Agilent 7000 Triple Quadrupole GC/MS System

Troubleshooting and Maintenance Manual

APEX SCIENTIFIC
sales@apexscientific.ie
tel. 01 6854686

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Manual Part Number

G7000-90037

Edition

Second edition, September 2009

Printed in USA

Agilent Technologies, Inc.
5301 Stevens Creek Boulevard
Santa Clara, CA 95051

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Safety Notices

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

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This manual describes the troubleshooting and maintenance of the Agilent Technologies 7000 Triple Quadrupole Mass Spectrometer (MS) system. It is often referred to in this document as the 7000 Triple Quad GC/MS. This manual assumes familiarity with the procedures and information detailed in the *Agilent 7000 Series Triple Quad GC/MS Operation Manual* and with the Agilent MassHunter Workstation software.

The 7000 Triple Quad GC/MS system consists of a 7890A gas chromatograph (GC) and a 7000 triple quadrupole mass spectrometer (MS).

This section provides general information about the 7000 Series Triple Quad GC/MS, including a hardware description, general safety warnings, and hydrogen safety information.

Abbreviations Used

The abbreviations in Table 1 are used in discussing this product. They are collected here for convenience.

Table 1 Abbreviations

Abbreviation	Definition
AC	Alternating current
ALS	Automatic liquid sampler
BFB	Bromofluorobenzene (calibrant)
CC	Collision cell
CI	Chemical ionization
CID	Collision induced dissociation
DC	Direct current
DFTPP	Decafluorotriphenylphosphine (calibrant)
DIP	Direct insertion probe
EI	Electron impact
EM	Electron multiplier (detector)
EMV	Electron multiplier voltage
EPC	Electronic pneumatic control
eV	Electron volt
GC	Gas chromatograph
HED	High-energy dynode (refers to detector and its power supply)
id	Inside diameter
LAN	Local Area Network
LCP	Local control panel
m/z	Mass to charge ratio
MFC	Mass flow controller

Table 1 Abbreviations (continued)

Abbreviation	Definition
MRM	Multiple reaction monitoring
MS	Mass spectrometer
MS1	Front quadrupole
MS2	Rear quadrupole
NCI	Negative chemical ionization
OFN	Octafluoronaphthalene (sample)
PCI	Positive chemical ionization
PFDTD	Perfluoro-5,8-dimethyl-3,6,9-trioxydodecane (calibrant)
PFTBA	Perfluorotributylamine (calibrant)
QQQ	Triple quadrupole
Quad	Quadrupole mass filter
RF	Radio frequency
RFPA	Radio frequency power amplifier
Torr	Unit of pressure, 1 mm Hg
Turbo	Split flow turbomolecular vacuum pump

The 7000 Series Triple Quad GC/MS

The 7000 Series Triple Quad GC/MS is a standalone capillary GC detector for use with the Agilent 7890A Series gas chromatograph. The Triple Quad MS features:

- One split flow turbomolecular vacuum pump
- Rotary vane foreline pump
- Independently MS heated ion source
- Chemical and electron-ionization modes available (PCI/NCI/EI)
- Two independently MS heated hyperbolic quadrupole mass filters
- Single hexapole collision cell
- High-energy dynode (HED) electron multiplier detector
- Independently GC heated GC/MS interface
- Independently GC controlled collision cell gas flows
- High sensitivity electronic upgrades for the EI source and HED available
- Local control panel (LCP) for locally monitoring the MS

Physical description

The 7000 Series Triple Quad GC/MS is a rectangular box, approximately 47 cm high, 35 cm wide, and 86 cm deep. The weight is 59 kg for the turbo pump mainframe. The attached foreline (roughing) pump weighs an additional 11 kg.

The basic components of the instrument are: the frame/cover assemblies, the vacuum system, the GC/MS interface, the ion source, the electronics, the collision cell, the detector, and the front and rear analyzers.

Local control panel

The local control panel allows local monitoring of the MS instrument status.

Vacuum gauge

The 7000 Series Triple Quad GC/MS is equipped with two ion vacuum gauges. The MassHunter Workstation can be used to read the pressure (high vacuum) in the vacuum manifold and at the turbomolecular vacuum pump discharge.

In this manual, the term “CI MS” refers to the 7000 Series Triple Quad GC/MS CI source system. It also applies, unless otherwise specified, to the flow modules for these instruments.

The 7000 Series Triple Quad GC/MS CI source system upgrade kit adds to the 7000 Triple Quad MS:

- EI/CI GC/MS interface
- High sensitivity EI source
- CI ion source and interface tip seal
- Reagent gas flow control module
- HED with high sensitivity electronics
- Bipolar HED power supply for PCI and NCI operation

A methane/isobutane gas purifier is provided and is required. It removes oxygen, water, hydrocarbons, and sulfur compounds.

The MS CI system has been optimized to achieve the relatively high source pressure required for CI while still maintaining high vacuum in the collision cell, quadrupoles, and detector. Special seals along the flow path of the reagent gas and very small openings in the ion source keep the source gases in the ionization volume long enough for the appropriate reactions to occur.

The CI interface has special plumbing for reagent gas. A spring-loaded insulating seal fits onto the tip of the interface.

Switching back and forth between CI and EI sources takes less than an hour, although a 1- to 2-hour wait is required to purge the reagent gas lines and bake out water and other contaminants. Switching from PCI to NCI requires about 2 hours for the ion source to cool.

Triple Quad GC/MS Hardware Description

Figure 1 is an overview of a typical 7000 Triple Quad GC/MS system.

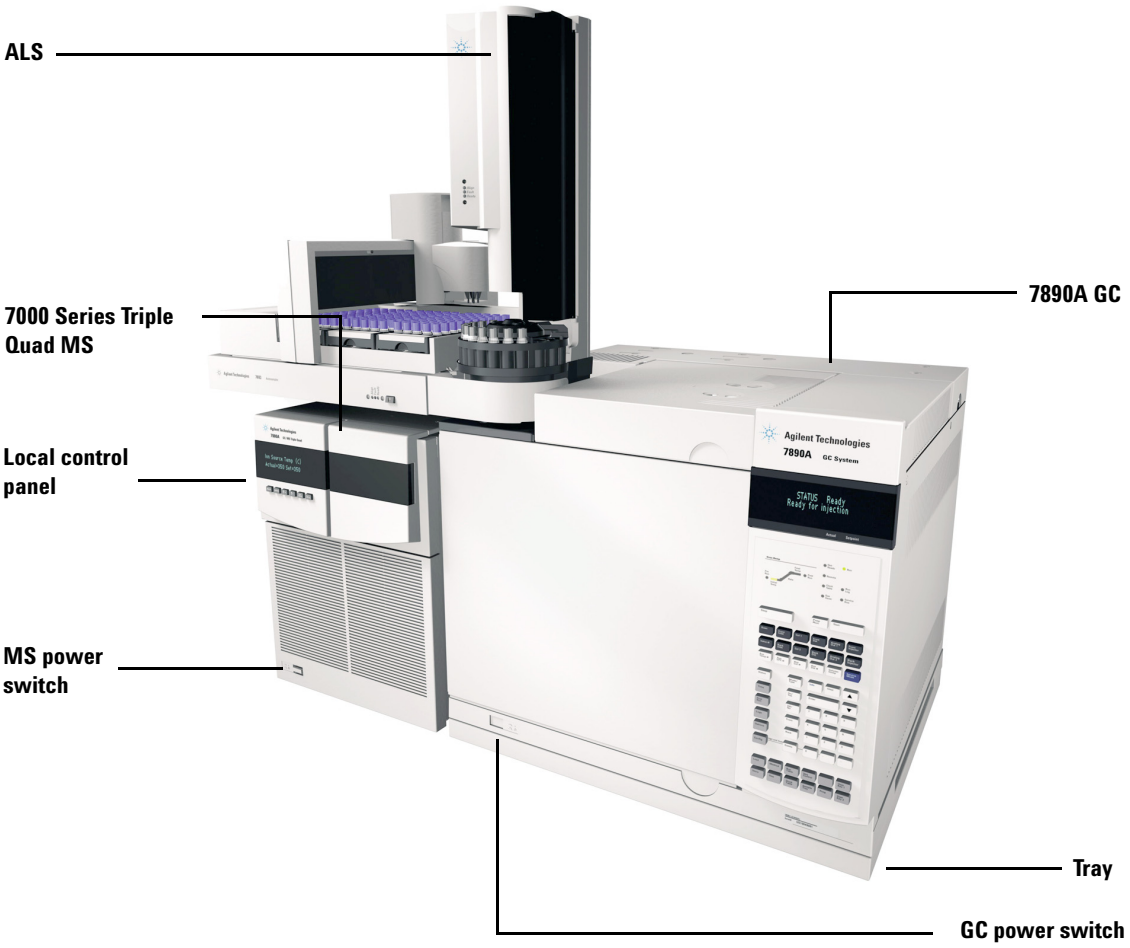

Figure 1 7000 Triple Quad MS

Important Safety Warnings

There are several important safety notices to always keep in mind when using the MS.

Many internal parts of the MS carry dangerous voltages

If the MS is connected to a power source, even if the power switch is off, potentially dangerous voltages exist on:

- The wiring between the MS power cord and the AC power supply
- The AC power supply itself
- The wiring from the AC power supply to the power switch

With the power switch on, potentially dangerous voltages also exist on:

- All electronics boards in the instrument
- The internal wires and cables connected to these boards
- The wires for any heater (oven, detector, inlet, or valve box)

WARNING **All these parts are shielded by covers. With the covers in place, it should be difficult to accidentally make contact with dangerous voltages. Unless specifically instructed to, never remove a cover unless the detector, inlet, and oven are turned off.**

WARNING **If the power cord insulation is frayed or worn, the cord must be replaced. Contact your Agilent service representative.**

Electrostatic discharge is a threat to MS electronics

The printed circuit boards in the MS can be damaged by electrostatic discharge. Do not touch any of the boards unless it is absolutely necessary. If you must handle them, wear a grounded wrist strap and take other antistatic precautions.

Many parts are dangerously hot

Many parts of the GC/MS operate at temperatures high enough to cause serious burns. These parts include, but are not limited to the:

- Inlet
- Oven and its contents
- Valve box
- Detectors
- Column nuts attaching the column to an inlet or detector
- Foreline pump
- GC/MS transfer line

Always cool these areas of the system to room temperature before working on them. They will cool faster if you first set the temperature of the heated zone to room temperature. Turn the zone off after it has reached the setpoint. If you must perform maintenance on hot parts, use a wrench and wear gloves. Whenever possible, cool the part of the instrument that you will be maintaining before you begin working on it.

WARNING **Be careful when working behind the instrument. During cool-down cycles, the GC emits hot exhaust that can cause burns.**

WARNING **The insulation around the inlets, detectors, valve box, and the insulation cups is made of refractory ceramic fibers. To avoid inhaling fiber particles, we recommend the following safety procedures: ventilate your work area; wear long sleeves, gloves, safety glasses, and a disposable dust/mist respirator; dispose of insulation in a sealed plastic bag in accordance with local regulations; wash your hands with mild soap and cold water after handling the insulation.**

The oil pan under the standard foreline pump can be a fire hazard

Oily rags, paper towels, and similar absorbents in the oil pan could ignite and damage the pump and other parts of the MS.

WARNING **Combustible materials (or flammable/nonflammable wicking material) placed under, over, or around the foreline (roughing) pump constitutes a fire hazard. Keep the pan clean, but do not leave absorbent material such as paper towels in it.**

Hydrogen Safety

WARNING **The use of hydrogen as a GC carrier gas is potentially dangerous.**

WARNING **When using hydrogen (H_2) as the carrier gas or fuel gas, be aware that hydrogen gas can flow into the GC oven and create an explosion hazard. Therefore, be sure that the hydrogen supply is turned off until all connections are made and ensure that the inlet and detector column fittings are either connected to a column or capped at all times when hydrogen gas is supplied to the instrument.**

Hydrogen is flammable. Leaks, when confined in an enclosed space, may create a fire or explosion hazard. In any application using hydrogen, leak test all connections, lines, and valves before operating the instrument. Always turn off the hydrogen supply at its source before working on the instrument.

Hydrogen is a commonly used GC carrier gas. Hydrogen is potentially explosive and has other dangerous characteristics.

- Hydrogen is combustible over a wide range of concentrations. At atmospheric pressure, hydrogen is combustible at concentrations from 4% to 74.2% by volume.
- Hydrogen has the highest burning velocity of any gas.
- Hydrogen has a very low ignition energy.
- Hydrogen that is allowed to expand rapidly from high pressure can self-ignite.
- Hydrogen burns with a nonluminous flame, which can be invisible under bright light.

Dangers unique to GC/MS operation

Hydrogen presents a number of dangers. Some are general, others are unique to GC or GC/MS operation. Dangers include, but are not limited to:

- Combustion of leaking hydrogen
- Combustion due to rapid expansion of hydrogen from a high-pressure cylinder

- Accumulation of hydrogen in the GC oven and subsequent combustion (See your GC documentation and the label on the top edge of the GC oven door.)
- Accumulation of hydrogen in the MS and subsequent combustion

Hydrogen accumulation in an MS

WARNING **The MS cannot detect leaks in inlet and/or detector gas streams. For this reason, it is vital that column fittings should always be either connected to a column or have a cap or plug installed.**

All users should be aware of the mechanisms by which hydrogen can accumulate (Table 2) and know what precautions to take if they are certain or suspect that hydrogen has accumulated. Note that these mechanisms apply to *all* mass spectrometers.

Table 2 Hydrogen accumulation mechanisms

Mechanism	Results
Mass spectrometer turned off	A mass spectrometer can be shut down deliberately. It can also be shut down accidentally by an internal or external failure. A mass spectrometer shutdown does not shut off the flow of carrier gas. As a result, hydrogen may slowly accumulate in the mass spectrometer.
Mass spectrometer automated shutoff valves closed	The mass spectrometers are equipped with automated shutoff valves for the calibration vial and the reagent gases. Deliberate operator action or various failures can cause the shutoff valves to close. Shutoff valve closure does not shut off the flow of carrier gas. As a result, hydrogen may slowly accumulate in the mass spectrometer.

Table 2 Hydrogen accumulation mechanisms (continued)

Mechanism	Results
GC off	A GC can be shut down deliberately. It can also be shut down accidentally by an internal or external failure. Different GCs react in different ways. If a 7890A GC equipped with Electronic Pressure Control (EPC) is shut off, the EPC stops the flow of carrier gas. If the carrier flow is *not* under EPC control, the flow increases to its maximum. This flow may be more than some mass spectrometers can pump away, resulting in the accumulation of hydrogen in the mass spectrometer. If the mass spectrometer is shut off at the same time, the accumulation can be fairly rapid.
Power failure	If the power fails, both the GC and mass spectrometer shut down. The flow of carrier gas, however, is not necessarily shut down. As described previously, in some GCs a power failure may cause the carrier gas flow to be set to maximum. As a result, hydrogen may accumulate in the mass spectrometer.

WARNING **Once hydrogen has accumulated in a mass spectrometer, extreme caution must be used when removing it. Incorrect startup of a mass spectrometer filled with hydrogen can cause an explosion.**

WARNING **After a power failure, the mass spectrometer may start up and begin the pumpdown process by itself. This does not guarantee that all hydrogen has been removed from the system or that the explosion hazard has been removed.**

Precautions

Take the following precautions when operating a GC/MS system with hydrogen carrier gas.

Equipment precautions

WARNING

You MUST make sure the top thumbscrew on the front analyzer side plate and the top thumbscrew on the rear analyzer side plate are both fastened finger-tight. Do not overtighten the thumbscrews; this can cause air leaks.

You MUST leave the collision cell chamber top plate shipping brackets fastened. Do not remove the shipping brackets from the top plate for normal operation; they secure the top plate in the event of an explosion.

You must remove the plastic cover over the glass window on the front of the analyzer. In the unlikely event of an explosion, this cover may dislodge.

WARNING

Failure to secure your MS as described above greatly increases the chance of personal injury in the event of an explosion.

General laboratory precautions

- Avoid leaks in the carrier gas lines. Use leak-checking equipment to periodically check for hydrogen leaks.
- Eliminate from your laboratory as many ignition sources as possible (for example, open flames, devices that can spark and sources of static electricity).
- Do not allow hydrogen from a high pressure cylinder to vent directly to atmosphere (danger of self-ignition).
- Use a hydrogen generator instead of bottled hydrogen.

Operating precautions

- Turn off the hydrogen at its source every time you shut down the GC or MS.
- Do not use hydrogen as a collision cell gas.

- Turn off the hydrogen at its source every time you vent the MS (do not heat the capillary column without carrier gas flow).
- Turn off the hydrogen at its source every time shutoff valves in the MS are closed (do not heat the capillary column without carrier gas flow).
- Turn off the hydrogen at its source if a power failure occurs.
- If a power failure occurs while the GC/MS system is unattended, even if the system has restarted by itself:
  1. Immediately turn off the hydrogen at its source.
  2. Turn off the GC.
  3. Turn off the MS and allow it to cool for 1 hour.
  4. Eliminate *all* potential sources of ignition in the room.
  5. Open the vacuum manifold of the MS to atmosphere.
  6. Wait at least 10 minutes to allow any hydrogen to dissipate.
  7. Start up the GC and MS as normal.

When using hydrogen gas, check the system for leaks to prevent possible fire and explosion hazards based on local Environmental Health and Safety (EHS) requirements. Always check for leaks after changing a tank or servicing the gas lines. Always make sure the vent line is vented into a fume hood.

Safety and Regulatory Certifications

The 7000 Series Triple Quad GC/MS conforms to the following safety standards:

- Canadian Standards Association (CSA): CAN/CSA-C222 No. 61010-1-04
- CSA/Nationally Recognized Test Laboratory (NRTL): UL 61010–1
- International Electrotechnical Commission (IEC): 61010–1
- EuroNorm (EN): 61010–1

The 7000 Triple Quad MS conforms to the following regulations on Electromagnetic Compatibility (EMC) and Radio Frequency Interference (RFI):

- CISPR 11/EN 55011: Group 1, Class A
- IEC/EN 61326
- AUS/NZ

This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB–001 du Canada.

The 7000 Series Triple Quad GC/MS is designed and manufactured under a quality system registered to ISO 9001.

Information

The Agilent Technologies 7000 Series Triple Quad GC/MS meets the following IEC (International Electrotechnical Commission) classifications: Equipment Class I, Laboratory Equipment, Installation Category II, and Pollution Degree 2.

This unit has been designed and tested in accordance with recognized safety standards and is designed for use indoors. If the instrument is used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired. Whenever the safety protection of the MS has been compromised, disconnect the unit from all power sources and secure the unit against unintended operation.

Refer servicing to qualified service personnel. Substituting parts or performing any unauthorized modification to the instrument may result in a safety hazard.

Symbols

Warnings in the manual or on the instrument must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions violates safety standards of design and the intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

See accompanying instructions for more information.

Indicates a hot surface.

Indicates hazardous voltages.

Indicates earth (ground) terminal.

Indicates potential explosion hazard.

Indicates radioactivity hazard.

Indicates electrostatic discharge hazard.

Indicates that you must not discard this electrical/electronic product in domestic household waste.

Electromagnetic compatibility

This device complies with the requirements of CISPR 11. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try one or more of the following measures:

1. Relocate the radio or antenna.
2. Move the device away from the radio or television.
3. Plug the device into a different electrical outlet, so that the device and the radio or television are on separate electrical circuits.
4. Make sure that all peripheral devices are also certified.
5. Make sure that appropriate cables are used to connect the device to peripheral equipment.
6. Consult your equipment dealer, Agilent Technologies, or an experienced technician for assistance.

Changes or modifications not expressly approved by Agilent Technologies could void the user's authority to operate the equipment.

Sound emission declaration

Sound pressure

Sound pressure Lp < 70 dB according to EN 27779:1991 and EN ISO 3744:1995.

Schalldruckpegel

Schalldruckpegel LP < 70 dB nach EN 27779:1991 und EN ISO 3744:1995.

Intended Use

Agilent products must only be used in the manner described in the Agilent product user guides. Any other use may result in damage to the product or personal injury. Agilent is not responsible for any damages caused, in whole or in part, by improper use of the products, unauthorized alterations, adjustments or modifications to the products, failure to comply with procedures in Agilent product user guides, or use of the products in violation of applicable laws, rules or regulations.

Cleaning/Recycling the Product

To clean the unit, disconnect the power and wipe down with a damp, lint-free cloth. For recycling, contact your local Agilent sales office.

Liquid Spills

Do not spill liquids on the MS.

Moving or Storing the MS

The best way to keep your MS functioning properly is to keep it pumped down and hot, with carrier gas flow. If you plan to move or store your MS, a few additional precautions are required. The MS must remain upright at all times; this requires special caution when moving. The MS should not be left vented to atmosphere for long periods. For more information, see To Move or Store the MS in the Operation Manual.

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This is a quick reference to symptoms and possible causes of the most common problems experienced by users. See Chapter 3, “CI Troubleshooting” on page 51 for help with CI-specific problems. For each symptom, one or more possible causes are listed. In general, the causes listed first are the most likely causes *or* the easiest to check and correct.

This chapter does not include corrective actions for the possible causes listed. Some of the corrective actions required may be dangerous if performed incorrectly. Do not attempt any corrective actions unless you are sure you know the correct procedure and the dangers involved. See the other chapters in this manual for more information.

If the material in this chapter and in the online help proves insufficient to help you diagnose a problem, contact your Agilent Technologies service representative.

Troubleshooting Tips and Tricks

Rule 1: "Look for what has been changed."

Many problems are introduced accidentally by human actions. Every time any system is disturbed, there is a chance of introducing a new problem.

- If the MS was just pumped down after maintenance, suspect air leaks or incorrect assembly.
- If carrier gas or helium gas purifier was just changed, suspect leaks or contaminated or incorrect gas.
- If the GC column was just replaced, suspect air leaks or a contaminated or bleeding column.

Rule 2: "If complex isn't working, go back to simple."

A complex task is not only more difficult to perform but also more difficult to troubleshoot. If you're having trouble detecting your sample, verify that autotune is successful.

Rule 3: "Divide and conquer."

This technique is known as "half-split" troubleshooting. If you can isolate the problem to only part of the system, it is much easier to locate.

To determine whether an air leak is in the GC or the MS, you can vent the MS, remove the column, and install the blank interface ferrule. If the leak goes away, it was in the GC.

General Symptoms

This section describes symptoms you might observe when first turning on the GC/MS system. All of these symptoms would prevent operation of the system.

GC does not turn on

Nothing happens when the GC is switched on. The GC fans do not turn on and the keypad display does not light.

- Disconnected GC power cord
- No voltage or incorrect voltage at the electrical outlet
- Failed fuse in the GC
- GC power supply is not working correctly

MS does not turn on

Nothing happens when the MS is switched on. The foreline pump does not start. The cooling fan for the high-vacuum pump does not turn on. The local control panel (LCP) does not turn on.

- Disconnected MS power cord
- No voltage or incorrect voltage at the electrical outlet
- Failed primary fuses
- MS electronics are not working correctly

Foreline pump is not operating

The MS is receiving power (the fan is operating and the local control panel is lit) but the foreline pump is not operating.

- A large air leak (usually the analyzer door open) has caused pumpdown failure. See “Pumpdown failure shutdown” on page 132. You must power cycle the MS to recover from this state.
- Disconnected foreline pump power cord
- Malfunctioning foreline pump
- Check power switch on foreline pump

MS turns on but then the foreline pump shuts off

The MS will shut down both the foreline pump and the high vacuum pump if the system fails to pump down correctly. This is usually because of a large air leak: either the side plate has not sealed correctly or the vent valve is still open. This feature helps prevent the foreline pump from sucking air through the system, which can damage the analyzer and pump.

See "Pumpdown failure shutdown" on page 132. You must power cycle the MS to recover from this state.

Local control panel says "No server found"

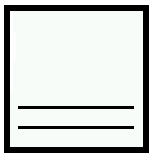
- Disconnected LAN cable between MS and the hub, or the hub and the PC
- PC is turned off
- Holding the No/Cancel key down for 5 seconds will bypass error and allow the user to look at the LCP.

Chromatographic Symptoms

These are symptoms you may observe in the chromatograms generated by data acquisition. In general, these symptoms do not prevent you from operating your GC/MS system. They indicate, however, that the data you are acquiring may not be the best data obtainable. These symptoms can be caused by instrument malfunctions but are more likely caused by incorrect chromatographic technique.

Two of the symptoms, *Low sensitivity* and *Poor repeatability* also apply to mass spectral data.

No peaks



If an analysis shows no chromatographic peaks, only a flat baseline or minor noise, run the automated tune program. If the MS passes tune, the problem is most likely related to the GC. If the MS does not pass tune, the problem is most likely in the MS.

Passes tune

- Incorrect sample concentration
- No analytes present
- Syringe missing from the ALS or not installed correctly
- Injection accidentally made in split mode instead of splitless mode
- Empty or almost empty sample vial
- Dirty GC inlet
- Leaking GC inlet*
- Loose column nut at the GC inlet*

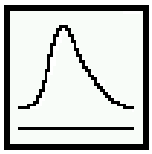
* This could cause a fault condition in the GC that would prevent the GC from operating.

Does not pass tune

- Calibration vial is empty
- Excessive foreline or analyzer chamber pressure
- Very dirty ion source

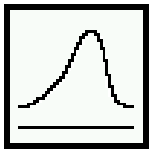
- Calibration valve is not working correctly
- Bad signal cable connection
- Filament has failed or is not connected correctly
- Bad ion source wiring connection
- Bad detector wiring connection
- Failed electron multiplier horn

Peaks are tailing



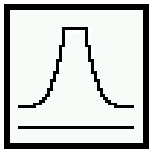
- Active sites in the sample path
- Injection is too large
- Incorrect GC inlet temperature
- Insufficient column flow
- GC/MS interface temperature is too low
- Ion source temperature is too low

Peaks are fronting



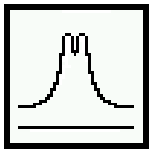
- Column film thickness mismatched with analyte concentration (column overload)
- Initial oven temperature is too low
- Active sites in the sample path
- Injection is too large
- GC inlet pressure too high
- Insufficient column flow

Peaks have flat tops



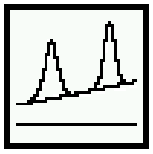
- Insufficient solvent delay
- Incorrect scale on the display
- Injection is too large
- Electron multiplier voltage is too high

Peaks have split tops



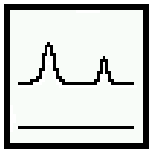
- Bad injection technique
- Injection is too large

Baseline is rising



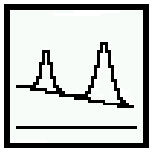
- Column bleed
- Other contamination

Baseline is high



- Column bleed
- Other contamination
- Electron multiplier voltage is too high

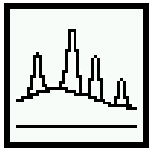
Baseline is falling



A falling baseline indicates contamination is being swept away. Wait until the baseline reaches an acceptable level. Common causes include:

- Residual air and water from a recent venting
- Column bleed
- Septum bleed
- Splitless injection time too long (inlet is not properly swept, resulting in excess solvent on the column and slow solvent decay)

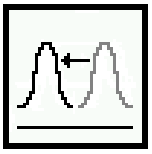
Baseline wanders



- Insufficient carrier gas supply pressure*
- Malfunctioning flow or pressure regulator*
- Intermittent leak in the GC inlet*

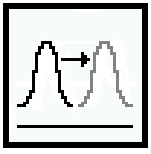
* This could cause a fault condition in the GC that would prevent the GC from operating.

Retention times for all peaks drift – shorter



- Column has been shortened
- Initial oven temperature was increased
- Column is getting old

Retention times for all peaks drift – longer



- Column flow has been reduced
- Initial oven temperature was decreased
- Active sites in the sample path
- Leaks in the GC inlet*

* This could cause a fault condition in the GC that would prevent the GC from operating.

Poor sensitivity

- Incorrect tuning, or tune file that does not match the type of analysis
- Repeller voltage is too low
- Incorrect temperatures (oven, GC/MS interface, ion source, or mass filter)
- Incorrect sample concentration
- Leaking GC inlet*
- Dirty GC inlet
- Incorrect split ratio
- Purge-off time in splitless mode is too short

- Excessive pressure in the front or rear chamber
- Dirty ion source
- Air leaks between chambers
- Poor filament operation
- Detector (HED electron multiplier) is not working correctly
- Incorrect mass filter polarity
- Collision cell voltage

  * This could cause a fault condition in the GC that would prevent the GC from operating.

Poor repeatability

- Dirty syringe needle
- Dirty GC inlet
- Leaking GC inlet*
- Injection is too large
- Loose column connections
- Variations in pressure, column flow, and temperature
- Dirty ion source
- Loose connections in the analyzer
- Ground loops

  * This could cause a fault condition in the GC that would prevent the GC from operating.

Mass Spectra General Symptoms

This section describes symptoms you might observe in mass spectra. Some of these symptoms will appear in the mass spectra of samples. Others you will observe only in a tune report. Some of these symptoms have causes that can be corrected by the operator. Others, however, require service by an Agilent Technologies service representative.

Two of the chromatographic symptoms, *Poor sensitivity* and *Poor repeatability* also apply to mass spectra.

No peaks

- Ion source cables not connected
- Bad connections to or from the detector
- HED power supply output cable has failed
- Collision cell voltages
- Collision cell gas flow
- Other electronics failure
- Incorrect tune file (inappropriate parameters)

Isotopes are missing or isotope ratios are incorrect

- Wrong precursor or wrong product ion was selected
- Scan speed is too high (MRM mode)
- Dwell time is too short (MRM mode)
- Electron multiplier voltage is too low
- Repeller voltage is too high
- Wrong ions are chosen
- High background
- Dirty ion source
- Collision cell voltage
- Collision cell gas flow
- Detector iris not working

High background

- Pressure in the analyzer chamber is too high
- Air leak
- Contamination

Mass assignments are incorrect (scan mode only)

Small shape changes at the top of the mass peaks can cause 0.1 *m/z* shifts in mass assignments. Shifts greater than 0.2 *m/z* indicate a possible malfunction.

- MS has not had enough time to reach thermal equilibrium
- Large variations in the temperature of the laboratory
- MS has not been tuned recently or at the temperature at which it is operating
- Incorrect tune file (inappropriate parameters)
- No voltage to extractor lens (if using extractor EI source)

Peaks have precursors

The tune report lists the size of the precursors for the tune masses. Small precursors are not unusual. If the precursors are unacceptably large for your application, one of the following may be responsible:

- Repeller voltage is too high
- Peaks are too wide
- Incorrect DC polarity on the quadrupole mass filter
- Dirty quadrupole mass filter

Peak widths are very low

- MS has not had enough time to reach thermal equilibrium
- Large variations in the temperature of the laboratory
- Incorrect tuning
- Calibration vial(s) empty or almost empty
- Calibration valve(s) not working correctly
- Dirty ion source

- Electron multiplier is nearing the end of it useful lifetime
- Ground loop problems

Relative abundance of *m/z* 502 is low or nonexistent

Autotune should give an *m/z* relative abundance greater than 1%. The relative abundance of *m/z* 502 can, however, vary a great deal depending on column flow, ion source temperature, and other variables. As long as relative abundance is above 1%, the stability of relative abundance is more important than the absolute value. If you observe significant changes in the relative abundance of *m/z* 502 for a fixed set of operating parameters, there may be a problem.

Low *relative* abundance of *m/z* 502 should not be confused with low *absolute* abundances at high masses. Sensitivity at high masses can be excellent even if the relative abundance of *m/z* 502 is near 1%. If your MS produces low absolute abundances at high masses, refer to the symptom "High mass sensitivity is poor" on page 37.

Manual tune programs (not autotune) may have different relative abundances.

- Tune program file has different relative ion source default values
- Not enough time for the MS to warm up and pump down
- Analyzer chamber pressure is too high
- Ion source temperature is too high
- Column carrier gas flow is too high
- Poor filament operation
- Dirty ion source
- Air leak
- Incorrect DC polarity on the quadrupole mass filter

Spectra look different from those acquired with other MSs

Ion ratios are different from those in older models MSs. This is due to the HED detector and the type of MS being compared, and is normal. Single quadrupole and triple quadrupole spectra will look different.

High mass sensitivity is poor

This refers to a condition where the *absolute* abundance at the upper end of the mass range is poor. Absolute abundance should not be confused with the *relative* abundance (percentage) of *m/z* 502 to *m/z* 69. Sensitivity at high masses can be excellent even if the relative abundance of *m/z* 502 is low.

- Wrong tune program
- Wrong tune file
- Repeller voltage is too low
- Not enough time for the MS to warm up and pump down
- Analyzer chamber pressure is too high
- Column (carrier gas) flow is too high
- Poor filament operation
- Dirty ion source
- Air leak
- Incorrect DC polarity on the quadrupole mass filter
- Collision cell gas flow is too high
- Collision cell voltages are too high
- Prefilter or postfilter
- No voltage to the extractor lens (if using extractor EI source)

Pressure Symptoms

This section describes unusual pressure readings and their possible causes. At typical column flow rates (0.5 to 2.0 mL/minute), the foreline pressure will be approximately 16 to 18 mTorr. The analyzer chamber pressure will be approximately 1×10^{-4} to 2×10^{-4} Torr. These pressures can vary widely from instrument to instrument so it is very important that you are familiar with the pressures that are typical for your instrument at given carrier and collision gas flows.

Foreline pressure is too high

If the pressure you observe for a given column flow has increased over time, check the following:

- Column (carrier gas) flow is too high
- Collision cell gas flow is too high
- Air leak (usually the side plate is not pushed in or vent valve is open)
- Foreline pump oil level is low or oil is contaminated
- Foreline hose is constricted
- Foreline pump is not working correctly

Analyzer chamber pressure is too high (EI operation)

If the pressure you observe is above 2.0×10^{-4} Torr or if the pressure you observe for a given column flow has increased over time, check the following:

- Column (carrier gas) flow is too high
- Collision cell gas flow is too high
- Air leak
- Foreline pump is not working correctly (See “Foreline pressure is too high” on page 38.)
- Turbo pump is not working correctly

Foreline pressure is too low

If the pressures you observe are below 20 mTorr, check for the following:

- Column (carrier gas) flow is too low
- Column plugged or crushed by an overtightened nut
- Collision gas flows are too low
- Empty or insufficient carrier gas supply*
- Bent or pinched carrier gas tubing*
- Foreline gauge is not working correctly

* This could create a fault condition in the GC that would prevent the GC from operating.

Analyzer chamber pressure is too low

If the pressures you observe are below 1×10^{-6} Torr, check for the following:

- Column (carrier gas) flow is too low
- Collision gas flows are too low
- Column plugged or crushed by overtightened nut
- Empty or insufficient carrier gas supply*
- Bent or pinched carrier gas tubing*

* This could create a fault condition in the GC that would prevent the GC from operating.

Temperature Symptoms

The MS has four heated zones:

- Ion source
- Front and rear mass filters
- GC/MS interface

Each heated zone has a heater and temperature sensor. The ion source and mass filters are powered and controlled by the MS. The GC/MS interface is powered and controlled by the GC.

Ion source will not heat up

- High-vacuum pump is off or has not reached normal operating conditions*
- Incorrect temperature setpoint
- Ion source has not had enough time to reach temperature setpoint
- Ion source heater cartridge is not connected*
- Ion source temperature sensor is not connected*
- Ion source heater failed (burned out or shorted to ground)*
- Ion source temperature sensor failed*
- Source power cable is not connected to the quadrupole board*
- MS electronics are not working correctly

* This will cause an error message.

Mass filter (quad) heaters will not heat up

- High-vacuum pump is off or has not reached normal operating conditions*
- Incorrect temperature setpoint
- Mass filter has not had enough time to reach temperature setpoint
- Mass filter heater cartridge is not connected*
- Mass filter temperature sensor is not connected*
- Mass filter heater failed (burned out or shorted to ground)*
- Mass filter temperature sensor failed*
- Cable is not connected to the quadrupole board*

- MS electronics are not working correctly

  * This will cause an error message.

GC/MS interface will not heat up

- Incorrect setpoint(s)
- Setpoint entered in wrong heated zone
- GC/MS interface has not had enough time to reach temperature setpoint
- GC is off
- GC experienced a fault and needs to be reset*
- GC/MS interface heater/sensor cable is not connected*
- GC/MS heater failed (burned out)*
- GC/MS sensor failed*
- GC electronics are not working correctly*

  * This will cause a GC error message. GC error messages are described in the documentation supplied with your GC.

Common Types of Errors

Sometimes a problem in your MS will cause an error message to appear in the MassHunter Workstation software. Some error messages appear only during tuning. Other messages may appear during tuning or data acquisition.

Some error messages are “latched.” These messages remain active in your data system even if the condition that caused the message has corrected itself. If the cause is removed, these messages can be removed by checking instrument status through the data system.

Difficulty in mass filter electronics

- Pressure in the analyzer chamber is too high
- RFPA is not adjusted correctly
- Mass filter (quad) contacts are shorted or otherwise not working correctly
- Mass filters are not working correctly
- MS electronics are not working correctly

Difficulty with the electron multiplier supply

- Large peaks, such as the solvent peak, eluted while the analyzer was on
- Pressure in the rear analyzer chamber is too high
- MS electronics are not working correctly

Difficulty with the fan

If a cooling fan fault occurs, the vacuum control electronics automatically shut off the high-vacuum pump and the ion source and mass filter heaters. Therefore, the message: “The system is in vent state” may also appear. It is important to note that even though the high-vacuum pump is off, the analyzer chamber may not actually be vented. See “The system is in vent state” on page 45 in this section for precautions to take.

- The fan is disconnected
- The fan has failed
- MS electronics are not working correctly

Difficulty with the HED supply

The only time this error occurs is if the output of the supply cannot get to its destination (the HED).

- Large peak, such as the solvent peak, eluted while the analyzer was on
- Pressure in the analyzer chamber is too high
- Detector is not working correctly
- MS electronics are not working correctly

Difficulty with the high vacuum pump

This indicates the pump failed to reach 50% of full speed within 10 minutes or experienced a fault.

You must switch the MS off and back on to remove this error message. Be sure the turbo pump has slowed down before switching off the MS. The message will reappear if the underlying problem has not been corrected.

- Large vacuum leak is preventing the turbo pump from reaching 50% of full speed
- Foreline pump is not working correctly
- Turbo pump is not working correctly
- Turbo pump controller is not working correctly
- MS electronics are not working correctly

High foreline pressure

- Excessive carrier gas flow (typically > 5 mL/min)
- Excessive solvent volume injected
- Large vacuum leak
- Severely degraded foreline pump oil
- Collapsed or kinked foreline hose
- Foreline pump is not working correctly

Internal MS communication fault

- MS electronics are not working correctly

Lens supply fault

- Electrical short in the analyzer
- MS cannot maintain the voltage setpoint
- MS electronics are not working correctly

Log amplifier ADC error

- MS electronics are not working correctly

No peaks found

- Emission current was set to 0
- Electron multiplier voltage is too low
- Poor mass axis calibration (either front or rear quad)
- Width gain or offset is too high (either front or rear quad)
- Calibration vial(s) empty or almost empty
- Excessive pressure in the analyzer chambers
- Air leak
- Signal cable is not connected
- Electrical leads to the detector are not connected correctly
- HED power supply output cable failed
- Electrical leads to the ion source are not connected correctly
- Filament to the source body is shorted

Temperature control disabled

- One of the heater fuses has failed
- MS electronics are not working correctly

Temperature control fault

This indicates that something has gone wrong with the temperature control of either the ion source or the mass filter (quad) heaters:

- Source temperature sensor is open
- Source temperature sensor is shorted

- Mass filter (quad) temperature sensor is open (either front or rear quad)
- Mass filter (quad) temperature sensor is shorted (either front or rear quad)
- No heater voltage (heater fuse has probably failed)
- Heater voltage is too low
- Temperature zone has timed out (heater failed, bad heater wiring, or loose temperature sensor)
- Problem with the temperature control electronics
- Source heater is open
- Source heater is shorted
- Mass filter heater is open (either front or rear quad)
- Mass filter heater is shorted (either front or rear quad)

The high-vacuum pump is not ready

- Turbo pump is on but has not had enough time (10 minutes) to reach 80% of its normal operating speed
- Turbo pump is not working correctly
- Foreline pump has not reached its target of 300 mTorr after 10 minutes
- MS electronics are not working correctly

The system is in vent state

The message says the system is vented, but if the fault has just occurred it may still be under vacuum and the turbo pump may still be at high speed. Wait at least 30 minutes after seeing this message before you actually vent the MS.

CAUTION Venting the MS too soon after this message appears can damage a turbo pump.

- System was vented purposely (no problem)
- Fan fault has turned off the high-vacuum pump (power cycle the MS to clear the fault)
- Fuse for the high-vacuum pump has failed
- MS electronics are not working correctly

There is no emission current

- Check tune file to be certain that emission current is not = 0
- Filament is not connected properly; try the other filament
- Filament has failed; try the other filament
- MS electronics are not working correctly

There is not enough signal to begin tune

- Corrupted tune file
- Poor mass axis calibration
- Width gain or offset is too high
- Calibration vial(s) empty or almost empty
- Excessive pressure in the analyzer chamber
- Air leak
- Electron multiplier voltage is too low
- Signal cable is not connected
- Electrical leads to the detector are not connected correctly
- Electrical leads to the ion source are not connected correctly
- Filament shorted to the source body
- Collision cell gas flow
- Collision cell voltages

Air Leaks

Air leaks are a problem for any instrument that requires a vacuum to operate. Leaks are generally caused by vacuum seals that are damaged or not fastened correctly. Symptoms of leaks include:

- Higher than normal analyzer chamber pressure or foreline pressure
- Higher than normal background
- Peaks characteristic of air (*m/z* 18, 28, 32, and 44 or *m/z* 14 and 16)
- Poor sensitivity
- Low relative abundance of *m/z* 502 (this varies with the tune program used)

Leaks can occur in either the GC or the MS. The most likely point for an air leak is a seal you recently opened.

In the GC, most leaks occur in:

- GC inlet septum
- GC inlet column nut
- Broken or cracked capillary column

Leaks can occur in many more places in the MS:

- GC/MS interface column nut
- Side plate O-rings (all the way around)
- Vent valve O-ring
- Calibration valve
- GC/MS interface O-ring (where the interface attaches to the analyzer chamber)
- Front and rear end plate O-rings
- Turbo pump O-rings
- Collision cell cover O-ring

Contamination

Contamination is usually identified by excessive background in the mass spectra. It can come from the GC or from the MS. The source of the contamination can sometimes be determined by identifying the contaminants. Some contaminants are much more likely to originate in the GC. Others are more likely to originate in the MS.

Contamination originating in the GC typically comes from one of these sources:

- Column or septum bleed
- Dirty GC inlet
- GC inlet liner
- Contaminated syringe
- Poor quality carrier gas
- Dirty carrier gas tubing
- Fingerprints (improper handling of clean parts)

Contamination originating in the MS typically comes from one of the following sources:

- Air leak
- Cleaning solvents and materials
- Foreline pump oil
- Fingerprints (improper handling of clean parts)

Table 3 lists some of the more common contaminants, the ions characteristic of those contaminants, and the likely sources of those contaminants.

Table 3 Common contaminants

Ions (*m/z*)	Compound	Possible source
18, 28, 32, 44 or 14, 16	H_2O, N_2, O_2, CO_2 or N, O	Residual air and water, air leaks, outgassing from Vespel ferrules
31, 51, 69, 100, 119, 131, 169, 181, 214, 219, 264, 376, 414, 426, 464, 502, 576, 614	PFTBA and related ions	PFTBA (tuning compound)
31	Methanol	Cleaning solvent
43, 58	Acetone	Cleaning solvent
78	Benzene	Cleaning solvent
91, 92	Toluene or xylene	Cleaning solvent
105, 106	Xylene	Cleaning solvent
151, 153	Trichloroethane	Cleaning solvent
69	Foreline pump oil or PFTBA	Foreline pump oil vapor or calibration valve leak
73, 147, 207, 221, 281, 295, 355, 429	Dimethylpolysiloxane	Septum bleed or methyl silicone column bleed
149	Plasticizer (phthalates)	Vacuum seals (O-rings) damaged by high temperatures, vinyl gloves
Peaks spaced 14 *m/z* apart	Hydrocarbons	Fingerprints, foreline pump oil

3
CI Troubleshooting

Common CI-Specific Problems 52
Troubleshooting Tips and Tricks 53
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Tuning-Related Symptoms 70

This chapter outlines the troubleshooting of Agilent 7000 Series Triple Quad GC/MSs equipped with the chemical ionization (CI) source. Most of the troubleshooting information in the previous chapter also applies to CI Triple Quads.

Common CI-Specific Problems

Because of the added complexity of the parts required for CI, there are many potential problems added. By far the greatest number and most serious problems with CI are associated with leaks or contamination in the reagent gas introduction system. NCI is especially sensitive to the presence of air; leaks small enough to cause no problems in PCI can destroy NCI sensitivity.

As with EI, if the MS tunes well and no air leak is present, sample sensitivity problems should be addressed by GC inlet maintenance first.

- Wrong reagent gas
- Reagent gas not hooked up or hooked up to wrong reagent gas inlet port
- Wrong ions entered in tune file
- Wrong tune file selected
- Not enough bakeout time has elapsed since vent (background is too high)
- Wrong column positioning (extending > 2 mm past tip of interface)
- Interface tip seal not installed
- EI source installed in CI mode
- EI filament or other EI source parts in CI ion source
- Air leaks in reagent gas flow path
- CI filament has stretched and sagged:
  - High EMV
  - Linear (no inflection point) electron energy (EIEnrgy) ramp

Troubleshooting Tips and Tricks

Rule 1: "Look for what has been changed."

Many problems are introduced accidentally by human actions. Every time any system is disturbed, there is a chance of introducing a new problem.

- If the MS was just pumped down after maintenance, suspect air leaks or incorrect assembly.
- If the reagent gas bottle or gas purifier were just changed, suspect leaks or contaminated or incorrect gas.
- If the GC column was just replaced, suspect air leaks or contaminated or bleeding column.
- If you have just switched ion polarity or reagent gas, suspect the tune file you have loaded in memory. Is it the appropriate file for your mode of operation?

Rule 2: "If complex isn't working, go back to simple."

A complex task is not only more difficult to perform, but also more difficult to troubleshoot as well. For example, CI requires more parts to work correctly than EI does.

- If you're having trouble with NCI, verify that PCI still works.
- If you're having trouble with other reagent gases, verify that methane still works.
- If you're having trouble with CI, verify that EI still works.

Rule 3: "Divide and conquer."

This technique is known as "half-split" troubleshooting. If you can isolate the problem to only part of the system, it is much easier to locate.

- To isolate an air leak, select **Shutoff valve**. If abundance of m/z 32 decreases, the problem is not in the flow module.

Air Leaks

How do I know if I have an air leak?

Large air leaks can be detected by vacuum symptoms: loud gurgling noise from the foreline pump, inability of the turbo pump to reach 95% speed, or, in the case of smaller leaks, high pressure readings on the high vacuum gauge controller.

The mass flow controller is calibrated for methane and the high vacuum gauge controller is calibrated for nitrogen, so measurements are not accurate in absolute terms:

Familiarize yourself with the measurements on ***your*** system under operating conditions. Watch for ***changes*** that may indicate a vacuum or gas flow problem.

Always look for small air leaks when setting up methane flow. Run the ***methane*** pretune, starting with a good PCI tune file (Figure 2). The abundance of *m/z* 19 (protonated water) should be less than 50% of *m/z* 17 for acceptable PCI performance. For NCI, the abundance of *m/z* 19 (protonated water) should be less than 25% that of *m/z* 17. If the MS was just pumped down, look for the abundance of *m/z* 19 to be decreasing.

There should not be any peak visible at *m/z* 32 (O_2). This almost always indicates an air leak.

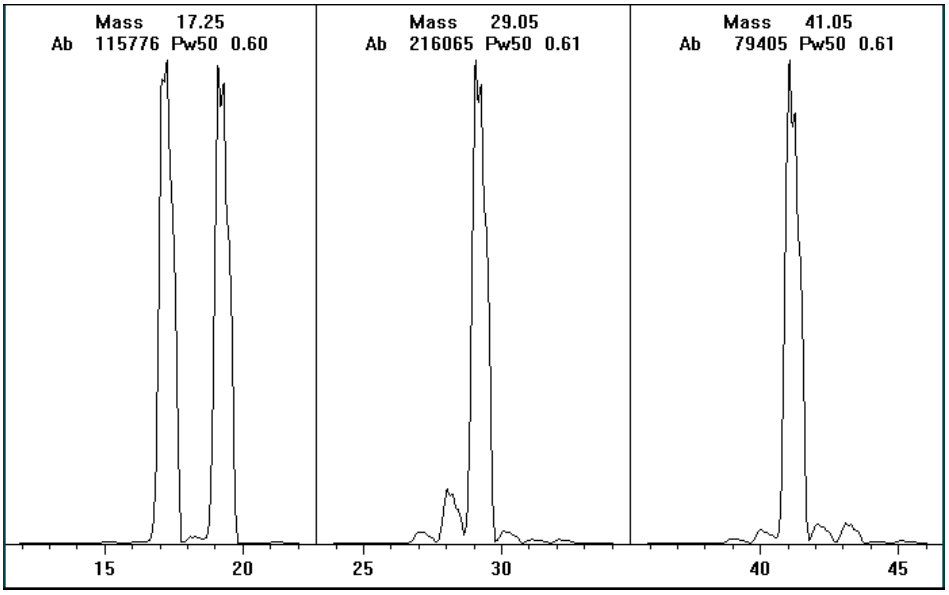

Figure 2 Looking for air leaks

Special NCI notes

Since NCI is so extremely sensitive, air leaks that are not detectable in EI or PCI can cause sensitivity problems in NCI. To check for this kind of air leak in NCI, inject OFN. The base peak should be at *m/z* 272. If the abundance of *m/z* 238 is much greater than that of *m/z* 272, you have an air leak.

How do I find the air leak?

1 See Figure 3 and Table 4.

2 Look for the last seal that was disturbed.

- If you just pumped down the MS, press on the sideplate to check for proper seal. Poor alignment between the front analyzer and the GC/MS interface seal can prevent the sideplate from sealing.
- If you just replaced the reagent gas bottle or gas purifier, check the fittings you just opened and refastened.

3 Check for tightness of seals at GC inlet and interface column nuts. Ferrules for capillary columns often loosen after several heat cycles. Do not overtighten the interface nut.

4 If any of the fittings *inside* the flow module (VCR fittings) were loosened and then retightened, the gasket must be replaced. These gaskets are good for one use only.

CAUTION Do not loosen the nuts on any VCR fittings unless you intend to replace the gaskets. Otherwise, you will create an air leak.

5 Remember that most small air leaks visible in CI mode are located in either the carrier gas or reagent gas flow paths. Leaks into the analyzer chamber are not likely to be seen in CI because of the higher pressure inside the ionization chamber.

6 Half-split the system.

- Close valves starting at the gas select valves (**Gas A**, then **Gas B**), then close the shutoff valve. See Figure 3 and Table 4.
- Cool and vent the MS, remove the GC column, and cap off the interface.

If you use argon or other introduced gas to find air leaks, this does not work well for the reagent gas flow system. It takes as long as 15 minutes for the peak to reach the ion source if the leak is at the inlet to the flow module.

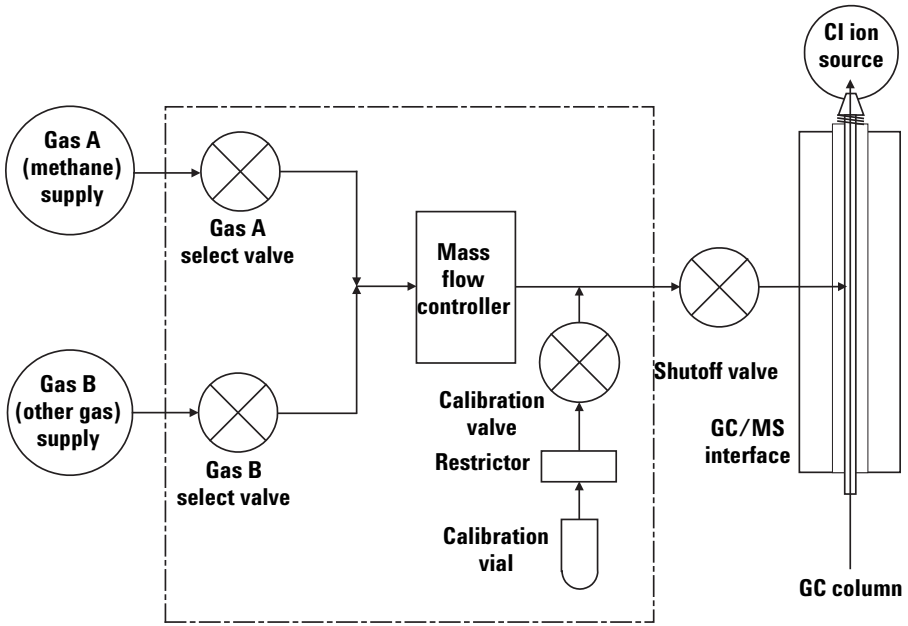

Figure 3 Schematic of CI flow control module

Table 4 Flow module valve state diagram

Result	Gas A flow	Gas B flow	Purge with Gas A	Purge with Gas B	Pump out flow module	Standby, vented, or EI mode
Gas A	Open	Closed	Open	Closed	Closed	Closed
Gas B	Closed	Open	Closed	Open	Closed	Closed
MFC	On (at setpoint)	On (at setpoint)	On (at 100%)	On (at 100%)	On (at 100%)	Off (at 0%)
Shutoff valve	Open	Open	Open	Open	Open	Closed

Pressure-Related Symptoms

The following symptoms are all related to high vacuum pressure. Each symptom is discussed in more detail in the following pages.

The mass flow controller is calibrated for methane and the high vacuum gauge controller is calibrated for nitrogen, so these measurements are not accurate in absolute terms (Table 5). They are intended as a guide to typical observed readings. They were taken with the following set of conditions:

Source temperature	300 °C
Quad temperature	150 °C
Interface temperature	280 °C to 320 °C
Helium carrier gas flow	1 mL/min

Table 5 Typical analyzer vacuum with reagent gas flow

	Collision cell gas flow on		Collision cell gas flow off	
MFC (%)	**Rough vac**	**High vac**	**Rough vac**	**High vac**
10	1.77×10^{-1}	7.15×10^{-5}	1.33×10^{-1}	2.56×10^{-6}
15	1.86×10^{-1}	7.19×10^{-5}	1.43×10^{-1}	3.00×10^{-6}
20	1.94×10^{-1}	7.23×10^{-5}	1.53×10^{-1}	3.45×10^{-6}
25	2.02×10^{-1}	7.27×10^{-5}	1.63×10^{-1}	3.86×10^{-6}
30	2.10×10^{-1}	7.31×10^{-5}	1.71×10^{-1}	4.30×10^{-6}
35	2.18×10^{-1}	7.39×10^{-5}	1.80×10^{-1}	4.76×10^{-6}
40	2.25×10^{-1}	7.43×10^{-5}	1.88×10^{-1}	5.18×10^{-6}

Poor vacuum without reagent gas flow

Excess water in the background

Scan from 10 to 40 *m/z*. A large peak at *m/z* 19 (>*m/z* 17) indicates water in the background. If water is present, allow the instrument to bake out more and flow reagent gas through the lines to purge any accumulated water.

Air leak

Run Methane Pretune. See the *Operation Manual*. A visible peak at *m/z* 32 indicates air in the system. Check for and correct any leaks. See "Air Leaks" on page 54.

The foreline pump is not working properly

For the standard foreline pump, replace the pump oil. If that does not help, or for the dry foreline pump, it may be necessary to replace the pump. Contact your local Agilent Technologies Customer Engineer.

The turbo pump is not working properly

Check the pump speed. It should be at least 95%. Contact your local Agilent Technologies service representative.

CAUTION Use of ammonia as reagent gas can shorten the life of the foreline pump oil (with standard pump) and possibly of the foreline pump itself. See "To Minimize Foreline Pump Damage from Ammonia" on page 124.

High pressure with reagent gas flow

The reagent gas flow rate is too high

On the flow controller, turn down reagent gas flow as appropriate. Verify that reagent ion ratios are correct.

Air leak

Run Methane Pretune. See the *Operation Manual*. Visible peak at *m/z* 32 indicates air in the system. Check for and correct any leaks. See the "Air Leaks" on page 54.

Interface tip seal is not installed

Check the source storage box. If the seal is not in the box, vent the MS and verify that the seal is correctly installed.

Pressure does not change when reagent flow is changed

The reagent gas regulator is closed

Check and, if necessary, open the reagent gas regulator.

The reagent gas regulator is set to the wrong pressure

Set the reagent gas regulator to 10 psi (70 kPa) for methane or to 3 to 10 psi (20 to 70 kPa) for isobutane or ammonia.

The valve on the reagent gas bottle is closed

Check and, if necessary, open the valve on the reagent gas bottle.

The reagent gas supply is empty

Check and, if necessary, replace the reagent gas supply.

Reagent lines kinked, bent, pinched, or disconnected

Inspect the reagent lines and repair any defects. Check especially to make sure the reagent line is connected to the rear of the flow module. Be sure the methane line is connected to the Gas A inlet.

GC/MS interface clogged or damaged

Check for flow and repair or replace components as indicated.

Signal-Related Symptoms

This section describes symptoms related to the signal. The symptom may be too much signal, too little signal, a noisy signal, or an incorrect signal. Signal-related symptoms are generally observed during tuning but may also be observed during data acquisition.

Error messages in autotune due to insufficient signal may vary.

The following symptoms are covered in more detail in this section:

- No peaks. See page 62.
- No or low reagent gas signal. See page 64.
- No or low PFDTD signal. See page 66.
- Excessive noise. See page 67.
- Low signal-to-noise ratio. See page 67.
- Large peak at *m/z* 19. See page 68.
- Peak at *m/z* 32. See page 69.

No peaks

When troubleshooting “no peaks” it is important to specify what mode of operation is being used and what expected peaks are not being seen. Always start with methane PCI and verify presence of reagent ions.

No reagent gas peaks in PCI

If MS has been working well and nothing seems to have been changed

- Wrong tune file loaded, or tune file corrupted
- Wrong ion polarity (there are no reagent ions visible in NCI)
- No reagent gas flow; look for background ions and check pressure
- Wrong reagent gas selected for the tune file (looking for wrong ions)
- Large air leak
- Dirty ion source
- Poor vacuum (pump problem). See page 58.

If MS was recently switched from EI to CI

- Interface tip seal not installed
- No reagent gas flow
- Analyzer not sealed (big air leak)
- Wrong tune file loaded or tune file corrupted
- Ion source not assembled or connected correctly
- Wrong reagent gas selected for the tune file (looking for wrong ions)

No PFDTD peaks in PCI

- Incorrect reagent gas. There ***are*** no PCI PFDTD peaks created with isobutane or ammonia. Switch to methane.
- Analyzer not sealed (big air leak)
- No calibrant in vial
- Defective calibration valve(s)
- Air leak in carrier or reagent gas path

No reagent gas peaks in NCI

- Reagent gases do not ionize in NCI; look for background ions instead
- Verify tune parameters
- If no background ions are visible, go back to methane PCI

No PFDTD calibrant peaks in NCI

- Look for background ions: 17 (OH^-), 35 (Cl^-), and 235 ($ReO3^-$)
- Verify tune parameters
- Go back to methane PCI

No sample peaks in NCI

- Look for background ions: 17 (OH^-), 35 (Cl^-), and 235 ($ReO3^-$)
- Go back to methane PCI
- Poor quality reagent gas (purity less than 99.99%)

Large peak at *m/z* 238 in NCI OFN spectrum

- Look for background ions: 17 (OH^-), 35 (Cl^-), and 235 ($ReO3^-$)
- Find and fix your small air leak

No or low reagent gas signal

If you have just installed the CI ion source and have an air leak or large amounts of water in the system and have run one or more autotunes, the ion source is probably dirty now.

Fix the air leak. Clean the ion source. Then bake out for two hours before tuning. See the *Operation Manual*.

The wrong reagent gas is flowing.

Turn on the correct reagent gas for your tune file.

Ion polarity is set to Negative. No reagent gas ions are formed in NCI.

Switch to Positive ionization mode.

The reagent gas flow is set too low.

Increase the reagent gas flow.

Reagent gas supply tubing is blocked, kinked, pinched, or disconnected.

Inspect and, if necessary, repair or replace the reagent gas supply tubing.

Wrong filament wires are connected to filament.

Make sure that the filament 1 wires are connected to the CI ion source filament and that the filament 2 wires are connected to the dummy filament.

Carbon has built up on the filament or filament has sagged out of alignment.

Inspect the filament. If necessary, replace the filament.

Too much air or water in the system.

Run the methane pretune. Peaks at *m/z* 32 and 19 usually indicate air and water, respectively. Bake out and purge the instrument until there is no visible peak at *m/z* 32 and the peak at *m/z* 19 is reduced to a very low level. If the peak at *m/z* 32 does not decrease, an air leak is likely. See “Air Leaks” on page 54 for more information.

The signal cable is not connected.

Check and, if necessary, reconnect the signal cable.

The filament or filament support is shorted to the ion source body or repeller.

Inspect the filament. If necessary, realign the filament support arms.

The electron inlet hole is blocked.

Inspect the electron inlet hole. If necessary, clean the hole with a clean toothpick and a slurry of aluminum oxide powder and methanol. If the electron inlet hole is that dirty, the entire ion source probably needs to be cleaned. See Chapter 4, “General Maintenance” on page 75 for more information.

Ion source wires are not connected, or incorrectly connected.

Inspect the repeller. Make sure the repeller lead is firmly attached to the repeller. Inspect the wires to the ion focus and entrance lenses. If the connections are reversed, correct the problem.

One of the detector leads (in the analyzer chamber) is not connected.

Check and, if necessary, reconnect the electron multiplier leads.

Saturated methane/isobutane gas purifier

Replace the gas purifier.

Poor quality methane (purity below 99.99%)

Replace the methane with high-purity methane. If necessary, clean and purge the reagent gas lines and clean the ion source.

No or low PFDTD signal, but reagent ions are normal

You are using any reagent gas but methane in PCI.

Switch to methane.

Wrong or corrupted tune file loaded

Check your tune file.

No PFDTD in the calibrant vial

Inspect the calibration vial on the back of the flow controller. If necessary, fill the vial with PFDTD. Do not fill the vial completely; keep the level at least 0.5 cm from the top of the vial.

The pressure of the methane entering the flow controller is too high.

Make sure the regulator on the methane supply is set to 10 psig (70 kPa).

The CI ion source is dirty.

Clean the ion source. See Chapter 5, “CI Maintenance” on page 123 for more information.

The calibration valve was not purged after the vial was refilled.

Purge the calibration valve as described in “To refill/purge the EI calibration vial” on page 89. Then clean the ion source.

The calibrant vial was overfilled. Excess PFDTD can quench the chemical ionization reactions.

Check the level of the PFDTD in the calibration vial. It should be *below* the end of the inside tube in the vial.

Poor quality methane (purity below 99.99%)

Replace the methane with high-purity methane. If necessary, clean and purge the reagent gas lines and clean the ion source.

Excessive noise or low signal-to-noise ratio

The GC inlet needs maintenance.

Refer to the GC manual.

The CI ion source is dirty.

Clean the ion source. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual* for more information.

Poor vacuum

Check the pressure on the high vacuum gauge controller.

Air leak

Run Methane Pretune (in PCI). Large peak at *m/z* 32 indicates air in the system. Check for and correct any leaks. See "Air Leaks" on page 54.

Saturated methane/isobutane gas purifier

Replace the gas purifier.

Poor quality methane (purity below 99.99%)

Replace the methane with high-purity methane. If necessary, clean and purge the reagent gas lines and clean the ion source.

Reagent gas flows too high (in EI/PCI MSs)

Verify that the reagent gas setup is correct.

Large peak at *m/z* 19

If the abundance of the peak at *m/z* 19 is more than half abundance of the peak at *m/z* 17, then there is probably too much water in the system.

The system was not baked out sufficiently after it was last vented.

Bake out the system as described in Chapter 4, "General Maintenance" on page 75.

Moisture left over in the reagent gas supply tubing and flow module

Purge the reagent gas supply lines for at least 60 minutes.

Contaminated reagent gas supply

Replace the reagent gas supply and purge the lines and flow module.

Saturated methane/isobutane gas purifier

Replace the gas purifier.

Peak at *m/z* 32

A visible peak at *m/z* 32 in methane pretune often indicates air in the system.

Residual air from recent venting — check for water indicated by a large peak at *m/z* 19.

Bake out the system under vacuum to eliminate water.

New or dirty reagent gas supply tubing

Purge the reagent gas supply lines and flow module for at least 60 minutes. See the *Operation Manual*.

Air leak

Check for leaks and correct any that you find. See "Air Leaks" on page 54. After all leaks have been corrected, clean the ion source.

Contaminated reagent gas supply. Suspect this if you have recently replaced your gas tank, and you have ruled out air leaks.

Replace the reagent gas supply.

The capillary column is broken or disconnected.

Inspect the capillary column. Make sure it is not broken and it is installed correctly.

Saturated methane/isobutane gas purifier

Replace the gas purifier.

Tuning-Related Symptoms

This section describes symptoms related to tuning. Most symptoms involve difficulties with tuning or with the results of tuning. The following symptoms are covered in this section:

- CI ion ratio is difficult to adjust or unstable
- High electron multiplier voltage
- Cannot complete autotune
- Peak widths are unstable

Reagent gas ion ratio is difficult to adjust or unstable

The interface tip seal is incorrectly placed, damaged, or missing.

Inspect the interface tip seal. If necessary, remove and reinstall it to ensure a good seal with the CI ion source. Replace it if it is damaged. Install it if it is missing.

Residual air and water in the MS or in the reagent gas supply lines

Run the methane pretune. Air will appear as a peak at *m/z* 32 and excessive water as a peak at *m/z* 19 > *m/z* 17. If either of these conditions is present, purge the reagent gas supply lines and bake out the MS. Continued presence of a large peak at *m/z* 32 may indicate an air leak. After correcting the problems, you may need to clean the ion source.

Air leak

Run Methane Pretune (in PCI). Large peak at *m/z* 32 indicates air in the system. Check for and correct any leaks. See "Air Leaks" on page 54.

The reagent gas supply is at the wrong pressure.

Check the regulator on the reagent gas supply. It should be adjusted to 20 psi (140 kPa).

A leak in the reagent gas delivery path. This is especially likely if you have set the methane flow much higher than normal and the ratio is still too low.

Check the reagent gas path. Tighten fittings.

The CI ion source is dirty.

Clean the ion source. See the *Operation Manual* for more information.

High electron multiplier voltage

The electron multiplier voltage can range from a few hundred volts to 3000 V. If the CI autotune program consistently sets the electron multiplier voltage at or above 2600 V but can still find peaks and complete the tune, it may indicate a problem.

The filament is worn out.

The CI filament may wear out without actually breaking. Check the Electron Energy ramp; the curve should have a definite maximum with an inflection point. If the curve is linear with a positive slope and no inflection point, and the EMV is high, the filament has stretched to the point where it does not line up with the hole in the ion source body, and most electrons are not getting into the source.

Replace the filament.

The analyzer is not at the proper operating temperature.

Verify the ion source and quadrupole temperatures. The default source temperature is 250 °C for PCI and 150 °C for NCI. The quadrupole temperature is 150 °C for both CI modes.

The CI ion source is dirty.

Clean the ion source. See *Operation Manual* for more information.

The electron multiplier (detector) is failing. Switch to EI mode and confirm.

Replace the electron multiplier.

Cannot complete Autotune

Wrong or corrupted tune file

Check the tune parameters.

The *m/z* 28/27 ion ratio (for methane) is incorrect. The correct ratio should be between 1.5 and 5.0.

If the ion ratio is incorrect, adjust it. See the *Operation Manual*.

The CI ion source is dirty.

Clean the ion source. See *Operation Manual* for more information.

Too much air or water in the system

See “Air Leaks” on page 54. After eliminating these problems, clean the ion source.

Peak widths are unstable

Wrong or corrupted tune file

Check the tune parameters.

The CI ion source is dirty.

Clean the ion source. See Chapter 5, "CI Maintenance" on page 123 for more information.

Air leak

Run Methane Pretune (in PCI). A visible peak at *m/z* 32 indicates air in the system. Check for and correct any leaks. See "Air Leaks" on page 54. After eliminating all air leaks, clean the ion source.

4
General Maintenance

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Before Starting

For your safety, read all of the information in this introduction before performing any maintenance tasks.

Scheduled maintenance

Common maintenance tasks are listed in Table 6. Performing these tasks when scheduled can reduce operating problems, prolong system life, and reduce overall operating costs.

Keep a record of system performance (tune reports) and maintenance operations performed. This makes it easier to identify variations from normal operation and to take corrective action.

Table 6 Maintenance schedule

Task	Every week	Every 6 months	Every year	As needed
Tune the MS				X
Check the foreline pump oil level	X			
Check the calibration vial		X		
Replace the foreline pump oil*		X		
Check the foreline pump				X
Clean the ion source				X
Check the carrier gas trap(s) on the GC and MS				X
Replace the worn out parts				X
Lubricate side plate or vent valve O-rings†				X
Replace CI Reagent gas supply				X
Replace GC gas supplies				X

* Every 3 months for CI MSs using ammonia reagent gas.

† Vacuum seals other than the side plate O-ring and vent valve O-ring do not need to be lubricated. Lubricating other seals can interfere with their correct function.

Tools, spare parts, and supplies

Some of the required tools, spare parts, and supplies are included in the GC shipping kit, MS shipping kit, or MS tool kit. You must supply others yourself. Each maintenance procedure includes a list of the materials required for that procedure.

High voltage precautions

Whenever the MS is plugged in, even if the power switch is off, potentially dangerous voltage (120 VAC or 200/240 VAC) exists on the wiring and fuses between where the power cord enters the instrument and the power switch.

When the power switch is on, potentially dangerous voltages exist on:

- Electronic circuit boards
- Toroidal transformer
- Wires and cables between these boards
- Wires and cables between these boards and the connectors on the back panel of the MS
- Some connectors on the back panel (for example, the foreline power receptacle)

Normally, all of these parts are shielded by safety covers. As long as the safety covers are in place, it should be difficult to accidentally make contact with dangerous voltages.

WARNING **Perform no maintenance with the MS turned on or plugged into its power source unless you are instructed to do so by one of the procedures in this chapter.**

Some procedures in this chapter require access to the inside of the MS while the power switch is on. Do not remove any of the electronics safety covers in any of these procedures. To reduce the risk of electric shock, follow the procedures carefully.

Dangerous temperatures

Many parts in the MS operate at, or reach, temperatures high enough to cause serious burns. These parts include, but are not limited to:

- GC/MS interface
- Analyzer parts
- Vacuum pumps

WARNING **Never touch these parts while your MS is on. After the MS is turned off, give these parts enough time to cool before handling them.**

WARNING **The GC/MS interface heater is powered by a heated zone on the GC. The interface heater can be on, and at a dangerously high temperature, even though the MS is off. The GC/MS interface is well insulated. Even after it is turned off, it cools very slowly.**

WARNING **The foreline pump can cause burns if touched when operating. An optional safety shield will prevent you from touching it.**

The GC inlets and GC oven also operate at very high temperatures. Use the same caution around these parts. See the documentation supplied with your GC for more information.

Chemical residue

Only a small portion of your sample is ionized by the ion source. The majority of any sample passes through the ion source without being ionized. It is pumped away by the vacuum system. As a result, the exhaust from the foreline pump will contain traces of the carrier gas and your samples. Exhaust from the foreline pump also contains tiny droplets of foreline pump oil.

An oil trap is supplied with the foreline pump. This trap stops *only* pump oil droplets. It *does not* trap any other chemicals. If you are using toxic solvents or analyzing toxic chemicals, do not use this oil trap. For all foreline pumps, install a hose to take the exhaust from the foreline pump outdoors or into a fume hood vented to the outdoors. For the foreline pump, this requires removing the oil trap. Be sure to comply with your local air quality regulations.

WARNING **The oil trap supplied with the foreline pump stops only foreline pump oil. It does not trap or filter out toxic chemicals. If you are using toxic solvents or analyzing toxic chemicals, remove the oil trap.**

The fluid in the foreline pump also collects traces of the samples being analyzed. All used pump fluid should be considered hazardous and handled accordingly. Dispose of used fluid as specified by your local regulations.

WARNING **When replacing pump fluid, use appropriate chemical-resistant gloves and safety glasses. Avoid all contact with the fluid.**

Electrostatic discharge

All of the printed circuit boards in the MS contain components that can be damaged by electrostatic discharge (ESD). Do not handle or touch these boards unless absolutely necessary. In addition, wires, contacts, and cables can conduct ESD to the electronics boards to which they are connected. This is especially true of the mass filter (quadrupole) contact wires, which can carry ESD to sensitive components on the quadrupole board. ESD damage may not cause immediate failure, but it will gradually degrade the performance and stability of your MS.

When you work on or near printed circuit boards or when you work on components with wires, contacts, or cables connected to printed circuit boards, always use a grounded antistatic wrist strap and take other antistatic precautions. The wrist strap should be connected to a known good earth ground. If that is not possible, it should be connected to a conductive (metal) part of the assembly being worked on, but *not* to electronic components, exposed wires or traces, or pins on connectors.

Take extra precautions, such as a grounded antistatic mat, if you must work on components or assemblies that have been removed from the MS. This includes the analyzer.

CAUTION To be effective, an antistatic wrist strap must fit snugly (not tight). A loose strap provides little or no protection.

Antistatic precautions are not 100% effective. Handle electronic circuit boards as little as possible and then only by the edges. Never touch components, exposed traces, or pins on connectors and cables.

Maintaining the Mainframe

The mainframe consists of everything that does not fit in the vacuum, analyzer, interface, or electronics categories.

To remove the MS covers

Materials needed

- Screwdriver, Torx T-15 (8710-1622)

If you need to remove one of the MS covers (see Figure 4), follow these procedures:

WARNING **The GC/MS interface, the analyzer parts, and the vacuum system operate at temperatures high enough to cause serious burns. Give these parts enough time to cool before accessing them or handling them.**

To remove the top cover

Remove the seven screws and lift the cover off.

To remove the front right analyzer window cover

1. Pull out from the top of the window and forward from the bottom. The cover is held in place by magnets.
2. Lift the window forward and off the MS.

To remove the front bottom cover

Grasp the cover on both sides and pull the cover forward.

To open the left side panel

1. Remove the front right analyzer window.
2. Pull gently on the front left window and allow the left side panel to swing forward and down.

To remove the left side panel

1 Open the left side panel

2 Remove the screws holding the cover.

To remove the left side cover

1 Remove the front bottom cover.

2 Remove the left side panel.

3 Remove the screws that hold the left side cover in place.

4 Push the cover slightly to the rear to disengage the two right side tabs and then lift it off the MS.

To remove the left rear cover

1 Open the left side panel.

2 Remove the top screw from the rear cover.

3 Lift the bottom flap of the cover out of the groove in the back of the MS to free the cover.

WARNING **Do not remove any other covers. Dangerous voltages are present under other covers.**

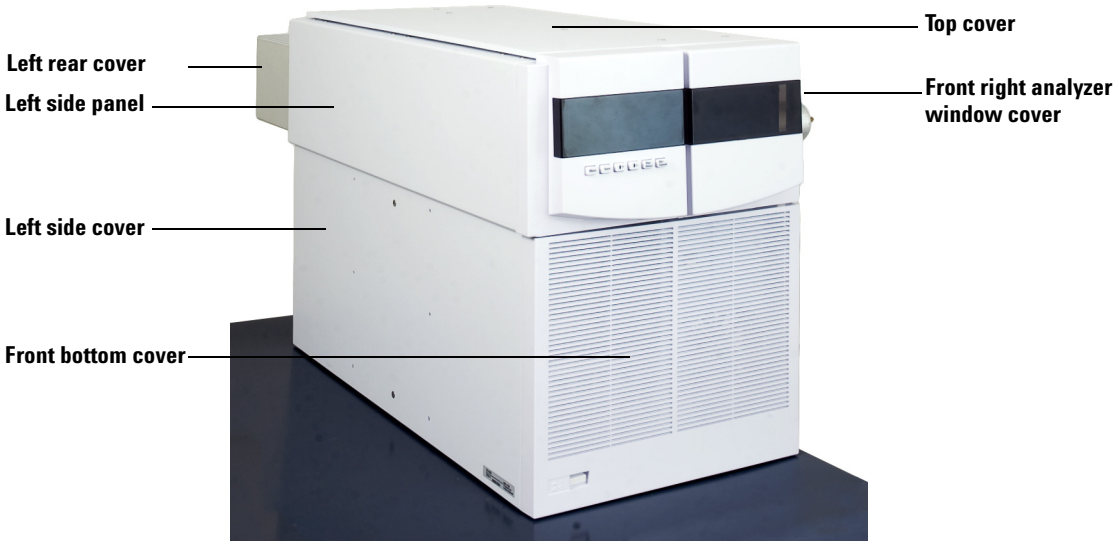

Figure 4 MS covers

To move or store the MS

Materials needed

- Ferrule, blank (5181-3308)
- Interface column nut (05988-20066)
- Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)

Procedure

WARNING **Make sure the GC/MS interface and the analyzer zones are cool (below 100 °C) before you vent the MS. A temperature of 100 °C is hot enough to burn skin; always wear cloth gloves when handling analyzer parts.**

WARNING **If you are using hydrogen as a carrier gas, the carrier gas flow must be off before turning off the MS power. If the foreline pump is off, hydrogen will accumulate in the MS and an explosion may occur. Read "Hydrogen Safety" before operating the MS with hydrogen carrier gas.**

WARNING **When the MS is vented, do not put the MassHunter Workstation software into Instrument Control view. Doing so will turn on the interface heater.**

CAUTION Be sure the GC oven and the GC/MS interface are cool before turning off the carrier gas flow.

CAUTION Never vent the MS by allowing air in through either end of the foreline hose. Use the vent valve or remove the column nut and column.

Do not vent while the turbo pump is still spinning at more than 50%.

Do not exceed the maximum recommended total gas flow. See Table 2.

1. Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
2. Remove the column.
3. Disconnect the collision gas supply tubing.
4. Install a plug on the end of the collision gas tubing that leads into the analyzer chamber.
5. Move the MS away from the GC.
6. Unplug the GC/MS interface heater cable from the GC.
7. Remove the front analyzer window and open the left side analyzer panel. See "To remove the MS covers" on page 80.
8. Finger-tighten the side plate thumbscrews for both analyzers. (Figure 5).

CAUTION Do not overtighten the side plate thumbscrews. Overtightening will strip the threads in the analyzer chamber. It will also warp the side plate and cause leaks.

CAUTION Always wear clean gloves while handling any parts that go inside the analyzer chambers.

9. Switch the MS on to establish a rough vacuum.
10. When you hear the hissing sound of the pumpdown, close the vent valve. Continue the pumpdown for 2 to 3 minutes.
11. Switch the MS off.
12. Close the analyzer cover and replace the front analyzer window.
13. Disconnect the LAN, remote, and power cable.

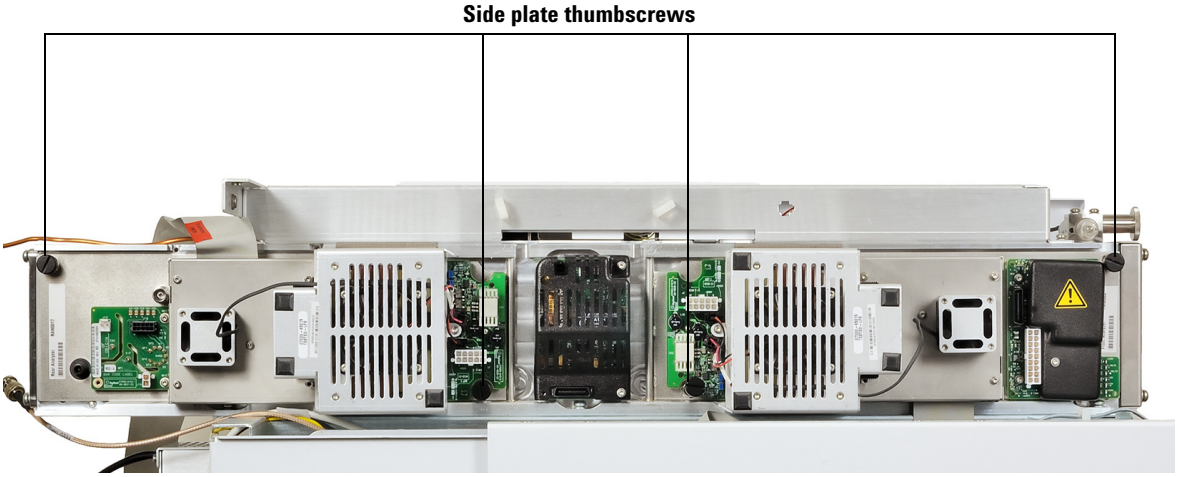

Figure 5 Side plate thumbscrews

The MS can now be stored or moved. The foreline pump cannot be disconnected; it must be moved with the MS. Make sure the MS remains upright and is never tipped on its side or inverted.

CAUTION The MS must remain upright at all times. If you need to ship your MS to another location, contact your Agilent Technologies service representative for advice about packing and shipping.

To separate/connect the MS and the GC

Materials needed

- Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)

Separation

WARNING **Make sure the GC/MS interface and the analyzer zones are cool (below 100 °C) before you vent the MS. A temperature of 100 °C is hot enough to burn skin; always wear cloth gloves when handling analyzer parts.**

WARNING **If you are using hydrogen as a carrier gas, the carrier gas flow must be off before turning off the MS power. If the foreline pump is off, hydrogen will accumulate in the MS and an explosion may occur. Read "Hydrogen Safety" before operating the MS with hydrogen carrier gas.**

CAUTION Be sure the GC oven and the GC/MS interface are cool before turning off carrier gas flow.

WARNING **Make sure the GC/MS interface and GC oven have cooled before you remove the column.**

1. Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
2. Turn off the GC.
3. Remove the capillary column from the GC/MS interface.
4. The foreline pump may be located on the floor, on the lab bench next to or behind the MS, or under the analyzer chamber at the back of the MS. Move it as needed to provide slack in the tubing and cables.
5. Move the MS away from the GC until you have access to the GC/MS interface cable (Figure 6).

6 Place a column nut with a blank ferrule on the end of the interface. This will help keep contamination out of the MS.

7 Disconnect the GC/MS interface cable. Disconnecting the cable with the GC on can cause a fault condition.

8 Continue to move the MS until you have access to the part requiring maintenance.

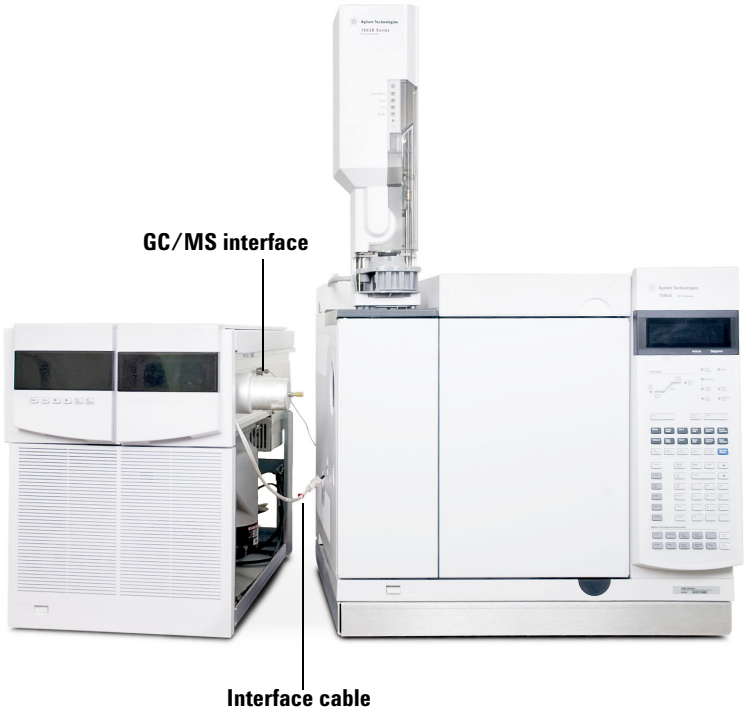

Figure 6 Separating/connecting the MS and GC

Reconnection

1 Position the MS so the end of the GC/MS interface is near the GC (Figure 6).

2 Reconnect the GC/MS interface cable.

3 Slide the MS to its regular position next to the GC.

Be careful not to damage the GC/MS interface as it passes into the GC. Make sure the end of the GC/MS interface extends into the GC oven.

4 The foreline pump may be located on the floor or on the lab bench next to or behind the MS.

5 Reinstall the capillary column.

6 Pump down the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

WARNING **Make sure your MS meets all the conditions listed in the Pump Down section of the *Agilent 7000 Series Triple Quad GC/MS Operation Manual* before starting up and pumping down the MS. Failure to do so can result in personal injury.**

CAUTION Do not turn on any GC heated zones until carrier gas flow is on. Heating a column with no carrier gas flow will damage the column.

CAUTION During pumpdown, do not push on the filament board safety cover while pressing on the analyzer boards. This cover was not designed to withstand this type of pressure.

7 Turn on the GC. Enter appropriate temperature setpoints for the GC/MS interface and GC oven.

To refill/purge the EI calibration vial

Materials needed

- PFTBA (05971-60571)

Refill

1 Stop any tuning or data acquisition.

2 Turn off the MS electronics.

3 Remove the analyzer window cover. See "To remove the MS covers" on page 80.

4 Turn the calibration vial collar counterclockwise to loosen it (Figure 7). Do not remove the collar.

5 Pull the calibration vial out. You may feel some resistance due to the O-ring around the vial tube section.

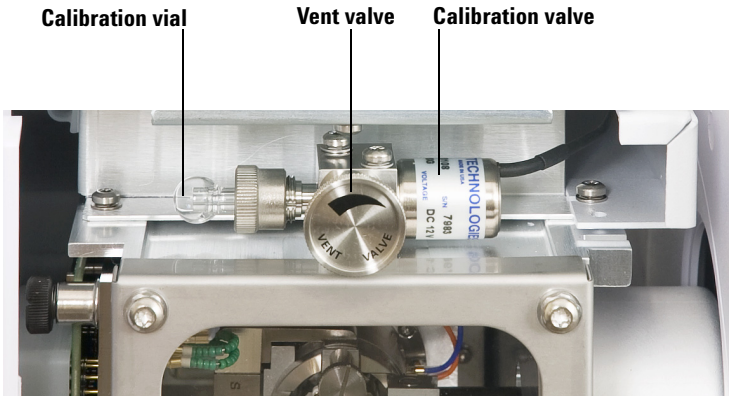

Figure 7 Removing the EI calibration vial

6 Syringe or pipette PFTBA into the vial. With the vial vertical, the liquid should be just below the end of the internal tube, approximately 70 µL of sample.

7 Push the calibration vial into the valve as far as possible.

8 Withdraw the vial 1 mm. This prevents damage when you tighten the collar.

9 Turn the collar clockwise to tighten it.

The collar should be snug but not overly tight. Do *not* use a tool to tighten the collar. It does not require that much force.

10 Reinstall the analyzer window cover.

11 In **Instrument Control** panel, select the **MS Tune** icon to display the **GC-QQQ Tune** dialog box. Select the **Manual Tune** tab then select the **Ion Source** tab to display the ion source parameters.

12 Turn off the **Emission** by clicking in the check box.

13 Purge the calibration valve by clicking in the **EI Cal Valve** check box to open the calibration valve. Close the **EI Cal Valve** after 30 seconds.

CAUTION After removing a calibrant vial, you ***must*** purge the calibration valve. Failure to do so will result in damage to the filaments and the electron multiplier.

To remove/reinstall the calibration and vent valve assembly

Removal

Materials needed

- Screwdriver, Torx T-15 (8710-1622)

WARNING **If you are using hydrogen as a carrier gas, do not start carrier gas flow until the MS has been pumped down. If the vacuum pumps are off, hydrogen will accumulate in the MS and an explosion may occur. Read "Hydrogen Safety" before operating the MS with hydrogen carrier gas.**

WARNING **Make sure the GC/MS interface and the analyzer zones are cool (below 100 °C) before you vent the MS. A temperature of 100 °C is hot enough to burn skin; always wear cloth gloves when handling analyzer parts.**

CAUTION Be sure the GC oven and the GC/MS interface are cool before turning off carrier gas flow.

1. Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
2. Remove the analyzer window cover and the top cover. See "To remove the MS covers" on page 80.
3. Loosen the two screws holding the valve assembly to the top of the analyzer chamber. Do not lose the O-ring under it.
4. Trace the calibration valve cable to the connector and disconnect it.
5. Remove valve assembly.

CAUTION Removing the valve with the vial installed can result in liquid calibrant getting into the valve assembly. Liquid in the restrictor will cause diffusion of PFTBA into the analyzer chamber when the valve is closed. Replace the valve if this happens.

Reinstallation

Materials needed

- Calibration valve (G3170-60204)
- O-ring for calibration valve (0905-1217)
- PFTBA (05971-60571)
- Screwdriver, Torx T-15 (8710-1622)

1. Remove the old valve assembly. See "To remove/reinstall the calibration and vent valve assembly" on page 91 and Figure 7.
2. Be sure the valve O-ring is in place. If it is worn or damaged, replace it.
3. Install the calibration and vent valve assembly and tighten the screws that hold it in place.
4. Reconnect the calibration valve cable to the connector.
5. Remove the vial from the new calibration valve. See "To refill/purge the EI calibration vial" on page 89. The valve is supplied with a vial already installed.
6. Fill and reinstall the calibration vial. See "To refill/purge the EI calibration vial" on page 89.

CAUTION Do not turn on any GC heated zones until the carrier gas flow is on. Heating a column with no carrier gas flow will damage the column.

7. Pump down the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

Maintaining the Vacuum System

Periodic maintenance

As listed in Table 6, some maintenance tasks for the vacuum system must be performed periodically. These include:

- Checking the foreline pump fluid (every week)
- Checking the calibration vial (every 6 months)
- Replacing the foreline pump oil (every 6 months)
- Tightening the foreline pump oil box screws (first oil change after installation)

Failure to perform these tasks as scheduled can result in decreased instrument performance. It can also result in damage to your instrument.

Other procedures

Tasks such as replacing an ion vacuum gauge should be performed only when needed. See Chapter 2, “General Troubleshooting” on page 25 and see the online help in the MassHunter Workstation software for symptoms that indicate this type of maintenance is required.

More information is available

If you need more information about the locations or functions of vacuum system components, see “Vacuum System” on page 129.

Most of the procedures in this chapter are illustrated with video clips on the 7000 Series MS User Information DVD.

To remove/install the ion vacuum gauges

Each MS contains two ion vacuum gauges; one for the analyzer chamber pressure and one for the foreline pump entrance.

WARNING **Make sure the GC/MS interface and the analyzer zones are cool (below 100 °C) before you vent the MS. A temperature of 100 °C is hot enough to burn skin; always wear cloth gloves when handling analyzer parts.**

WARNING **If you are using hydrogen as a carrier gas, the carrier gas flow must be off before turning off the MS power. If the foreline pump is off, hydrogen will accumulate in the MS and an explosion may occur. Read "Hydrogen Safety" before operating the MS with hydrogen carrier gas.**

WARNING **The turbo pump can cause burns if touched when operating. Make sure the pump has time to cool before touching.**

CAUTION Never vent the MS by allowing air in through either end of the foreline hose. Use the vent valve or remove the column nut and column.

Do not vent while the turbo pump is still spinning at more than 50%.

Do not exceed the maximum recommended total gas flow. See Table 2.

WARNING **Make sure your MS meets all the conditions listed in the Pump Down section of the *Agilent 7000 Series Triple Quad GC/MS Operation Manual* before starting up and pumping down the MS. Failure to do so can result in personal injury.**

CAUTION During pumpdown, do not push on the filament board safety cover while pressing on the analyzer boards. This cover was not designed to withstand this type of pressure.

Removal, analyzer chamber gauge

1. Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
2. The chamber ion gauge is under the collision cell area. See Figure 8.
3. Separate the MS from the GC. See "To separate/connect the MS and the GC" on page 86.
4. Remove the cable from the bottom of the ion gauge.
5. Remove the screws from around the base of the ion gauge.
6. Remove the gauge and O-ring from the chamber.

Installation, analyzer chamber gauge

Installation is the reverse of the removal procedure.

Removal, foreline pump gauge

1. Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
2. Separate the MS from the GC. See "To separate/connect the MS and the GC" on page 86.
3. Unplug the foreline gauge cable from the foreline gauge.
4. Unscrew the large wingnut on the gauge clamp. See Figure 8.
5. While supporting the gauge body, remove the clamp from the mounting flange.
6. Remove the gauge and hose together.
7. Loosen the hose clamp.
8. Pull the foreline gauge assembly out of the foreline hose.

Installation, foreline pump gauge

Installation is the reverse of the removal procedure.

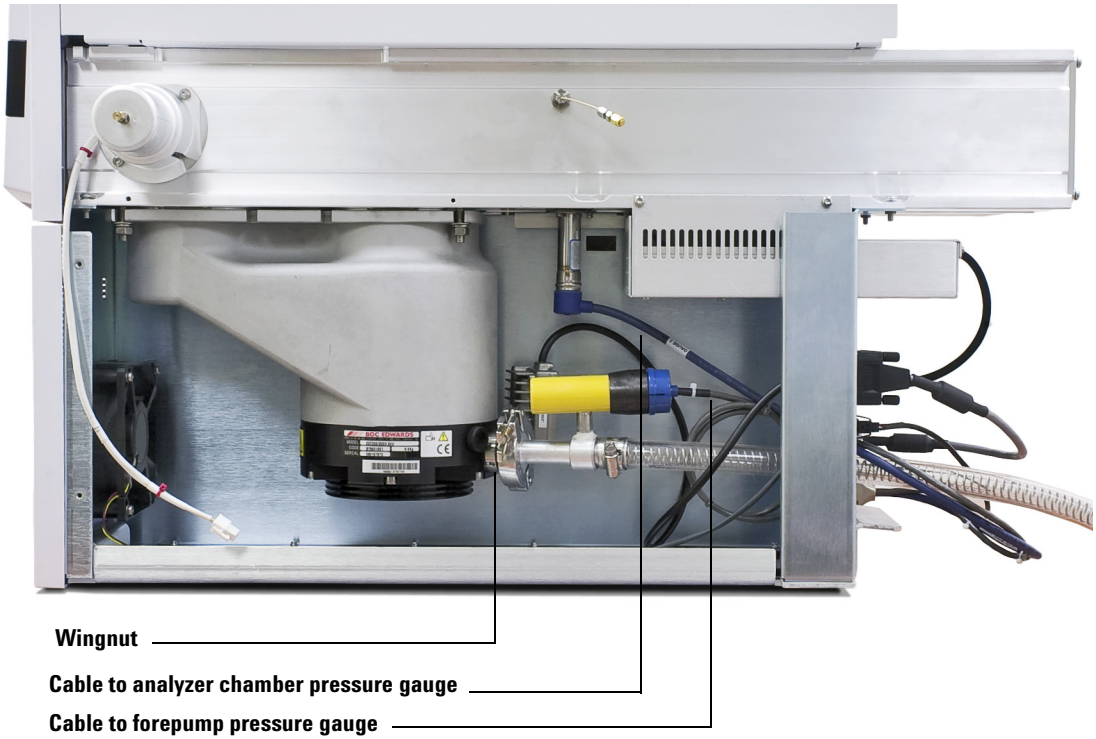

Figure 8 Ion vacuum gauge cables

To check and add foreline pump oil

This procedure describes the standard foreline pump (Pfeiffer Duo 2.5). The higher flow pump (Edwards RV5) is similar.

Materials needed

- Foreline pump oil (6040-0834)
- Funnel (9301-6461)
- Hex key, 5-mm, to remove drain plug (8710-1838)
- Screwdriver, flat-blade, to remove top fill cap

Procedure

WARNING **The foreline pump can cause burns if touched when operating. An optional safety shield will prevent the user from touching it.**

1 Examine the oil level window (Figure 9).

Note the two lines on the pump left of the window. The oil level should be between the lines. The foreline pump oil should be almost clear. If the oil level is near or below the lower line, follow steps 2 through 6 to add foreline pump oil.

WARNING **Never add oil while the foreline pump is on.**

If your MS is nearing its scheduled time for replacement of the foreline pump oil, replace the oil instead of adding oil. If the oil is dark or cloudy, replace it. See "To drain/refill the foreline pump" on page 99 for instructions on replacing the foreline pump oil.

2 Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

3 Remove the foreline pump fill cap.

4 Add pump fluid until the oil level in the window is near, but not above, the upper line.

5 Reinstall the fill cap.

6 Pump down the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

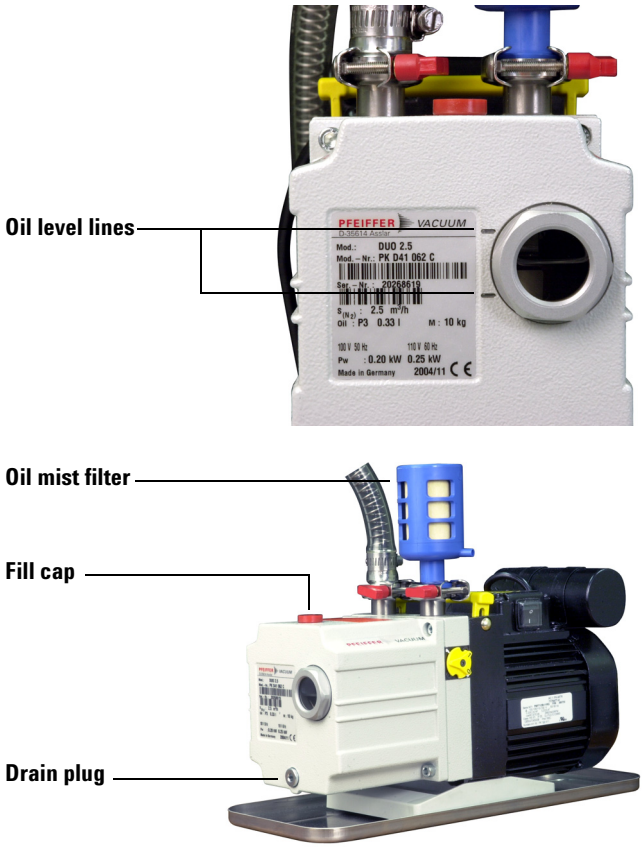

Figure 9 Standard foreline pump

To drain/refill the foreline pump

Materials needed

- Book or other solid object approximately 5 cm thick
- Container for catching old pump oil, 500 mL
- Gloves, oil- and solvent-resistant
- Screwdriver, flat-blade, large (8730-0002)
- Hex key, 5-mm (8710-1838)
- Foreline pump oil (6040-0834)

Drain the pump

WARNING **The foreline pump can cause burns if touched when operating. An optional safety shield will prevent the user from touching it.**

1 Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

2 If necessary, slide the foreline pump to a safe, accessible location.

The foreline pump may be located on the floor, on the lab bench next to or behind the MS, or under the analyzer chamber at the back of the MS.

WARNING **The foreline pump may be hot.**

3 Place a book or other object under the back of the pump motor to tilt the front of it down slightly. Remove the fill cap. See Figure 9.

4 Place a container under the drain plug.

5 Remove the drain plug. Allow the pump oil to drain out. The oil drains faster if it is still warm.

WARNING **The old pump oil may contain toxic chemicals. Treat it as hazardous waste.**

6 Replace the drain plug after draining the oil.

7 Refill the foreline pump until the oil level is near, but not above, the upper line mark in the sight window.

8 Replace the fill cap.

Refill the pump

WARNING **The foreline pump can cause burns if touched when operating. An optional safety shield will prevent the user from touching it.**

1 Drain the foreline pump. See "To drain/refill the foreline pump" on page 99.

2 Reinstall the drain plug. If the old O-ring appears worn or damaged, replace it.

3 Remove the propping object from under the pump motor.

4 Add foreline pump oil until the oil level in the window is near, but not above, the upper line. The typical foreline pump requires approximately 0.28 L of oil.

5 Wait a few minutes for the oil to settle. If the oil level drops, add oil to bring the oil level near the upper line.

6 Reinstall the fill cap.

7 If necessary, slide the foreline pump back under the analyzer chamber.

The foreline pump may be located on the floor, on the lab bench next to or behind the MS, or under the analyzer chamber at the back of the MS.

WARNING **Make sure your MS meets all the conditions listed in the Pump Down section of the *Agilent 7000 Series Triple Quad GC/MS Operation Manual* before starting up and pumping down the MS. Failure to do so can result in personal injury.**

CAUTION During pumpdown, do not push on the filament board safety cover while pressing on the analyzer boards. This cover was not designed to withstand this type of pressure.

8 Pump down the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

To replace the fan for the turbo pump

Procedure

1 Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

2 Turn the MS off.

3 Move the MS away from the GC to make the fan accessible.

4 Remove the fan plenum (four screws).

5 Disconnect the fan wiring from the extender cable (Figure 10).

6 Remove the four fan screws and the safety grill. Remove the fan. Keep the screws.

WARNING **Do not touch the high vacuum pump. The pump could still be hot enough to burn you.**

---

7 Connect the fan wiring to the new fan.

8 Install the new fan with the flow arrow on the side pointing toward the pump.

9 Add the safety grill and the four screws. Tighten the screws firmly.

WARNING **Make sure the safety grill that shields the fan blades is in place.**

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10 Connect the fan wiring to the extender cable.

11 Pump down the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

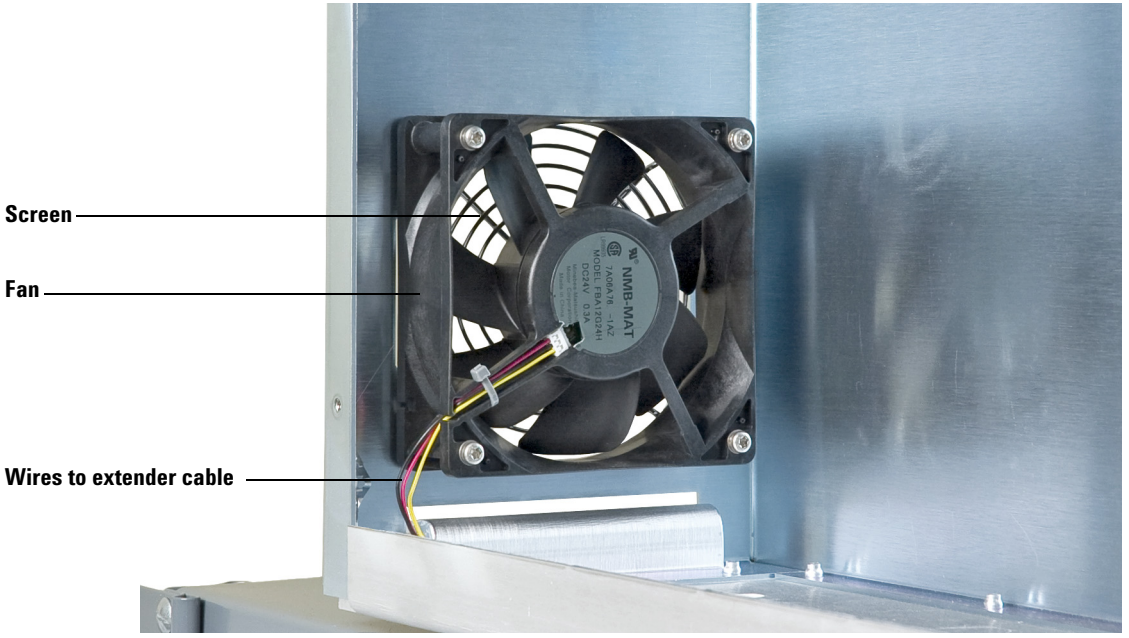

Figure 10 Replacing the turbo pump fan

To lubricate the side plate O-rings

Materials needed

- Cloths, clean (05980-60051)
- Gloves, clean, lint-free
  - Large (8650-0030)
  - Small (8650-0029)
- Grease, Apiezon L, high-vacuum (6040-0289)

The side plate O-rings may require a thin coat of grease to ensure a good vacuum seal. If an O-ring appears dry or does not seal correctly, lubricate it using this procedure. A good test is to wipe off the side plate with methanol, then close the analyzer chamber. If the O-ring has enough grease on it, it will leave a faint trace on the side plate.

WARNING **The analyzer, GC/MS interface, and other components in the analyzer chamber operate at very high temperatures. Do not touch any part until you are sure it is cool.**

CAUTION Vacuum seals other than the side plate O-ring and vent valve O-ring do not need to be lubricated. Lubricating other seals can interfere with their correct function.

CAUTION Always wear clean gloves to prevent contamination when working in the analyzer chamber.

CAUTION Electrostatic discharges to analyzer components are conducted to the quad driver board, where they can damage sensitive components. Wear a grounded antistatic wrist strap and take other antistatic precautions (see "Electrostatic discharge is a threat to MS electronics" on page 13) before you open the analyzer chamber.

Procedure

1. Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
2. Open an analyzer chamber.
3. Use a clean, lint-free cloth or glove to spread a *thin* coat of high-vacuum grease only on the exposed surface of the O-ring (Figure 11).

CAUTION Do not use anything except the recommended vacuum grease. Excess grease can trap air and dirt. Grease on surfaces of the O-ring other than the exposed surface can trap air, resulting in air spikes during operation.

4 Use a clean, lint-free cloth or glove to wipe away excess grease. If the O-ring looks shiny, there is too much grease on it.

5 Close the analyzer chamber.

6 Repeat this procedure for the other analyzer chamber.

7 Pump down the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

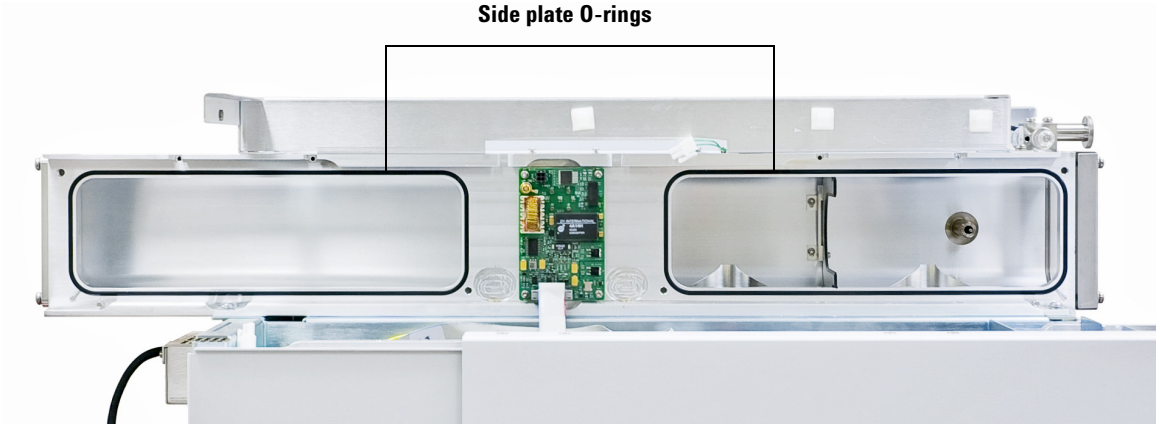

Figure 11 Side plate O-ring

To lubricate the vent valve O-ring

Materials needed

- Cloths, clean (05980-60051)
- Gloves, clean, lint-free
  - Large (8650-0030)
  - Small (8650-0029)
- Grease, Apiezon L, high-vacuum (6040-0289)
- O-ring, vent valve (0905-1217). Replace if the old O-ring is worn or damaged

The vent valve O-ring needs a very thin coat of lubrication to ensure a good vacuum seal and smooth operation. If the vent valve O-ring does not turn smoothly or does not seal correctly, lubricate it using this procedure.

CAUTION Vacuum seals other than the side plate O-ring and vent valve O-ring do not need to be lubricated. Lubricating other seals can interfere with their correct function.

Procedure

1. Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
2. Completely remove the vent valve knob (Figure 12).
3. Inspect the O-ring. If the O-ring appears damaged, replace it.
4. Use a clean, lint-free cloth or glove to spread a *thin* coat of high-vacuum grease on the exposed surface of the O-ring.

CAUTION Excess grease can trap air and dirt. Grease on surfaces of the O-ring other than the exposed surface can trap air, resulting in air spikes during operation.

5. Use a clean, lint-free cloth or glove to wipe away excess grease. If the O-ring looks shiny, there is too much grease on it

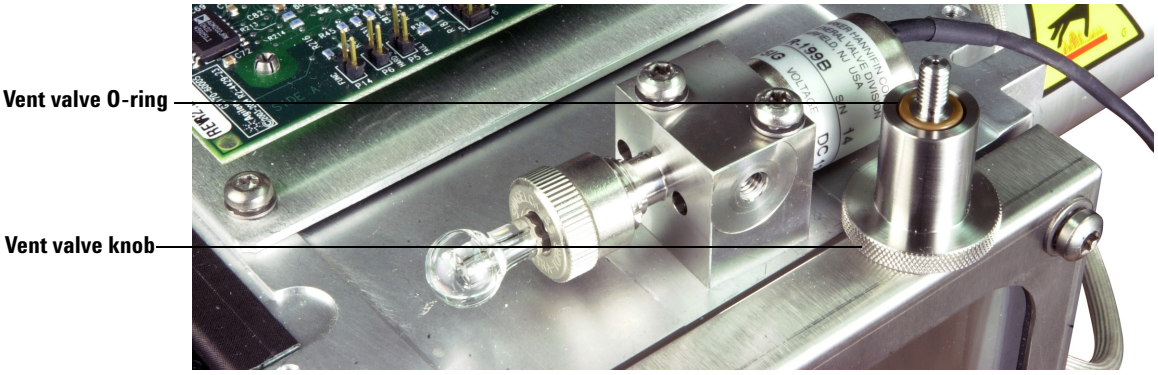

Figure 12 Vent valve O-ring

6 Reinstall the vent valve knob.

CAUTION Be very careful when reinstalling the vent valve knob. It is possible to cross-thread the knob and damage the threads in the valve body. Be sure the O-ring stays in place.

7 Pump down the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

Maintaining the Analyzers and Collision Cell

Scheduling

None of the analyzer components requires periodic maintenance. Some tasks, however, must be performed when MS behavior indicates they are necessary. These tasks include:

- Cleaning the ion source
- Replacing filaments
- Replacing the electron multiplier horn

See Chapter 2, "General Troubleshooting" on page 25 for information about symptoms that indicate the need for analyzer maintenance.

Precautions

Cleanliness

Keep components clean during analyzer maintenance. Analyzer maintenance involves opening the analyzer chamber and removing parts from the analyzer. During analyzer maintenance procedures, take care to avoid contaminating the analyzer or the interior of the analyzer chamber.

Wear clean gloves during all analyzer maintenance procedures. After cleaning, parts must be thoroughly baked out before they are reinstalled and should be placed only on clean, lint-free cloths.

CAUTION If not done correctly, analyzer maintenance can introduce contaminants into the MS.

WARNING **The analyzers operate at high temperatures. Do not touch any part until you are sure it is cool.**

Some parts can be damaged by electrostatic discharge

The wires, contacts, and cables connected to the analyzer components can carry electrostatic discharges (ESD) to the electronics boards to which they are connected. This is especially true of the mass filter (quadrupole) contact wires, which can conduct ESD to sensitive components on the quadrupole board. ESD damage may not cause immediate failure but will gradually degrade performance and stability. See "Electrostatic discharge" on page 79 for more information.

CAUTION Electrostatic discharges to analyzer components are conducted to the quadrupole board where they can damage sensitive components. Wear a grounded antistatic wrist strap (see "Electrostatic discharge" on page 79) and take other antistatic precautions *before* you open the analyzer chambers.

Some analyzer parts should not be disturbed

The mass filters (quadrupoles) require no periodic maintenance. In general, a mass filter should never be disturbed. In the event of extreme contamination, it can be cleaned, but such cleaning should only be done by a trained Agilent Technologies service representative. The HED insulator must never be touched.

CAUTION Incorrect handling or cleaning of the mass filter can damage it and have a serious, negative effect on instrument performance. Do not touch the HED insulator.

More information is available

See the *Agilent 7000 Series Triple Quad GC/MS Operating Manual* for information on removing, disassembling, cleaning, assembling, and installation of the ion source. This chapter contains procedures for removing and installing the heaters and sensors for the ion source and the analyzers.

If you need more information about the locations or functions of analyzer components, refer to Chapter 7, "Analyzers and Collision Cell" on page 145.

To remove/reinstall the heater/sensor assembly of the ion source

Materials needed

- Gloves, clean, lint-free
  - Large (8650-0030)
  - Small (8650-0029)
- Hex ball driver, 1.5 mm (8710-1570)
- Hex ball driver, 2.0 mm (8710-1804)
- Hex nut driver, 5.5 mm (8710-1220)

Removal

WARNING **The analyzer, GC/MS interface, and other components in the analyzer chamber operate at very high temperatures. Do not touch any part until you are sure it is cool.**

CAUTION Always wear clean gloves to prevent contamination when working in the analyzer chamber.

CAUTION Make sure you use an antistatic wrist strap and take other antistatic precautions before touching analyzer components.

1. Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
2. Open the front analyzer chamber. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
3. Remove the ion source. See “To remove the EI ion source” in the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
4. Remove the filaments.

5 Separate the source heater assembly from the source body by removing the two screws. The source heater assembly includes the source heater, repeller, and related parts. (See Figure 13.)

6 Disassemble the repeller assembly by removing the repeller nut, washers, ceramic insulators and repeller. (See Figure 13.)

7 Unscrew the interface socket from the source body. A 10 mm open-end wrench fits the flat sides on the interface socket.

CAUTION When disconnecting leads, pull on the connectors, not on the wires.

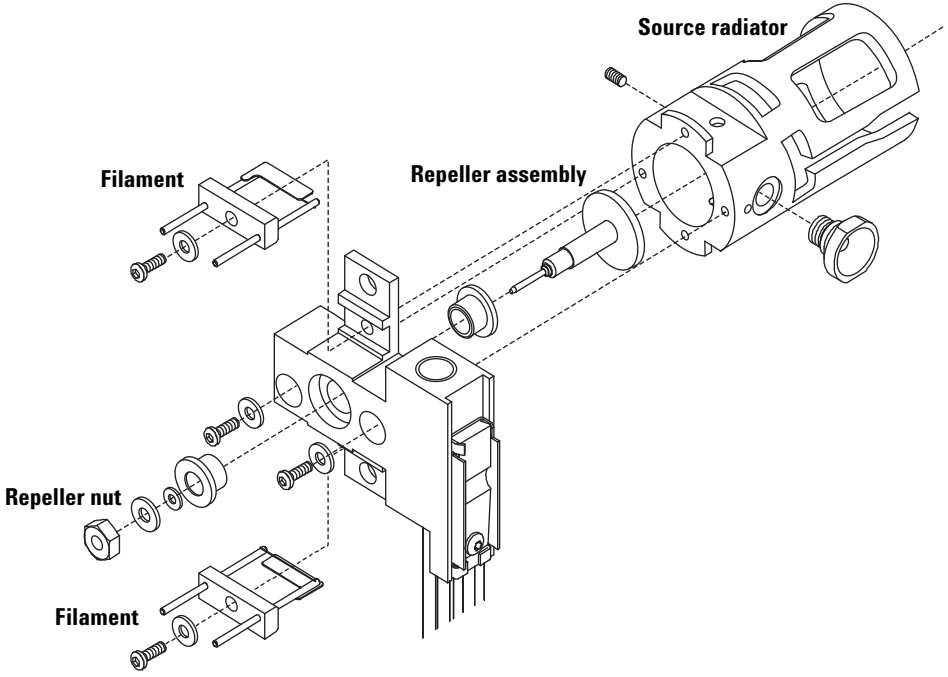

Figure 13 Replacing the heater and sensor

Reinstallation

1 Unpack the new source heater assembly (G3170-60177). The heater, temperature sensor, and heater block are already assembled.

CAUTION Always wear clean gloves to prevent contamination when working in the analyzer chamber.

2 Reinstall the repeller, repeller insulators, washer, and repeller nut (Figure 13). The resulting assembly is called the repeller assembly.

CAUTION Do not overtighten the repeller nut or the ceramic repeller insulators will break when the source heats up. The nut should only be finger-tight.

3 Connect the repeller assembly to the source body with the two screws and washers.

4 Reinstall the filaments.

WARNING **The analyzers, GC/MS interface, and other components in the analyzer chamber operate at very high temperatures. Do not touch any part until you are sure it is cool.**

CAUTION Make sure you use an antistatic wrist strap and take other antistatic precautions before touching analyzer components.

5 Reinstall the ion source in the analyzer chamber.

6 Reconnect the wires from the feedthrough board to the ion source.

7 Reconnect the heater and temperature sensor wires to the feedthrough board.

8 Close the analyzer chamber.

9 Pump down the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

To remove/reinstall the heater and sensor for the mass filter

Materials needed

- Gloves, clean, lint-free
  - Large (8650-0030)
  - Small (8650-0029)
- Hex ball driver, 1.5 mm (8710-1570)
- Hex ball driver, 2.0 mm (8710-1804)

Removal

WARNING **The analyzers, GC/MS interface, and other components in the analyzer chamber operate at very high temperatures. Do not touch any part until you are sure it is cool.**

CAUTION Always wear clean gloves to prevent contamination when working in the analyzer chamber.

CAUTION Make sure you use an antistatic wrist strap and take other antistatic precautions before touching analyzer components.

1. Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
2. Open the front or rear analyzer chamber.

CAUTION When disconnecting leads, pull on the connectors, not on the wires.

3. Disconnect the mass filter heater and temperature sensor wires from the feedthrough board.
4. Remove the mass filter heater assembly from the mass filter radiator by removing the two screws. See Figure 14 for the front mass filter. The rear mass filter heater/sensor removal is similar.

CAUTION Do not touch the mass filter contact leads. This could cause ESD damage to the quadrupole board.

Reinstallation

1. Unpack the new mass filter heater assembly (Figure 14). The heater, temperature sensor, and heater block are already assembled.
2. Install the heater assembly on top of the mass filter radiator using the two screws. See Figure 14 for replacing the front mass filter heater/sensor. The rear mass filter heater sensor is similar.
3. Connect the heater and temperature sensor wires to the feedthrough board.
4. Close the analyzer chamber.
5. Pump down the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

CAUTION Do not touch the mass filter contact leads. This could cause ESD damage to the quadrupole board.

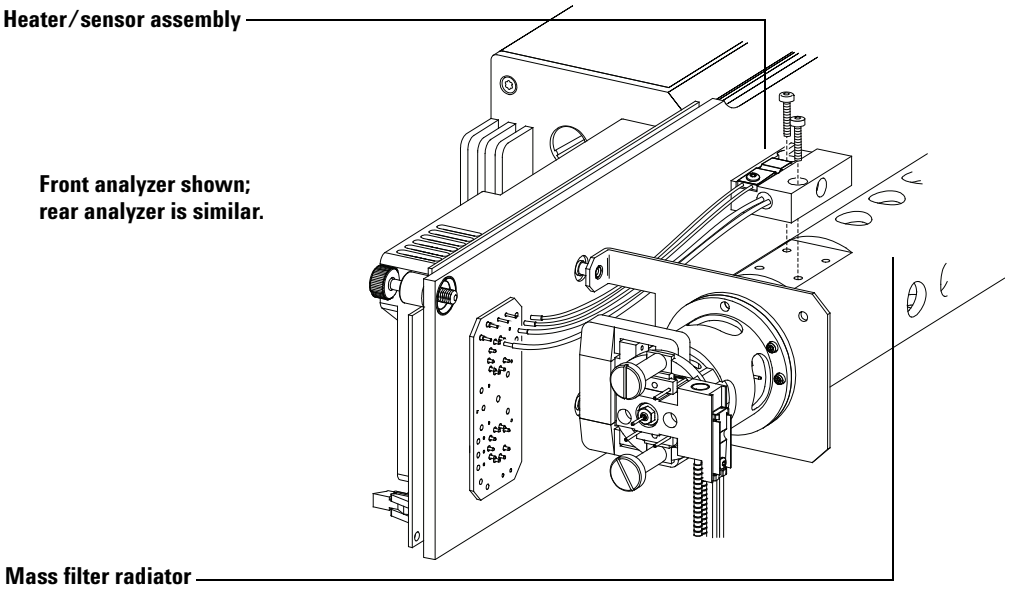

Figure 14 Mass filter heater and sensor

Maintaining the GC/MS Interface

The GC/MS interface requires no periodic maintenance

Rarely, the heater cartridge in the GC/MS interface fails. In those cases, it is necessary to replace the heater and sensor. This section contains procedures for removing the heater and sensor and installing new ones. See Figure 15.

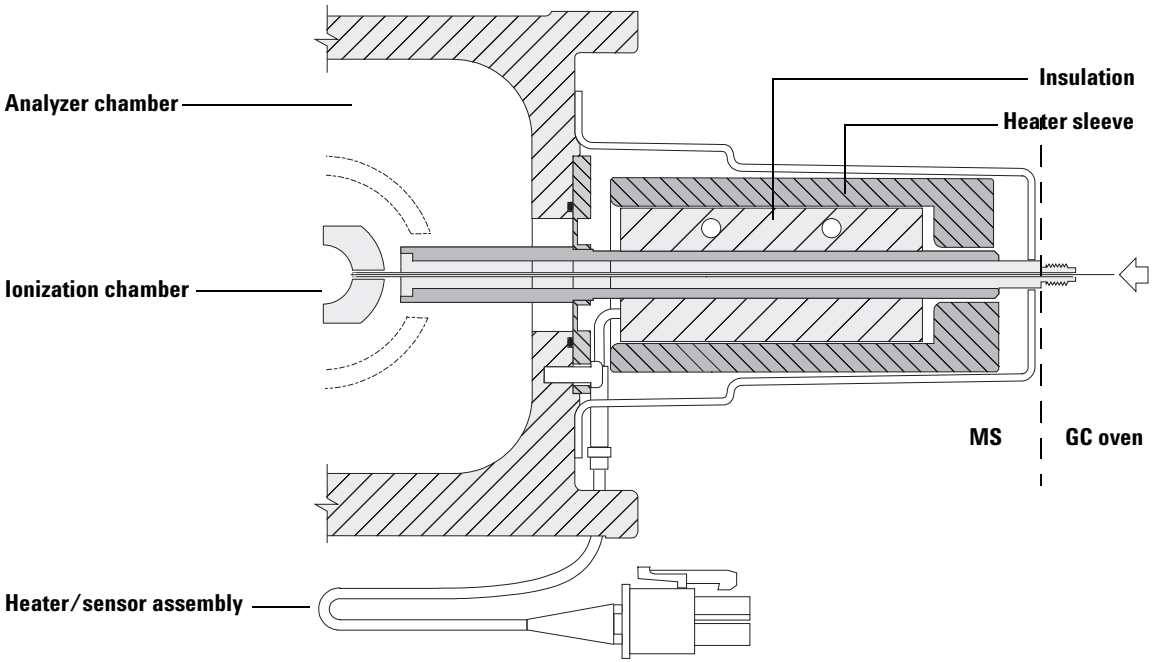

Figure 15 GC/MS interface

To remove/reinstall the GC/MS interface heater and sensor

Materials needed

- Screwdriver, Torx T-15 (8710-1622)
- Hex driver, 1.5 mm (8710-1570)

Removal

1. Vent the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.
2. Make sure you turn off the GC/MS interface heater. This heater is controlled and powered by the GC.
3. Separate the MS from the GC. See "To separate/connect the MS and the GC" on page 86.
4. Remove the cover from the GC/MS interface.

WARNING **The GC/MS interface operates a very high temperatures. It is also well insulated. Make sure the interface is cool *before* you touch it.**

5. Slide the insulation off the GC/MS interface (Figure 16).
6. Loosen the two heater sleeve screws.
7. Slide the heater sleeve off the GC/MS interface. It may be necessary to *gently* pry open the slot in the heater sleeve to loosen the heater sleeve from the interface.
8. Loosen the setscrew and remove the heater and temperature sensor from the heater sleeve.

Heat and oxidation often result in a heater or, less frequently, a temperature sensor, being "welded" inside the heater sleeve. The holes for the heater and sensor pass all the way through the heater sleeve. A rod can be inserted to drive the stuck part out. However, to function correctly, the heater and sensor must have perfect contact with their holes. If a heater or sensor is difficult to remove, the holes will probably be damaged enough that the heater sleeve should be replaced. Polishing the holes is not an acceptable solution since it will enlarge the holes.

CAUTION Installing a new heater and sensor in a damaged heater sleeve will result in poor performance of the heated zone and could reduce the lifetime of the new parts.

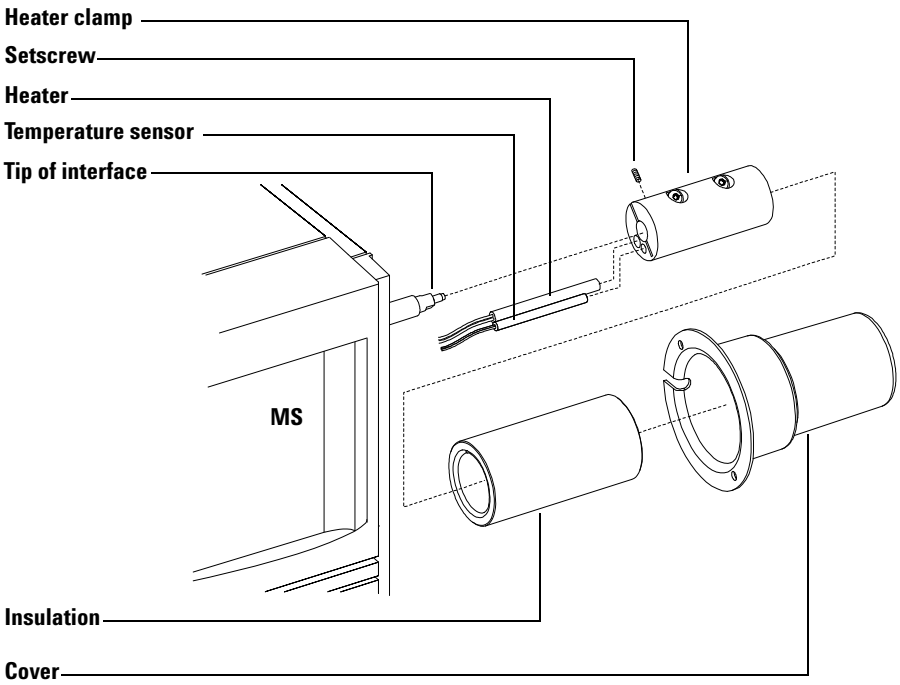

Figure 16 Replacing the GC/MS interface heater and sensor

Reinstallation

Materials needed

- GC/MS interface heater assembly (G1099-60107)
- Heater clamp (G1099-20210); replace the old clamp if it is damaged
- Screwdriver, Torx T-15 (8710-1622)
- Hex driver, 1.5 mm (8710-1570)

1 Slide the new heater and temperature sensor into the heater sleeve (Figure 16).

2 Reinstall the setscrew.

3 Slide the heater sleeve onto the GC/MS interface. Align the heater sleeve so the screws are on top. Tighten the screws evenly.

4 Slide the insulation onto the GC/MS interface.

CAUTION There is a shallow groove along the inner surface of the insulation. This groove *must* line up with the heads of the screws in the heater sleeve. If it does not, you can crack or otherwise damage the insulation.

5 Reinstall the GC/MS interface cover. Make sure the wires from the heater and sensor pass through the cutout in the interface cover.

6 Reconnect the MS to the GC. See step 1 on page 87.

7 Reconnect the GC/MS interface cable to the GC. Reinstall the capillary column.

8 Pump down the MS. See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.

9 Turn on the GC. Enter appropriate temperature setpoints for the GC/MS interface and GC oven.

Maintaining the Electronics

Scheduled maintenance

None of the electronic components of the MS needs to be replaced on a regular schedule. None of the electronic components in the MS needs to be adjusted or calibrated on a regular schedule. Avoid unnecessary handling of the MS electronics.

Electronic components

The primary fuses can be replaced by the operator. All other maintenance of the electronics should be performed by your Agilent Technologies service representative.

WARNING **Improper use of these procedures could create a serious safety hazard. Improper use of these procedures could also result in serious damage to, or incorrect operation of, the MS.**

WARNING **Vent the MS and disconnect its power cord before performing any of these procedures *except* adjusting the RF coils.**

Electrostatic precautions

All of the printed circuit boards in the MS contain components that can be damaged by electrostatic discharge (ESD). Do not handle or touch these boards unless absolutely necessary. In addition, wires, contacts, and cables can conduct ESD to the printed circuit boards to which they are connected. This is especially true of the mass filter (quadrupole) contact wires, which can carry ESD to sensitive components on the quadrupole board. ESD damage may not cause immediate failure but it will gradually degrade the performance and stability of your MS.

When you work on or near printed circuit boards, or when you work on components with wires, contacts, or cables connected to printed circuit boards, always use a grounded antistatic wrist strap and take other antistatic precautions. The wrist strap should be connected to a known good earth

ground. If that is not possible, it should be connected to a conductive (metal) part of the assembly being worked on, but *not* to electronic components, exposed wires or traces, or pins on connectors.

Take extra precautions, such as a grounded antistatic mat, if you must work on components or assemblies that have been removed from the MS. This includes the analyzer.

CAUTION In order to be effective, an antistatic wrist strap must fit snugly (not tight). A loose strap provides little or no protection.

CAUTION Antistatic precautions are not 100% effective. Handle electronic circuit boards as little as possible and then only by the edges. Never touch the components, exposed traces, or pins on connectors and cables.

More information is available

If you need more information about the functions of electronic components, refer to Chapter 8, "Electronics" on page 165.

To replace the primary fuses

Materials needed

- Fuse, 8 A, time-delay slow blow, (2110-0969) – 2 required
- Fuse, 12.5 A, time-delay slow blow, (2110-1398) – 2 required
- Screwdriver, flat-blade (8730-0002)

The most likely cause of failure of the primary fuses is a problem with the foreline pump. If the primary fuses in your MS fail, check the foreline pump.

Procedure

1 Vent the MS (See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*) and unplug the power cord from the electrical outlet.

If one of the primary fuses has failed, the MS will already be off, but for safety you should switch off the MS and unplug the power cord. It is not necessary to allow air into the analyzer chamber.

WARNING **Never replace the primary fuses while the MS is connected to a power source.**

WARNING **If you are using hydrogen as a GC carrier gas, a power failure may allow it to accumulate in the analyzer chamber. In that case, further precautions are required. See "Hydrogen Safety" .**

2 The fuse holders are on the back panel. Turn one of the fuse holders counterclockwise until it pops out. The fuse holders are spring loaded.

3 Examine the fuse. If it is blown, remove the old fuse from the fuse holder.

4 Install a new fuse in the fuse holder. Each holder is marked with the correct fuse value.

5 Reinstall the fuse holder.

6 Repeat for the other three fuses.

4 General Maintenance

5
CI Maintenance

To Minimize Foreline Pump Damage from Ammonia 124
To Replace the Methane/Isobutane Gas Purifier 125
To Clean the Reagent Gas Supply Lines 126
To Refill the CI Calibrant Vial 127

This chapter describes maintenance procedures and requirements that are unique to a 7000 Series Triple Quad GC/MS equipped with the Chemical Ionization hardware.

To Minimize Foreline Pump Damage from Ammonia

Air ballasting for an hour every day removes most of the ammonia from the pump oil. This will greatly increase the life of the pump.

CAUTION Only perform this procedure if the pump is at normal operating temperature. The water vapor in air can cause condensation of the ammonia at the ballast valve if the pump is cold.

Procedure

1 Turn the ballast valve on the foreline pump (Figure 17) until the **1**s are aligned. The sound of the pump will get much louder.

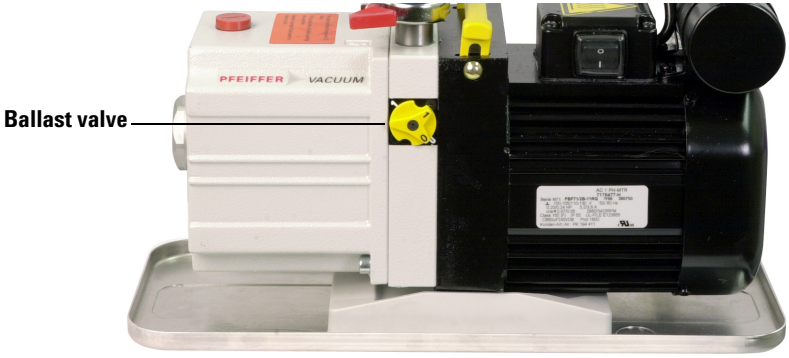

Figure 17 Minimizing ammonia damage

2 Leave the ballast valve open for one hour. You can continue to run samples while the pump is ballasting.

3 Close the ballast valve by aligning the **0**s. Leaving the ballast valve open all the time will result in loss of pump oil and damage to the pump.

CAUTION Always purge the flow module with methane after flowing ammonia. The use of ammonia reagent gas also requires that the foreline pump oil be changed every 2 to 3 months instead of the usual 6 months.

To Replace the Methane/Isobutane Gas Purifier

Materials needed

- Methane/Isobutane gas purifier (G1999-80410)
- Front ferrule for 1/8-inch tubing (5180-4110)
- Rear ferrule for 1/8-inch tubing (5180-4116)
- Tubing cutter (8710-1709)

The methane/isobutane gas purifier needs to be replaced after four tanks of reagent gas. This frequency may vary depending on purity of the gas and care taken in uncapping and installing the gas purifier. A large leak upstream from the gas purifier can quickly exhaust the reduced metal of the oxygen and moisture traps.

Procedure

1 To install the methane/isobutane gas purifier, follow the instructions on the label for installation and replacement intervals.

CAUTION Do not remove the caps until you are ready to install the gas purifier. Only remove the caps in the gas flow to prevent contamination by air.

WARNING **Methane is flammable. Extinguish all flames in the area before turning on gas flow.**

2 Disconnect the fittings on the old filter.

3 Remove the ferrules from the tubing at the outlet of the gas purifier. Using the tubing cutter, cut off the end of the tubing with the ferrules.

4 Install the new filter.

5 Purge the new filter.

6 Cap the old filter and prepare it to be sent for regeneration. See the instructions on the label.

To Clean the Reagent Gas Supply Lines

Materials needed

- Clean, dry nitrogen
- Heat gun
- Tubing cutter (8710-1709)

Procedure

If the reagent gas lines become contaminated, they can be cleaned.

1. Disconnect the reagent gas tubing from the gas supply, the gas purifier, and the MS.
2. Cap the gas purifier following the instructions on the label.
3. Connect one end of the tubing to a supply of clean, dry nitrogen and turn on gas flow.
4. Use the heat gun to warm the tubing, starting at the supply end and working your way to the free end.
5. Repeat for any other pieces of tubing that need to be cleaned.
6. Reconnect the tubing to the gas supply, gas purifier, and MS. Follow the instructions on the gas purifier label.

WARNING **Do not heat the gas tubing when reagent gas is flowing.**

CAUTION Do not put liquids into the tubing. Do not heat the tubing when it is connected to the MS.

To Refill the CI Calibrant Vial

Materials needed

- PFDTD calibrant (8500-8510)

Procedure

1 Set the reagent gas flow to **Gas Off.**

2 Vent the MS.

3 Remove the capillary column from the GC/MS interface.

4 Pull the MS away from the GC to expose the calibration vial and valve. See page 86.

5 Loosen the collar holding the calibration vial in place. Do not remove the collar.

6 Remove the calibrant vial. See Figure 18.

CAUTION

Do ***not*** rinse the vial with any solvents. ***Never*** expose the inside of the vial to chlorinated solvents or isopropyl alcohol or water — this will result in severe loss of CI sensitivity.

7 Fill the vial no higher than the bottom of the internal tube with fresh PFDTD calibrant (8500-8510).

8 Replace the vial and tighten the collar.

9 Reposition the MS next to the GC. See page 86.

10 Reinstall the capillary column.

11 Pump down the MS.

12 In **Instrument Control** panel, select the **MS Tune** icon to display the **GC-QQQ Tune** dialog box. Select the **Manual Tune** tab then select the **Ion Source** tab to display the ion source parameters.

13 Turn off the **Emission** by clicking in the check box.

CAUTION

After removing a calibrant vial, you ***must*** purge the calibration valve. Failure to do so will result in damage to the filaments and the electron multiplier.

14 Purge the calibration valve by clicking in the **CI Cal Valve** check box to open the calibration valve. Close the **CI Cal Valve** after 30 seconds.

CAUTION After removing the calibrant vial, you ***must*** purge the calibration valve. Failure to do so will result in severe contamination of the ion source and damage to the filament and electron multiplier.

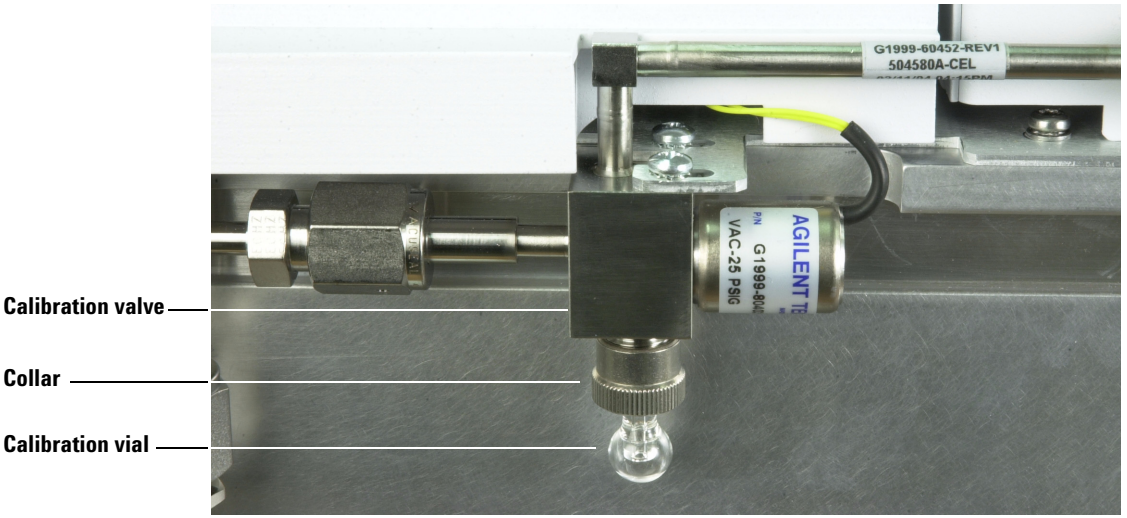

Figure 18 CI calibration valve and vial

6
Vacuum System

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This chapter describes components of the 7000 Triple Quad GC/MS vacuum system.

Overview

The vacuum system creates the high vacuum (low pressure) required for the GC/MS to operate. Without the vacuum, the molecular mean free path would be very short and ions would collide with air molecules before they could reach the detector. Operation at high pressures also would damage analyzer components.

The 7000 Series Triple Quad GC/MS uses two vacuum pumps to obtain the vacuum levels needed. The foreline pump creates a low vacuum, then a high vacuum pump engages to create the vacuum needed for operation. The 7000 Series Triple Quad GC/MS uses one turbomolecular (turbo) pump.

Most of the vacuum system operation is automated. Operator interaction and monitoring is accomplished through the data system.

Vacuum System Components

The parts of the vacuum system are:

- Foreline (rough) pump
- High-vacuum turbo pump
- Front and rear analyzer chambers
- Collision cell cover
- Side plates (analyzer doors), and front and rear end plates
- Vacuum seals
- Calibration valve and vent valve
- Vacuum control electronics
- Vacuum gauges and gauge control electronics

Each of these is discussed in more detail in this chapter.

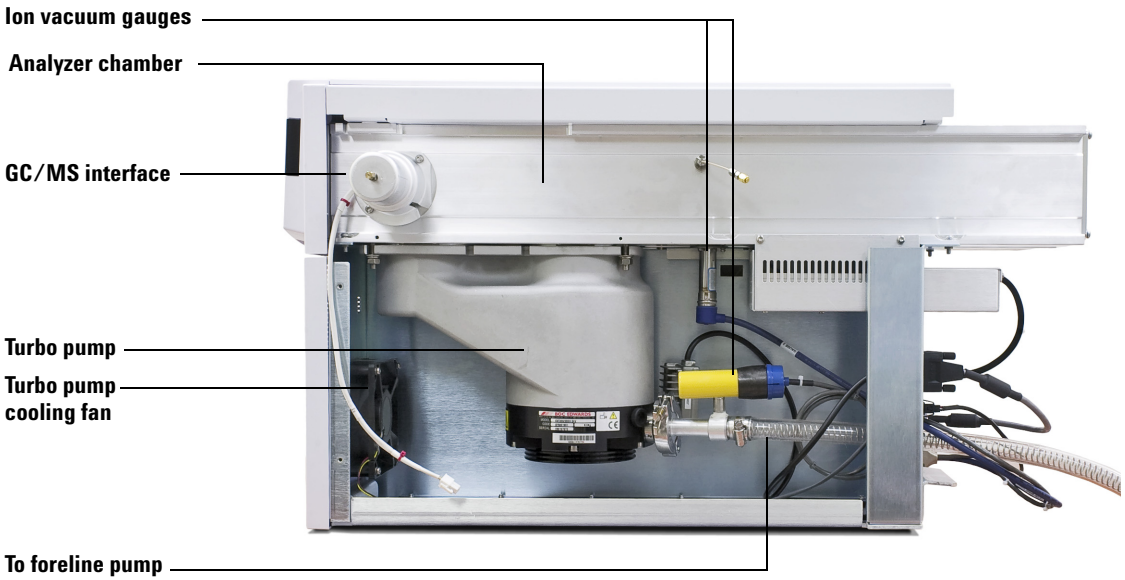

Figure 19 Major vacuum system components

Common Vacuum System Problems

Air leak symptoms

The most common problems associated with any vacuum system are air leaks. Symptoms of air leaks include:

- Loud gurgling noise from the foreline pump (very large leak)
- Inability of the turbo pump to reach 95% speed
- Higher than normal high-vacuum gauge controller readings

The 7000 Triple Quad will *not* pump down successfully unless you press on the side boards (analyzer doors) when you turn on the MS power. Continue to press until the sound from the foreline pump becomes quieter.

Pumpdown failure shutdown

The system will shut down both the high-vacuum and the foreline pump if the system fails to pump down correctly. It takes approximately 10 minutes for the foreline pump to achieve 300 mTorr, which then starts the turbo pump. If the turbo pump speed is below 80% after an additional 10 minutes, the system shuts down.

This is usually because of a *large* air leak: either the side plates have not sealed correctly or the vent valve is still open. We suggest this pumpdown sequence:

1. Leave the vent valve partially open.
2. Start the pumpdown while holding the side plates closed.
3. When you hear a hissing sound, release the side plates and close the vent valve.

To restart the MS, find and correct the air leak, then switch the power off and on. Be sure to press on the side plates when turning on the MS power to ensure good seals.

Foreline Pump

The foreline pump reduces the pressure in the analyzer chamber so the high-vacuum pump can operate. It also pumps away the gas load from the high-vacuum turbo pump. The foreline pump is connected to the high-vacuum pump by a 130-cm hose called the foreline hose.

Figure 20 shows the standard pump; the high-throughput pump is similar.

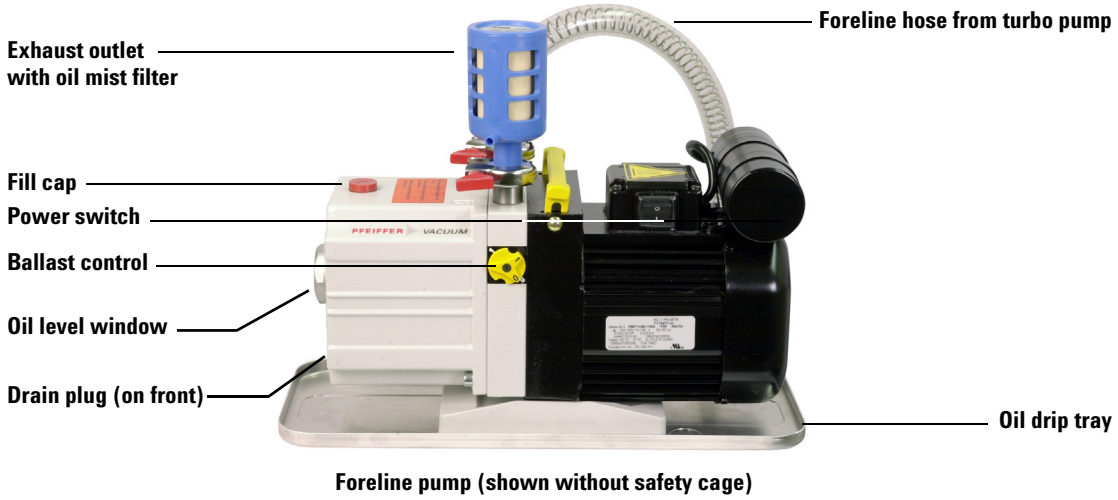

Figure 20 The foreline pump

The foreline pump is a two-stage rotary-vane pump. The pump turns on when the MS power is turned on. The foreline pump has a built-in check valve to help prevent backstreaming in the event of a power failure.

The foreline pump is usually on the floor below the MS.

An oil trap (not shown) is available for the pump that can be used to filter pump oil out of the foreline pump exhaust. This trap stops *only* pump oil. Do not use the trap if you are analyzing toxic chemicals or using toxic solvents. Instead, install an 11-mm id hose to remove the exhaust from your lab.

WARNING **The oil trap supplied with the foreline pump stops only foreline pump oil. It does not trap or filter out toxic chemicals. If you are using toxic solvents or analyzing toxic chemicals, remove the oil trap. do not use the trap if you are using a CI MS. Install a hose to take the foreline pump exhaust outside or to a fume hood.**

CAUTION Do not place the foreline pump near any equipment that is sensitive to vibration.

CAUTION The ballast control knob controls the amount of air allowed into the pump. Keep the ballast control closed (fully clockwise) at all times, except when ballasting the pump.

A window (sight glass) in the front of the foreline pump shows the level of the foreline pump oil. There are two marks next to the window. The level of the pump oil should never be above the upper mark or below the lower mark. If the level of pump oil is near the lower mark, add foreline pump oil.

The oil pan under the foreline pump can be a fire hazard

Oily rags, paper towels, and similar absorbents in the oil pan could ignite and damage the pump and other parts of the MS.

WARNING **Combustible materials (or flammable/nonflammable wicking material) placed under, over, or around the foreline (roughing) pump constitutes a fire hazard. Keep the pan clean, but do not leave absorbent material such as paper towels in it.**

Turbo Pump

The 7000 Series Triple Quad has one turbo pump.

The turbo pump chambers have screens to keep debris out of the pump. Pump speed is controlled by the turbo controller.

Analyzer Chambers

The analyzer chambers (Figure 21) are located inside the vacuum manifold. The manifold is extruded and machined from an aluminum alloy. Large openings in the side, front, rear, and top of the manifold are closed by plates and sealed by O-rings. Ports in the manifold and the plates provide attachment points for the ion vacuum gauge, calibration valve, vent valve, collision cell, GC/MS interface, and high-vacuum pump.

The turbo pump is bolted directly to the bottom of the manifold.

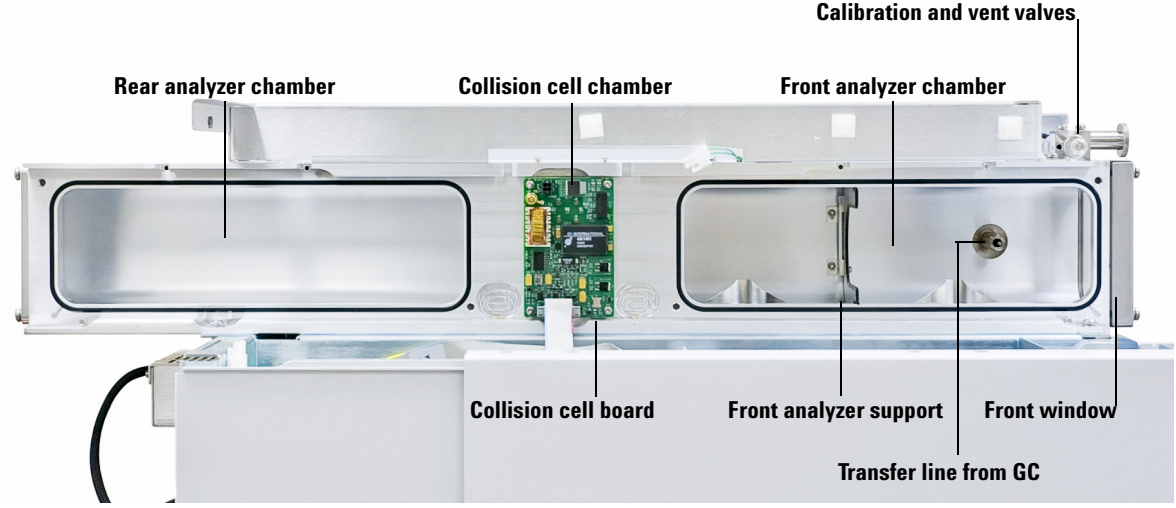

Figure 21 Analyzer chambers

Side Plates

The side plates cover the large openings in the side of the manifold. They are attached to the manifold with hinges. The analyzer assemblies are attached to the side plates inside the analyzer chambers. The hinges allow the side plates to swing away from the manifold for easy access to the analyzers.

The front side plate carries the front quadrupole driver and the filament drive. The rear side plate carries the rear quadrupole driver and the detector board.

Several electrical feedthroughs are built into the side plates. Wires connect the feedthroughs to analyzer components.

Thumbscrews are located at each end of the side plates. We recommend that the thumbscrews be loosely tightened

CAUTION Fasten both side plate thumbscrews for shipping or storage only. For normal operation, both thumbscrews should be loose. For operation with hydrogen carrier gas, or with flammable or explosive reagent gases, the top thumbscrews on the analyzer side plates should be fastened just finger-tight. Overtightening will warp the side plate and cause air leaks. Do not use a tool to tighten the side plate thumbscrews.

CAUTION When you turn on the power to pump down the MS, be sure to press on the side boards to ensure good seals.

Vacuum Seals

Vacuum seals are shown in Figure 22.

Several types of Viton elastomer O-ring seals are used to prevent air leaks into the analyzer chamber. All these O-rings, and the surfaces to which they seal, must be kept clean and protected from nicks and scratches. A single hair, piece of lint, or scratch can produce a serious vacuum leak. Three of the O-rings are *lightly* lubricated with Apiezon-L vacuum grease: the side plate O-rings and the vent valve O-ring.

Face seals

A face seal is an O-ring that fits in a shallow groove. The sealing surface is usually a flat plate. The manifold side plates and end plate O-rings fit into grooves around the large openings in the analyzer chamber. The side plate swings into place against the side plate O-ring, and must be held in place when the MS is turned on for pumpdown to ensure a good seal.

The front and rear end plates are screwed onto the manifold and should not need to be removed. The GC/MS interface fastens to the manifold with three screws.

The calibration valve assembly is fastened onto the front end of the manifold by two screws. The vent valve knob threads into the front end plate. Small O-rings in grooves in the front end plate provide vacuum seals.

KF (NW) seals

Most of the seals for the high-vacuum pumps, foreline gauge, and foreline pump are KF seals. KF seals have an O-ring supported by a centering ring. The centering ring can be either on the inside or the outside of the O-ring. The clamp presses two flanges against the O-ring, making a seal. KF clamps must not be overtightened.

Compression seals

A compression fitting consists of a threaded fitting on the analyzer chamber and a threaded collar with a ferrule and O-ring. A cylindrical part fits inside the collar. Tightening the collar presses the ferrule, compressing the O-ring around the part. The calibration vials use compression seals.

High-voltage feedthrough seal

The high-voltage (HED) feedthrough seal is an O-ring that is compressed against the side plate by a threaded collar.

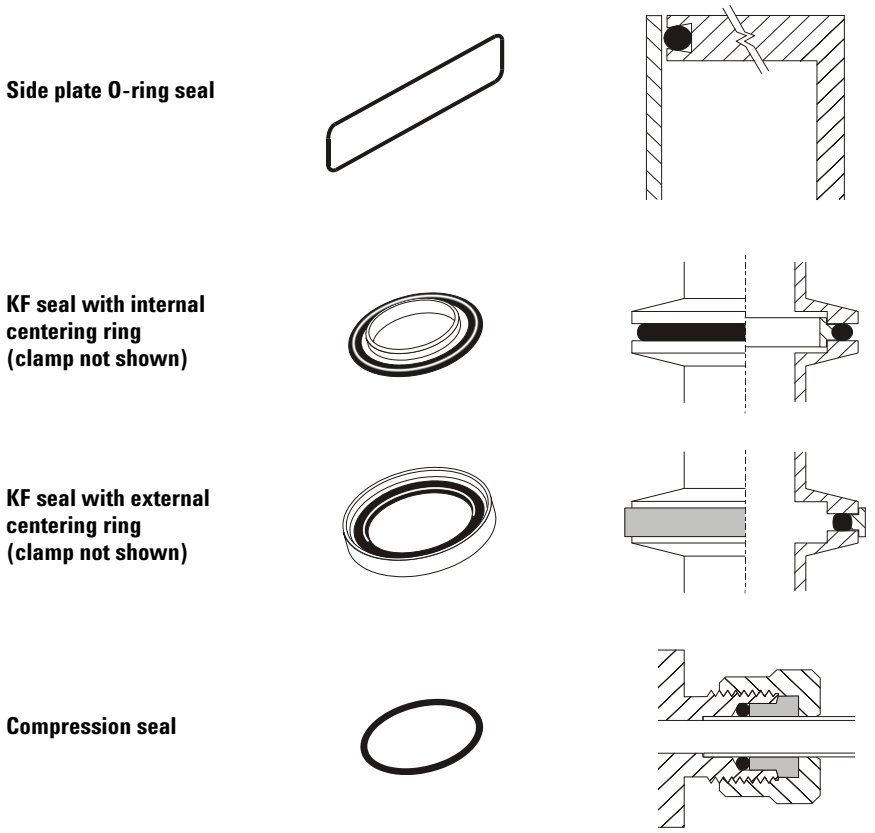

Figure 22 Vacuum seals

Foreline Gauge

The foreline gauge monitors the pressure (vacuum) at the exit of the turbo pump. The primary function of the foreline gauge is pump control. When the foreline pump has reduced the pressure in the analyzer chamber to below 300 mTorr (0.3 Torr), the turbo pump is automatically switched on. If the foreline pressure rises above 400 mTorr (0.4 Torr), the AC board switches off the analyzer electronics.

Turbo Pump and Fan

The turbo pump is bolted directly to the bottom of the manifold.

The main inlet to the turbo pump is under the front analyzer. A secondary inlet is near the ion source. The pump body is a central shaft or cylinder. Sets of small blades (airfoils) radiate from the central shaft. The shaft spins at up to 60,000 revolutions per minute (rpm).

Turbo pumps move gas by momentum transfer. The turbine blades are angled so that when they strike a gas molecule it is deflected downward. Each set of blades pushes the gas molecules further down toward the pump outlet.

The foreline pump is connected by a hose to the outlet of the turbo pump. It removes the gas molecules that reach the outlet.

A controller regulates current to the pump and monitors pump motor speed and temperature. A cooling fan is located between the turbo pump and the front panel of the MS. The fan draws air from outside the MS and blows it over the pump.

The turbo pump turns on automatically when the foreline pump has reduced the pressure below 300 mTorr. The system allows the analyzer to be turned on when the turbo pump is greater than 80% speed, but the pump normally operates at 100% speed. Turbo pump MSs typically maintain an indicated pressure below 8×10^{-5} Torr for helium column flows up to 4 mL/minute.

The turbo pump spins up (starts) and spins down (stops) quickly. This simplifies pumpdown and venting. From initial power-on, the system can pump down to operating pressure in 5 to 10 minutes.

See Also

- To pump down the MS *(*See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual.)*
- To vent the MS *(*See the *Agilent 7000 Series Triple Quad GC/MS Operation Manual*.)

Calibration Valve and Vent Valve

Calibration valve

A calibration valve (Figure 23 and Figure 24) is an electromechanical valve with a vial to hold the tuning compound. When a calibration valve is opened, tuning compound in the vial diffuses into the ion source. The valves are controlled by the MassHunter Workstation software.

EI Calibration Valve

The EI calibration valve is held onto the top of the analyzer chamber by two screws. A small O-ring provides a face seal.

Perfluorotributylamine (PFTBA) is the most commonly used tuning compound for EI operation. PFTBA is required for automatic tuning of the MS.

CI Calibration Valve

The CI tuning compound is perfluoro-5,8-dimethyl-3,6,9-trioxidodecane (PFDTD). The CI calibration valve is part of the reagent gas flow control module. It is controlled by the MassHunter Workstation software. It opens automatically during CI autotune or manual tuning, allowing PFDTD to diffuse through the GC/MS interface and into the ion source.

Vent valve

The vent valve knob (Figure 25) screws into a threaded port in the front of the calibration valve. An O-ring is compressed between the knob and the valve to form a seal. The threaded end of the knob has an air passage inside it, allowing air to flow into the manifold when the knob is partially unscrewed. If you turn the knob too far, the O-ring can come out of its slot.

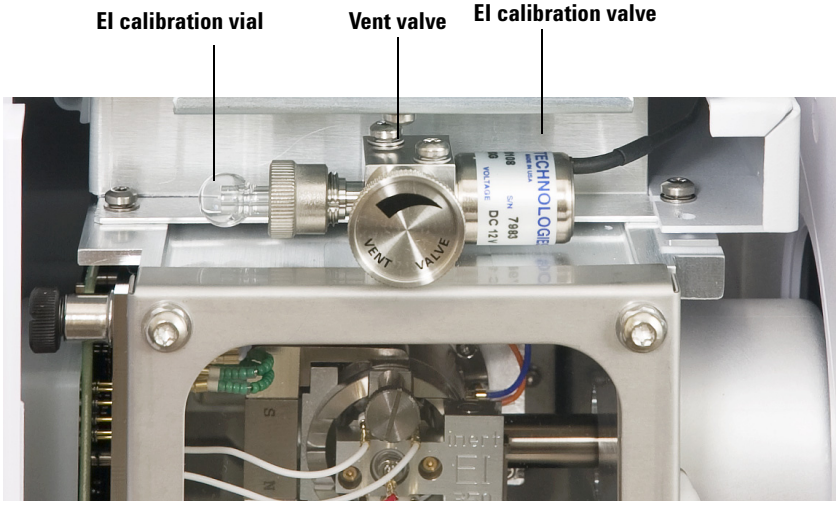

Figure 23 Triple quad vent valve and EI calibration valve

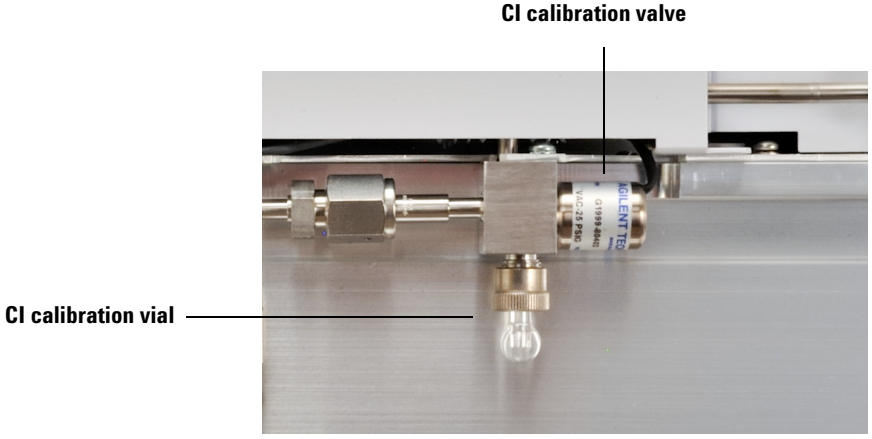

Figure 24 CI calibration valve

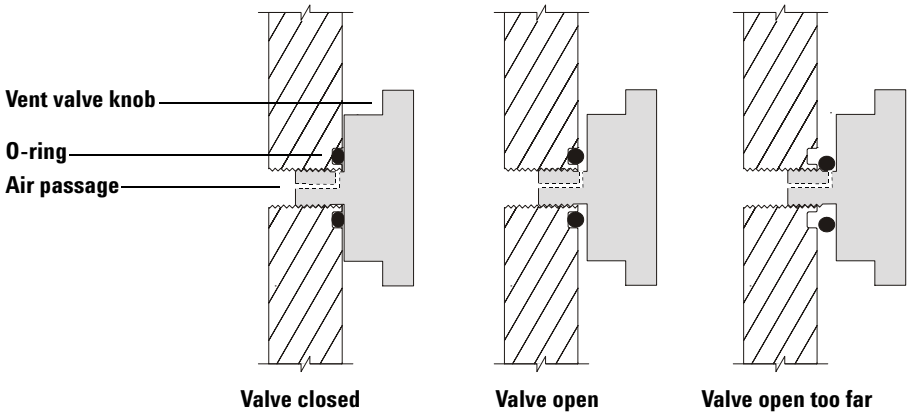

Figure 25 Vent valve

6 Vacuum System

7
Analyzers and Collision Cell

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Overview

The complete analyzer system is shown in Figure 26.

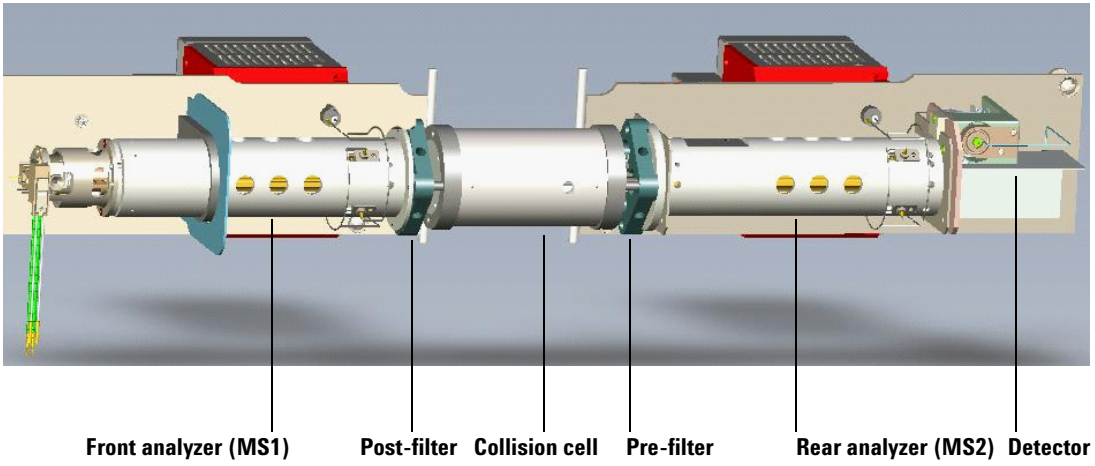

Figure 26 The analyzer system

The front analyzer

The front analyzer consists of the ion source, the front quadrupole, heaters/sensors, and the post-filter.

The sample components exiting the GC column flow into the ion source. In the ion source, the sample molecules are ionized and fragmented. The resulting ions are repelled from the ion source into the front quadrupole mass filter. The selected ions pass through the filter, and post-filter, and enter the collision cell.

The post-filter

This device, located on the end of the front quadrupole, helps transfer the selected ions to the collision cell. It also aligns the front of the collision cell with the front analyzer.

The collision cell

The precursor ions selected by the front quadrupole collide with a reaction gas, typically a nitrogen/helium mixture. This generates additional product ions.

The pre-filter

This device, located on the entrance of the rear analyzer, transfers the remaining precursor ions and the product ions generated in the collision cell to the rear analyzer. It also aligns the rear of the collision cell with the rear analyzer.

The rear analyzer

The rear analyzer consists of the rear quadrupole, the detector, and a heater/sensor assembly.

The ion stream now consists of the ions selected by the front analyzer and the ions formed by collision with the reaction gas. The rear analyzer separates these ions and passes them to the detector.

The detector

Ions that pass the rear analyzer strike a high-energy dynode, where they generate secondary electrons. These enter a multiplier and are collected to become the output signal.

EI Ion Source

The EI ion source (Figure 27) operates by electron impact ionization. The sample enters the ion source from the GC/MS interface. Electrons emitted by a filament enter the ionization chamber, guided by a magnetic field. The high-energy electrons interact with the sample molecules, ionizing and fragmenting them. The positive voltage on the repeller pushes the positive ions into the lens stack, where they pass through several electrostatic lenses. These lenses concentrate the ions into a tight beam, which is directed into the mass filter.

Ion source body

The ion source body (Figure 27) is a cylinder. It holds the other parts of the ion source, including the lens stack. With the repeller and the drawout plate, it forms the ionization chamber. The ionization chamber is the space where the ions are formed. Slots in the source body help the vacuum system to pump away carrier gas and un-ionized sample molecules or fragments.

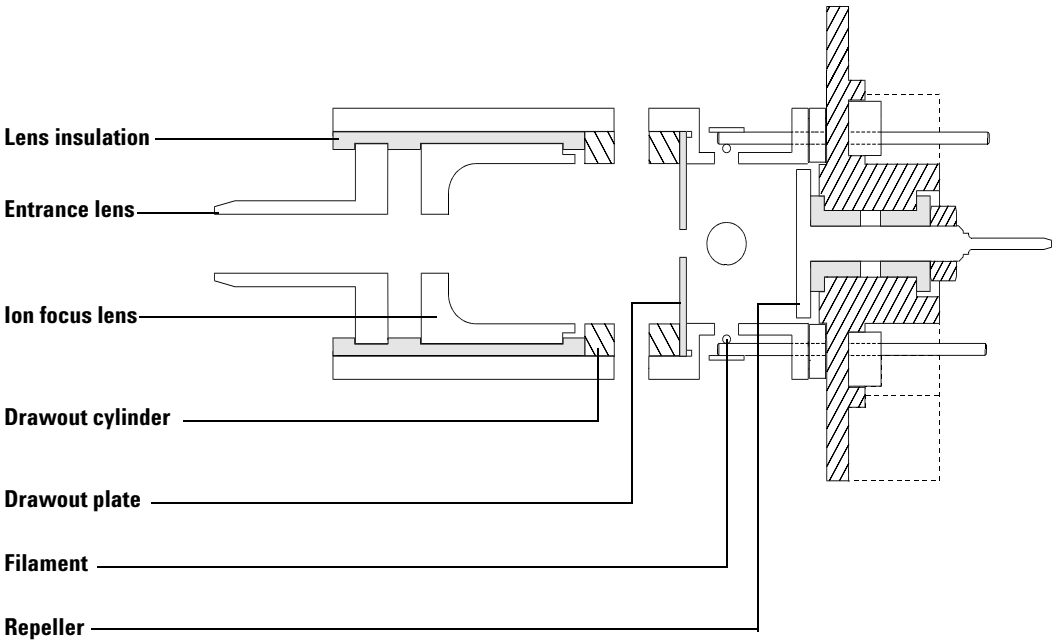

Figure 27 Ion source structure

The CI ion source is similar in design, but critical dimensions are different. Do not interchange parts.

CI Ion Source

The CI ion source (Figure 28 and Figure 29) is similar to the EI source, but only has one part in common with the EI source – the entrance lens. The single CI filament has a straight wire and a reflector. A “dummy” filament provides connections for the other wires.

The holes in the ion source (electron-entrance and ion-exit) are very small (0.5 mm), making it possible to pressurize the ionization chamber. Both the source body and the plate are at repeller potential, electrically isolated from the radiator and the CI interface tip. The seal for the interface tip ensures a leak-tight seal and electrical isolation between the CI interface and ion source.

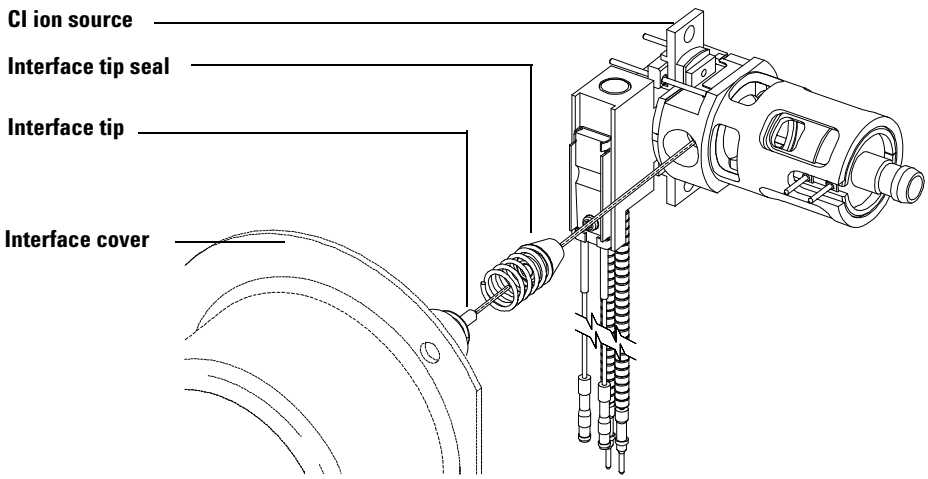

Figure 28 CI ion source tip seal

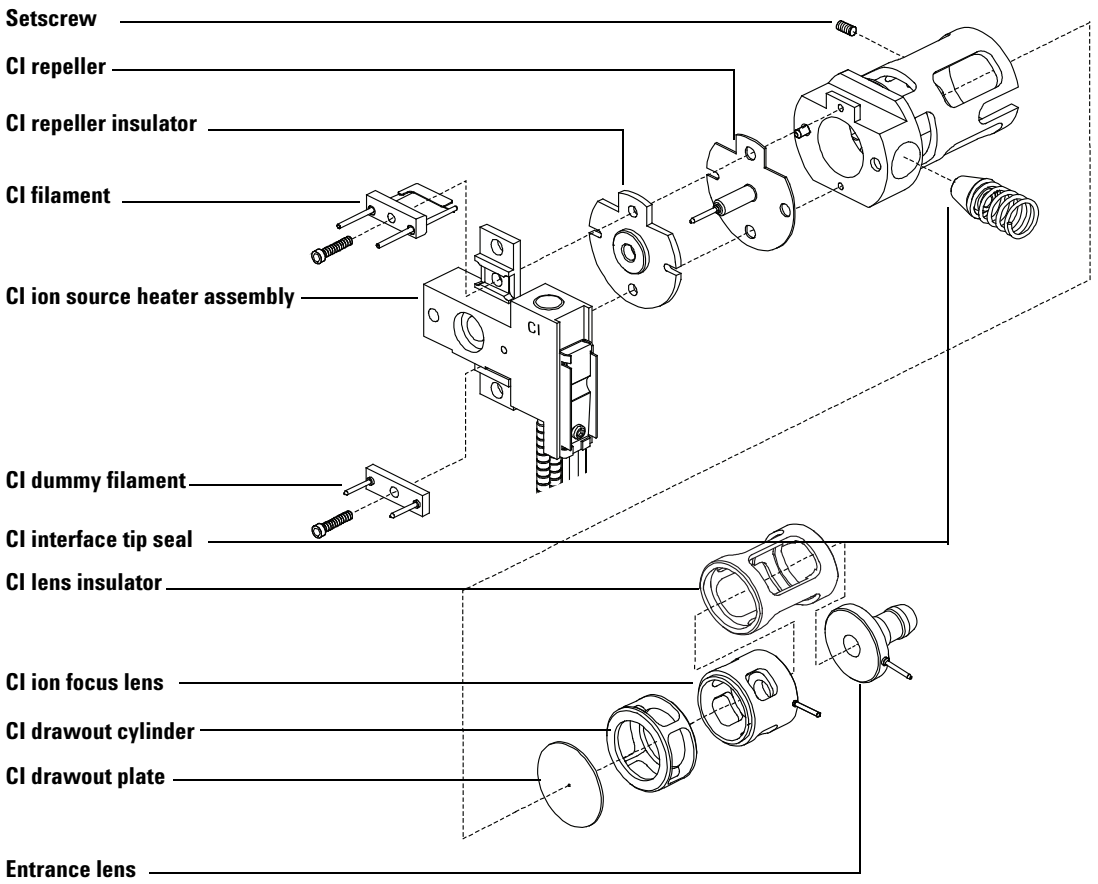

Figure 29 CI ion source exploded view

Filaments

Two filaments (Figure 27 and Figure 29) are located on opposite sides of the outside of the EI ion source. The *active* filament carries an adjustable AC emission current. The emission current heats the filament causing it to emit electrons which ionize the sample molecules. In addition, *both* filaments have an adjustable DC bias voltage. The bias voltage determines the energy on the electrons, usually –70 eV.

The CI ion source has only one filament of a different design from the EI filaments. A “dummy” filament provides connections for the Filament 2 wires.

The filament is shut off automatically if there is a general instrument shutdown. Three parameters affect the filaments: filament selection (Filament), filament emission (Emission) current, and electron energy (EIEnrgy).

Filament selection

The filament selection parameter (Filament) selects which filament in the ion source is active. In the CI source, it is always Filament 1.

Since filaments may have some variability, we advise running a tune for each filament and saving the tune accordingly.

Emission current

The filament emission current (Emission) is variable between 0 and –315 µA, but should be set to the software default for normal operation.

Electron energy

The electron energy (EIEnrgy) is the amount of energy on the ionizing electrons. It is determined by the bias voltage; –70 VDC bias on the filament causes emitted electrons to possess –70 eV (electron volts). This value is adjustable from –5 to –241 VDC, but for normal operation, set this parameter to 70.

Filament care

Like the filaments in incandescent light bulbs, the ion source filaments will eventually burn out. Certain practices will reduce the chance of early failure:

- Use the ion vacuum gauge to verify that the system has an adequate vacuum before turning on the analyzer, especially after any maintenance was performed.
- When setting up data acquisition parameters, set the solvent delay so that the analyzer will *not* turn on while the solvent peak is eluting.
- When the software prompts **Override solvent delay?** at the beginning of a run, *always* select **NO**.
- Higher emission current will reduce filament life.
- Higher electron energy will reduce filament life.
- Leaving the filament on for short times ($\leq$ 1 minute) during data acquisition will reduce filament life.

Other Source Elements

Magnet

The field created by the magnet directs the electrons emitted by the filament into and across the ionization chamber. The magnet assembly is a permanent magnet with a charge of 350 gauss in the center of the field.

Repeller

The repeller (Figure 27) forms one wall of the ionization chamber. A positive charge on the repeller pushes positively charged ions out of the source through a series of lenses. The repeller voltage is also known as the ion energy, although the ions only receive about 20% of the repeller energy. The repeller voltage can be varied from 0 to +42.8 VDC. Some tune programs use a fixed repeller voltage. Others ramp the repeller voltage to find the optimum setting.

- Setting repeller voltage too low results in poor sensitivity and poor high mass response.
- Setting repeller voltage too high results in precursors (poor mass filtering) and poor low mass resolution.

Drawout plate and cylinder

The drawout plate on a standard EI ion source (Figure 27) forms another wall of the ionization chamber. The ion beam passes through the hole in the drawout plate and into the drawout cylinder. The drawout cylinder is slotted. The slots correspond to slots in the source body. These slots allow carrier gas and un-ionized sample molecules or fragments to be pulled away by the vacuum system. The drawout plate and drawout cylinder are both at ground potential.

Extractor lens

The extractor lens is a part of the EI extractor ion source. This lens replaces the drawout plate and cylinder on a standard EI ion source, but performs a similar function. A voltage is applied to the extractor lens to increase focusing in the EI ion source.

Ion focus

The voltage on the ion focus lens (Figure 27) can be varied from 0 to –127 VDC. A typical voltage is between –70 and –90 VDC. In general:

- Increasing the ion focus voltage improves sensitivity at lower masses.
- Decreasing the ion focus voltage improves sensitivity at higher masses.
- Incorrect ion focus adjustment results in poor high mass response.

Entrance lens

The entrance lens (Figure 27) is at the entrance to the quadrupole mass filter. This lens minimizes the fringing fields of the quadrupole which discriminate against high-mass ions. There is a permanent +4.4 volt voltage added to the entrance lens. The total voltage applied to the entrance lens is the sum of the entrance lens offset and entrance lens gain and the +4.4 volt permanent offset.

Entrance lens voltage = +4.4 VDC + offset + (gain × mass)

Quadrupole Mass Filters

The mass filters separate ions according to their mass-to-charge ratio (m/z). At a given time, only ions of a selected mass-to-charge ratio can pass through the filter to the detector. The mass filters in the MS are quadrupoles (Figure 30).

The quadrupole is a set of four fused-silica (quartz) rods coated with a thin layer of gold. The four hyperbolic surfaces create the complex electric fields necessary for mass selection. Opposing rods are connected; adjacent rods are electrically isolated. One pair has positive voltages applied, the other negative.

A combined direct current (DC) and radio frequency (RF) signal is applied to the two pairs of rods. The magnitude of the RF voltage determines the mass-to-charge ratio of the ions that pass through the mass filter and reach the detector. The ratio of DC-to-RF determines the resolution (widths of the mass peaks). There are several parameters that control the DC and RF voltages. All these parameters are set by Autotune, but also can be manually adjusted in the Edit Parameters window:

- Width gain
- Width offset
- DC polarity
- Mass axis gain
- Mass axis offset

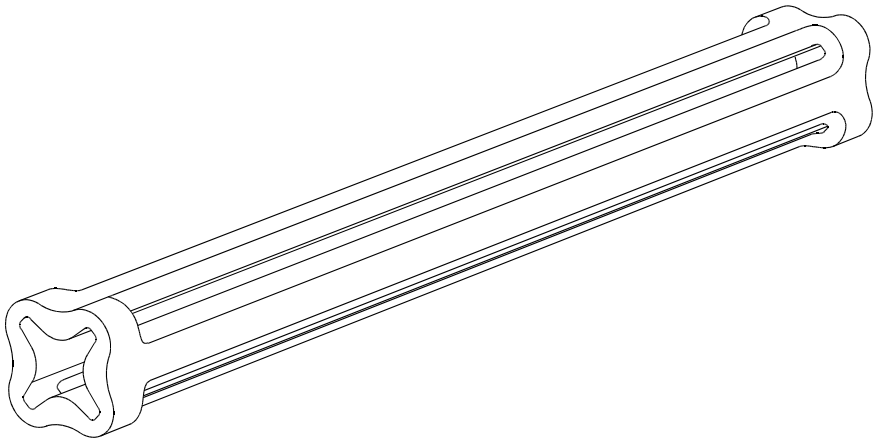

Figure 30 Quadrupole mass filter

Width gain

Width gain affects the ratio of DC voltage to RF frequency on the mass filter. This controls the widths of the mass peaks.

- Higher gain yields narrower peaks.
- Width gain affects peaks at high masses more than peaks at low masses.

Width offset

Width offset also affects the ratio of DC voltage to RF frequency on the mass filter.

- Higher offset yields narrower peaks.
- Width offset generally affects peak widths equally at all masses.

CAUTION Using the nonpreferred DC polarity may result in very poor performance. Always use the factory-specified polarity.

Mass gain

Mass gain controls the mass assignment, that is, assignment of a particular peak to the correct *m/z* value.

- A higher gain yields higher mass assignment.
- Mass gain affects peaks at high masses more than peaks at low masses.

Mass axis offset

Mass offset also controls the mass assignment.

- A higher offset yields higher mass assignment.
- Mass offset generally affects peaks equally at all masses.

Quadrupole maintenance

The mass filter requires no periodic maintenance. It should not be removed from the radiator. If *absolutely* necessary (that is, if the only alternative is replacement), the quadrupole can be cleaned. Cleaning *must* be performed by Agilent Technologies service personnel.

CAUTION

Never put the quadrupole in an ultrasonic cleaner.

Never change the physical orientation of the quadrupole mass filter.

The fused-quartz quadrupole is fragile and will break if dropped or handled roughly.

The material in the cusps of the quadrupole is very hygroscopic. If exposed to water, the quadrupole must be dried very slowly to prevent damage.

Post- and Pre-Filters

These four-electrode devices are located at the end of the front analyzer and the beginning of the rear analyzer. They have three purposes:

- Support and align the collision cell between the two analyzers.
- Direct the selected ion stream into the collision cell.
- Direct the precursor ions and the product ions into the rear analyzer.

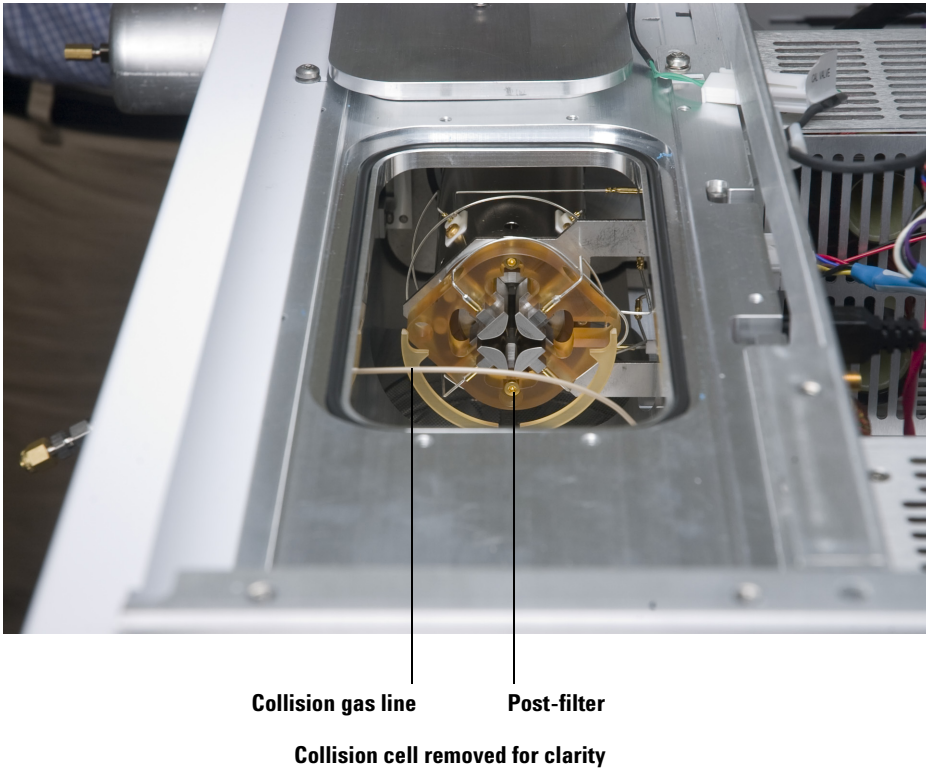

Figure 31 Post-filter

Collision Cell

The collision cell requires no periodic maintenance.

The cell houses a hexapole (this is the second of the three quadrupoles) containing a reaction gas, typically a nitrogen/helium mixture. Precursor ions from the front analyzer may interact with the reaction gas to form product ions.

When the front and rear analyzer doors close, alignment pins on the collision cell engage the post- and pre-filters. They lift the collision cell from its cradle and align it with the two analyzers.

The ion stream is passed on to the rear analyzer.

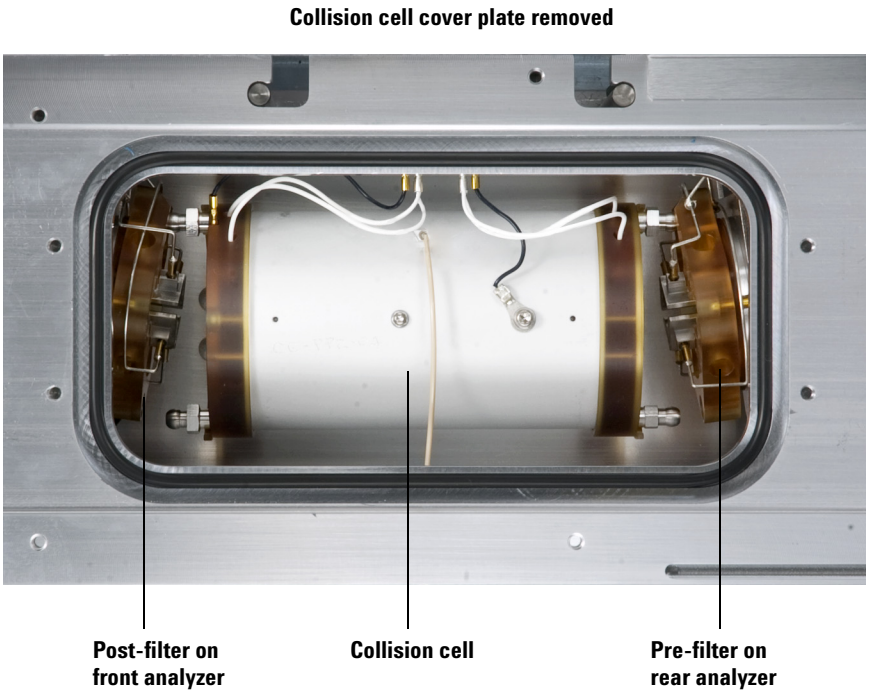

Figure 32 Collision cell in place, analyzer doors open

Detector

The detector (Figure 33) in the MS analyzer is a high energy conversion dynode (HED) coupled to an electron multiplier (EM). The detector is located at the exit of the rear analyzer. It receives the ions that have passed through the mass filter. The detector generates an electronic signal proportional to the number of ions striking it. The detector has three main components: the detector ion focus, the HED and the EM horn.

Detector ion focus

The detector ion focus directs the ion beam into the HED, which is located off axis. The voltage on the detector focus lens is fixed at –600 V.

High-energy dynode

The HED operates at –10,000 volts for EI. It is located off-axis from the center of the quadrupole mass filter to minimize signals due to photons, hot neutrals, and electrons coming from the ion source. When the ion beam hits the HED, electrons are emitted. These electrons are attracted to the more positive EM horn. Do not touch the insulator.

EM horn

The EM horn carries a voltage of up to –3000 volts at its opening and 0 volts at the other end. The electrons emitted by the HED strike the EM horn and cascade through the horn, liberating more electrons as they go. At the far end of the horn, the current generated by the electrons is carried through a shielded cable outside the analyzer to the signal amplifier board.

The voltage applied to the EM horn determines the gain. The voltage is adjustable from 0 to –3000 VDC. Use the EM voltage found in autotune as a baseline for the EM voltage setting.

- To increase signal gain, increase the EM voltage.
- For concentrated samples where less signal gain is needed, decrease the EM voltage.

As the EM horn ages, the voltage (EMVolts) required increases over time. If the EM voltage must always be set at or near –3000 VDC to complete Autotune, with no other probable cause, it may need to be replaced. A warning message will alert you if more then 3000 volts are needed to achieve the gain values.

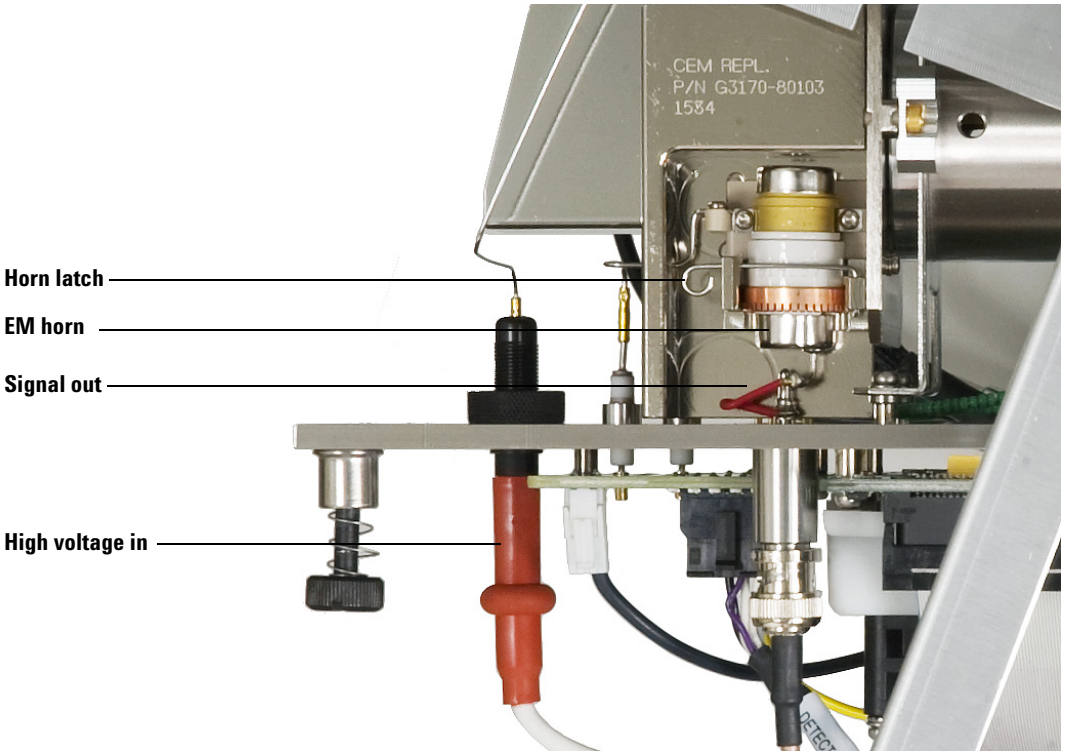

Figure 33 The detector

Analyzer Heaters and Radiators

The ion source and mass filter are housed in cylindrical aluminum tubes called radiators (Figure 34). The radiators control the distribution of heat in the analyzer. They also provide electrical shielding for analyzer components. The source heater and temperature sensor are mounted in the source heater block. The mass filter (quad) heaters and temperature sensors are mounted on the mass filter radiators. Analyzer temperatures can be set and monitored from the MassHunter Workstation software.

In selecting the temperatures to use, consider the following:

- Higher temperatures help keep the analyzer clean longer.
- Higher ion source temperatures result in more fragmentation and therefore lower high-mass sensitivity.

After pumpdown, it takes at least 2 hours for the analyzer to reach thermal equilibrium. Data acquired sooner may not be reproducible.

Recommended settings (for EI operation):

- Ion source 230 °C
- Quadrupoles (front and rear)150 °C

CAUTION Do not exceed 200 °C on the quadrupole or 350 °C on the ion source.

The GC/MS interface, ion source, and front mass filter (quad) heated zones interact. The analyzer heaters may not be able to accurately control temperatures if the setpoint for one zone is much lower than that of an adjacent zone.

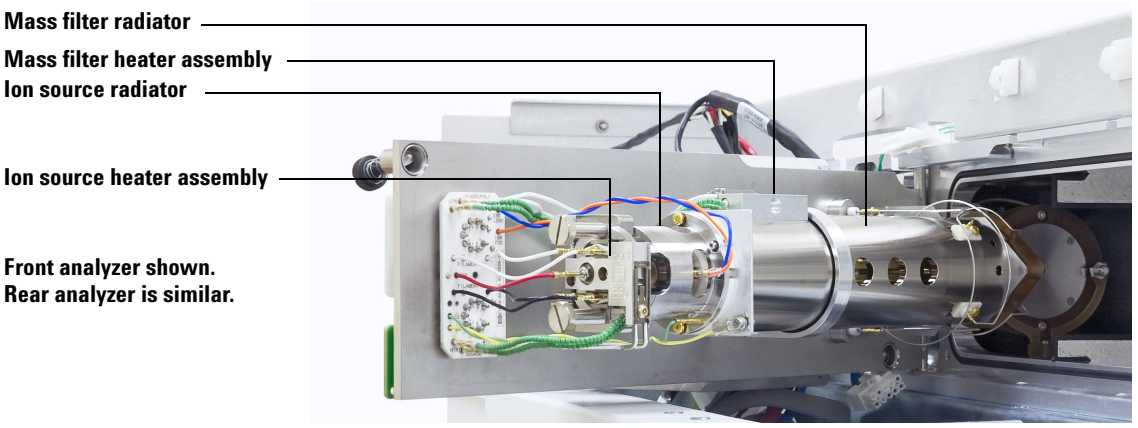

Figure 34 Heaters and radiators

8 Electronics

Power Switch 166
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Electronics Module 171
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Except for the *Back panel and connectors*, and *Interfacing to external devices* sections, most of this material is not essential for day-to-day operation of the GC/MS. It may be of interest to persons responsible for servicing the GC/MS.

WARNING **Dangerous voltages are present under the safety covers. Do not remove safety covers. Refer servicing to your Agilent Technologies service representative.**

Power Switch

See also

The *GC/MS MassHunterWorkstation* in the *Getting Started* manual.

Power switch

The power switch is located on the lower left of the front of the MS. It is separate from the electronics module and is connected via a cable. It is used to turn the MS and foreline pump on and off.

CAUTION Do not switch the MS off unless it has completed the vent program. Incorrect shutdown can seriously damage the MS.

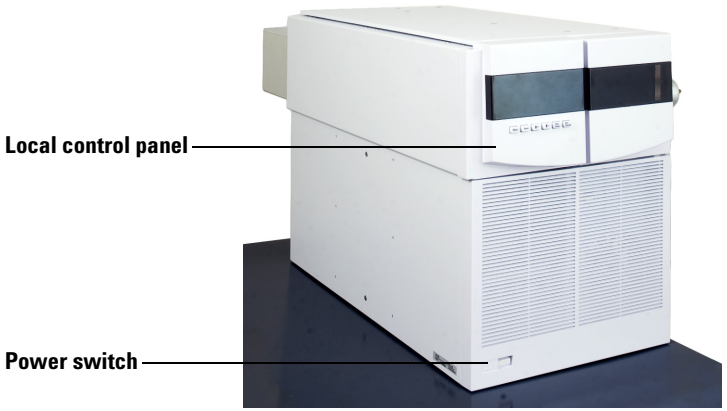


Figure 35 Front of the MS

Ion Source Board

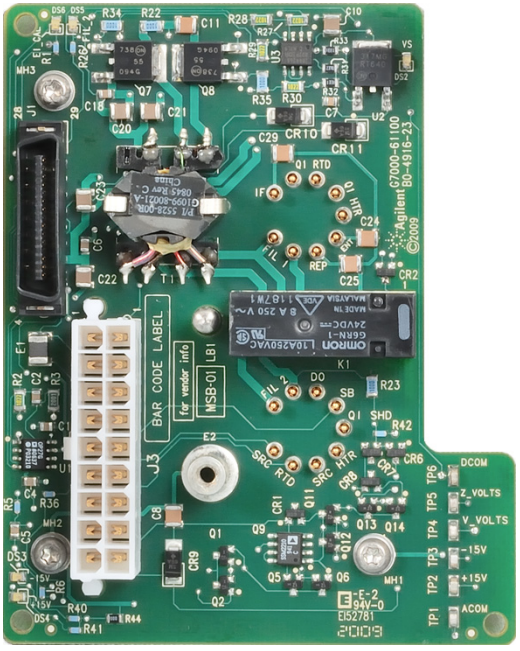
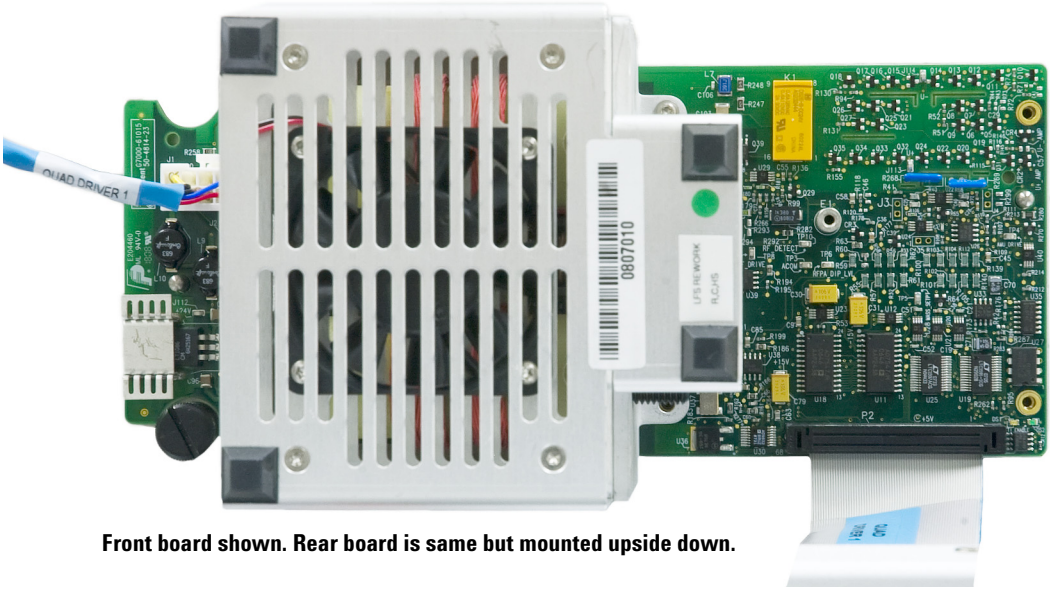


Figure 36 Ion source board

The ion source board performs these functions:

- Passes voltages generated on the main board and the filament drive board to elements in the ion source.
- Generates and adjusts filament emission current and electron energy as controlled by the main board.
- Switches the filament power from one filament to the other.

Quadrupole Boards



Front board shown. Rear board is same but mounted upside down.

Figure 37 Quadrupole boards

The quadrupole boards are mounted on the side plates. They perform these functions:

- Provide the 1 MHz reference clock for the RF amplifier.
- Generate the RF component of the voltage applied to the quadrupole mass filters according to a signal from the main board. The amplitude of this voltage is proportional to the mass selected.
- Generate the DC component of the voltage applied to the quadrupole mass filter. The magnitude of this voltage is proportional to the RF voltage.
- Monitor for RF faults and shut down the analyzer if one is detected.

Collision Cell Board

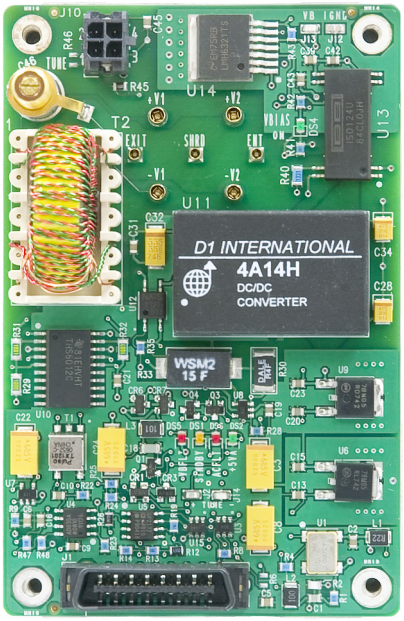


Figure 38 Collision cell board

This board has two functions:

- Generates the controlling voltages for the hexapole.
- Creates the RF signal for the collision cell.

Detector Board

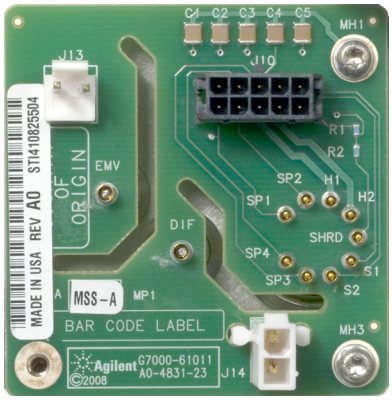


Figure 39 Detector board

The detector board performs these functions:

- Passes high voltage to the detector.
- Receives and passes on the detector signal.

Electronics Module

Most of the electronics in the MS are contained in the electronics module. The whole electronics module can be replaced, if necessary, by your Agilent Technologies service representative.

The electronics module contains:

- Main Board 1
- Main Board 2
- Signal amplifier board
- LAN/MS control card (Smartcard 4)
- Bus board
- AP6 remote card
- PLX card
- AC board (power distribution/vacuum control board)
- Low voltage (AC-DC) power supply
- High-voltage (HED) power supply
- Toroid transformer assembly

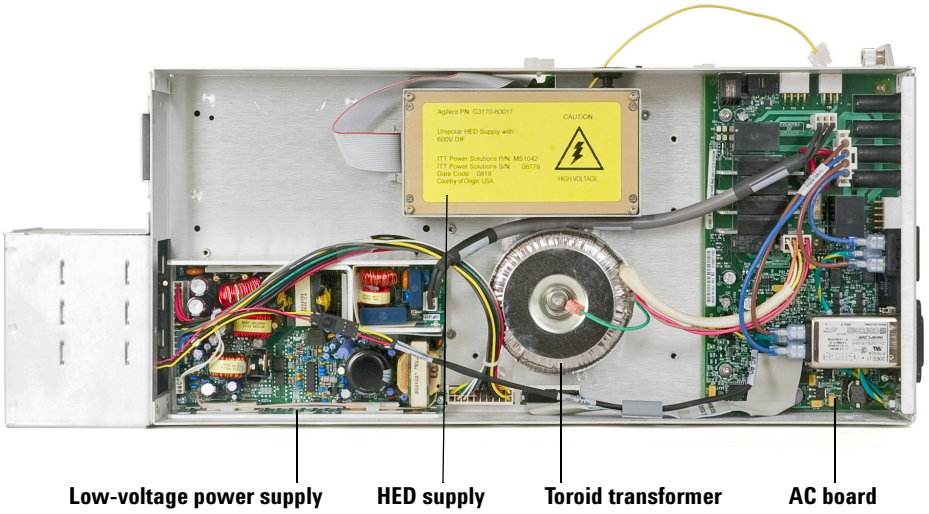


Figure 40 Electronics module, side 1

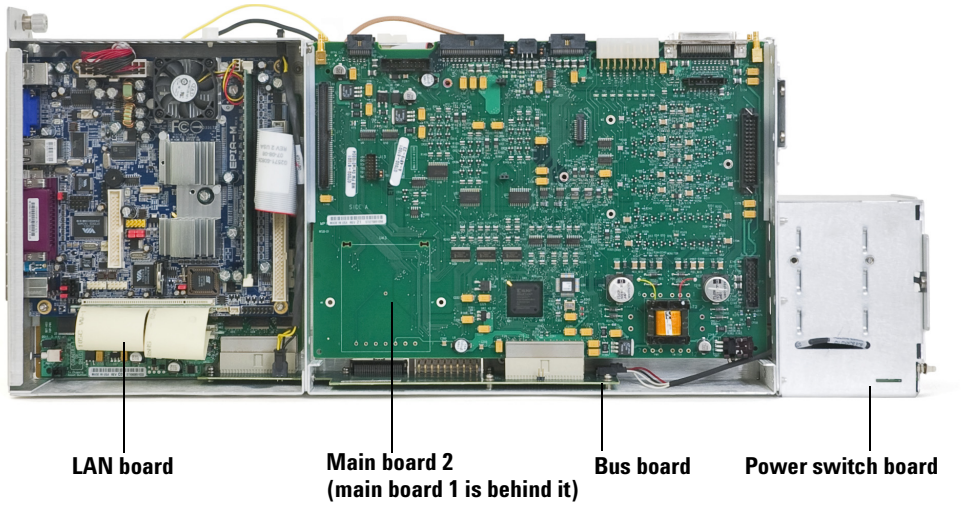


Figure 41 Electronics module, side 2

Main boards

Two main boards are mounted on the outer side of the electronics module. The boards are identical except that main board 1 carries the log amplifier for the detector signal and the EMV power supply.

The main boards are mounted on the outer side of the electronics module. They perform these functions:

- Receive and decode digital instructions from the LAN/MS control card.
- Send digital information to the LAN/MS control card.
- Generate voltages for the ion source lenses and the collision cell.
- Generate control signals for filament selection, filament emission current, and electron energy. Generate control signals for quadrupole RF drive, quad frequency adjustment, DC polarity selection, and all detector voltages.

- Perform analog-to-digital conversion for the direct signal, ion source, and mass filter temperature signals, and foreline pressure or turbo pump speed signal.
- Monitor the signals from the vacuum system and fans and the filament status, HV fault and RF fault signals from the quadrupole board. Activate the shutdown line when the analyzer electronics must be disabled.
- Generate the control signals (on and off) used by the AC board for the high-vacuum pump and calibration valve.
- Generate ± 600 and ± 300 VDC (nominal) power for main board lens amplifiers and quadrupole board DC amplifiers.
- Supply and control the power for the ion source and quadrupole (mass filter) heaters.
- Provide 24 VDC power for the cooling fan.

Signal amplifier board

The log amplifier board amplifies the output of the detector. It produces an output voltage of 0 to 10 volts DC, proportional to the logarithm of the input current of 3 picoamps to 50 microamps.

An analog-to-digital converter converts the amplifier output voltage to digital information. The LAN/MS control card converts the data into abundance counts proportional to the detector signal current.

AC board

The AC board is mounted on the opposite side of the electronics panel from the LAN/MS CPU. The AC board is also sometimes called the power distribution/vacuum control board. It performs these functions:

- Provides input voltage transparency for the MS.
- Distributes AC line power to the AC/DC power supply, the foreline pump, and the turbo pump controller.
- Turns the calibration valve on or off as directed by the main board.
- Provides the voltage for the calibration valve.
- Provides a logic interface to turbo controller.
- Controls the foreline gauge.

- Turns on the turbo pump once the foreline pressure is low enough, as directed by the main board.
- Turns off the turbo pump if the foreline pressure is too high.
- Passes the foreline pressure signal from the foreline gauge or turbo pump speed and other vacuum status information to the main board.
- Turns off the foreline pump in case of a problem with pumpdown.

Turbo pump control

Your MS is equipped with a turbo pump with an integrated controller.

The AC board sends control signals to, and receives turbo pump status information from, the turbo pump controller. The turbo pump controller provides power to the turbo pump and regulates pump speed.

If the pump fails to reach 80% speed within 10 minutes after beginning pumpdown or if the speed drops below 50% during operation, the controller shuts off the turbo pump and the AC board shuts off the foreline pump.

Pumpdown failure shutdown

The AC board will shut down both the high-vacuum and the foreline pump if the system fails to pump down correctly. One condition that triggers shutdown is turbo pump speed below 80% after 10 minutes, or if the foreline pressure is above 300 mTorr after 10 minutes.

This is usually because of a *large* air leak: either the side plate has not sealed correctly or the vent valve is still open. This feature helps prevent the foreline pump from sucking air through the system, which can damage the analyzer and pump.

To correct the problem, power cycle the MS and troubleshoot. You have 10 minutes to find and correct the air leak before the system shuts down again. Be sure to press on the side plate when turning on the MS power to ensure a good seal.

Bus board

This board is mounted on the bottom of the electronics module. It acts as a bus connecting the two main boards.

PLX card

This card, located inside the SmartCard module, provides fast communications between the processor module and other parts of the MS system. It speeds up the entire system by removing communications tasks from the central processor.

LAN/MS Control Card (Smartcard 4)

The LAN/MS control card is located to the left of Main Boards 1 and 2 on the electronics panel. The LAN/MS control card has two main functions:

- Provide a communication interface between the MS and the data system
- Provide real-time control of the MS, freeing the data system for other tasks

Functional areas of the LAN/MS control card include:

- Instrument controller
- Data processor
- Main processor
- Serial communication processor
- Network communication controller
- Remote start processor
- Random access memory (RAM)
- Status LEDs

LEDs on the LAN/MS control card are visible near the LAN connector on the rear panel.

Power Supplies

Low-voltage (AC-DC) power supply

The low voltage power supply is mounted next to the toroid transformer in the electronics module. A universal input power supply, it converts AC line voltage into the DC voltages used by the rest of the electronics. The power supply generates the following DC voltages:

- +24 V (nominal)
- +15 V (nominal)
- –15 V (nominal)
- +5 V (nominal)

High-voltage (HED) power supply

The high-voltage power supply provides the –10,000 volts DC for the high-energy dynode (HED) in the detector for the EI MS. The HED power supply also provides 600 VDC for the detector focus lens. Due to the high impedance of this circuit, measuring the detector focus voltage with a handheld voltmeter will give a typical reading of 90 to 100 volts where the polarity matches that of the HED voltage.

Toroid transformer

The toroid transformer is mounted next to the AC board. It provides 24 VAC for the mass filters and source heater circuits. The input wires take 120 VAC or 200 to 260 VAC from the AC board. The line voltage switch on the top of the electronics module straps the toroid primary. The output wires connect to the AC board.

Back Panel Connectors

The back panel contains several connectors (Figure 42) and the four primary fuses.

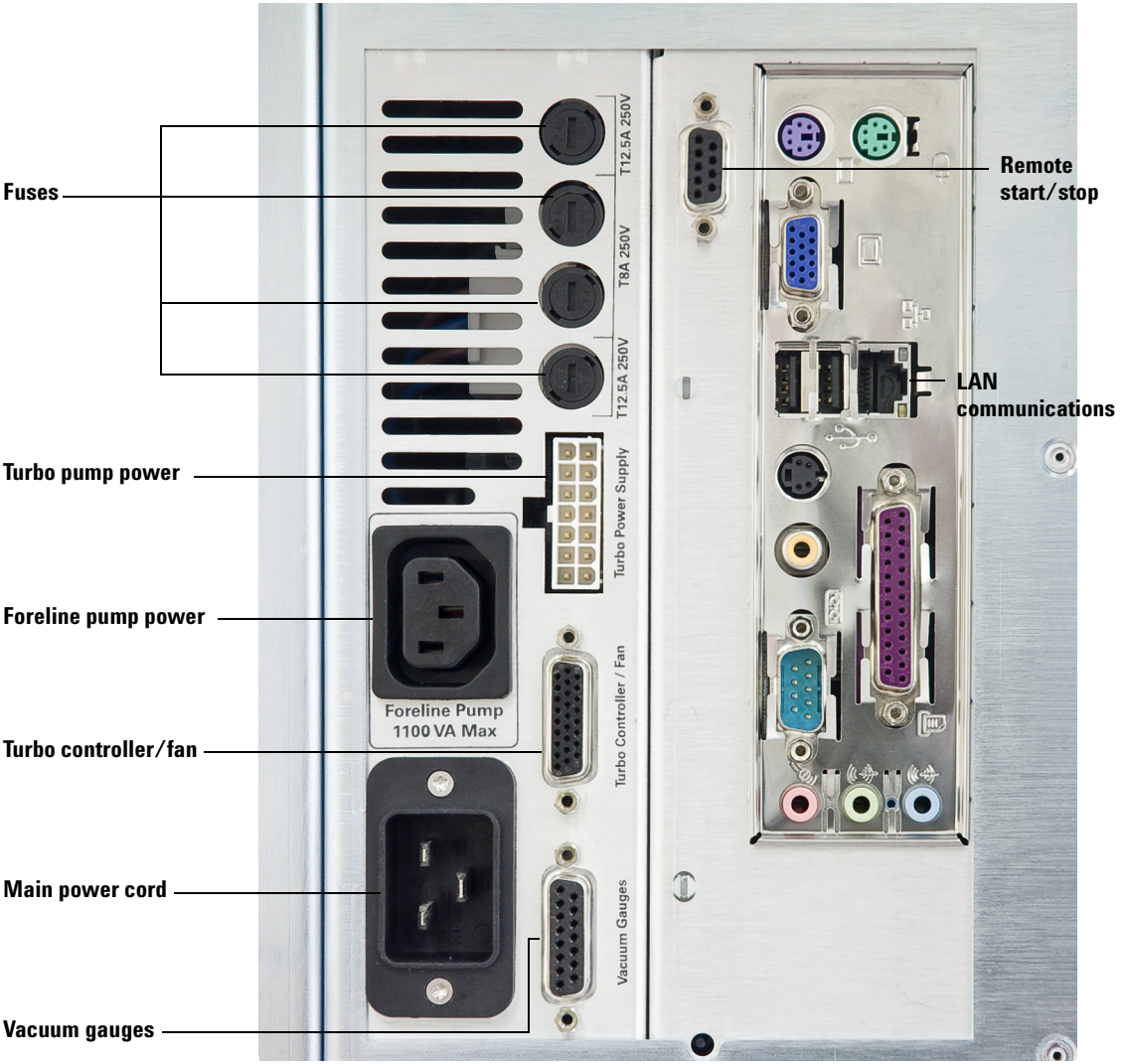


Figure 42 Back panel connections

Primary fuses

The four primary fuses limit current into the MS in case of a short circuit in the foreline pump. Fuse values are shown on the panel.

Turbo pump power receptacle

The turbo pump power receptacle provides power for the turbo pump.

Foreline pump power receptacle

The foreline pump power cord receptacle provides AC power for the foreline pump. If the power switch is off, no power is supplied to the foreline pump.

Turbo controller / fan receptacle

This provides power and control for the turbo pump controller and the turbo pump cooling fan.

Main power cord receptacle

The AC power cord brings in all electrical power for the MS. The power cord can be detached from the MS.

Vacuum gauge connector

This connector powers the two vacuum gauges and connects their signals to the controlling electronics.

Remote start connector

The remote start connector is the external connector for the remote start circuitry on the LAN/MS control card. It receives remote start signals from the GC.

LAN (I/O) connector

The LAN cable from the data system is connected to the LAN communications connector. It carries all data communication between the PC and the MS.

Interfacing to External Devices

Remote control processor

The remote control processor on the LAN/MS control card synchronizes start-run signals with GCs and other devices. The functions of the remote control processor are extended to the remote start (Remote) connector (Figure 43) on the back panel of the MS. The remote start cable connects the GC and the MS.

Remote start signals

It is often necessary to communicate with external devices (for example, a purge-and-trap) during a run. Typically, these communications are requests to send a system-ready signal. They also include:

- Receive a start run signal from an external device
- Program the timing of events during a run

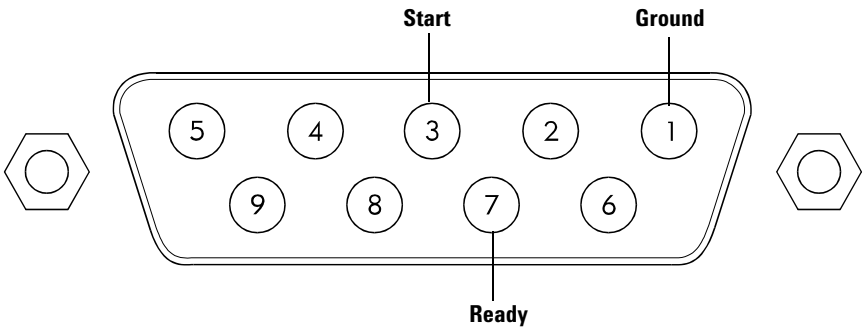


Figure 43 Remote start connector

System ready

When interfacing to an external device, it is often desirable to send a system-ready signal to the device. In the case of a multisample Tekmar purge-and-trap, each sample is purged onto a trap where it waits for a ready

signal. On receipt of the ready signal, the desorbtion cycle begins. When a specific temperature is reached, the purge-and-trap closes a contact to indicate the run has started.

The ready pin on the remote start connector on the GC is held low at all times except when the GC, MS, and data system are all ready. On system ready, a logic high of 5 VDC is present between that pin and any ground. This same high can be detected between the ready and ground pins on the remote start connector on the MS.

Start run input

The best way to generate a start run signal is to use the remote start connector on the GC. Since remote start cables are made for most common devices, this is often the simplest way. A general-purpose remote start cable (05890-61080), is also available that terminates in spade lugs. Care must be taken to ensure that the system is actually ready before the start run signal is sent.

If necessary, the remote start connector on the back of the MS can be used to send the start run signal. A contact closure between the start and ground pins will start the run if the system is ready.

9
Replacement Parts

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Analyzer 195
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Consumables and Maintenance Supplies 206
Additional CI Parts 210

This chapter lists parts that can be ordered for use in maintaining your 7000 Series Triple Quad GC/MS. It includes most of the parts or assemblies in the MS.

Some of the parts listed are not user-replaceable. They are listed here for use by Agilent Technologies service representatives.

To Order Parts

To order parts for your MS, address the order or inquiry to your local Agilent Technologies office. Supply them with the following information:

- Model and serial number of your MS, located on a label on the lower left side near the front of the instrument.
- Part number(s) of the part(s) needed
- Quantity of each part needed

Some parts are available as rebuilt assemblies

Rebuilt assemblies pass all the same tests and meet all the same specifications as new parts. Rebuilt assemblies can be identified by their part numbers. The first two digits of the second part of the part number are 69 or 89 (such as xxxxx-69xxx or xxxxx-89xxx). Rebuilt assemblies are available on an exchange-only basis. When you return the original part to Agilent Technologies (after you receive the rebuilt assembly) you will receive a credit.

If you cannot find a part you need

If you need a part that is not listed in this chapter, check the Agilent Technologies Analytical Supplies Catalog or the online catalog on the Worldwide Web at http://www.agilent.com/chem. If you still cannot find it, contact your Agilent Technologies service representative or your Agilent Technologies office.

Electronics

The printed circuit boards in the MS are available only as complete assemblies. Individual electronic components are not available. This section contains the following parts: cables (Tables 7 and 8), printed circuit boards (Table 9), and fuses and switches (Table 11).

Cables

Table 7 External cables

Description	Part number
Remote Start-Stop cable	G1530-60930
Y-Remote Start-Stop Cable	G1530-61200
H-Remote Start-Stop Cable	35900-60800
LAN Cable (shielded)	8121-0008
Power cord, Australia, New Zealand	8120-1369
Power cord, Australia, 15 A	8120-6900
Power cord, China, 10 A	8121-0723
Power cord, China, 15 A	8121-0070
Power cord, EU/CL, 16 A	8120-6899
Power cord, DK/Greenland	8120-3997
Power cord, India/South Africa	8121-0710
Power cord, Israel	8121-0161
Power cord, Swiss/DK, 16 A	8121-8622
Power cord, Thai, 15 A	8121-1301
Power cord, Japan	8120-6903
Power cord, Switzerland	8120-2104
Power cord, UK, Hong Kong, Singapore, Malaysia	8120-8620
Power cord, US, 120 V	8120-6894
Power cord, US, 240 V	8121-0075

Table 8 Internal cables

Description	Part number
Cable, AC board main power input	G2571-60844
Cable, SC4 Low voltage power	G2571-60825
Cable, Hard disk	G2571-60826
Cable, SM4 reset	G2571-60885
Cable, Standby switch	G7000-60819
Cable, Communication	G1978-60802
Cable, HED 10 KV output	G7000-60813
Cable, HED control	G1946-60048
Cable, Log amp-detector feedthrough	G2571-60806
Cable, RFPA DC power	G7000-60807
Cable, Fan extension	G1960-60846
Cable, Power supply DC	G7000-60820
Cable, Power supply AC	G7000-60821
Cable, LCP	G7000-60808
Cable, Quad driver-1 data	G7000-60802
Cable, Quad driver-2 data	G7000-60803
Cable, Collision cell board data	G7000-60804
Cable, Filament drive board data	G7000-60801
Cable, Main harness	G7000-60826
Cable, Ion gauge tube	G1960-60872
Cable, Turbo supply	G7000-60810
Cable, 4 GByte USB drive	G7000-60811
Cable, Wire iris	G7000-60828
Cable, Wire extractor lens	G7000-60827
Cable, Fan extension	G7000-60822
Cable assembly, Ceramic source board	G7000-60525

Printed circuit boards

Table 9 Printed circuit boards

Description	Part number
Quad driver assembly (2)	G7000-65015
Filament drive board	G7000-61100
Collision cell board	G7000-61005
Detector feedthrough board	G7000-61011
Motherboard, 1 GHz, 1 GB memory	0960-2490
SDRAM, 256 MB	1818-8947
PLX board	G2571-61001
4 GByte USB drive	G7000-80200
Main board	G7000-61001
SC4 bus	G7000-61008
Log amp	G3170-65101
Extender board, PCI, 32 bit	0403-1169

Table 10 Power supplies and related parts

Description	Part number
Toroid transformer	G7000-60229
Power supply, AC/DC, 4 output	0950-4826
AC board, LC-TOF	G2597-61017
Power supply, EMV	G7000-80016
Power supply, HED, unipolar	G3170-80017
Power supply, HED, bipolar	G3170-80018
Power supply, Turbo pump	G7000-60600

Fuses and power switch

Table 11 Fuses and power switches

Description	Part number
Fuse 8A, slow blow, electronics, fans, and power supplies	2110-0969
Fuse, 12.5A, slow blow, foreline and turbo pump	2110-1398
Power switch board	G7000-61010
Push rod	G7000-40050
Switch board cable	G7000-60819

Local Control Panel

This section lists replaceable parts for the LCP and related covers. See Figure 44.

Table 12 LCP and related parts

Item	Description	Part number
1	LCP fascia	G7000-60094
2	LCP fascia with LCP board	G7000-61002

Figure 44 Local control panel replacement parts

Vacuum System

This section lists replacement parts available for the vacuum system. It includes clamps, O-rings and seals (Table 13), foreline pump and related components (Table 14 and Figure 45), and turbo pump vacuum system components (Table 15).

O-rings and seals

Table 13 O-rings and seals

Description	Part number
Calibration valve O-ring (1/4-inch)	5180-4182
End plate O-ring (for front and rear end plates)	0905-1441
GC/MS interface O-ring	0905-1405
HED feedthrough	G1099-80012
HED feedthrough O-ring	0905-0490
KF10/16 seal (foreline pump inlet and turbo pump outlet)	0905-1463
KF25 O-ring assembly (turbo pump outlet)	0100-1551
Seal, performance turbo pump inlet	0100-1879
O-ring, forepump drain plug	0905-1619
Fill plug, forepump	0100-2451
Analyzer ion gauge	G1960-80303
Foreline ion gauge	G1960-80101
O-ring, forepump fill plug	0905-1630
O-ring, ion gauge	0905-1627
O-ring, collision cell feedthrough	0905-1405
O-ring, collision cell plate	0905-1689
Side plate O-ring	0905-1690
Vent valve O-ring (1/4-inch)	5180-4182

Foreline pump and related parts

Both foreline pumps are included in this table:

- DUO 2.5 standard pump
- RV5 high flow pump

Table 14 Foreline pump and related parts (Figure 45)

Item	Description	Part number
	Foreline hose assembly (hose and internal spring)	05971-60119
	• Hose Clamp* used with 05971-60119	1400-3241
1	Duo 2.5 foreline pump – 120V	G3170-80025
1	Duo 2.5 foreline pump – 220V	G3170-80026
1	Duo 2.5 foreline pump – 200V – Japanese	G3170-80024
	Rebuilt standard foreline pump – 120V	G3170-89025
	Rebuilt standard foreline pump – 220V	G3170-89026
	Rebuilt standard foreline pump – 200V – Japanese	G3170-89024
	Exch Avail-RV5 pump – 200V – Inland	G7000-80021
	Exch Avail-RV5 pump – 115V – Inland	G7000-80020
	Exch Avail-RV5 pump – 230V – Inland	G7000-80022
	Rebuilt RV5 pump – 200V – Inland	G7000-89021
	Rebuilt RV5 pump – 115V – Inland	G7000-89020
	Rebuilt RV5 pump – 230V – Inland	G7000-89022
	Pump tray, RV5 pump	G1946-00034
	Variable return kit (A505-23-000), RV5 pump	G6600-60023
	Filter (A46226000), RV5 pump	G6600-80043
	Filter (A462-29-000), RV5 pump	3162-1056
	Oil drain kit for mist filter, RV5 pump	3162-1057
	Foreline pump inlet seal (KF10/16)	0905-1463
	KF10/16 Clamp (foreline inlet), Ion vacuum gauge	0100-1397
	KF16 Hose adapter	G1099-20531

Table 14 Foreline pump and related parts (Figure 45) (continued)

Item	Description	Part number
	KF25 to KF16 adapter	
	KF25 Clamp (tp end of hose – not shown)	0100-0549
	KF25 Hose adapter (tp end of hose – not shown)	G1099-20532
	Oil drip tray	G1099-00015
	Oil mist filter	G1099-80039
	Hose barb adapter (exhaust fitting)	G3170-80006
	O-ring for oil mist filter and hose barb adapter	0905-1193
	Pump oil, Inland 45	6040-0621
	Safety Cage kit, Duo foreline pump	G3170-60028
5	Standoff, Pump Cage Qty. 2	G3170-20035
6	M6 Acorn Cap Hex nut Qty. 2	0535-1044
7	M4 Internal Star washer Qty. 2	2190-0009

* Hose clamps are interchangeable, but give an optimum fit if they are matched

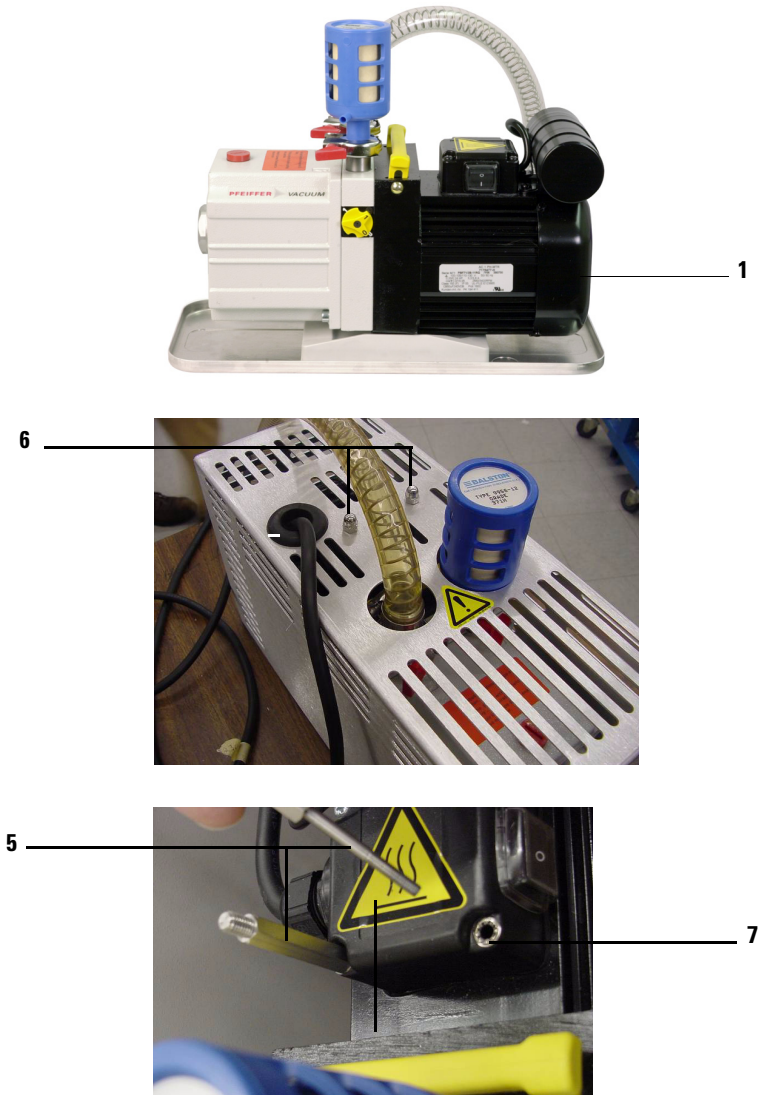

Figure 45 Foreline pump top and safety cage parts

Turbo pump and related parts

Table 15 Turbo pump MS vacuum system components

Item	Description	Part number
1	Fan (for high-vacuum pump)	G1099-60564
	KF25 clamp (for turbo pump outlet)	0100-0549
	KF25 O-ring assembly (for turbo pump outlet)	0100-1551
	Split flow turbo pump	G7000-80010
	Split flow turbo pump, rebuilt	G7000-89010
	ISO100 seals	0100-1879
	Flat washers, 4 (to mount pump)	3050-0881
	Lock washers, 4 (to mount pump)	2190-0669
	Hex nuts, 4 (to mount pump)	0535-0048
	Turbo controller, EXDC80, 24V	G67000-80080
	O-ring, foreline hose assembly	0905-1680
	Hinged clamp with wing nut, NW20/25	0100-1398
	Cable, turbo pump and controller	G7000-60811
	Power supply, TMH	G7000-60600
	Auxiliary EPC flow module	G1570-60535

Analyzer

Table 16 shows the analyzer chambers and associated parts.

Table 16 Front analyzer chamber and related parts (Figure 46)

Item	Description	Part number
1	Shield/plate for ion gauge port	G3170-00003
	Ion vacuum gauge baffle	G3170-00015
	• M3X12 TX T10 PN SQ Cone SS (qty 2)	0515-0664
2	EI Calibration valve assembly	G3170-60204
3	Calibration vial	G3170-80002
4	End plate front glass	G3170-20552
4	End plate front acrylic	G3170-20022
5	End plate front frame	G3170-00001
	End plate rear cap	G3170-20553
	Side plate (includes feedthrough and thumbscrews)	G3170-60021
6	Vent valve knob	G3170-20554

Figure 46 Analyzer chambers and related parts

Table 17 shows the replacement parts for the analyzers. Analyzer screws (Table 18) and the individual ion source parts (Table 19) are listed in the tables that follow.

Table 17 Analyzer parts

Item	Description	Part number	
		Front quad	**Rear quad**
	Feedthrough board (source board)	G7000-6525	
	HED feedthrough		G1099-80012
	O-ring, Viton for HED feedthrough	0905-0490	0905-0490
6	Magnet assembly	05971-60160	
	Low gauss magnet assembly	G3163-60560	
	Mass filter cable kit	G3170-60130	
	Mass filter contacts (4)	G1099-60142	G1099-60142
	Mass filter canted coil support, detector end	G3170-20025	
	Mass filter canted coil spring	G1460-2724	
	Mass filter ceramic support, source end	G1099-20123	
3	Mass filter heater assembly	G7000-60172	
	Pins for source and detector end mounting brackets	G1099-20137	
	Quad mount detector		G7000-20043
	Quad mount grnd quad	G7000-20225	G7000-20225
	Analyzer with Inert ion source, new	G7000-65006	
	Analyzer with Inert ion source, rebuilt	G7000-69006	
	Analyzer with HED detector, new		G7000-65003
	Analyzer with HED detector, rebuilt		G7000-69003
	Analyzer with HED detector with iris, new		G7000-65703
	Analyzer with HED detector with iris, rebuilt		G7000-69703
	Front side plate	G7000-60021	
	Rear side plate		G7000-60022

Table 18 Analyzer screws

Description	Part number
Heater/Sensor (quad) setscrew	0515-1446
Ion source thumbscrew	G1099-20138
Magnet mounting screws	0515-1046
Screw – magnet bracket to source radiator	0515-1602
Screws – source radiator and detector to quad radiator	G3170-20123
Screws – mass filter contact assembly/heater block	G3170-20122
Screws – radiator. Mounting brackets quadrupole board	0515-0430
Source radiator screws	0515-1052
Screws for Quad Stop	0515-0221

EI source

Table 19 Inert EI ion source

	Description	Part number
	Inert ion source, new	G7000-65700
	Inert ion source, rebuilt	G7000-69700
11	Drawout cyclinder	G1999-20444
12	Drawout plate – 3 mm Inert	G2589-20100
	Drawout plate – 6 mm Inert	G2589-20045
9	Entrance lens	G3170-20126
3	EI filament	G2590-80070
	EI high temp filament	G2590-60053
4	Interface socket	G7000-20136
10	Ion focus lens	G1999-20443

Table 19 Inert EI ion source (continued)

	Description	Part number
8	Lens insulator (one piece)	G3170-20530
	Inert EI 350 Anodized Repeller assembly	G3170-60171
7	Screws for filament	G1999-20021
6	Source heater assembly	G3170-60177
2	Setscrew for lens stack	G1999-20021
1	Source body	G7000-20130

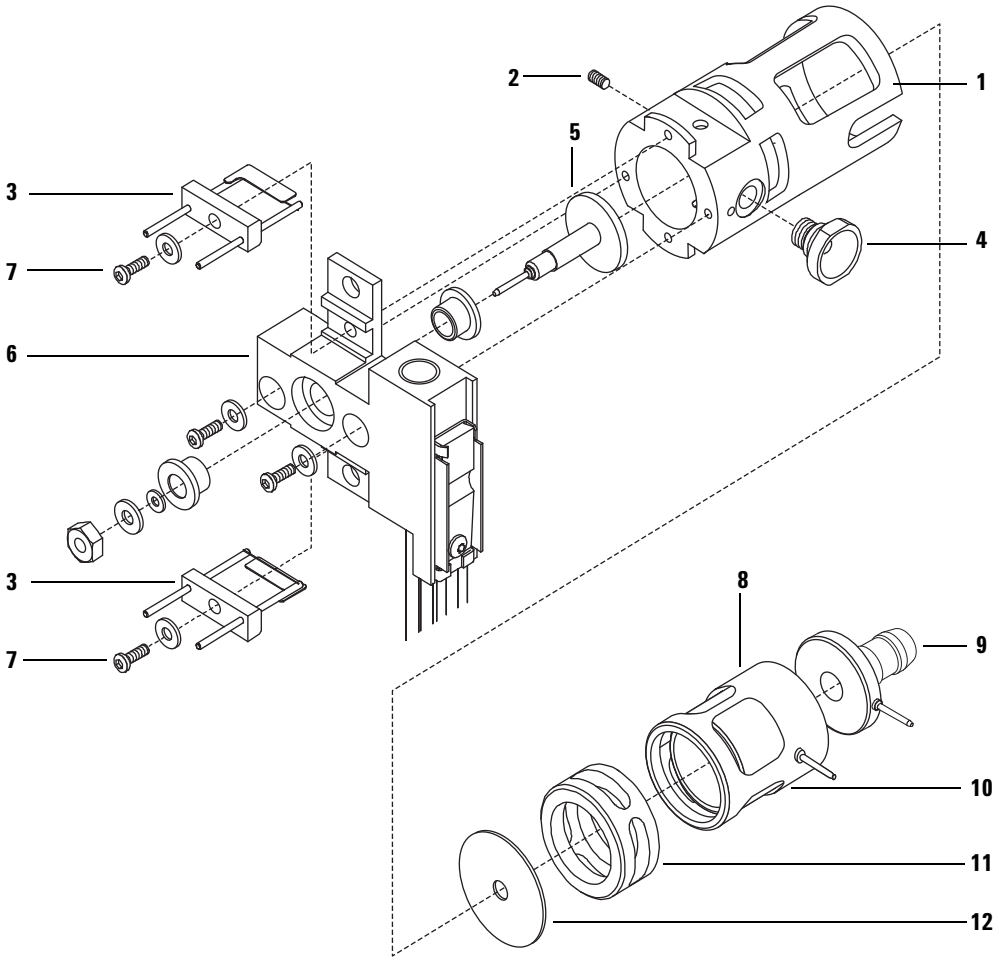

Figure 47 EI 7000 ion source

EI Extractor source

Table 20 EI extractor ion source

	Description	Part number
	Inert ion source, new	G7000-65710
	Inert ion source, rebuilt	G7000-69710
11	Extractor lens, 3 mm	G7000-20444
	Extractor lens, 6 mm	G7000-20446
12	Extractor lens insulator	G7000-20445
	Extractor lens wire	G7000-60827
9	Entrance lens	G3170-20126
3	EI filament	G2590-80070
	EI high temp filament	G2590-60053
4	Interface socket	G7000-20136
10	Ion focus lens	G1999-20443
8	Lens insulator (one piece)	G3170-20530
	Inert EI 350 Anodized Repeller assembly	G3170-60171
7	Screws for filament	G1999-20021
6	Source heater assembly	G3170-60177
2	Setscrew for lens stack	G1999-20021
1	Source body	G7000-20430

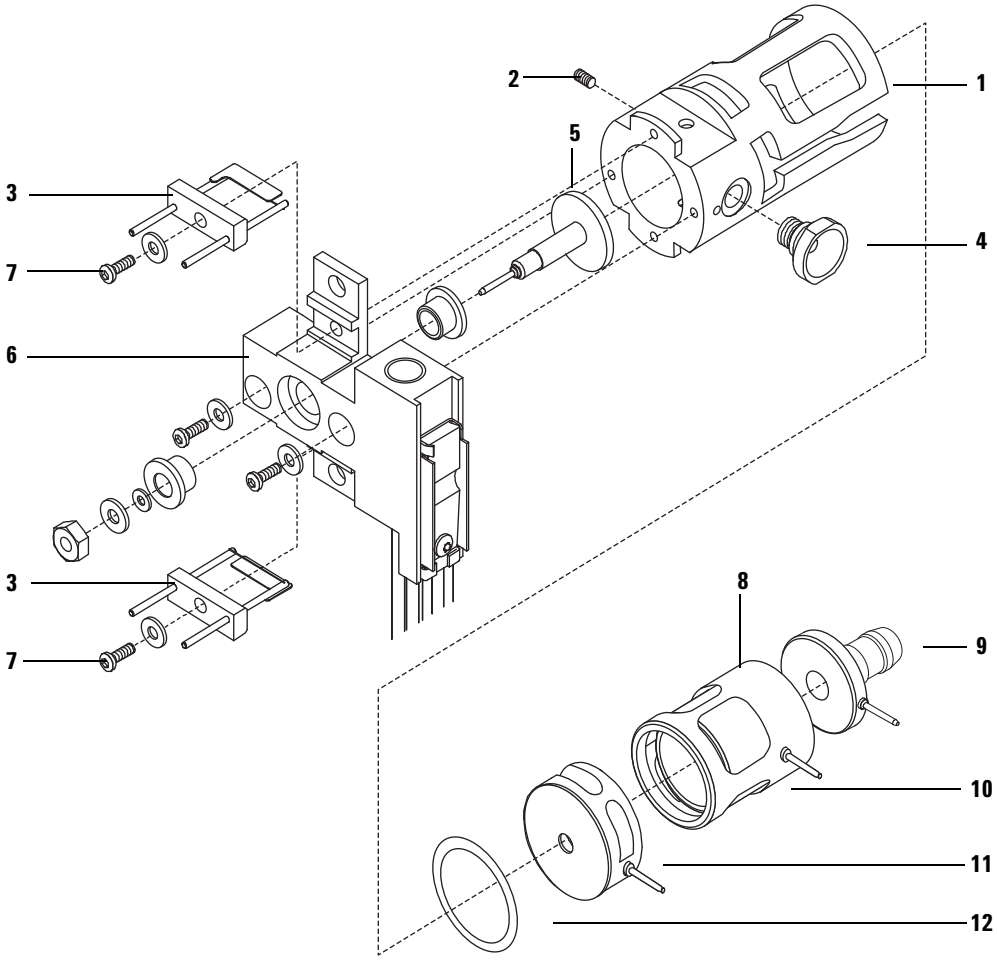

Figure 48 EI extractor ion source

CI source

Table 21 CI ion source

	Description	Part number
	Inert ion source, new	G3170-65403
11	CI Drawout cyclinder	G1999-20444
12	CI Drawout plate	G1999-20446
9	Entrance lens assembly	G3170-20126
3	CI filament	G1099-80053
13	CI Dummy filament	G1999-60454
4	CI interface tip seal	G1999-60412
10	CI Ion focus lens	G1999-20443
8	CI lens insulator (one piece)	G3170-20540
5	CI repeller	G1999-20432
14	CI repeller insulator	G1999-20433
7	Gold fil screw	G1999-20021
6	Source heater assembly	G3170-60415
2	Screw-set, M3x3L, gold plated	G1999-20022
1	CI Source body	G1999-20430
	CI ion source box	G1999-65001
	Washer-spr CRVD 1.6 1.8-MM-ID, 4-MM-OD, SS	3050-1375

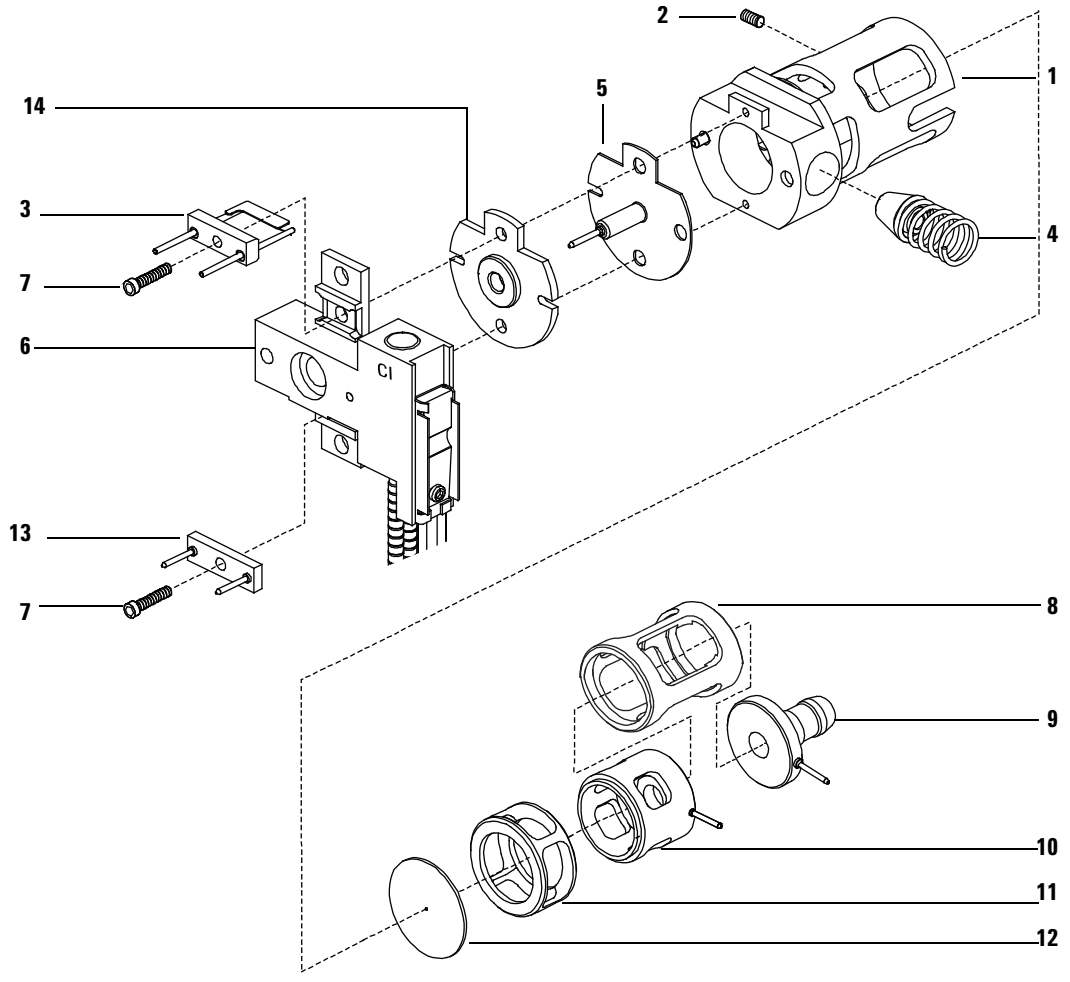

Figure 49 CI ion source

Repeller assembly

Table 22 Repeller assembly

Description	Part number
EI 350 Anodized Repeller assembly	G3170-60172
Inert EI 350 Anodized Repeller assembly	G3170-60171
Insulator (2 required)	G1099-20133
Nut, 5.5-mm	0535-0071
Repeller	G2589-20044
Setscrew	0515-1446
Anodized Source Heater Assembly	G3170-60177
Washer for repeller	3050-0891

EI GC/MS Interface

Table 23 lists the replacement parts related to the EI GC/MS interface.

Table 23 EI GC/MS interface

Description	Part number
GC/MS interface (complete)	G1099-60300
Interface column nut	05980-20066
Heater sleeve	G1099-20210
Heater/Sensor assembly	G1099-60107
Insulation	G1099-20301
Setscrew for heater/sensor assembly	0515-0236
Screws, M4x0.7 panhead, for heater sleeve	0515-0383
Welded interface assembly	G1099-60301
RTGA Welded interface assembly	G2589-60060
GC/MS interface O-ring	0905-1405
Interface cover	G1099-00005
Transfer line cover	G3170-00405
Screws for mounting interface and cover to analyzer chamber	0515-0380

Consumables and Maintenance Supplies

This section (Tables 24 through 27) lists parts available for cleaning and maintaining your MS.

Table 24 EI maintenance supplies

Description	Part number
Abrasive paper, 30 µm	5061-5896
Alumina powder, 1 kg	8660-0791
Cloths, clean (qty 300)	05980-60051
Cloths, cleaning (qty 300)	9310-4828
Cotton swabs (qty 100)	5080-5400
Foreline pump oil, Inland 45	6040-0834
Gloves, clean – Large	8650-0030
Gloves, clean – Small	8650-0029
Grease, Apiezon L, high vacuum	6040-0289

Table 25 Tools

Description	Part number
Column installation tool	G1099-20030
Funnel	9301-6461
Hex key, 5 mm	8710-1838
Tool Kit	G1099-60566
Ball drivers, 1.5-mm	8710-1570
Ball drivers, 2.0-mm	8710-1804
Ball drivers, 2.5-mm	8710-1681
Hex nut driver, 5.5-mm	8710-1220
Pliers, long-nose (1.5-inch nose)	8710-1094
Screwdrivers Flat-blade, large	8730-0002
Screwdrivers Torx, T-10	8710-1623
Screwdrivers Torx, T-15	8710-1622
Screwdrivers Torx. T-20	8710-1615
MS shipping kit	G3170-60501
RV5 pump shipping kit	G7000-60500
7000 MS Shipping kits	G7000-60501
7890A GC Shipping kits	G3430-60581
Tweezers, non-magnetic	8710-0907
Wrenches, open-end 1/4-inch x 5/16-inch	8710-0510
Wrenches, open-end 10-mm	8710-2353
Wrist strap, antistatic, small	9300-0969
Wrist strap, antistatic, medium	9300-1257
Wrist strap, antistatic, large	9300-0970

Table 26 Ferrules

Description	Part number
For the GC/MS interface	
• Blank, graphite-vespel	5181-3308
• 0.3-mm id, 85%/15% for 0.10-mm id columns	5062-3507
• 0.4-mm id, 85%/15%, for 0.20 and 0.25-mm id columns	5062-3508
• 0.5-mm id, 85%/15%, for 0.32-mm id columns	5062-3506
• 0.8-mm id, 85%/15%, for 0.53-mm id columns	5062-3538
For the GC inlet	
• 0.27-mm id, 90%/10%, for 0.10-mm id columns	5062-3518
• 0.37-mm id, 90%/10%, for 0.20-mm id columns	5062-3516
• 0.40-mm id, 90%/10%, for 0.25-mm id columns	5181-3323
• 0.47-mm id, 90%/10%, for 0.32-mm id columns	5062-3514
• 0.74-mm id, 90%/10%, for 0.53-mm id columns	5062-3512

Table 27 Miscellaneous parts and samples

Description	Part number
EM horn	G3170-80103
Auxiliary EPC flow module	G1570-60535
Wire, iris	G7000-60828
Wire, extractor lens	G7000-60827
HED Detector assembly, with iris lens	G7000-80102
EPC manifold	G3270-20055
Heater/Sensor assembly, GC/MS interface	G1099-60107
Octafluoronaphthalene, OFN, 100 fg/µL	5188-5348
PFTBA, 10 gram	8500-0656
Benzopheone, 100 pg/µL	8500-5440
PFTBA sample kit	05971-60571
Foreline pump tray	G1099-00015
Eval A, hydrocarbons	05971-60045
Micro-Ion gauge electronics	G3170-89001
J20' 1/8-inch id stainless steel	7157-0210
Wipes (qty 300)	9310-4828
Swagelok ferrule, front, 1/8-inch, 10/package	5180-4110
Swagelok ferrule, rear, 1/8-inch, 10/package	5180-4116
Swagelok nut, for 1/8-inch fitting, 10/package	5180-4104
Swagelok nut and ferrules, 10 set/package	5080-8751
Tubing cutter for SS tubing	8710-1709
Tubing cutter replacement blades	8710-1710

Additional CI Parts

Table 28 and Table 29 show parts that may be required to maintain the 7000 Series Triple Quad GC/MS with CI. The parts in this section are related directly to the CI accessory, and are in addition to the source parts listed in Table 21; other parts for the MS can be found in the previous sections of this chapter.

Table 28 CI flow control module

Item	Description	Part number
	CI flow control module	G7000-60450
1	CI calibration valve assembly	G1999-60452
	PFDTD calibrant	8500-8510
2	Calibration sample vial	G3170-80002
	Sample vial O-ring, 1/4-inch Viton	5180-4182
	Solenoid valve and cable	G1999-60452
	CI cable from SC to CI Flow Module	G3170-60808
	Cable, CI to CI Bulkhead	G7000-60825
	CI Flow control PCA	G7000-61000
3	Mass flow controller	0101-1006
4	Shutoff valve	G1999-80402
	Mass flow controller cable	G1999-60464
5	Reagent gas select valve (Gas A and Gas B)	G1999-80401
	VCR gasket, 1/4-inch	0100-1436
	VCR gasket, 1/8-inch	0100-0468
	Methane/Isobutane gas purifier	G1999-80410
	Stainless steel tubing, 1/8-inch id, 20 feet	7157-0210
	Swagelok ferrule, front, 1/8-inch, 20/package	5180-4110
	Swagelok ferrule, rear, 1/8-inch, 20/package	5180-4116
	Swagelok nut, for 1/8-inch fitting, 20/package	5080-8751
	Swagelok nut and ferrules, 20 sets/package	5080-8751

Table 29 CI GC/MS interface and covers

Description	Part number
CI GC/MS interface Assembly	G3170-65400
Heater clamp	G1999-20410
Heater/Sensor assembly	G1099-60107
Transfer line cup (cover)	G3170-00405
Interface insulation	G1999-20401
Screws for heater clamp	0515-0383
Screws to attach interface to manifold	0515-0380
Welded interface	G3170-60401
Interface tip seal	G199-60412
CI trim piece - top cover	G7000-00020
CI rear top cover	G7000-00411
CI top cover with gaskets	G7000-60112

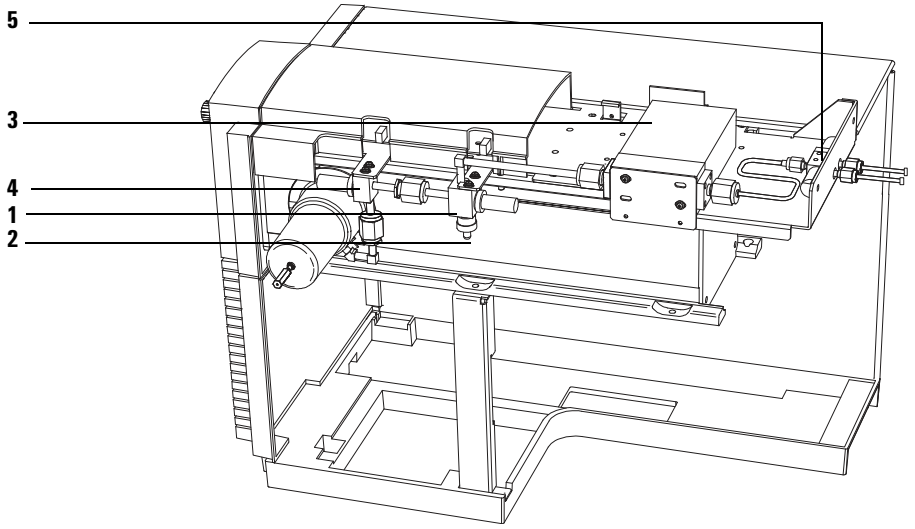

Figure 50 CI flow control module

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sales@apexscientific.ie
tel. 01 6854686

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