power module, as described in “[Replacing the Power Module](#)” on [page 101](#).
- Rotary-vane pump causes circuit breaker to trip. Check the rotary-vane pump voltage setting; replace if necessary.

## **DSQ II turns on, but there are no voltages available.**

### **Possible Solutions**

- No +5, +/- 15, +24 V power. Check power module. The F1 in-line fuse may be blown or power supply 1 may be faulty. Replace if necessary.
- No +28 V power. Check fuse on RF generator board; replace if necessary. If fuse blows again after replacement, replace RF generator board. See [“Replacing the RF Generator Board”](#) on [page 109](#).
- No +/- 150 V power. Check regulator board in power module; replace if necessary.
- No 28 V current. Check connections to RF generator board, RF control board, RF coil, and RF feedthroughs.
- No +28 V current, -28 V, or +36 V (system is off). Turn system on from *DSQ II Tune*.

## **+28 V current is below acceptable range.**

### **Possible Solutions**

- There is a bad connection in the RF circuit. Check connection sequences between RF generator board, low pass filter, DC driver, RF coil, RF control board, RF feedthroughs, quadrupole, and prefilter.

## **+28 V current is higher than acceptable range.**

### **Possible Solutions**

- The RF frequency is not calibrated. Run an automatic tune to calibrate the RF frequency.
- The RF generator board overheated:
  - Check fans on back of DSQ II; clean or replace as necessary.
  - Verify there is adequate ventilation around the DSQ II.
  - Verify that lab temperature is within operating limits of DSQ II.
  - Verify that the RF frequency is calibrated by running an automatic tune.
- The RF generator board is faulty. Replace the RF generator board, as described in [“Replacing the RF Generator Board”](#) on [page 109](#).
- The RF detector capacitors are faulty. Check capacitor plate for high-voltage arcing; replace if necessary.
- There is a short circuit to ground in an RF feedthrough. Replace RF feedthrough.
- There is a short circuit in the RF coil. Replace the RF coil.

## ±550 V is outside the acceptable range.

### Possible Solutions

- The DC driver is faulty or the +36 V is missing. Make sure the DC driver is plugged in and the +36 V power supply is working correctly.

## RF and DC Control Symptoms

Automatic RF frequency calibration or RF dip and gain problems can be caused by several things. Begin troubleshooting control problems using *DSQ II Tune* diagnostics.

Diagnostics helps you identify whether the fault is due to a power supply problem, a break in the RF signal path, or a faulty component. Figure 3-1 is an excellent resource to begin troubleshooting RF 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.

## RF dip calibration shows random noise instead of a smooth RF dip.

### Possible Solutions

- There is a loose cable. Check these cables:

**Table 5.** Possible loose cables

Cables
Analog to Low Pass Filter board
Analog to RF Detector board
Analog to RF Generator board
Cables from DC Driver to Low Pass Filter board
Cables from RF Coil to RF Detector Capacitor or RF Feedthroughs
Lens Interface to Low Pass Filter board
RF Detector to DC Driver and RF Generator board
RF Generator to Low Pass Filter board

- Quadrupole mass filter is not connected to RF feedthroughs. Vent the system and check the two connections. The two wires from the quadrupole mass filter should be connected to the top and bottom RF feedthroughs on the rear pins. The connections to the quadrupole mass filter may also be loose.

- Prefilter is not connected to RF feedthroughs. Vent the system and check the two connections. The two wires from the prefilter should be connected to the top and bottom RF feedthroughs on the front pins.
- There is high voltage arcing. Vent the system and check the quadrupole mass filter and prefilter. Also, check the wires inside the RF coil box. Make sure the four wires going to the RF feedthroughs are far from any surface and especially each other. Check for burn marks or evidence of arcing. Clean components if necessary. Replace the components if problems persist.

## **RF Dip is present, but outside acceptable range.**

### **Possible Solutions**

- There is a fault with the RF coil or the RF detector board. Contact Technical Support for assistance.
- There is high voltage arcing. Vent the system and check the quadrupole mass filter and prefilter.
- Also, check the wires inside the RF coil box. Make sure the four wires going to the RF feedthroughs are far from any surface and especially each other.
- Check for burn marks or evidence of arcing. Clean components if necessary. Replace the components if problems persist.

## **The Det RF line (RF Gain Calibration screen) is not a smooth, straight line out to $m/z$ 1050.**

### **Possible Solutions**

- The RF generator gain is not adjusted. Contact Technical Support for assistance.
- There is high voltage arcing. Vent the system and check the quadrupole mass filter and prefilter.
- Also, check the wires inside the RF coil box. Make sure the four wires going to the RF feedthroughs are far from any surface and especially each other. Check for burn marks or evidence of arcing. Clean components if necessary. Replace the components if problems persist.

## The Det RF and RF Mod lines are erratic.

### Possible Solutions

- There is a loose cable. Check these cables:

**Table 6.** Possible loose cables

Cables
Analog to RF Detector board
RF Detector to DC Driver and RF Generator board
Lens Interface to Low Pass Filter board
Analog to Low Pass Filter board
RF Generator to Low Pass Filter board
Cables from RF Coil to RF Detector Capacitor or RF feedthroughs
Cables from DC Driver to Low Pass Filter board
Analog to RF Generator board

- There is a problem with the RF control board, low pass filter board, the RF generator board, or the RF coil. Contact Technical Support.
- There is high voltage arcing. Vent the system and check the quadrupole mass filter and prefilter. Also, check the wires inside the RF coil box. Make sure the four wires going to the RF feedthroughs are far from any surface and especially each other. Check for burn marks or evidence of arcing. Clean components if necessary. Replace the components if problems persist.

## Rod DC diagnostic fails.

### Possible Solutions

- If all tests fail, the DC driver is unplugged or faulty. Check all cables to the DC driver. If necessary, replace the DC driver, as described in [“Replacing the DC Driver”](#) on [page 83](#).
- If A Rod DC and B Rod DC fail but Average DC passes, RF dip, RF gain, or RF null may be adjusted incorrectly. Check RF dip and RF gain calibrations. The RF may not be working properly or the DC driver is disconnected or faulty. Check the RF null (see the *DSQ II User’s Guide*).

## Sensitivity Symptoms

If 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 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 ion source, lens, or prefilter contamination, and are easily remedied by cleaning the ion volume, lenses, and prefilter.

The electron multiplier influences sensitivity and has a limited lifetime. Eventually it will need to be replaced. Improper GC maintenance is another cause of diminished sensitivity. It is important to establish a routine maintenance program for the GC, which is described in the documentation.

### Poor sensitivity or sudden loss in sensitivity.

#### Possible Solutions

- Check the ion volume and holder for contamination.
- There is a large air leak. Run a leak check as part of an automatic tune or look for  $m/z$  28 as base peak in full scan. See [“High Vacuum Symptoms”](#) on [page 135](#).
- Cable J3 on the analog board is connected to J4. Check the cable and correct if necessary.
- Check the filament to see if it is warped. Replace if necessary.
- Check the position of the ion volume. Position it correctly or reinstall it.
- Cables are incorrectly installed or missing. If some ions are present, make sure entrance lens is plugged in and make sure cables for P1 and P2 are plugged in correctly on the Low Pass Filter board.
- Dust has collected in the electron multiplier or on the conversion dynode. Blow clean, dry gas on the electron multiplier and conversion dynode.
- There is a problem with filament or lens control. See [“Filament and Lens Control Symptoms”](#) on [page 130](#).
- GC column is not inserted beyond end of transfer line or column is broken off in ion source. Make sure the column is properly installed.
- Injection port liner is contaminated. Clean or replace the injection port liner.
- Graphite or septa particles have contaminated the injection port. Clean the injection port.
- The injector or septum is leaking. Replace the septum and perform a leak check on the GC.



- The instrument is out of tune or the tune file is incompatible. Select the correct tune file for the method or run an automatic tune.
- Ion source board is faulty, which allows the emission current to leak to ground. Replace the ion source board.
- The magnets above and below the ion source are installed incorrectly. Position both magnets so the south pole is on top. Electrons will not be focused into the ion volume if one magnet is upside down.
- The ion source, lenses, or prefilter are dirty. Clean the lenses, and prefilter, as described in [“Cleaning the Ion Source, Lenses and Prefilter”](#) on [page 45](#).
- The wrong type of ion volume is installed. EI and CI require different ion volumes. They may not be used interchangeably.
- Method development problems are occurring. Contact Technical Support or Customer Support.
- Prefilter is misaligned or broken. Check the alignment of the prefilter.
- Reagent gas is leaking into the analyzer and suppressing the EI signal. Check for the presence of CI reagent ions in the spectrum. If necessary, replace the CI gas flow module, as described in [“Replacing the CI Reagent Gas Flow Module”](#) on [page 79](#).
- Insufficient sample delivery due to clogged syringe needle. Clean or replace the syringe.
- Incorrectly matched syringe, injection port liner, and column depth in injector. See the GC documentation for compatible combinations.

## **Sensitivity is unstable or shows decrease with repeated injections.**

### **Possible Solutions**

- Electron multiplier is faulty. See [“Tuning Symptoms”](#) on [page 149](#).
- There is a problem with the filament emission current control. See [Filament and Lens Control Symptoms](#) [p. 130](#).
- GC temperature ramp does not continue to a high enough temperature to elute high boiling point compounds. Multiple injections cause these compounds to accumulate in column, thus reducing sensitivity. Extend upper temperature or time at upper temperature in GC oven ramp.
- Injection port liner or capillary column are contaminated. Replace the injection port liner and trim the capillary column.
- Ion source temperature is too low, causing it to contaminate too quickly. Clean the ion volume, lenses, and prefilter and then raise the ion source temperature. See [“Cleaning the Ion Source, Lenses and Prefilter”](#) on [page 45](#) for more information.
- Ion volume or holder may be loose. Adjust the ball valve to ensure they fit snugly.

## No ions are visible in Tune after selecting “Restore Default Calibration”.

### Possible Solutions

- Instrument is not calibrated. Run an automatic tune with all calibrations selected.
- No high  $m/z$  ion intensity because the RF is not tuned correctly. See “[RF and DC Control Symptoms](#)” on [page 141](#).

## Poor high mass response.

### Possible Solutions

- No high  $m/z$  ion intensity because the RF is not tuned correctly. See [RF and DC Control Symptoms p. 141](#).
- The ion volume, lenses, or prefilter are dirty. Clean the ion volume, lenses, and prefilter, as described in “[Cleaning the Ion Source, Lenses and Prefilter](#)” on [page 45](#).
- Poor high  $m/z$  ion ratios because the ion source temperature is too high. Reduce the ion source temperature to reduce the amount of thermal decomposition and fragmentation of your analyte.
- The conversion dynode is disconnected or faulty. Check the cable or replace the electron multiplier/conversion dynode power supply.
- Reagent gas is leaking into the analyzer and suppressing the EI signal. Check for the presence of CI reagent ions in the spectrum. If necessary, replace the CI reagent gas flow module, as described in “[Replacing the CI Reagent Gas Flow Module](#)” on [page 79](#).

## Poor low mass sensitivity or $m/z$ 219 is base peak for calibration gas.

### Possible Solutions

- Prefilter offset voltage is too negative. Adjust the prefilter offset closer to zero.
- The ion volume, lenses, or prefilter are dirty. Clean the ion volume, lenses, and prefilter, as described in “[Cleaning the Ion Source, Lenses and Prefilter](#)” on [page 45](#).
- Prefilter is misaligned or broken. Check the alignment of the prefilter.
- Lens voltages are incorrect. Select **Restore Default Tune** in *DSQ II Tune*.

## Isotopes are missing or isotope ratios are incorrect.

### Possible Solutions

- Masses are not resolved. Adjust resolution and/or ion offset in *DSQ II Tune* by selecting **Tune | Show Manual Tune View** and then click the Resolution tab.
- Detector gain is too low. Increase the detector gain.

## Irregular ion ratios.

### Possible Solutions

- The wrong type of ion volume is installed. EI and CI require different ion volumes, which can not be used interchangeably.
- Lens voltages or prefilter offset voltage are incorrect. Select **Restore Default Tune** in *DSQ II Tune*.
- Prefilter is misaligned or broken. Check the alignment of the prefilter.
- The ion volume, lenses, or prefilter are dirty. Clean the ion volume, lenses, and prefilter, as described in [“Cleaning the Ion Source, Lenses and Prefilter”](#) on page 45.
- The GC column is not inserted beyond the end of the transfer line or it is broken off in the ion source. Make sure the column is properly installed.
- There is a large air leak. Run a leak check as part of an automatic tune or look for  $m/z$  28 as base peak in full scan. See [“High Vacuum Symptoms”](#) on page 135.
- Cables are incorrectly installed or missing. If some ions are present, ensure the entrance lens is properly connected and P1 and P2 cables are connected to the low pass filter board.

## Weak Signal.

### Possible Solutions

- The ion volume, lenses, or prefilter are dirty. Clean the ion volume, lenses, and prefilter, as described in [“Cleaning the Ion Source, Lenses and Prefilter”](#) on page 45.
- The detector gain is set too low. Run detector gain calibration as part of an automatic tune. Try a higher gain setting. A multiplier >2-3 years old may be too noisy for the detector gain calibration to accurately set the voltage. Replace multiplier if necessary.
- The wrong type of ion volume is installed. EI and CI require different ion volumes. They may not be used interchangeably.

- The ion volume is absent or incorrectly positioned. Verify that the ion volume is positioned correctly by removing and reinserting it.
- There is a filament or lens control issue. See [“Filament and Lens Control Symptoms”](#) on page 130.

## Poor sensitivity in CI mode.

### Possible Solutions

- An EI ion volume is installed. Install a CI ion volume.
- The small hole in the CI ion volume is clogged. Use a dental pick or old syringe needle to clear it.
- The filament is not aligned. Remove the ion volume and check if the ion burn is centered around the small electron entrance hole. Be sure the filament is properly inserted into the connector. Carefully bend the filament wire to better align it with the ion volume.
- The ion volume is not inserted properly. While running the instrument, you can push on the ion volume with the I/R tool. Be sure to monitor the pressure to ensure that you get a good seal around the I/R tool. Otherwise, you may damage the filament. An increase in signal for the calibration gas as you push on the ion volume usually indicates that the filament is not aligned properly.



**CAUTION INSTRUMENT DAMAGE.** Failure to ensure a good vacuum seal around the I/R tool will leak air into the DSQ II. This air leak could damage the filament if it is on.

## Stability Symptoms

Stability problem symptoms occur when the instrument is not consistently precise and when accurate results are not reproducible. Good operating conditions for the DSQ II, GC, and autosampler contribute to instrument stability.

Sample preparation, spiking errors, sample injection errors, and lack of routine maintenance on the instruments may cause false stability symptoms.

When hardware faults affect instrument stability, try simple solutions first, such as cleaning the ion volume and lenses, or checking for air leaks. Usually, a hardware fault that affects stability will show different symptoms than those attributed to stability.

## Mass assignment is unstable.

### Possible Solutions

- The RF and DC have not stabilized. Allow the instrument to scan for about 1 min.
- There is a problem with the RF or DC. See [“RF and DC Control Symptoms”](#) on [page 141](#).

## Signal response is unstable or shows unexpected drop-out.

### Possible Solutions

- Autosampler rinse vials have septum pieces in them, which can clog or change the amount of sample in the syringe. Use aluminum foil instead of septa for the rinse vials. Special Teflon caps are also available for the AI/AS 3000 Series and the Tri-Plus.
- There is a problem with the filament or lens control. See [“Filament and Lens Control Symptoms”](#) on [page 130](#).
- There is an air leak. Check for leaks. See [“High Vacuum Symptoms”](#) on [page 135](#).
- There is a high vacuum problem. See [“High Vacuum Symptoms”](#) on [page 135](#).
- There is a contamination problem. See [“Contamination Symptoms”](#) on [page 127](#).
- Dust has collected in the electron multiplier or on the conversion dynode. Blow clean, dry gas on the electron multiplier and conversion dynode.

## Tuning Symptoms

Tuning symptoms may be the result of an incorrectly adjusted manual control parameter. You should suspect a tuning problem when an automatic tune fails. Automatic tune performs several functions and symptoms or error messages indicate different problems. A tuning symptom can usually be found by running diagnostics in the *DSQ II Tune* software.

## Automatic Tune reports “Cannot perform RF frequency calibration”.

### Possible Solutions

There is a problem with the RF control system. See [“RF and DC Control Symptoms”](#) on [page 141](#).

## Automatic Tune reports “Cannot find calibration gas peaks”.

### Possible Solutions

- The calibration gas vial is empty. Add 100 µL (max) to calibration gas vial.
- There is a mechanical problem with the ion source or lenses. Verify that an EI ion volume is installed. Verify correct orientation and cleanliness of ion volume. Verify cleanliness and correct operation of lenses.
- There is a problem with the RF or DC. See [“RF and DC Control Symptoms”](#) on [page 141](#).

## Automatic Tune reports “Mass Calibration or Resolution Calibration should be run”.

### Possible Solutions

- Instrument has not been given sufficient time to stabilize. Allow instrument to stabilize power supplies while scanning  $m/z$  50 to 650 for 1 minute.
- Instrument requires calibration. Select Mass Calibration or Resolution Calibration as part of running an automatic tune.

## Automatic Tune reports “Cannot perform detector gain calibration”.

### Possible Solutions

- Chemical background in the manifold is elevated. Remedy leaks or sources of water contamination in carrier gas. See [“High Vacuum Symptoms”](#) on [page 135](#).
- The electrometer board is noisy. Replace the electrometer board, as described in [“Replacing the Electrometer Board”](#) on [page 89](#).
- The electron multiplier has not been given sufficient time to outgas since venting. Allow more time to pump out.
- The electron multiplier is near the end of its lifetime. Multipliers typically last about 2-3 years before they are too noisy for the gain to be set accurately. Replace the electron multiplier, as described in [“Replacing the Electron Multiplier”](#) on [page 59](#).
- Dust on conversion dynode or electron multiplier. Remove the dust with dry gas.
- The electron multiplier power supply is faulty. Replace the electron multiplier power supply, as described in [“Replacing the Electron Multiplier”](#) on [page 59](#).
- The filament is the source of too much background noise. See [“Filament and Lens Control Symptoms”](#) on [page 130](#).
- The GC column flow is too high. Lower it to 1 mL/min.

- Mass and resolution are not calibrated. Adjust the detector gain in *DSQ II Tune* to see background ions and run resolution and mass calibrations as part of an automatic tune.
- The calibration gas vial is empty. Add 200 µL (max) to calibration gas vial.
- The multiplier anode is dirty or leaking. Inspect the anode.

## Automatic Tune reports “Cannot calibrate resolution”.

### Possible Solutions

- Contaminant ions interfere with  $m/z$  100 or  $m/z$  502. Allow contaminants to pump away.
- Calibration gas ions ( $m/z$  69, 131, 264) are present, but more than  $\pm 12.5\%$  or  $\pm 20$  u off, whichever is smaller.
  - Manually adjust mass calibration by configuring *DSQ II Tune* to display the Manual Calibration field in the Instrument Configuration Service tab.
  - Enter the observed  $m/z$  for calibration gas ions in the Manual Calibration field of *DSQ II Tune* and select **Mass Calibrate**.
- The calibration gas vial is empty. Add 200 µL (max) to calibration gas vial.
- DC/RF gain is set incorrectly. Contact Technical Support.

## Automatic Tune reports “Cannot perform mass calibration”.

### Possible Solutions

- Manually adjust mass calibration by configuring *DSQ II Tune* to display the Manual Calibration field in the Instrument Configuration Service tab.
- Calibration gas ions ( $m/z$  69, 131, 264) are present, but more than  $\pm 12.5\%$  or  $\pm 20$  u off, whichever is smaller.
- Contaminant ions interfere with calibration gas ions. Allow contaminants to pump away.
- Enter the observed  $m/z$  for calibration gas ions in the Manual Calibration field of *DSQ II Tune* and select **Mass Calibrate**.
- Resolution is not calibrated. Calibrate resolution by running an automatic tune.
- The calibration gas vial is empty. Add 200 µL (max) to calibration gas vial.

## **Automatic Tune reports “An air leak has been detected”.**

### **Possible Solutions**

There may be an air leak. See [“High Vacuum Symptoms”](#) on [page 135](#).

## **Tune reports an error while saving a Tune file.**

### **Possible Solutions**

A file with the same name already exists with read-only attributes. Change the existing file's attributes so it can be overwritten.



## Vacuum System and Gas Inlets

This chapter describes the theory of operations for the vacuum system and gas inlets.

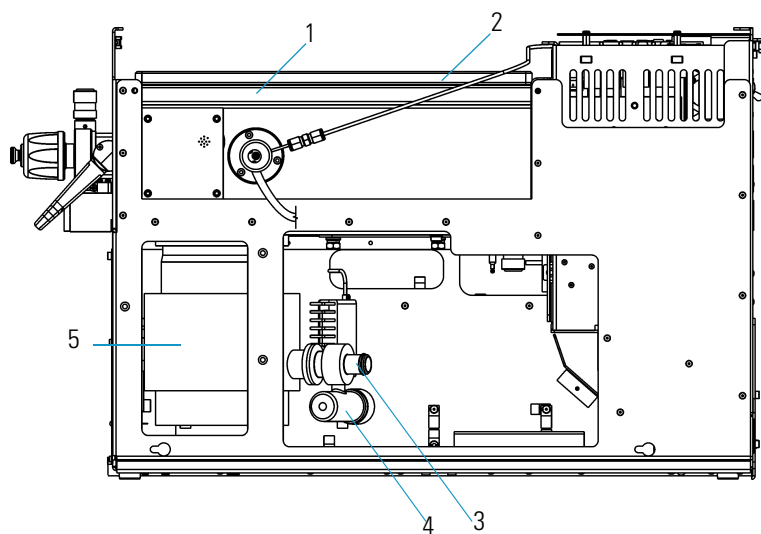
### Vacuum System

Vacuum system components maintain the low pressure necessary for the ion source, quadrupole, and ion detector to operate properly. The vacuum manifold, which houses the ion source, quadrupole, and ion detector, is pumped (or evacuated) by the high vacuum (turbomolecular) pump. All components, except the rotary-vane pump, are located around the vacuum manifold.

The vacuum system consists of the following components:

- Fore pressure gauge
- High vacuum pump
- Ion gauge (upgrade)
- Rotary-vane pump
- Vacuum manifold

**Figure 74.** Vacuum System Components (Right Side)



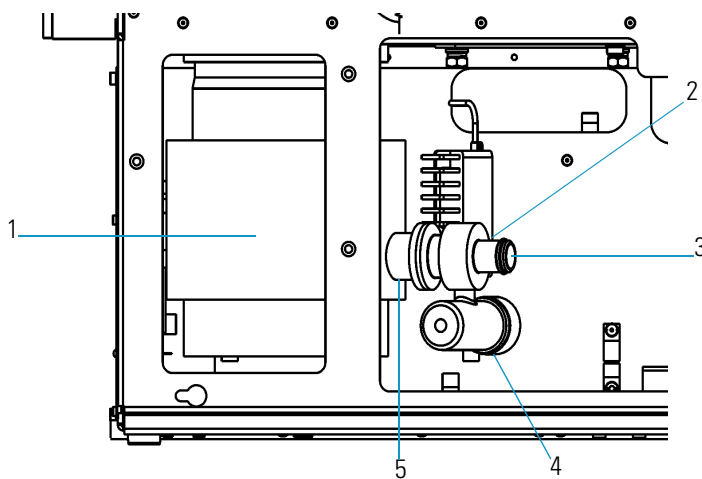
1	Vacuum Manifold	4	Fore Pressure Gauge
2	Ion Gauge (on Left Side of Vacuum Manifold)	5	High Vacuum (Turbomolecular) Pump
3	Foreline Adapter (Connects the Foreline Hose to the Rotary-Vane Pump)		

## Fore Pressure Gauge and Foreline Adapter

The fore pressure gauge and foreline adapter are connected to the high vacuum pump. The fore pressure gauge measures the pressure in the foreline. If the pressure inside become too high, the vacuum control board removes power to the high vacuum pump to prevent damage.

The foreline adapter connects the foreline hose from the rotary-vane pump inlet to the high vacuum pump.

**Figure 75.** Fore Pressure Gauge and Foreline Adapter (Right Side)



1	High Vacuum (Turbomolecular) Pump	4	Fore Pressure Gauge
2	Foreline Adapter	5	High Vacuum (Turbomolecular) Pump Outlet
3	Foreline Hose Outlet		

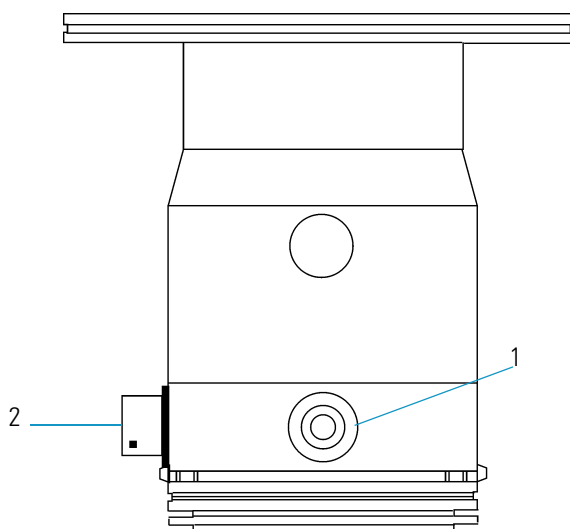
## High Vacuum Pump (Single Turbomolecular Pump)

The high vacuum pump creates the low pressure require by the ion source, quadrupole, and ion detector. The DSQ II can be equipped with one of two types of single turbomolecular pumps: a 70 L/s or a 250 L/s.

In this configuration, the ion source, quadrupole, and ion detector are pumped by a single pump. The 250 L/s pump is recommended for applications that use high gas flows into the vacuum manifold, such as CI.

Turbomolecular pump operation is purely mechanical and does not require oil to create a high vacuum. These turbomolecular pumps have a multi-stage axial-flow turbine in which high-speed rotating blades provide compression by increasing the probability of gas molecules moving in the pumping direction. The turbomolecular pump requires the use of a rotary-vane pump to exhaust to atmosphere.

**Figure 76.** 70 L/s Turbomolecular Pump



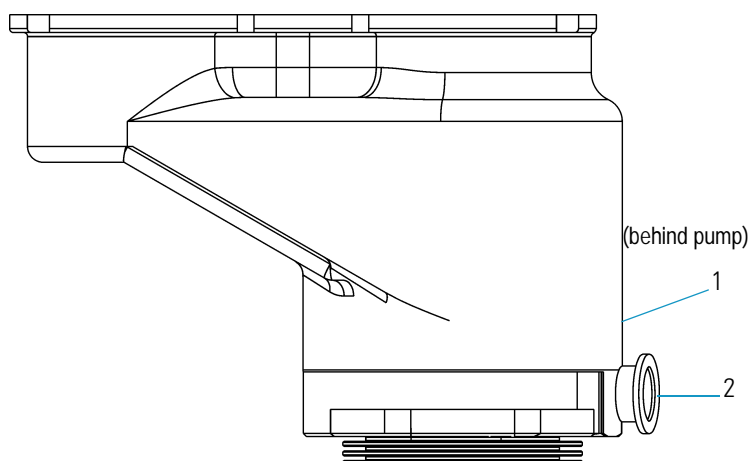
1	Turbomolecular Pump Outlet	2	Electrical Supply Connector
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## High Vacuum Pump (Split-Flow Turbomolecular Pump)

As an upgrade option, a differentially pumped configuration of DSQ II is available. In a differentially pumped instrument, the ion source is pumped separately from the quadrupole and ion detector. Rather than using two individual turbomolecular pumps, a split-flow turbomolecular pump is used. Such a pump uses less power, is more reliable, and less expensive than two separate pumps.

With a differentially pumped system, you can use higher flow rates of gas (helium from the GC and CI reagent gas) into the ion source without adversely affecting the performance of the quadrupole. Sensitivity and resolution are optimum when the pressure in the quadrupole is low.

**Figure 77.** Split-flow Turbomolecular Pump



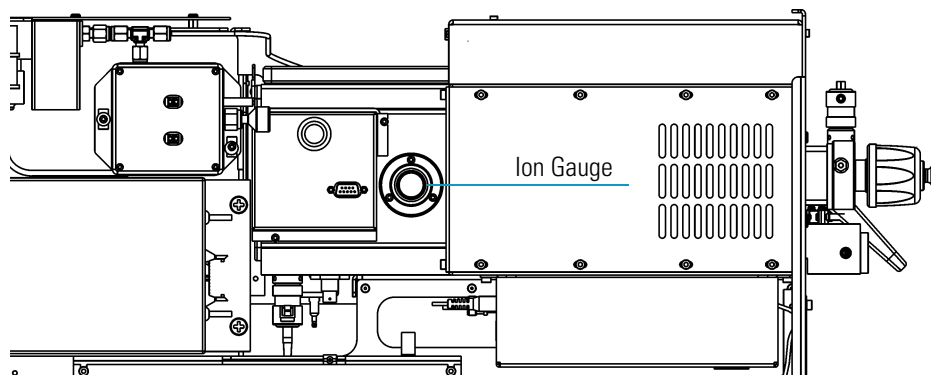

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1	Electric Supply Connector (Not Shown)	2	Turbomolecular Pump Outlet
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## Ion Gauge (Upgrade)

**Figure 78.** Ion Gauge (Left Side)



The ion gauge mounts on the left side of the vacuum manifold. An ion gauge measures the pressure inside the vacuum manifold and produces energetic electrons to ionize 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.

If you have an ion gauge, it must be on and the pressure below  $1 \times 10^{-3}$  Torr to turn on the filament, electron multiplier, or conversion dynode. This protects these components from damage.

## Rotary-Vane Pump

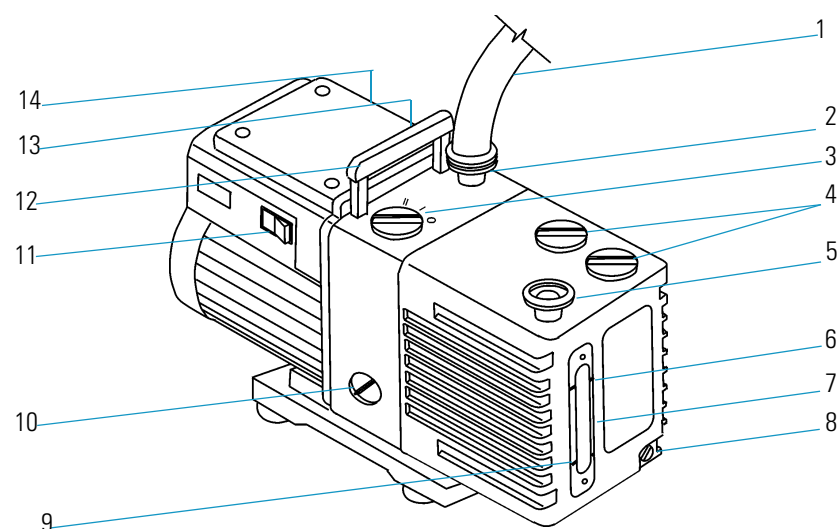
The rotary-vane pump is typically located on the floor behind the DSQ II. It is a two-stage forepump that connects to the outside of the DSQ II. It establishes the vacuum necessary for properly operating the high vacuum pump.

The rotary-vane pump connects to the high vacuum pump by a piece of 0.75 in. i.d. tubing. The power cord plugs into the rear of the DSQ II in the outlet labeled MECH PUMP. This outlet powers the pump and is controlled by the main circuit breaker and not by the service switch.



**CAUTION - INSTRUMENT DAMAGE.** Always connect the rotary-vane pump power cord to the outlet on the rear of the DSQ II and never into a wall outlet. If the pump is not plugged into the DSQ II rear, it will not shut down when the instrument is powered off. As a result, the pump will continue to run and the DSQ II will not be able to vent to atmosphere.

**Figure 79.** Rotary-Vane Pump

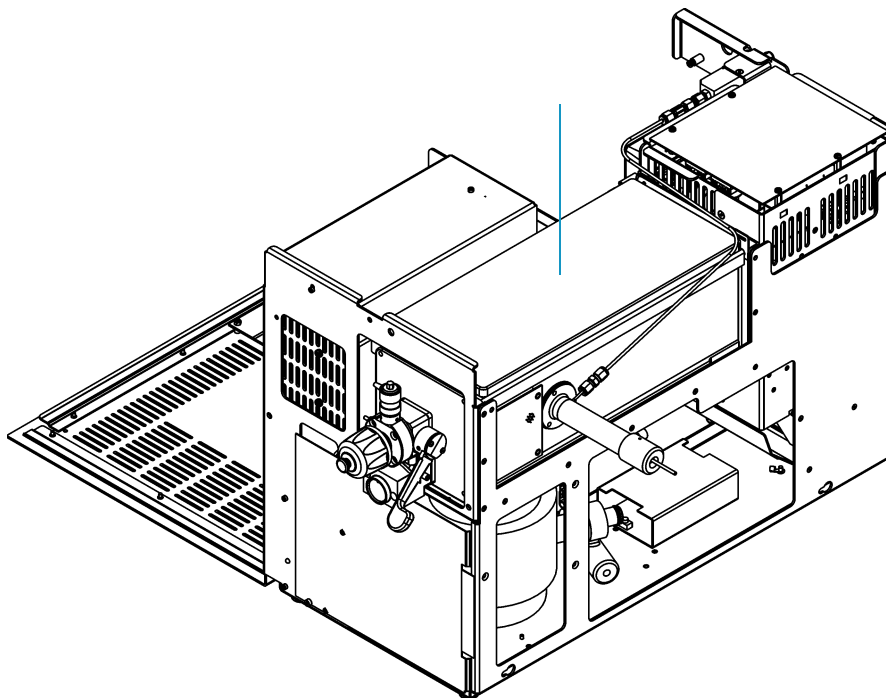


1	Foreline Vacuum Hose	8	Drain Plug
2	Inlet Port	9	MIN (Minimum Level Mark)
3	Gas-Ballast Control	10	Mode Selector
4	Oil Filler Plugs	11	On/Off Switch
5	Outlet Port	12	Handle
6	MAX (Maximum Level Mark)	13	Voltage Indicator
7	Oil-Level Sight-Glass	14	Electrical Inlet Connector

## Vacuum Manifold

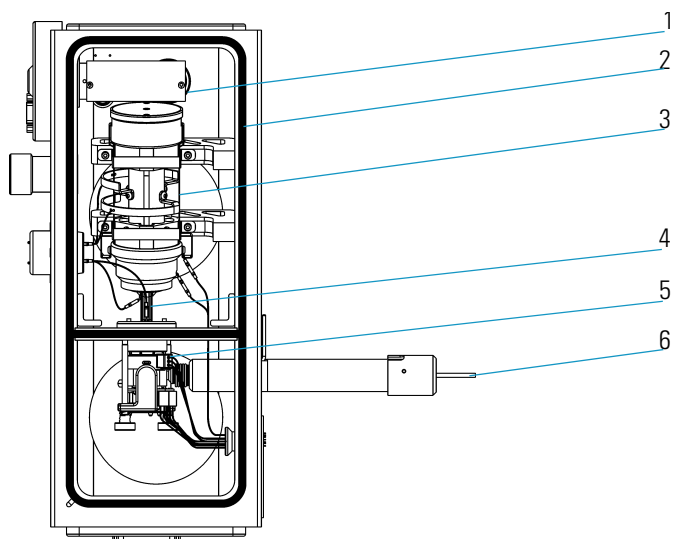
The vacuum manifold is located on the top right of the DSQ II, directly above the high vacuum pump. The vacuum manifold is a thick walled, aluminum chamber that encases the heart of the DSQ II (the ion source, quadrupole, and ion detector). The vacuum manifold has a removable cover, machined flanges on the front and rear, and various electrical feedthroughs and gas inlets.

**Figure 80.** Vacuum Manifold (Front, Right Side)





**Figure 81.** Vacuum Manifold Components

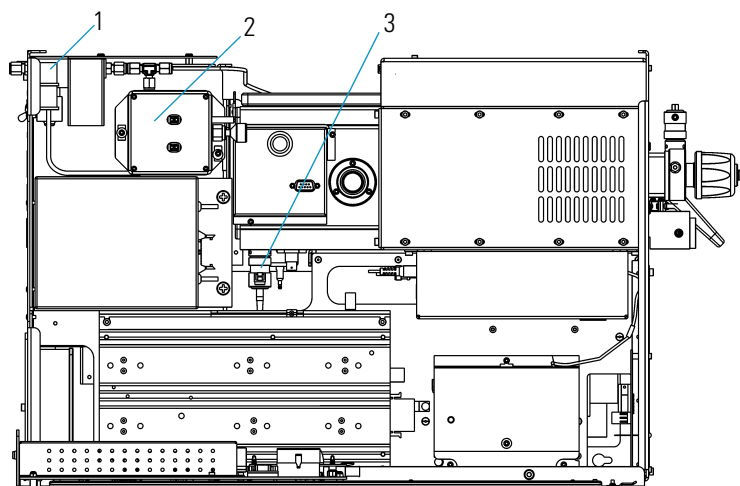


1	Ion Detector	4	Prefilter
2	O-ring	5	Ion Source
3	Quadrupole	6	Transfer Line

## Gas Inlet Components

There are three gas inlets that control the input of various gases into the vacuum manifold. The calibration gas flow module controls the calibration compound, the CI reagent gas flow module regulates the flow of CI reagent gas into the ion source, and the vent valve solenoid vents the vacuum manifold to the atmosphere.

**Figure 82.** Gas Inlets (Left Side)



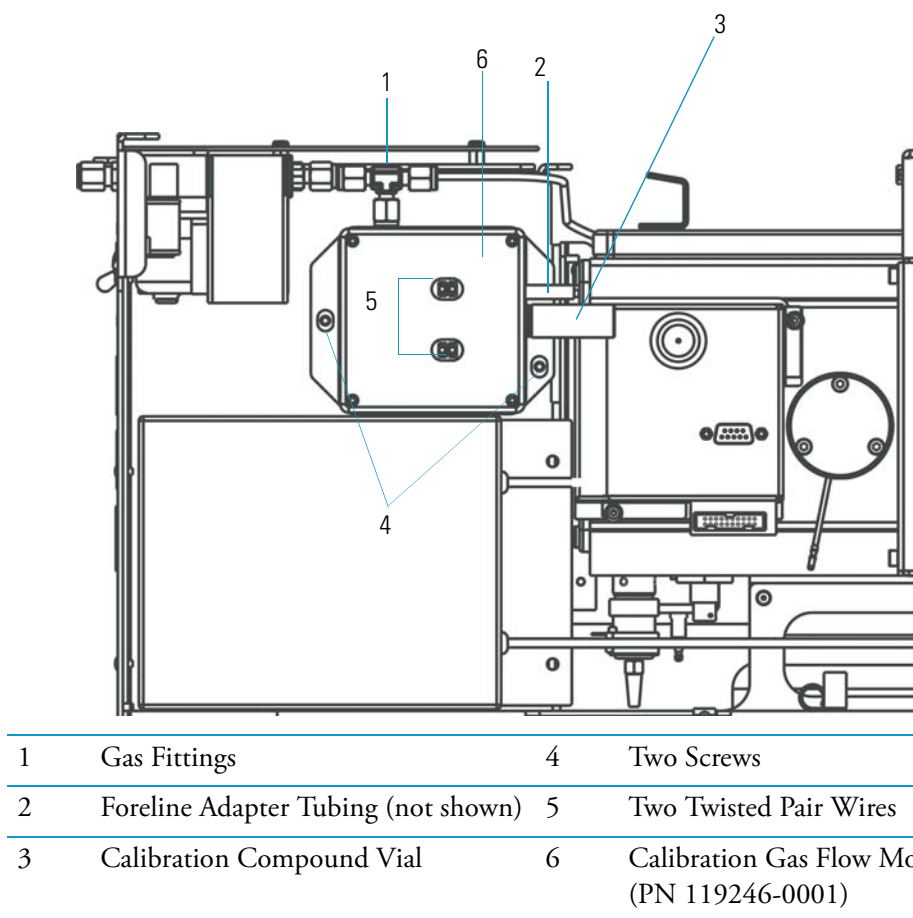
1	CI Reagent Gas Flow Module	3	Vent Valve Solenoid
2	Calibration Gas Flow Module		

## Calibration Gas Flow Module

The calibration gas flow module controls the flow of calibration compound into the ion source and is mounted at the back left of the DSQ II. The calibration compound provides reference peaks to tune and calibrate the DSQ II.

The module can deliver two different flows of calibration compound. One is a low flow for EI and NICI. The other is a higher flow used for PICI. The module permits calibration compound to enter the ion source through 1/8 in. o.d. tubing. The module is factory charged with 0.1 mL of perfluorotributylamine, which is adequate for approximately one year of operation.

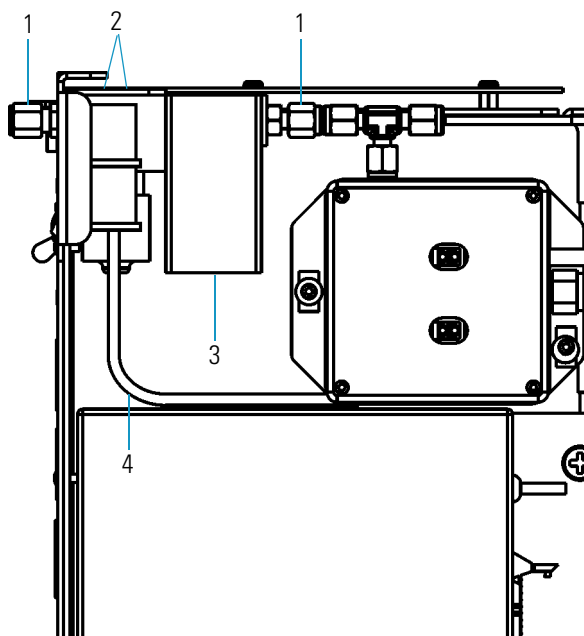
**Figure 83.** Calibration Gas Flow Module



## CI Reagent Gas Flow Module (Upgrade)

The CI reagent gas flow module controls the flow of CI reagent gas into the ion source and is located at the back left of the DSQ II. The module uses electronic pressure control to precisely set the flow of reagent gas. The flow is programmed using *Xcalibur*, which allows you to accurately reproduce flows.

**Figure 84.** CI Reagent Gas Flow Module



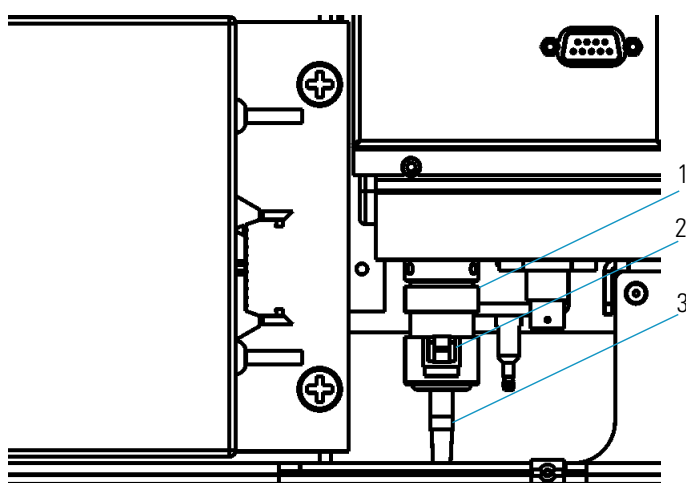
1	Two Gas Fittings	3	Cable (to Analog Board)
2	Two Screws Around the Module	4	Foreline Adapter Tubing

## Vent Valve Solenoid

The vent valve solenoid allows the vacuum manifold to vent to atmospheric pressure and is mounted on the bottom of the vacuum manifold. It is controlled by the vacuum control board. The vent valve filter prevents dust and debris from getting in the vacuum manifold.

When the main circuit breaker is on, the vacuum control board supplies power to the vent valve solenoid to keep it closed. Approximately two to three seconds after power is removed from the system, the vent valve solenoid opens and the vacuum manifold is vented to atmospheric pressure. This process takes about four minutes.

**Figure 85.** Vent Valve Solenoid



1	Vent Valve Solenoid	3	Vent Valve Filter
2	Cable		

## **4 Vacuum System and Gas Inlets**

### Gas Inlet Components

## Ion Source and Inlet Valve

This chapter describes the theory of operation for ion source components and the inlet valve.

### Ion Source

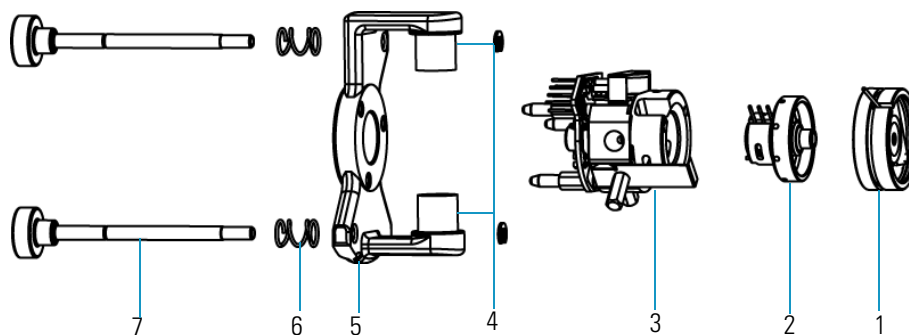
The ion source is the part of the DSQ II where ions are formed. It is located inside and to the front of the vacuum manifold. The ion source has two main functions: to generate a beam of electrons and to provide a site for these electrons to interact with sample or reagent gas molecules to form ions. Once formed, these ions are then focused by the lenses into the prefilter and then the quadrupole mass filter.

The ion source uses an interchangeable ion volume so that three different ionization modes can be used (EI, PCI, or NCI). The ion volume sits inside the ion source, which is heated by three cartridge heaters. Three lenses at the back of the ion volume draw out either positive or negative ions from the ion volume and pass them into the prefilter.

The ion source consists of the following components:

- Filament
- Ion source
- Ion volume
- Lenses
- Magnets and magnet yoke

**Figure 86.** Ion Source



1	Source Spacer with PreFilter Lens	5	Magnet Yoke
2	Lens Assembly	6	Two Springs
3	Ion Source	7	Two Thumbscrews
4	Two Magnets		



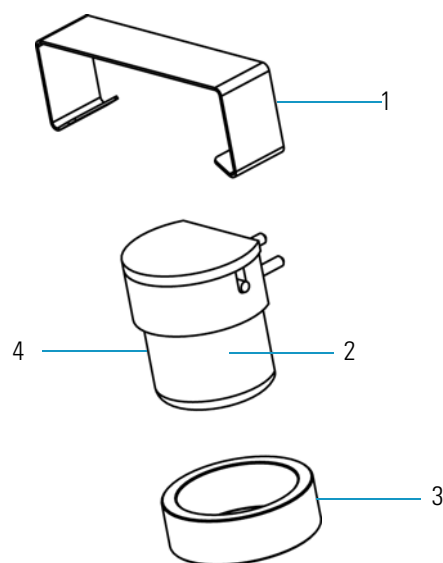
## Filament

A filament contains an electron lens, filament, filament spacer, and reflector. It is positioned on top of the ion source and plugs into the 3-pin filament connector on the ion source board.

An electron lens (the metal cylinder enclosing the filament and reflector) prevents positive ions from traveling up the electron beam, extending the life of the filament. It is located between the filament and the ion volume. The voltage applied to the electron lens affects the flux of electrons that enter the ion volume. Notice that the filament is a rhenium wire inside the electron lens that is electrically heated to produce electrons by thermionic emission.

A reflector is located inside the electron lens, and repels electrons emitted by the filament toward the ion volume. Filaments and reflectors are maintained at negative potential relative to the ion volume, usually -70 V. The electrons emitted by the filament are accelerated into the ion volume. The filament spacer is a ceramic ring that aligns the filament with the electron entrance hole in the ion source block and ion volume. Likewise, the filament retainer clip is a metal clip that ensures good alignment and fit of the filament to the source block.

**Figure 87.** Filament



1	Filament Retainer Clip	3	Filament Spacer
2	Filament and Reflector (inside Electron Lens)	4	Electron Lens

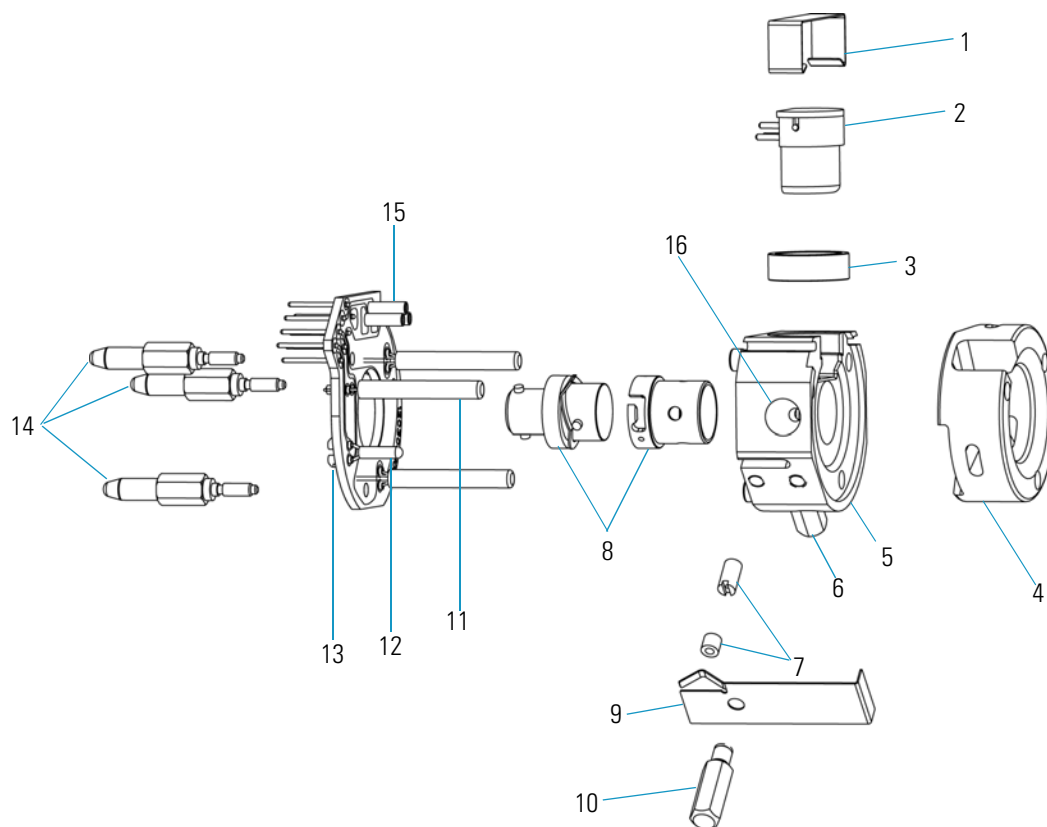
## **Ion Source**

During operation, the ion source holds an ion volume in its center. It is aligned by the ion volume key thumbscrew and secured by the ball plunger. Samples are introduced from a GC through the transfer line into the sample inlet aperture located on the side of the ion source. Calibration compound and chemical ionization reagent gas also enter the ion volume through the transfer line.

The ion source board supplies voltages to the filament, electron lens, and cartridge heaters, as it passes signals from the temperature sensor. Three base studs hold the ion source board to the ion source. These studs slip into the magnet yoke and position the ion source between two permanent magnets.

Three cartridge heaters and a temperature sensor are mounted on the ion source board. Cartridge heaters pass through and heat the ion source, as well as heat, align, and support the three ion source lenses. The temperature sensor monitors the temperature of the ion source. The heater ring slips over the cartridge heaters and transfers heat to the lenses.

**Figure 88.** Ion Source



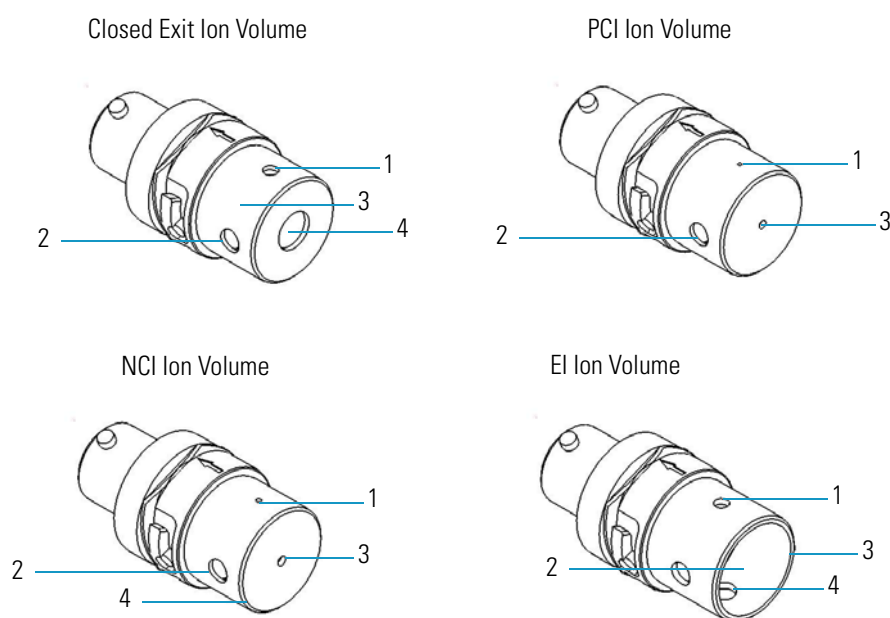
1	Filament Retainer Clip	9	Spring
2	Filament	10	Spring Thumbscrew
3	Filament Spacer	11	Three Cartridge Heaters
4	Heater Ring	12	Temperature Sensor
5	Ion Source	13	Ion Source Board
6	Alignment Pin/Ion Volume Key Thumbscrew	14	Three Base-Studs
7	Ion Volume Pin/Set Screw & Ball Plunger	15	3-pin Filament Connector
8	Ion Volume and Holder	16	Sample Inlet Aperture

## Ion Volume

The ion volume is where the molecules interact with energetic electrons to form ions. Different ion volumes are needed for EI, PCI, and NCI operation modes. These optimized geometries maximize sensitivity for each ionization mode. An NCI ion volume offers a compromise in sensitivity for both EI and CI and is best for NCI. It allows you to switch ionization modes from one run to the next. This is especially useful for qualitative analysis.

The ion volume consists of the ion volume holder and the ion volume. The ion volume is located in the center of the ion source.

**Figure 89.** EI, PCI, NCI, and CEI Ion Volumes



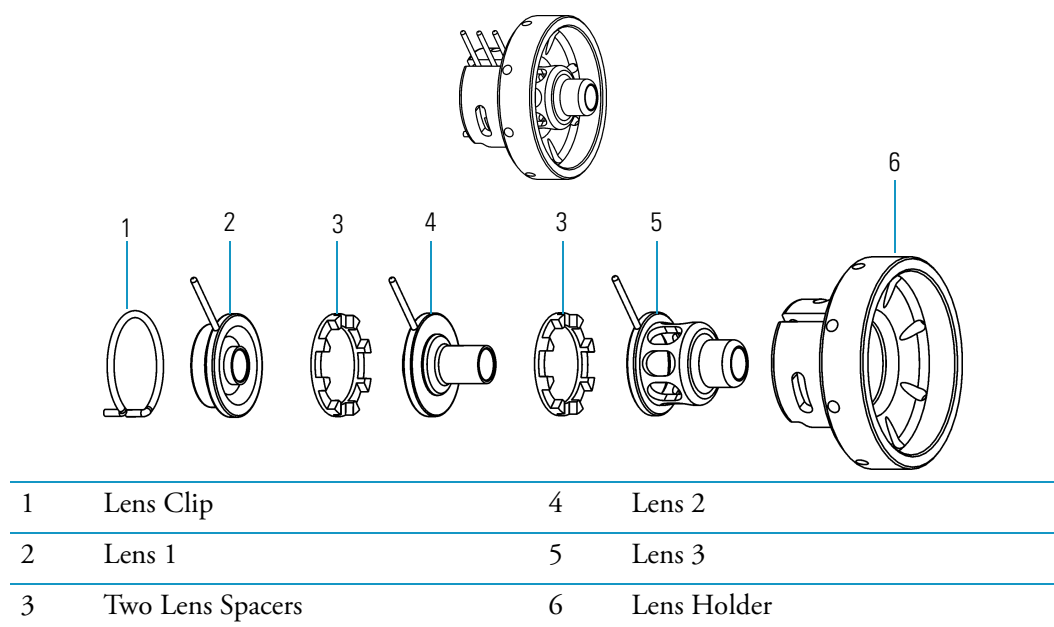
1	Electron Entrance Hole	3	Ion Exit Hole
2	GC Effluent, Calibration Gas, CI Reagent Gas entrance hole	4	Electron Exit Hole

## Lenses

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

A lens' electrical connection is made through a stainless steel pin protruding from the edge of the lens. A small 3-pin lens connector attaches to these pins and carries the voltage from the electrical feedthrough to the lens.

**Figure 90.** Ion Source Lenses

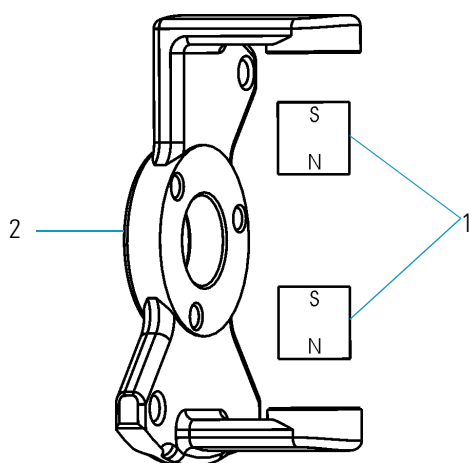


## Magnets and Magnet Yoke

Two magnets focus emitted electrons into a beam that spirals through the ion volume. The spiraling of the beam ensure optimum ionization of the sample. The magnet yoke holds the two magnets in the proper position above and below the ion source.

Position both magnets so the south pole is on top otherwise sensitivity will be poor. Electrons are not focused into the ion volume if one magnet is upside down.

**Figure 91.** Magnets and Magnet Yoke



1 Magnets

2 Magnet Yoke

## Inlet Valve (Upgrade)

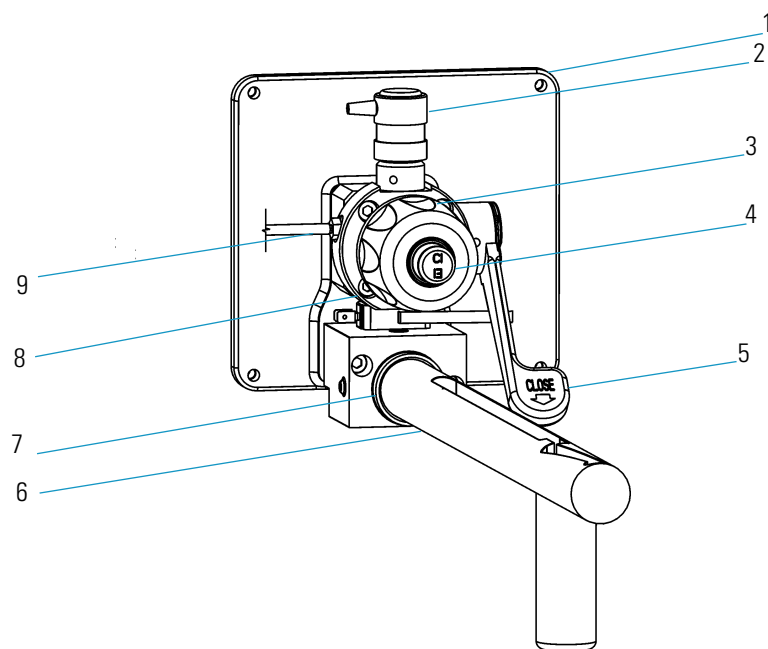
The inlet valve mounts on the front of the vacuum manifold and is the vacuum interlock mechanism for the DSQ II. The inlet valve is a vacuum sealed valve through which you insert and remove the ion volume assembly using an I/R (insertion/removal) tool.

With the use of the I/R tool and guide bar, the inlet valve lets the ion volume be removed or installed in the ion source without having to vent the vacuum manifold to atmospheric pressure. Once excess pressure is removed by opening the inlet valve solenoid, the inlet valve can be opened that allows the I/R tool to be inserted into the vacuum manifold. Excess pressure introduced into the inlet valve when inserting the I/R tool is removed through the foreline hose connection back to either a primary or secondary rotary-vane pump.

The inlet valve consists of the following components:

- Ball valve
- Inlet valve lever
- Guide bar housing
- I/R tool and guide bar
- Inlet valve plug
- Inlet valve seal

**Figure 92.** Inlet Valve Components (I/R Tool Not Shown)



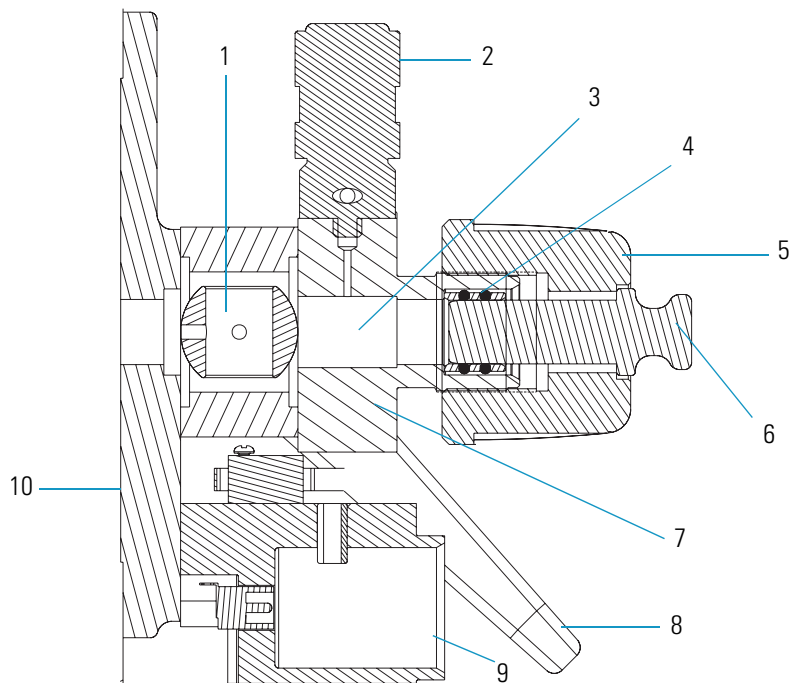
1	Vacuum Manifold	6	Guide Bar
2	Inlet Valve Solenoid	7	Guide Bar Entry
3	Inlet Valve Knob (Ferrule Inside)	8	Four Hex Socket Screws
4	Inlet Valve Plug	9	Foreline Hose Connection
5	Inlet Valve Lever		



## Ball Valve

The ball valve (located inside the inlet valve) is a ball with a hole through it. The ball valve is open when the hole in the ball is aligned with the opening between the vacuum manifold and the inlet valve chamber. When the ball valve is closed, it prevents the vacuum manifold from venting to atmosphere.

**Figure 93.** Inlet Valve Components

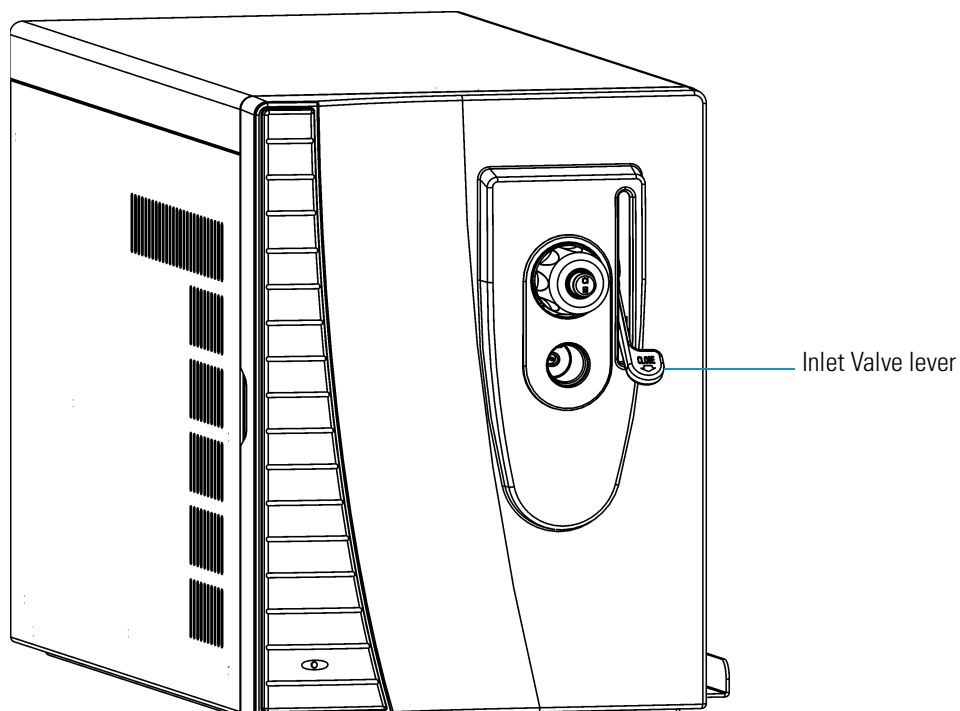


1	Ball Valve	6	Inlet Valve Plug
2	Inlet Valve Solenoid	7	Inlet Valve Block
3	Inlet Valve Chamber	8	Ball Valve Lever
4	Inlet Valve Seal	9	Guide Bar Housing
5	Inlet Valve Knob	10	Vacuum Manifold

## Inlet Valve Lever

The inlet valve lever is used to open and close the ball valve. When the inlet valve lever is up, the ball valve is open. The ball valve is closed when the inlet valve lever is in the down position. The lever turns the ball valve to allow a probe device (sample probe or I/R Tool) to enter the vacuum manifold.

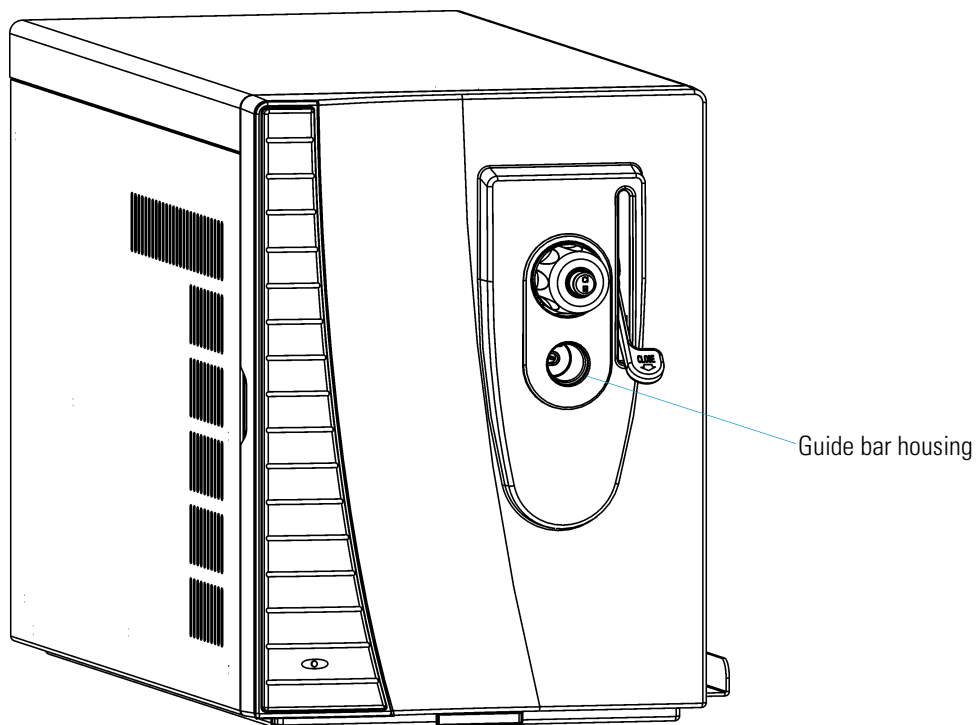
**Figure 94.** Inlet Valve Lever



## Guide Bar Housing

The guide bar housing is an aluminum chamber mounted on the vacuum manifold. The guide bar housing has an opening for the guide bar.

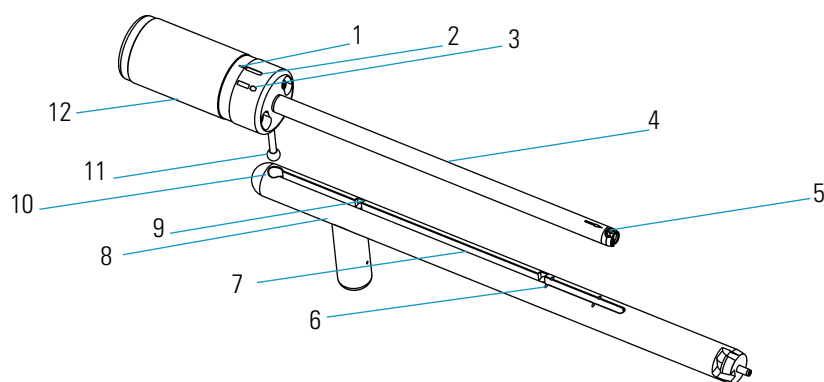
**Figure 95.** Guide Bar Housing



## I/R Tool and Guide Bar

The I/R (ion volume/removal) tool is used to insert and remove the ion volume and consists of a shaft, handle, and guide ball. The I/R tool is designed to be used with the guide bar. The guide ball located on the I/R tool fits inside a hole located on the guide bar, then slides forward along the guide ball track. The guide bar is designed to accurately stop the I/R tool the correct distance within the inlet valve in order to evacuate atmospheric pressure before opening the ball valve. Once the ball valve is opened, the I/R tool is slid along the guide bar track all the way into the vacuum manifold.

**Figure 96.** I/R Tool and Guide Bar

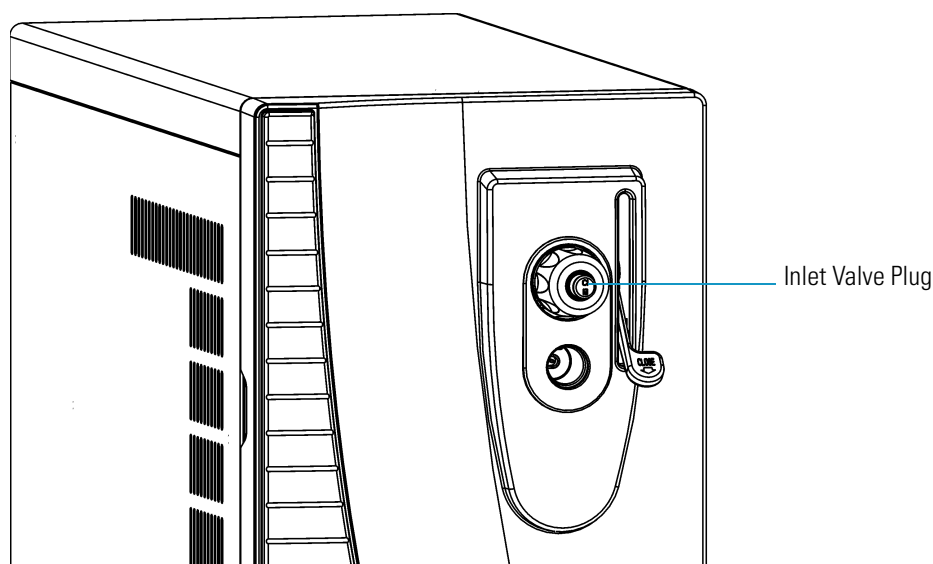


1	Alignment Line	7	Guide Bar Track
2	Hold Position	8	Guide Bar
3	Release Position	9	Guide Bar First Stop
4	I/R Tool	10	Guide Ball Hole
5	Bayonet Lock	11	Guide Ball
6	Guide Bar Second Stop	12	Handle

## Inlet Valve Plug

The inlet valve plug seals the opening of the inlet valve when it is not in use. The inlet valve plug is etched with “EI” on one side and “CI” on the other to remind you whether an EI or CI ion volume is installed.

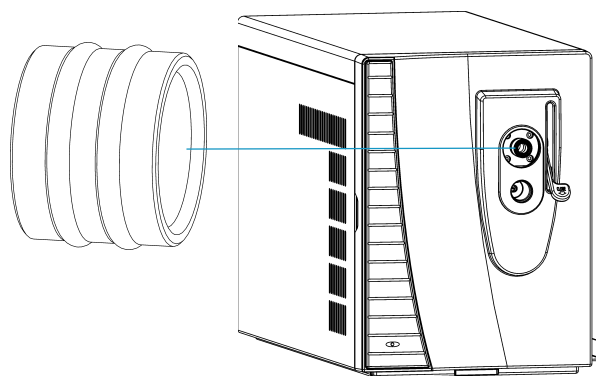
**Figure 97.** Inlet Valve Plug



## Inlet Valve Seal

An inlet valve seal forms a vacuum-tight seal over the shaft of the I/R tool when it is inserted into the inlet valve. The inlet valve knob allows you to tighten the seal against the I/R tool to form a vacuum-tight seal or you can loosen it to allow the I/R tool to be inserted and removed. You should replace the inlet valve seal periodically.

**Figure 98.** Inlet Valve Seal



## **5 Ion Source and Inlet Valve**

Inlet Valve (Upgrade)

## Prefilter and Quadrupole

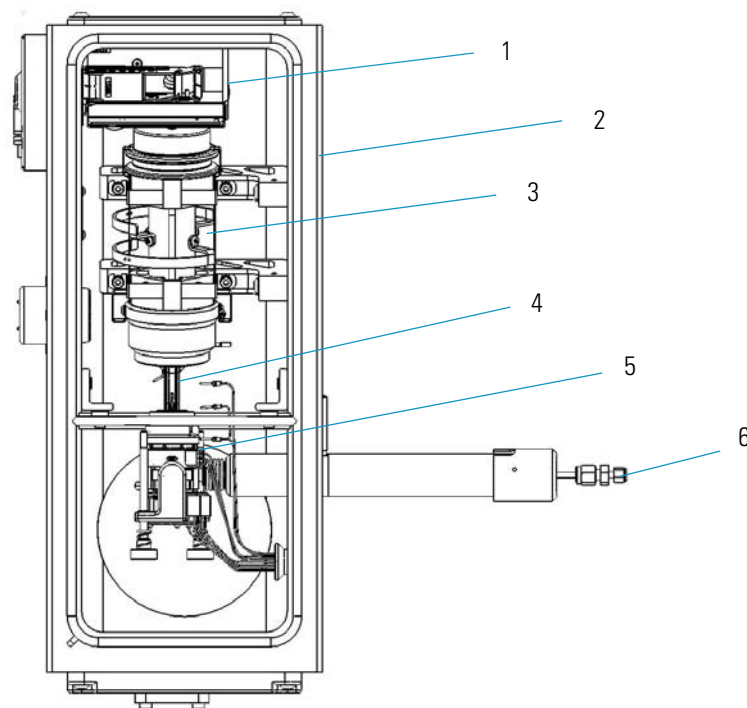
This chapter describes the theory of operations for the prefilter and quadrupole mass filter, which are located inside the vacuum manifold.

The quadrupole consists of the following components:

- Prefilter
- Entrance Lens
- Quadrupole Mass Filter
- Exit Lens

After ions leave the ion source lenses, they pass through the prefilter. The prefilter is mounted to the back side of the baffle wall and consists of four metal rods held in a square array. The prefilter is curved to prevent neutral species (like helium) from reaching the ion detector. Ions next pass through the entrance lens and into the quadrupole mass filter. The quadrupole mass filter, like the prefilter, is composed of four metal rods held in a square array. However, these rods are precision-aligned so the quadrupole should be handled with care. Finally, ions pass through the exit lens and to the ion detector.

The four quadrupole mass filter rods are charged with a combination of radio frequency (RF) and direct current (DC) voltages. The magnitudes of these voltages give stable oscillations to ions with a specific  $m/z$  ratio and unstable oscillations to all others. The unstable ions strike one of the rods, become neutralized, and are pumped away. The quadrupole mass filter behaves as a filter allowing only ions with a certain  $m/z$  ratio to reach the ion detector. As the RF and DC voltages are ramped, ions of different  $m/z$  ratios are transmitted through the exit lens to the ion detector. This produces the mass spectrum.

**Figure 99.** Vacuum Manifold Components

1	Ion Detector	4	Prefilter
2	O-ring	5	Ion Source
3	Quadrupole	6	Transfer Line

The ratio of the RF and DC voltage determines the range of  $m/z$  ions that pass through the quadrupole mass filter at one time. This determines the width of mass peaks and is called resolution. Resolution can be adjusted. Higher resolution produces narrower mass peaks but lower sensitivity.

Ion offset controls the how fast ions fly through the quadrupole mass filter. Lower ion offsets produce better resolution since ions spend a longer time in the quadrupole mass filter. Higher ion offsets often produce higher sensitivity because ions are focused better.

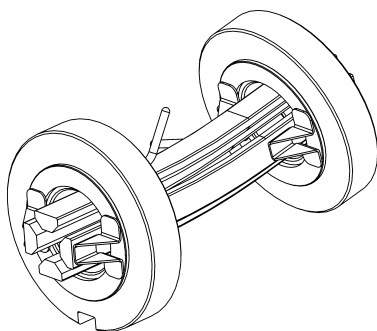
Rod DC (A or B) sets the polarity of the DC that is applied to each pair of quadrupole mass filter rods. The rod DC that works best for your instrument has been selected at the factory. To ensure the best operation, do not change the rod DC setting.

To improve the performance of the quadrupole mass filter a prefilter is used before the quadrupole mass filter. The prefilter also has a combination of RF and DC offset voltages applied to it. The prefilter serves two main purposes. First, the efficiency of the quadrupole mass filter is impaired after a build up of ions impacting on them, so the prefilter removes many of the low  $m/z$  ions that would have otherwise struck the quadrupole mass filter rods. This increases the time needed between routine cleaning of the instrument.

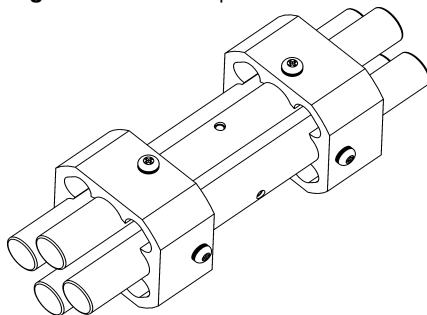


Second, helium atoms (not ions) coming from the ion source cause noise if they reach the exit lens or ion detector. This is known as neutral noise. Helium atoms cannot negotiate the bend in the prefilter. Therefore, the noise is virtually eliminated. This leads to better signal-to-noise ratio and lower limits of detection. In addition, higher GC helium flows can be used without causing excessive amounts of noise that would blind an instrument without a curved prefilter to low-level signals.

**Figure 100.** Prefilter



**Figure 101.** Quadrupole Mass Filter

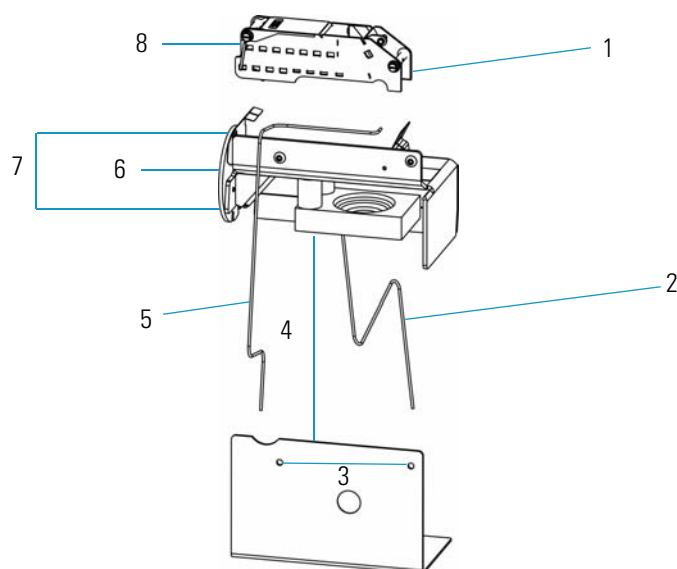




## Ion Detector

This chapter describes the theory of operations for an ion detector, which consists of a conversion dynode and an electron multiplier. The ion detector is mounted inside the vacuum manifold directly behind the quadrupole.

**Figure 102.** ETP Ion Detector



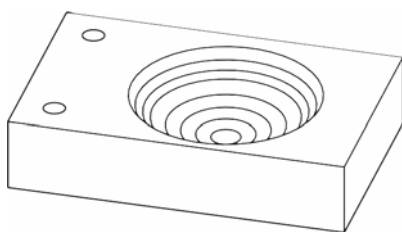
1	Electron Multiplier Cathode	5	Electron Multiplier Connection
2	Conversion Dynode Connection	6	Base
3	Two Screws Around the Shield	7	Two Screws Around the Base,
4	Shield & Conversion Dynode	8	Electron Multiplier Anode

## Conversion Dynode

The conversion dynode is a concave metal surface located at a right angle to the ion beam. A potential of +10 kV for negative ion detection or -10 kV for positive ion detection is applied to the conversion dynode.

The conversion dynode increases signal and decreases noise. 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.

**Figure 103.** ETP Conversion Dynode



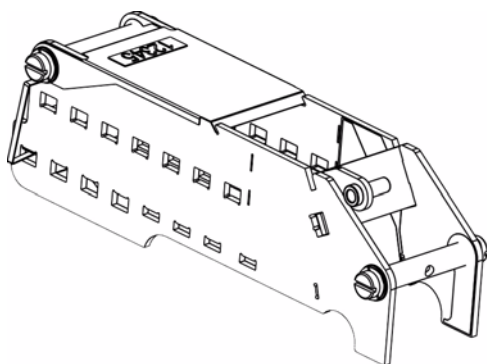
When an ion strikes the surface of the conversion dynode, one or more secondary particles are produced. These secondary particles can include positive ions, negative ions, protons, electrons, and neutrals. When positive ions strike a negatively charged conversion dynode, the secondary particles are negative ions and electrons. When negative ions strike a positively charged conversion dynode, the secondary particles are positive ions and protons. These secondary particles are focused by the curved surface of the conversion dynode and accelerated toward the electron multiplier.

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

## Electron Multiplier

An electron multiplier amplifies a current by generating an electron cascade from an oxide-coated surface of an electrode. The two components of an electron multiplier are the cathode and anode.

**Figure 104.** ETP Electron Multiplier



Cathodes serve as the electrode the electron multiplier uses to generate the electron cascade. It receives a potential of up to -2.5 kV from the high voltage ring. The anode is near ground potential.

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 design of the electron multiplier, the ejected electrons do not travel far before they again strike a surface, causing the emission of more electrons. Thus, a cascade of electrons is created that finally results in a measurable current at the anode. The current collected by the anode is proportional to the number of secondary particles striking the cathode.

Typically, the electron multiplier has a gain of about  $10^5$ . If the current of ions 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 through the anode. This current is converted to a voltage by the electrometer circuit and recorded by the data system.



## Reordering DSQ II Components

This appendix contains DSQ II drawings and part numbers for replaceable parts and consumables.

To ensure proper results in servicing the DSQ II system, order only the parts listed or their equivalent. Contact Technical Support and have your DSQ II serial number ready when calling.

### Contents

- “Vacuum Manifold Parts List” on page 192
- “Ion Source Parts List” on page 194
- “Ion Source Parts List” on page 195
- “Lens Assembly Parts List” on page 197
- “Quadrupole Parts List” on page 198
- “Gas Inlets and Gauges Parts List” on page 199
- “Boards and Cables Parts List” on page 201
- “Turbomolecular Pump Parts List” on page 208
- “Split-Flow Turbomolecular Pump (Upgrade) Parts List” on page 210
- “Inlet Valve (Upgrade) Parts List” on page 212
- “Power Module Parts List” on page 214
- “Installation Kit Parts List” on page 214
- “Documentation Parts List” on page 215
- “Miscellaneous Items Parts List” on page 216

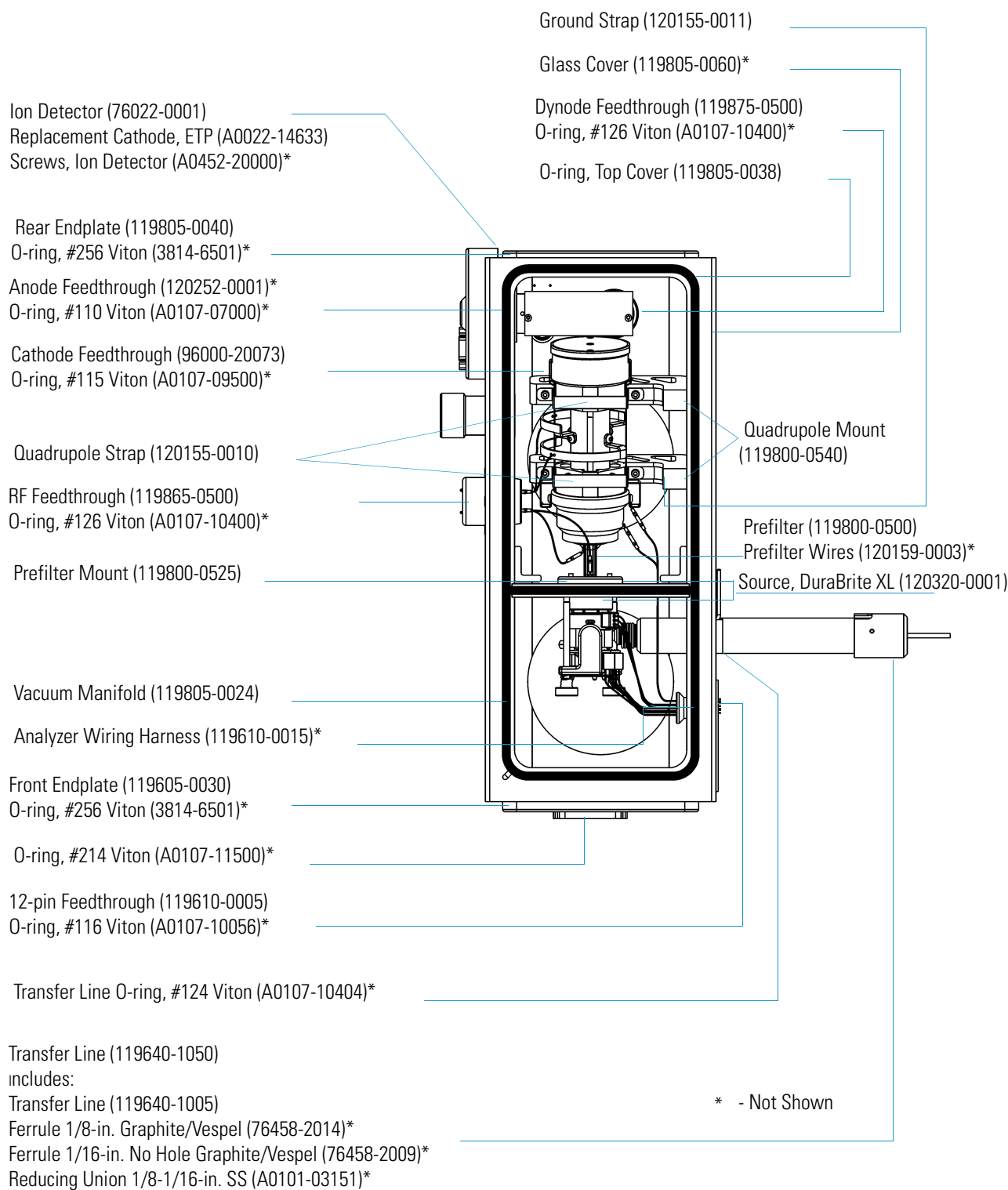
## Vacuum Manifold Parts List

**Table 7.** Vacuum Manifold Parts List

Component	Part Number
12-Pin Feedthrough	119610-0005
Analyzer Wiring Harness	119610-0015
Anode Feedthrough	120252-0001
Baffle Wall, Differential Pump	119805-0026
Baffle Wall, Single Pump	119805-0025
Cathode Feedthrough	96000-20073
Dynode Feedthrough	119875-0500
Electron Multiplier, Replacement, ETP	A0022-14633
ETP, Ion Detector, with leads	76022-0001
Glass Cover	119805-0060
O-ring, Top Cover	119805-0038
Prefilter	119800-0500
Prefilter Mount	119800-0525
Prefilter Wires	120159-0003
Quadrupole Mount	119800-0540
Quadrupole Strap	120155-0010
RF Feedthrough	119865-0500
Source, DSQ II Durabrite XL	120320-0001
Transfer Line	119640-1050
Vent Valve Solenoid	76461-1003



**Figure 105.** Vacuum Manifold Components

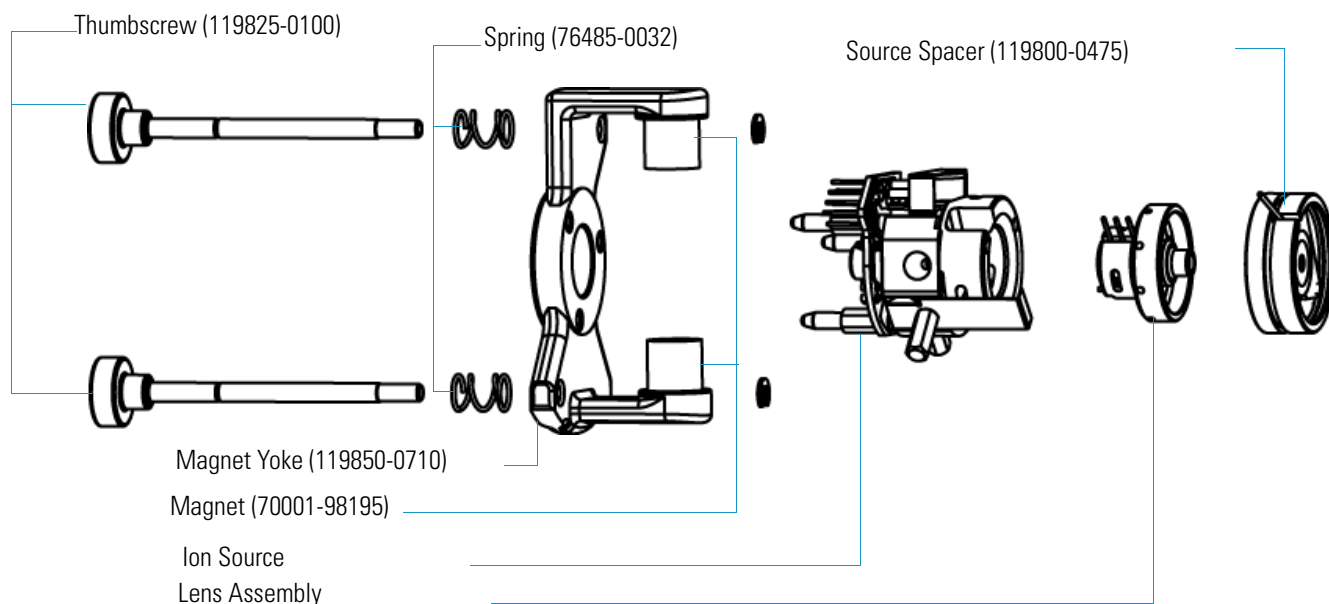


## Ion Source Parts List

**Table 8.** Ion Source Parts List

Component	Part Number
Ion Source includes:	120320-0001
• Ion Source	120320-0101
• Lens Alignment Tool	120271-0001
• Lens Assembly	119650-0151
• Magnet	70001-98195
• Magnet Yoke	119850-0710
• Source Spacer	119800-0475
• Spring	76485-0032
• Thumbscrew	119825-0100

**Figure 106.** Ion Source Components

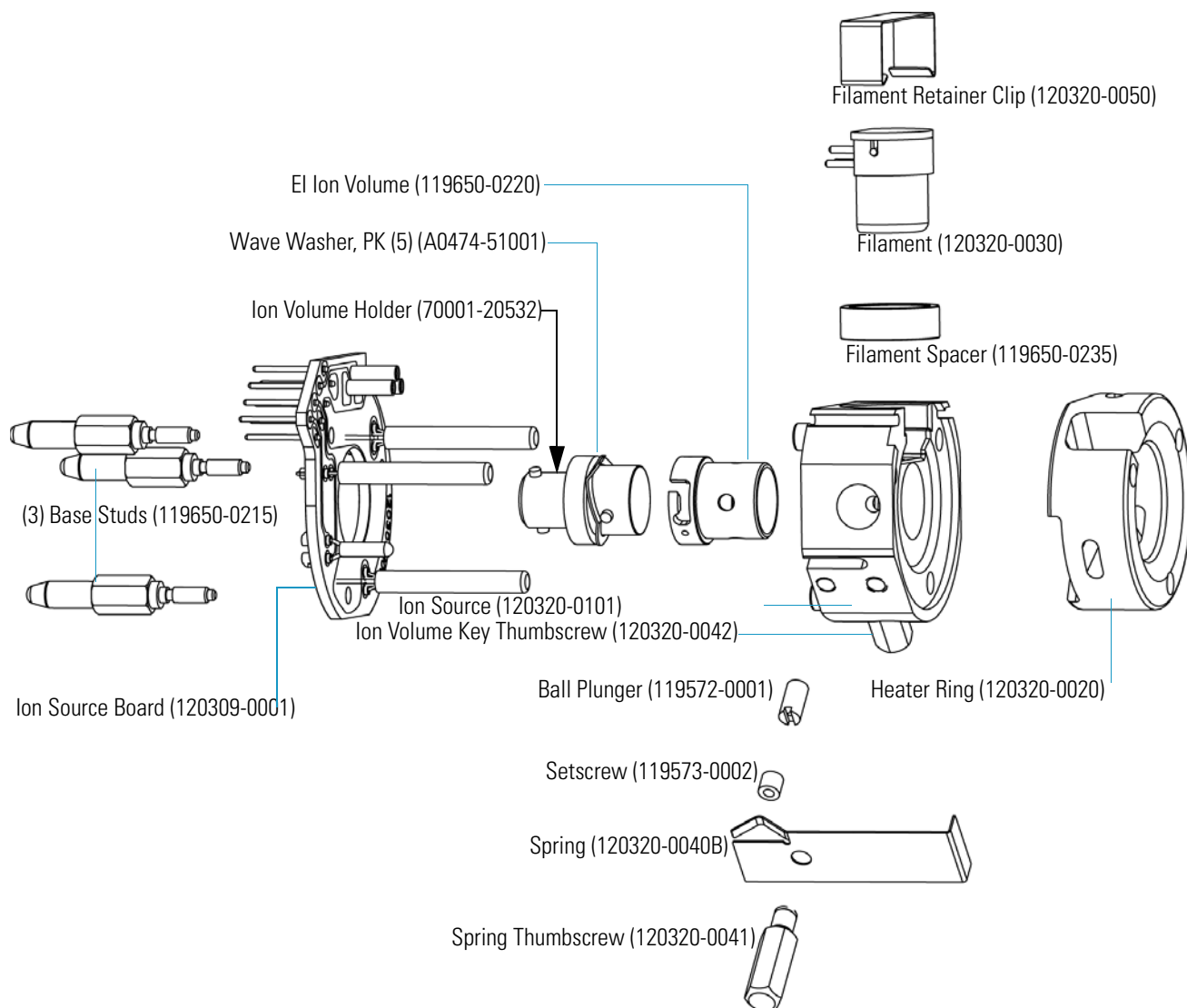


## Ion Source Parts List

**Table 9.** Ion Source Parts List

Component	Part Number
Base Stud	119650-0215
Ball Plunger	119572-0001
Filament	120320-0030
Filament Retainer Clip	120320-0050
Filament Spacer	119650-0235
Heater Ring	120320-0020
Ion Source	120320-0101
Ion Source Board	120309-0001
Ion Volume, CI	119650-0230
Ion Volume, EI	119650-0220
Ion Volume, EI/CI Combo	119650-0240
Ion Volume, CEI	119650-0221-T
Ion Volume Holder, CEI	70001-20532-T
Ion Volume Key Thumbscrew	120320-0042
Ion Volume Holder	70001-20532
Ion Volume Holder for Probes	119324-0001
Setscrew	119573-0002
Spring	120320-0040B
Spring Thumbscrew	120320-0041
Wave Washer, Ion Volume Holder (5)	A0474-51001

**Figure 107.** Ion Source Components

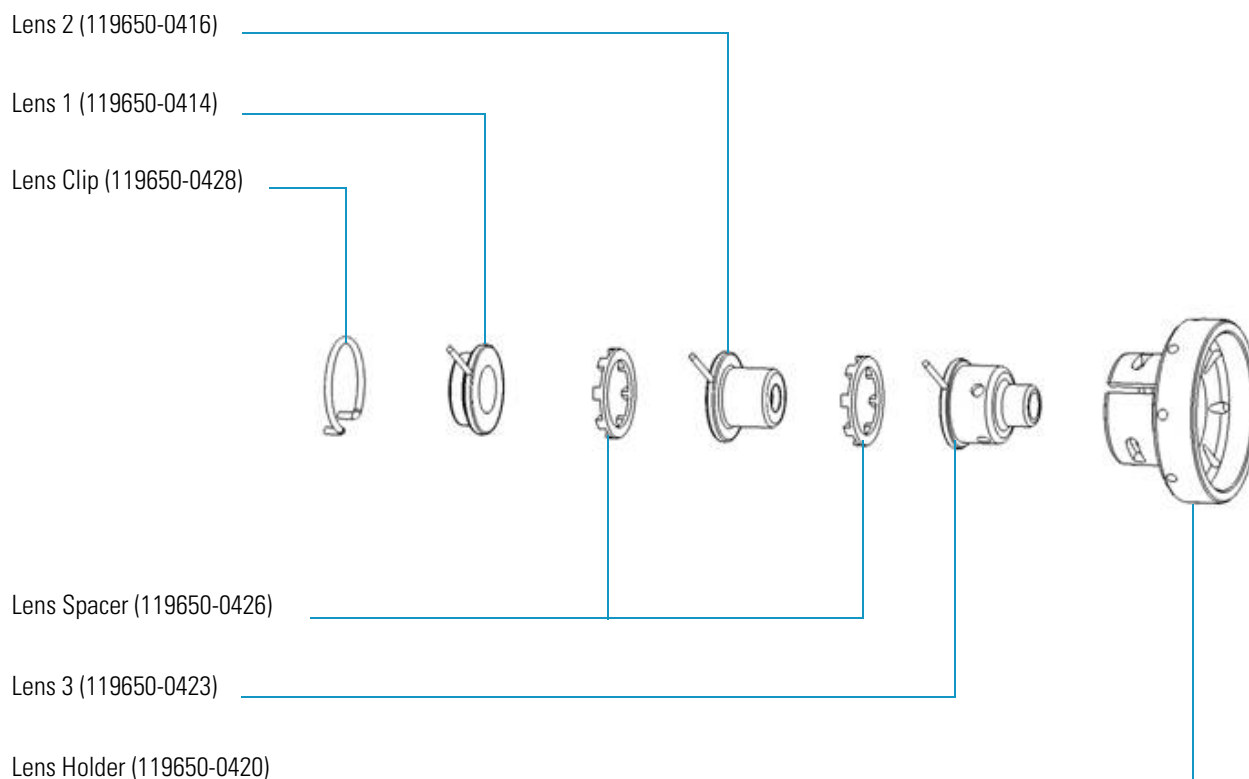


# Lens Assembly Parts List

**Table 10.** Lens Assembly Parts List

Component	Part Number
Lens 1	119650-0414
Lens 2	119650-0416
Lens 3	119650-0423
Lens Clip	119650-0428
Lens Holder	119650-0420
Lens Spacer	119650-0426

**Figure 108.** Lens Assembly Components

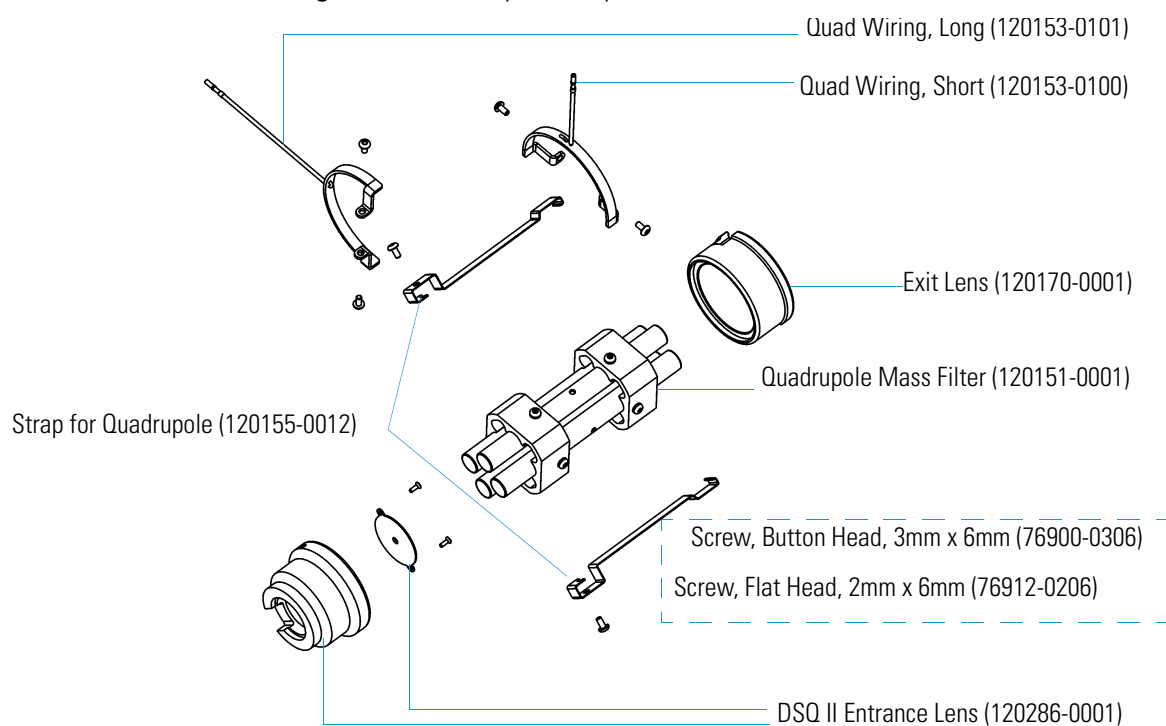


## Quadrupole Parts List

**Table 11.** Quadrupole Parts List

Component	Part Number
Quadrupole includes:	120151-0100
Entrance Lens	120286-0001
Exit Lens	120170-0001
Quad Wiring, Long	120153-0101
Quad Wiring, Short	120153-0100
Quadrupole Mass Filter	120151-0001
Strap for Quadrupole	120155-0012

**Figure 109.** Quadrupole Components

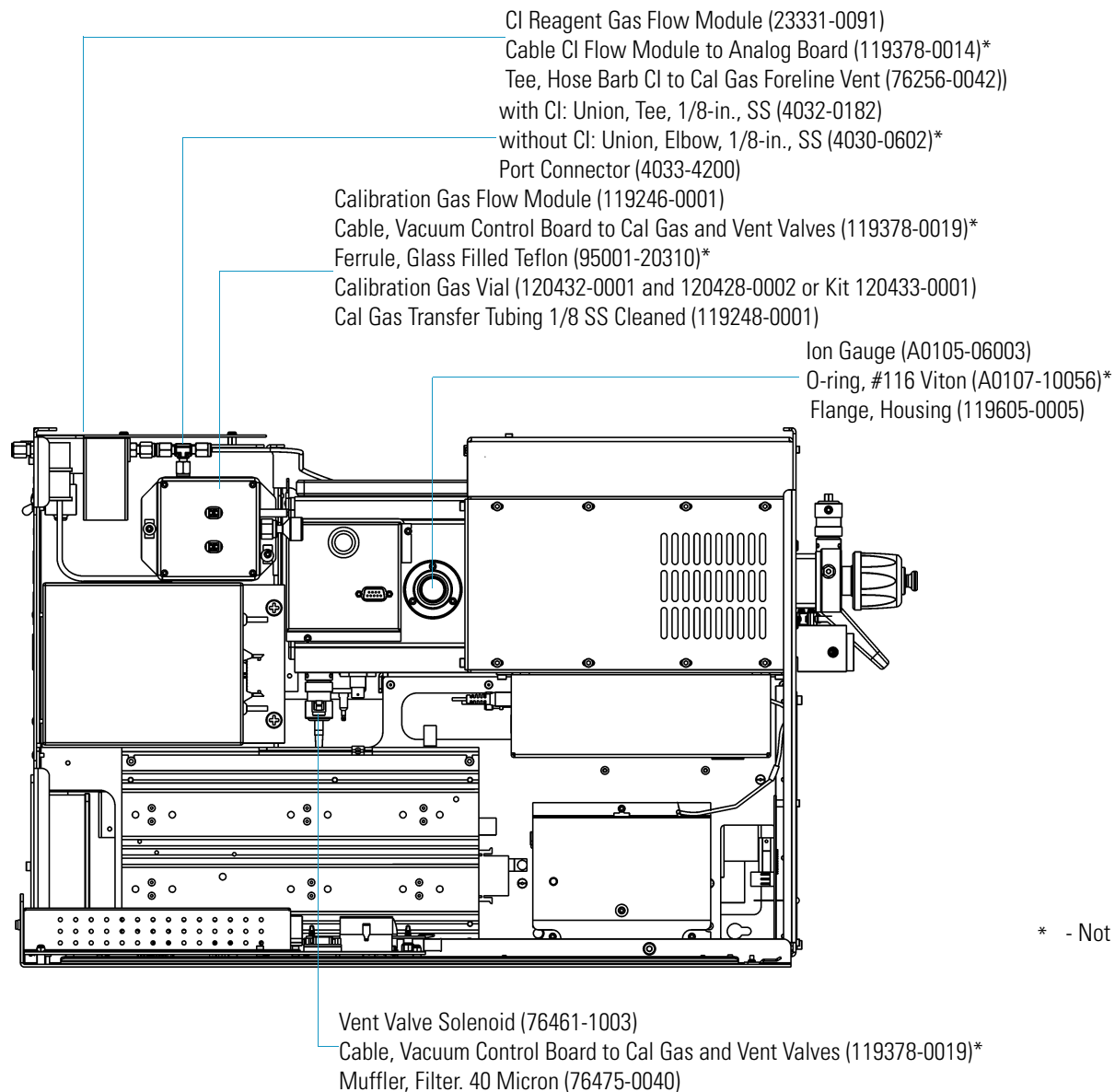


## Gas Inlets and Gauges Parts List

**Table 12.** Gas Inlets and Gauges Parts List

Component	Part Number
Cable, CI Flow Module to Analog Board	119378-0014
Cable, Vacuum Control Board to Calibration Gas and Vent Valves	119378-0019
Calibration Gas Flow Module	119246-0001
Calibration Gas Tubing, Cleaned	119248-0001
Calibration Gas Vial Kit, includes 120432-0001 and 120432-0002	120433-0001
CI Reagent Gas Flow Module	23331-0091
Ferrule, Glass Filled Teflon	95001-20310
Ion Gauge Flange	119605-0005
Ion Gauge Tube, Replacement	A0105-06003
Muffler/Filter 40 Micron	76475-0040
O-ring, # 116 Viton	A0107-10056
Port Connector, CI Gas Module	4033-4200
Tee, Hose Barb - CI Vent to Foreline	76256-0042
Union, Elbow, 1/8-in., SS (Without CI)	4030-0602
Union, Tee, 1/8-in., SS (With CI)	4032-0182
Vent Valve Solenoid	76461-1003

**Figure 110.** Gas Inlets and Gauges Components



\* - Not Shown



## Boards and Cables Parts List

**Table 13.** Boards and Cables Parts List (Left Side)

Component	Part Number
Analog Board	119590-0022
Cable, Analog Board to Low Pass Filter Board	119378-0039
Cable, Ground Strap	119378-0030
Cable, Main System Power	119378-0001
Cable, Ribbon, Analog Board to Multiplier/Dynode Power Supply	119378-0009
Digital Board	119590-0010
Dynode/Multiplier Power Supply	119377-0001
PPINICI Dynode/Multiplier Power Supply	119377-0002
RF Generator Board	119590-0060
Spacer, Analog Board	76350-0056
Spacer, Digital to Analog Board	119567-0001

**Figure 111.** Boards and Components (Left Side)

Cable, Ribbon, Analog Board to Dynode/Multiplier Power Supply (119378-0009)\*

Cable, Ground Strap (119378-0030)

Dynode/Multiplier Power Supply (119377-0001)

PPINICI Dynode/Multiplier Power Supply (119377-0002)

RF Generator Board (119590-0060)

Digital Board (119590-0010)\*

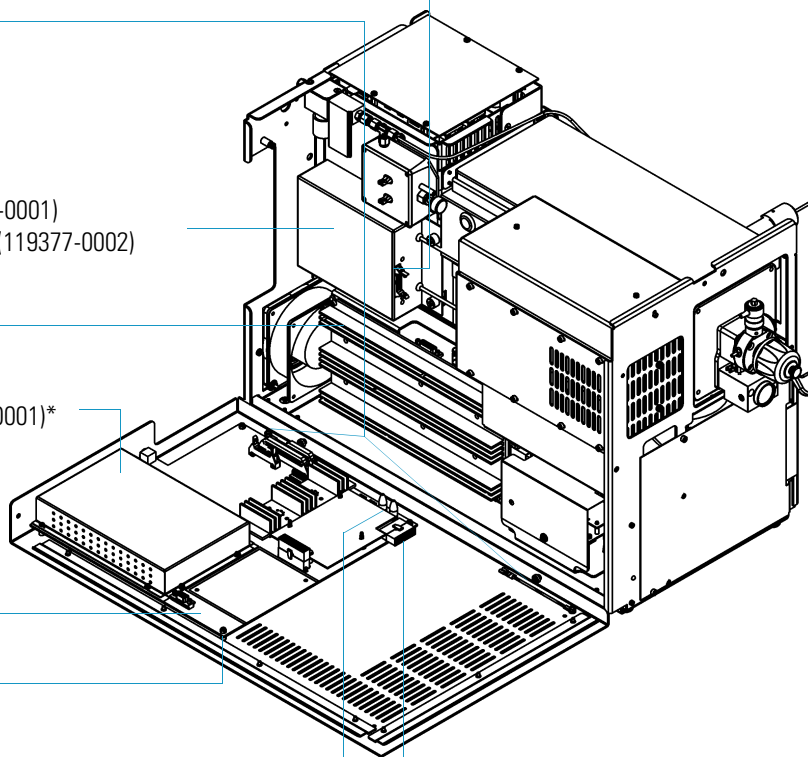
Spacer, Digital to Analog Board (119567-0001)\*

Analog Board (119590-0022)

Spacer, Analog Board (76350-0056)

Cable, Analog Board to Low Pass Filter Board (119378-0039)\*

Cable, Main System Power (119378-0001)

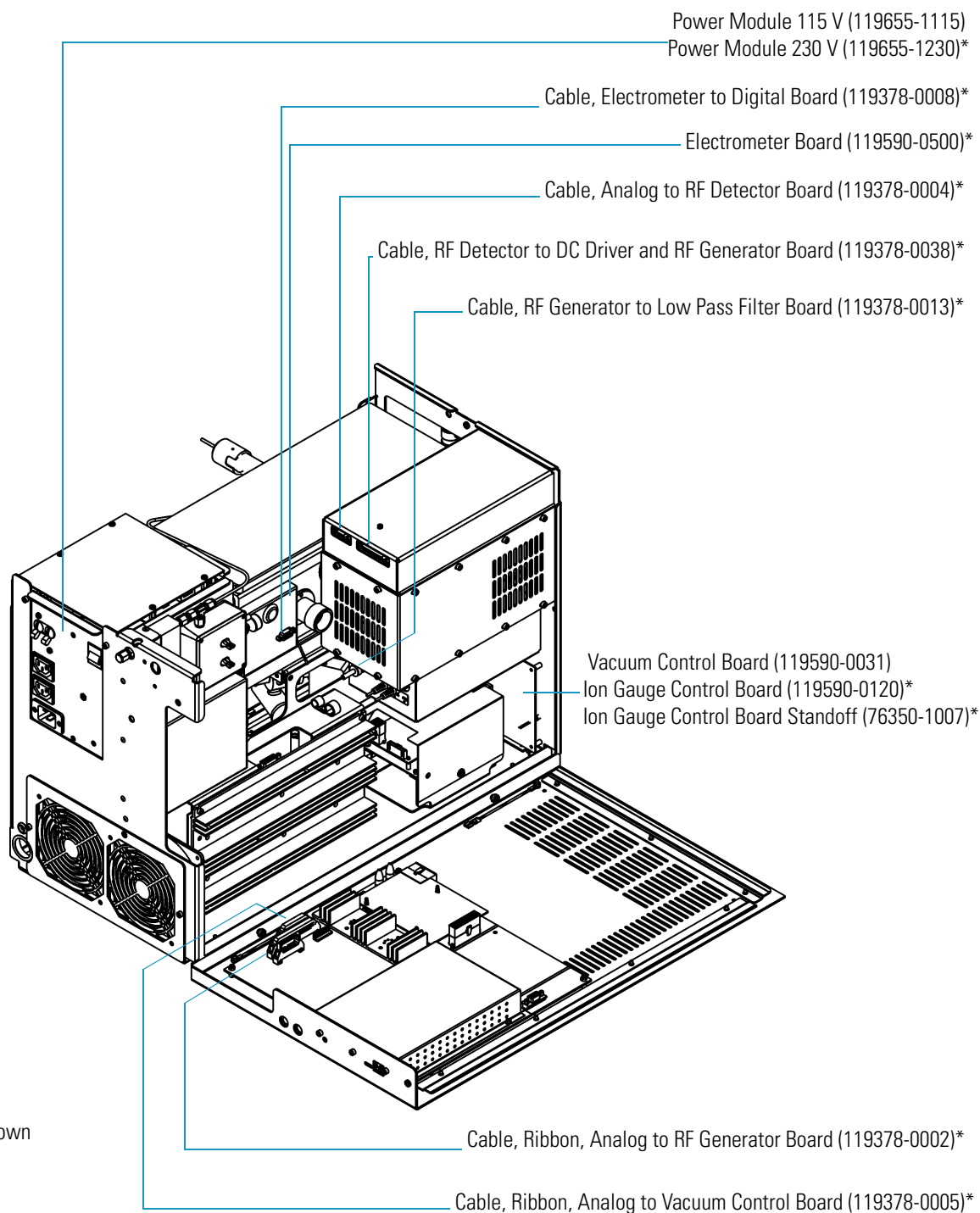


\* - Not Shown

**Table 14.** Boards and Cable Parts List (Left Side)

Component	Part Number
Cable, Analog to RF Detector Board	119378-0004
Cable, Coax, RF Generator to Low Pass Filter Board	119378-0013
Cable, Electrometer to Digital Board	119378-0008
Cable, RF Detector to DC Driver and RF Generator Board	119378-0038
Cable, Ribbon, Analog to RF Generator Board	119378-0002
Cable, Ribbon, Analog to Vacuum Control Board	119378-0005
Electrometer Board	119590-0500
Ion Gauge Control Board	119590-0120
Ion Gauge Control Board Standoff	76350-1007
Power Module 115 V	119655-1115
Power Module 230 V	119655-1230
Vacuum Control Board	119590-0031

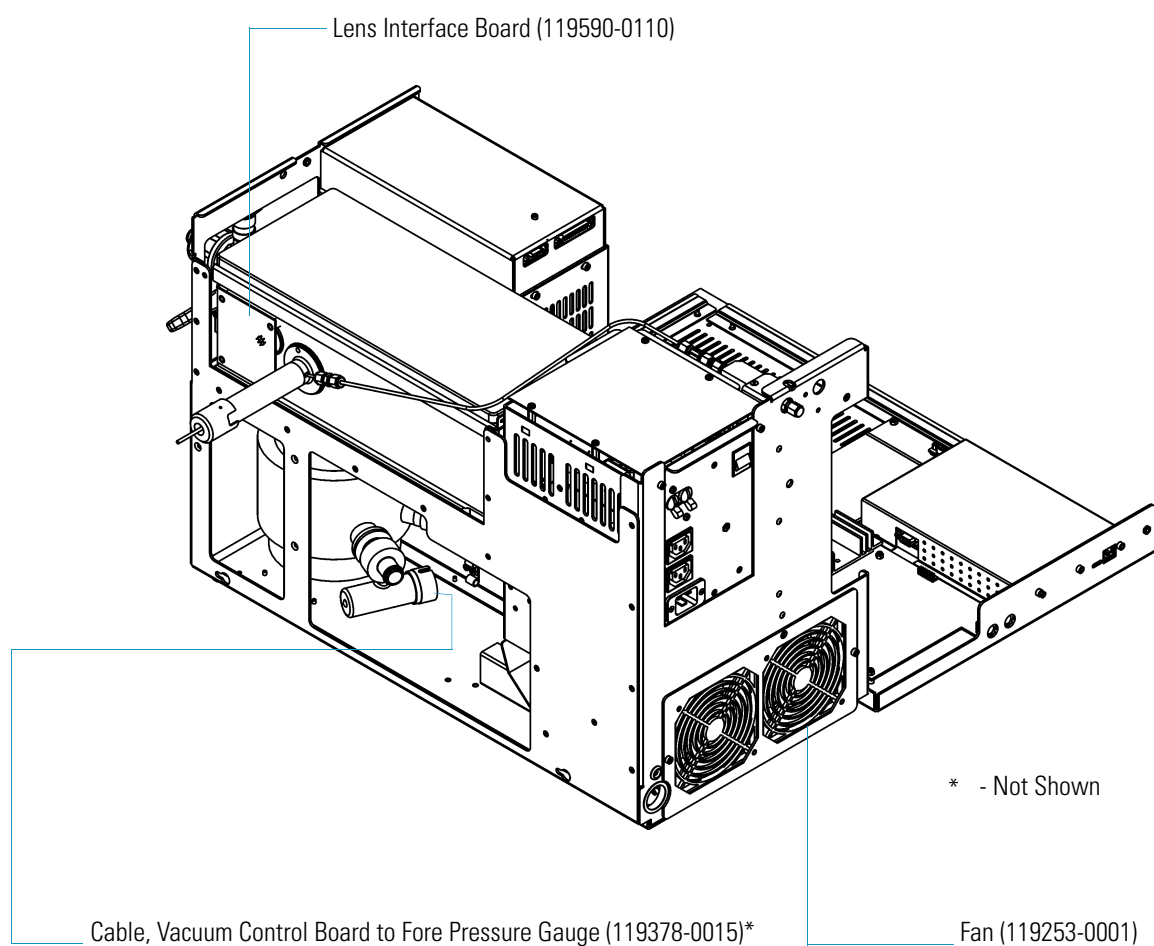
**Figure 112. Boards and Components (Left Side)**



**Table 15.** Boards and Cable Parts List (Right Side)

Component	Part Number
Cable, Vacuum Control Board to Fore Pressure Gauge	119378-0015
Fan	119253-0001
Lens Interface Board	119590-0110

**Figure 113.** Boards and Components (Right Side)



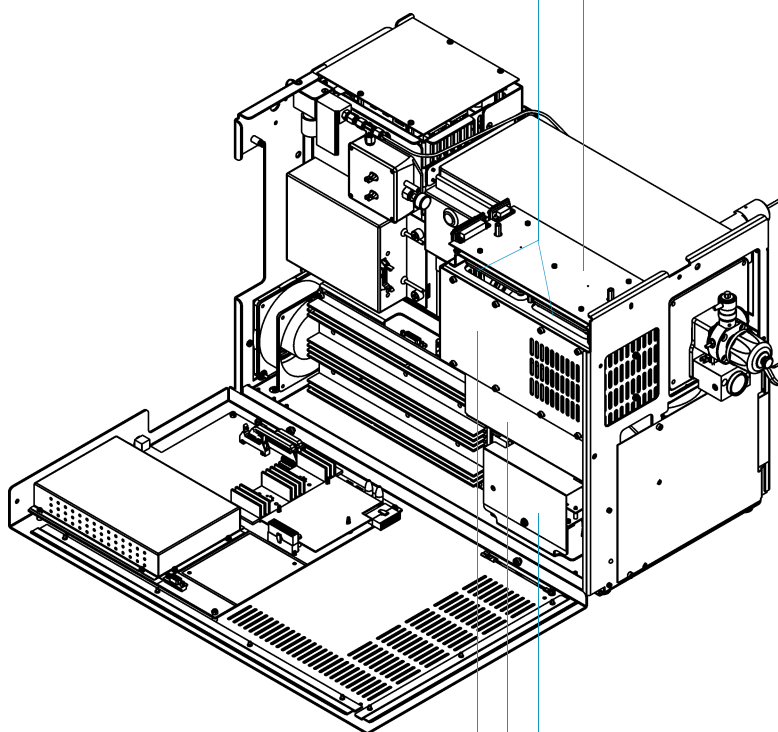
**Table 16.** Boards and Cable Parts List (Under the RF Detector Cover)

Description	Part Number
Cable, Analog Board to DC Driver	119378-0037
Cable, DC Driver to Low Pass Filter Board	119378-0036
Cable, RF Coil to Low Pass Filter Board	119378-0040
DC Driver	120152-1000
Low Pass Filter Board	119590-0480
RF Detector Board	119590-0270
RF Capacitor	119669-0250
RF Coil	119668-1000

**Figure 114.** Boards and Components

RF Detector Board (119590-0270)

RF Capacitor (119669-0250)



RF Coil (119668-1000)\*

Cable, RF Coil to Low Pass Filter Board (119378-0040)\*

Low Pass Filter Board (119590-0480)\*

DC Driver (120152-1000)

Cable, Analog Board to DC Driver (119378-0037)\*

Cable, DC Driver to Low Pass Filter Board (119378-0036)\*

## Turbomolecular Pump Parts List

**Table 17.** Turbomolecular Pump Parts List

Component	Part Number
Cable, Turbomolecular Pump Power Supply to Main Power	119378-0042
Cable, Turbomolecular Pump Power Supply to Vacuum Control Board	119378-0041
Clamp Nut, NW16	76505-1013
Clamp Nut, NW25	76505-2002
Foreline Adapter (70 L/s Turbo Pump) includes:	119259-0003
• Fore Pressure Gauge	A0105-00501
Foreline Adapter (250 L/s Turbo Pump) includes:	119259-0002
• Fore Pressure Gauge	A0105-00501
Foreline Hose	76505-0003
Oil, Rotary-Vane Pump, 1 L	A0301-15101
O-ring, w/centering ring, NW16	76505-0005
O-ring, w/centering ring, NW25	76505-2001
Rotary-Vane Pump	76505-3007
Turbomolecular Pump, 70 L/s	76505-3006
Turbomolecular Pump, 250 L/s	119268-0001
Turbomolecular Pump Controller	76505-3005
Turbomolecular Pump Power Supply	76330-0230
Turbomolecular Pump Power Supply Assembly	119254-1000
<b>Includes:</b>	
• Cable, Turbo Power Supply to Main Power	119378-0042
• Cable, Turbo Power Supply to Vacuum Control Board	119378-0041



**Figure 115. Turbomolecular Pump Components**

Turbomolecular Pump Controller (76505-3005)

250 L/s Turbomolecular Pump

Clamp, NW25 (76505-2002)\*

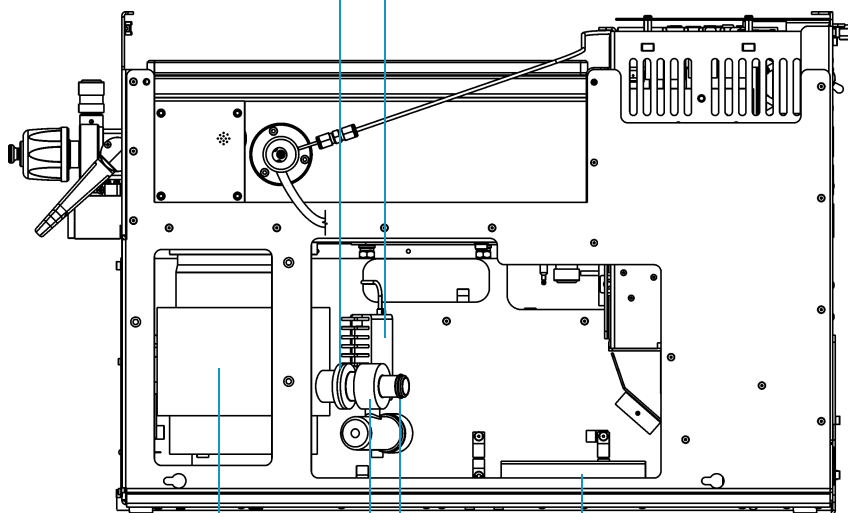
O-ring, w/Centering Ring, NW25 (76505-2001)\*

70 L/s Turbomolecular Pump

Clamp, NW16 (76505-1013)\*

O-ring, w/Centering Ring, NW16 (76505-0005)\*

Rotary-vane Pump (76505-3007)\*



Turbomolecular Pump, 250 L/s (119268-0001)

Turbomolecular Pump, 70 L/s (76505-3006)\*

250 L/s Turbomolecular Pump

Foreline Adapter (119259-0002)\*

includes:

Fore Pressure Gauge (A0105-00501)

70 L/s Turbomolecular Pump

Foreline Adapter (119259-0003)\*

includes:

Fore Pressure Gauge (A0105-00501)

Foreline Hose (76505-0003)\*

- \*Not Shown

Turbomolecular Pump Power Supply (76330-0230)

Cable, Turbomolecular Pump Power Supply to Main Power (119378-0042)

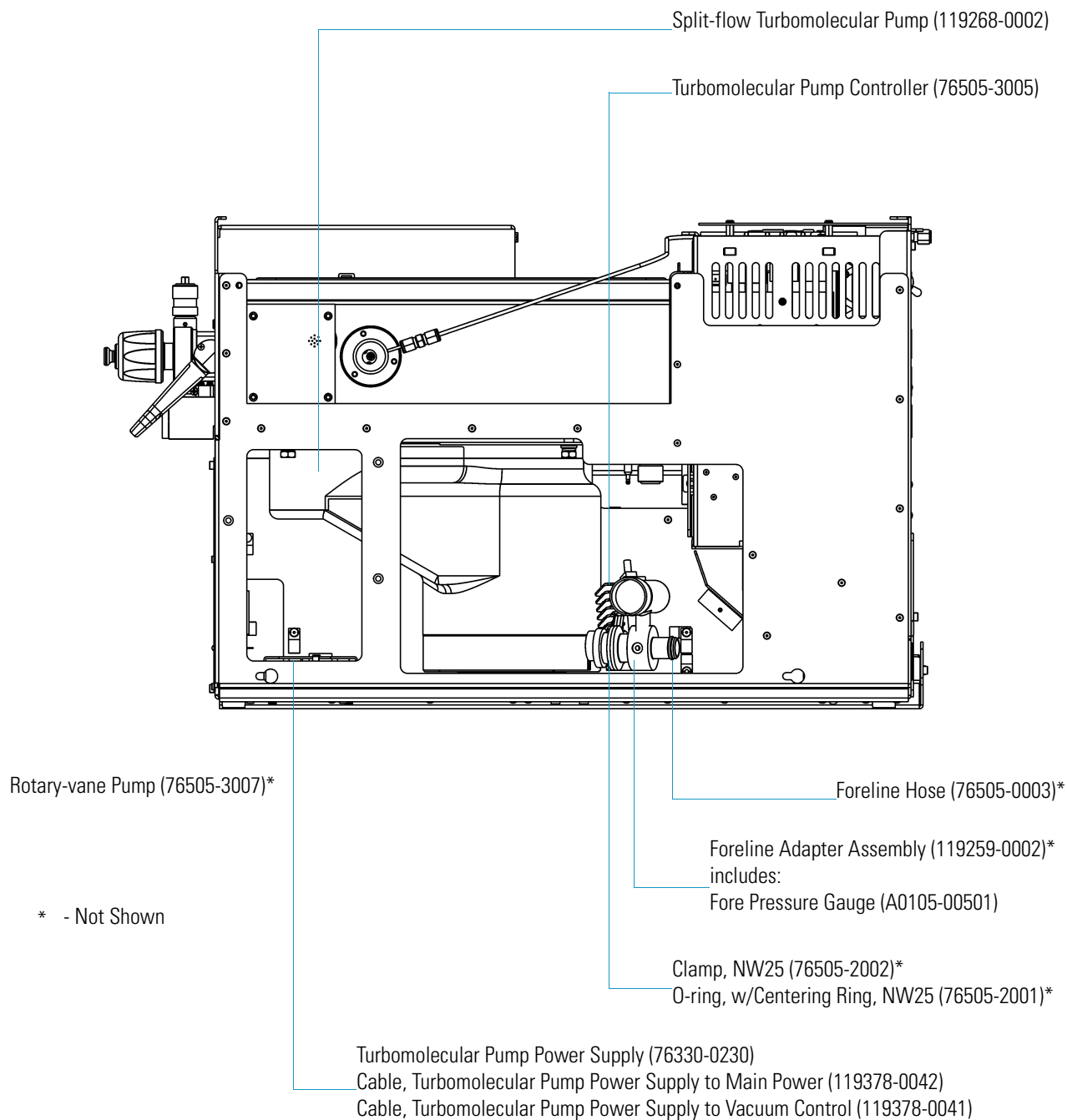
Cable, Turbomolecular Pump Power Supply to Vacuum Control (119378-0041)

## Split-Flow Turbomolecular Pump (Upgrade) Parts List

**Table 18.** Split-Flow Turbomolecular Pump Parts List

Component	Part Number
Foreline Adapter Assembly includes:	119259-0002
Fore Pressure Gauge	A0105-00501
Cable, Turbomolecular Pump Power Supply to Main Power	119378-0042
Cable, Turbomolecular Pump Power Supply to Vacuum Control Board	119378-0041
Clamp, 250 L/s Turbo Pump, NW25	76505-2002
Foreline Hose	76505-0003
O-ring, w/centering ring, NW25	76505-2001
Oil, Rotary-Vane Pump, 1 L	A0301-15101
Rotary-Vane Pump	76505-3007
Split-Flow Turbomolecular Pump	119268-0002
Turbomolecular Pump Controller	76505-3005
Turbomolecular Pump Power Supply	76330-0230
Turbomolecular Pump Power Supply Assembly	119254-1000
Includes:	
Cable, Turbo Power Supply to Main Power 119378-0042	
Cable, Turbo Power Supply to Vacuum Control Board 119378-0041	

**Figure 116.** Split-Flow Turbomolecular Pump Components

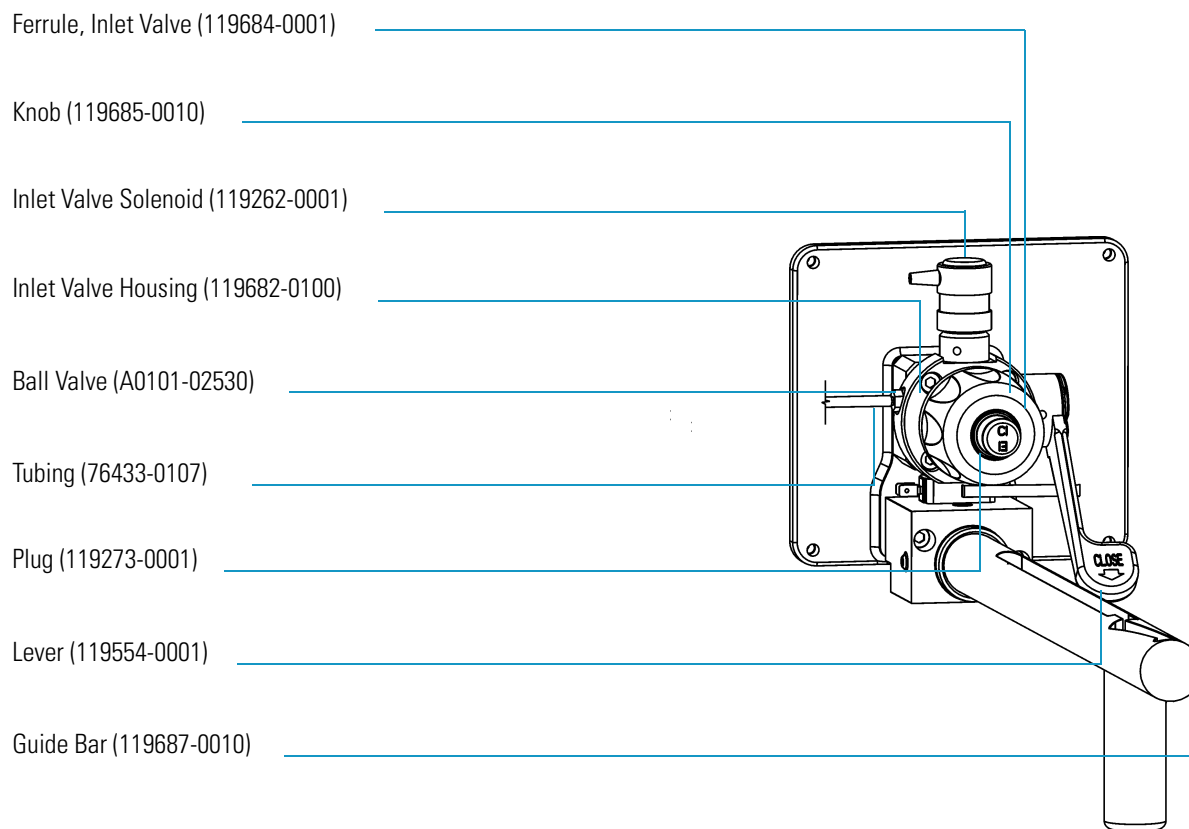


## Inlet Valve (Upgrade) Parts List

**Table 19.** Inlet Valve Parts List

Component	Part Number
Ball Valve	A0101-02530
Ball Valve Seal Replacement Kit	76461-2002
Ball Valve Stem Bearing Kit	76461-2003
Ferrule, Inlet Valve	119684-0001
Guide Bar	119687-0010
I/R Tool	96000-60057
Inlet Valve Housing	119682-0100
Inlet Valve Seal Replacement Kit	119265-0003
Inlet Valve Solenoid	119262-0001
Knob	119685-0010
Lever	119554-0001
Plug	119273-0001
Tubing	76433-0107

**Figure 117.** Inlet Valve Components



## Power Module Parts List

**Table 20.** Power Module Parts List

Component	Part Number
Power Module	
• 115 V	119655-1115
• 230 V	119655-1230
Circuit Breaker, 15 A, 115 V	A0019-00520
Circuit Breaker, 10 A, 230 V	A0019-00505
Fuse, 3.15 A SB, 5x20 mm, 250 V (F1, F2)	A0006-10510
HV Regulator Board	119590-0050
Line Filter	A0007-18349
Power Cord, 115 V (NEMA 5-20P plug)	96000-98034
Power Cord, 230 V (no plug)	96000-98036
Power Supply 1 (+5, $\pm 15$ , +24 V)	76330-0225
Power Supply 2 (+36, -28 V)	76330-0226
Power Supply 3 (+5, $\pm 12$ V)	76330-0080
Transformer	119376-0002

## Installation Kit Parts List

**Table 21.** Installation Kit Parts List

Component	Part Number
Kit, includes:	119255-0003
• Allen Wrench Kit, Metric	3812-0100
• Aluminum Oxide	32000-60340
• Back Ferrule, 1/8-in., Brass	A0101-02500
• Cable, PC to Instrument (15 ft Ethernet crossover)	76396-0052
• Cable Tie, 7-in	A0007-90500
• Calibration Compound	50010-30059
• CD ROM GCMS Manuals & Methods	120315-CDMans
• Column Measuring Tool	119640-0550
• Copper Tubing, Precleaned, 25 ft	76381-0041
• Cotton Tipped Applicators (1 pack)	A0301-02000

**Table 21.** Installation Kit Parts List, continued

• Filament Assembly	120320-0030
• Forceps	76360-0400
• Front Ferrule, 1/8-in., Brass	A0101-08500
• Fuse, 0.315 A SB	A0006-04550
• Fuse, 0.5 A	A0006-07608
• Fuse, 0.8 A SB	A0006-06075
• Fuse, 1.0 A	A0006-07610
• Fuse, 2A Microfuse	76339-0008
• Fuse, 3.15A SB	A0006-10510
• Gloves, Nitrile, Large	23827-0009
• Gloves, Nitrile, Medium	23827-0008
• Ion Volume Tool	119270-0001
• Lens Alignment Tool	120271-0001
• Nut, 1/8-in., Brass	A0101-15500
• Oxygen, Hydrocarbon, Moisture Trap (replacement for use with a quick change base)	A0950-R1600
• Oxygen, Hydrocarbon, Moisture Trap (with quick change base)	A0950-01600
• DSQ II User's Guide	120299-0003
• Syringe, 10 µL with 70 mm Needle	36500103
• Test Mix, octafluoronaphthalene, benzophenone	120150-TEST
• Transfer Line Ferrule, 1/16-in. to 0.4 mm, Graphite/Vespel	A0101-18100
• Union, Tee, 1/8-in., Brass	4032-0082

## Documentation Parts List

**Table 22.** Documentation Parts List

Component	Part Number
DSQ II Preinstallation Guide	120299-0001
DSQ II Hardware Manual	120299-0002
DSQ II User's Guide	120299-0003

## Miscellaneous Items Parts List

**Table 23.** Miscellaneous Items Parts List

Component	Part Number
Cable, TRACE GC Ultra to PC	230 980 00
Cable, TRACE GC Ultra to DSQ II Remote Start	76396-0050
Capillary Column, 5MS, 0.25 mm i.d., 15 m, 0.25 $\mu$ m	76317-3015
Injector Ferrule, for 0.25 mm i.d. Column	290 134 88
Syringe, 10 $\mu$ L with 70 mm Needle	365 001 03
Transfer Line Ferrule, 1/16-in. to 0.4 mm, Graphite/Vespel	A0101-18100



## Functional Block Diagrams

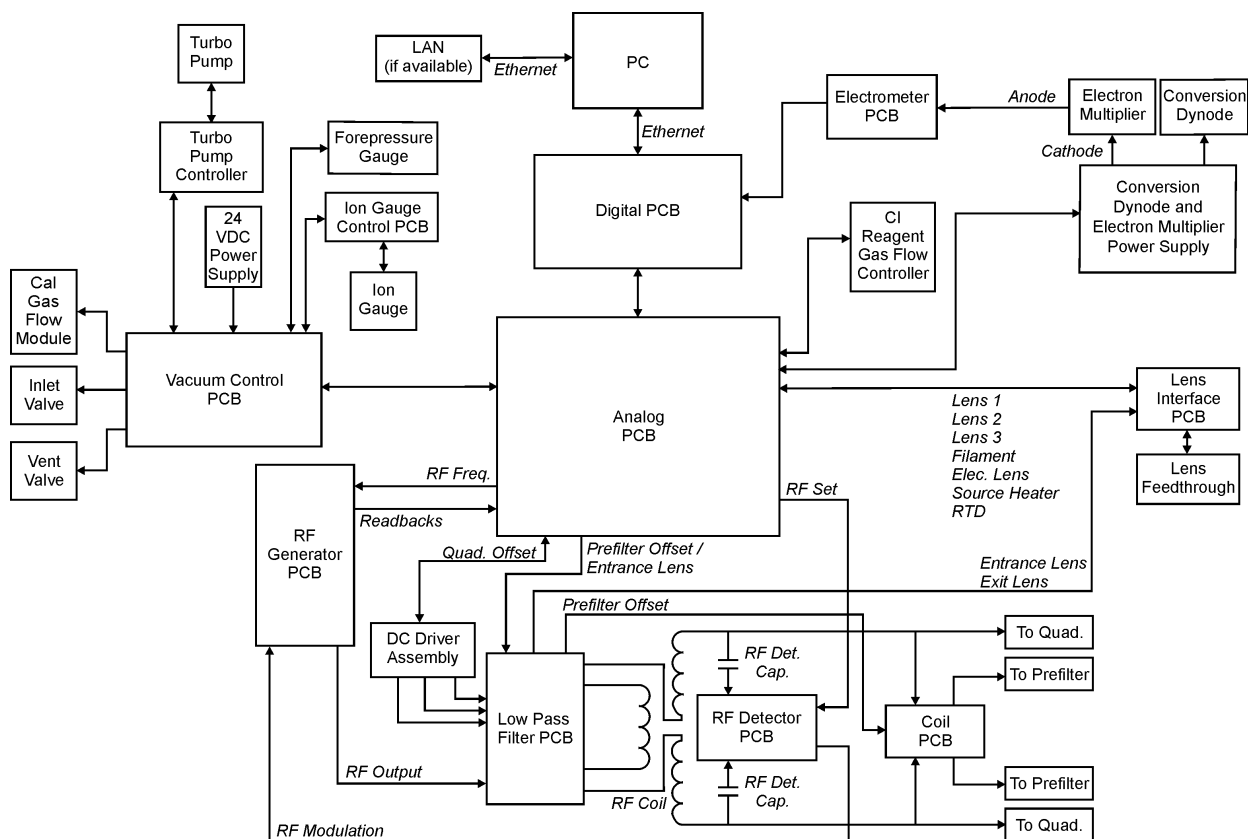
This appendix contains functional block diagrams for the DSQ II system and its subsystems.

### Contents

- [Electronic Assemblies p. 218](#)
- [Power Distribution p. 219](#)
- [Remote Start Cable Connections p. 220](#)

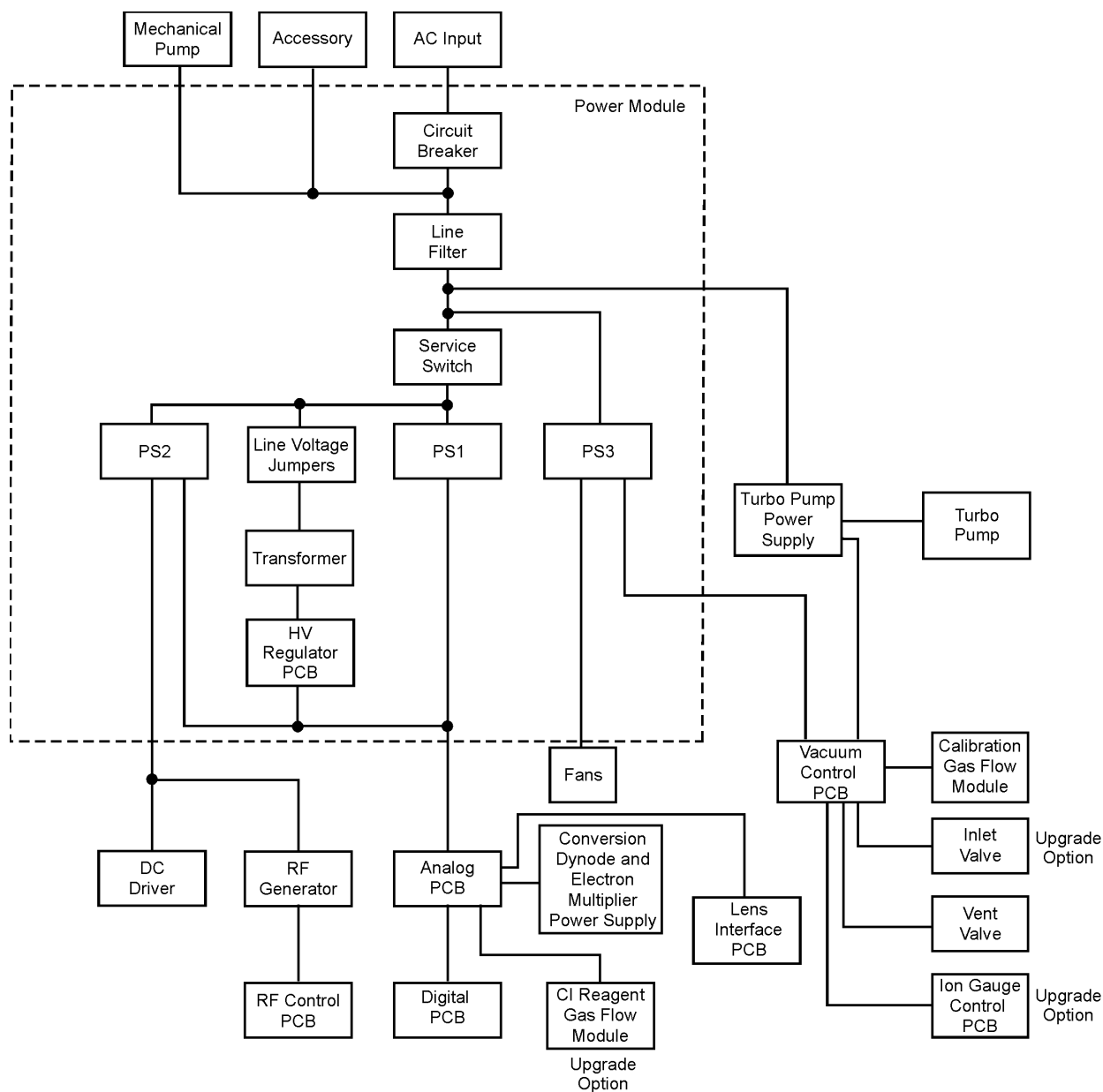
## Electronic Assemblies

**Figure 118.** Electronic Assemblies



# Power Distribution

**Figure 119.** Power Distribution

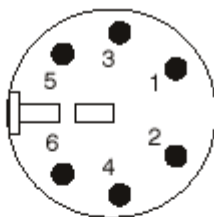


## Remote Start Cable Connections

The DSQ II offers two connections to start remote injections; Accessory Start and GC Start. Use these connections to determine which connection to plug the remote start cable into. Plug one end of the remote start cable into the back of the DSQ II and the other end into the device you intend to use to start injections.

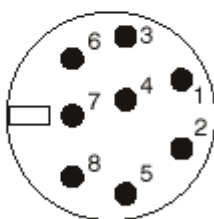
**Figure 120.** Remote Start Cable Connections (Back)

### Accessory Start



Trigger Bit 0 *	1
Trigger Bit 1 *	2
Trigger Bit 2 *	3
Trigger Bit GND **	4
Remote Start In ***	5
GND	6

### GC Start



N/C (Not Connected)	1
Inhibit Ready Out with High Signal	2
GND	3
Remote Start In ***	4
N/C	5
N/C	6
N/C	7
Inhibit Ready Out with Low Signal	8

\* For electromagnetic compatibility, use a shielded cable. Tie the shield to the connector's metal can.

\*\* Use only with trigger bits (pins 1-3).

\*\*\* Polarity set in instrument configuration. Default is start when signal is low.

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