Agilent

Agilent 7000/7010 Series Triple Quadrupole

Troubleshooting and Maintenance Manual

Notices

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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.

Contents

1 Introduction

This manual describes the troubleshooting and maintenance of the Agilent Technologies 7000D/7010B TQ GC/MS system. It is often referred to in this document as the 7000/7010 TQ GC/MS. This manual assumes familiarity with the procedures and information detailed in the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.

The 7000/7010 TQ GC/MS system consists of an 8890, 9000, or 7890 Series Gas Chromatograph (GC) and a 7000/7010 Series Triple Quadrupole (TQ) Mass Spectrometer (MS).

This section provides general information about the 7000/7010 TQ 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
CC	Collision cell
CI	Chemical ionization
CID	Collision-induced dissociation
CSB	Ceramic source board
DC	Direct current
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)
HES	High efficiency source
id	Inside diameter
LAN	Local Area Network
m/z	Mass to charge ratio
MFC	Mass flow controller
MRM	Multiple reaction monitoring
MS	Mass spectrometer
MS1	Front quadrupole
MS2	Rear quadrupole
NCI	Negative chemical ionization

Table 1 Abbreviations (continued)

Abbreviation	Definition
OFN	Octafluoronaphthalene (sample)
PCI	Positive chemical ionization
PFDTD	Perfluoro-5,8-dimethyl-3,6,9-trioxydodecane (calibrant)
PFTBA	Perfluorotributylamine (calibrant)
Quad	Quadrupole mass filter
RF	Radio frequency
RFPA	Radio frequency power amplifier
Torr	Unit of pressure, 1 mm Hg
TQ	Triple Quad (quadrupole)
Turbo	Split flow turbomolecular vacuum pump
XTR	EI Extractor source

The 7000/7010 TQ GC/MS

The 7000/7010 TQ GC/MS is a standalone capillary GC detector for use with the Agilent 8890, 9000, or 7890 GCs. The TQ MS features:

- One split flow turbomolecular vacuum pump
- Rotary vane or optional dry scroll foreline pump
- A choice of two independently MS-heated high sensitivity EI sources
- An optional JetClean system for cleaning the ion source in place under vacuum
- CI and EI modes available (PCI/NCI/EI)
- Two independently MS-heated hyperbolic quads
- Single hexapole CC
- A HED EM detectors with high sensitivity electronics (Series 2)
- Independently GC-heated GC/MS interface
- Independently GC-controlled CC gas flows

Physical description

The 7000/7010 TQ 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 and 64 kg for the mainframe with CI. The attached foreline (roughing) pump weighs an additional 22.2 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 CC, the detector, and the front and rear analyzers.

Vacuum gauge

The 7000/7010 TQ GC/MS is equipped with two ion vacuum gauges. The Agilent MassHunter GC/MS Acquisition software can be used to read the pressure (high vacuum) in the vacuum manifold and at the turbomolecular vacuum pump discharge.

7000/7010 TQ CI System

In this manual, the term “CI MS” refers to the 7000/7010 TQ GC/MS CI source system. It also applies, unless otherwise specified, to the mass flow controller (MFC) for these instruments.

The 7000/7010 TQ GC/MS CI source system (preconfigured or upgrade kit) adds to the 7000/7010 TQ MS:

- EI/CI GC/MS interface
- CI source
- Reagent gas MFC system
- JetClean option available that shares the same MFC system
- Bipolar HED power supply for PCI and NCI operation
- HED with high-sensitivity electronics

A required methane/isobutane gas purifier is provided. 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 CC, 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 GC/MS 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 about 1 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.

7000/7010 TQ GC/MS Hardware Description

Figure 1 is an overview of a typical Agilent 7000/7010 TQ GC/MS system.

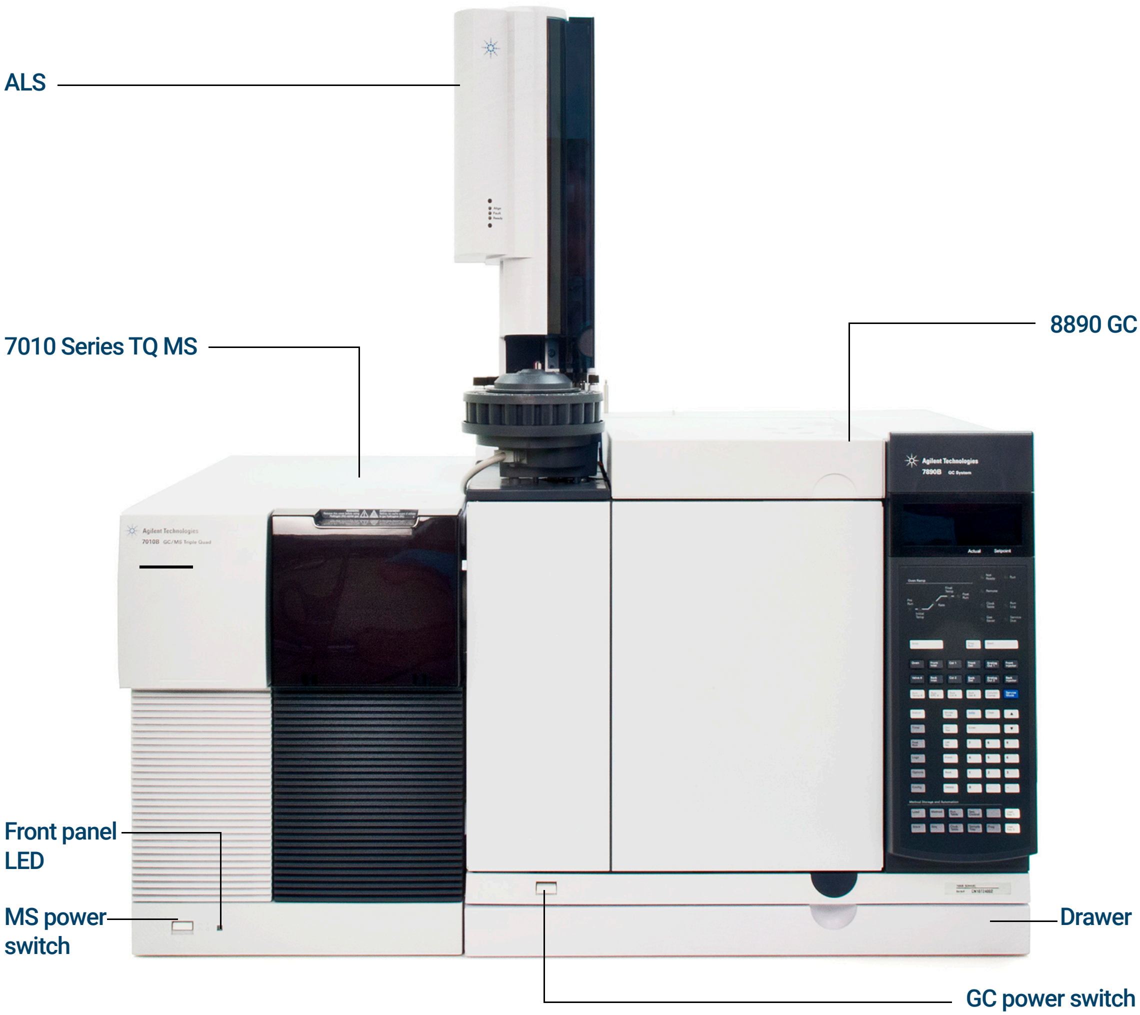


Figure 1. 7010 TQ MS System with 8890 GC

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.**

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

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

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:

- GC inlet
- GC oven and its contents
- GC valve box
- GC detectors
- Column nuts attaching the column to an inlet or detector
- Foreline pump
- GC/MS interface
- Quadrupole
- Ion source

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 rotary vane 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, detector fuel gas, or in the optional JetClean system 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, detector fuel gas, and reactive cleaning gas for the optional JetClean system. 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.
- When using hydrogen as a carrier gas, remove the large round plastic cover for the MSD transfer line located on the GC left side panel. In the unlikely event of an explosion, this cover may dislodge.

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 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.**

WARNING **The MS cannot detect leaks in the valves for the optional JetClean system. It is possible that hydrogen can leak into the MS from this cleaning system. Always close the manual hydrogen shutoff valve to the JetClean MFC, and ensure good vacuum before venting the MS.**

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

Table 2 Hydrogen accumulation mechanisms

Mechanism	Results
MS turned off	A MS can be shut down deliberately. It can also be shut down accidentally by an internal or external failure. A MS shutdown does not shut off the flow of carrier gas. As a result, hydrogen may slowly accumulate in the MS.
MS automated shutoff valves closed	The MSs are equipped with automated shutoff valves for the calibration vial, optional JetClean system, 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 MS.
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 an 8890/9000/7890 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 MSs can pump away, resulting in the accumulation of hydrogen in the MS. If the MS is shut off at the same time, the accumulation can be fairly rapid.
Power failure	If the power fails, both the GC and MS 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 MS.

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

WARNING **After a power failure, the MS 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, or when operating the MS with the JetClean option that supplies hydrogen to the MS from a MFC located on the analyzer.

Equipment precautions

WARNING

You MUST ensure 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 CC 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, fuel gas, and in the optional JetClean system 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 CC 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 ensure the vent line is vented into a fume hood.

Safety and Regulatory Certifications

The 7000/7010 Series TQ 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 7000/7010 TQ 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.

South Korean Class A EMC Declaration

A 급 기기 (업무용 방송통신기자재)

This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.
이 기기는 업무용 (A 급) 전자파적합기기로서 판 매자 또는 사용자는 이 점을 주의하시기 바라 며 , 가정외의 지역에서 사용하는 것을 목적으 로 합니다 .

The 7000/7010 Series TQ GC/MS is designed and manufactured under a quality system registered to ISO 9001.

Information

The Agilent Technologies 7000/7010 Series TQ GC/MS meets the following IEC 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.

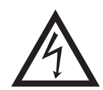
Refer servicing to qualified service personnel. Substituting parts or performing any unauthorized modification to the instrument may result in a safety hazard.

Symbols

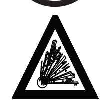
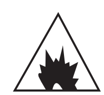
Warnings in the manual or on the instrument must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions violates safety standards of design and the intended use of the instrument. Agilent Technologies assumes no liability for the customer’s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

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:

- Relocate the radio or antenna.
- Move the device away from the radio or television.
- Plug the device into a different electrical outlet, so that the device and the radio or television are on separate electrical circuits.
- Ensure that all peripheral devices are also certified.
- Ensure that appropriate cables are used to connect the device to peripheral equipment.
- 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 be used only 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

In case of an accidental liquid spill, first turn off the MS and remove the power cord from the buildings electrical power supply. Then call your local Agilent service representative for assistance.

Only Agilent trained technicians should service the electrical components inside an 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. (See **"To move or store the MS when used with an 8890 or 7890 GC"** on page 88.)

2 General Troubleshooting

This is a quick reference to symptoms and possible causes of the most common problems experienced by users. Help with CI-specific problems are discussed later in this manual. (See **Chapter 3**, “CI Troubleshooting,” starting on page 51.) 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 is not 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 GC keypad or touchscreen 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 front panel LED does not turn on.The local control panel is not 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 and the front panel LED 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 136.) 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.

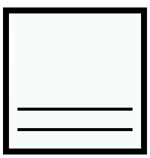
You must power cycle the MS to recover from this state. (See **"Pumpdown failure shutdown"** on page 136.)

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 also apply to mass spectral data. (See **"Poor sensitivity"** on page 32 and **"Poor repeatability"** on page 33.)

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*

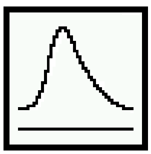
  * This could cause a fault condition in the GC that would prevent the GC from operating.

Does not pass tune

- Calibration vial is empty
- Excessive foreline or analyzer chamber pressure
- Very dirty ion source
- Calibration valve is not working correctly

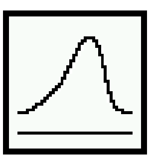
- Bad signal cable connection
- Filament has failed, or is not connected correctly
- Bad ion source wiring connection
- Bad detector wiring connection
- Failed electron multiplier horn
- Verify source lens ramps

Peaks are tailing



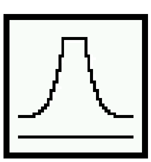
- Active sites in the sample path
- Injection is too large
- Incorrect GC inlet temperature
- Insufficient column flow
- GC/MS interface temperature is too low
- Ion source temperature is too low

Peaks are fronting



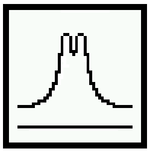
- Column film thickness mismatched with analyte concentration (column overload)
- Initial oven temperature is too low
- Active sites in the sample path
- Injection is too large
- GC inlet pressure too high
- Insufficient column flow

Peaks have flat tops



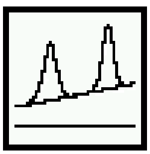
- Insufficient solvent delay
- Incorrect scale on the display
- Injection is too large
- EMV is too high

Peaks have split tops



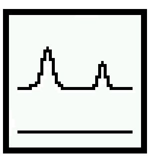
- Bad injection technique
- Injection is too large

Baseline is rising



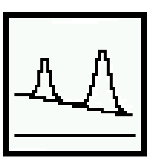
- Column bleed
- Other contamination

Baseline is high



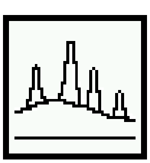
- Column bleed
- Other contamination
- EMV is too high

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)



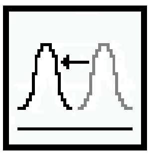
Baseline wanders

- Insufficient carrier gas supply pressure*

- Malfunctioning flow or pressure regulator*
- Intermittent leak in the GC inlet*

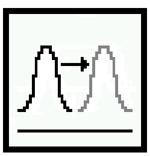
  * This could cause a fault condition in the GC that would prevent the GC from operating.

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 EM) is not working correctly
- Incorrect mass filter polarity
- CC voltage
- Vacuum system is not working correctly

  * 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 also apply to mass spectra. (See **"Poor sensitivity"** on page 32 and **"Poor repeatability"** on page 33.)

No peaks

- Ion source cables not connected
- Bad connections to or from the detector
- HED power supply output cable has failed
- CC voltages
- CC 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)
- EMV is too low
- Repeller voltage is too high
- Wrong ions are chosen
- High background
- Dirty ion source
- CC voltage
- CC 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

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 Quad
- Dirty Quad

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
- EM 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 high mass sensitivity is poor symptom. (See **"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 Quad

Spectra look different from those acquired with other MSs

Ion ratios are different from those in older models. This is due to the HED detector and the type of MS being compared, and is normal. Single quadrupole and TQ 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 Quad
- CC gas flow is too high
- CC voltages are too high
- Prefilter or postfilter
- No voltage to the extractor lens (if using HES or XTR 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
- CC 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 (rotary vane foreline pump)
- Foreline pump tip seals need to be replaced (dry scroll foreline pump)
- Foreline hose is constricted
- Foreline pump is not working correctly
- Foreline pump exhaust hose is constricted

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
- CC 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 mass filter
- Rear mass filter
- 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 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
- Mainframe has the wrong power input selection

  * 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
- Mainframe has the wrong input power selection

  * 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 interface heater failed (burned out)*
- GC/MS interface 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.

Error Messages

Sometimes a problem in your MS will cause an error message to appear in the Agilent MassHunter GC/MS Acquisition 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 EM 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. There are precautions that you need to take. (See **“The system is in vent state”** on page 45.)

- 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. Ensure 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
- EMV 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 10 Torr 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
- EMV 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
- CC gas flows
- CC voltages
- Vacuum system is not working correctly

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) (H_2O, N_2, O_2, CO_2 or N, O respectively)
- 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
- CC 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 (See **Table 3** on page 49.):

- Air leak
- Cleaning solvents and materials
- Foreline pump oil (rotary vane foreline pump)
- Foreline pump tip seal (dry scroll foreline pump)
- Fingerprints (improper handling of clean parts)

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

This chapter outlines the troubleshooting of Agilent 7000/7010 TQ GC/MSs equipped with the CI source. Most of the troubleshooting information in the previous chapter also applies to CI TQs.

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
- Incorrect CI source wiring
- 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 is not 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 MFC 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. Select **Methane Pretune** from the Setup menu in the Agilent MassHunter GC/MS Acquisition software, and follow the system prompts. See the software online help for additional information. Start with a good PCI tune file. (See **Figure 2** on page 55.) 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.

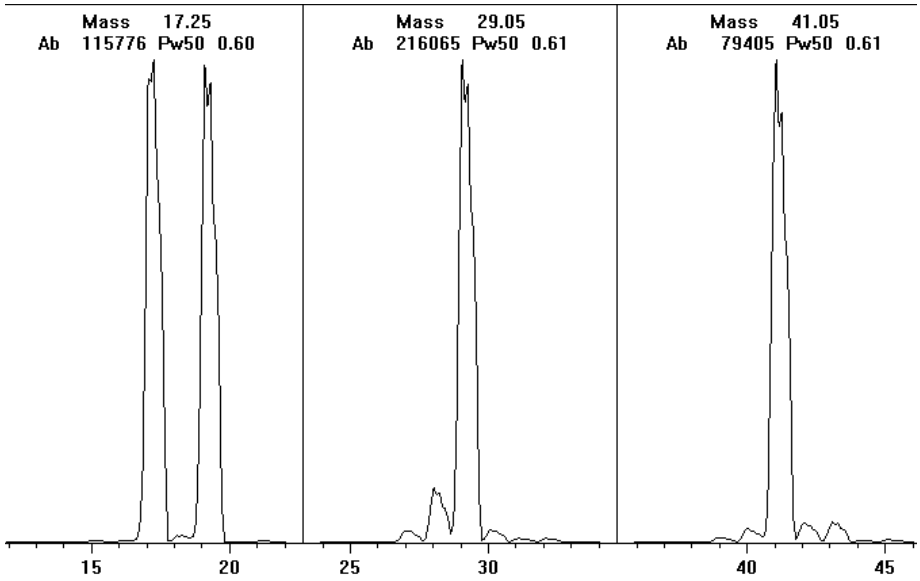


Figure 2. Looking for air leaks

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 Look for the last seal that was disturbed. (See **Figure 3** on page 57 and **Table 4** on page 57.)
   - 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.

2 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.

3 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.**

4 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.

5 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** on page 57 and **Table 4** on page 57.)
- 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.

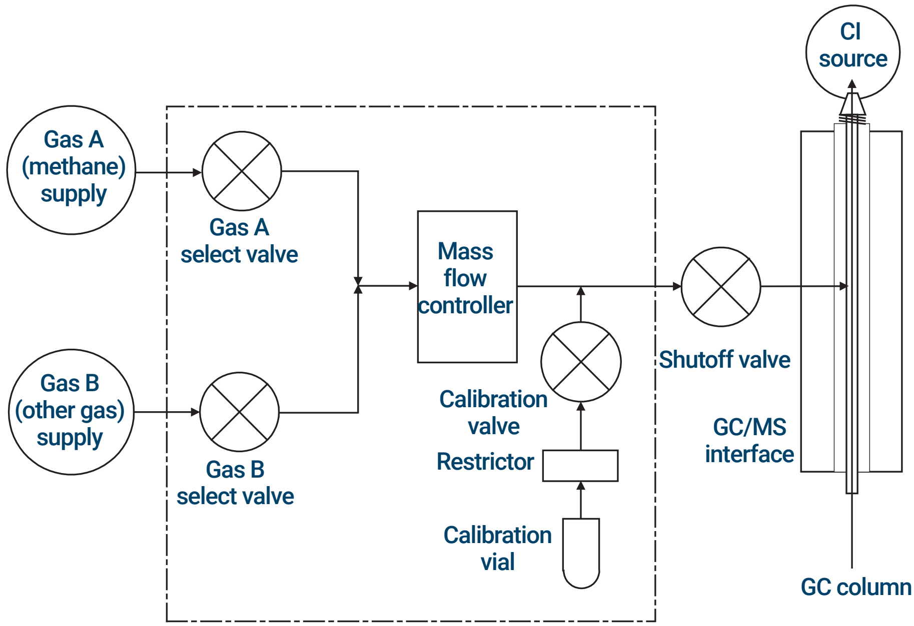


Figure 3. Schematic of CI flow control module

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 MFC is calibrated for methane, and the high vacuum gauge controller is calibrated for nitrogen; so these measurements are not accurate in absolute terms. (See **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
GC/MS Interface temperature	280 °C to 320 °C
Helium carrier gas flow	1 mL/min

Table 5 Typical analyzer vacuum with reagent gas flow

	CC gas flow on		CC 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

In PCI mode, select **Methane Pretune** from the Setup menu in the Agilent MassHunter GC/MS Acquisition software, and follow the system prompts. See the software online help for additional information. 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 126.)**

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

Select **Methane Pretune** from the Setup menu in the Agilent MassHunter GC/MS Acquisition software, and follow the system prompts. See the software online help for additional information. Visible peak at *m/z* 32 indicates air in the system. Check for and correct any leaks. (See **"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 20-25 psi (140-175 kPa) for methane or 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 that the reagent line is connected to the rear of the flow module. Ensure 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 68.**)

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 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.

Fix the air leak. Clean the ion source. Then bake out for 2 hours before tuning. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating 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.

Ensure that the filament 1 wires are connected to the CI 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 and, if necessary, replace the filament.

Too much air or water in the system.

Select **Methane Pretune** from the Setup menu in the Agilent MassHunter GC/MS Acquisition software, and follow the system prompts. See the software online help for additional information. 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.)

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 and, 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," starting on page 75.)

Ion source wires are not connected, or incorrectly connected.

Inspect the repeller. Ensure 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 EM leads.

Saturated chemical ionization 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.

Ensure 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,” starting on page 125.)

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

Purge the calibration valve. (See **“To refill the EI calibration vial”** on page 93.) Then clean the ion source.

The calibrant vial was overfilled. Excess PFDTD can quench the CI 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. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual* for more information.

Poor vacuum

Check the pressure on the high vacuum gauge controller.

Air leak

In PCI mode, select **Methane Pretune** from the Setup menu in the Agilent MassHunter GC/MS Acquisition software, and follow the system prompts. See the software online help for additional information. Large peak at *m/z* 32 indicates air in the system. Check for, and correct any leaks. (See **"Air Leaks"** on page 54.)

Saturated chemical ionization 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, 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. (See **Chapter 4**, “General Maintenance,” starting 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 chemical ionization 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. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating 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. Ensure it is not broken, and it is installed correctly.

Saturated chemical ionization 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 EMV
- 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 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

Select **Methane Pretune** from the Setup menu in the Agilent MassHunter GC/MS Acquisition software, and follow the system prompts. See the software online help for additional information. 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

In PCI mode, select **Methane Pretune** from the Setup menu in the Agilent MassHunter GC/MS Acquisition software, and follow the system prompts. See the software online help for additional information. 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 source is dirty.

Clean the ion source. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual* for more information.

High EMV

The EMV can range from a few hundred volts to 3,000 V. If the CI autotune program consistently sets the EMV at or above 2,600 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 source is dirty.

Clean the ion source. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual* for more information.

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

Replace the EM.

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 2.0 and 5.0.

If the ion ratio is incorrect, adjust it. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.

The CI source is dirty.

Clean the ion source. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual* for more information.

Too much air or water in the system

After eliminating these problems, clean the ion source. (See **"Air Leaks"** on page 54.)

Peak widths are unstable

Wrong or corrupted tune file

Check the tune parameters.

The CI source is dirty.

Clean the ion source. (See **Chapter 5**, “CI Maintenance,” starting on page 125.)

Air leak

In PCI mode, select **Methane Pretune** from the Setup menu in the Agilent MassHunter GC/MS Acquisition software, and follow the system prompts. See the software online help for additional information. 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

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 rotary vane foreline pump oil level	X			
Check the calibration vial		X		
Replace the rotary vane foreline pump oil*		X		
Replace the dry scroll foreline pump tip seal			X	
Replace the dry scroll foreline pump exhaust filter			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
Leak detection				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. (See **"Replacement Parts"** on page 191.)

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

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

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-20 (8710-1615)

Procedure

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.**

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

If you need to remove one of the MS covers follow these procedures: (See **Figure 4** on page 81.)

To remove the analyzer window cover

1 Pull the window towards you. 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 gently pull the cover forward so you can remove the LED cable.

To open the left side panel

Pull gently on the front of the left side panel and allow the panel to swing forward and down.

To remove the left rear cover

1. Open the left side panel.
2. Loosen the captive top screw on 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.

Figure 4. MS covers

To separate or attach the MS and the 8890 or 7890 GC

Materials needed

- Ferrule, blank (5181-3308)
- Interface column nut (05988-20066)
- Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)
- Gloves, clean, lint-free (Large 8650-0030) (Small 8650-0029)

Procedure

WARNING **Ensure 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 or for the JetClean system, the carrier gas flow and JetClean hydrogen supply shutoff valves must be closed before turning off the MS power. If the foreline pump is off, hydrogen will accumulate in the MS and an explosion may occur. Before operating the MS with hydrogen carrier gas read the hydrogen safety information. (See** **"Hydrogen Safety" on page 16.)**

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

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

Separate the MS and GC

1. Vent the MS. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual.*
2. Turn off the GC.
3. Remove the capillary column from the GC/MS interface.
4. Place a column nut with a blank ferrule on the end of the interface. This will help keep contamination out of the MS.

5. 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.
6. Move the MS away from the GC until you have access to the GC/MS interface cable. (See **Figure 5**.)
7. Disconnect the GC/MS interface cable. Disconnecting the cable with the GC on can cause a fault condition. If the MS needs to be moved a significant distance from the GC, also disconnect the APG cable.
8. Continue to move the MS until you have access to the part requiring maintenance.

Figure 5. Separating/connecting the MS and GC

Attach the MS and GC

1. Position the MS so the end of the GC/MS interface is near the GC. (See **Figure 5**.)
2. Reconnect the GC/MS interface cable and, if necessary, the APG 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. Ensure 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 Install the capillary column.

6 Pump down the MS. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.

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.**

WARNING **Ensure your MS meets all the conditions listed in the Pump Down section of the *Agilent 7000/7010 Triple Quad GC/MS Operating Manual* before starting up and pumping down the MS. Failure to do so can result in personal injury.**

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

To separate or attach the MS and the 9000 GC

Materials needed

- Screwdriver, T-20 Torx (8710-1615)
- Ferrule, blank (5181-3308)
- MS transferline plug (G4590-60250)
- Gloves, clean, lint-free (Large 8650-0030) (Small 8650-0029)

Procedure

WARNING **Ensure 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 closed before turning off the MS power. If the foreline pump is off, hydrogen will accumulate in the MS and an explosion may occur. Before operating the MS with hydrogen carrier gas read the hydrogen safety information. (See** **"Hydrogen Safety" on page 16.)**

CAUTION **Ensure the GC heated zones and the GC/MS interface are cool before turning off carrier gas flow.**

WARNING **Ensure the GC/MS interface and GC heated zones have cooled before you remove the 9000 GC/MS Tail.**

Separate the MS and 9000 GC

1. Vent the MS. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.
2. Remove the 9000 GC/MS Tail. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.
3. Power off the GC.
4. Using a T-20 Torx screwdriver, loosen the lock plate by turning the lock plate screw clockwise.

5 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.

6 Slide the MS backwards, and then away from the GC until you have access to the GC/MS cables. (See **Figure 6** on page 86.)

7 Disconnect the GC/MS interface cables. Disconnecting the cable with the GC on can cause a fault condition. If the MS needs to be moved a significant distance from the GC, also disconnect the APG cable.

8 Install an MS transferline plug and blank ferrule on the end of the GC/MS interface. This will help keep contamination out of the MS.

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

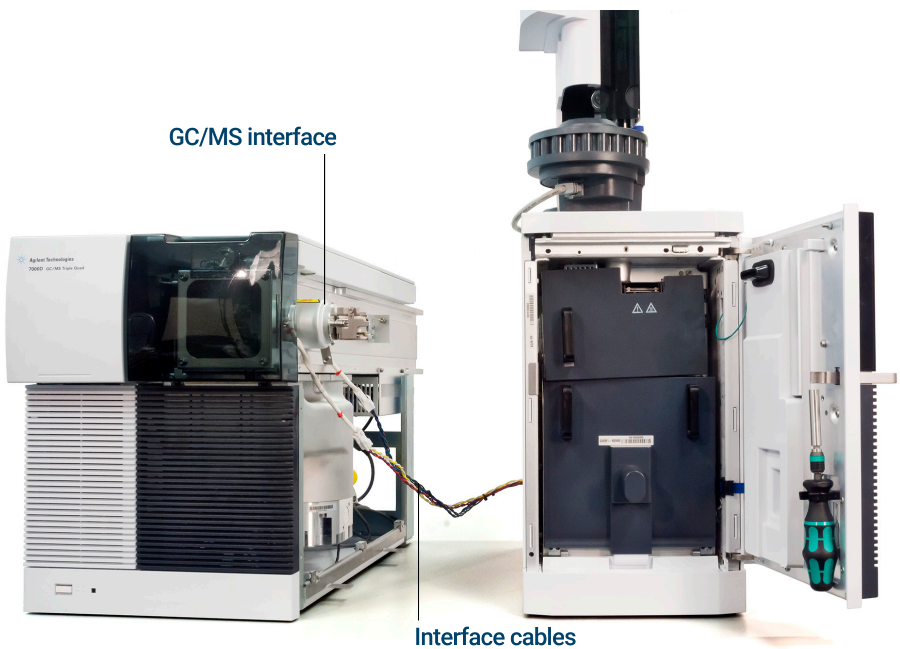


Figure 6. Separating/connecting the MS and 9000 GC

Join the MS and the 9000 GC

This procedure starts with both instruments shut down and at room temperature.

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

2 Tighten the thumb screw at the top of the interface heater clamp. If the thumb screw is loose when reconnecting the GC/MS, it will be difficult to retighten when installing the 9000 GC/MSD Tail.

3 Open the GC front door.

4 Connect the GC/MS interface cables and, if necessary, the APG cable.

5 Slide the MS against the GC with the GC/MS interface entering the GC side opening (see **Figure 7** on page 87), and the metal brackets entering their slots in the base of the GC.

   Be careful not to damage the GC/MS interface as it passes into the GC.

6 Slide the MS forward until the GC/MS interface lightly contacts the bus.

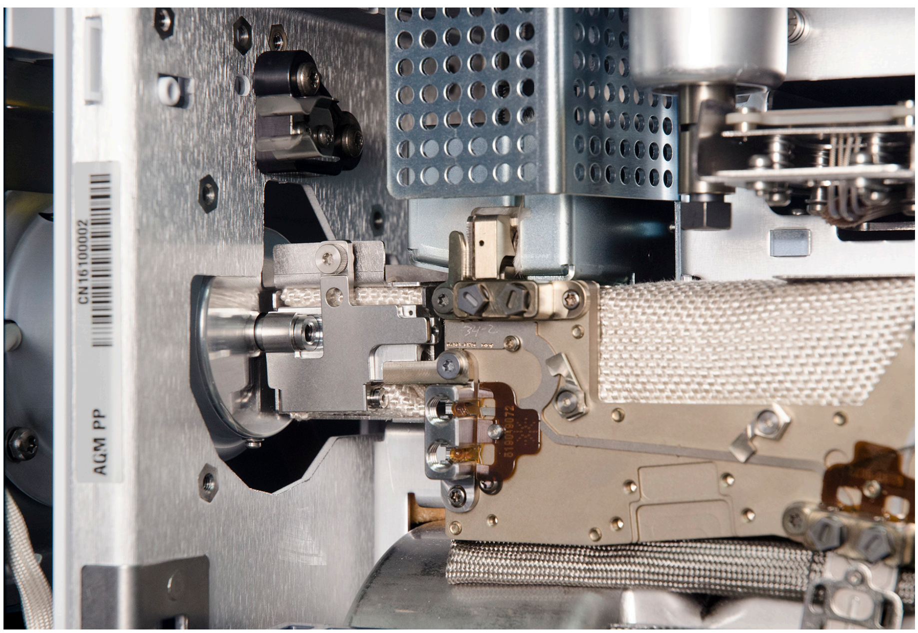


Figure 7. GC/MS interface and bus

7 Using a T-20 Torx screwdriver, tighten the lock plate by turning the lock plate screw counter clockwise.

8 Install the 9000 GC/MS Tail.

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.

WARNING Ensure your MS meets all the conditions listed in the Pump Down section of the *Agilent 7000/7010 Triple Quad GC/MS Operating Manual* before starting up and pumping down the MS. Failure to do so can result in personal injury.

To move or store the MS when used with an 8890 or 7890 GC

Materials needed

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

Procedure

WARNING Ensure 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 or for the JetClean system, the carrier gas flow and JetClean hydrogen supply shutoff valves must be closed before turning off the MS power. If the foreline pump is off, hydrogen will accumulate in the MS and an explosion may occur. Before operating the MS with hydrogen carrier gas read the hydrogen safety information. (See "Hydrogen Safety" on page 16.)

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

CAUTION **Ensure 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 on page 18.)

1 Move the MS away from the GC. (See **"Separate the MS and GC"** on page 82.)
2 Verify that carrier gas, collision gas, CI reagent gas (if present), and JetClean gas (if present) supplies are all off.
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 If a JetClean system is present, disconnect the hydrogen supply tubing from the MFC, and plug the MFC connection.
6 If a CI system is present, disconnect the reagent gas tubing from the MFC, and plug the connection.
7 Remove the front analyzer window, and open the left side panel. (See **"To remove the MS covers"** on page 80.)
8 Finger-tighten the side plate thumbscrews for both analyzers. (See **Figure 8** on page 90.)

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.

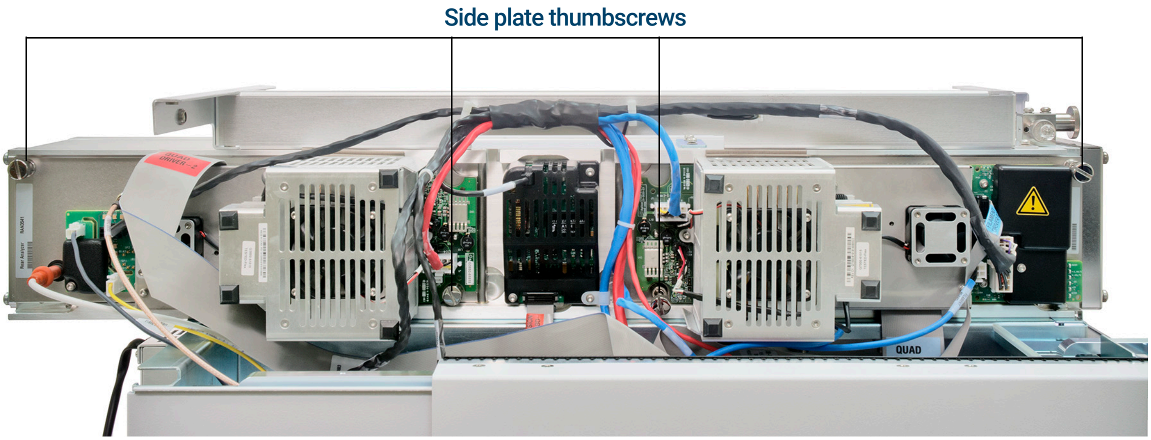


Figure 8. Side plate thumbscrews

The MS can now be stored or moved. The foreline pump cannot be disconnected; it must be moved with the MS. Ensure 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 move or store the MS when used with a 9000 GC

Materials needed

- Ferrule, blank (5181-3308)
- MS transferline plug (G4590-60250)
- 7/16-inch open-end wrench

Procedure

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

CAUTION **Ensure the GC heated zones 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 on page 18.)

1 Separate the MS and the 9000 GC. See **"To separate or attach the MS and the 9000 GC"** on page 85.
2 Verify that carrier gas, reaction gas, and JetClean gas (if present) supplies are all off.
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 If a JetClean system is present, disconnect the hydrogen supply tubing from the MFC and plug the connection.

6 Remove the analyzer window cover, and open the left side panel. (See **"To remove the MS covers"** on page 80.)

7 Finger-tighten the side plate thumbscrews for both analyzers. (See **Figure 9**.)

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.**

8 Switch the MS on to establish a rough vacuum.

9 When you hear the hissing sound of the pumpdown, close the vent valve. Continue the pumpdown for 2 to 3 minutes.

10 Switch the MS off.

11 Close the left side panel and replace the analyzer window cover.

12 Disconnect the LAN, remote, and power cables.

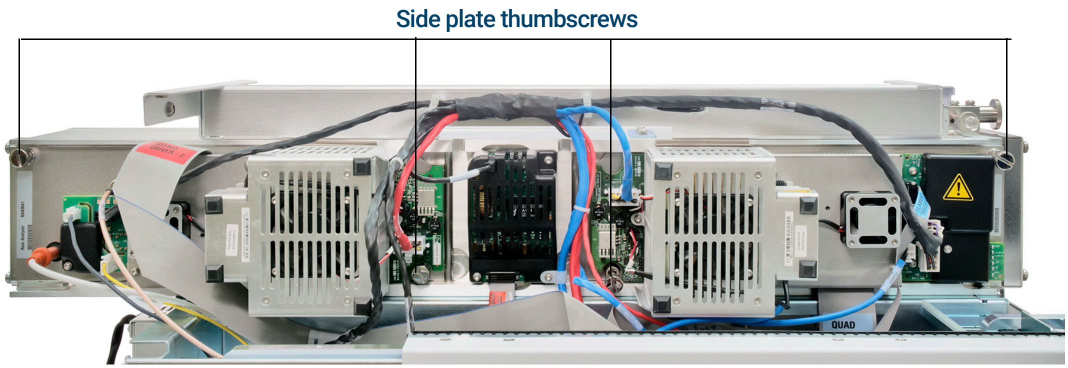


Figure 9. Side plate thumbscrews

The MS can now be stored or moved. The foreline pump cannot be disconnected; it must be moved with the MS. Ensure 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 refill the EI calibration vial

Materials needed

- PFTBA (05971-60571)
- Syringe or pipette

Procedure

CAUTION **Keep a dedicated syringe for this task, or use a fresh pipette tip to prevent contamination.**

1 Stop any tuning or data acquisition.

2 Turn off the MS electronics. (See MassHunter software online help.)

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. (See **Figure 10**.) Do not remove the collar.

5 Pull the calibration vial out. You may feel some resistance due to O-ring friction and residual vacuum.

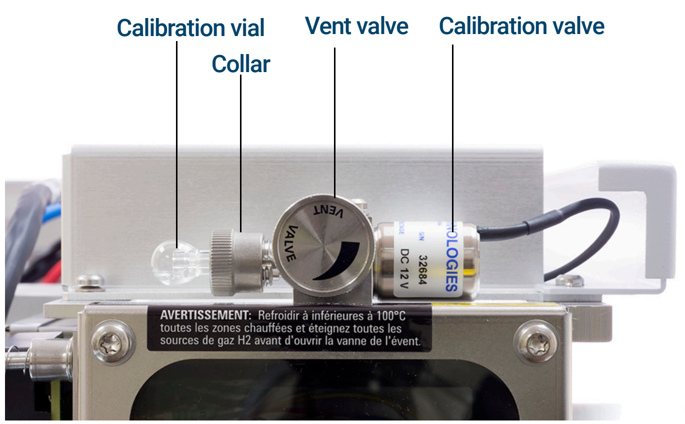


Figure 10. Removing the EI calibration vial

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. Tighten the collar, and reinstall the analyzer window cover.

Maintaining the Vacuum System

Periodic maintenance

Some maintenance tasks for the vacuum system must be performed periodically. (See **Table 6** on page 76.) These include:

- Checking the foreline pump oil (every week)
- Checking the calibration vial (every 6 months)
- Replacing the foreline pump oil (every 6 months, or every 3 months if using NH_3)
- 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," starting on page 25.) Refer to the online help in the Agilent MassHunter GC/MS Acquisition 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 **Chapter 6**, "Vacuum System," starting on page 133.)

Most of the procedures in this chapter are illustrated with video clips on the User Manuals and Tools DVD.

To remove/install the ion vacuum gauges

Materials needed

- Screwdriver, flat-blade (8730-0002)

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

WARNING Ensure 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 or for the JetClean system, the carrier gas flow and JetClean hydrogen supply shutoff valves must be closed before turning off the MS power. If the foreline pump is off, hydrogen will accumulate in the MS and an explosion may occur. Before operating the MS with hydrogen carrier gas read the hydrogen safety information. (“Hydrogen Safety” on page 16.)

WARNING The turbo pump can cause burns if touched when operating. Ensure 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 on page 18.)

WARNING Ensure your MS meets all the conditions listed in the Pump Down section of the *Agilent 7000/7010 Triple Quad GC/MS Operating 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, foreline pump gauge

1 Vent the MS. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.

2 Separate the MS from the GC. (See **“To separate or attach the MS and the 8890 or 7890 GC”** on page 82.)

3 Unplug the foreline gauge cable from the foreline gauge.

4 Unscrew the large wingnut on the gauge clamp. (See **Figure 11** on page 97.)

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.

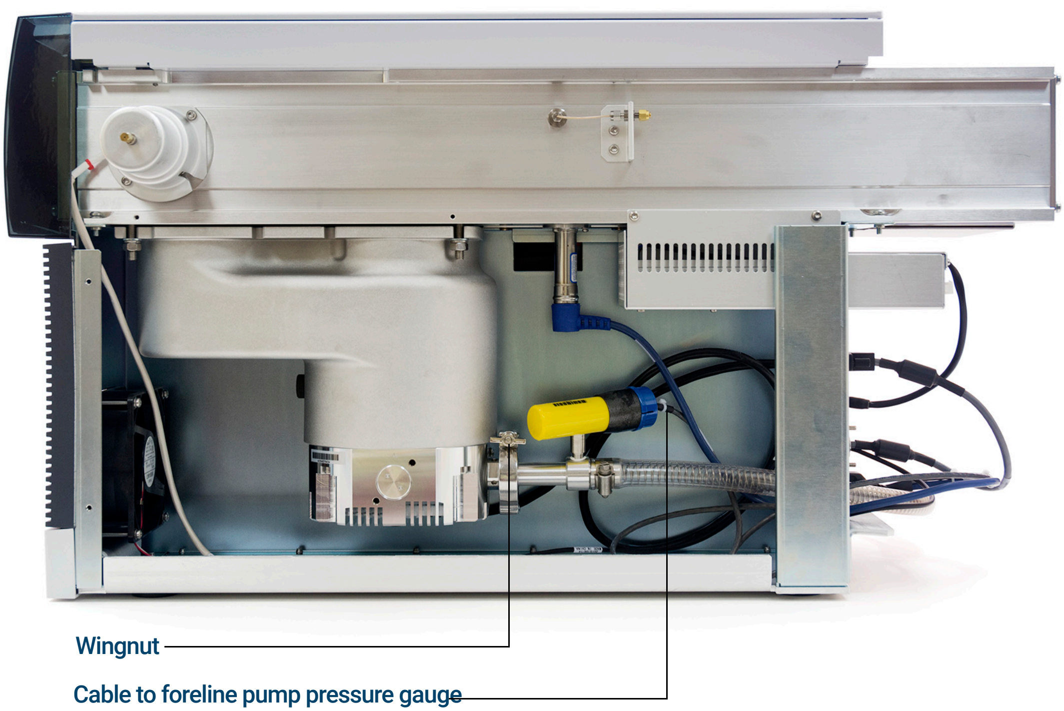


Figure 11. Ion vacuum gauge cable

Maintaining the Rotary Vane Foreline Pump

This section lists procedures to maintain the standard rotary vane foreline pump (See **Figure 12**). They should be performed according to the maintenance schedule, or as indicated by instrument symptoms.

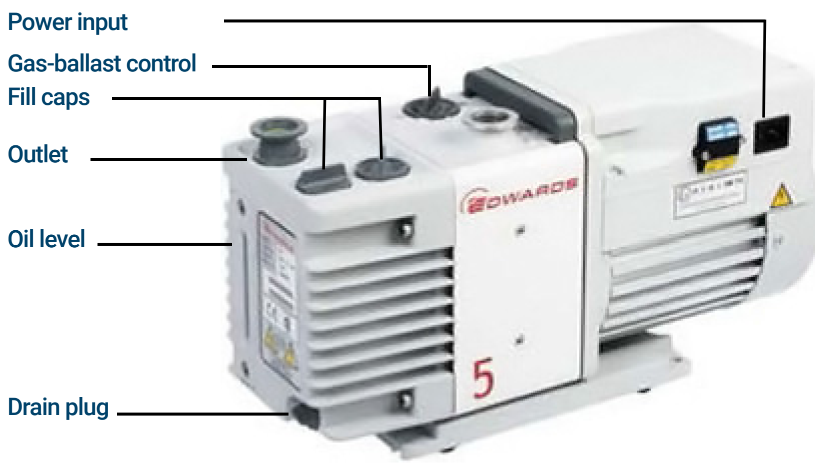


Figure 12. Rotary vane foreline pump

To check the foreline pump oil level

CAUTION **Never add or replace the foreline pump oil while the pump is on.**

Procedure

Check the level and color of the pump oil weekly.

1. Check the oil level in the window of the foreline pump (See **Figure 12** on page 98). The oil level should be between the marks for Max and Min.
2. Check that the color of the pump oil is clear or almost clear with few suspended particles. If the pump oil is dark or full of suspended particles, replace it.

NOTE **Record this procedure in the Maintenance Logbook.**

To add foreline pump oil

Add pump oil when the pump oil level is low.

Materials needed

- Funnel (9301-6461)
- 5-mm Allen wrench (8710-1838)
- Gloves, chemical resistant, clean, lint free (9300-1751)
- Foreline pump oil (Inland 45 oil, 6040-0834)
- Safety glasses (goggles)

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

WARNING **The fill cap and pump may be dangerously hot. Check that the fill cup and pump are cool before you touch them.**

CAUTION **Use only Inland 45 oil, any other fluids can substantially reduce pump life and invalidate the pump warranty.**

Procedure

1. Vent and turn off the instrument. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.
2. Unplug the instrument power cord from the electrical outlet.
3. Remove the fill cap on the foreline pump. (See **Figure 12** on page 98.)
4. Add new pump oil until the oil level is near, but not over the maximum mark beside the oil level window. (See **Figure 12** on page 98.)
5. Reinstall the fill cap.
6. Wipe off all excess oil around and underneath of the pump.
7. Reconnect the power cord.
8. Start the instrument. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.

To replace the foreline pump oil

Replace the pump fluid every six months, or sooner if the fluid appears dark or cloudy.

Materials needed

- Container for catching old pump fluid
- Funnel (9301-6461)
- Gloves, chemical resistant, clean, lint free (9300-1751)
- Foreline pump oil (Inland 45, 6040-0834)
- Screwdriver, flat-bladed, large (8710-1029)
- 5-mm Allen wrench (8710-1838)
- Safety glasses (goggles)

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

WARNING **The fill cap and pump may be dangerously hot. Check that the fill cap and pump are cool before you touch them.**

WARNING **Do not touch the pump oil. The residue from some samples are toxic. Properly dispose of the oil.**

CAUTION **Use only Inland 45 type oil. Any other fluids can substantially reduce pump life and invalidate the pump warranty.**

Procedure

1. Turn off the instrument. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.
2. Unplug the power cord from the instrument.
3. Place a container under the drain plug of the foreline pump. (See **Figure 12** on page 98.)
4. Remove the fill cap, then open the drain plug. (See **Figure 12** on page 98.) Drain the oil completely by raising the motor end of the pump up.
5. Reinstall the drain plug.

6. Pour in new pump oil until the oil level is near, but not above the maximum mark beside the oil level window. (See **Figure 12** on page 98.)
7. Reinstall the fill cap.
8. Reconnect the power cord.
9. Start up the instrument. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.
10. Pump down for 30 minutes, then inspect the pump for leaks.
11. Continue pumping down overnight and inspect the pump for leaks the next day.

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.

To replace the fan for the turbo pump

Materials needed

- Screwdriver, T-20 Torx (8710-1615)

Procedure

1. Vent the MS. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual.*
2. Turn the MS off.
3. Move the MS away from the GC to make the fan accessible. (See **"To separate or attach the MS and the 8890 or 7890 GC"** on page 82, or **"To separate or attach the MS and the 9000 GC"** on page 85)
4. Disconnect the fan wiring from the extender cable. (See **Figure 13** on page 104.)
5. 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.**

6. Connect the fan wiring to the new fan.
7. Install the new fan with the flow arrow on the side pointing toward the pump.
8. Add the safety grill and the four screws. Tighten the screws firmly.

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

9. Connect the fan wiring to the extender cable.
10. Pump down the MS. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual.*

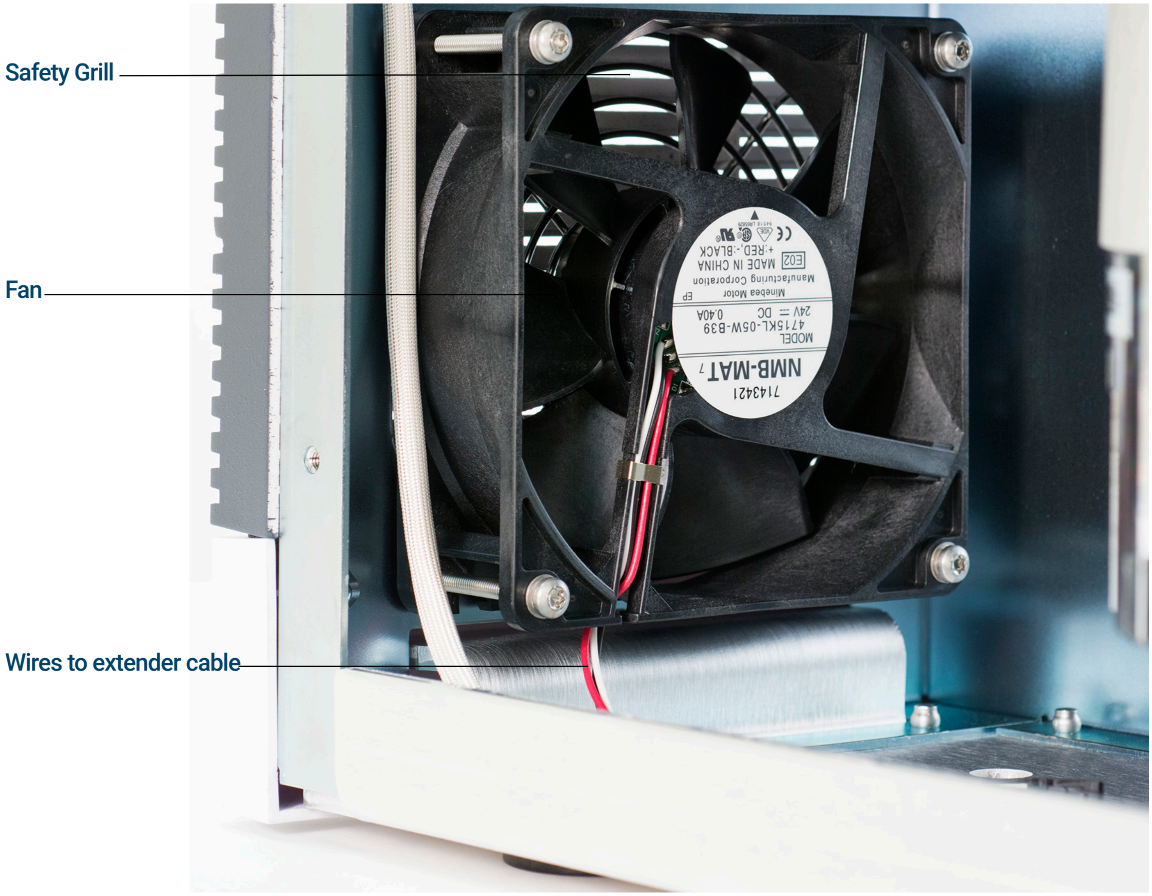


Figure 13. Replacing the turbo pump fan

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 before you open the analyzer chamber. (See** **"Electrostatic discharge is a threat to MS electronics" on page 14.)**

Procedure

Video shows lubrication of 5977 Series MSD but the procedure is identical.

1 Vent the MS. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.

2 Open an analyzer chamber.

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.**

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. (See **Figure 14**.)
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. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.

Figure 14. Side plate O-rings

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

Video shows lubrication of 5977 Series MSD but the procedure is identical.

1. Vent the MS. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.
2. Completely remove the vent valve knob. (See **Figure 15** on page 108.)
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

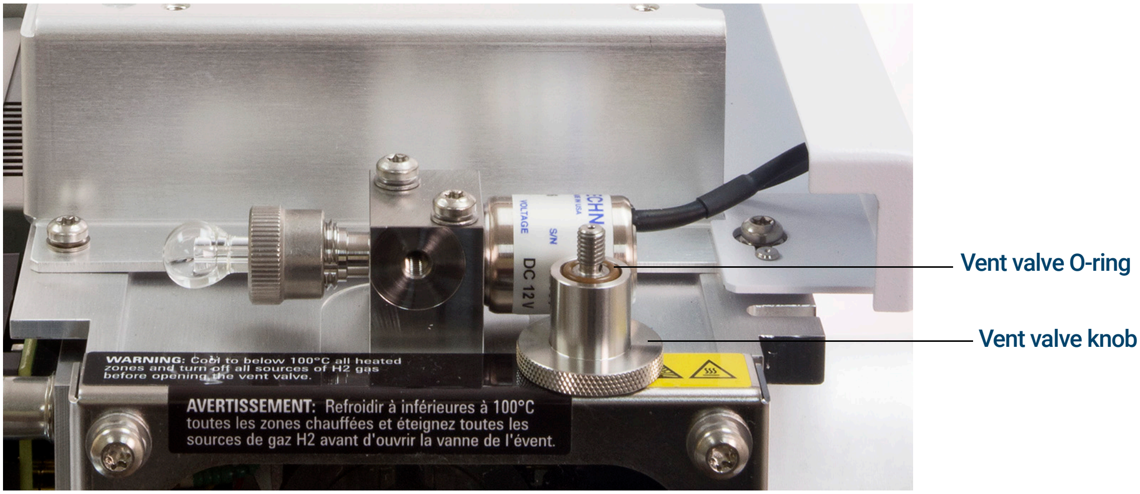


Figure 15. Vent valve O-ring

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. Ensure the O-ring stays in place.**

6 Reinstall the vent valve knob.
7 Pump down the MS. Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.

Maintaining the Dry Scroll Foreline Pump

This section lists procedures to maintain the optional IDP-10 dry scroll foreline pump. They should be performed according to the maintenance schedule, or as indicated by instrument symptoms.

To replace the tip seals and clean the dry scroll foreline pump

Use this procedure to replace the tip seals of, and clean, the optional IDP-10 dry scroll foreline pump.

Materials needed

- Hex key, 6 mm
- Hex key, 4 mm
- Face Mask W/Adjustable Nosepiece (9300-2647)
- Cloths, clean, lint-free 15 PK (05980-60051)
- Scouring Pad-General Purpose 6X9-in (9300-2646)
- Swab 6.0 in LG; cotton tipped,100/bag (8520-0023)
- Nylon Gloves, large (8650-0030)
- Solvents (grade is not important) Ethanol or Methanol
- Tip Seal Replacement Kit (X3807-67000)
- Tweezers, nonmagnetic (8710-0907)

Procedure

1 Vent the mass spectrometer (see *To Vent the MS in the Agilent 7000/7010 Series Triple Quadrupole Operating Manual*).

WARNING **The IDP-10 dry scroll pump operates at high temperatures. Do not touch any part until you are sure it is cool.**

2 Unplug the pump from the mass spectrometer.

3 Disconnect the inlet hose and the exhaust filter/hose assembly from the pump.

WARNING **The IDP-10 dry scroll pump weighs approximately 25 kg (55 lb). Use caution when moving it.**

4 If necessary, move the pump to a lab bench or other location where it is easy to work on.

5 Use the 4-mm hex key to remove the three front cowling screws.

CAUTION **The cowling and attached fan are connected to the rest of the pump by the fan cable. Do not pull the cowling too far from the pump or you could damage the cable.**

6 Gently pull the front cowling off the pump and set the cowling down.

7 Disconnect the fan cable and set the cowling and fan aside.

WARNING **Wear a face mask. The IDP-10 dry scroll pump may contain significant quantities of dust containing chemicals analyzed by the mass spectrometer. Do NOT use compressed air to blow out this dust. Using compressed air will contaminate your laboratory with potentially hazardous dust.**

8 Ensure the scroll housing (see Figure 16) has cooled to a safe temperature and then remove the four scroll housing screws.

Figure 16. Removing the scroll housing

9 Remove the scroll housing by lifting it away from the rest of the pump.

10 Use tweezers to remove the old tip seals from their grooves in the scroll housing and orbiting scroll.

11 Use tweezers to remove the main O-ring that seals the connection between the scroll housing and pump body.

12 Use a combination of clean cloths, cotton swabs, and ethanol or methanol to clean the large, square scroll channel in the scroll housing. The channel needs to be clean, but does not have to be spotless.

13 Also in the scroll housing, use a combination of clean cloths, cotton swabs, and ethanol or methanol to clean the groove for the tip seal. One technique that works well is covering the wooden end of a swab with a clean cloth, dampening it with ethanol or methanol, and running it through the tip seal groove.

CAUTION **Do not drip solvent into the electronics located below the orbiting scroll.**

14 Repeat steps 12 and 13 for the scroll channel and tip seal groove in the orbiting scroll.

CAUTION **Never attempt to clean and reuse tip seals; they will not provide adequate performance.**

15 Wrap one end of a **new** tip seal several times around the shaft of a pen (see Figure 17). This helps establish a spiral and makes it easier to install the tip seal in its groove.

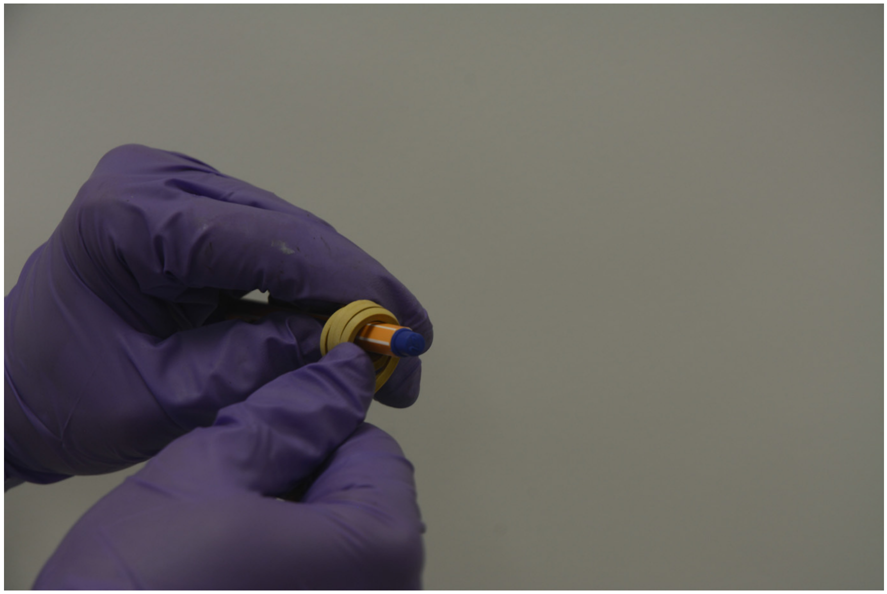


Figure 17. Add spiral to new tip seal

16 Take the spiraled end of the new tip seal and, starting 8-12 mm from the inner end of the tip seal groove on the orbiting scroll, press the seal into the groove (see **Figure 18**).Work your way out until you reach the outer end of the groove.

Figure 18. Installing a new tip seal

17 With sharp scissors or a sharp knife, cut the tip seal so that its outer end is 8-12 mm short of the outer end of the tip seal groove.

CAUTION **The gaps at the beginning and end of the tip seal are necessary because a new tip seal will expand slightly when first used.**

18 Repeat steps 15 through 17 to install a new tip seal on the scroll housing.

19 Lubricate a new main O-ring with the lubricant provided in the tip seal replacement kit.

20 Install the new main O-ring in its groove in the scroll housing.

21 Position the scroll housing on the pump body (see **Figure 19**).

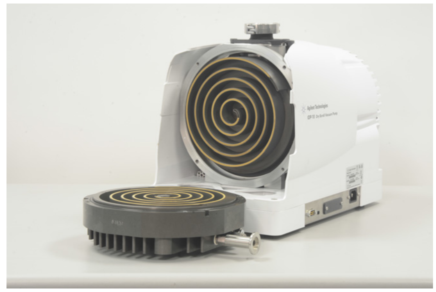


Figure 19. Scroll housing on the dry scroll pump

22 Insert the scroll housing screws through the scroll housing, and thread them into the pump body, but ***do not tighten them***.

CAUTION **Tightening the scroll housing screws completely, one at a time, can cause vacuum leaks.**

23 In a repeating upper left, lower right, upper right, lower left pattern, tighten the scroll housing screws a little at a time to a final torque of 4 N-m (40 in-lbs).

24 Connect the fan cable.

CAUTION **Be careful to not pinch the fan cable when installing the front cowling.**

25 Install the front cowling and fan.

26 Install the three front cowling screws. These screws should be snug, but do not need to be especially tight.

WARNING **The IDP-10 dry scroll pump weighs approximately 25 kg (55 lb). Use caution when moving it.**

27 If you moved the pump to work on it, move it back to its normal location.

28 Connect the inlet hose and the exhaust filter/hose assembly to the pump.

NOTE **It is generally recommended that the exhaust filter cartridge be replaced at the same time the tip seals are replaced and the pump is cleaned. See “To Replace the Dry Scroll Foreline Pump Exhaust Filter Cartridge” on page 115.**

29 Connect the pump power cord to the mass spectrometer.

CAUTION **If you hear loud noises or observe labored operation when the dry scroll pump is first powered up, the tip seal or main O-ring may be out of place. Turn the system off immediately and correct the problem before proceeding.**

30 Pump down the mass spectrometer (see *To Pump Down the MS in the Agilent 7000/7010 Series Triple Quadrupole Operating Manual*).

To Replace the Dry Scroll Foreline Pump Exhaust Filter Cartridge

Replace the exhaust filter cartridge at the same time the tip seals in the optional IDP-10 dry scroll foreline pump are replaced and the pump is cleaned.

Materials needed

- Nylon Gloves, Large (8650-0030)
- Exhaust filter cartridge (XXXX_XXXX)

Procedure

1 If the mass spectrometer is not already vented, vent the mass spectrometer (see *To Vent the MS in the Agilent 7000/7010 Series Triple Quadrupole Operating Manual*).

WARNING The IDP-10 dry scroll pump operates at high temperatures. Do not touch any part until you are sure it is cool.

WARNING Wear a face mask. The exhaust filter cartridge may contain chemicals analyzed by the mass spectrometer. Handle and dispose of the used cartridge as appropriate.

2 The exhaust filter cannister has two halves. (See **Figure 20**) Separate the cannister halves by pressing the halves together and rotating the outer half counterclockwise. The cannister halves fit together tightly and it may require considerable force to separate them.

Figure 20. Exhaust filter

3 Remove the old filter cartridge.

4 Install a new filter cartridge.

5 Assemble the filter cannister.

6 Pump down the mass spectrometer (see *To Pump Down the MS in the Agilent 7000/7010 Series Triple Quadrupole Operating Manual.*)

Maintaining the Analyzers and Collision Cell

Scheduling

None of the analyzer components require 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

Information about symptoms that indicate the need for analyzer maintenance can be found in this manual. (See **Chapter 2**, “General Troubleshooting,” starting on page 25.)

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.)

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

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

Refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual* for information on removing, disassembling, cleaning, assembling, and installing the ion source. This chapter contains procedures for removing and installing the heaters and sensors for the ion source and the analyzers.

More information about the locations or functions of analyzer components can be found in this manual. (See **Chapter 7**, "Analyzers and Collision Cell," starting on page 149.)

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 **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

More information about the functions of electronic components can be found in this manual. (See **Chapter 8**, “Electronics,” starting on page 173.)

To replace the primary fuses

Materials needed

- Fuse, 8 A, time-delay slow blow, (2110-0969) – 2 required for back panel external fuses
- 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

If one of the primary fuses or circuit breakers have failed, the MS will already be off. To safely restart the MS, you must first switch off the MS and unplug the power cord.

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" on page 16.)**

1. With the MS off and unplugged, locate and reset (push in) the circuit breakers. (See **Figure 21** on page 123.)
2. Plug in and turn on the MS. If the MS starts, skip the other steps.
3. If the MS does not start in step 2, switch the MS off and unplug it from the building power mains.
4. Locate the fuse holders on the back panel. (See **Figure 21** on page 123.) Use a flat-blade screwdriver to turn one of the fuse holders counterclockwise until it is released. The fuse holders are spring loaded.
5. Examine the fuse. If it is blown, remove the old fuse from the fuse holder.
6. Install a new fuse in the fuse holder. Each fuse holder is marked with the correct fuse value.
7. Install the fuse holder.
8. Repeat steps 4 through 7 for the other fuse. If you replace one fuse, replace both fuses.

9 Plug in the MS to the building power mains, and switch it on. If the MS does not start and you have eliminated the foreline pump as a failure point, contact your Agilent service representative for help.

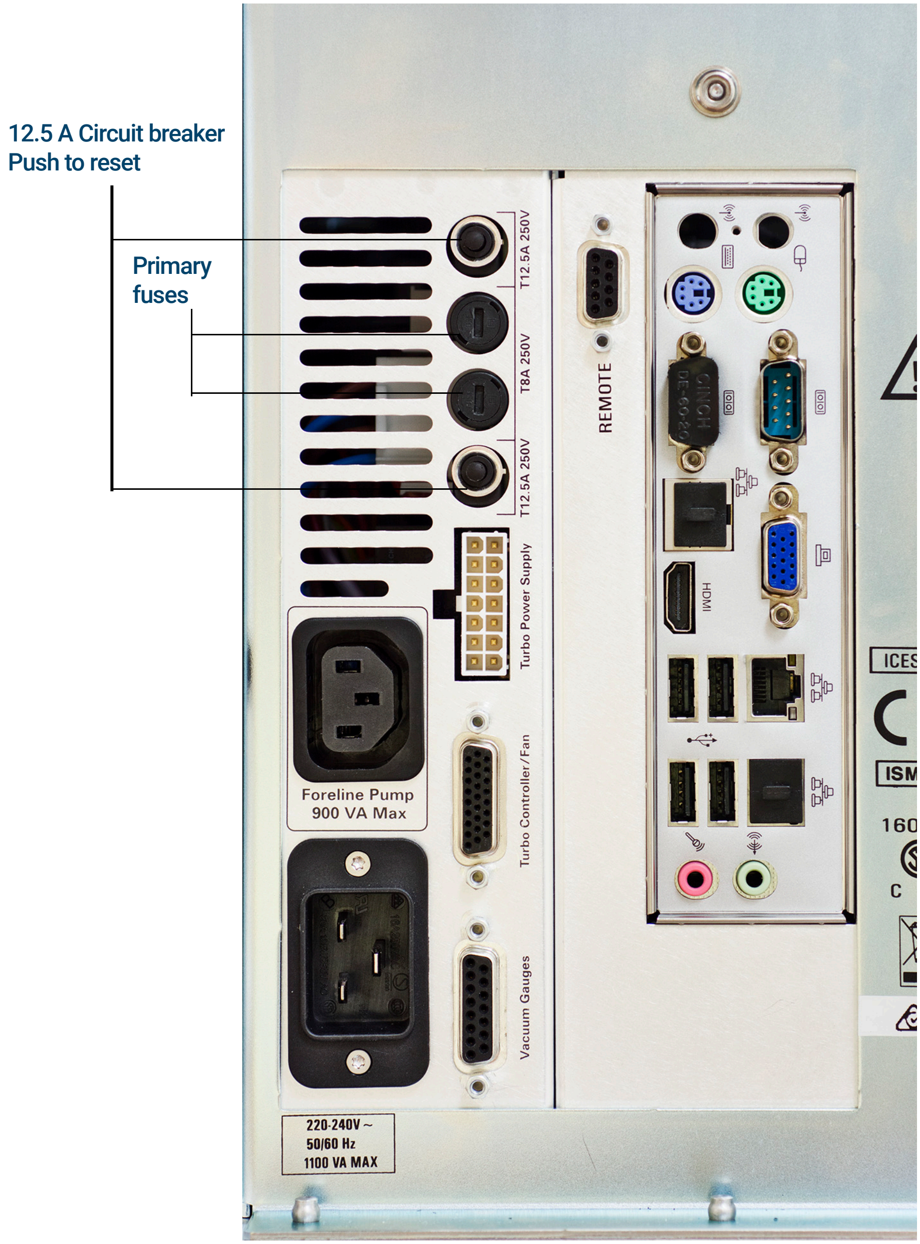


Figure 21. Replacing the fuses

5

CI Maintenance

This chapter describes maintenance procedures and requirements that are unique to a 7000/7010 TQ GC/MS equipped with the CI hardware.

To Minimize Foreline Pump Damage from Ammonia

Air ballasting for 1 hour every day removes most of the ammonia from the pump oil. This will greatly increase the life of the pump. Air ballasting is required only for the standard rotary vane foreline pump. It is not required for the optional dry scroll foreline pump.

WARNING **The pump may be dangerously hot. Wear insulating gloves before you touch it or the gas-ballast control.**

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 gas-ballast control if the pump is cold.**

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.**

Procedure

1 Turn the gas-ballast control on the foreline pump until the **1**s are aligned. (See **Figure 22**.) The sound of the pump will get much louder.

Figure 22. Minimizing ammonia damage

2 Leave the gas-ballast control open for 1 hour. You can continue to run samples while the pump is ballasting.

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

To Replace the Chemical Ionization Gas Purifier

Materials needed

- Chemical ionization gas purifier (5190-9071)
- Front ferrule for 1/8-inch tubing (5180-4110)
- Rear ferrule for 1/8-inch tubing (5180-4116)
- Tubing cutter (8710-1709)

The chemical ionization 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. Follow the instructions on the label for installation and replacement intervals.

Procedure

1 Turn off gas flow to the purifier.

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 purifier.

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 purifier.

5 Turn on the gas flow and purge the new purifier.

6 Cap the old purifier, 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)

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.**

Procedure

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

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

To Refill the CI Calibration Vial

Materials needed

- PFDTD calibrant (8500-8510)
- Syringe

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 **“To separate or attach the MS and the 8890 or 7890 GC”** on page 82.)

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

6 Remove the calibration vial. (See **Figure 23** on page 131.)

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 finger-tight.

9 Reposition the MS next to the GC. (See **“To separate or attach the MS and the 8890 or 7890 GC”** on page 82.)

10 Reinstall the capillary column.

11 Pump down the MS.

CAUTION **After removing the calibration 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 EM.**

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.

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.

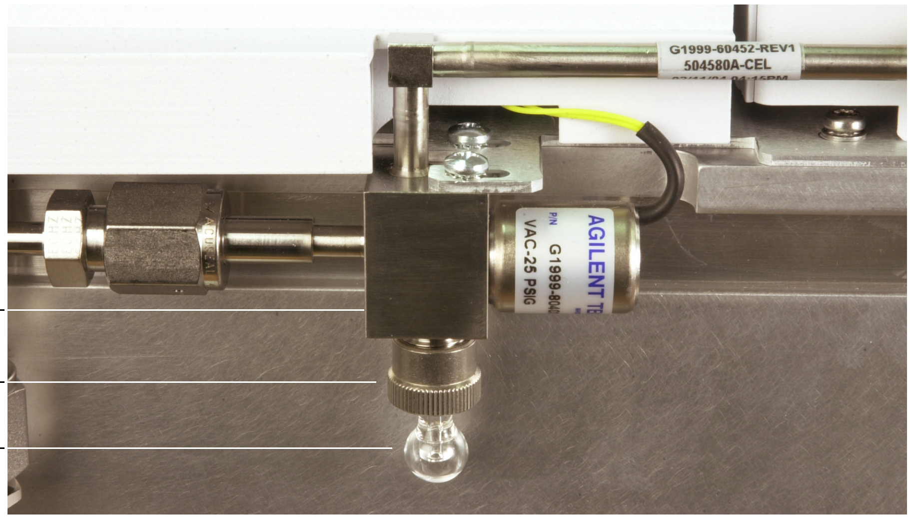


Figure 23. CI calibration valve and vial

6 Vacuum System

This chapter describes components of the 7000/7010 TQ 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 7000/7010 TQ 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 7000/7010 TQ 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. and/or local control panel.

Vacuum System Components

The parts of the vacuum system (see **Figure 24**) are:

- Foreline (rough) pump
- High-vacuum turbo pump
- Front and rear analyzer chambers
- CC 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.

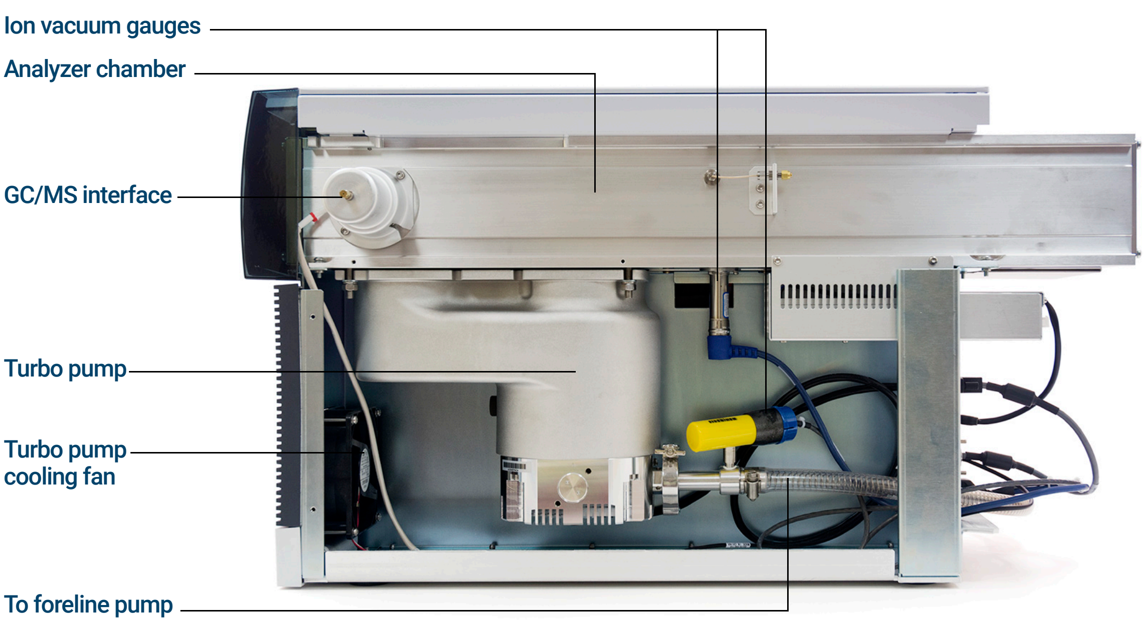


Figure 24. Major vacuum system components

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 7000/7010 TQ 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 1 Torr, 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. 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 25 shows the standard rotary vane foreline pump; the high-throughput pump is similar.

Figure 25. The standard rotary vane foreline pump

Rotary vane foreline pump

The standard rotary vane 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 gas-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, and do not leave absorbent material such as paper towels in it.**

Dry scroll foreline pump

The optional IDP-10 foreline pump is a dry scroll pump. It turns on when the MS power is turned on, and rapidly pumps down to low base pressures. The IDP-10 does not use oil, thus eliminating a possible source of hydrocarbon contamination in the vacuum system. It reduces noise and vibration without using a quiet cover. It also requires less maintenance less frequently than the standard foreline pump.

Analyzer Chambers

The analyzer chambers are located inside the vacuum manifold. The manifold is extruded and machined from an aluminum alloy. (See **Figure 26**.) 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, CC, GC/MS interface, and high-vacuum pump. The turbo pump is bolted directly to the bottom of the manifold.

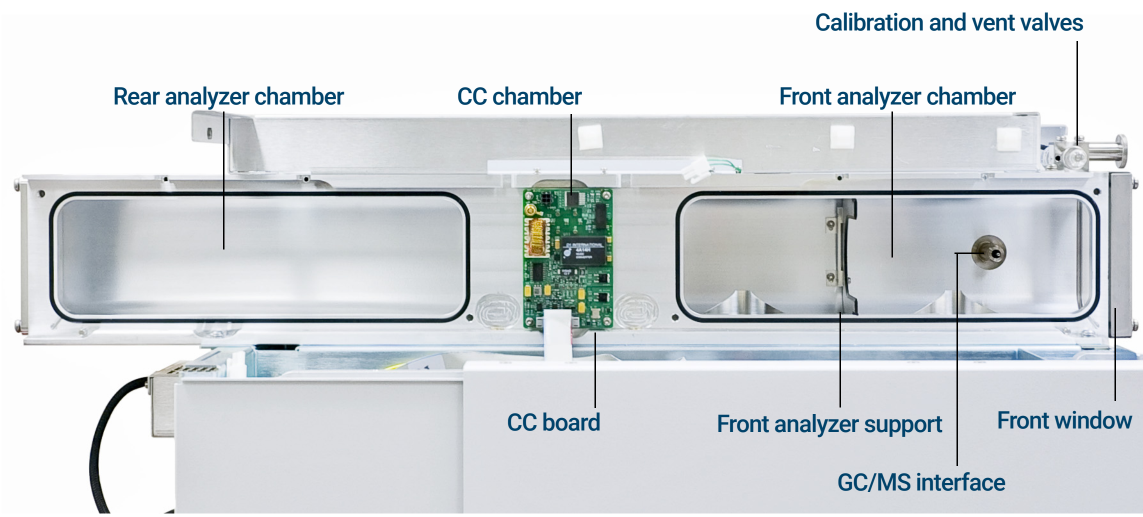


Figure 26. Analyzer chambers

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 MS1 driver and the filament drive. The rear side plate carries the MS2 driver and the detector board.

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

Each side plate has two captive thumbscrews. During normal operation, the thumbscrews on the rear side plate should be engaged and very gently tightened. During normal operation, the thumbscrews on the front side panel can be loose. For operation with any flammable or explosive carrier gas, detector fuel gas, or reactive cleaning gas (JetClean), the top thumbscrew on the front side plate should also be engaged and gently tightened.

WARNING **For operation with any flammable or explosive carrier gas, detector fuel gas, or reactive cleaning gas (JetClean), the top thumbscrews on both side plates should be engaged and finger tightened. 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, press on the side boards to ensure good seals.**

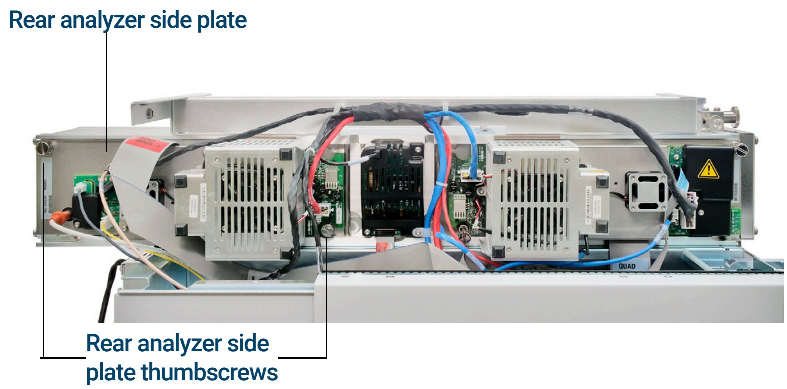


Figure 27. Rear analyzer side plate

Vacuum Seals

Several types of Viton elastomer O-ring seals are used to prevent air leaks into the analyzer chamber. (See **Figure 28** on page 142.) 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 two side plate O-rings and the vent valve O-ring.

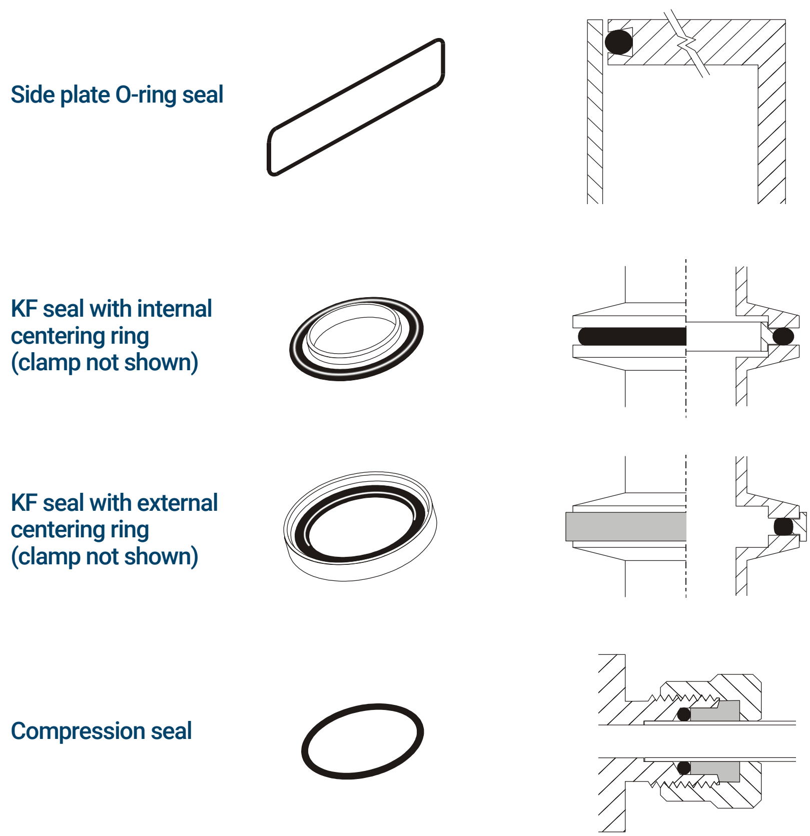


Figure 28. Vacuum seals

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 feedthrough seal is an O-ring that is compressed against the side plate by a threaded collar.

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 10 Torr, the turbo pump is automatically switched on.

Turbo Pump and Fan

The 7000/7010 MS is equipped with one high-vacuum turbomolecular (turbo) pump (see **Figure 24** on page 135), which is bolted directly to the bottom of the vacuum manifold.

The main inlet to the turbo pump is under the front analyzer. A secondary inlet is near the ion source. Screens at the turbo pump inlets help keep debris out of the pumps.

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 10 Torr. 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, refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.)

To vent the MS, refer to the *Agilent 7000/7010 Series TQ GC/MS Operating Manual*.)

Calibration Valve and Vent Valve

Calibration valve

A calibration valve is an electromechanical valve with a vial to hold the tuning compound. (See **Figure 29** on page 147.) When a calibration valve is opened, tuning compound in the vial diffuses into the ion source. The valves are controlled by the Agilent MassHunter GC/MS Acquisition 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.

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 Agilent MassHunter GC/MS Acquisition 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 screws into a threaded port in the front of the calibration valve. (See **Figure 30** on page 147.) 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.

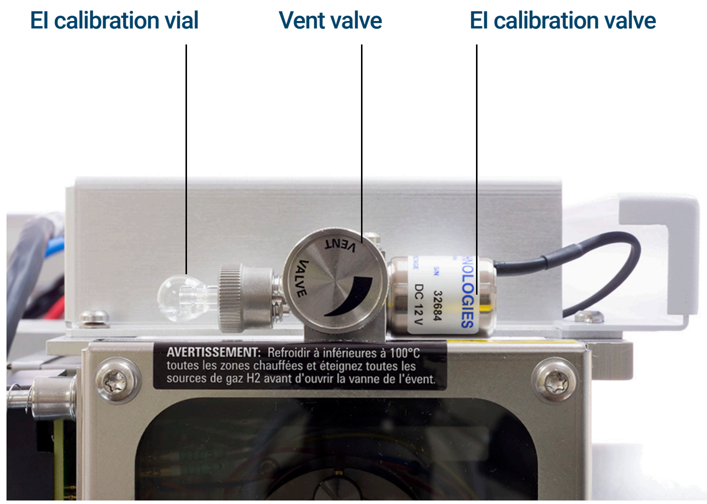


Figure 29. TQ vent valve and EI calibration valve

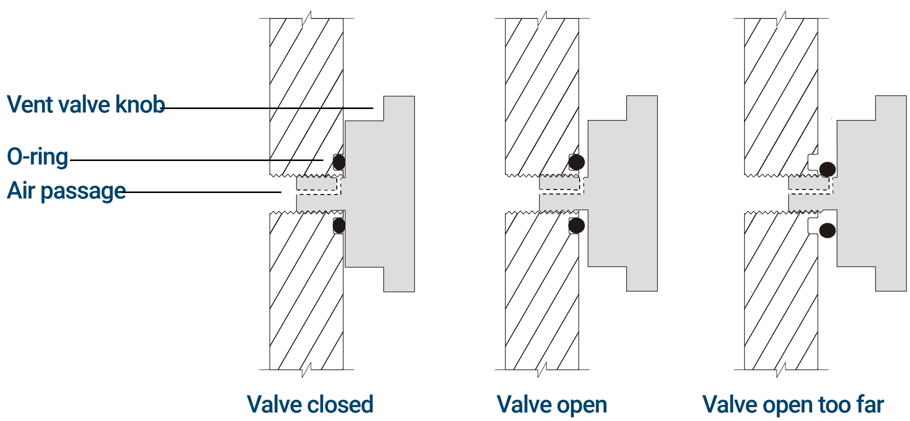


Figure 30. Vent valve

7 Analyzers and Collision Cell

Overview

The complete analyzer system is shown in **Figure 31**.

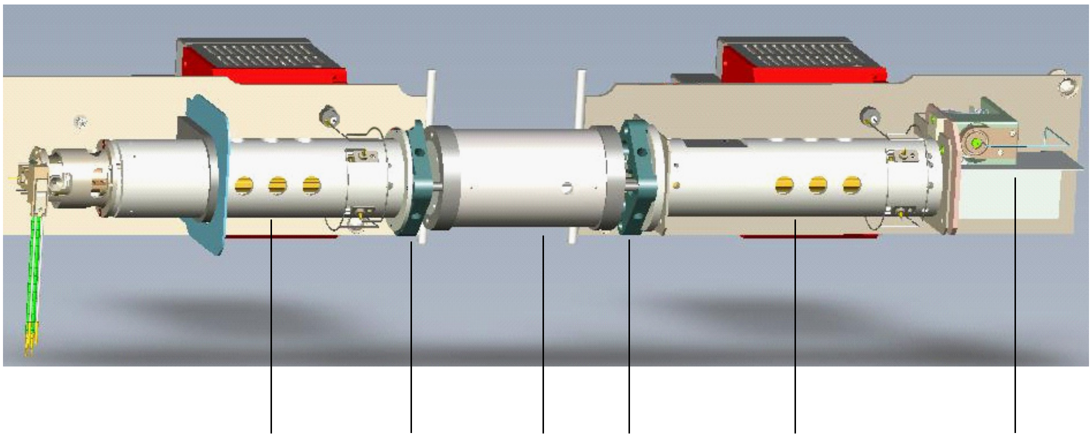


Figure 31. The analyzer system

Front analyzer (MS1)

The front analyzer consists of the ion source, the MS1, 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 MS1 mass filter. The selected ions pass through the filter, and post-filter, and enter the CC.

Post-filter

This device, located on the end of the MS1, helps transfer the selected ions to the CC. It also aligns the front of the CC with the front analyzer.

Collision cell (CC)

The precursor ions selected by the MS1 collide with a reaction gas, typically a nitrogen/helium mixture. This generates product ions.

Prefilter

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

Rear analyzer (MS2)

The rear analyzer consists of the MS2, 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.

Detector

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

EI Source

The EI HES and the EI XTR ion source operate by electron impact ionization. (See **Figure 32** on page 153 and **Figure 33** on page 155.) 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.

HES body

The HES body (9) is a cylinder. (See **Figure 32** on page 153.) It holds the other parts of the source, including the lens stack (items 3, 11, 10, 6, and 5). The repeller (item 17), source mount (item 16), and filament block (item 2) form 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.

Extraction Source body

The EI XTR source body is a cylinder. (See **Figure 33** on page 155.) It holds the other parts of the source, including the lens stack. With the repeller, 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 pump away carrier gas and unionized sample molecules or fragments. The CI source is similar in design to the EI XTR source, but critical dimensions are different. Do not interchange parts.

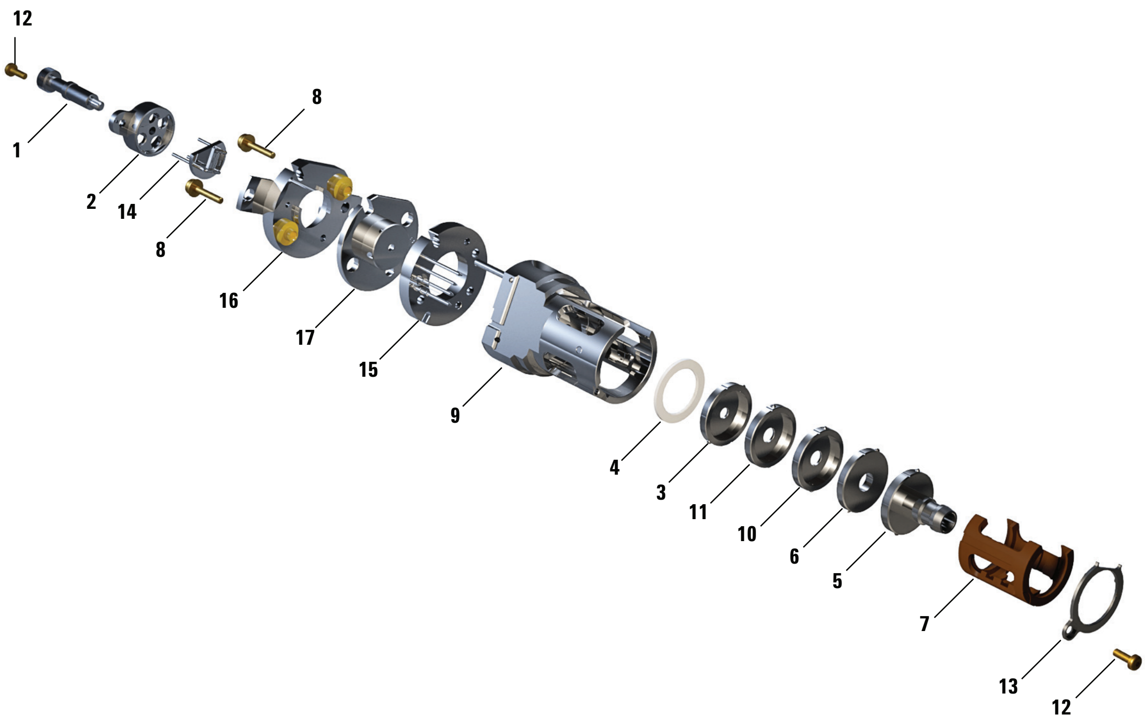


Figure 32. Exploded parts view of the EI HES

Table 7 Parts list for EI HES (Figure 32)

Item	Description	Part number
1	Source finger grip	G7002-20008
2	Filament block	G7002-20019
3	Extractor lens (5)*, with 3 mm opening	G7004-20061
4	Ceramic insulator for Extractor	G7002-20064
5	Entrance lens assembly, Extended, HES (1)*	G7004-20065
6	Ion focus lens (2)*	G7004-20068
7	Lens insulator/holder	G7002-20074
8	M2 x 0.4 screw x 12 mm long gold plated screw	G7002-20083
9	Source body	G7002-20084

Table 7 Parts list for EI HES (Figure 32) (continued)

Item	Description	Part number
10	Post extractor lens 2 (3)*	G7004-20090
11	Post extractor lens 1 (4)*	G7004-20004
12	M2 x 6 mm gold plated screw	G7002-20109
13	Locking ring lens insulator	G7002-20126
14	High efficiency dual filament	G7002-60001
15	Ring heater/sensor assembly	G7002-60043
16	Source mount 1.5 mm	G7002-60053
17	Repeller assembly	G7002-67057
Not shown	EI HES assembly	G7004-67055

* The number in parenthesis is the number engraved on the lens

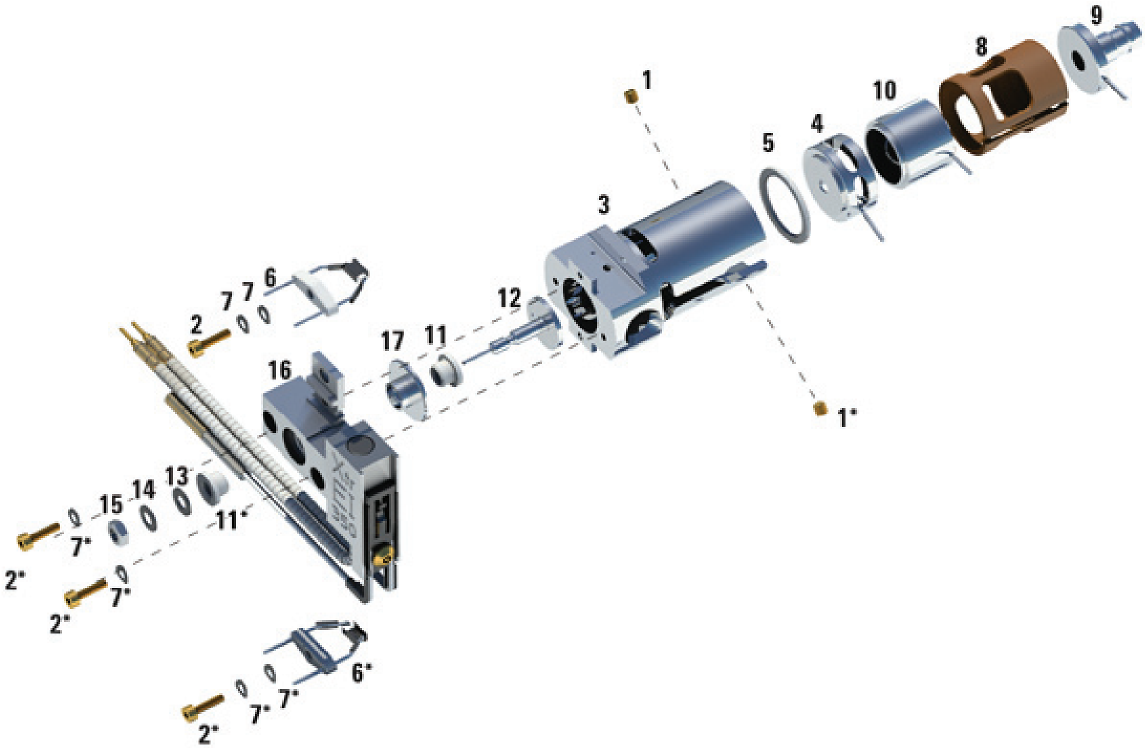


Figure 33. EI XTR source structure

Table 8 Parts list for EI XTR source (Figure 33)

Item	Description	Part number
1	Setscrews	G3870-20446
2	Screws	G3870-20021
3	Source body	G3870-20440
4	Extractor lens	G3870-20444
5	Extractor lens insulator	G3870-20445
6	Filaments	G7005-60061
7	Spring washer	3050-1301
7	Flat washer	3050-0982

Table 8 Parts list for EI XTR source (Figure 33) (continued)

Item	Description	Part number
8	Lens insulator	G3870-20530
9	Entrance lens assembly, Extended	G7000-20026
10	Ion focus lens	05971-20143
11	Repeller insulator	G1099-20113
12	Repeller	G3870-60171
13	Flat washer	3050-0891
14	Belleville spring washer	3050-1301
15	Repeller nut	0535-0071
16	Source heater block assembly	G3870-60177
17	Repeller block insert	G3870-20135
Not shown	EI XTR source assembly	G7003-67720

Filaments

For the HES, two filaments are located on a single assembly located on the center of the EI HES. (See item 14 in **Figure 32** on page 153.) For the EI XTR source, two filaments are located on opposite sides of the source body. (See item 6 in **Figure 33** on page 155.) 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 source has only one filament. (See **Figure 35** on page 162.) A “dummy” filament provides connections for the extra filament wire(s) (1 wire on the 7010 and 2 wires on the 7000).

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 (eVs). 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 (≤ 1 minute) during data acquisition will reduce filament life.

Other Source Elements

Magnet

EI HES

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 650 gauss in the center of the field.

EI XTR and CI Source

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 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 (CI only)

The drawout plate on a CI source forms another wall of the ionization chamber. (See **Figure 35** on page 162.) 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 unionized sample molecules or fragments to be pulled away by the vacuum system. The drawout plate and drawout cylinder are both at ground potential.

EI HES

Extractor lens (Lens 5)

The extractor lens is a part of the EI source. (See **Figure 32** on page 153.) This lens replaces the drawout plate and cylinder on a CI source, but performs a similar function. A voltage is applied to the extractor lens to increase focusing in the EI source.

Lens 4 and Lens 3

The voltage on post extractor 1 (Lens 4) and post extractor 2 (Lens 3) can be varied. (See **Figure 32** on page 153.) A typical voltage for Lens 4 is between -5 and -15 VDC. A typical voltage for Lens 3 is between -20 to -32 VDC.

Ion focus (Lens 2)

The voltage on the ion focus lens can be varied from 0 to –127 VDC. (See **Figure 32** on page 153.) A typical voltage VDC 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 (Lens 1)

The entrance lens is at the entrance to the Quad. (See **Figure 32** on page 153.) This lens minimizes the fringing fields of the quadrupole which discriminate against high-mass ions.

EI Extractor source

Extractor lens

The extractor lens is a part of the EI source. (See **Figure 33** on page 155.) This lens replaces the drawout plate and cylinder on a CI source, performing a similar function, but is not interchangeable with the drawout plate and cylinder. A voltage is applied to the extractor lens to increase focusing in the EI source.

CI Source

The CI source (See **Figure 34** and **Figure 35** on page 162) 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 drawout 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. The interface tip seal is also used on the EI HES and EI Extractor source.

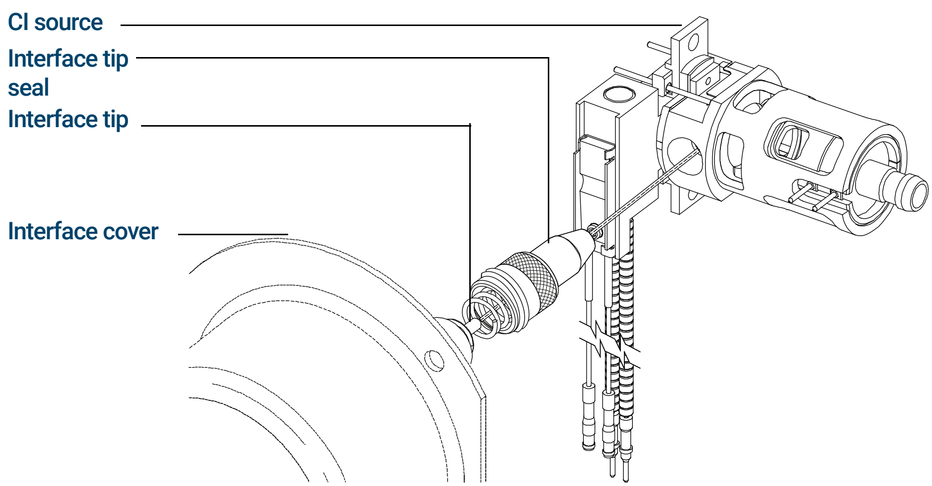


Figure 34. CI source and interface tip seal (used on EI sources also)

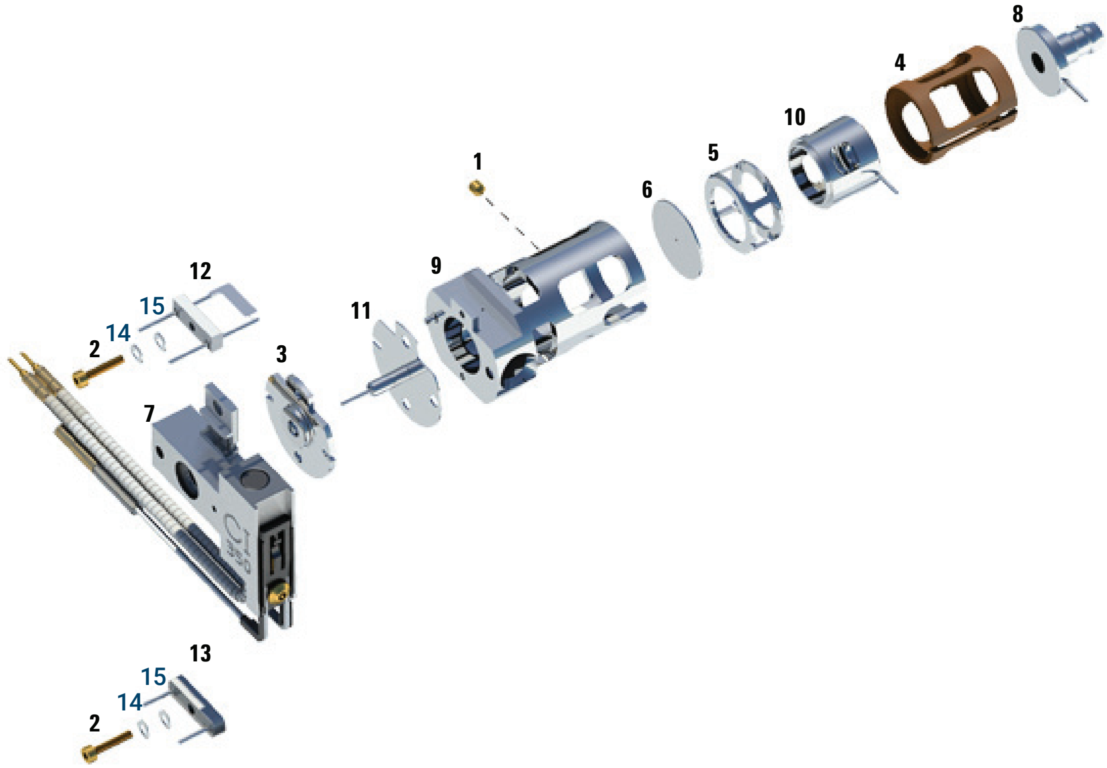


Figure 35. CI source exploded view

Table 9 Parts list for CI source (Figure 35)

Item	Description	Part number
1	Set screw	G1999-20022
2	Filament screw	G1999-20021
3	CI repeller insulator	G1999-20433
4	CI lens insulator	G3170-20540
5	CI drawout cylinder	G1999-20444
6	CI drawout plate	G1999-20446
7	CI source heater block assembly	G3870-60415
8	Entrance lens	G7000-20026

Table 9 Parts list for CI source (Figure 35) (continued)

Item	Description	Part number
9	CI source body	G3170-20430
10	Ion focus lens	G1999-20443
11	CI repeller	G7077-20432
12	CI filament- 2PK	G7005-60072
13	Dummy filament	G1999-60454
14	Washer spring curved 2.2 mm-ID 4.5 mm-OD 0 Qty. 2	3050-1374
15	Flat washer	3050-9082
Not shown	Package, GC source Clamshell	G7002-80008
Not shown	Bracket, GC source, Clamshell	G7002-00008
Not shown	350 CI source assembly	G7002-67404
Not shown	350 CI source assembly (without tip seal)	G7077-67404

Quadrupole Mass Filters

The mass filters separate ions according to their *m/z*. At a given time, only ions of a selected *m/z* can pass through the filter to the detector. The mass filters in the MS are quadrupoles. (See **Figure 36** on page 164.)

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 DC and RF signal is applied to the two pairs of rods. The magnitude of the RF voltage determines the *m/z* 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

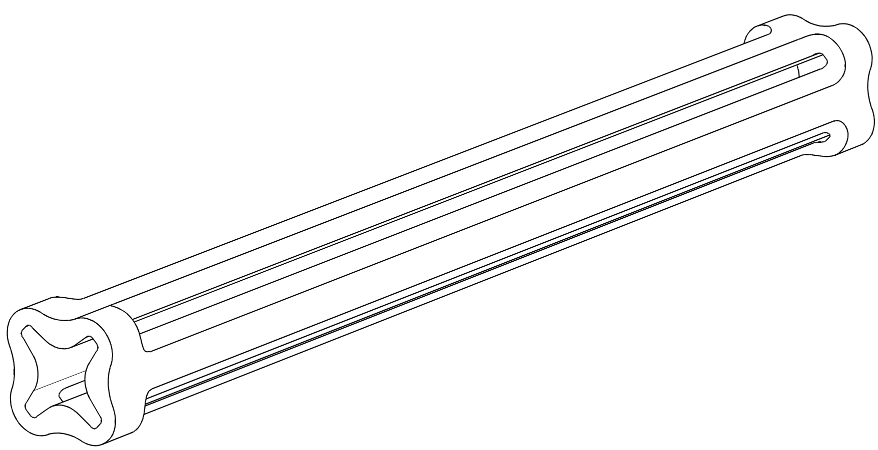


Figure 36. Quad

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 quadrupole 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 Quad.

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. (See **Figure 37**.) They have three purposes:

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

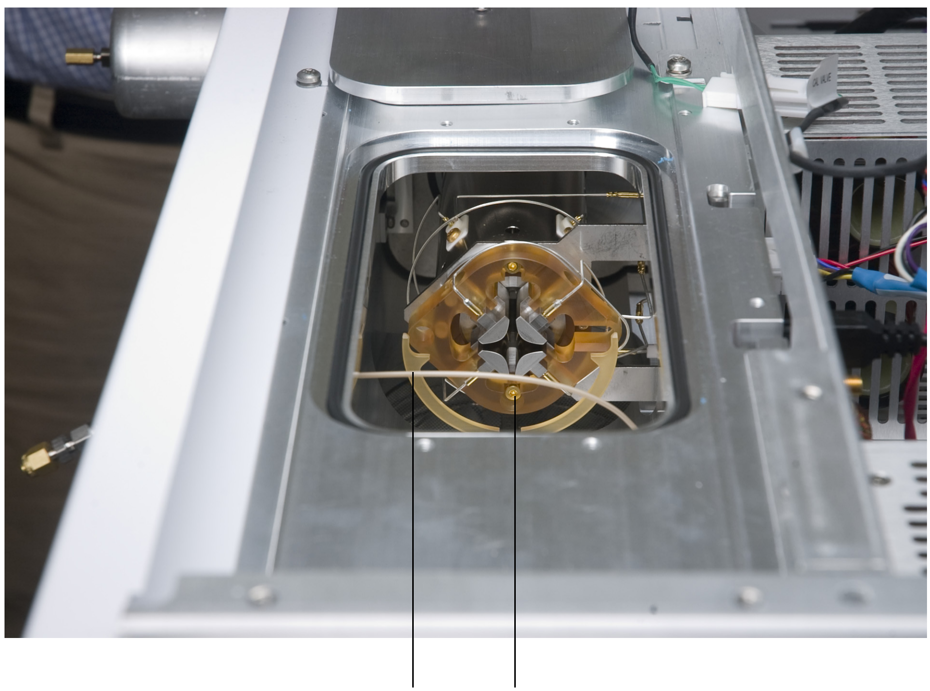


Figure 37. Post-filter

Collision Cell

The CC requires no periodic maintenance. (See **Figure 38**.)

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 CC engage the post- and pre-filters. They lift the CC from its cradle and align it with the two analyzers.

The ion stream is passed on to the rear analyzer.

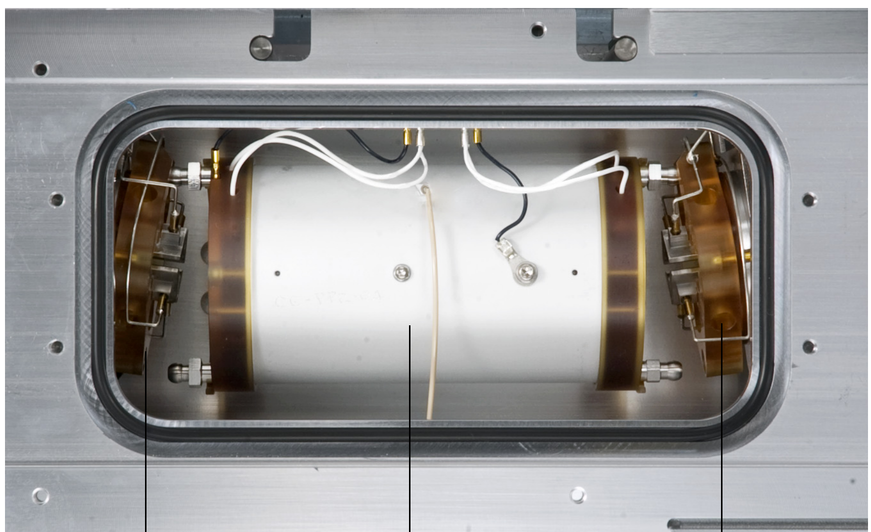


Figure 38. CC in place, analyzer doors open

Detector

The only detector available with this model is the Series 2 which provides improved performance.

The detector in the MS analyzer is a high energy conversion dynode (HED) coupled to an EM. (See **Figure 39** on page 170.) 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.

HED

The HED operates at –10,000 volts for EI. It is located off-axis from the center of the Quad 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.

Iris

The iris is an additional lead on the new high sensitivity detectors. It helps to focus the ion beam exiting the MS2.

Bias

The bias lens is part of the Series 2 detector. (See **Figure 39** on page 170.) It helps to ground and stabilize the detector. The bias provides a fixed voltage offset for the EM.

EM horn

The Series 2 EM horn is used. (See **Figure 39**.) The EM horn carries a voltage of up to –3,000 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 –3,000 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 –3,000 VDC to complete Autotune, with no other probable cause, it may need to be replaced. A warning message will alert you if more than 3,000 volts are needed to achieve the gain values.

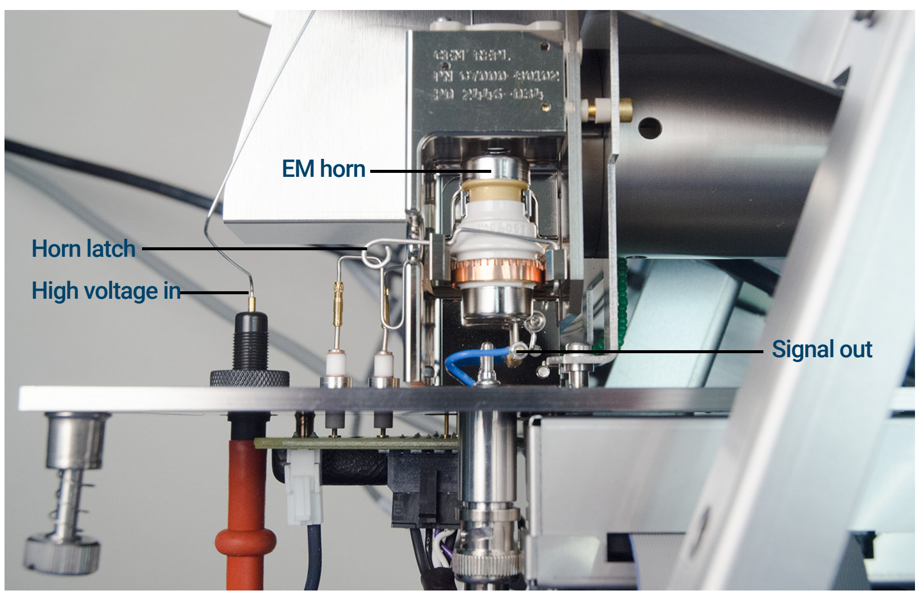


Figure 39. The Series 2 detector

Analyzer Heaters and Radiators

The ion source and mass filters are housed in cylindrical aluminum tubes called radiators. (See **Figure 40** on page 172.) 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 Agilent MassHunter GC/MS Acquisition 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 default temperature 230 °C, maximum 350 °C
- Quadrupoles (front and rear)150 °C

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

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.

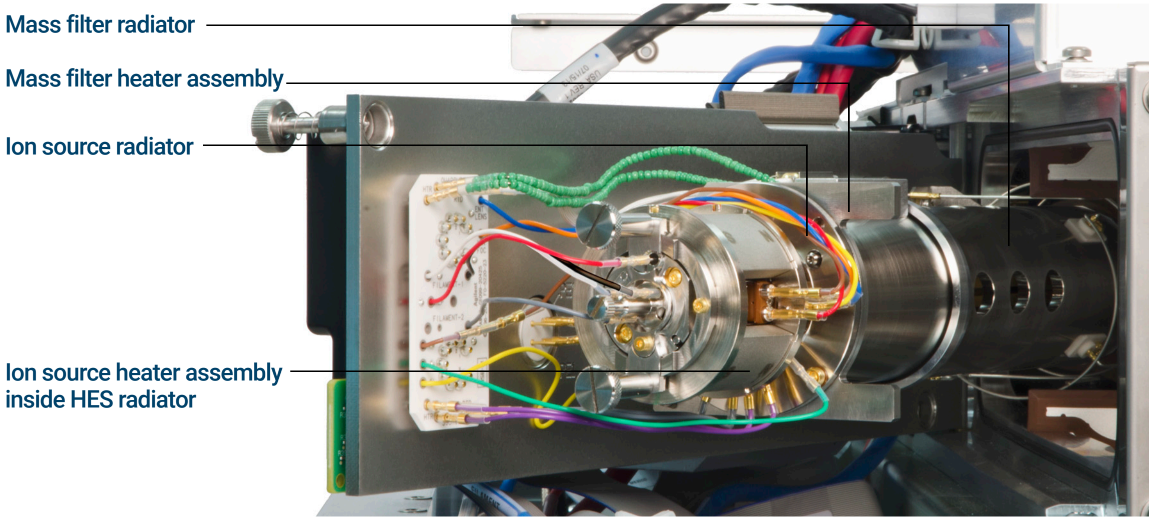


Figure 40. HES heaters and radiators

8 Electronics

Most of the material in this chapter 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. There are two topics which are the exception. (See **"Back panel connectors"** on page 187, and **"Interfacing to External Devices"** on page 189.)

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. (See **Figure 41**.) It is separate from the electronics module and is connected through 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 41. Front of the MS

Front Panel Instrument Status LED

Through the front panel Instrument Status LED, the operator can view the current status of the instrument using color codes and LED on/off timing. (See **Table 10**.)

Table 10 Front panel Instrument Status LED codes

Instrument status	LED code
Ready	Solid green
Acquiring data	Blinking green (<2 sec)
Not ready	Solid yellow
JetClean Acquire & Clean operation	Blinking magenta
JetClean Clean Only operation	Solid magenta
Ready and not connected to DS	Solid blue
Start up (prior to firmware load)	Blinking red (<2 sec)
Fault	Solid red

Filament Drive Board

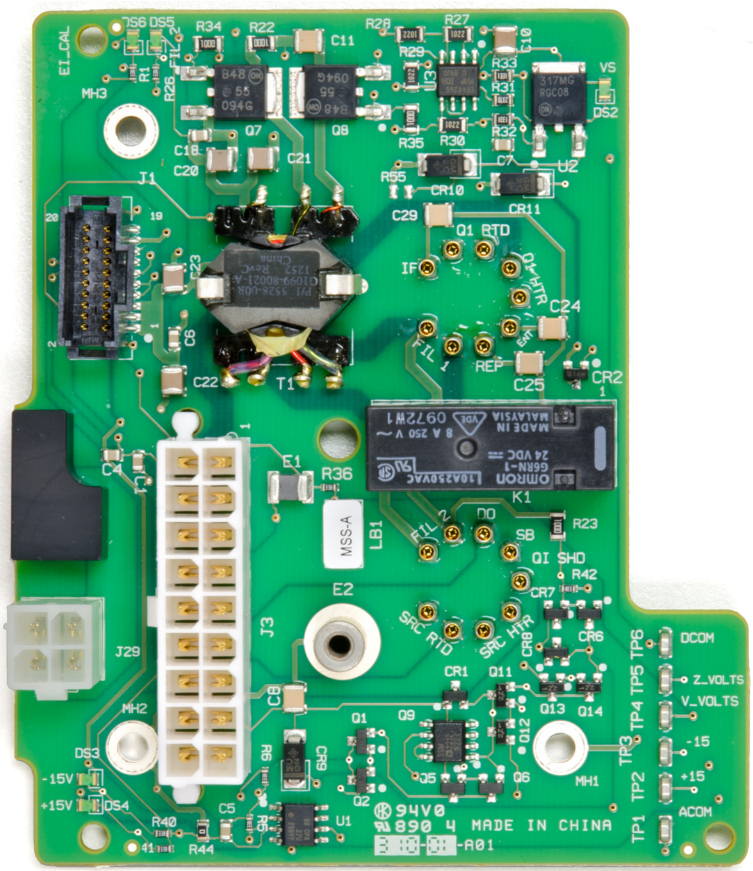


Figure 42. Filament drive board

The filament drive board (See **Figure 42**) performs these functions:

- Passes voltages generated on the main boards, lens board, and 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 voltage from filament 1 to filament 2.

Quad DriverBoards

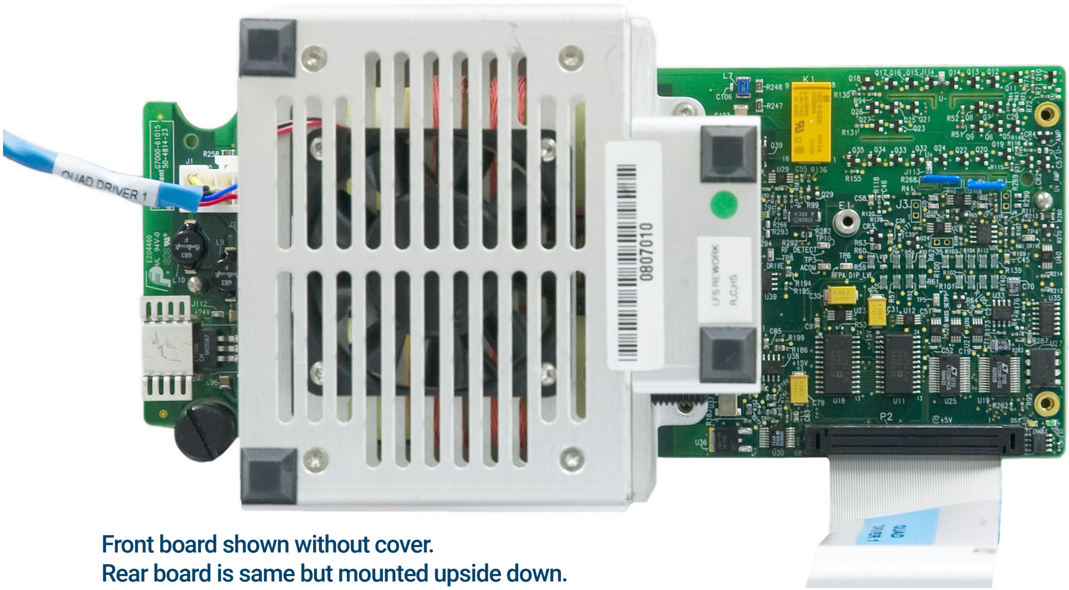


Figure 43. Quadrupole boards

The quadrupole boards (see **Figure 43**) 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 Quads 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 Quad. The magnitude of this voltage is proportional to the RF voltage.
- Monitor for RF faults, and shut down the analyzer if one is detected.

CC Board

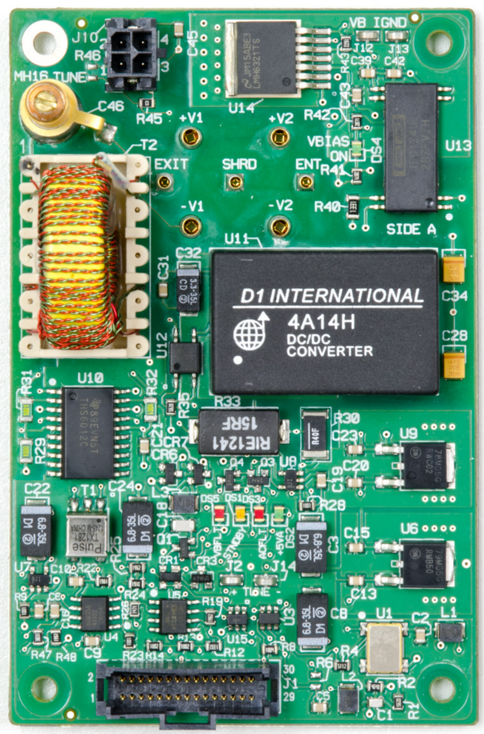


Figure 44. CC board

The collision cell board (see **Figure 44**) has two functions:

- Generates the controlling voltages for the hexapole.
- Creates the RF signal for the CC.

Detector Board

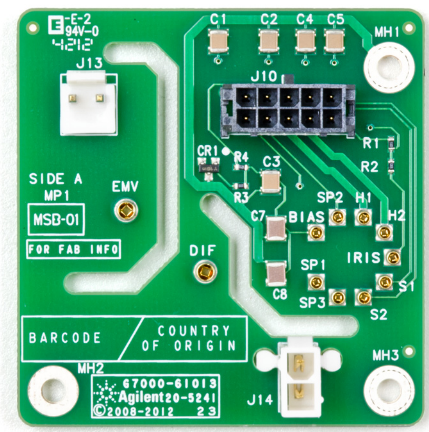


Figure 45. Detector board

The detector board (see **Figure 45**) 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. Any board in the electronics module can be replaced, if necessary, by your Agilent Technologies service representative.

The electronics module contains:

- Main Board 1 (See **Figure 48** on page 182.)
- Main Board 2 (See **Figure 47** on page 181.)
- Lens control board (See **Figure 48** on page 182.)
- Signal amplifier board (LogAmp) (See **Figure 48** on page 182.)
- LAN/MS control card (Smartcard 4) (See **Figure 47** on page 181.)
- Bus board (See **Figure 47** on page 181.)
- PLX card
- AC board (power distribution/vacuum control board) (See **Figure 46**.)
- Low voltage (AC-DC) power supply (See **Figure 46**.)
- High-voltage (HED) power supply (See **Figure 46**.)
- Toroid transformer assembly (See **Figure 46**.)
- Power switch board (See **Figure 47** on page 181.)

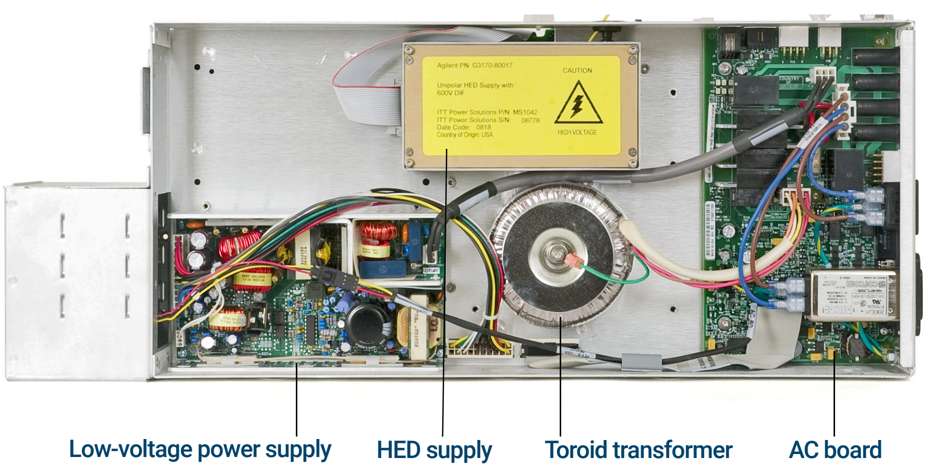


Figure 46. Electronics module, side 1

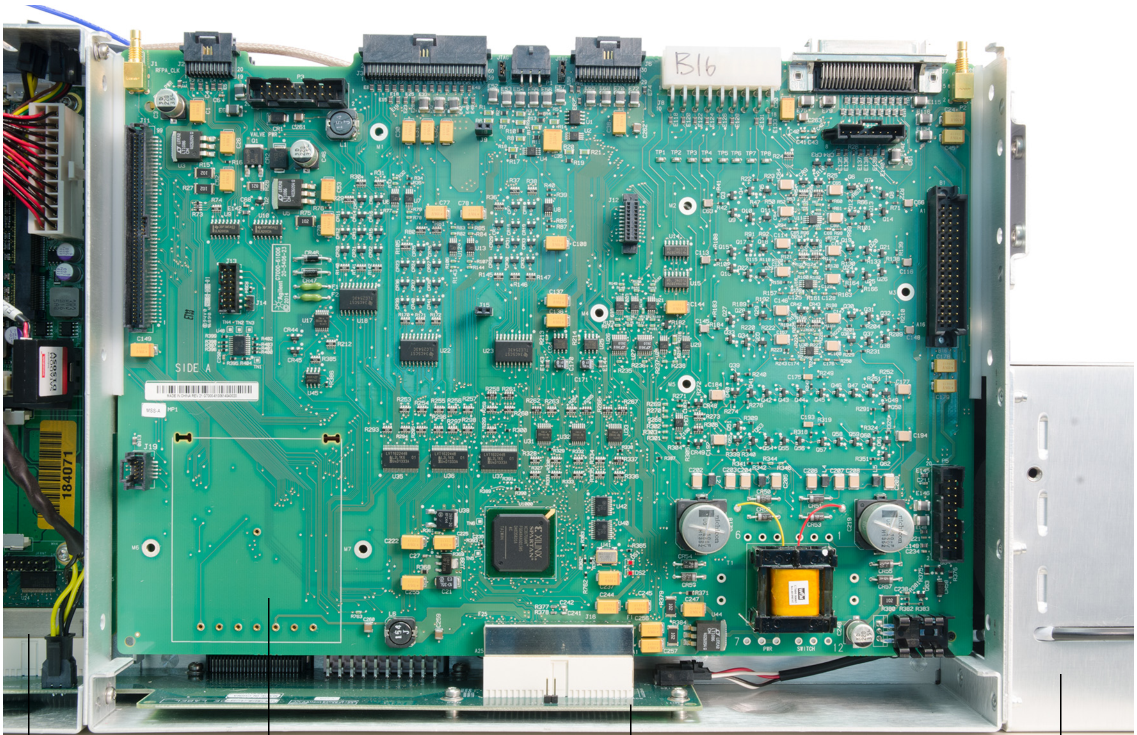


Figure 47. Electronics module, side 2

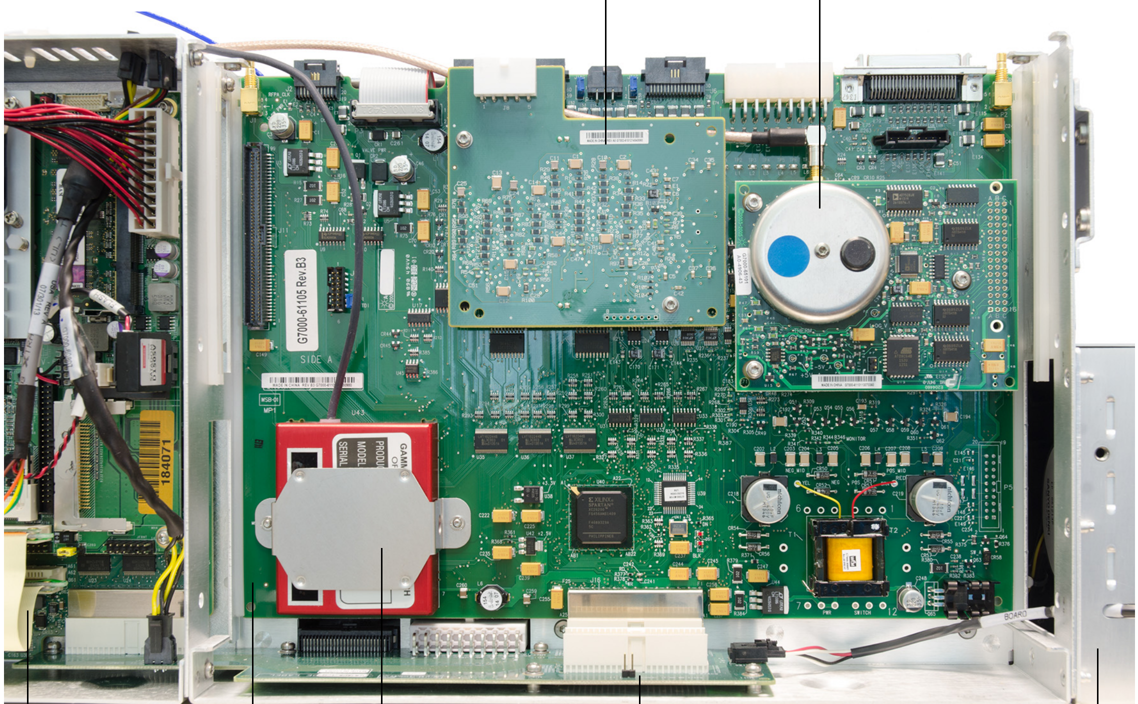


Figure 48. Electronics module, main board 1

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. In the 7010 model, main board 1 carries the extra lens voltages for the EI HES.

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 CC.

- 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.

Lens control board

Uses two voltage supplies from a main board and regulates them to control the individual voltages of two lenses in the ion source.

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.

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. 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 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 and the fuses. (See **Figure 49**.)

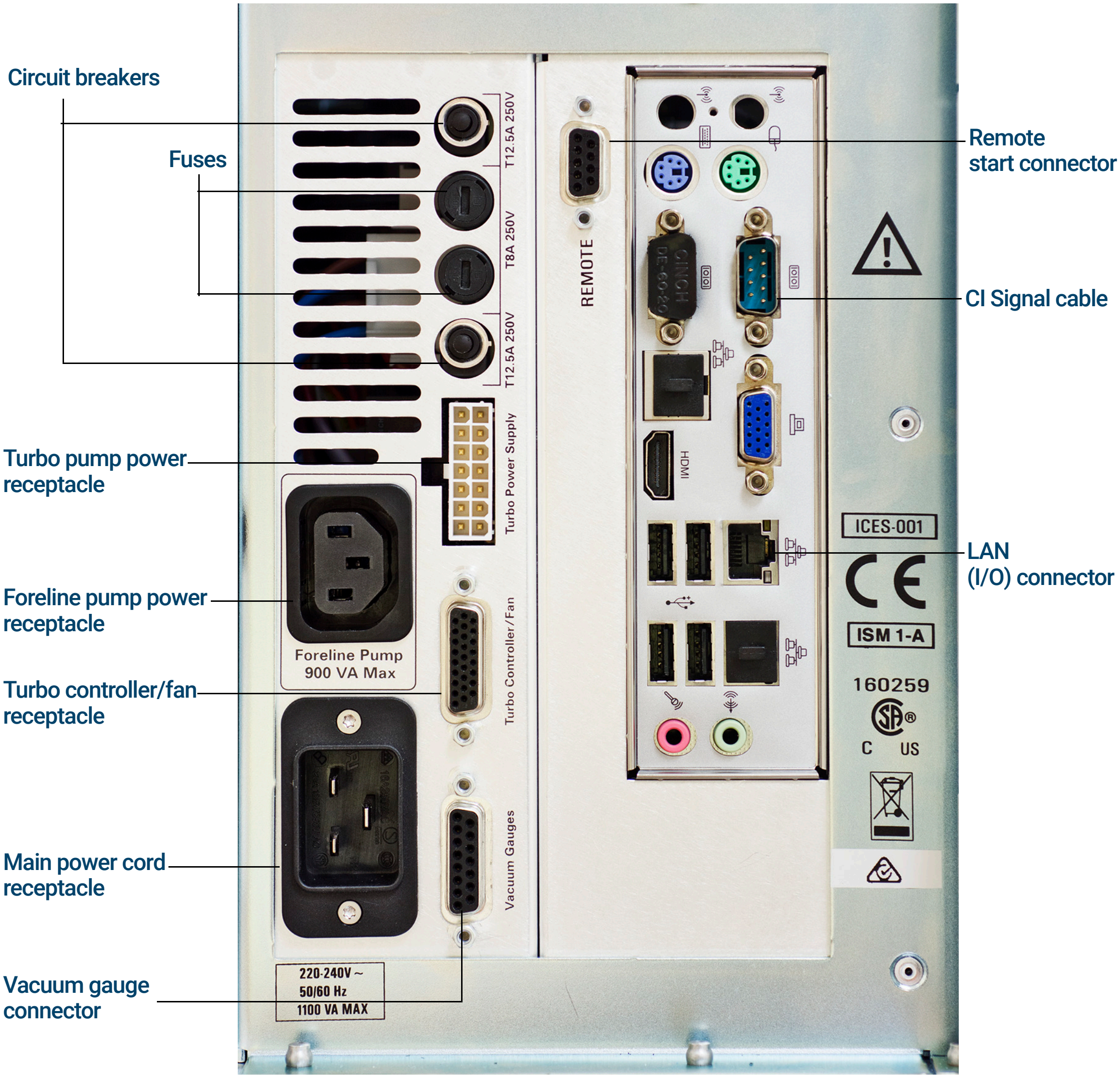


Figure 49. Back panel connections

Fuses

The two primary fuses and two circuit breaker 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 on the back panel of the MS. (See **Figure 50**.) 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

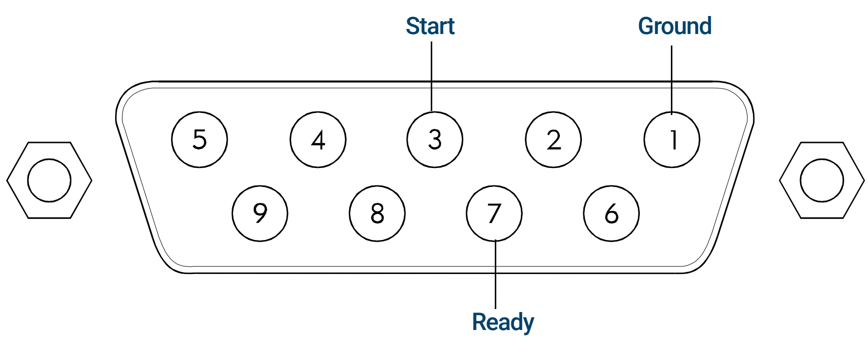


Figure 50. Remote start connector

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. Remote start cables are made for most common devices. The Y-Remote Start Stop cable, NON APG (G1530-61200), is the standard cable with the instrument. 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

This chapter lists parts that can be ordered for use in maintaining your 7000/7010 TQ GC/MS. It includes user-replaceable parts only.

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

Individual electronic components are not available. This section contains fuses. (See **Table 11**.)

Fuses

Table 11 Fuses

Description	Part number
Fuse 8A, slow blow, electronics, fans, and power supplies	2110-0969

Vacuum System

This section lists replacement parts available for the vacuum system. It includes O-rings and seals (See **Table 12** and **Table 13**.), and foreline pump and related components. (See **Table 14** on page 195 and **Figure 51** on page 196.)

O-rings and seals

Table 12 O-rings and seals

Description	Part number
Calibration valve O-ring (1/4-inch)	5180-4182
KF10/16 seal (foreline pump inlet and turbo pump outlet)	0905-1463
KF25 O-ring assembly (turbo pump outlet)	0100-1551
SEAL,CNTR RING,NW16,ALUM	KC16AV
O-ring, forepump fill plug	0905-1630
O-ring, ion gauge	0905-1627
Side plate O-ring	0905-1690
Vent valve O-ring (1/4-inch)	5180-4182

Table 13 Gauges

Description	Part number
Manifold ion gauge	G1960-80303
Foreline ion gauge	G7000-60545

Foreline pumps and related parts

Table 14 Foreline pump and related parts (see Figure 51 on page 196)

Description	Part number
Rotary vane foreline pump	
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
Filter (A46226000), RV5 pump	G6600-80043
Oil mist filter kit, RV5 pump	3162-1056
Oil return line, RV5 pump	3162-1057
Pump oil, Inland 45	6040-0834
Ship kit for RV5 vacuum pump	G7000-60500
Rough pump oil pan	G1946-00034
Oil mist filter for RV5 pump: SCD/NCD	G6600-80043
O-Ring, size 2-320, fluorocarbon	0905-1592
NW25 TO 5/8-inch tube elbow	G1960-20003
NW 20/25 clamping ring	0100-0549
IDP-10 dry scroll pump	
IDP-10 Upgrade Kit for GC/QQQ	G6697A
IDP-10 Shipping kit	G7004-67027
IDP-10 Tip seal	G7004-67026
IDP-10 gas ballast accessory kit	G7004-67514
Filter element, for exhaust silencer	replslfilter

Figure 51. Standard RV5 rotary vane foreline pump (left) and optional IDP-10 dry scroll foreline pump (right)

Analyzer

This section shows the analyzer chambers and associated parts. (See **Table 15** and **Figure 52**.)

Table 15 Analyzer chambers and related parts (Figure 52)

Item	Description	Part number
1	Calibration vial	G3170-80002
2	O-ring, side plates	0905-1690
3	Interface tip seal	G3870-20542
Not shown	Electron multiplier horn (Series 2)	G7002-80103

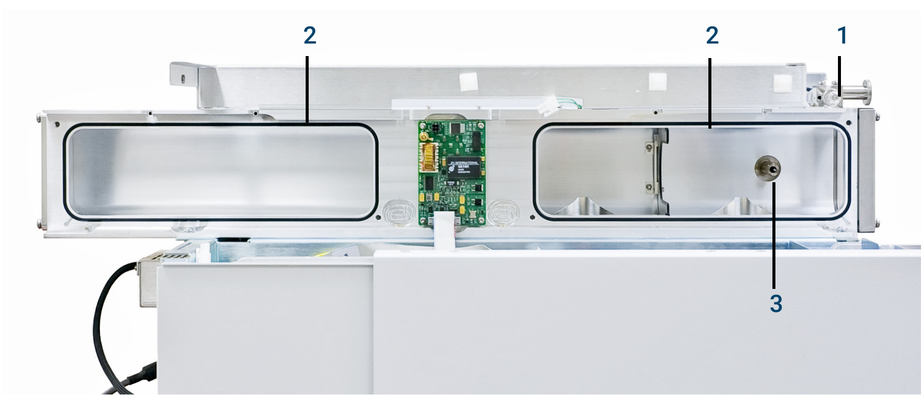


Figure 52. Analyzer chambers and related parts

EI HES

This section lists the EI HES parts. (See **Table 16** and **Figure 53** on page 199.)

Table 16 Parts list for EI HES (Figure 53 on page 199)

Item	Description	Part number
1	Source finger grip	G7002-20008
2	Filament block	G7002-20019
3	Extractor lens (5)*, with 3 mm opening	G7004-20061
4	Ceramic insulator for Extractor	G7002-20064
5	Entrance lens assembly, Extended, HES (1)*	G7004-20065
6	Ion focus lens (2)*	G7004-20068
7	Lens insulator/holder	G7002-20074
8	M2 x 0.4 screw x 12 mm long gold plated screw	G7002-20083
9	Source body	G7002-20084
10	Post Extractor Lens 2 (3)*	G7004-20090
11	Post Extractor Lens 1 (4)*	G7004-20004
12	M2 x 6 mm gold plated screw	G7002-20109
13	Locking ring Lens Insulator	G7002-20126
14	High efficiency dual filament	G7002-60001
15	Ring heater/sensor assembly	G7002-60043
16	Source mount 1.5 mm	G7002-60053
17	Repeller Assembly	G7002-67057
Not shown	EI HES assembly	G7004-67055

* The number in parenthesis is the number engraved on the lens

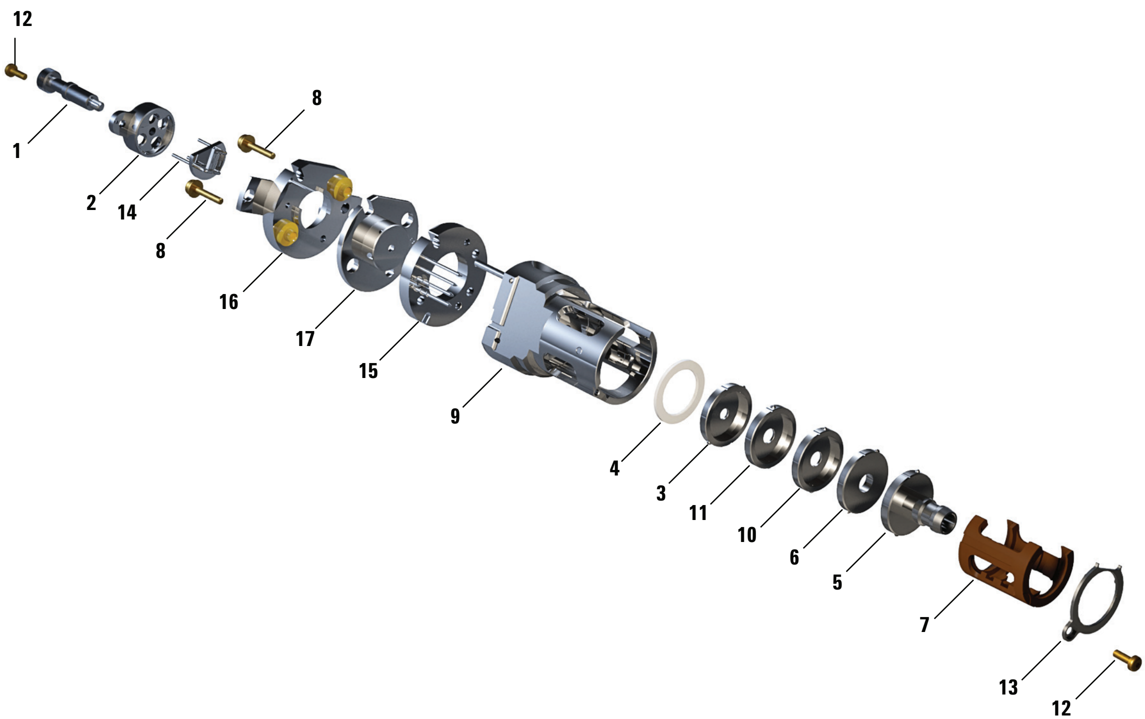


Figure 53. EI HES

EI XTR source

Table 17 Parts list for EI XTR source (Figure 54 on page 201)

Item	Description	Part number
1	Setscrews	G3870-20446
2	Screws	G3870-20021
3	Source body	G3870-20440
4	Extractor lens	G3870-20444
5	Extractor lens insulator	G3870-20445
6	Filaments	G7005-60061
7	Spring washer	3050-1301
7	Flat washer	3050-0982
8	Lens insulator	G3870-20530
9	Entrance lens assembly, Extended	G7000-20026
10	Ion focus lens	05971-20143
11	Repeller insulator	G1099-20113
12	Repeller	G3870-60171
13	Flat washer	3050-0891
14	Belleville spring washer	3050-1301
15	Repeller nut	0535-0071
16	Source heater block assembly	G3870-60177
17	Repeller block insert	G3870-20135
Not shown	EI XTR source assembly	G7003-67720

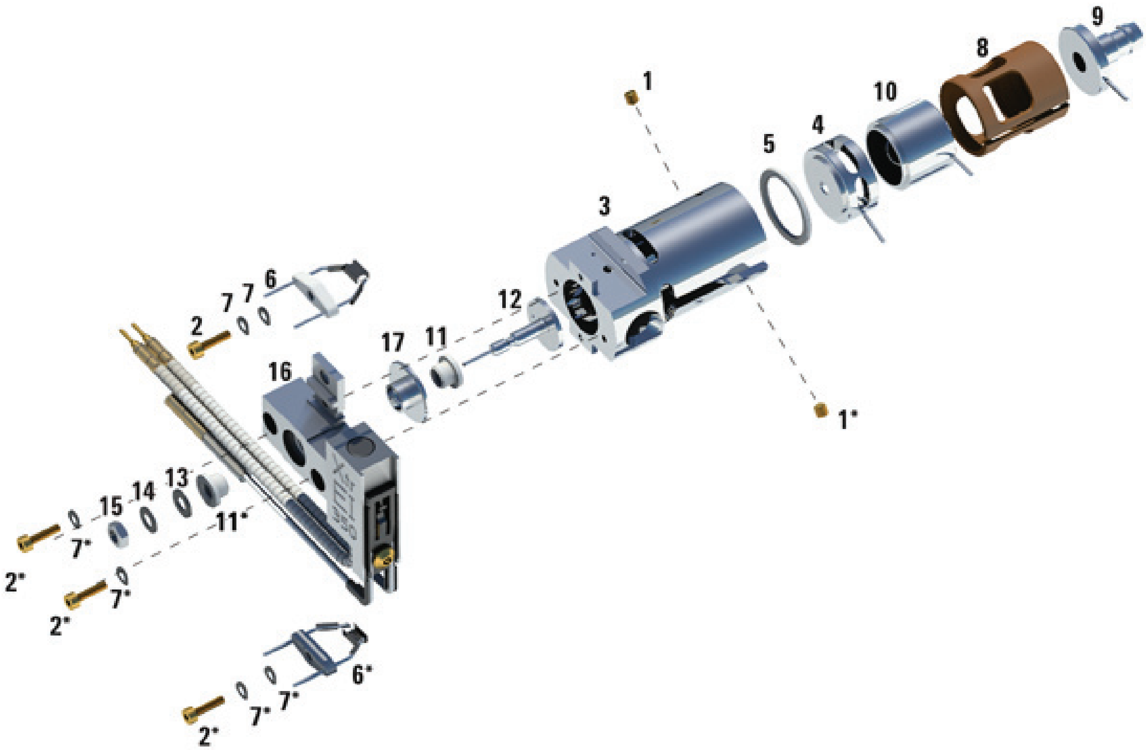


Figure 54. EI XTR source

CI source

Table 18 Parts list for CI source (Figure 55 on page 203)

Item	Description	Part number
1	Set screw	G1999-20022
2	Filament screw	G1999-20021
3	CI repeller insulator	G1999-20433
4	CI lens insulator	G3170-20540
5	CI drawout cylinder	G1999-20444
6	CI drawout plate	G1999-20446
7	CI source heater block assembly	G3870-60415
8	Entrance lens	G7000-20026
9	CI source body	G3170-20430
10	Ion focus lens	G1999-20443
11	CI repeller	G7077-20432
12	CI filament- 2PK	G7005-60072
13	Dummy filament	G1999-60454
14	Washer spring curved 2.2 mm-ID 4.5 mm-OD 0 Qty. 2	3050-1374
15	Flat washer	3050-9082
Not shown	Package, GC Source Clamshell	G7002-80008
Not shown	Bracket, GC Source, Clamshell	G7002-00008
Not shown	350 CI source assembly	G7002-67404
Not shown	350 CI source assembly (without tip seal)	G7077-67404

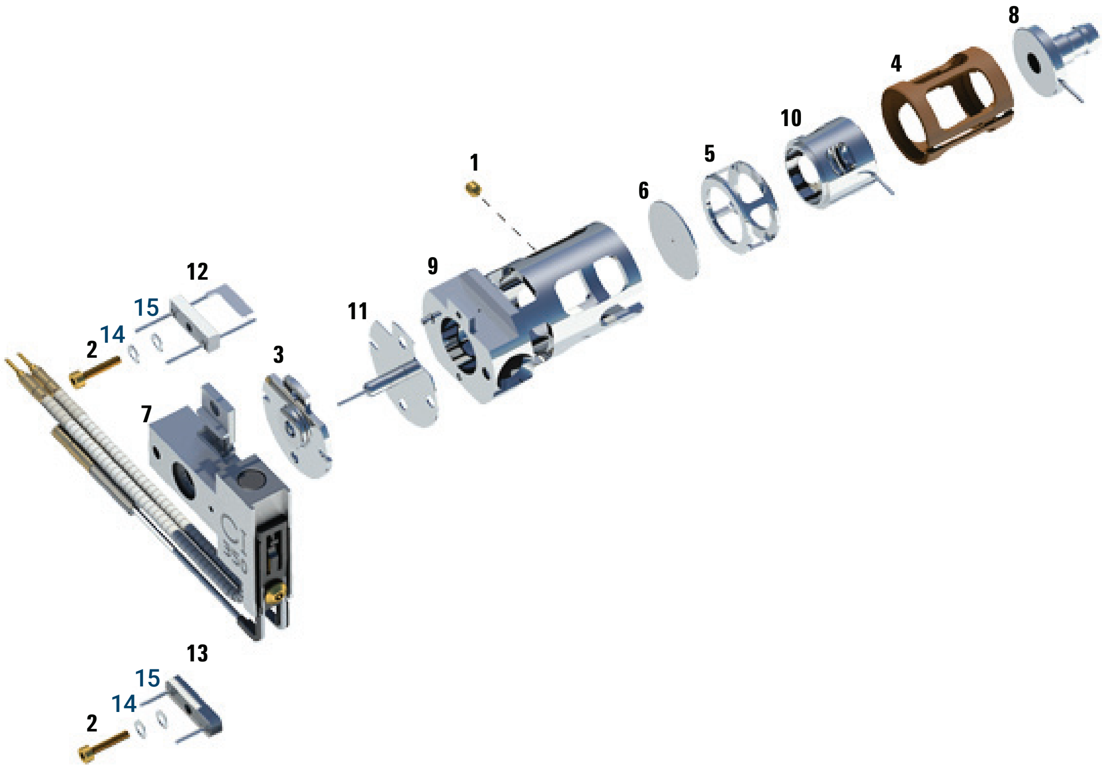


Figure 55. CI source

GC/MS interface for 8890 and 7890 GCs

A list of the replacement parts related to the GC/MS interface for 8890 and 7890 GCs and an illustration of the parts is also provided. (See **Table 19** and **Figure 56** on page 205.)

Table 19 GC/MS interface for 8890 and 7890 GCs (Figure 56 on page 205)

Item	Description	Part number
Not shown	Transferline assembly (No CI or JetClean)	G7077-67300
Not shown	GC/MS Transferline assembly, untested (CI or JetClean)	G7077-67400
1	Knurled tip seal retainer, threaded	G3870-20547
2	1/16 Ferrule no hole graphitised Vespel	0100-0691
2	1/16 Ferrule no hole (qty 10)	5181-3308
3	M3 x 3L Set screw, gold plated	0515-0236
4	Transferline tip base, threaded	G3870-20548
5	Interface tip seal	G3870-20542
6	Column nut	05988-20066
7	M3 screw	G1999-20022
8	M4 X 0.7 16MM-LG	0515-0383
9	Heater clamp (No CI or EI JetClean)	G7077-20210
9	Heater clamp (CI or EI JetClean)	G7077-20410
10	Tip seal spring	G7005-20024
11	Welded interface assembly (No CI or EI JetClean)	G3870-60301
11	Welded interface assembly (CI or EI JetClean)	G7077-60401
12	Heater/sensor assembly	G1099-60107
13	M3 x 16L T-10 screw	0515-1141

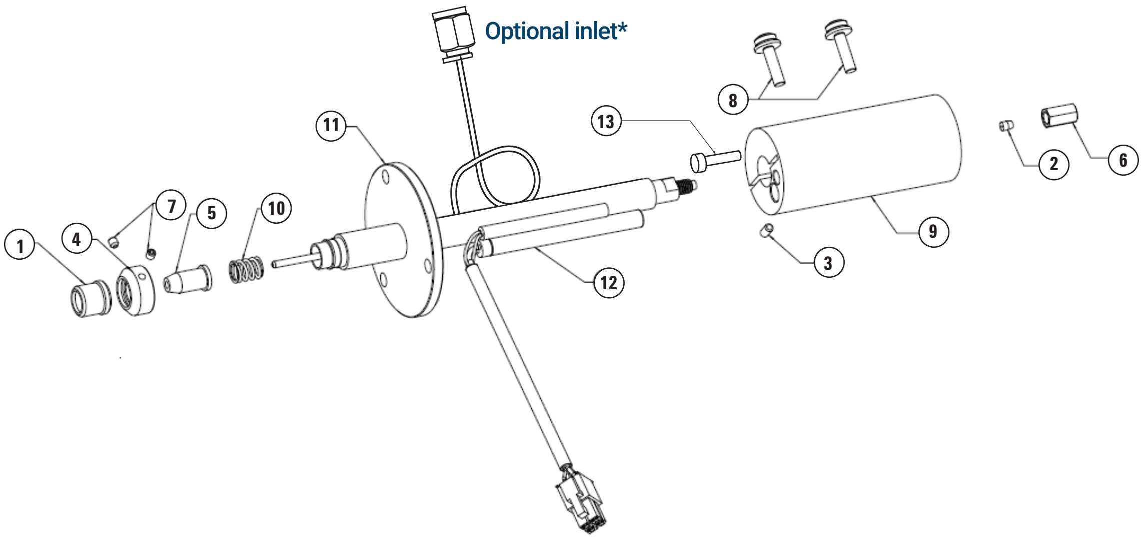


Figure 56. GC/MS interface for 7890

*Optional reagent gas/JetClean inlet on welded interface assembly G3870-67041 only. For EI without JetClean, use welded interface assembly G3870-60301

Consumables and Maintenance Supplies

This section lists parts available for cleaning and maintaining your MS. (See Tables **20** through **23**.)

Table 20 EI maintenance supplies

Description	Part number
Abrasive paper, 30 µm	5061-5896
Aluminum oxide powder, 100 g	393706201
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 21 Tools

Description	Part number
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
Screwdriver, Flat-blade, large	8730-0002
Screwdriver, Torx, T-10	8710-1623
Screwdriver, Torx, T-15	8710-1622

Table 21 Tools (continued)

Description	Part number
Screwdriver, Torx, T-20	8710-1615
T6 driver add to ship kit	8710-2548
Ship kit for RV5 foreline pump	G7000-60500
7010 MS Shipping kit	G7002-60501
7890 GC Shipping kit	G3430-60581
7890 Inert MSD interface kit	G3430-60588
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 22 Ferrules

Description	Part number
For the GC/MS interface using a standard column nut	
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	5062-3512
For self-tightening column nut	
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

Table 22 Ferrules (continued)

Description	Part number
0.8-mm id, 85%/15%, for 0.53-mm id columns	5062-3512
For the GC inlet with the standard or self-tightening nut	
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 23 Miscellaneous parts and samples

Description	Part number
EM horn	G7002-80103
Wire, iris	G7000-60828
Wire, extractor lens	G7000-60827
EPC manifold	G3270-20055
OFN, 100 fg/µL	5188-5348
OFN 2 fg/µL in isooctane 3 x 1mL	5190-6898
OFN 10 fg/µL GC/MS Checkout std 3 x 1mL	5190-0585
1 pg/µL OFN 5 pg/µL BZP	393065201
PFTBA, 10 gram	8500-0656
PFTBA sample kit	0597-60571
Ship kit for RV5 foreline pump	G7000-60500
Rough pump oil pan	G1946-00034
Oil mist filter for RV5 pump: SCD/NCD	G6600-80043
O-Ring, size 2-320, fluorocarbon	0905-1592
NW25 TO 5/8-inch tube elbow	G1960-20003
NW 20/25 clamping ring	0100-0549
Eval A, hydrocarbons (GC/MS Check out sample)	05971-60045

Table 23 Miscellaneous parts and samples (continued)

Description	Part number
Vacuum gauges	
Manifold vacuum gauge	G1960-80303
Ion gauge baffle	G7000-20049
O-Ring	0905-1627
Foreline gauge	G7000-60545
Foreline hose	G7077-60119
1/8-inch id stainless steel tubing 20 feet long	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
VCR Gasket, size 4, Ag on Ni, retainer	0100-1436
VCR Cap, size 4	0100-2013
Plug, size 4, 316SS	0100-2014
Lens wires	
Lens 1 wire	G7002-60831
Lens 2 wire	G7002-60832
Wire, source heater	G7002-60833
Wire, source sensor	G7002-60834

Additional CI Parts

This section shows parts that may be required to maintain the 7000/7010 TQ GC/MS with CI. (See **Table 24**.) The parts in this section are related directly to the CI accessory, and are in addition to the source parts listed earlier in this manual. (See **Table 18** on page 202.) Other parts for the MS can be found in the previous sections of this chapter.

Table 24 CI flow control module

Description	Part number
CI calibration valve assembly	G1999-60452
PFDTD calibrant	8500-8510
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	G7000-61025
GF 100 Mass Flow Controller	G7000-80030
Shutoff valve	G1999-80402
MFC cable	G1999-60464
Reagent gas select valve (Gas A and Gas B)	G1999-80401
VCR cap, size 4 (1/4-inch)	0100-2013
Plug, size 4 316SS	0100-2014
VCR gasket, 1/4-inch, Ag on Ni retainer	0100-1436
VCR gasket, 1/8-inch	0100-0468
Chemical ionization gas purifier	5190-9071
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/packages	5080-8751

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