

Agilent 7500 Series ICP-MS

Hardware Manual



Agilent Technologies

Notices

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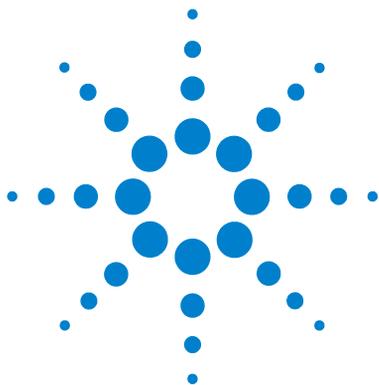
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The *Agilent 7500 Series ICP- MS Hardware Manual* provides an instrument overview, safety precautions and procedures for optimization, maintenance and troubleshooting. Please read the chapters regarding the overview and safety information before using the instrument.

This manual refers primarily to the Agilent 7500a/cs/cx instruments. Please note that the 7500ce, where referred to, is a predecessor instrument to the 7500cx.



Who Should Read This Book

The primary audience for the *Agilent 7500 Series ICP- MS Hardware Manual* consists of chemists and instrument operators in a laboratory. To use this manual effectively, you should have a strong knowledge of chemistry, and at least a basic level of computer experience.

How to Use This Book

The *Agilent 7500 Series ICP- MS Hardware Manual* contains six chapters that can be accessed independently, as needed. This manual contains the following chapters:

Chapter 1, “Overview”, introduces the Agilent 7500 Series ICP- MS.

Chapter 2, “Precautions”, describes Safety Information, Environmental Conditions, and Utility Requirements.

Chapter 3, “Startup, Shutdown and Status”, explains how to start up and shut down the instrument, and how to check the instrument status.

Chapter 4, “Maintenance”, explains how to maintain each of the components of the Agilent 7500.

Chapter 5, “Troubleshooting”, explains how to check error messages, procedures for troubleshooting, and describes the error and alarm messages that can appear when you operate the Agilent 7500.

Chapter 6, “Technical Information”, describes the detailed technical information of the Agilent 7500.

“Appendix”, explains the Organic Solvent Kit.

Conventions Used in This Book

This book uses certain conventions to distinguish different types of information easily. This section describes these conventions.

Instructions

All step-by-step instructions are numbered and in bold, as in the following example.

1 Select Instrument >> Tune from the ICP- MS Top.

The **Sensitivity** tuning window appears.

Alternatives

Lines beginning with a bullet (•) in step-by-step instructions indicate alternative steps, as in the following example:

2 Change the parameter value in one of the following ways:

- Click the right or left arrow at the end of the scroll bar, which changes the parameter value in small increments.
- Click the scroll bar, which changes the parameter value in larger increments.
- Double-click the box above the scroll bar and enter a new parameter value.

Menu Items

This book uses the following format for referring to menu items:

Instrument >> Tune

The text before the arrow symbol is the name of the menu; the text after the arrow symbol is the menu choice. This example refers to the Tune menu choice in the Instrument menu.

Terminology

This book frequently uses the following terms:

Table 1

Convention	Information
Press	To hold down a button on the keyboard.
Click	To press and release the mouse button.
Double-click	To click the mouse button twice in rapid succession.
Drag	To press and hold the mouse button while moving the pointer.
Active Window	The window in which the cursor is currently located.
Radio Buttons	Choices where you can select only one item from a list. The selected radio button contains a solid dot. A grayed out radio button is a choice that is unavailable at a given time.
Check Box	Choice where you can select or clear the named item. Multiple items can be chosen simultaneously and are each marked with an X in a square. You cannot use a grayed out check box.
Push Button	Button used to initiate an immediate action. Cancel and Help are examples of push buttons. Push buttons are labeled on the buttons themselves.
ICP-MS	An inductively coupled plasma mass spectrometer.
Agilent 7500	The Agilent Technologies 7500 Series ICP-MS.
MassHunter Workstation	The MassHunter Workstation software for Agilent Technologies ICP-MS.
ChemStation	The ChemStation software for Agilent Technologies ICP-MS.

Notes

Notes contain a reminder about the effect of particular actions. They are indicated as follows:

NOTE

This example shows how a note is displayed.

Cautions

Cautions indicate situations that could overwrite data or require immediate attention to prevent harm to the instrument. Cautions are indicated as follows:

CAUTION

This example shows how a caution is displayed.

Warnings

Warnings indicate situations that could cause bodily harm. Warnings are indicated as follows:

WARNING

This example shows how a warning is displayed.

Where to Go for More Information

In addition to the *Agilent 7500 Series ICP- MS Hardware Manual*, you can reference the following resources:

- *Agilent 7500 Series ICP- MS MassHunter Workstation (G7200A) Operator's Manual*
or *Agilent 7500 Series ICP- MS ChemStation (G1834B) Operator's Manual*
- *Agilent 7500 Series ICP- MS Tuning and Application Handbook*
- *Agilent 7500 Series ICP- MS Customer Maintenance Parts List*
- *Agilent 7500 Series ICP- MS Site Preparation Guide*
- *Online Help*

Agilent Technologies on the Internet

For the latest information on products and services visit our worldwide web site on the internet at:

<http://www.agilent.com/chem/icpms>

Other Information

7500cs, 7500cx with H2 line, and ORS upgrade with H2 line are licensed under U.S. Patents 5,767,512; 6,259,091 and associated counterparts.

Your computer system has additional manuals that document the software and hardware. For more information on using or maintaining your computer, printer, or peripheral equipment, consult the respective hardware user's guide. Microsoft® Windows™ have a user's guide that explains how to install, use, and troubleshoot the software.

Microsoft, Windows, are either registered trademarks or trademarks of Microsoft Corporation in the United States.



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The Agilent Technologies 7500 Series ICP- MS (Agilent 7500) is an inductively coupled plasma mass spectrometer (ICP- MS). It can measure trace elements as low as one part per trillion (ppt) or quickly scan more than 70 elements to determine the composition of an unknown sample. The MassHunter Workstation (or ChemStation) software automates the analysis and accurately interprets the resulting data.

This chapter describes the principles of operation of the Agilent 7500 and its components in detail. The chapter concludes with a description of sampling options and peripheral equipment that are available to extend the application range of the Agilent 7500.



Instrument Components

This section describes the instrument components, starting with a general overview of the operating principles of the Agilent 7500.

The general system consists of the following instruments. The auto sampler and the water chiller are optional.

- | | |
|--|--|
| 1 ICP- MS Instrument | Agilent 7500 ICP- MS |
| 2 MassHunter Workstation (or ChemStation) | MassHunter Workstation (or ChemStation) controls the Agilent 7500 ICP- MS, acquires data, and analyzes the acquired data. |
| 3 Printer | Printer outputs the analysis results. |
| 4 Rotary Pump | One or two rotary pumps are used depending on the options ordered.
The rotary pump is used as the backing pump for the turbomolecular pump. It is also used to pump the interface chamber in analysis mode.
The electric power for the pump is supplied from the Agilent 7500. MassHunter Workstation (or ChemStation) controls the pump's ON/OFF control. |
| 5 Autosampler | MassHunter Workstation (or ChemStation) controls the autosampler. For more information, refer to the autosampler manual. |
| 6 Water Chiller | The water chiller supplies the cooling water to cool the Peltier cooler (spray chamber cooler), the sampling cone, the skimmer cone, the RF amp and the work coil. For more information, refer to the water chiller manual. |

The following steps provide a brief overview of how the Agilent 7500 analyzes a sample. More detail is provided in later sections.

- 1** The sample solution is pumped into the inlet system where it is nebulized, forming a fine sample aerosol.
- 2** The aerosol is then carried into a high temperature argon plasma which atomizes and ionizes the sample to produce a cloud of positively charged ions.
- 3** The sample ions are extracted from the plasma into a vacuum system containing a quadrupole analyzer or mass filter. The analyzer can scan the mass range very quickly allowing a multi- element analysis to be performed on the sample.
- 4** The ions are focused into the analyzer where they are separated by their mass- to- charge ratio (m/z).
- 5** The ion concentration of a specific mass- to- charge ratio is measured by an electron multiplier detector.
- 6** The count rate obtained for a particular ion is compared with a calibration plot to give the concentration for that element in the sample (for quantitative analysis).

Agilent 7500 – Part Names

The names of the parts of the Agilent 7500 are described in this section.

Front View

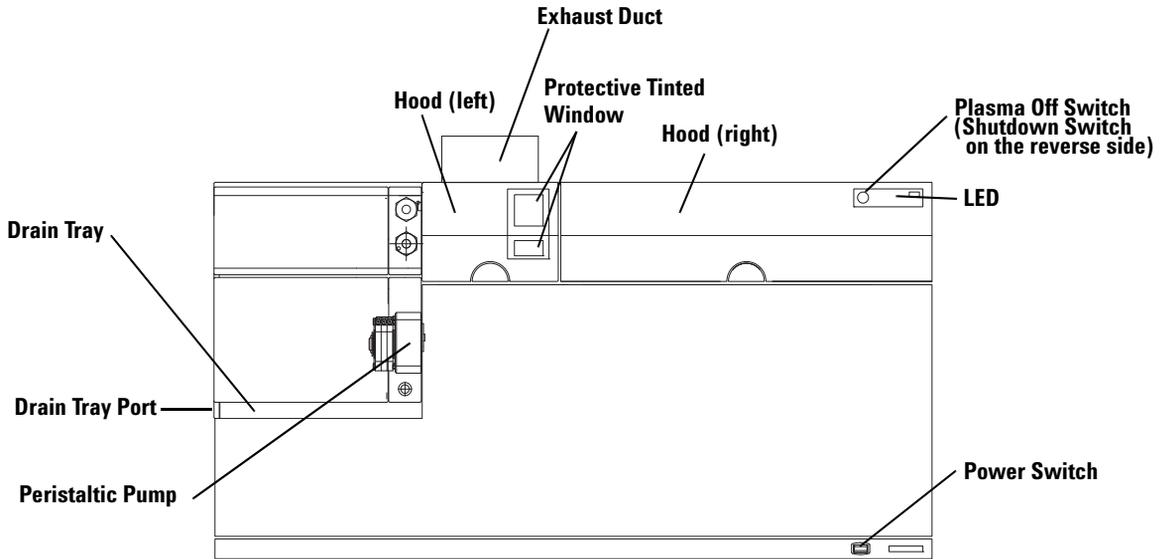


Figure 1 Agilent 7500 (Front View)

Hood (Left) This hood is used to cover the torch and interface area during operation.

Hood (Right) This hood is used to cover the ion lens system, the mass filter and the detector areas.

Protective Tinted Window This window is used as a viewing glass to observe the plasma.

LED The LED indicates the instrument status by changing colors or blinking.

Green:	Analysis mode
Orange:	Standby mode
Red:	Error
Orange blinking:	Mode transition
Turn off:	Shutdown mode

Power Switch	<p>Main power switch of Agilent 7500.</p> <p>Before turning on this switch, you need to turn on the power breaker located on the rear side. When the power is on, the green indicator in the center of the switch lights green.</p>
Plasma Off Switch	<p>When you push this switch for more than 1 second, the plasma will turn off and the instrument will transfer to standby mode.</p> <p>This switch is used to immediately shut off the plasma if an abnormal condition exists.</p>
Shutdown Switch	<p>The Shutdown Switch is located on the under side of the right hood.</p> <p>When you push this switch, the instrument will return to shutdown mode safely. This allows switching the instrument to shutdown mode, even if MassHunter Workstation (or ChemStation) communication is lost. Before pushing this switch, return the instrument to standby mode when possible.</p> <p>After using the Shutdown Switch, turn OFF the main power switch of the Agilent 7500 and then turn it back ON. MassHunter Workstation (or ChemStation) can once again control the Agilent 7500.</p>
Drain Tray	<p>This tray protects the Instrument from chemical spills (samples and solvents).</p>
Drain Tray Overflow Port	<p>This port allows chemical spills to be safely drained, and it is recommended that you connect tubing from this port to a suitable chemical waste container.</p>
Tubing Specification	<p>ID : 10 - 10.5mm (Internal surface must be Smooth)</p> <p>Length : 1m (Maximum)</p> <p>Material Type : Tygon[®]</p> <p>(eg : Tygon[®] R-3603 ID 10mm × OD 14mm)</p>

NOTE

The tubing must have a vertical drop to assist gravity drain. Connect the tubing from the overflow port to the chemical waste container and avoid any restriction of flow.

WARNING

Do not remove the front or side covers of the instrument. High voltage and radio frequency radiation from the RF power supply is present and may be very dangerous.

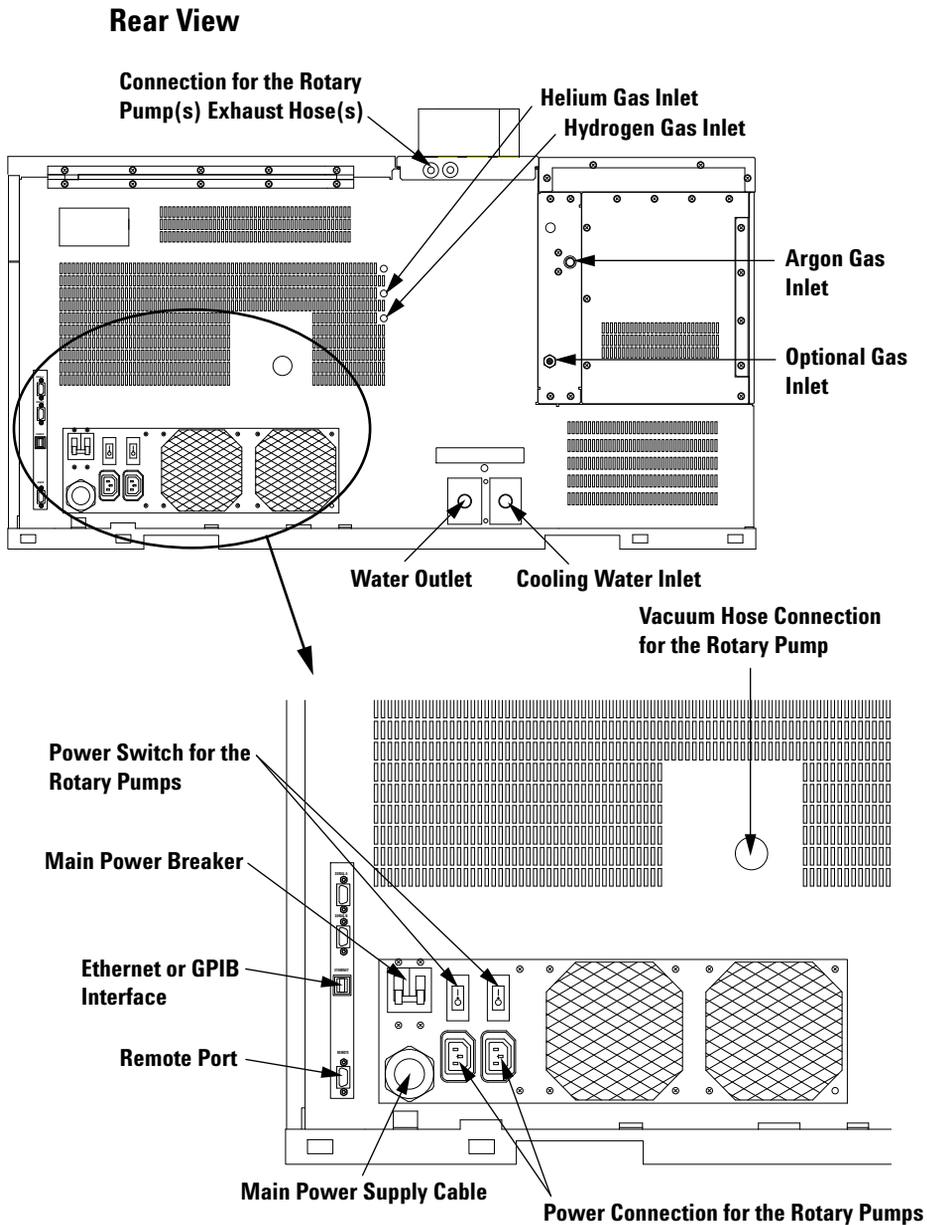


Figure 2 Agilent 7500 (Rear View)

Cooling Water Inlet/Outlet	Cooling water inlet and outlet port
Argon Gas Inlet	Argon gas inlet port
Optional Gas Inlet	Optional gas inlet port
Helium Gas Inlet	Helium gas inlet port for Agilent 7500cs, 7500cx
Hydrogen Gas Inlet	Hydrogen gas inlet port for Agilent 7500cs. Optional for 7500cx.
Main Power Supply Cable	Power cable
Main Power Breaker	The main power supply circuit breaker. Generally, this breaker remains ON, and the power switch (front side of the instrument) is used for power ON/OFF.
Power Supply connection for the Rotary Pumps	Power connections for the rotary pump(s).
Power Switch for Rotary Pumps	The rotary pumps instrument circuit breaker. Generally, these switches are kept ON because MassHunter Workstation (or ChemStation) controls the rotary pump power ON/OFF.
Vacuum Hose Connection from Rotary Pump	Connection for the rotary pump(s) vacuum hose.
Connection of Rotary Pump Exhaust Hose	Connection for the rotary pump(s) exhaust hose.
Ethernet or GPIB Interface	The connection port for the Ethernet Cable. The Ethernet cable is connected between the Agilent 7500 and the PC.
Remote Port	The Connection port for the APG Remote cable.

Side View

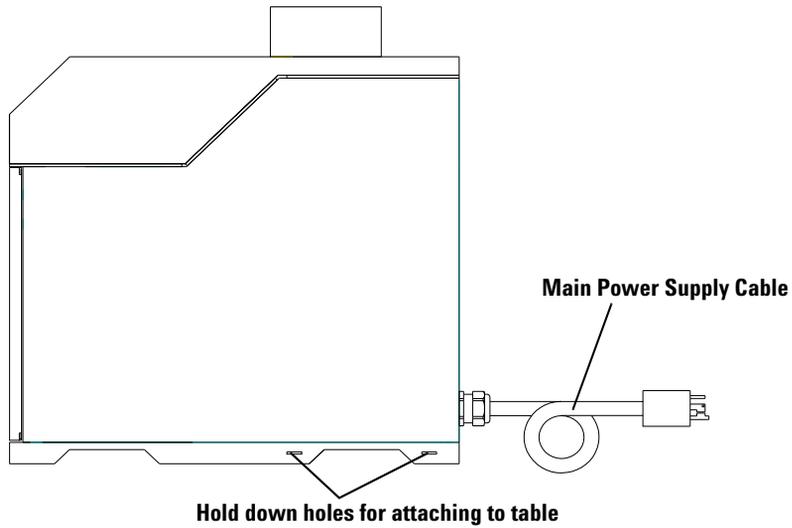


Figure 3 Agilent 7500 Side View (Left)

Hold down holes for attaching to a Table or bench.

If you need to attach the Agilent 7500 to a table or bench, slots are provided as fastening points.

Name of Gas Piping and Cooling Water Tubing

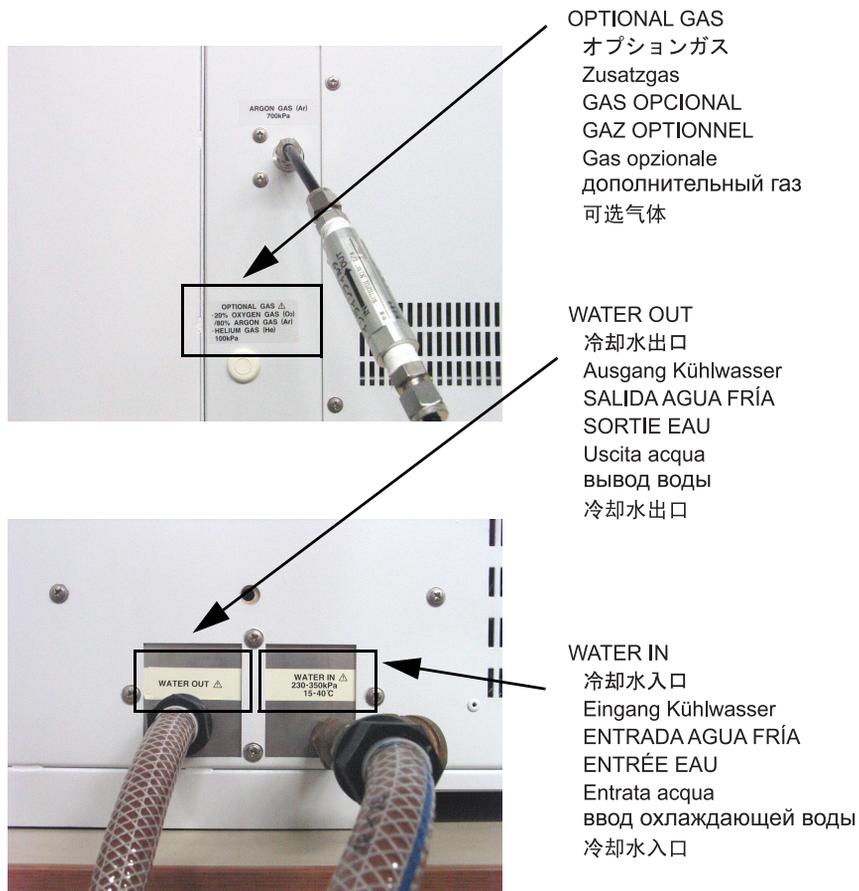


Figure 4 Name of Gas Piping and Cooling Water Tubing

1 Overview

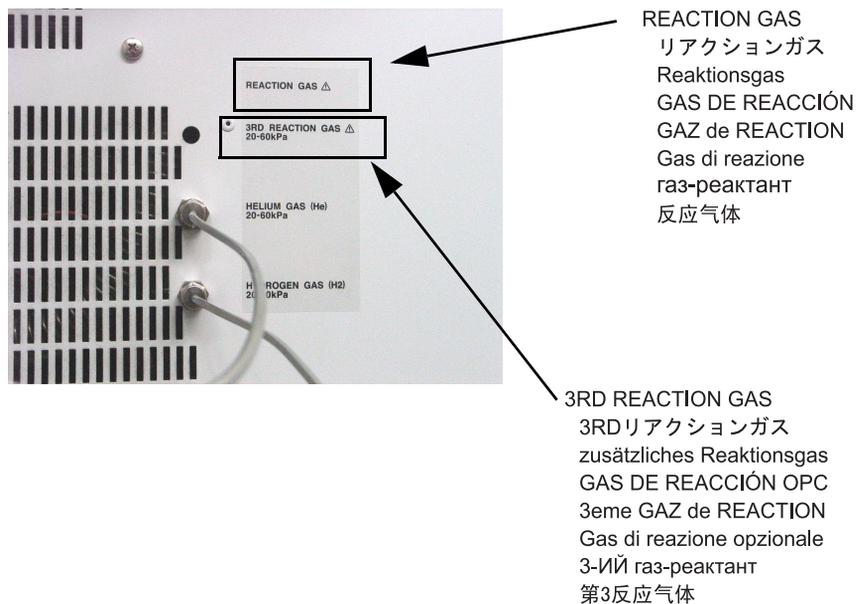
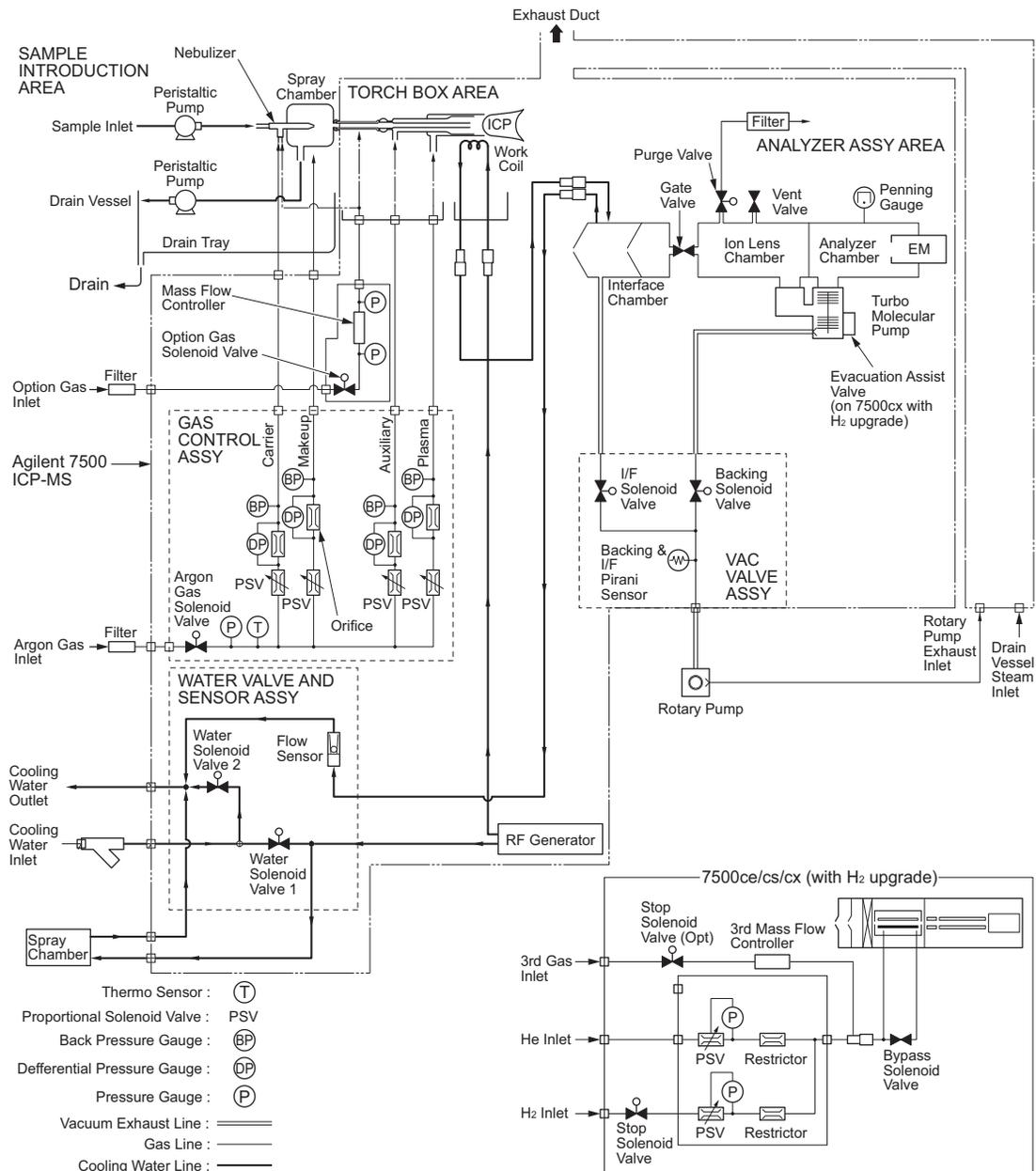


Figure 5 Name of Gas Piping and Cooling Water Tubing



Function of Components

This section describes the components of the Agilent 7500 in detail and in the sequence listed below:

- sample introduction
- inductively coupled plasma (ICP) source
- interface/vacuum
- ion lenses
- analyzer
- detector
- vacuum system
- RF generator

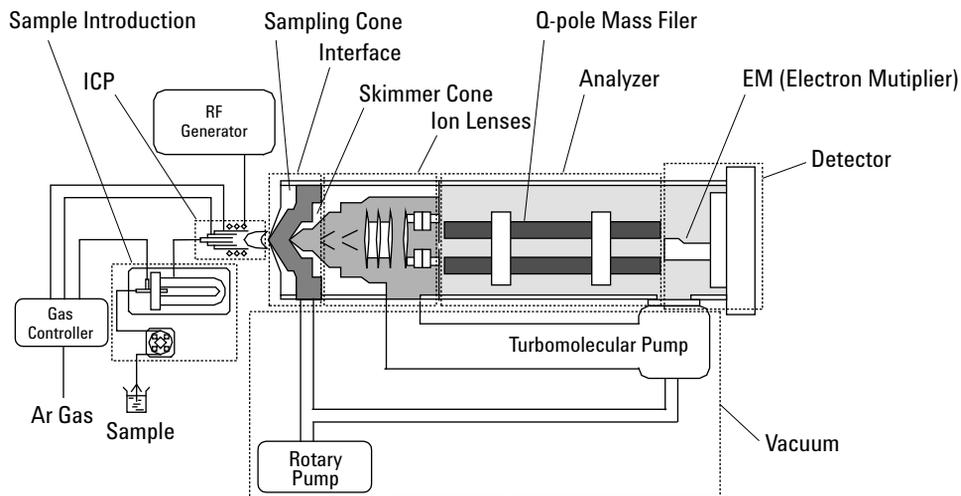


Figure 7 System Diagram (7500a)

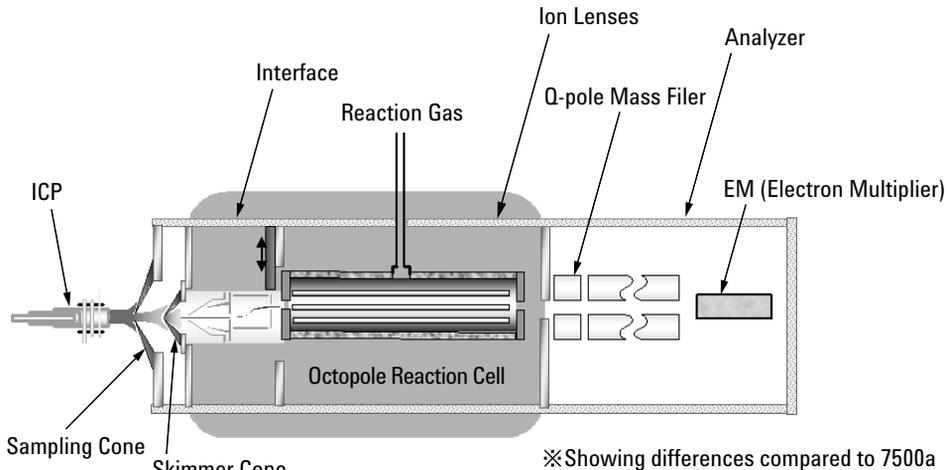


Figure 8 Octopole Reaction System (7500cs/cx)

Sample Introduction

The Agilent 7500 features an on-board peristaltic pump that controls the flow of sample solution into and waste (drain) out of the instrument. The peristaltic pump continuously pumps the sample solution into the sample introduction system. The solution passes into a nebulizer that disperses the sample using a stream of argon gas (Figure 9).

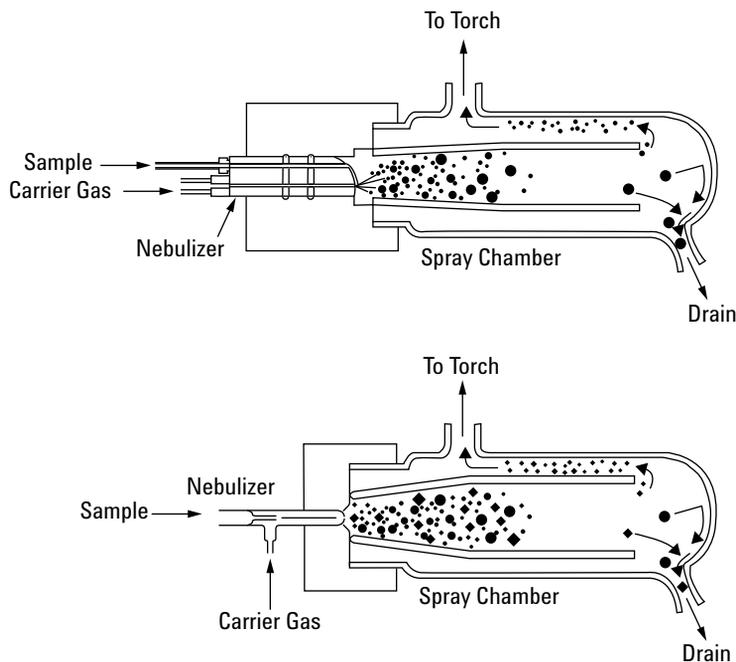


Figure 9 Nebulizer and Spray Chamber (Top: Babington type, Bottom: concentric type)

A sample solution mist forms and passes through a double-pass spray chamber where the larger sample droplets are removed by collision with the spray chamber wall. To prevent the spray chamber from filling up with liquid, the peristaltic pump drain channel constantly removes excess sample solution.

The Peltier cooler, a thermoelectric device, cools the spray chamber. This cooler enables the temperature inside the chamber to be precisely controlled, which gives the Agilent 7500 a very stable ion signal. In addition, cooling the sample aerosol also removes some of the water from the sample, reducing the level of polyatomic oxide species formed, which in turn reduces the interference on certain analytes.

ICP Source

The fine sample aerosol that exits the spray chamber passes directly into the injector tube of the horizontally mounted ICP torch. The ICP torch is comprised of three concentric quartz tubes through which streams of argon pass (Figure 10). These three gas streams are referred to as the plasma gas, auxiliary gas and nebulizer (carrier) gas.

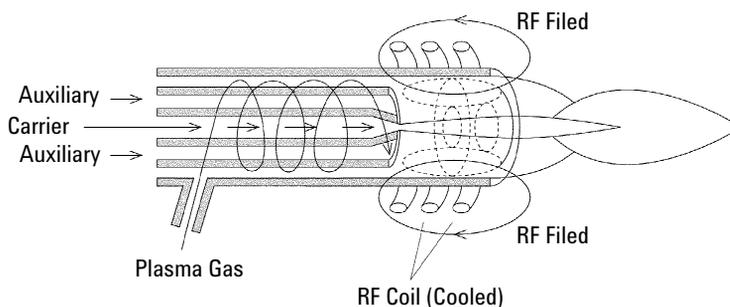


Figure 10 ICP Torch and Load Coil

The end of the torch is situated inside the 4-turn work coil, through which a radio frequency (RF) current oscillating at 27.12 megahertz (MHz) is passed. After seeding the plasma with electrons, collisions of Ar atoms in the intense RF field generates and sustains an argon plasma.

In the center of the plasma, temperatures range from 8,000 to 10,000 Kelvin (K). The sample aerosol is instantaneously desolvated and ionized. The Argon plasma is a good source of singly charged positive ions allowing most of the elements of interest to be ionized with an efficiency of greater than 90 percent. All the Argon gas and optional gas supplies are mass flow controlled. This contributes to very good signal stability.

The carrier gas flows through the innermost tube called the injector tube and delivers the sample aerosol to the plasma.

The make-up gas line is used for adding make-up gas when using the ShieldTorch interface (cool plasma).

An optional gas mass flow controller (if installed) allows for the addition of mixed carrier gases to the plasma. This can be useful for certain applications. For example, the addition of O₂ reduces carbon build-up on the interface when analyzing organic solvents.

After focusing by a conventional Einzel lens, the ion beam is bent off-axis by an Omega lens, which consists of two split-ring elements that alternately repel and attract the ions. This Omega lens deflects the ion beam approximately 5 mm off-axis into the front plate of the quadrupole. Photons and neutral species are not diverted off-axis and so do not enter the quadrupole. This ensures that the system has a very low random background, resulting in excellent detection limits.

Octopole Reaction System (ORS) (7500cs/cx)

The Octopole Reaction System (ORS) is an octopole ion guide contained within a stainless steel vessel and pressurized with a gas, most often He or H₂. The ORS is positioned between the ion lens assembly and the quadrupole mass filter (Figure 8). As ions from the sample enter this cell, they interact with the gas, resulting in the reduction of the molecular interference, normally below the level of the blank solution. The use of 8 rods in the octopole has greater ion transmission efficiency compared to 6 rod (hexapole) or 4 rod (quadrupole) systems. The ORS Eliminates key interferences arising from the sample matrix that are not argon based and cannot be eliminated using “traditional” approaches.

Quadrupole

The quadrupole mass analyzer consists of four long metal rods with a hyperbolic cross section which are arranged parallel to each other, and have RF and DC voltages applied to them. By varying these voltages, the rods act as a mass filter allowing only ions of a specific mass-to-charge ratio to pass through the center of the quadrupole at any given combination of applied voltages. All other masses are unstable and collide with the rods. These voltages are ramped very rapidly so the quadrupole can scan the entire mass range (2- 260 amu) in 100 milliseconds. As a result, spectra of mass versus intensity can be obtained for all elements virtually simultaneously.

Quadrupoles are limited effectively to unit mass resolution so they can't resolve polyatomic and isobaric interferences. However, of all of the elements detectable by ICP-MS, only indium does not have an isotope that is free from overlap by another element.

Detector

After passing through the quadrupole, ion signals are measured by the electron multiplier detector. Both the quadrupole and detector are located in the analyzer stage, which is evacuated by a second turbo- molecular pump.

The electron multiplier (EM) has many dynodes. When an ion enters the EM, the ion hits the first dynode and a shower of electrons is generated. The electrons then hit the next dynode generating more electrons.

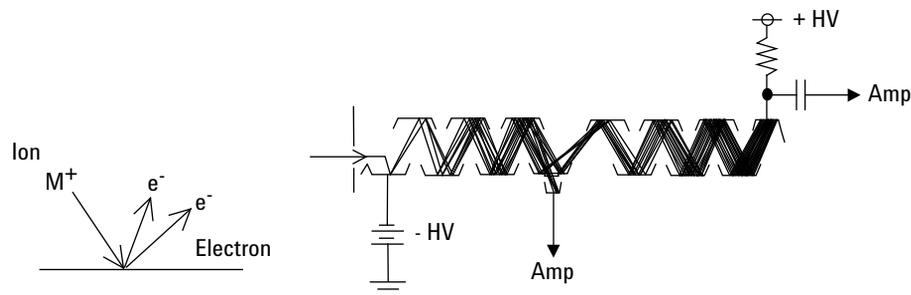


Figure 12 Electron Multiplier

Depending on the concentration of the analytes being measured, the detector operates in one of two modes:

- Pulse mode for low sample concentrations.
- Analog mode for high sample concentrations.

Vacuum System

The sample is ionized in the plasma and the ions go through the interface, the ion lens, and the mass filter to the detector. A lower vacuum pressure in the vacuum chamber is required to transmit the ions. The Agilent 7500 has a 3-stage vacuum system which consists of the interface chamber, the ion lens chamber, and the analyzer chamber.

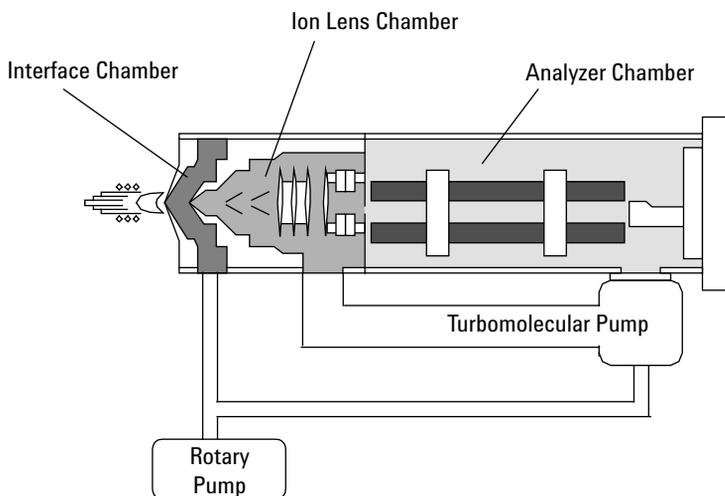


Figure 13 Vacuum System

Interface Chamber

The interface chamber is located between the sampling cone and the skimmer cone. A rotary pump evacuates the interface chamber.

Ion Lens Chamber

The ion lenses are located in the ion lens chamber. A turbomolecular pump evacuate the ion lens chamber.

Analyzer Chamber

The mass filter and the detector are located in the analyzer chamber. A turbomolecular pump evacuates the analyzer chamber.

The rotary pump is also used for pumping the interface chamber turbomolecular pump.

RF Generator

This system supplies RF power to the work coil to generate plasma.

The RF generator consists of a RF driver, RF power amplifier, and an impedance matching circuit.

The driver generates the 27.12 MHz RF.

The impedance matching circuit is located between the work coil and the RF power amplifier. This circuit matches the impedance of the work coil to supply maximum RF power to the plasma. The impedance matching is controlled automatically.

Support Systems

The Agilent 7500 requires argon, cooling water, electrical power and positive exhaust ventilation. Refer to the *Agilent 7500 Series ICP-MS Site Preparation Guide* for additional information.

The MassHunter Workstation (or ChemStation) software controls the Agilent 7500 and interprets the resulting data.

Following subsystems are water cooled.

- Spray Chamber
- Work Coil
- Interfaces
- RF Generator

NOTE

If an anti-freeze solution is added to the cooling water, do not exceed 10% v/v. It will reduce the cooling efficiency and may overheat the components of the Agilent 7500.

Optional Equipment

The Agilent 7500 can be adjusted for various types of analyses by utilizing options in the sample introduction area. For details of the optional equipment please refer to the *Agilent 7500 Series ICP-MS Customer Maintenance Parts List*.

Peripheral Equipment

The optional peripheral equipment extends the application range of the Agilent 7500. The following sections describe the available peripherals.

Autosampler (I-AS)

You can use the random access autosampler to analyze a sequence of samples without operator intervention. A two-channel peristaltic pump provides a flowing rinse and segmented racks allow for rack replacement during operation.

This peripheral is controlled and programmed using the MassHunter Workstation (or ChemStation) software. The *Agilent 7500 ICP-MS MassHunter Workstation Operator's Manual (or ChemStation Operator's Manual)* contains instructions on how to utilize the autosampler intelligent processing.

ASX-500 Series Autosampler

The ASX-500 series Autosampler can automate the introduction of up to 360 samples. Random sampling order is controlled by the microprocessor built in to the ASX-500 series.

The ASX-500 series Autosampler is controlled by MassHunter Workstation (or ChemStation) through the RS232C serial port. For details, please refer to the *Agilent 7500 Series ICP-MS MassHunter Workstation Operator's Manual (or ChemStation Operator's Manual)*.

EXR-8 Autosampler

The EXR-8 Autosampler can automatically and continuously analyze up to 720 samples using the same sample racks as the ASX-500 Series Autosampler. The built-in microprocessor selects samples sequentially or randomly and introduces them into the Agilent 7500.

The EXR-8 Autosampler is controlled by MassHunter Workstation (or ChemStation) through the RS232C interface. Regarding the settings, refer to the *Agilent 7500 Series ICP-MS MassHunter Workstation Operator's Manual (or ChemStation Operator's Manual)*.

Integrated Sample Introduction System (ISIS)

The Integrated Sample Introduction System (ISIS) is a very flexible sample introduction system for the Agilent 7500 ICP-MS. The ISIS design is optimized for the Agilent ICP-MS and is dedicated to expand its analytical ability.

ISIS can be setup to perform various on-line sample introduction techniques such as:

- Pre-defined application: High Sample Throughput, Auto Dilution, Discrete Sampling
- Customer definable application: Hydride Generation, Matrix Elimination

Laser Ablation System

The Laser Ablation System provides a means of rapid, direct analysis of solid samples without dissolution and minimal sample preparation. Ablation may be performed on samples of electrically conductive or non-conductive materials, including glasses, ceramics, or polymers.

Plasma Chromatographic Software

The Plasma Chromatographic Software (Plasma chrom) is for time resolved data analysis for example chromatograms acquired through LC- ICP- MS.

Intelligent Sequence Software

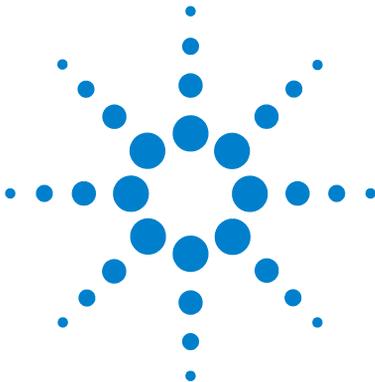
The Intelligent Sequence automates a variety of QA/QC control procedures from analysis to data reporting.

Specifications

The following specifications are subject to change without notice. A copy of the most recent specifications in the form of a specification sheet can be obtained from your local Agilent Technologies office.

Table 2

Name		Agilent 7500 Series ICP-MS (Agilent 7500)
ICP		Solid State System
	Frequency	27.12 MHz
	RF power	1600 W (maximum)
	Torch	Fassel Type
MS	Mass Filter	Hyperbolic Quadrupole Mass Filter
	Frequency	about 3 MHz
	Mass Range	2 to 260 amu
	Detector	Electron Multiplier
Vacuum System		3 Stage Vacuum System
	Pump	Rotary Pump Turbomolecular Pump
Size		1100 (W) x 600 (D) x 650 (H) mm, about 175 kg
Regulatory Compliance		Please refer to the Declaration of Conformity .



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This chapter describes Safety Information, Environmental Conditions, and Utility Requirements.



WARNING

If you have a pacemaker or similar implanted device, consult your physician before using this device. This device can potentially affect pacemaker function.

CAUTION

The Agilent 7500 Series ICP-MS (Agilent 7500) is a very safe instrument with many built-in protective features:

- A safety interlock prevents opening of the hoods during operation.
 - A plasma viewing window provides eye protection.
 - Sensors monitor the water and argon flow rate and pressure. If the water flow is too low to sufficiently cool the Agilent 7500, or if the argon supply is insufficient, the plasma is turned off automatically.
 - There are fans to help ensure that the instrument's internal temperature stays within the preset limits. The plasma is turned off automatically if any of these fans, except the QP fan, fail.
 - Temperature sensors on the exhaust vent, intake air line, and intake water line stop the plasma if overheating occurs.
 - A manual switch shuts down the instrument immediately, even if the computer is inoperable.
-

CAUTION

In case of uncertainty about a specific fluid, that fluid should not be used until confirmation by the manufacturer that it will not present a Hazard.

CAUTION

Dealing with liquid spills

Tuning solution, rotary pump oil and other solution spills: please clean with a dry cloth. In the case of large spills, use of a spill kit is recommended. Please refer to and follow the safety instructions on the MSDS (Material Safety Data Sheet) when available.

CAUTION

Before using any cleaning or decontamination methods except those specified by Agilent, please confirm with Agilent that the proposed method will not damage the equipment.

NOTE

To shut down the instrument quickly, turn OFF the power switch located on the lower right side of the front panel. To switch the instrument to Standby mode and/or Shutdown mode without using MassHunter Workstation (or ChemStation), a “**Plasma Off Switch**” and “**Shutdown Switch**” are available on the instrument top cover.

CAUTION

- A sensor monitors the radio frequency (RF) generator and shuts it down if it is improperly matched to the work coil.
- A fiber-optic sensor shuts off the RF high voltage power whenever the plasma is not present or is turned off manually.
- The Agilent 7500 MassHunter Workstation (or ChemStation) displays warning messages in its green status line when the sensors first detect a problem, enabling you to stop work before the shutdown limits are reached.
- The parameters displayed in the instrument control window change from green to yellow/red as the shutdown limits are approached/reached. However, some parameter windows do not change color when the value reaches the shutdown limit.

In addition to the above safety features, the following precautions should always be taken during operation or maintenance of the Agilent 7500:

- Check acid concentration. Continuous aspiration of a highly concentrated acid might attack the inside of the instrument. Refer to the *Agilent 7500 Series ICP-MS Tuning and Application Handbook* for more detail on acid concentration.
- Close the instrument hoods and panels before operation.
- Check the exhaust system for a positive extraction at the exhaust duct.
- Handle solvents correctly.
- Check the drain vessel frequently.
- Store argon safely.
- Wait for the instrument to cool before performing any maintenance operation.
- Check the condition of the pipes, replace as needed.

Pay close attention to the cautions and warnings within this manual and the *Agilent 7500 Series ICP-MS MassHunter Workstation Operator's Manual (or ChemStation Operator's Manual)*.

Protective Earth

WARNING

Connecting the Agilent 7500 ICP-MS to a power source that is not equipped with a protective earth contact creates a shock hazard for the operator and can damage the instrument. Likewise, interrupting the protective conductor inside or outside the Agilent 7500 ICP-MS or defeating the power cord ground creates a shock hazard for the operator and can damage the instrument.

Closing the Instrument Panels and Hoods

Close the instrument hoods before starting the plasma. Because the instrument can be optimized entirely via computer, there is no need to open the front and side panels or hood after the plasma is ignited. In addition, a safety interlock shuts off the plasma if the hood is lifted.

WARNING

The instrument's external covers shield the operator from internal hazards while the instrument is in operation. Exposure to high voltage and radio frequency radiation from the RF power supply is present and can be very dangerous.

Wearing Safety Glasses

WARNING

The Agilent 7500 provides a protective tinted window for viewing the plasma during operation. Your eyes can still be exposed to ultraviolet rays if you look at the plasma directly through the hole on the left side of the left-hand hood. When operating the instrument, always wear safety glasses prescribed for viewing ultraviolet rays (UV approved). Direct viewing of ultraviolet rays without protection causes permanent blindness or vision impairment.

Safety glasses will also protect your eyes from hazardous liquids. Wear safety glasses whenever preparing or handling samples, maintaining the instrument, or emptying the drain vessel.

Checking the Exhaust System

CAUTION

Due to potential health hazards, the exhaust gases from the plasma and vacuum systems must be eliminated through the laboratory ventilation system via the instrument exhaust vent. If inadequate ventilation occurs, it will cause vaporized pump fluid, ozone, and other toxic combustion products to accumulate in the laboratory. Hydrofluoric acid (HF) fumes, if inhaled, cause extensive burning of lung tissue.

CAUTION

There is continuous oil mist from the rotary pump, even when the instrument is not in Analysis mode. Please make sure the ventilation system is always in operation. Also, harmful hydrogen may remain even when not analyzing so the ventilation system should always be on, even in Standby mode.

CAUTION

Ensure that the exhaust system established during installation continues to operate effectively. Connect a low-flow warning light to the extraction system or use an air-flow measurement device to give an alarm in the event of a malfunction. Otherwise, check the laboratory's ventilation duct and the hood over the sample preparation table before operating the instrument. Hold a tissue paper into the openings of both ducts to verify that they are drawing in air.

NOTE

The exhaust system for Agilent 7500 must have the capacity to maintain positive extraction of 7~8 m³/min for the 7500cs (with option duct which is standard on 7500ce/cs) or 4~6 m³/min for the 7500a/cx (without optional duct).

CAUTION

If the exhaust fan is inoperable or there is insufficient air flow, do not start the plasma until the appropriate maintenance personnel have rectified the problem.

Handling Solvents Correctly

CAUTION

Organic and aqueous solvents can be hazardous if handled improperly. Always follow the precautions listed below to protect both operator and instrument:

- Read the Material Safety Data Sheet (MSDS) for each solvent used.
- Prepare samples and transfer acids under a fume hood with adequate extraction.
- Wear gloves when handling acids or solvents.
- Wear safety glasses when handling any liquids.
- Cover volatile samples to minimize exposure to fumes and possible explosion hazard.
- Clean any spillage immediately using the approved laboratory procedures.
- Store and prepare samples away from the instrument to prevent corrosion.
- Use peristaltic pump tubing that is compatible with the sample solvent being pumped. For more information, refer to [Chapter 6, "Technical Information"](#).
- Solvent spillage into instrument: please call the customer contact center.

Acid digestion at atmospheric or increased pressure require these additional precautions:

- Apply heat slowly, watching for a possible reaction after each increase in temperature.
 - Drip a second acid or washing aid slowly into a hot sample while watching for signs of a vigorous reaction.
 - Cool the digested sample before you transfer it, or dilute it slowly with water.
 - Never use perchloric acid in a pressure digestion.
-

Checking the Drain Vessel

CAUTION

The drain vessel contains the spray chamber effluent, which can be toxic. Improper handling of the vessel can result in a serious explosion or fire if incompatible substances are accumulated. Corrosion of the vessel and connecting tube can result in leaks that may damage the instrument or cause bodily harm. If the effluent collected in the drain vessel contains toxic materials or solvents, follow approved laboratory procedures to safely dispose of this hazardous waste.

Ensure that the drain bottle is adequately ventilated (by the lab ventilation system, the same as for the ICP-MS mainframe) to deal with vapors from the bottle.

Clean the drain vessel every time you empty it by thoroughly flushing it with water. If it has contained organic solvents, wash the drain vessel in acetone and allow it to dry.

Follow the procedures below to avoid exposure to the contents of the drain vessel:

- When using organic solvent, please use a suitably sized waste container of appropriately resistant material for the collection of organic solvent.
 - Use the capped plastic drain vessel provided with the instrument. Never use glass.
 - Place the drain vessel on the instrument table, where it is easy to check the liquid level.
 - Tightly connect the drainage tubing from the spray chamber around the peristaltic pump to the drain vessel. Do not crimp the tubing.
 - Check the drain vessel frequently. Empty it before you ignite the plasma.
 - Be aware of the nature of the vessel contents. If the contents are toxic, dispose of them as hazardous waste. Also, always empty the vessel when switching from aqueous to organic sample solutions.
 - Check the tubing and vessel for deterioration. If the tubing becomes brittle or cracked, replace it. Organic solvents generally cause more rapid deterioration than aqueous solutions.
-

Storing Argon Safely

WARNING

Argon, which is used to create the plasma, is a dangerous gas only if it displaces the air you are breathing or is mishandled in its storage cylinder. Take the following precautions to prevent an explosion or suffocation hazard:

- Secure the cylinder valve caps and move the cylinder with an approved handcart.
 - Label the gas cylinder clearly and store it vertically away from all ignition and heat sources. The Ar cylinder will release argon through the pressure-relief device if the temperature exceeds 52 °C (125 °F).
 - Protect a cylinder stored outside from the sun and extreme temperatures. Place the cylinder on a level surface above ground.
 - Attach the argon hoses tightly to both the instrument and gas source. Route the hoses so they cannot be damaged or crimped. Check for leaks using a soap solution or an electronic leak detector.
 - Provide adequate ventilation around the gas cylinders, especially if they are placed in a small storeroom.
-

Hydrogen (H₂) Gas

WARNING

The Agilent 7500ce/cs use hydrogen (H₂) gas in the standard configuration, while the Agilent 7500cx uses hydrogen (H₂) gas as an optional gas. While the Agilent 7500 models are designed for safe operation under normal usage, hydrogen gas has the following characteristics and extreme care must be taken to safely control its use.

- Hydrogen is flammable over a wide range of concentrations. At atmospheric pressure, hydrogen is combustible at concentrations from 4% to 75%.
 - Hydrogen has the highest burning velocity of any gas.
 - Hydrogen has a very low ignition energy.
 - Hydrogen temperature increases as the gas expands.
 - Hydrogen that is allowed to expand rapidly from high pressure can actually self-ignite.
 - Hydrogen burns with a nonluminous flame that is often invisible under bright light.
-

Dangers During ICP-MS Operation

WARNING

Hydrogen presents a limitless number of dangers during ICP-MS operation. These include, but are not limited to:

- Combustion from leaking hydrogen.
- Combustion due to rapid expansion of hydrogen from high pressure.
- Accumulation of hydrogen in the ICP-MS and subsequent combustion.

Hydrogen can accumulate in the ICP-MS in a number of unstipulated or uncommon ways. All users must be aware of the mechanisms by which hydrogen can accumulate. They must also know what precautions to take if they know or suspect that hydrogen accumulation has occurred.

ICP-MS Shutdown

WARNING

Use deliberate and careful judgment when shutting down the ICP-MS. The ICP-MS can also be shut down accidentally by an internal or external failure. Even though the ICP-MS is shut down, hydrogen remains in the vacuum system, so the flow of the gas is not immediately terminated. As a result, hydrogen may slowly accumulate in the vacuum pump line and possibly vent through the rotary pump oil mist filter to the exhaust duct of the ICP-MS. Make sure the exhaust duct is always operating.

Power Failure

WARNING

A power failure is one of the most common causes of hydrogen accumulation in the ICP-MS. The ICP-MS shuts down when there is a power failure. The flow of hydrogen gas in the vacuum system does not terminate immediately and may slowly accumulate in the ICP-MS and/or the exhaust duct. Make sure the exhaust duct is always operating.

Necessary Precautions During ICP-MS Operation

WARNING

The following are general precautions that should be taken during ICP-MS operation to prevent combustion of hydrogen gas. Other precautions may be necessary depending on the setting and configuration in which you use the system. Pay careful attention to safety management when using this system.

- Make sure the hydrogen gas line is without leaks.
 - Periodically check equipment for hydrogen leaks using the appropriate devices (leak detector, soapy solution, etc.).
 - Eliminate from your laboratory as many ignition sources as possible (open flames, devices that can spark, sources of static electricity, etc.)
 - Do not vent hydrogen from a high-pressure chamber directly into the atmosphere. There is a danger the gas will self-ignite.
 - Always turn off the hydrogen gas at its source whenever you turn off the ICP-MS.
 - Always turn off the hydrogen gas at its source before opening the vent valve or otherwise introducing ambient air into the ICP-MS. Hydrogen gas can concentrate and combust at atmospheric pressure.
 - Turn off the hydrogen gas at its source as soon as a power failure occurs. Do not resume operation of the ICP-MS before inspecting it for damage or irregularities.
 - The exhaust duct should always be operating. Hydrogen gas released while the exhaust duct is not operating can result in accumulation of the gas in the ICP-MS and/or the exhaust duct.
-

Other Gas

CAUTION

Gases must be handled with care.

- Refer to the MSDS (Material Safety Data Sheet) for safe handling information.
 - Check for gas leaks periodically using the appropriate tools (leak detector, soapy water, etc.)
-

Allowing the Hot Instrument to Cool

WARNING

The torch and interface remain hot after the plasma is turned off. Do not touch the torch box or interface cones for 10 minutes after turning off the plasma to allow for cooling.

Torch Box Cover

CAUTION

Attach the torch box cover after maintenance. This cover reduces the emission noise from the plasma.

Peristaltic Pump

CAUTION

Be aware that the clamp of the peristaltic pump opens and closes. You can get your finger stuck in between the stator and the rotator, or between the stator and the stopper.

Rotary Pump

WARNING

Rotary pump oil is flammable. Keep away from fire.

For accidental spillage of rotary pump oil on skin, mouth, eyes; wash immediately and thoroughly and seek expert medical attention.

Air Intake and Outlet

CAUTION

Do not cover the holes for air intake and outlet on the Agilent 7500.

Beryllium and Beryllium Oxide

Product and environmental safety - toxic materials

WARNING

There is a toxic hazard associated with parts containing beryllium. Precautions need to be observed in the handling, storage, transport and disposal of such parts.

Beryllium oxide is a white powder which may be molded into shape by a sintering process to form a ceramic similar in appearance to other electrical ceramics. In this finished form it has a hard, smooth surface which may either remain white or have been tinted during manufacturing.

Agilent ICP-MS instruments use the following parts, which are known to contain beryllium oxide:

Manufacturer	Manufacturer's P/N	Marking
MOTOROLA, INC.	MRF148	MRF148
MOTOROLA, INC.	MRF148A	MRF148A
MOTOROLA, INC.	MRF150	MRF150
STMICROELECTRONICS	SD2931-10	SD2931-10
STMICROELECTRONICS	SD2931-11	SD2931-11
STMICROELECTRONICS	SD2918	SD2918
ROYAL PHILIPS ELECTRONICS	BLF177	BLF177
COMPONENT GENERAL, INC.	CBR-150 25Ω	CGI 25 5%
COMPONENT GENERAL, INC.	CBR-150 100Ω	CGI 100 5%
FLORIDA RF LABS	31-1003 25Ω	25 FROLIDA RF

These are used in the following assemblies:

Agilent P/N	Description	Parts ID on PCB
G1833-66506	RF DRIVER	Q402 (MRF148/148A)
G1833-66530	OCTP DRIVER	Q402 (MRF148A/SD2918)
G1833-66550	QP RF AMP	Q101 (MRF148/148A/SD2918) Q102, Q103 (MRF150/(SD2931-10/11/BLF177))
G1833-66555	RF POWER	Q207, Q208, Q307, Q308 (SD2931-10/11/BLF177)
G1833-66557	COMBINER	R101 to R103 (CBR-150)
G1833-66620	COMBINER	R101 to R103 (CBR-150/31-1003)
G3270-66526	QUAD-TANK	Q3 (SD2918) Q1, Q2 (SD2911-10/11/BLF177)
G3270-60626	QUAD-TANK	Q3 (SD2918) Q1, Q2 (SD2911-10/11/BLF177)

All persons who handle, use, or dispose of these parts should be aware of their nature and of the necessary safety precautions. After use, dispose of as chemical or special waste according to local regulations. These parts must never be thrown out with the general or domestic waste.

Moving the Agilent 7500 ICP-MS

CAUTION

Stated below are precautions you should observe when you want to move your Agilent 7500.

- Make sure the Agilent 7500 Main Power Breaker (located on the rear side) is turned OFF before moving the Agilent 7500.
 - Make sure all the cables between other units are unplugged and the utility tubing are disconnected before moving equipment (small moves for adjustments etc. can be done without unplugging and disconnecting).
 - The Agilent 7500 is heavy (about 175 kg), so if there is a need to lift the Agilent 7500, it should be lifted by at least by 4 people or with a mechanical lifter.
 - At time of installation, and upon instrument movement, please check for leaks using appropriate device.
-

Environmental Conditions and Utility Requirements

Temperature and Humidity Ranges

The Agilent 7500 ICP-MS should be operated and stored under the temperature and humidity ranges described below:

Operation condition:

- Temperature: 15 °C - 30 °C (59 °F - 86 °F)
< 2 °C change in 1 hour
- Relative humidity: 20% - 80% (non- condensing)
- Altitude: Up to 2000 m
- Atmosphere: Non Condensing; Non Corrosive

For optimum instrument performance, the temperature variations should be less than 2 °C in 1 hour.

Storage condition:

- Ambient temperature: -20 - 60 °C
- Relative humidity: 15 - 85% (non- condensing)

Installation category based on IEC1010: II (See Note.)

Pollution level based on IEC1010: 2 (See Note.)

NOTE

The “Installation category” implies the regulation for impulse withstand voltage. It is also called the “Over voltage category”. “II” applies to electrical equipment.

“Pollution level” describes the degree to which a solid, liquid, or gas which deteriorates dielectric strength is adhering. “2” applies to a normal indoor atmosphere.

Electromagnetic Compatibility

EN55011/CISPR11

Group 1 ISM equipment: group 1 contains all ISM equipment in which there is intentionally generated and/or used conductively coupled radio-frequency energy which is necessary for the internal functioning of the equipment itself.

Class A equipment is equipment suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

This device complies with the requirements of CISPR11, Group 1, Class A as radiation professional equipment. Therefore, there may be potential difficulties in ensuring electromagnetic compatibility in other environments, due to conducted as well as radiated disturbances.

Operation is subject to the following two conditions:

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

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

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

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

ICES/NMB-001

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme à la norme NMB-001 du Canada.

Electrical Power (Voltage, Frequency, Amperage, Phase)

200- 240 VAC, 50/60 Hz, 30 A, single phase

Argon Gas Supply

Minimum Purity: 99.99%
Maximum Flow Rate: 20 L/min
Supply Pressure: 700 kPa

Reaction Gas Supply (Agilent 7500cs, 7500cx)

Gas: Helium, Hydrogen (optional for 7500cx)
Minimum Purity: 99.999%
Maximum Flow Rate: He 10 mL/min, H₂ 7 mL/min
Typical Pressure: 40 kPa

Cooling Water

Inlet Temperature: 15 - 40 °C
Inlet Pressure: 230 - 400 kPa
Minimum Flow Rate: 5.0 L/min

Exhaust Duct

Extraction Flow Rate: 4 - 6 m³/min Agilent 7500a/cx (without optional duct) 7 - 8 m³/min Agilent 7500ce/cs (with optional duct which is standard on 7500cs)

Symbols Used on the Instrument

The following symbols are used on the instrument.



: To avoid personal injury, death, or damage to the instrument, the operator must refer to an explanation in the Manual. This symbol is placed on the product where it is necessary for you to refer to the manual in order to understand a hazard.



: Protective grounding terminal.



: Alternating current.



: ON (power)



: OFF (power)



: This symbol is placed on the product in areas where hot parts and surfaces are present. Allow the product to cool down before performing work in this area.



: This symbol is placed on the product where there will be a risk of electric shock if the cover is removed.

Others

Part Numbers

In the *Agilent 7500 Series ICP-MS Customer Maintenance Parts List*, Agilent Technologies part numbers are generally listed in parentheses after the name of the part or in the tables. A few tools and supplies listed have no part number and are not available from Agilent Technologies. Most of these can be obtained from laboratory supply companies.

Serial Number

The Agilent 7500 ICP-MS is identified by a serial number on a label attached to the instrument.

When corresponding with Agilent Technologies about your Agilent 7500 ICP-MS, be sure to include the model number and the full 10-digit serial number.

2 Precautions



3 Startup, Shutdown and Status

- Starting the Instrument 3-2
- Shutting Down the Instrument 3-10
- Checking the Instrument Status 3-13
- Typical Meter Values for the Vacuum System 3-18

The Agilent 7500 Series ICP-MS is designed so that it is easy to startup and shutdown. The instrument has three states of operation that are displayed in the Agilent 7500 MassHunter Workstation (or ChemStation) instrument control software:

- Analysis
During tuning and sample analysis, the Agilent 7500 is in **Analysis** mode.
- Standby
At the end of the working day, place the Agilent 7500 in **Standby** mode.
In this mode both the turbo pumps and the backing rotary pumps remain on, but the quadrupole, detector, and RF (plasma) are switched off.
- Shutdown
To maintain or move the Agilent 7500, put it into **Shutdown** mode. In an emergency, you can flip the main power switch to stop the instrument.

This chapter explains how to startup and shutdown the Agilent 7500, as well as check instrument status.



Starting the Instrument

There are three states from which the Agilent 7500 can be started:

- Unplugged
- Shutdown mode
- Standby mode

This section explains how to start the instrument from all three states.

Starting the Instrument from Cold

Use the following procedure to startup the instrument after it has been unplugged for a move, maintenance, or a long-term shutdown.

1 Ensure that the instrument is plugged in.

Plug the instrument into a NEMA L15-30R power receptacle.

2 Ensure that the hoses and power cables of the rotary pumps, the Ar gas hose, the Ethernet or GPIB cable to the Agilent 7500, and the water hoses are all properly connected.

The hoses and the cables are connected on the rear side of the instrument. For more information, refer to the [Figure 2 \(Chapter 1\)](#).

3 Turn on the rotary pump power switches.

A manual power switch located on each of the rotary pumps must first be switched ON before attempting to turn on the pumps. Always check this switch before starting the instrument's vacuum. When the switches are in the on position, the pumps can then be turned on from MassHunter Workstation (or ChemStation). The pumps will remain off until the vacuum is turned on by the MassHunter Workstation (or ChemStation) software.

4 Turn on the main power breaker and the pump switch(es) on the Agilent 7500.

These three switches are located on the rear of the instrument. ([Figure 14](#))

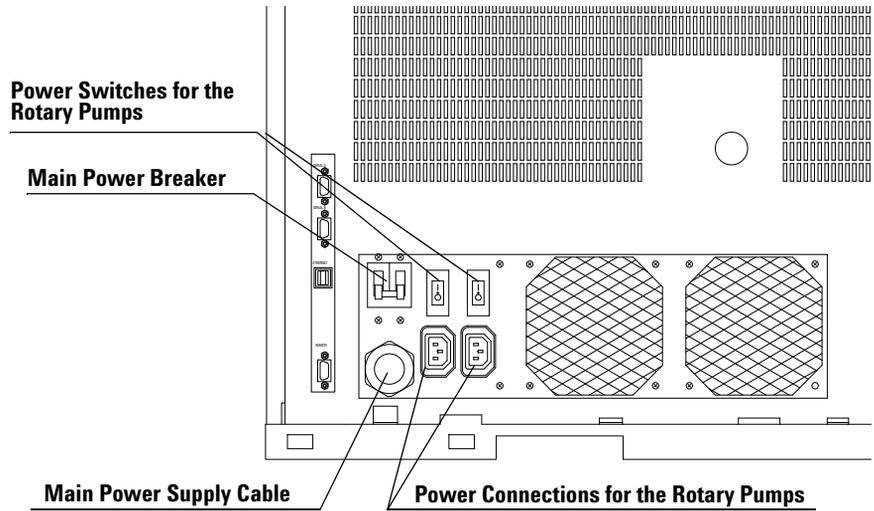


Figure 14 Rear View and Control Switches

5 Turn on the instrument power switch.

The power switch is located on the front panel. The instrument now has power and the green light on the power switch is lit.

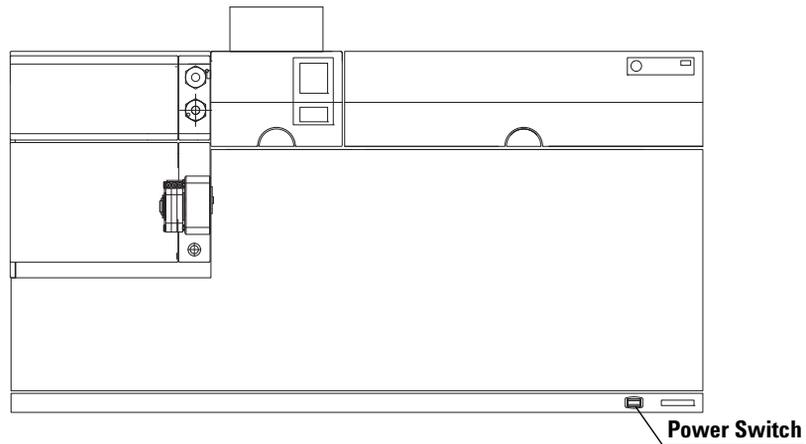


Figure 15 Front View of the Agilent 7500

3 Startup, Shutdown and Status

6 Startup the printer and computer.

Refer to the printer and computer user manuals for more information.

7 Start the MassHunter Workstation (or ChemStation) software.

Refer to Chapter 1, “Using the Agilent 7500 Series ICP- MS MassHunter Workstation Software” in the *Agilent 7500 Series ICP- MS MassHunter Workstation Operator’s Manual* (or “Using the Agilent 7500 Series ICP- MS ChemStation Software” in the *Agilent 7500 Series ICP- MS ChemStation Operator’s Manual*) for information on accessing and exiting the software. The **ICP- MS Top** window appears.

CAUTION

When the MassHunter Workstation (or ChemStation) software starts running immediately after turning on the main switch of the ICP-MS instrument, the mainboard of the instrument sometimes hangs up and becomes unavailable to control the instrument. If this happens, turn off and then on the mainframe, wait more than 40 seconds, and then turn on MassHunter Workstation (or ChemStation). MassHunter Workstation (or ChemStation) software should be started more than 40 seconds after turning on the main switch of the instrument.

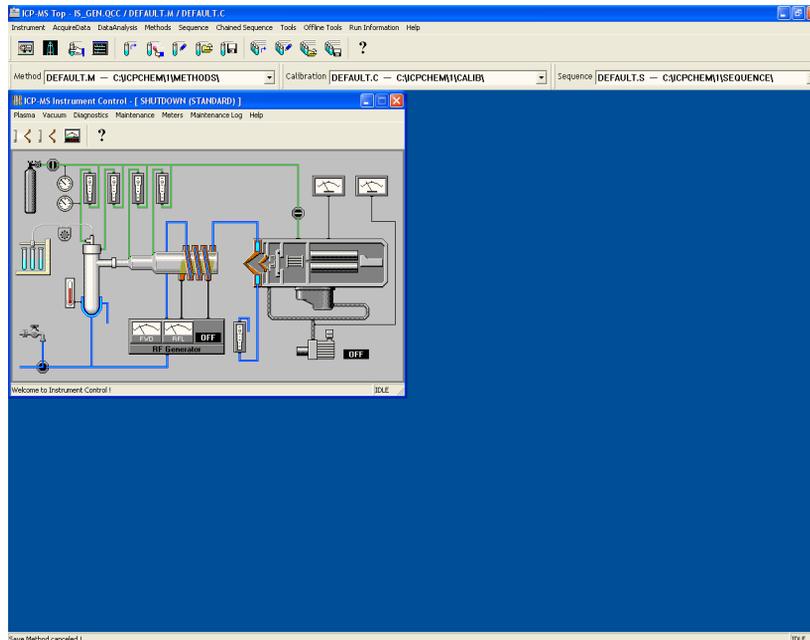


Figure 16 ICP-MS Top Window

8 Select *Instrument*>>*Instrument Control*.

The *Instrument Control* window (Figure 17) appears. The title bar shows that the instrument is in Shutdown mode. The LED located on the top right corner of the right top cover is off during Shutdown mode. Continue with “Starting from Shutdown Mode”.

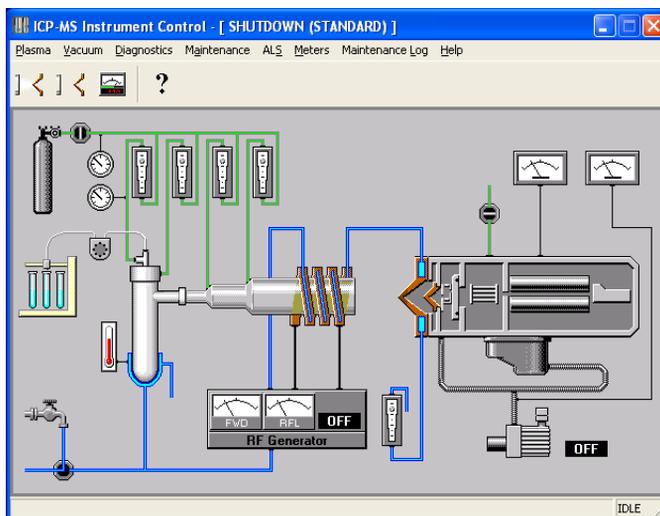


Figure 17 Instrument Control Window in Shutdown Mode
(Picture may differ depending on ICP-MS Model/Mode)

Starting from Shutdown Mode

The following instructions assume that the instrument is turned on and the *Instrument Control* window is displayed. See “Starting the Instrument from Cold” to perform the necessary tasks. Then, complete the following steps:

1 Select *Vacuum*>>*Vacuum On*.

A dialog box appears, asking if you want to turn the vacuum on.

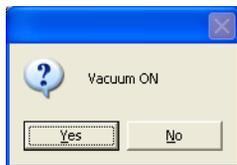


Figure 18

3 Startup, Shutdown and Status

2 Click Yes.

The instrument will turn on the rotary pump, open the backing line valve and turn on the turbo pump. The **Instrument Control** diagram displayed in MassHunter Workstation (or ChemStation) will indicate that the rotary pump is on. It can take from 15 minutes to 2 hours for the vacuum chamber to attain its correct pressure of 5×10^{-4} Pa. The instrument is now in **Standby** mode, as displayed in the title bar. The process takes longer when the vacuum chamber has been open to the atmosphere for any length of time.

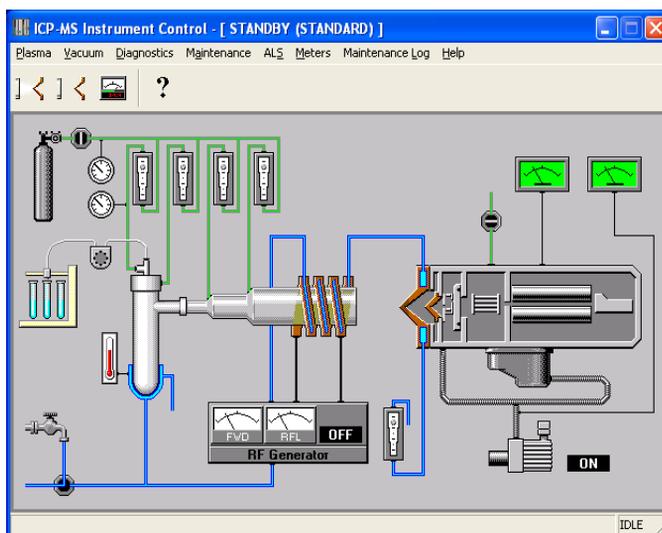


Figure 19 Instrument Control Window in Standby Mode
(Picture may differ depending on ICP-MS Model/Mode)

Starting from Standby Mode

The following instructions assume that the instrument is in *Standby* mode and the analyzer vacuum chamber is evacuated to a partial or high vacuum. See “[Starting from Shutdown Mode](#)” to evacuate the vacuum chamber.

The plasma is off when the Agilent 7500 is in *Standby* mode. At this point the Plasma can be switched on. Once the interface vacuum has reached 4.5×10^2 Pa and the plasma is on, the instrument will switch to *Analysis* mode and you can perform tuning and sample analysis. To start the instrument from *Standby* mode, complete the following steps:

1 Ensure that the instrument is in Standby mode.

The title bar shows that the instrument is in the *Shutdown* mode. Also the LED on the top cover displays an orange light. (A blinking orange LED indicates that the mode is changing).

2 Close the hoods.

Close both hoods tightly. The safety function is tripped if either hood is open. The plasma will not ignite and go to analysis mode if the covers are open.

3 Ensure that the vent air flow is acceptable.

The exhaust air flow should be $7\sim 8 \text{ m}^3/\text{min}$ for the 7500ce/cs (with option duct which is standard on 7500cs) or $4\sim 6 \text{ m}^3/\text{min}$ for the 7500a/cx (without optional duct). See [Chapter 2, “Precautions”](#) for information on “[Checking the Exhaust System](#)”.

4 Supply the instrument with cooling water and argon gas.

The cooling water chiller must be turned on.

The primary argon gas pressure should be:

$100 \pm 2.8 \text{ psi}$ ($700 \pm 20 \text{ kPa}$),

5 Ensure that the drain vessel is empty.

See [Chapter 2, “Precautions”](#), for information on emptying the drain vessel.

6 Ensure that the gas tubing is not pinched and that the torch box and sample introduction gas connections seal correctly.

Check the gas tubing and make adjustments if necessary. See [Chapter 4, “Maintenance”](#) for information on connecting the gas hoses.

7 Ensure that all peristaltic pump (peripump) tubes are in good condition and correctly clamped into the peristaltic pumps.

CAUTION

Be sure to clamp the peripump tubing from the drain in the peripump. The drainage for the spray chamber is provided by this peripump. If the spray chamber is not drained properly, it will fill with solution causing solution to flow to the torch which will cause the plasma to turn off.

8 Select *Plasma*>>*Plasma On*.

A dialog box appears asking if you want to turn the plasma on.



Figure 20

9 Click *Yes*.

The gases for the plasma torch are switched on and the gas lines are purged. The plasma ignites and the interface rotary pump starts to evacuate the interface vacuum chamber. When the change to Analysis mode is completed, the title bar indicates that the instrument has changed from Standby to Analysis mode.

NOTE

The Agilent 7500 returns to Standby mode when the plasma is off and remains there unless the instrument is shutdown for major maintenance or for relocation.

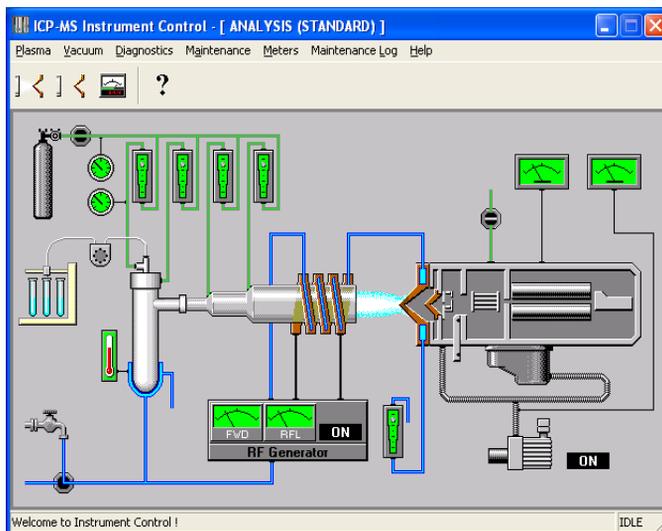
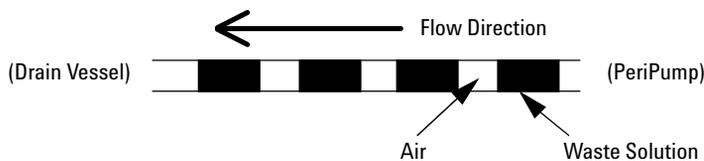


Figure 21 Instrument Control Screen in Analysis Mode
(Picture may differ depending on ICP-MS Model/Mode)

WARNING



Confirm that the drain is flowing. Check that the tube from the drain peristaltic pump to the drain bottle is properly connected. You should see a regular pattern of liquid and air as shown above.

Shutting Down the Instrument

The Agilent 7500 is in *Analysis* mode during tuning and sample analysis. When not being used for these procedures, the instrument remains in *Standby* mode. To maintain or move the instrument, it should be placed in *Shutdown* mode and turned off.

The following sections explain how to return the Agilent 7500 to *Standby* mode at the end of each day and how to put the instrument in *Shutdown* mode when necessary.

Putting the Instrument in Standby Mode

To return the instrument to *Standby* mode after running samples, complete the following steps:

- 1 Select *Instrument*>>*Instrument Control* from the *Top* task.

The *Instrument Control* window appears.

- 2 Select *Plasma*>>*Plasma Off*

The dialog box appears.

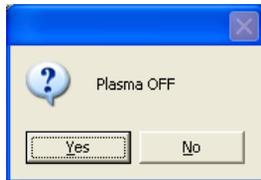


Figure 22

- 3 Click *Yes*.

The *Instrument Diagram* shows that the plasma is off.

The Agilent 7500 automatically turns off all gases, the torch RF generator, the peripump, and the cooling water flow after cooling the torch and interfaces. Only the vacuum pumps remain on.

CAUTION

Ensure that positive extraction remains operative while the instrument is in Standby mode. The rotary pump exhaust continues to pass into the exhaust duct when the instrument is in Standby mode.

NOTE

Turning off the computer and printer while the instrument is in the Standby mode will not cause any problems.

Putting the Instrument in Shutdown Mode

CAUTION

Except in emergency situations, you should put the Agilent 7500 into the **Shutdown** mode before turning off the main power.

To return the instrument to Shutdown mode, complete the following steps:

1 Put the Instrument into Standby Mode

Follow the instructions for [“Putting the Instrument in Standby Mode”](#)

2 Supply argon gas by opening the argon gas valve.

When the instrument is changing to **Shutdown** mode, argon gas is introduced into the vacuum chamber. For this reason, the argon gas supply needs to be opened until the instrument has switched to **Shutdown** mode.

3 Select *Vacuum*>>*Vacuum Off*

The dialog box appears.

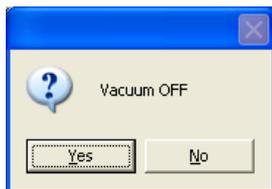


Figure 23

4 Click *Yes*.

The instrument starts to go to **Shutdown** mode. After a short time, argon gas is introduced into the vacuum chamber. This is done to prevent pump oil from going up into the vacuum chamber. The turbo and rotary pumps are turned off. Only the main power to the instrument remains on. The title bar of the instrument control task shows that the instrument changes to **Shutdown** mode.

NOTE

Do not turn off the main power until the mode has changed to Shutdown. It takes about 5-10 minutes to change from Standby to Shutdown.

NOTE

If argon gas is not supplied, air will be introduced into the vacuum chamber instead of argon. In this case, it may take more time to go back to Standby mode.

Turning the Instrument Completely Off

Turn the Agilent 7500 completely off when you want to perform maintenance on electrical components or move the instrument. To achieve a total shutdown, complete the following steps:

1 Put the Instrument into Shutdown Mode

Follow the instructions in [“Putting the Instrument in Shutdown Mode”](#)

2 Exit the software and turn off the computer and printer

Refer to the *Agilent 7500 MassHunter Workstation Operator's Manual (or ChemStation Operator's Manual)*, and the printer and computer user's manuals for more information.

3 Turn off the power switch

The switch is located on the front ([Figure 15](#)). The power indicator light is now off.

4 If needed, unplug the instrument

Checking the Instrument Status

The Agilent 7500 MassHunter Workstation (or ChemStation) software provides two methods for checking the instrument status:

- Instrument Control Diagram
- Meter Control Panel

This section explains how to use these monitoring screens.

Checking the Instrument Control Diagram

The *Instrument Control* window is a real-time display that enables you to quickly assess the current status of the instrument. It is a simplified representation of Agilent 7500 components. The window includes gauges, meters and on/off indicators, each of which corresponds to an instrument component. You can use this window when the instrument is in *Shutdown*, *Standby*, or *Analysis* mode.

To access and interpret the *Instrument Control* window, complete the following steps:

1 Select *Instrument*>>*Instrument Control* from the Top menu.

The *Instrument Control* window (Figure 21) appears. The title bar shows what mode the instrument is in.

2 Starting from the upper left corner of the window, place the cursor on the circular gauge. Press the left mouse button when the cursor changes to a small meter box.

The *Argon Tank Gas Pressure* meter box appears (Figure 24), showing the value in kilopascals (kPa). The value depends on the type of nebulizer used.

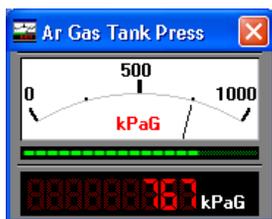


Figure 24 Argon Gas Tank Pressure Meter Box

3 Moving the cursor clockwise, place it on the next gauge and press the left mouse button when the cursor changes to the small meter box.

The *Carrier Gas Flow* meter box appears. An acceptable range of values for this meter is application specific.

- 4 Repeat Step 3 until you have checked all 14 system components on the *Instrument Control* screen.**

Checking the Meter Control Panel

MassHunter Workstation (or ChemStation) also provides a *Meter Control Panel* for checking the instrument's status. Selected parameters appear on the screen in the meter boxes that provide real-time operating values for the Agilent 7500 components. The *Meter Control Panel* enables you to monitor more components than you can access from the *Instrument Control* window. Also the meters remain on the screen until you choose to remove them or close the *Instrument Control* window.

NOTE

Up to five meter boxes can be displayed at one time. If you select a sixth meter to monitor, you must deselect one that is already displayed.

To monitor the Agilent 7500 internal and external environments, complete the following steps:

- 1 Select *Instrument>>Instrument Control*.**

The *Instrument Control* screen appears ([Figure 21](#)).

2 Select *Meters*>>*Meter Control Panel*.

The *Meters* panel appears (Figure 25).

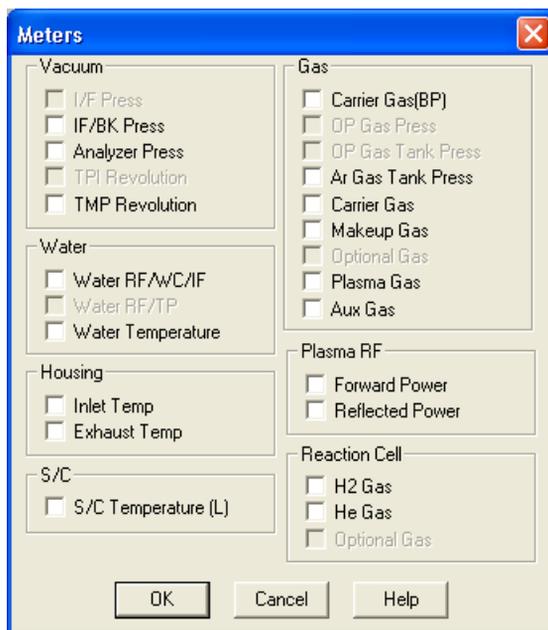


Figure 25 Meters Panel (Picture may differ depending on ICP-MS Model/Mode)

3 Select up to five components to monitor by clicking the appropriate check boxes and then clicking *OK*.

Meter boxes for the selected components appear on the right side of the screen. Check the following table to ensure that values displayed are within acceptable limits.

NOTE

A delay in displaying the value on the meter in the can occur due to processing time required by PC.

NOTE

Meter boxes are displayed until you close them individually or close the Instrument Control window. Meter boxes that are open when the Instrument Control window is closed will redisplay when this window is reopened.

3 Startup, Shutdown and Status

- 4 To monitor other components, deselect the current ones by clicking the appropriate boxes. Then click the boxes next to the additional components you want to monitor.**

Meter boxes for the newly selected components appear on the right side of the screen.

- 5 Repeat Step 4 until all necessary components have been checked.**

Table 3 Meter Control Panel Values

Meter	Typical Ranges			Units
	Shutdown Mode	Standby Mode	Analysis Mode	
IF/BK Press	–	0.3 ~ 5	250 ~ 490 (1 RP) ^{*1} 180 ~ 300 (2 RPs)	Pa
Analyser Press	–	$3 \times 10^{-5} \sim 6 \times 10^{-4}$	$3 \times 10^{-4} \sim 2 \times 10^{-3}$ ^{*2}	Pa
TMP Revolution	–	65 ~ 100	95 ~ 100	%
Water RF/WC/IF	0.0	0.0	1.3 ~ 5.0	L/min
Water Temperature	15 ~ 25	15 ~ 25	15 ~ 45	°C
Inlet Temp	Room Temp.	Room Temp.	25 ~ 35	°C
Exhaust Temp	Room Temp.	Room Temp.	45 ~ 55	°C
S/C Temperature (L)	Room Temp.	Room Temp.	2	°C
Carrier Gas (BP) ^{*3}	0	0	450 ~ 600 (BN) ^{*4} 200 ~ 300 (CN) 200 ~ 500 (MFN) 200 ~ 300 (MMF)	kPa
OP Gas Press	0	0	^{*5}	kPa
OP Gas Tank Press	0	0	^{*5}	kPa
Ar Gas Tank Press	700	700	700	kPa
Carrier Gas	0	0	0.8 ~ 1.3	L/min
Makeup Gas	0	0	0 ~ 1.0	L/min
Optional Gas	0	0	^{*5}	%
Plasma Gas	0	0	15	L/min
Aux Gas	0	0	0 ~ 1.0	L/min
Forward Power	0	0	700 ~ 1600 ^{*6}	W
Reflected Power	0	0	< 20	W

Table 3 Meter Control Panel Values (continued)

Meter	Typical Ranges			Units
	Shutdown Mode	Standby Mode	Analysis Mode	
H ₂ Gas ^{*7}	0	0	3 ~ 5	mL/min
He Gas ^{*7}	0	0	3 ~ 5	mL/min

*1 RP: Rotary Pump

*2 Depending on the type and flow rate of the reaction gas used, pressure may rise out of the typical range when operating in the standard mode, He mode, or H₂ mode (standard for 7500cs/ce and optional for 7500cx).

*3 BP: Backing Pressure

*4 BN: Babington Nebulizer, CN: Concentric Nebulizer, MFN: MicroFlow Nebulizer, MMN: MicroMist Nebulizer

*5 Depends on application

*6 RF

*7 When using reaction cell

Typical Meter Values for the Vacuum System

Refer to the following meter values when the error occurs.

1 After the vacuum is ON

Table 4

Parameters	Limit	Conditions
Backing pressure (IF/BK)	> 100 Pa	if BK is higher, even 60 seconds after the vacuum is ON.
Backing pressure (IF/BK)	> 25 Pa	if BK is higher, even 70 minutes after the vacuum is ON.
Analyzer pressure (AN)	> 5×10^{-4} Pa	if AN is higher, even 5 hours after the vacuum is ON.

The Agilent 7500 goes back to Shutdown mode.

2 After the plasma is OFF

Table 5

Parameters	Limit	Conditions
Interface pressure (IF/BK)	> 450 Pa	if IF is higher, even 2 minutes after the IF pump is ON.
Analyzer pressure (AN)	> 1.2×10^{-3} Pa	if AN is higher, even 3 minutes after the gate valve is opened.

The Agilent 7500 goes back to Shutdown mode.

3 After the plasma is OFF

Table 6

Parameters	Limit	Conditions
Analyzer pressure (AN)	> 5×10^{-4} Pa	if AN is higher, even 15 seconds after the gate valve is closed.

The Agilent 7500 goes back to Shutdown mode.

4 In Standby mode

Table 7

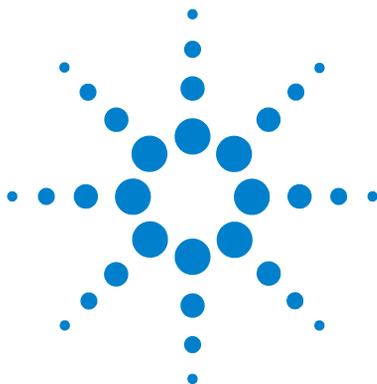
Parameters	Limit	Conditions
Analyzer pressure (AN)	$> 2 \times 10^{-3}$ Pa	Agilent 7500 goes back to Shutdown mode.
Backing pressure (IF/BK)	> 60 Pa	Agilent 7500 goes back to Shutdown mode.

5 In Analysis mode (std) (7500cs/cx)

Table 8

Parameters	Limit	Conditions
Interface pressure (IF/BK)	> 530 Pa	Agilent 7500 goes back to Standby mode.
Analyzer pressure (AN)	$> 2 \times 10^{-3}$ Pa	Agilent 7500 goes back to Standby mode.
Backing pressure (IF/BK)	> 60 Pa	Agilent 7500 goes back to Shutdown mode.

3 Startup, Shutdown and Status



4 Maintenance

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Maintenance

This chapter contains operator maintenance procedures for the Agilent 7500. A summary table of tasks is given, followed by the procedures by component. To repair any Agilent 7500 component not listed, call your Agilent Technologies service representative. For maintenance of the computer workstation or a peripheral, refer to the hardware manuals for that equipment.

Each maintenance procedure is prefaced by a list of necessary tools and supplies. Agilent Technologies provides a tool kit at installation. An additional kit of consumable supplies can be purchased from Agilent Technologies.

Scheduling Maintenance

Table 9 Maintenance Schedule

Frequency	Component	Task/Action	Remarks
Daily (As a matter of routine, check daily before starting work and over the course of daily analysis)	Argon gas	Check argon gas pressure and volume	
	Drain vessel	Check, empty if required	Refer to note in Chapter 2, "Precautions"
	Peristaltic pump tubing	Check for damage/deterioration	
Weekly	Sampling cone, Skimmer cone	Check orifice for foreign matter, deformation and enlargement	Clean if required
Monthly	Rotary pump	Check oil level and color. Check mist filter for presence of oil	
	Nebulizer	Run Nebulizer test, take appropriate action as indicated	For the Nebulizer Test refer to the MassHunter Workstation Operator's Manual (or ChemStation Operator's Manual), Chapter 3
	RF return strips and shield bar	Clean	
	Cooling water	Check water level and condition	
3 ~ 6 Months	Extraction Lenses*	Clean	7500a
	Extraction/Omega Lenses*	Clean	7500cs, 7500cx
6 Months	Einzel/Omega Lenses*	Clean	7500a
	Entrance Lens, Exit Lens, Plate Bias / Cell Entrance, QP Focus*	Clean	7500cs, 7500cx
	Rotary pump	Change oil	
Annually	Rotary pump oil mist filter	Check / replace mist filter	
	Penning gauge	Clean	Replace or clean
	Water strainer	Check and clean	
	Octopole*	Clean	7500cs, 7500cx

4 Maintenance

Table 9 Maintenance Schedule (continued)

Frequency	Component	Task/Action	Remarks
Periodically (Maintenance frequency of these components is highly dependent on lab conditions and sample throughput. They should be checked periodically, at least on an annual basis, and appropriate action taken)	Sample Introduction area parts: such as Spray chamber, End cap	Clean	
	Torch	Clean	Replace when necessary
	Electron Multiplier	Evaluate	Replace when necessary
	Plasma gas, auxiliary gas tubing	Check	Replace when necessary
	Argon gas filter	Replace (2 years after installation)	

- * The frequency of maintenance indicated for these parts is a general guideline only. Actual cleaning regimen may be infrequent, dependant on local lab/workload variables.

Refer to the *Agilent 7500 Series Maintenance DVD* for instructional videos on how to perform all maintenance tasks. It is easier to schedule maintenance if you keep a log of the instrument readings for each analysis. Generating a tuning report daily is also strongly recommended. The "Maintenance LogBook" feature explained later in this chapter has a similar function.

Checking Lab Conditions

You must maintain the environmental conditions required by the Agilent 7500 which were established during installation, because they can affect both safety and instrument performance. For additional information, refer to the Chapter 2 and the *Agilent 7500 Series ICP-MS Site Preparation Guide*.

Maintenance Clocks

Use the MassHunter Workstation (or ChemStation) software to help determine your maintenance schedule.

The **Running time** dialog box can display messages to notify you of the maintenance schedule such as changing the rotary pump oil, cleaning the ion lenses, etc. MassHunter Workstation (or ChemStation) generates messages based on the total time of plasma ignition, vacuum operation and the lapse of time.

Check the following items:

- Cumulative time for power ON
- Cumulative time for vacuum ON
- Cumulative time for plasma ON
- Cumulative ion count for the electron multiplier (EM)
- Cumulative operation time for rotary pump
- Cumulative operation time for turbo pump
- A lapse of time after maintenance and resetting the operation time

Viewing the Maintenance Clocks

To check the maintenance counter and clocks, complete the following steps:

- 1 Select **Instrument>>Instrument Control** from the ICP- MS Top window. The **Instrument Control** window appears.
- 2 Select **Diagnostics>>Running Time**.

The **Running Time** dialog box appears. See on- line help for additional information on each value displayed.

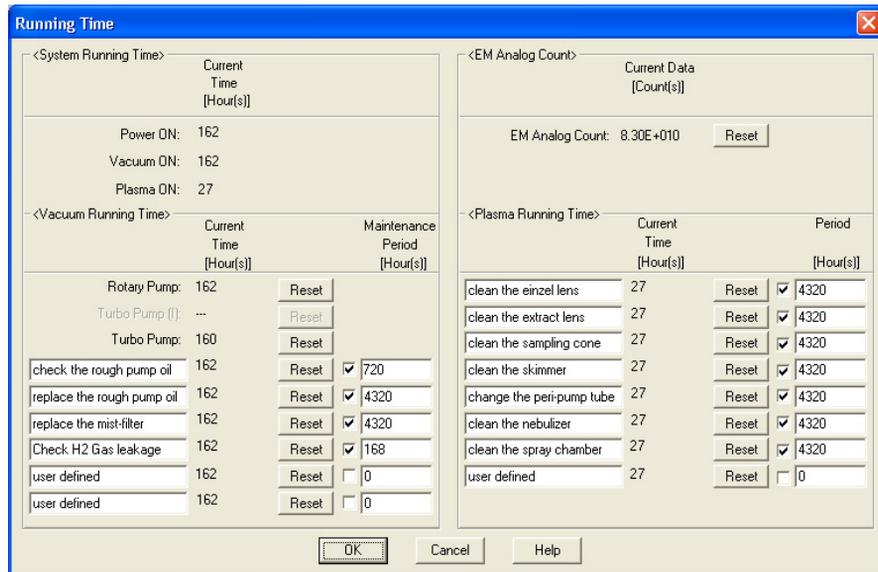


Figure 26 Running Time Dialog Box (Picture may differ depending on ICP-MS Model/Mode)

3 Check the Current Time (or EM Total Current).

The lapse of time displayed in the **Vacuum Running Time** area means the cumulative time of vacuum operation (Standby mode and Analysis mode). The lapse of time in the **Plasma Running Time** area means the cumulative time of plasma ignition (Analysis mode). Both areas show the lapse time from the last click of the **Reset** button until the present time.

For the Current Time (or EM Total Current) of the items which the maintenance period can be set, the color of the numbers will be changed depending on the lapse time as follows:

- **Green:** 0 to 90% of maintenance period has passed
- **Yellow:** 91 to 100% of maintenance period has passed
- **Red:** It is time for maintenance.

If it passes beyond 100% of the maintenance period, the following message will be displayed when you run the **Instrument Control Window**.



Figure 27 The Example of the Message

Changing the Item Name

It is possible to change the item name in a textbox.

The following is the procedure to change the item names.

1 Place the mouse pointer on a text box and click it.

A blinking cursor is displayed on the clicked textbox.

2 Change the item name.

NOTE

All the text box typed items, such as the 5 items in the **Vacuum Running Time** area and the 8 items in the **Plasma Running time** area can be changed.

Setting the Maintenance Period

If the maintenance items and maintenance periods are set beforehand, it is possible to display the message telling the maintenance time based on the total time of igniting the plasma, operating the vacuum, and the lapse of time.

To set the maintenance period, complete the following steps:

- 1 Input the period of time in the *Maintenance Period* textbox.**
- 2 Click the checkbox to the left to display a check in it.**

Resetting the Maintenance Clocks

To accurately monitor instrument usage, reset the maintenance clocks or counters using the MassHunter Workstation (or ChemStation) software. Reset the clocks whenever operators finish any of the following maintenance tasks:

- Cleaning/Replacing ion lenses
- Changing rotary pump oil
- Replacing a rotary pump
- Replacing a turbo pump
- Replacing the electron multiplier

To reset the maintenance monitors, complete the following steps:

- 1 Select *Instrument>>Instrument Control*.**

The **Instrument Control** diagram appears.

- 2 Select *Diagnostics>>Running Time*.**

The **Running Time** dialog box appears (Figure 26).

- 3 Click *Reset*.**

- 4 Click *Yes*.**

The time is reset to zero.

NOTE

Once you reset the time, it is not possible to restore it to the previous time. It's important to check the item that you want to reset carefully before clicking.

Maintenance Log

It is possible to record the tuning parameters, the tuning report, and all the parameters regarding the instrument condition in the maintenance logbook. You can also add maintenance records and comments in the logbook. The logbook is saved in the below directory.

MassHunter Workstation: \ICPMH\1\maintain

ChemStation: \ICPCHEM\1\maintain

Maintenance LogBook

To use the maintenance logbook, select **Maintenance Log>>LogBook** from the **Instrument Control Window** (or the **Tuning Window**). The **Maintenance LogBook** window appears.



Figure 28 Maintenance LogBook window

In this window, the list of time and dates when the logs were recorded will be displayed with folder names. The list of recorded maintenance in the logbook can be printed by clicking **Print List**. It is also possible to display a maximum of 6 items for tuning parameters, measured values, and meter values.

To change the displayed items, complete the following steps:

- 1 Click the item area above the *Maintenance LogBook* window.

The **Change List Item** dialog box appears.

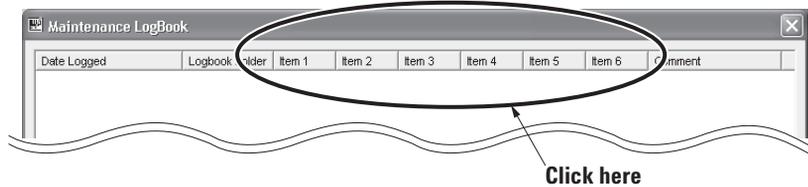


Figure 29 The displayed item area of the *Maintenance LogBook* window

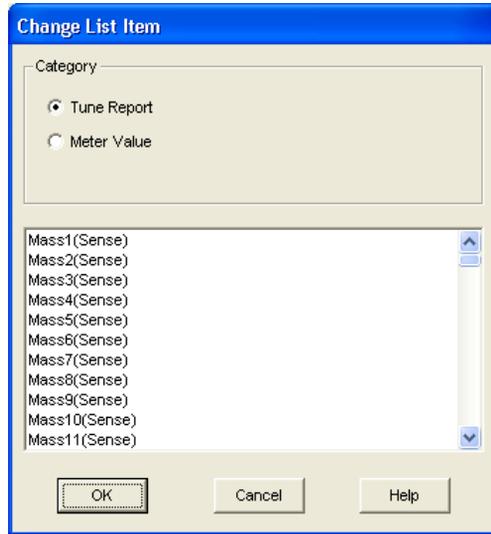


Figure 30 *Change List Item* Dialog Box.

- 2 Select the *Tune report* or *Meter Value* in the *Category* area and choose the item in the column below. Click *OK*, then the selected item appears in the *Maintenance LogBook* window.

Recording the Maintenance Log

When the maintenance logs are recorded, current meter values and the last tuning report are recorded.

To record the maintenance logs, complete the following steps:

1 Click *Record Log* in the *Maintenance LogBook* window.

The **Logbook Editor** dialog box appears.

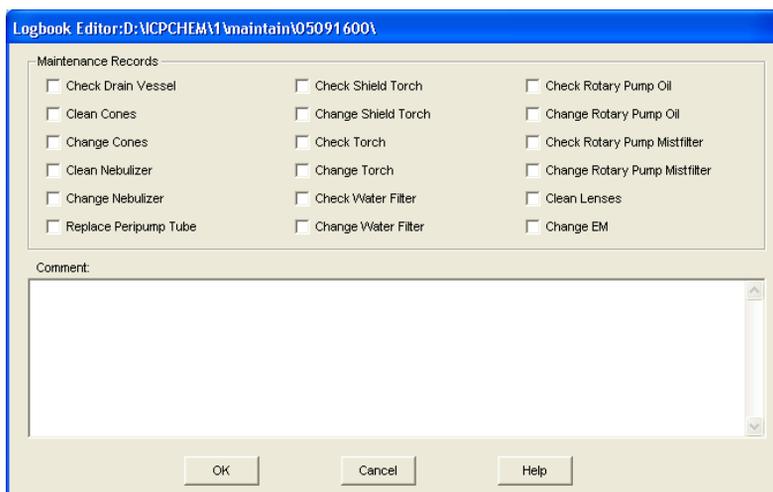


Figure 31 *Logbook Editor* dialog box

2 In the *Logbook Editor*, if there are maintenance items to be done at this time, click the check boxes. You can also type comments to record in the logbook.

3 Click *OK* to record the maintenance log.

The Maintenance LogBook is created. The tuning parameters and tuning result values when the tuning report was printed are saved. Meter values are saved by clicking **OK**.

NOTE

The maximum number of logs is 256 per day.

The Maintenance Log Display

Use the **Logbook Viewer** dialog box to examine each recorded maintenance log. To display the maintenance logs, complete the following steps:

- 1 Choose and click the log item to be displayed in the *Date Logged* of the *Maintenance LogBook* window, and click *View Log* (Figure 28).

The **Logbook Viewer** dialog box appears.

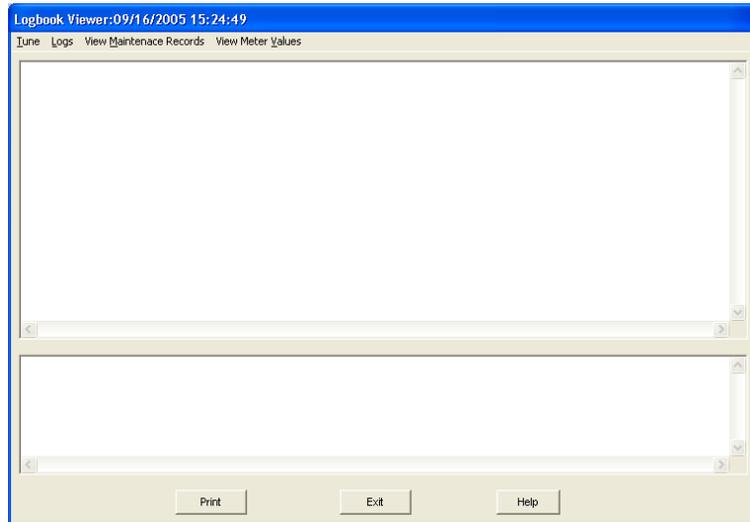


Figure 32 Logbook Viewer Dialog Box

NOTE

You can also display the **Logbook Viewer** by double clicking the date.

2 Check the contents of the logbook.

The following content appears when selecting each menu.

- **Tune**
Tuning parameters and tuning results are displayed.
- **Logs>>View ACQ Log**
Data acquisition log is displayed.
- **Logs>>View Sequence Log**
Sequence log is displayed.
- **Logs>>View Chained Seq Log**
Chained sequence log is displayed.
- **Logs>>View Error Log**
Error log is displayed.
- **View Maintenance Records**
Maintenance items selected in the check box of Logbook Editor dialogue box appears.
- **View Meter Values**
The meter reading values will be displayed.
Click **Print** to print the displayed contents.

Deleting the Maintenance Log

To delete unnecessary maintenance logs, complete the following steps.

- 1 **Click and select the log item to delete in the *Date Logged* of *Maintenance LogBook* window and then click *Delete Log*.**

The dialog box to confirm appears.



Figure 33

- 2 **Click *Yes*.**

Fuse

The fuse is not replaceable by the user because it is inside of the enclosure. If you believe the fuse is blown, please contact your local Agilent Technologies office.

Cleaning the Frame

When the surface of the Agilent 7500 Mainframe becomes dirty, wipe it with a dry cloth.

Sample Introduction

- Replacing the peristaltic pump tubing.
- Cleaning and exchanging of the nebulizer, spray chamber, and end cap.

It is important to always keep the sample introduction parts clean. Check the following points before maintenance.

If there is a memory of a previously analyzed sample (a previous sample still remains without being replaced), it is recommended to introduce a 5% contamination-free Nitric Acid solution in Analysis mode to clean the sample introduction parts. Set peristaltic pump speed at 0.3 to 0.5 rps.

After cleaning, check the memory in the tuning window. If there is no memory, perform maintenance on the sample introduction parts, which is explained in the following section.

CAUTION

Handle fragile glass parts carefully.

NOTE

Pure water used for cleaning is indicated as water that has been generated using the ion-exchange method and a membrane filter, and has an electrical resistance of at least 18 M Ω .

Peristaltic Pump Tubing

When the peristaltic pump (peripump) no longer pumps the sample with an even flow, wash or replace the pump tubing or readjust the pump clamps.

Change the peristaltic pump tubing in the following cases.

- When the tubing becomes too loose to uptake a solution.
- When the inside of the tubing is damaged and dregs are released.
- When it is impossible to remove sample memory.

This is especially important if you keep using old tubing. The inside tends to come off and cause the nebulizer to become clogged. It is recommended to replace the peristaltic pump tubing frequently.

There are three kinds of peristaltic pump tubing: (the colors of the tube stoppers are indicated in parentheses)

- Sample tube: Tygon (white- black, 1.02mm i.d.)
- Internal standard tube: Tygon (orange- red, 0.19mm i.d.)
 - * Set the maximum number of pump revolutions for the internal standard tube at 0.3 rps.
- Drain the tube: PharMed (yellow- blue, 1.52mm i.d.)

CAUTION

Some chemicals attack the peristaltic pump tubing. This might cause leakage in the sample introduction and drain line, and cause corrosion of the sample introduction system.

Cleaning the Peristaltic Pump Tubing

The peristaltic pump tubing has to be washed prior to use. The common way is to soak it in a 5% Nitric Acid (v/v) solution for two or three days. If HCl is used, Sn is eluted from the Tygon tube. In this block, 3% HCl (v/v) should be pumped at 0.1 rps for an hour or less through the new peristaltic pump tube.

NOTE

An alternative way of washing is to pump a 5% Nitric Acid solution through the tubing at 0.1 rps after installation. In this block, do not use the peristaltic pump until no stains are found inside the tubing.

Replacing the Peristaltic Pump Tubing

To replace the peristaltic pump tubing, complete the following steps:

WARNING

When replacing the peristaltic pump tubing, stop the pump rotation before disassembling.

Before changing the peristaltic pump tubing, replace the solution in the tubing to water.

1 Place the instrument in Standby mode.

See [Chapter 3, “Startup, Shutdown and Status”](#) to turn off the plasma, which puts the instrument in Standby mode.

2 Remove the tubing from the peristaltic pump.

Open the clamps and lift the tubing from the pump heads. Refer to [Figure 34](#). Examine the tubing for wear and replace any tube that is compressed or damaged.

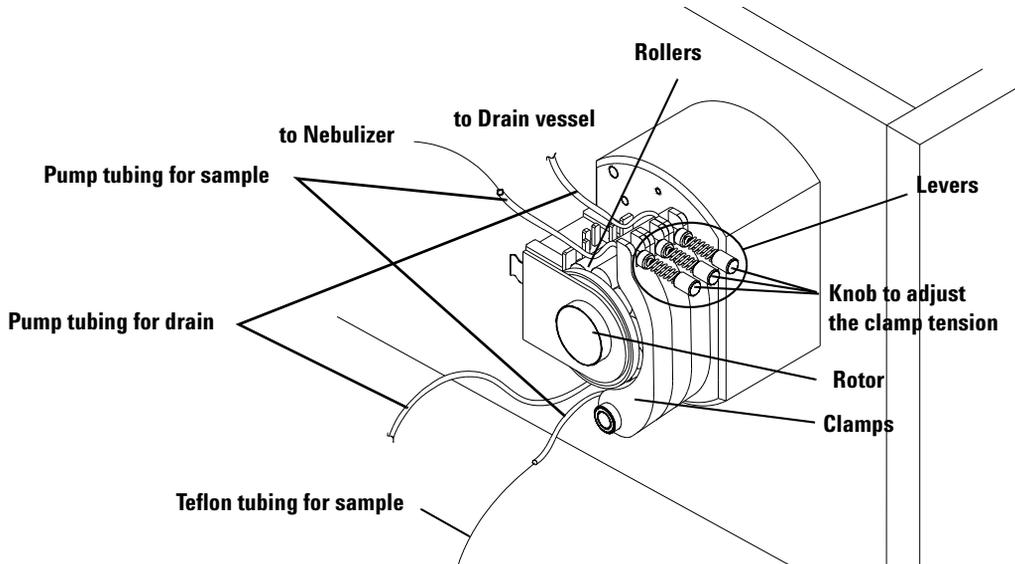


Figure 34 Peristaltic Pump

3 Installing tubes on the peristaltic pump.

- 1 Connect a sample tube from both ends of the pump tube.
- 2 Referring to [Figure 34](#), install the combined tube in the peristaltic pump. Based on the direction of the peristaltic pump rotation, hang one stopper on the pump. Stretch the tube to bring it into close contact with the roller and hang the other stopper on the pump.
- 3 Clamp the tubes in place.

NOTE

The order of the pump tubing is “sample tube,” “internal standard tube,” and “drain tube” from the outside (from left to right).
The peristaltic pump rotates in the direction of the arrow sticker.

4 Adjusting clamp tension.

From the **Instrument Control** window, select **Maintenance>>Sample Introduction**. ([Figure 35](#)). Allow the peristaltic pump (Nebulizer Pump in the PeriPump area in [Figure 35](#)) to draw up pure water by setting the speed to about 0.1 rps. Gradually loosen the knob applying pressure to the peristaltic pump clamp until the peristaltic pump stops drawing up water. Gradually tighten the knob until the peristaltic pump begins to draw up water again. Continue to tighten the knob of the sample uptake clamp an additional 1 - 2 turns, and tighten the knob of the drain tube clamp 2 - 3 turns.

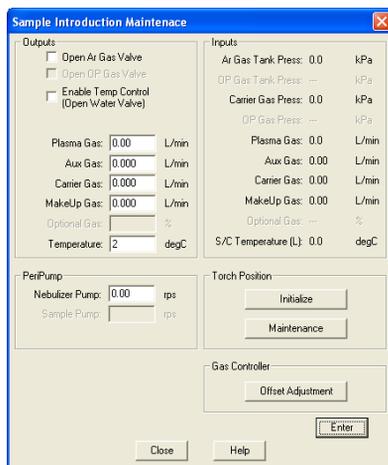
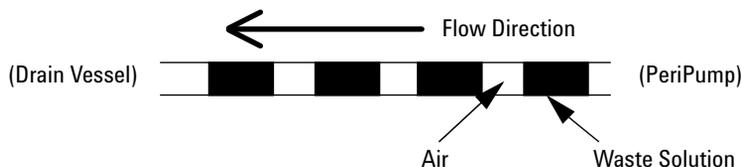


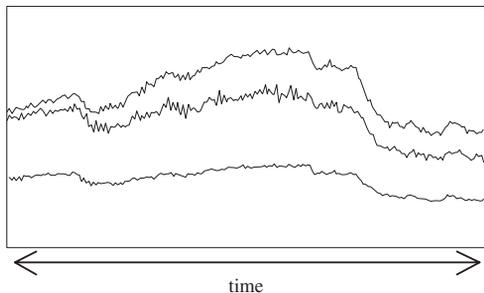
Figure 35 Sample Introduction Maintenance dialog box

WARNING

Confirm that the drain is flowing. Check that the tube from the drain peristaltic pump to the drain bottle is properly connected. You should see a regular pattern of liquid and air as shown above.

Sample Line Connector Block

The action of the peristaltic pump rollers on the pump tubing can generate static electricity in dry atmospheric conditions. This can cause signal instability/fluctuations under certain conditions depending on the type of nebulizer used.



When this phenomenon occurs, the tuning window will show signal fluctuations like those shown in the above figure. Sensitivity may also be lower than normal. To confirm the drift is due to charging, allow the nebulizer to free aspirate (assuming this is possible with the type of nebulizer used), which will eliminate any charging since the peristaltic pump is not used. If charging is confirmed, use the Agilent 7500 Sample Line Connector Block Kit to ground the sample line. This is a neat and effective way to eliminate signal instability due to electrostatic charging.

NOTE

The connector block may be left in place when the block is bypassed. For on-line addition of the internal standard solution, see the [“Internal Standard Tubing Kit”](#) Section.

To attach this connector, complete the following steps:

1 The connector block is shown in the following figure.

The connector block (black) is made of an electrically conductive polymer, which grounds the sample solution to the chassis via a fine Pt wire. The Pt wire just protrudes through the end of the connector, making contact with the sample.

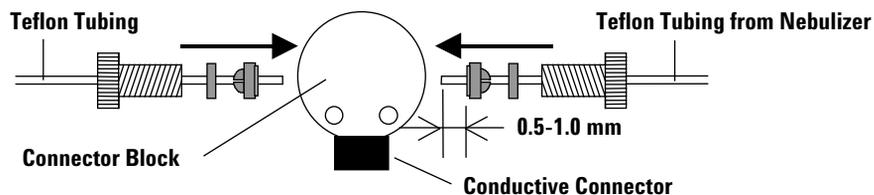


Figure 36 Sample Line Connector Block

2 Cut the edge of the Teflon tubing at a 90-degree angle in order to avoid leaking or clogging.

3 Slide the Teflon nut, back ferrule and front ferrule onto the Teflon tubing and allow the tubing to protrude 0.5 to 1.0 mm beyond the front ferrule.

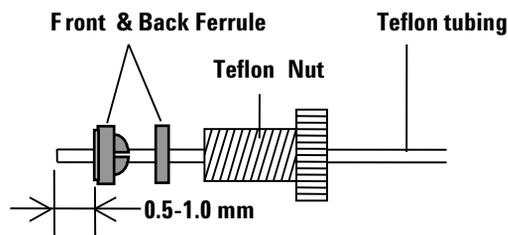


Figure 37 Teflon Nut, Front and Back Ferrule

4 Insert the end of the Teflon tubing into the connector block as far as possible. Next, slide the Teflon nut and tighten the Teflon nut into the connector block.

To reduce the dead volume, keep the Teflon tubing pushed in as far as possible until the connection is finished.

Fixing the tube tightly into the connector makes the dead volume a minimum. Consequently, the tube tip and the fit tip will be coherent.

- 5 Complete steps 2- 4 for both the tube from the nebulizer and the supplied sample tube.

NOTE

Connect the peristaltic pump tube to the opposite end of the supplied sample tube.

- 6 Clip the block into the ground clamp. The conductive connector fits in the ground clamp, making an electrical contact between the sample and the chassis. Check for leaks.

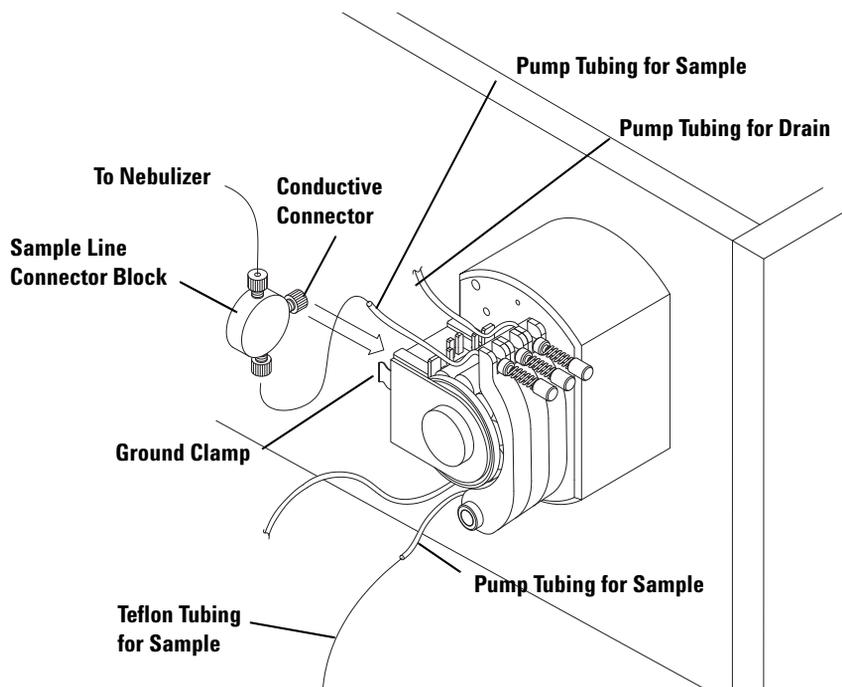


Figure 38

NOTE

The block is made from high purity materials, which have been thoroughly tested by Agilent, and no sample contamination has been observed. The block has a very small dead volume (1 μL), so sample washout time is not affected. For users analyzing H_2O_2 solutions, the Pt contact, although very small, may cause minute O_2 bubbles to be formed; in this block, a block using an Au contact can be supplied.

Internal Standard Tubing Kit

This kit is for on-line addition of internal standard solution. Please refer to the following description for this kit prior to use. The connector block is made from high-purity materials, which have been thoroughly tested by Agilent, and no sample contamination has been observed. The block has a very small dead volume (1 micro liter), minimizing sample washout time. This kit also serves as the “sample line connector block” at the same time.

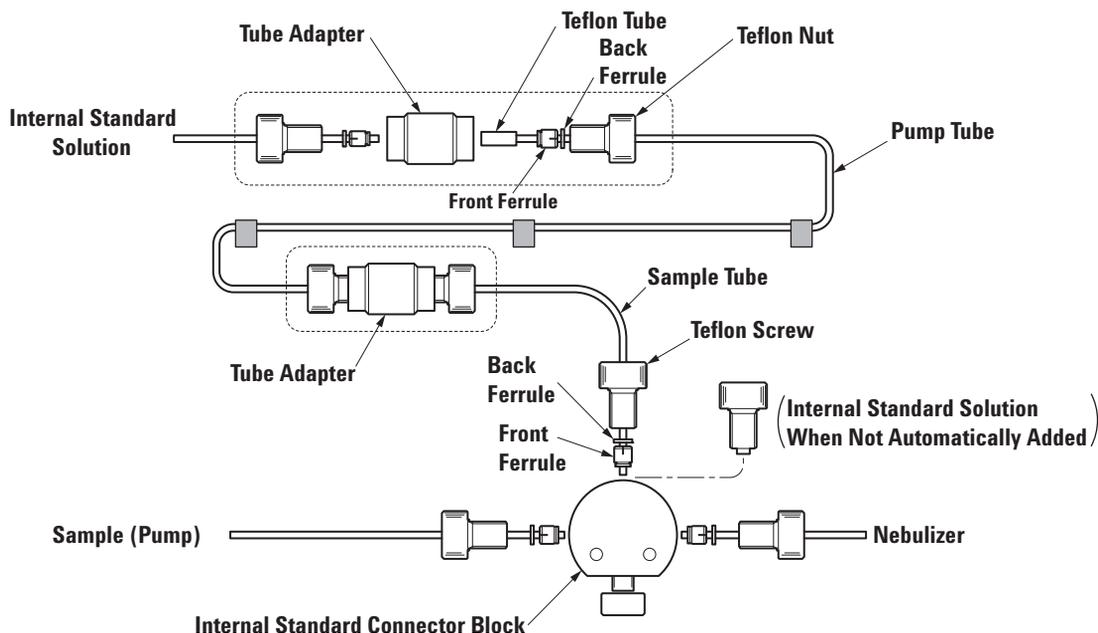


Figure 39 Tubing Diagram

To attach this kit, complete the following steps:

1 Perform the following procedure to connect the tube adapter and pump tube.

- 1 Cut the pump tube diagonally and moisten with pure water.
- 2 Insert the moistened pump tubing into the Teflon tubing until it is fed completely through.
- 3 Cut the pump tubing together with the Teflon tubing. If the tubes are not cut at a 90-degree angle, a leakage or blockage may occur in the connector.
- 4 Slide a Teflon nut, back ferrule and front ferrule on to the tubing. The tubing should protrude between 0.5 and 1.0 mm beyond the front ferrule.

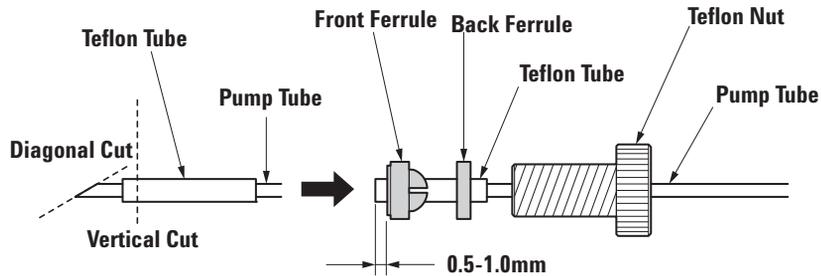


Figure 40 Attach the Nut, Back Ferrule and Front Ferrule

- 5 Insert the tube end in to the tube adapter as far as possible and tighten the set screw. Tighten the screw an additional 1/3 turn after feeling some resistance.
- 6 Repeat this procedure for both ends of the pump tube.

2 Perform the following procedure for non-pump tube connections.

- 1 Cut the ends of the tubing at a 90-degree angle to prevent leakage or blockage.
- 2 Slide a Teflon nut, back ferrule and front ferrule on to the tubing. The tubing should protrude between 0.5 and 1.0 mm beyond the front ferrule.

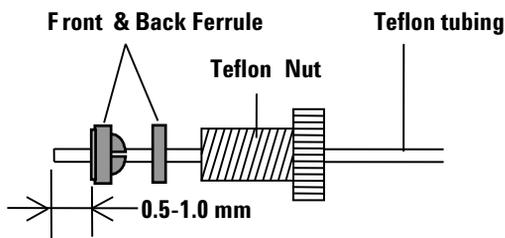


Figure 41 Teflon Nut, Front and Back Ferrule

- 3 Insert the end of the Teflon tubing into the connector block as far as possible. Next, slide the Teflon nut and tighten the Teflon nut into the connector block.

To reduce the dead volume, keep the Teflon tubing pushed in as far as possible until the connection is finished. This will align the tip of the tube and the tip of the nut.

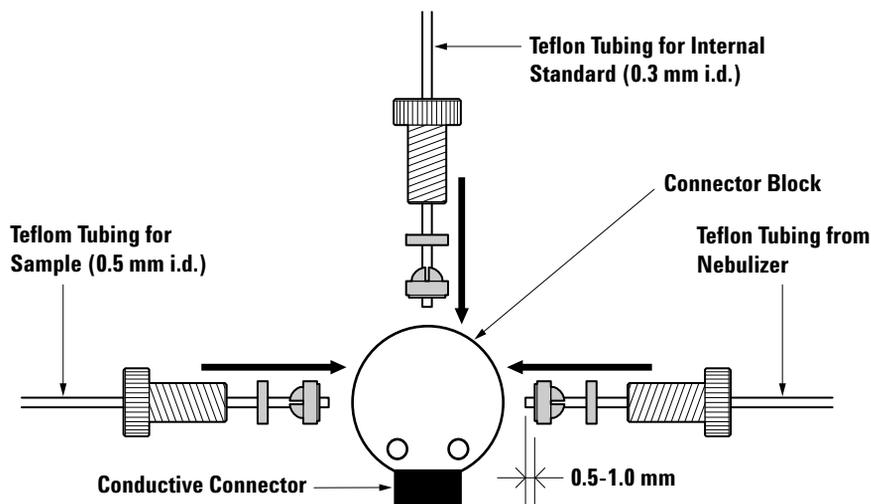


Figure 42 Internal Standard Tubing Kit

NOTE

Excessive tightening will cause leakage and clogging in the connector.

3 Connect 3-way Connector Block, Peristaltic Pump Tubing, Internal Standard Tubing Kit, etc.

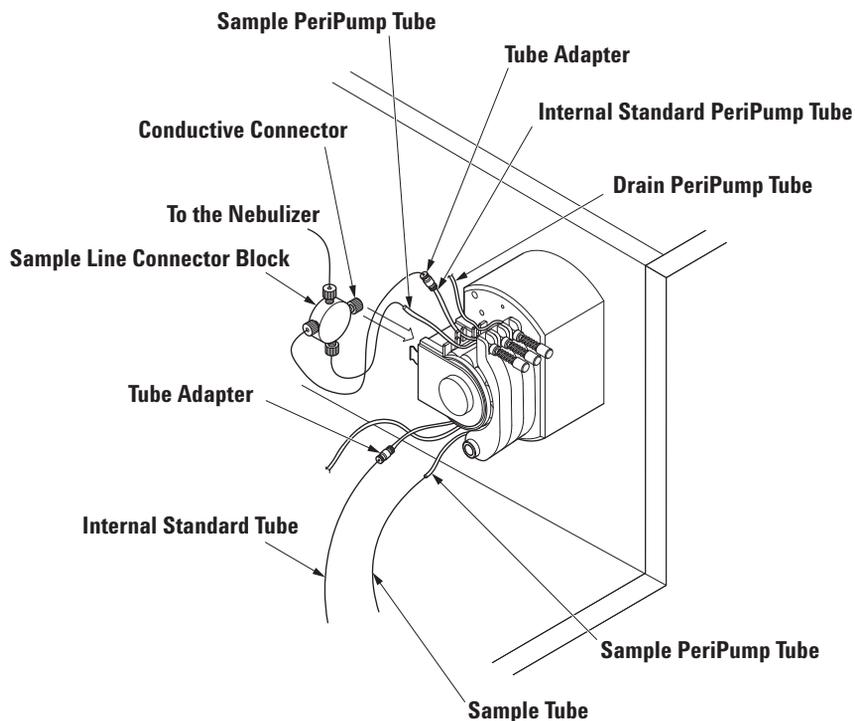


Figure 43

NOTE

Make sure that there is no leakage at each connection for approximately 1 minute after sample flows through it.

If there is a leak, tighten the connection an additional 1/4 turn.

If the leak persists, repeat this procedure from the beginning. Please be reminded that clogging in the nebulizer is also a possibility. Check the nebulizer.

Maintaining the Nebulizer and Spray Chamber

The nebulizer and spray chamber need to be cleaned if memory effects are observed after running high matrix samples, or when ultimate detection limits (ppt) are necessary.

The nebulizer and spray chamber are located in the open area of the sample introduction part on the left of the instrument. The spray chamber is tilted to facilitate drainage. This section contains steps to maintain the Babington, Concentric, and PFA Concentric nebulizers, as well as the standard and inert spray chambers.

In this section, the following three kinds of nebulizers are described. The required argon gas pressure is 700kPa.

- Babington nebulizer
- Concentric nebulizer
- PFA Concentric nebulizer

There are two kinds of materials for the spray chamber, quartz and polypropylene.

CAUTION

- As the tip of the nebulizer is delicate, scrupulous care should be taken in handling it, especially regarding damage to the tip, getting oils from your hands on the surface of nebulizer, and clogging with dregs.
- If the gas tubing and sample introduction around the nebulizer leak even a small amount, it causes a sharp fluctuation in signals. To prevent leaks, be especially careful not to damage the O-rings.

Locating Tools and Supplies

To maintain the nebulizer, you will need the following tools and supplies:

- Safety glasses
- Protective laboratory gloves
- 5% Nitric Acid bath
- Acetone
- Methanol
- Pure water in a rinse container
- Nebulizer O- rings
- Babington nebulizer removal tool

WARNING

- **Use organic solvent such as acetone and methanol in a well-ventilated place like the draft.**
 - **Handle acid carefully.**
-

NOTE

Pure water used for cleaning is indicated as water that has been generated using the ion-exchange method and a membrane filter, and has an electrical resistance of at least 18 M Ω .

Removing and Checking the Nebulizer and Spray Chamber

WARNING

HF or organic solvents remaining in the spray chamber can be hazardous or flammable if they come into contact with skin or are spilled on the tray. Before removing the spray chamber from the spray chamber chiller, complete the following procedures:

- 1 **Wash the spray chamber by aspirating pure water at a high speed and flowing the carrier gas.**
 - 2 **Stop the carrier gas. Aspirate air through the peristaltic pump for 1-2 minutes and confirm that all of the solution from the spray chamber has drained.**
-

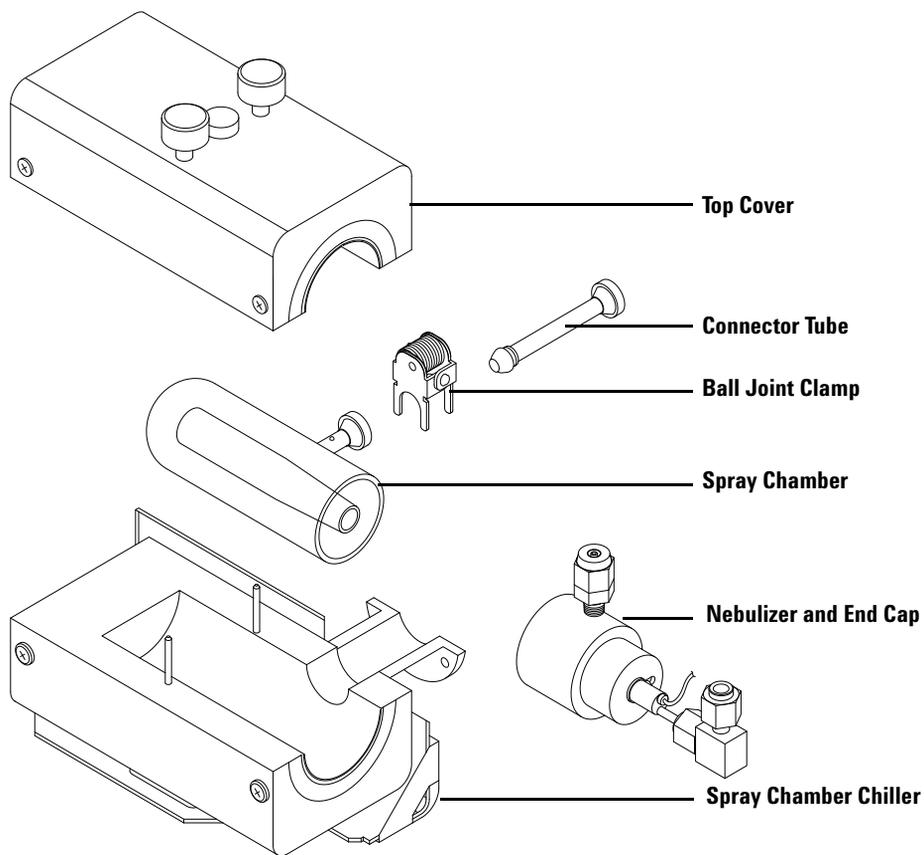


Figure 44 Nebulizer, Spray Chamber and Spray Chamber Chiller

To remove and check the nebulizer and spray chamber, complete the following steps:

1 Put the instrument in Standby mode.

See Chapter 3, “**Startup, Shutdown and Status**”.

2 Remove the sample transfer line.

Remove the ball joint clamp and disconnect the connector tube (Figure 44).

If it is difficult to remove them, first slide the torch away.

3 Disconnect and check the gas hoses and sample tube.

Remove the quick-connect fittings. Carefully twist the hoses off the end cap and nebulizer (Figure 44). If makeup gas is being used, remove that clamp and hose. Otherwise, unscrew the gas plug and disconnect the sample tube.

As you remove the gas hoses and the sample tube, check them for damage such as splitting, pinches or deterioration. Replace if needed.

4 Remove the spray chamber retaining bracket.

The cooling block is located in the open area on the left of the instrument. Loosen the two screws on the top cover of the cooling block and remove the cover.

5 Remove the spray chamber with the end cap.

Lift the spray chamber out of its mounting block.

6 Disconnect the end cap and nebulizer.

Do not touch the nebulizer tip, as it is fragile. Remove the end cap from the spray chamber by gently twisting it while pulling on it. Refer to “Disconnecting the Babington Nebulizer from the End Cap”.

CAUTION

Remove the spray chamber from the cooling block before removing the end cap.

To clean a clogged nebulizer, complete the following steps:

- 1 Pump 5% Nitric Acid through the nebulizer for 10 minutes while it is still attached to the spray chamber.**

Wear safety glasses and gloves when working with acid.

- 2 If this does not remove the material clogging the nebulizer, remove the nebulizer from the end cap.**

The sample uptake tube can remain on the nebulizer. Refer to the [“Disconnecting the Babington Nebulizer from the End Cap”](#)

- 3 Ultrasonic the nebulizer for 10 minutes in 5% Nitric Acid.**

Wear safety glasses and gloves when working with acid.

- 4 Ultrasonic the nebulizer for 10 minutes in pure water.**

- 5 Rinse the nebulizer with pure water after washing.**

- 6 Dry the holes for the carrier gas and the sample using dry argon or nitrogen.**

- 7 Check the O- rings.**

Check the O- rings located on the nebulizer and in the connector between the nebulizer and carrier gas tube, and replace them if they are cracked or too loose to seal properly. Wash the O- rings by immersing them in pure water and dry them gently with a clean laboratory tissue.

If necessary, also replace the end cap O- ring, which is located inside the nebulizer end cap, and the ferrules, which are located in the connector between the nebulizer and carrier gas tube.

NOTE

If the gas tubing and sample introduction around the nebulizer leaky even a small amount, it will cause a sharp signal fluctuation. To prevent leaks, be especially careful not to damage the O-ring.

To resolve signal instability, complete the following steps:

1 Remove the nebulizer and end cap.

The sample uptake tube can remain on the nebulizer. Refer to the [“Disconnecting the Babington Nebulizer from the End Cap”](#)

Remove the O-ring before soaking the nebulizer in acetone. Once the O-ring is soaked in acetone, it will swell and installation will be difficult.

2 Soak the nebulizer for 10 minutes in acetone.

3 Soak the nebulizer for 10 minutes in methanol.

4 Dry the carrier gas and sample holes and remove any organic solvent using argon or nitrogen gas.

If you start analyzing without drying completely, carbonate originated in organic solvent may cause interference. If the signal instability still persists, the nebulizer may be clogged or there may be leaks in the gas or sample lines. Refer to 'To clean a clogged nebulizer' or check the connections for leaks.

5 Check the O-rings.

Check the O-rings, which are located on the nebulizer and in the connector between the nebulizer and carrier gas tube, and replace them if they are cracked or too loose to seal properly. Wash the O-rings by immersing them in pure water and dry them gently with a clean laboratory tissue.

If necessary, also replace the end cap O-ring, which is located inside the nebulizer end cap, and the ferrules, which are located in the connector between the nebulizer and carrier gas tube.

NOTE

If the gas tubing and sample introduction around the nebulizer leak even a small amount, it causes a sharp signal fluctuation. To prevent leaks, be especially careful not to damage the O-ring.

To solve memory problems, complete the following steps:

1 Disconnect the nebulizer and the end cap.

The sample uptake tube can remain on the nebulizer. Refer to the [“Disconnecting the Babington Nebulizer from the End Cap”](#)

2 Ultrasonic the nebulizer in 5% Nitric Acid.

Wear safety glasses and gloves when working with acid. If the memory problem persists, disconnect the sample uptake tube referring to [“Disconnecting the Babington Nebulizer from the End Cap”](#)

3 Ultrasonic the sample tube in 5% Nitric Acid.

Wear safety glasses and gloves when working with acid.

4 Check the O- rings.

Check the O- rings, which are located on the nebulizer and in the connector between the nebulizer and carrier gas tube, and replace them if they are cracked or too loose to seal properly. Wash the O- rings by immersing them in pure water and dry them gently with a clean laboratory tissue.

If necessary, also replace the end cap O- ring, which is located inside the nebulizer end cap, and the ferrules, which are located in the connector between the nebulizer and carrier gas tube.

NOTE

If the gas tubing and sample introduction around the nebulizer leaky even a small amount, it causes a sharp signal fluctuation. To prevent leaks, be especially careful not to damage the O-ring.

Disconnecting the Babington Nebulizer from the End Cap

NOTE

Wear gloves when handling the Babington nebulizer to avoid getting oils from your hands on the surface of nebulizer. If contaminated with oil, wettability of the surface of the nebulizer is compromised and the signal becomes unstable.

The wettability of spray surface of the Babington nebulizer is significant for the signal stability. If the signal is unstable, check the wettability of the surface of the nebulizer visually after disconnecting the end cap from the spray chamber.

To disconnect the Babington nebulizer from the end cap, complete the following steps:

1 Disconnect the carrier gas and makeup gas hoses.

Disconnect the carrier gas hose connector, also.

2 Disconnect the nebulizer from the end cap using the removal tool.

To remove the nebulizer, refer to the figure on the following page.

- a** Place the plate on the nebulizer end cap.
- b** Pass the nebulizer through the hole of the removal tool and slide the removal tool so that it mates with the groove on the nebulizer body.
- c** Insert the two thumbscrews in the removal tool, and alternately tighten the screws until the nebulizer pulls out of the end cap.

CAUTION

Be careful not to rotate the removal tool. This may damage or break the guide pin attached to the nebulizer.

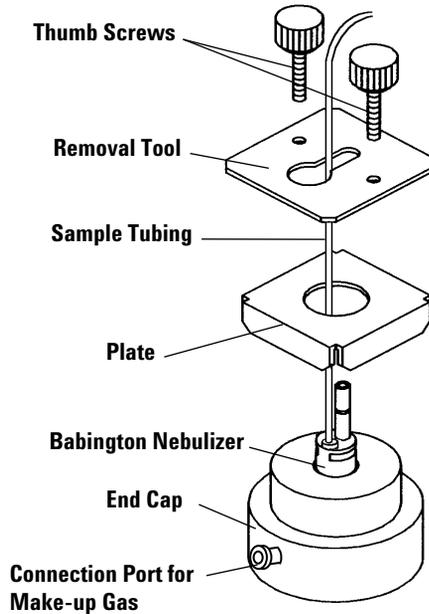


Figure 46

3 Remove the two O- rings.

4 Complete following steps to disconnect the sample uptake tube with the tube adapter if there is a memory problem:

- a Insert the groove of the attachment tool between the tube connector and the nebulizer body. Refer the following figure.



Figure 47 Attachment Tool for the tube connector

- b Push up the connector using the tool as a lever (see the following figure).
- c Grasp the connector and pull it gently out of the nebulizer body. The Teflon tubing and the tube connector are unified.

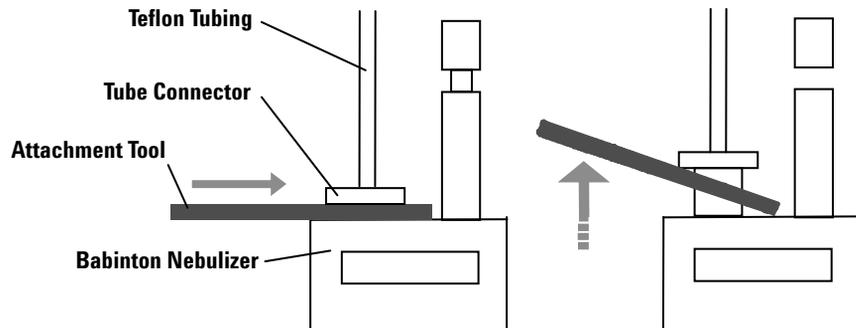


Figure 48 Disconnecting the Tube Connector

NOTE

Do not disconnect the Teflon tubing from the tube connector unless there is a heavy memory problem or the tip is broken.

5 Check the O- ring in the end cap.

Reattaching the Babington Nebulizer and the End Cap

CAUTION

Wear gloves when handling the Babington nebulizer or the sample tube to avoid getting oils from your hands on the surface of nebulizer. If contaminated with oil, the wettability of the surface of the nebulizer is compromised and the signal becomes unstable. Also, the spray part of the nebulizer is delicate. Do not touch.

1 Reconnect the sample uptake tube if it has been removed.

When you disconnect the sample uptake tube from the nebulizer body, reattach it in the following way to suppress the memory problem.

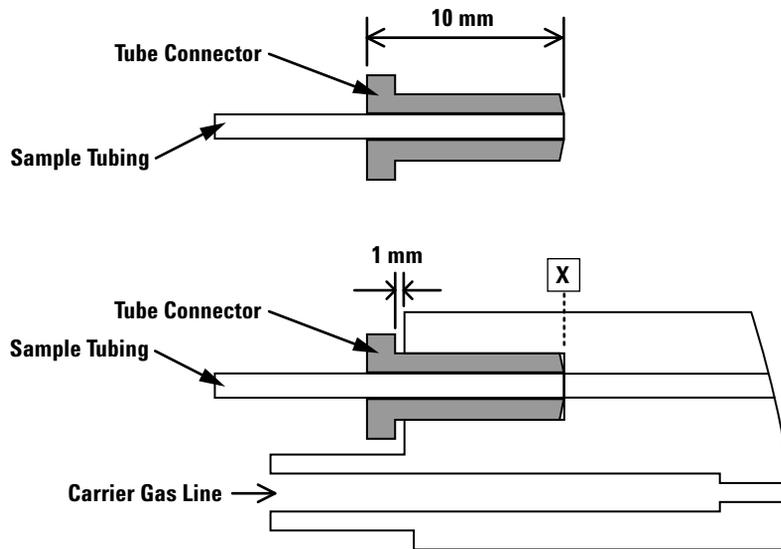


Figure 49 Tube connector (top),
Babington Nebulizer with Tube Connector (bottom)

- a Ensure that the edges of the sample uptake tube (0.5 mm i.d. x 1/16" o.d., PFA) and the tube connector are flush with each other.

If not, complete the following steps,

- 1 Slide the tube connector so that about 5 to 6 mm of sample uptake tube protrudes beyond the tube connector.
- 2 After cutting the excess length of the protruded tube, re-slide the tube connector so that about 1 mm of sample uptake tube protrudes.

- 3 Place the sample uptake tube end on a clean plane vertically as shown the following figure.
- 4 Slide the tube connector toward the clean plane gently so that the edges of the sample uptake tube and the tube connector are flush with each other. Refer to the following figure. Be careful not to handle the tip with force, or it may become disfigured.

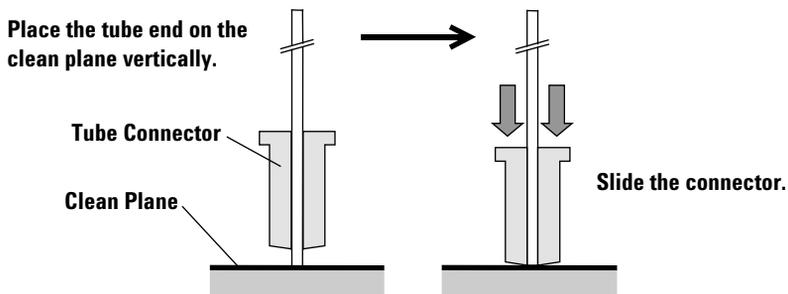


Figure 50

- b Insert the tube connector with the sample uptake into the sample tube hole of the Babington Nebulizer (Figure 51). Use the shallow groove side of the attachment tool for tube connector until the edge of the tube connector reaches the bottom of the hole. The gap between the base of the tube connector and the edge of the hole should be 1 mm.

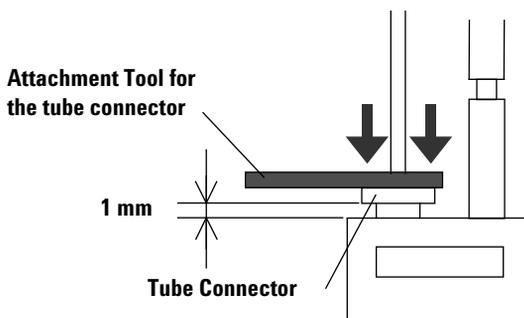


Figure 51

- 2 Reattach the O- rings.
- 3 Reattach the nebulizer to the end cap.

Gently push the nebulizer into the end cap making sure that the alignment pin fits into the slot on the back of the end cap. The tip of the nebulizer protrudes through the front of the end cap. Adding a few drops of pure water will ease insertion.

NOTE

There is a dedicated end cap for the Babington Nebulizer. The Babington Nebulizer has an alignment pin and the end cap has a slot into which the alignment pin fits. The Babington Nebulizer must be rotated as it is pushed through the end cap to prevent the O-rings from pinching. When the end cap is attached to the spray chamber, the word 'TOP' on the end cap must be facing up.

4 Reattach the carrier gas and makeup gas hoses.

5 Install the O- ring on the end cap.

NOTE

Make sure the nebulizer surface is wetting properly each time before using the Babington Nebulizer. Proper wetting of the nebulizer surface is required for signal stability. Complete the following steps to insure proper wetting of the nebulizer:

- 1 Select **Instrument >>Tune** from the ICP-MS Top Window.
 - 2 Select **Tune >>Sensitivity** from the menu in the Tuning Window. Set the peripump speed to 0.3 - 0.5 rps and aspirate pure water.
 - 3 Set the Carrier gas flow to 0 L/min for 10 - 20 seconds.
 - 4 Reset the Carrier gas flow to the value normally used.
 - 5 Repeat the procedure 3 - 4, two to three times.
-

Cleaning the Concentric Nebulizer, MicroMist Nebulizer and the End Cap

NOTE

Maintenance for the MicroMist Nebulizer is same as the Concentric Nebulizer.

The carrier gas pressure is generally 200 to 300 kPa at a 1.0 L/min carrier gas flow rate. The argon gas supply pressure has to be set to 700 kPa. If the carrier gas pressure rises to more than 300 kPa, the nebulizer may become clogged.

CAUTION

- Do not use chemicals such as Hydrofluoric Acid (HF) that erodes quartz with the concentric nebulizer.
- A wire must not be used to clear a clogged concentric nebulizer or it will be damaged.
- Ultrasonic wash must not be used to clean the delicate spray part of the concentric nebulizer.

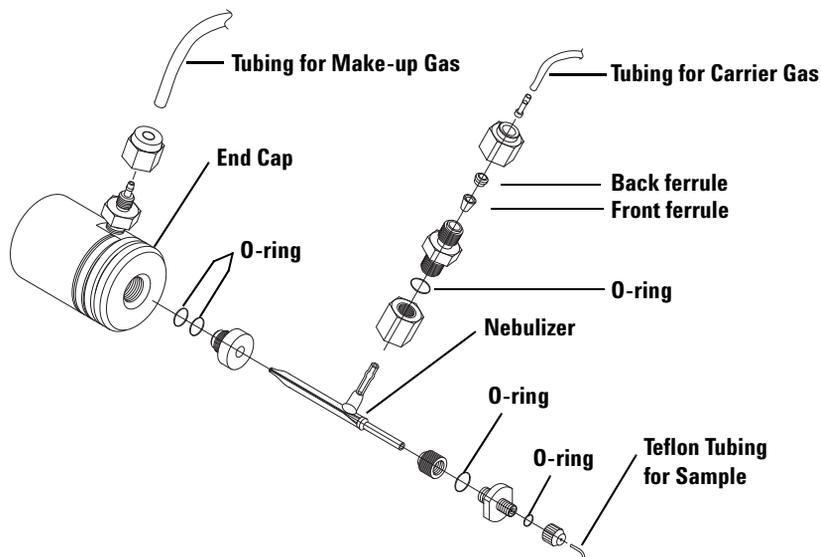


Figure 52 Concentric Nebulizer and End Cap

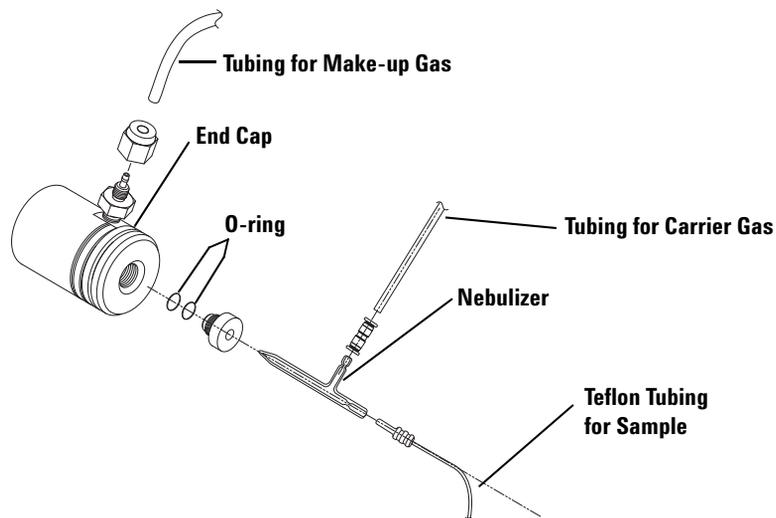


Figure 53 MicroMist Nebulizer and End Cap

To clean a clogged nebulizer, complete the following steps:

1 Disconnect the nebulizer from the end cap.

Refer to [“Disconnecting the Concentric Nebulizer and the End Cap”](#).

2 Wash the nebulizer by pumping pure water through the nebulizer in the opposite direction.

Reverse the sample tubing on the peripump and place the nebulizer tip in pure water. Allow the peripump to draw water through the tip and out the back of the nebulizer for a few minutes. Take care not to touch the tip of the nebulizer.

3 Check the O-rings

Check the O-rings on the sample and carrier gas connectors and replace them if they are cracked or too loose to seal properly. Wash the O-rings by immersing them in pure water and dry them gently with a clean laboratory tissue. Replace any damaged O-rings.

If necessary, also replace the end cap O-rings, which are located inside the nebulizer end cap, and the ferrules, which are located in the connector between the nebulizer and carrier gas tube.

NOTE

If the gas tubing and sample introduction around the nebulizer leaky even a small amount, it causes a sharp signal fluctuation. To prevent leaks, be especially careful not to damage the O-ring.

If the signal is unstable, clean the nebulizer in the following way:

1 Disconnect the nebulizer from the end cap. Remove the O- rings.

Refer to the “[Disconnecting the Concentric Nebulizer and the End Cap](#)”
Remove both the sample tube and the connector as well.

2 Soak the nebulizer in 5% Nitric Acid both overnight.

Wear safety glasses and gloves when working with acid.

3 Check the O- rings.

Check the O- rings on the sample and carrier gas connectors and replace them if they are cracked or too loose to seal properly. Wash the O- rings by immersing them in pure water and dry them gently with a clean laboratory tissue. Replace any damaged O- rings.

If necessary, also replace the end cap O- rings, which are located inside the nebulizer end cap, and the ferrules, which are located in the connector between the nebulizer and carrier gas tube.

NOTE

An ultrasonic wash must not be used to clean the concentric nebulizer.

If the gas tubing and sample introduction around the nebulizer leak even a small amount, it causes a sharp signal fluctuation. To prevent leaks, be especially careful not to damage the O-ring.

4 Rinse the nebulizer in pure water at least 3 times. After rinsing, dry on a clean surface.

5 When there is a leak, the peak count of 14, 28, 54amu will be extraordinarily high due to nitrogen (N). Re- check the connector connections.

If there is a memory, clear it by completing the following steps:

1 Disconnect the nebulizer from the end cap. Remove the O- rings.

Refer to “[Disconnecting the Concentric Nebulizer and the End Cap](#)”.
Disconnect the sample tube and the connector as well.

2 Soak the nebulizer in 5% Nitric Acid both overnight.

Wear safety glasses and gloves when working with acid.

3 Check the O- ring.

Check the O- ring used as the connector between the sample line and the carrier gas. Replace O- ring if it has damage or is too loose to fit properly. Soak the O- ring in pure water and gently dry with a clean laboratory tissue.

If necessary, replace the ferrule used for the O- ring and the connector inside the end cap.

NOTE

An ultrasonic wash must NOT be used to clean the spray part of concentric nebulizer.

If the gas tubing and sample introduction around the nebulizer leak even a small amount, it causes a sharp signal fluctuation. To prevent leaks, be especially careful not to damage the O-ring.

Disconnecting the Concentric Nebulizer and the End Cap

1 Disconnect the nebulizer.

Loosen the nebulizer holder nut and gently pull the nebulizer out of the end cap while gently twisting it. Take care not to touch the nebulizer tip against the inside wall of end cap. Wash the two nebulizer O- rings by removing them from the end cap and cleaning them with pure water. Replace if needed.

2 Remove and check the O- ring in the end cap that fits over the spray chamber. To clean the end cap, take out the O- ring with tweezers from the hole where the connector for nebulizer fits in.

NOTE

Be careful not to loosen the small O-ring in the connector for the sample tube.

Replacing or Refitting the Concentric Nebulizer and the End Cap

1 Reinsert the nebulizer into the end cap.

Replace the two O-rings in the hole in the center of the end cap. Install the nebulizer holder nut on to the end cap first. At this time, do not tighten it. Insert the nebulizer through the nebulizer holder nut and then insert the nebulizer into the O-rings by gently applying pressure and twisting the nebulizer. Lubricating the nebulizer and O-rings with pure water helps the nebulizer slide into the O-rings. Insert the nebulizer into the end cap until the tip of the nebulizer is flush with the inside surface of the end cap. Position the carrier gas arm of the nebulizer so that it points in the same direction as the makeup gas fitting. Tighten the nebulizer holder nut so that it is finger tight. The tip of the nebulizer should be positioned as shown in the following figure.

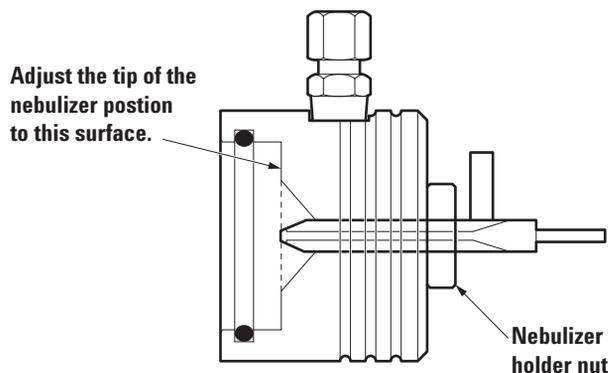


Figure 54

2 Insert the spray chamber O-ring in the end cap.

CAUTION

Do not install the nebulizer together with the nebulizer holder nut to the end cap. This may damage the screw of nebulizer holder nut.

Cleaning the PFA Concentric Nebulizer

The carrier gas pressure is generally 200 to 300 kPa at a 1.0 L/min carrier gas flow rate. The argon gas supply pressure has to be set to 700 kPa. If the carrier gas pressure rises to more than 300 kPa, the nebulizer may become clogged.

CAUTION

A wire or similar material must not be used to clear a clogged concentric nebulizer or the nebulizer will be damaged and may be rendered unusable.

The spray section of the nebulizer is designed as a microstructure. Please do not under any circumstances wash ultrasonically.

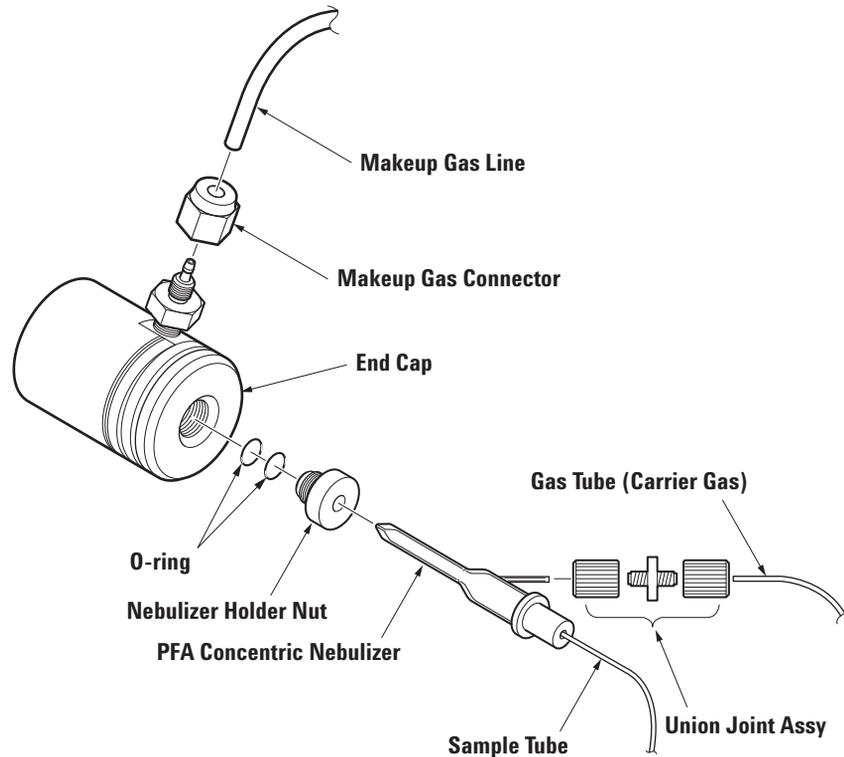


Figure 55 PFA Concentric Nebulizer

When Blockage Occurs

When blockage is evident please clean following the method below. If washing with the below method does not clear the blockage, please replace the PFA concentric nebulizer. When removing the nebulizer from the end cap, please also inspect the O-ring. If there is any deterioration please replace the O-ring.

1 Disconnect the nebulizer from the end cap.

Refer to the later section “[Removing the PFA Concentric Nebulizer](#)”

2 Use the peristaltic pump to wash the nebulizer by pumping pure water through the nebulizer in the opposite direction.

Reverse the sample tubing on the peripump and place the nebulizer tip in pure water. Run the peripump for several minutes, allowing it to draw water through the tip and out the back of the nebulizer. Take care not to touch the tip of the nebulizer.

If there is memory, clear it by the following special cleaning procedure outlined below:

1 Please clean the nebulizer either by self- aspiration or pumping, according to circumstances.

Using a mixture of 5% nitric acid and 5% hydrofluoric acid, self-aspirate for 8 hours at a carrier gas flow rate of 1.0 L/min.

Using a mixture of 5% nitric acid and 5% hydrofluoric acid, pump with the peripump for 8 hours at more than 170 μ L/min.

NOTE

Wear safety glasses and gloves when working with acid.

2 Then rinse for 5 minutes with a flow of pure water.

3 Blow dry with clean, dry air or an inert gas (such as Argon) for 5 minutes.

Removing the PFA Concentric Nebulizer

- 1 Loosen the union connector which connects the carrier gas tube and remove the tube.**
- 2 Remove the nebulizer.**

Loosen the nebulizer holder nut and gently pull the nebulizer out of the end cap while gently twisting it. Take care not to touch the nebulizer tip against the inside wall of the end cap.

- 3 When removing the nebulizer, also remove the end cap and inspect the O- rings between the end cap and spray chamber for deterioration or damage.**

To clean the end cap, take out the 2 nebulizer O- rings with tweezers from the hole where the nebulizer holder nut for the nebulizer fits in.

Wash the O- rings with pure water. Replace if needed.

Installing the PFA Concentric Nebulizer

- 1 Insert the nebulizer into the end cap.**

Replace the two O- rings in the hole in the center of the end cap. Install the nebulizer holder nut on to the end cap first. At this time, do not tighten it. Insert the nebulizer through the nebulizer holder nut and then insert the nebulizer into the O- rings by gently applying pressure and twisting the nebulizer. Lubricating the nebulizer and O- rings with pure water helps the nebulizer slide into the O- rings. Insert the nebulizer into the end cap until the tip of the nebulizer is flush with the inside surface of the end cap. Position the carrier gas arm of the nebulizer so that it points approximately as shown in (Figure 56). The tip of the nebulizer should be positioned as shown in figure 4- 30.

- 2 Tighten the nebulizer holder nut so that it is finger tight.**
- 3 Install the O- ring in the spray chamber side of the end cap.**

NOTE

Do not install the nebulizer together with the nebulizer holder nut to the end cap. This may damage the screw of nebulizer holder nut.

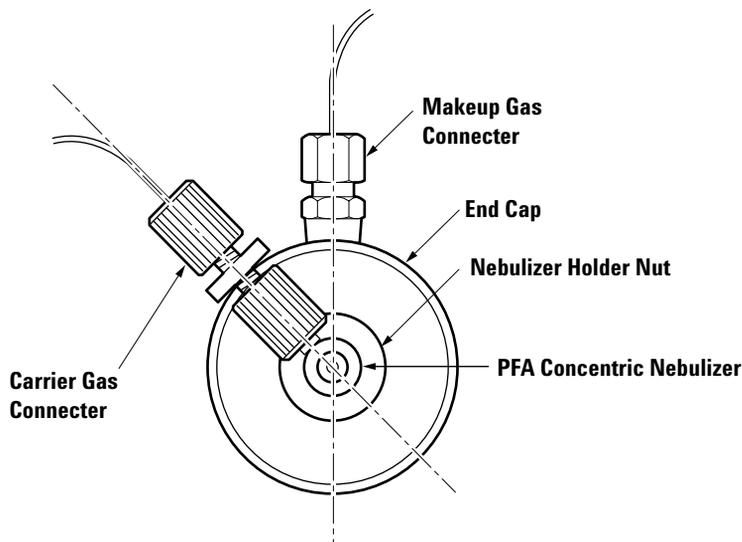


Figure 56 Nebulizer Orientation

Cleaning the Spray Chamber and the Transfer Line

To clean the spray chamber and the transfer line, complete the following steps:

CAUTION

- Do not use chemicals such as Hydrofluoric Acid (HF), which erodes quartz, to clean the spray chamber.
- An ultrasonic wash must not be used to clean spray chambers that are made of quartz. Use an ultrasonic wash for spray chambers made of polypropylene.
- The polypropylene spray chamber has lower wettability than the quartz chamber. If the polypropylene spray chamber is not used for more than half of a day, soak it in 1% TMAH (Tetra Methyl Ammonium Hydride) or 1% ammonia water (NH_4OH). This is very effective to reduce memory (especially boron (B)) and to improve the stabilization of signals. Take it out of the washing solution before using and fully rinse with pure water. If washing with TMAH is not enough, the peak of carbon contained in TMAH (C: 12 amu) will be overlapped with boron (B: 11 amu) and it may interfere with signals.

CAUTION

TMAH and ammonia water are basic reagents. Be sure to wear gloves when handling them.

Do not mix basic reagents such as TMAH and ammonia water with acidic reagents such as nitric acid and hydrofluoric acid.

Be sure to fully rinse parts soaked in basic reagents with pure water before use.

1 Remove the transfer line and the spray chamber from the end cap.

Refer to the [“Removing and Checking the Nebulizer and Spray Chamber”](#).

2 Thoroughly wash with pure water.

3 Soak in 5% Nitric Acid.

Soak the spray chamber in a 5% Nitric Acid bath overnight. If memory is a problem, soak in a 10% Nitric Acid bath overnight. Wear safety glasses and gloves when working with acid.

4 Rinse the spray chamber in pure water at least 3 times. After rinsing, dry on a clean surface.

Cleaning the End Cap

1 Thoroughly wash the end cap of the Babington nebulizer or the concentric nebulizer with pure water.

2 If it stains heavily, soak it with 5% Nitric Acid or clean it with the ultrasonic wash, then rinse with pure water.

3 Check the O- ring for damage or dents.

4 Thoroughly dry the inside of the connector.

Replacing or Refitting the Nebulizer and Spray Chamber

Before reconnecting the gas hoses, reattach the nebulizer and spray chamber. Replace these components if they are cracked or broken.

To refit the nebulizer and spray chamber, complete the following steps:

1 Fit the end cap onto the spray chamber.

See [Figure 44](#). Push the end cap onto the spray chamber until there is a snug fit and the makeup gas fitting is perpendicular to the ball joint fitting. Make sure that the O-rings in the end cap make a gas-tight seal with the outer wall of the spray chamber.

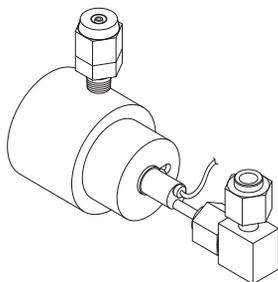


Figure 57 End Cap Orientation (example: Babington Nebulizer)

NOTE

The carrier gas and the makeup gas tubing must be connected to the nebulizer and the end cap so that they are positioned vertically. If the gas lines are positioned lower than the sample inlet or spray chamber drain and the argon gas flow is interrupted; the sample liquid may flow back into the gas lines. This could result in damage to the AFMC gas module.

2 Fit the spray chamber into the base of the spray chamber chiller.

Place the spray chamber into the mounting block applying slight pressure until you feel the drain O-ring make a good seal and the spray chamber is seated in the mounting block ([Figure 44](#)). Tighten the upper side block with the two screws.

WARNING

Make sure the spray chamber makes a good seal with the drain O-ring, especially when using organic solvents. Organic solvent leaks may present a fire hazard.

If there is a crevice between the upper block and the lower block, the spray chamber cannot maintain a uniform inside temperature. This may cause poor system performance.

3 Reconnect the sample and gas tubing.

Use the figures of each nebulizer to identify the sample introduction hose and gas hoses. Connect and fasten each hose onto its fitting.

CAUTION

Do not over-tighten the nuts or the quick-connect clamps. The glass will break if too much pressure is applied.

- a Connect the sample uptake tube.
Attach the sample tube from the uptake channel of the peristaltic pump to the end of the nebulizer.
- b Connect the carrier gas hose.
Attach the carrier gas hose to the nebulizers vertical gas connection.
- c Connect the make-up gas hose.
Attach the make-up gas hose or gas plug to the end cap gas connection.
- d Connect the sample transfer line.
Attach the transfer tube from the end of the torch to the spray chamber exhaust port. Use the clamp provided.

Testing the Nebulizer and Spray Chamber

Perform the basic maintenance test explained in 'Testing after Maintenance' later in this chapter. Check the gas pressures and flow rates in the Instrument Control window to determine if the gas hoses are connected tightly. See [Chapter 3, “Startup, Shutdown and Status”](#) in this manual for more information. Also check for leaks in the sample uptake connections. Liquid leaks are collected in the tray under the spray chamber and expelled out of the drain hole on the left side of the tray.

Maintaining the Torch

Replace the torch whenever you notice that it is chipped, cracked, or distorted from overheating. Replacement is also necessary when the central tube of torch is deformed or clogged. Clean the torch when ultra low levels (ppt) need to be analyzed. Any white deposit in the inner tube also indicates a need for maintenance.

CAUTION

Slight deformation of the torch may not cause any problems. However, if the torch is badly distorted problems such as “no sensitivity” or “difficulty in igniting plasma” may occur during use.

WARNING

The torch is exposed to very high temperatures, wait at least 10 minutes for cooling before starting any maintenance of the torch.

Locating Tools and Supplies

To maintain the ICP torch, you need the following supplies:

- Safety glasses and protective laboratory gloves
- 5% Nitric Acid bath
- Pure water in a rinse container
- Laboratory tissue

NOTE

Pure water used for cleaning is indicated as water that has been generated using the ion-exchange method and a membrane filter, and has an electrical resistance of at least 18 M Ω .

Removing and Checking the Torch

To remove the ICP torch, complete the following steps:

1 Put the instrument in Standby mode.

See [Chapter 3, “Startup, Shutdown and Status”](#).

WARNING

To avoid burns, wait 10 minutes after switching off the plasma before opening the instrument. The plasma reaches temperatures as high as 8000 K.

2 Open the torch box.

Open the cover, loosen the torch box screws and remove the torch box. Remove the connection tube.

CAUTION

- Completely wipe off spilled water or samples left in the torch box as they will cause erosion.
 - It may be difficult to ignite the plasma if the torch, torch stand, and around the torch is stained.
-

3 Remove the ball joint clamp and remove the transfer tube (connector tube) from the spray chamber.

4 Remove the gas lines.

Carefully loosen and the plasma gas and auxiliary gas tube and remove from the torch.

5 Remove the torch.

Open the quick-release clamp.

Carefully slide the torch out of the work coil and lift it out of the torch holder. Be careful to ease the torch projection out of the torch stand hole.

See [Figure 58](#).

CAUTION

When removing the torch, the bonnet may fall and break if the torch is not held level. Hold the torch level while removing it, or hold the bonnet to prevent it from falling off when removing the torch.

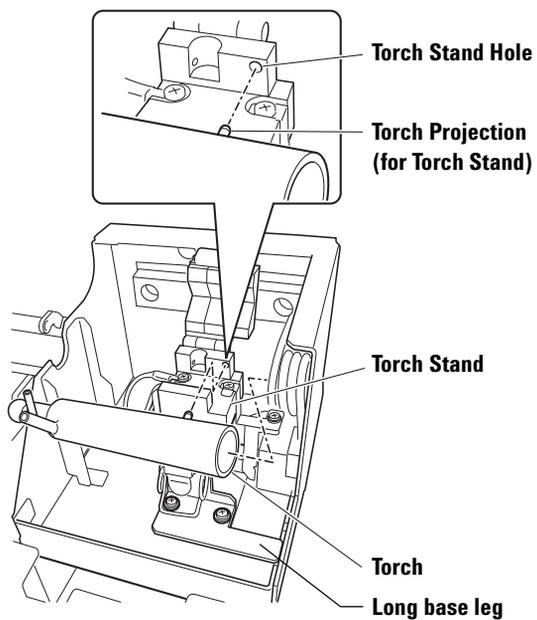


Figure 58 ICP Torch

6 Examine the torch.

Examine the torch for wear and contamination. Replace it if you find cracks, chips, or evidence of distortion due to overheating.

Install the joint connecting tube between the spray chamber and the torch. Tighten the spray chamber hold down screw and replace the two ball joint clamps. Close the torch box cover and tighten the thumb nut to secure the cover.

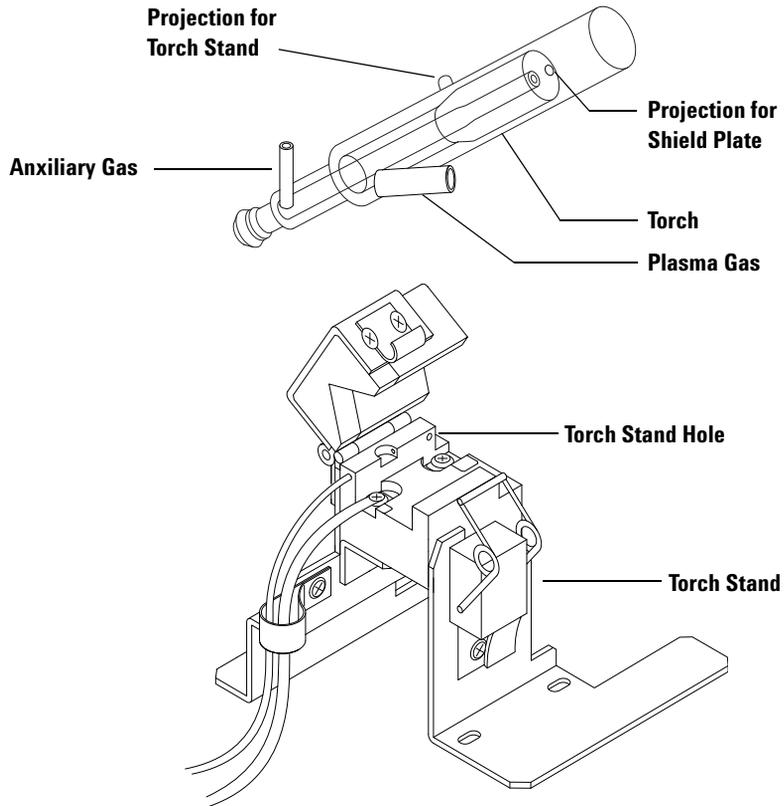


Figure 59 ICP Torch

Cleaning the Torch

To clean the torch, complete the following steps:

1 Soak the torch in a 5% Nitric Acid bath overnight.

Remove air bubbles trapped under the torch by slightly tipping the torch from side to side. Protective gloves and safety precautions should be observed at all time when working with Nitric acid.

NOTE

- Do not use HF to clean the torch as it will damage the torch.
 - Do not place the torch in an ultrasonic bath.
-

2 Rinse the torch with pure water.

Rinse the torch with pure water at least 3 times and lay on a clean surface to dry.

3 Dry the Torch.

Use a flow of clean Argon or Nitrogen to blow any remaining water from the torch before installing the torch into the instrument.

CAUTION

If the torch is still wet when it's installed, it will break or may cause difficulty igniting the plasma.

Refitting the Torch

To place the torch back in the instrument, complete the following steps:

1 Place the torch in its holder.

With the auxiliary gas fitting on top of the torch, carefully slide its open end inside the work coil and at the same time align the projection for the torch stand into the torch stand hole. Refer to [Figure 58](#) showing how the projection for torch stand aligns with the torch stand hole. The end of the middle, or auxiliary, tube will be 1 to 2 millimeters from the top of the work coil, as shown in [Figure 60](#). Close the quick-release clamp over the torch.

CAUTION

Difficulty in igniting the plasma or melting of the torch may be experienced if the position of the torch is too far or too close.

Also if the central tube of the torch may become clogged or deformed if a sample with a high sodium concentration is introduced.

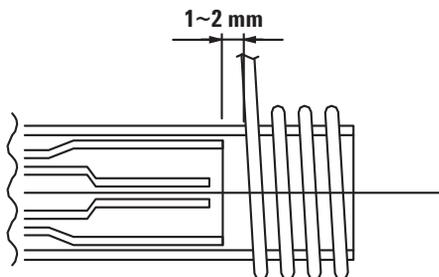


Figure 60 Position of Torch Inside Work Coil

2 Attach the hoses.

After connecting the gas hoses, tighten the nuts on the fittings. See [Figure 59](#) to correctly identify the gas hoses. To connect the gas hoses to the torch, complete the following steps:

CAUTION

Do not over-tighten the nuts on the quick-connect clamps. If you apply too much pressure, the torch will break.

a Attach the sample transfer tube (connector tube).

Connect the sample transfer tube from the spray chamber to the fitting on the end of the torch.

b Attach the auxiliary gas hose.

Connect the auxiliary- gas hose, which is smaller in diameter than the plasma gas hose.

c Attach the plasma gas hose.

Connect the plasma gas hose to the remaining gas fitting on the torch.

3 Close the torch box and instrument.

Close the torch cover and tighten its thumbscrew. Close the instrument hood.

CAUTION

The torch cover must be on while using the torch. This cover reduces the emission of noise from the plasma.

Testing the Torch

Perform the basic test after maintenance. See “Testing After Maintenance” at the end of this chapter. When the plasma is ignited, observe it through the tinted (UV protection) window to check the shape of the flame. If the gas pressures are too low, put the instrument in standby mode and wait 10 minutes before checking the connections for leaks.

Adjusting the Position of the Work Coil

The position of the work coil can be checked with the alignment plate (plastic plate) in the following way.

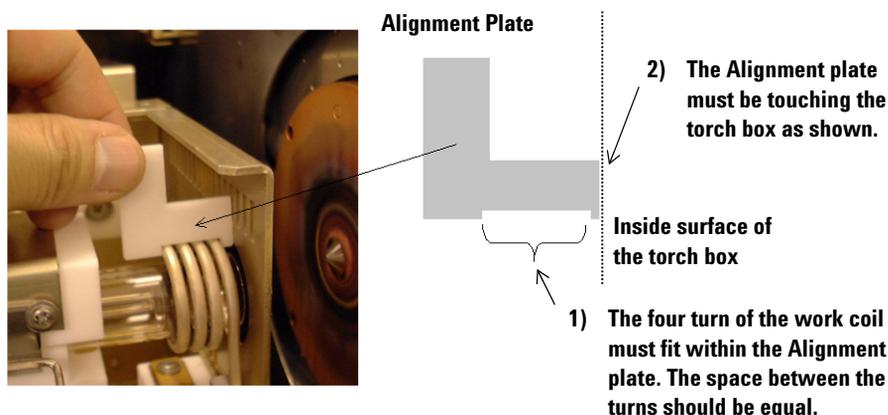


Figure 61

Cleaning the RF Return strip and Torch Box Area

With the Torch Box in its back position, wipe both the RF Return Strip located on the Torch Box and the area on the Interface where the RF return contacts with a laboratory tissue wetted with pure water. This insures a good RF contact during operation.

CAUTION

Replacement is necessary for badly eroded parts.

Maintaining the ShieldTorch

Check the torch, shield plate, and bonnet according to the following criteria and perform maintenance as necessary.

Torch

- Cracked, chipped, or deformed by high temperatures
- When performing analysis requiring ultra- sensitivity (ppt)
- Deposits have formed in the central torch tube

Shield Bar

- Extensive corrosion or high temperature deformation
- Background ArO signal can not be lowered

Bonnet

- Fractured, cracked, or chipped

Locating Tools and Supplies

To maintain the shield torch, the following items are needed:

- Safety glasses and laboratory gloves
- 5% Nitric acid
- Pure water
- Methanol (HPLC grade)
- Cotton swabs (P/N: 9300- 2574)

NOTE

Pure water used for cleaning is indicated as water that has been generated using the ion-exchange method and a membrane filter, and has an electrical resistance of at least 18 M Ω .

Removing the ShieldTorch

To remove the shield torch, complete the following procedure:

1 Put the Agilent 7500 into Standby (or Shutdown) mode.

WARNING

To avoid burns, wait 10 minutes after switching off the plasma before opening the instrument. The plasma reaches temperatures as high as 8000 K.

2 Open the torch box.

Open the cover, loosen the torch box screws and remove the torch box. Remove the connection tube.

CAUTION

- Completely wipe off spilled water or samples left in the torch box as they will cause erosion.
 - It may be difficult to ignite the plasma if the torch, torch stand, and around the torch is stained.
-

3 Remove the ball joint clamp and remove the transfer tube (connector tube) from the spray chamber.

4 Remove the gas lines.

Carefully loosen the plasma gas and auxiliary gas tube and remove from the torch.

5 Remove the shield torch.

Open the torch holder clip (quick-release clamp), slide the shield torch with the shield bar and bonnet still attached from the work coil, and remove the torch. Be careful to ease the torch projection out of the torch stand hole (refer to [Figure 58](#)).

CAUTION

When removing the torch, the bonnet may fall and break if the torch is not held level. Hold the torch level while removing it, or hold the bonnet to prevent it from falling off when removing the torch.

6 Disassemble the torch, shield plate, and bonnet.

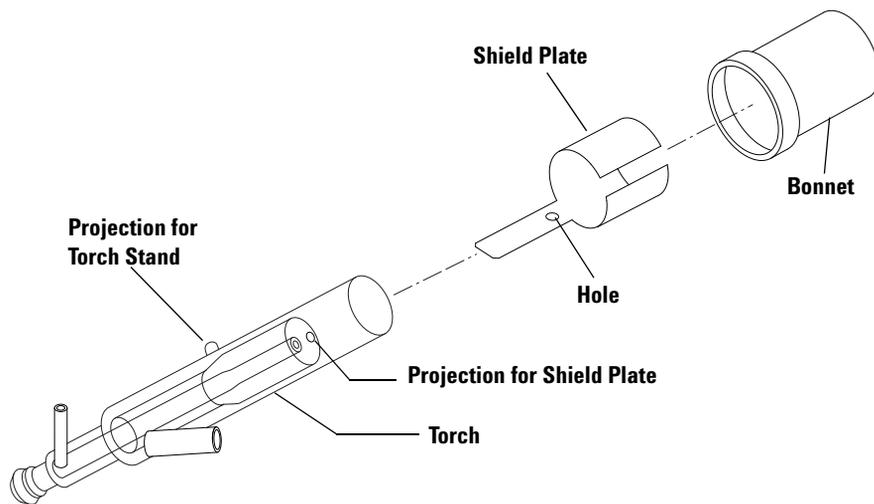


Figure 62 Torch, Shield Plate and Bonnet

Cleaning the Torch

To clean the torch, complete the following steps:

1 Soak the torch overnight in 5% nitric acid.

When soaking the torch in nitric acid, gently rock the torch from side to side to remove air bubbles trapped inside. Wear gloves when handling nitric acid.

CAUTION

Do not apply chemicals such as HF to the glass.

Do not use an ultrasonic bath.

2 Rinse the torch with pure water.

Rinse the torch at least 3 times with pure water. Place on a clean surface to dry.

3 Dry the torch.

Before installing the torch, blow it dry with clean argon or nitrogen to remove any remaining water.

CAUTION

The torch may crack or the plasma may not ignite properly if the torch is re-installed while wet.

Assembling the Torch, Shield Plate, and Bonnet

To assemble the torch, the shield plate, and the bonnet, complete the following steps:

1 Insert the torch into the shield plate.

Insert the torch into the shield plate. Adjust the projection of the torch into the hole of the shield plate.

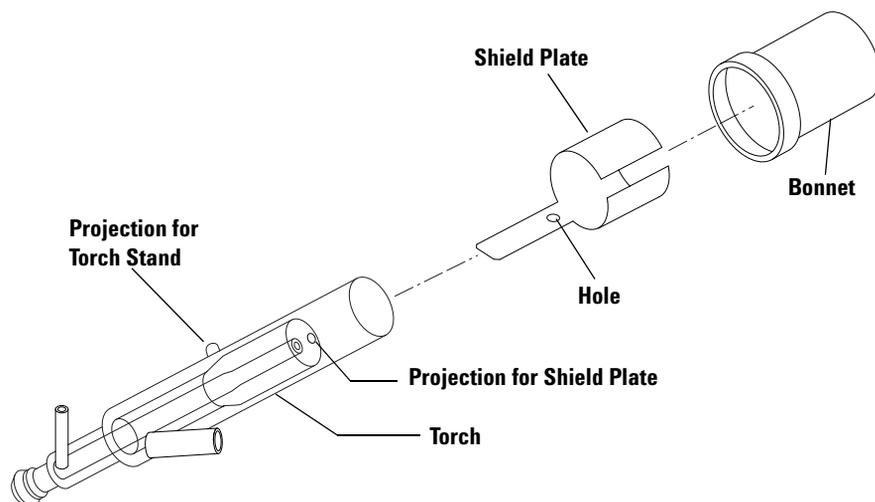


Figure 63 Torch, Shield Plate and Bonnet

2 Insert the torch and the shield plate into the bonnet.

Insert the assembled torch and shield plate into the bonnet until the bonnet touches the projection of the torch.

CAUTION

Ensure that the bonnet direction is correct. The brim of bonnet is set on left side.

Clean the Ignition Terminal and Shield Contact Area

Before installing the shield torch, clean the metallic surface that contacts the torch mounting assembly ignition terminal and shield plate as necessary.

- 1 **Moisten a cotton swab with methanol (HPLC grade).**
- 2 **Wipe the metallic surface that contacts the ignition terminal and shield contact plate.**

Installing the ShieldTorch System

To install the ShieldTorch, complete the following steps:

- 1 **Place the torch in its holder.**

With the auxiliary gas fitting on top of the torch, carefully slide its open end inside the work coil and at the same time align the projection for the torch stand into the torch stand hole. Refer to [Figure 58](#) showing how the projection for torch stand aligns with the torch stand hole. The end of the middle, or auxiliary, tube will be 1 to 2 millimeters from the top of the work coil, as shown in [Figure 64](#). Close the quick- release clamp over the torch.

NOTE

When you place the torch with auxiliary gas fitting on the top, the projection on the torch for the shield plate faces down. It is important that a part of the shield plate contacts the metal plate on the torch holder.

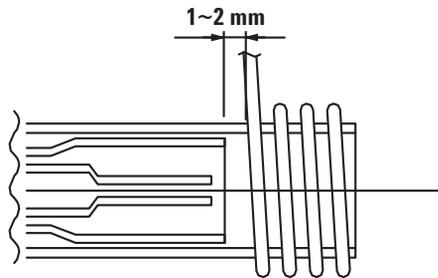


Figure 64 Position of Torch Inside Work Coil

2 Attach the hoses.

After connecting the gas hoses, tighten the nuts on the fittings. See [Figure 59](#) to correctly identify the gas hoses. To connect the gas hoses to the torch, complete the following steps:

CAUTION

Do not over-tighten the nuts on the quick-connect clamps. If you apply too much pressure, the torch will break.

a Attach the sample transfer tube (connector tube).

Connect the sample transfer tube from the spray chamber to the fitting on the end of the torch.

b Attach the auxiliary gas hose.

Connect the auxiliary-gas hose, which is smaller in diameter than the plasma gas hose.

c Attach the plasma gas hose.

Connect the plasma gas hose to the remaining gas fitting on the torch.

3 Recheck the position of the bonnet, shield plate, and torch.

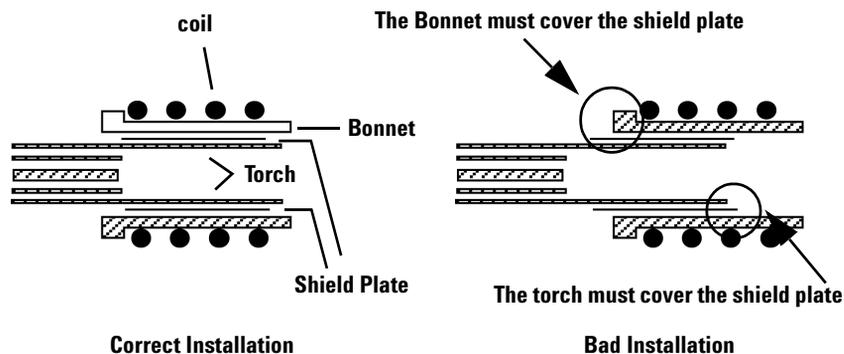


Figure 65 Shield Plate installation

4 Close the torch box and instrument.

Close the torch cover and tighten its thumbscrew. Close the instrument hood.

CAUTION

The torch cover must be on while using the torch. This cover reduces the emission of noise from the plasma.

Maintaining the Cones

Clean the cones when there are deposits on the orifice or the orifice is discolored. Because of its proximity to the torch, the sampling cone needs cleaning more frequently than the skimmer cone.

The MassHunter Workstation (or ChemStation) software can also indicate that maintenance is needed, if you observe high background memory, sensitivity loss, distorted peak shapes, or an interface vacuum reading higher than 5.0×10^2 Pa.

If the memory cannot be reduced, clean the sampling cone or skimmer cone, or replace them with a new sampling cone or skimmer cone.

Locating Tools and Supplies

To maintain the interface cones, the following items are needed:

- Safety glasses and protective lab gloves
- Sampling cone wrench
- Skimmer wrench
- Alumina abrasive powder
- Sampling cone O-rings (P/N: G1820-65025)
- 2% Nitric Acid bath
- Pure water
- Cotton swabs (P/N: 9300-2574)
- Citranox (P/N: 5188-5359)
- Magnifying lens (10x)
- Ultrasonic bath
- 2% detergent solution
- Indelible marker

NOTE

Pure water used for cleaning is indicated as water that has been generated using the ion-exchange method and a membrane filter, and has an electrical resistance of at least 18 M Ω .

Removing the Cones**CAUTION**

The **platinum skimmer cone** should only be used with the brass skimmer base. This allows the cone to operate at a lower temperature than with the standard stainless steel skimmer base, extending the life of the cone. When fitting the brass skimmer base, transfer the extraction lenses from the stainless steel base. For removing and refitting the skimmer base and the extraction lens, refer to the [“Removing the Extraction Lenses”](#) and the [“Refitting the Extraction Lenses”](#) in the section entitled “Maintaining the Lenses”.

The **nickel skimmer cone** works better at higher temperatures and should always be used with the stainless steel base.

Be sure to wear gloves when handling the cones. To remove the cones, complete the following steps:

1 Put the instrument in Standby mode.

See Chapter 3, [“Startup, Shutdown and Status”](#) in this manual.

2 Open the left cover.**WARNING**

To avoid burns, wait 10 minutes after switching the plasma off before you open the instrument.

3 Remove the torch box cover by loosening the two screws.

4 Move the torch box assembly to its maintenance position using the MassHunter Workstation (or ChemStation) software.

To move the torch box assembly to its maintenance position, complete the following steps:

a Select ***Instrument>>Instrument Control*** from the ICP-MS Top window. The ***Instrument Control*** window appears.

b Select ***Maintenance>>Sample Introduction***.

The ***Sample Introduction Maintenance*** dialog box appears (Figure 66).

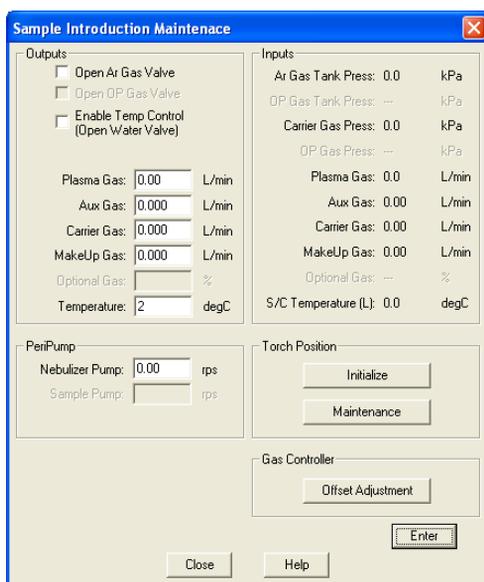


Figure 66 Sample Introduction Maintenance Dialog Box

c Click ***Maintenance***.

The torch box moves away for easy interface access.

NOTE

Unless the torch box cover is taken off, the cones cannot be removed. When you click **Maintenance** without removing the cover, click **Initialize** and remove the torch box cover. Click **Maintenance** again.

5 Remove the sampling cone.

Insert the sampling cone wrench into the sampling cone's exterior holes (Figure 67). Rotate the wrench counterclockwise to loosen the cone. Unscrew the cone by hand and remove it, holding it by its perimeter.

CAUTION

Do not touch the sampling cone orifice. Even slight pressure can damage the orifice. Loosen the sampling cone by holding it firmly.

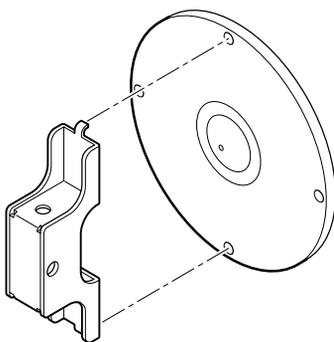


Figure 67 Removing the Sampling Cone

6 Pull and remove the sampling cone slowly to the axis. The skimmer cone can be seen inside.

CAUTION

Take care not to move the sampling cone vertically or allow it to fall. This would cause the tip of the skimmer cone to bump against the bottom of the sampling cone and cause damage.

7 Remove the skimmer cone.

Insert the skimmer wrench into the skimmer cone exterior holes and rotate the wrench counterclockwise to loosen the cone (Figure 68). Unscrew the cone by hand and remove it. Hold the cone by its perimeter.

CAUTION

Do not touch the skimmer cone orifice. Even slight pressure can damage the orifice.

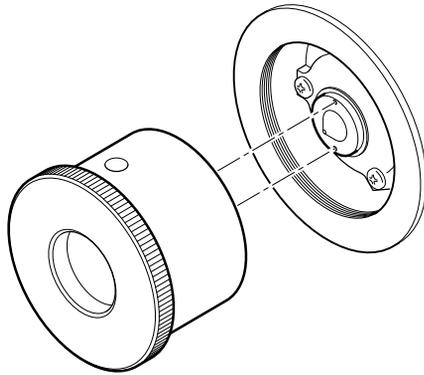


Figure 68 Removing the Skimmer Cone

Cleaning the Cones

Each cone must retain the shape of its orifice to be effective during analysis. Hold each cone by its perimeter and use only light pressure with your hand as you clean the orifice.

There are 4 cleaning steps, the first two of which should remove normal contamination. Perform the cleaning step that is appropriate for the level of contamination. After cleaning, allow the cone to dry and check the background, continuing to the next step if the background has not lowered.

CAUTION

- Do not over-clean the cones. It may shorten the life of cones.
- When setting the sampling and skimmer cones down, place them with the orifices pointing up. Even the slightest pressure can deform the orifice.
- Do not use organic solvents like acetone for cleaning the sampling cone and the skimmer cone. This is to avoid the molecular ions from the organic substances and other impurities (especially Na) in organic solvents.

To clean the cones, complete the following steps:

1 Check and clean the O- ring.

Remove the sampling cone O- ring, which is in the interface opening. If the O- ring is cracked, replace it. If it is dirty or very dry, then wipe it with pure water.

CAUTION

Do not put grease on the O-ring of the sampling cone.

2 Clean with pure water (Step 1)

1 Dip a cotton swab in pure water and clean both sides of the cone. Hold the cone by its outer perimeter. Carefully clean without using force as the orifice is easily deformed.

2 Rinse with pure water.

3 Ultrasonic the cone in pure water for 2 to 3 minutes.

3 Clean with a 2% Citranox solution (Step 2)

1 Ultrasonic the cone in a 2% Citranox solution for 2 to 3 minutes.

2 Rinse with pure water.

4 Clean with a 2% nitric acid solution (Step 3)

1 Dip a cotton swab in a 2% nitric acid solution and clean both sides of the cone. Hold the cone by its outer perimeter. Carefully clean without using force as the orifice is easily deformed. Wear gloves when cleaning with nitric acid.

2 Rinse with pure water.

5 Clean with alumina powder and Citranox (Step 4)

1 Use a mixture of alumina powder and pure water as a polishing solution. Dip a cotton swab in the polishing solution and clean both sides of the cone. Hold the cone by its outer perimeter. Carefully clean without using force as the orifice is easily deformed.

2 Rinse with pure water.

3 Ultrasonic the cone in a 2% Citranox solution for 2 minutes.

4 Rinse in pure water.

5 Ultrasonic the cone in pure water for an additional 2 to 3 minutes.

NOTE

The cones must not be stored in pure water for more than one night or they will become damaged by corrosion.

Check the Orifice

Retaining the correct shape and size of each orifice is critical for accurate analysis results. Ensure that the orifice diameter and the orifice shape of both the sampling cone and the skimmer cone have not changed. Use a 10x-magnifying lens to check the cone orifice. If the sampling cone's orifice is larger than 1.0 millimeters, replace the cone. If the skimmer orifice is larger than 0.4 millimeters, replace the cone.

It is necessary that the orifice shape of the sampling cone and the skimmer cone is perfectly round. If it is deformed, replace the cone.

NOTE

Discoloration or build up of impurities on the periphery of the sampling cone has no influence on the analysis.

CAUTION

- The tip part has great influence on analytical results. Handle with care and do not deform the tip.
- The tips of the sampling cone and the skimmer cone are easily deformed. Be careful when handling them.

Refitting the Cones

This procedure assumes the torch box assembly is in its maintenance position and the instrument is in Standby mode. Refer to the previous section, [“Removing the Cones”](#) for more information.

NOTE

The **platinum skimmer cone** should only be used with the brass skimmer base. This allows the cone to operate at a lower temperature than with the standard stainless steel skimmer base, extending the life of the cone. When fitting the brass skimmer base, transfer the extraction lenses from the stainless steel base. For removing and refitting the skimmer base and the extraction lens, refer to [“Removing the Extraction Lenses”](#) and [“Refitting the Extraction Lenses”](#) in the section entitled 'Maintaining the Lenses'.

The **nickel skimmer cone** works better at higher temperatures and should always be used with the stainless steel base.

To reattach the skimmer cone and sampling cone, complete the following steps:

1 Reattach the skimmer cone.

Using the skimmer wrench, screw the skimmer cone into the interface opening. Tighten the cone with the skimmer wrench (Figure 68).

CAUTION

If the sampling cone and the skimmer cone are not tightly installed in the base, the skimmer cone is not cooled, the tip melts, or the vacuum does not reach the standard value and it cannot change to Standby mode. Firmly install the sampling cone and the skimmer cone.

2 To install the sampling cone, complete the following procedure:

It is important that the sampling cone is not over tightened when installing it on the interface housing.

- 1 Install the sampling cone on the interface housing without the O- ring.
- 2 Hold the sampling cone by its outer perimeter and turn clockwise, tightening the cone until it contacts the interface housing.
- 3 Draw an alignment line on the sampling cone and the edge of the interface housing using an indelible marker. This mark indicates the correct tightened position of the cone on the interface housing after the O- ring has been attached.

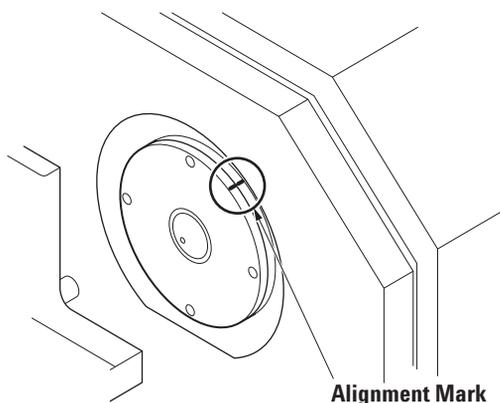


Figure 69 Sampling Cone and Interface Alignment Mark

- 4 Remove the sampling cone from the interface housing.

4 Maintenance

- 5 Place the O- ring in the gap on the interface.
 - 6 Replace the sampling cone on the interface. Turn by hand until tight. Be careful not to allow the cone to drop. Use your other hand to support the cone.
 - 7 Using the supplied sampling cone removal tool, tighten to the position indicated by the mark (Figure 69).
- 3 Move the torch box back to the original position, install the torch box cover, and close the cover.**

CAUTION

Attach the torch box cover after maintenance. This cover reduces the emission noise from the plasma.

Testing the Cones

Perform the basic test after maintenance. See “Testing After Maintenance” later in this chapter. If the vacuum level is inadequate when the plasma is on ($> 5 \times 10^{-2}$ Pa of the vacuum pressure (IF/BK), $> 2 \times 10^{-3}$ Pa of the vacuum pressure (AN)), switch to standby mode and wait 10 minutes before checking that the cones are attached tightly enough to seal with the vacuum chamber.

Maintaining the Lenses (Agilent 7500a)

There are two sets of lenses in the Agilent 7500a. These are the extraction lenses and the main lens assembly, which is comprised of the Einzel lens and the Omega lens. In this procedure both sets of lenses are removed and dismantled before cleaning each lens element individually. However, each lens assembly can be cleaned separately. It is critical to reassemble the ion lenses in exactly the same order as before dismantling. Work on a large clean surface where each piece can be kept in the order that it has been removed.

NOTE

If you are using the Agilent 7500cs/cx, refer to [“Maintaining the Lenses \(Agilent 7500cs or 7500cx\)”](#) on page 4-91.

To clean the main lens assemblies, it is necessary to open the analyzer vacuum chamber. The section, [“Working Inside the Vacuum Chamber”](#), contains procedures to correctly open and close this chamber.

In addition to the recommended cleaning frequency in the maintenance schedule, the lenses should be cleaned if any of the following symptoms are observed:

- The ion signal is unstable. For example, a signal drift of more than 10% in an hour. In this block, the cause may be other parts such as the sample introduction.
- After changing the lenses' voltage in the MassHunter Workstation (or ChemStation) software, the resulting ion signal changes very slowly. For example, vary the parameter drastically step by step and it takes more than 1 second for the signal to be stabilized.
- While tuning, when changing the tuning parameter value, the response speed of the signal is different between changing the value from the plus direction than changing it from the minus direction.

To minimize maintenance time, clean the Einzel lens and Omega lens first. After cleaning the lenses and while pumping down, clean the extraction lens. While cleaning the Einzel and Omega lens, replace the vacuum cover and allow the instrument to pump down.

CAUTION

Switch off the Agilent 7500 power when opening the ion lens chamber and analyzer chamber for cleaning ion lenses and performing maintenance.

Maintenance is performed on the following ion lenses.

- Extraction Lenses
- Einzel Lens
- Omega Lens

Locating Tools and Supplies

To maintain the ion lenses, you need the following supplies and tools:

- Safety glasses
- Close-fitting laboratory gloves
- Pure water
- 2% detergent solution
- Methanol (HPLC grade)
- Polishing paper (#400, #1200 grit P/N: G1833-65404)
- Allen wrench (included in the tool kit)
- Ultrasonic bath
- Ohm meter
- Laboratory tissue
- Phillips screwdriver
- Jewel driver
- Alumina abrasive powder (P/N: 8660-0791)
- Glass beaker (large/small)
- Plastic tray
- Tweezers
- Cotton swabs (P/N: 9300-2574)

- * Use clean and degreased tools.
- * Use gloves that are powder-free and tolerant to acetone.

NOTE

Pure water used for cleaning is indicated as water that has been generated using the ion-exchange method and a membrane filter, and has an electrical resistance of at least 18 M Ω .

CAUTION

- The parts in the vacuum chamber don't like stains. Be sure to wear clean gloves and handle them in a dust-free place.
- Work in a well-ventilated place due to the use of organic solvents.
- Do not soil or damage the surface of the O-ring. This will cause a vacuum leak.

Working Inside the Vacuum Chamber

The vacuum chamber must be sealed completely to achieve the high vacuum required by the quadrupole. Poor vacuum affects performance. This section explains how to break vacuum and how to achieve a good vacuum after the chamber has been opened. The chamber must be kept clean by wearing gloves and covering the unsealed chamber when not working on it.

NOTE

It is not necessary to open and close the vacuum chamber when removing the extraction lenses. It is necessary only when removing the Einzel lens and the Omega lenses. For removing the extraction lens, the Einzel lens, and the Omega lens, refer to [“Removing the Extraction Lenses”](#), [“Removing the Einzel Lens - Omega Lens Assembly”](#) and [“Removing Plate Bias Lens”](#) in this section.

Opening the Vacuum Chamber

Wear gloves when working inside the vacuum chamber. To correctly open the vacuum chamber, complete the following steps:

1 Shut down the instrument.

See [Chapter 3, “Startup, Shutdown and Status”](#).

2 Slowly loosen the vacuum vent valve on the front right side of the vacuum chamber. (For location, see [Figure 70](#))

Loosen the vent valve (only 1 turn) to let air into the vacuum chamber. A hissing sound begins as the air rushes in.

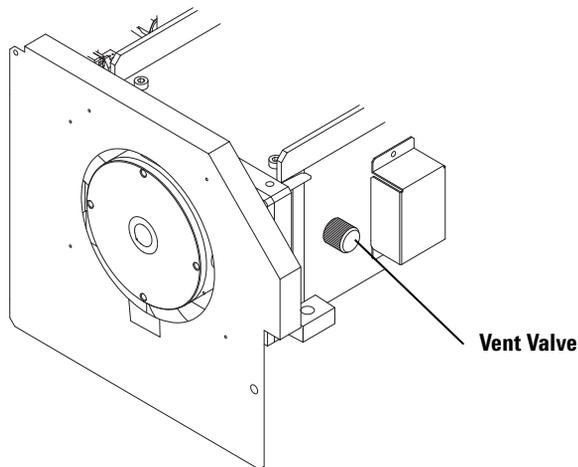


Figure 70 Vent Valve

3 Unscrew the vacuum cover.

Using an Allen wrench, unscrew the cover while waiting for the pressure to equalize (this may take up to 5 minutes).

4 When the pressure is equalized, open the cover.

After the hissing sound is finished, open the cover of the vacuum chamber.

5 Refit the vacuum vent valve.

Screw the vent valve back into the side of the vacuum chamber.

6 Place the cover on the vacuum chamber unless working inside it.

If the cover is left open, dust enters into the vacuum chamber. To maintain a clean vacuum environment, keep the vacuum chamber covered with the chamber cover when you are not actually working inside it.

NOTE

During long maintenance periods such as when cleaning the ion lens, place the cover on the vacuum chamber and pump down the system to the Standby mode.

Sealing the Vacuum Chamber and Pumping Down the System

Always wear gloves when working with an open vacuum chamber. To correctly seal the vacuum chamber, complete the following steps:

1 Check and clean the O- ring.

Replace the O- ring if it is cracked or compressed. Otherwise, wipe it with pure water.

2 Place the O- ring on the vacuum chamber.

Fit it snugly into the groove on the top of the chamber.

3 Check and clean vacuum chamber.

Check visually and if needed wipe inside the vacuum chamber and inside of the cover using pure water and clean laboratory tissue.

CAUTION

Clean the cover with pure water and a clean laboratory tissue before placing the cover on the vacuum chamber. Do not grease the O-ring of the vacuum chamber cover.

4 Cover the vacuum chamber.

Place the cover on the vacuum chamber and use the Allen wrench to re-tighten the screws. Tighten the screws in sequence, working from one side to the other until they are tight.

5 Ensure that the vacuum vent valve is tightened.

6 Close the cover.

7 Pump Down the System.

- Turn on the Instrument Power switch.
- From the MassHunter Workstation (or ChemStation), re-start ICP- MS Top. If the ICP- MS Top is already active, close the session and re-start ICP- MS Top.
- Select **Instrument>>Instrument Control** from the ICP- MS Top window.
- Select **Vacuum>>Vacuum ON**. After a short delay the Pumps will start and the pump down will start. When the vacuum starts, the cover will slide down a little, therefore tighten the screw again.

CAUTION

After leaving the cover open for a long period of time, if the humidity is high, or after replacing or cleaning the parts inside, it may take a while to reach Standby mode. If it takes more than 5 hours to reach the Standby mode, an error will be generated. After acknowledging the error, try to change to the Standby mode again.

Removing the Extraction Lenses

The two extraction lenses are located through the interface behind the skimmer cone. The sampling and skimmer cones must be removed before removing the extraction lens assembly.

NOTE

This procedure assumes the instrument is in Standby mode and that the cones have been removed. To remove the cones, see “[Maintaining the Cones](#)” earlier in this chapter.

CAUTION

Disassemble in a dust-free place.

To remove the extraction lenses, complete the following steps:

1 Locate the extraction lens series.

The following diagram shows the location of the ion lenses behind the skimmer cone.

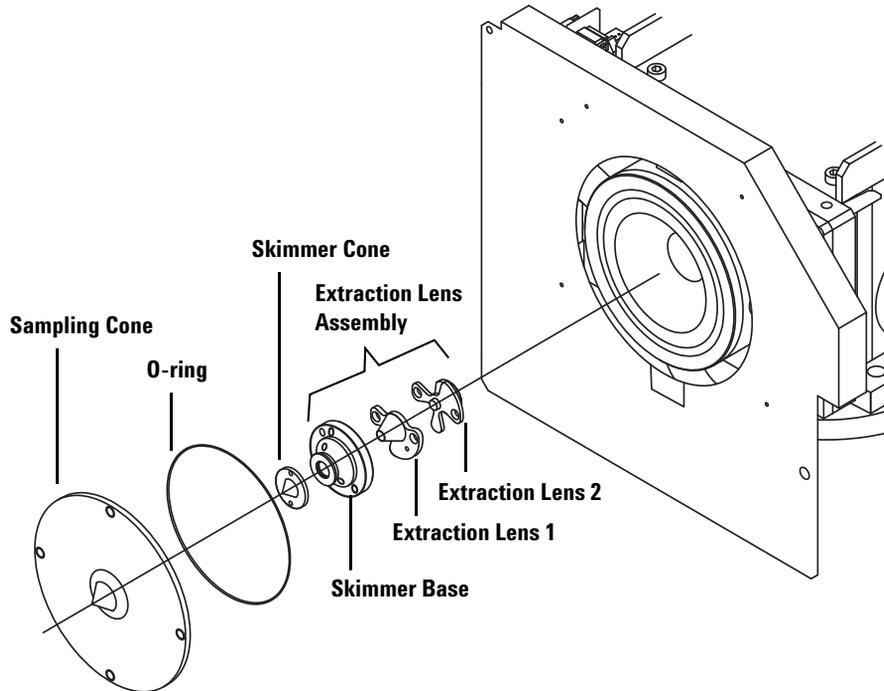


Figure 71 Interface Cones and Extraction Lenses

2 Remove the extraction lens assembly.

Using an Allen wrench, loosen the three screws from the skimmer base. Wearing gloves, pull the lens assembly, including the base, out of the instrument and set it down on a clean surface.

3 Disassemble the extraction lens assembly.

Disassemble the lens assembly so the orientation matches the following diagram.

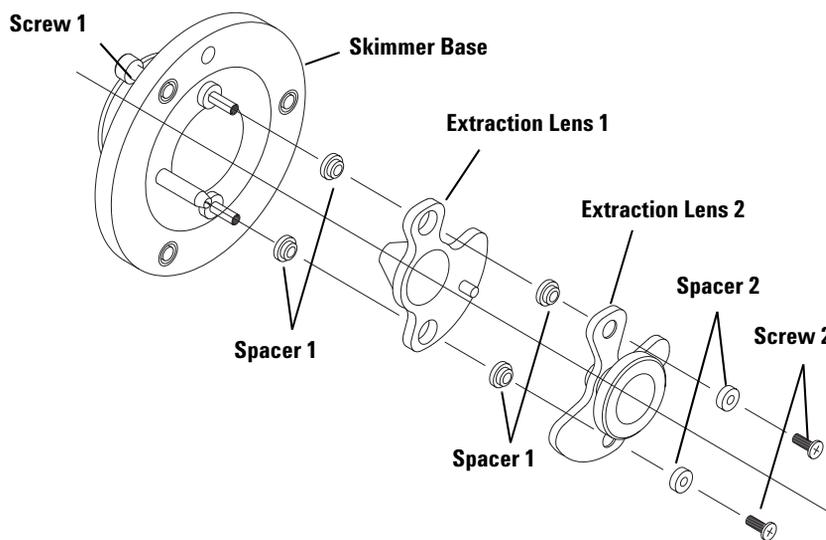


Figure 72 Expanded View of the Extraction Lenses

Removing the Einzel Lens - Omega Lens Assembly

The Einzel lens - Omega lens assembly is positioned inside the intermediate section of the vacuum chamber behind the extraction lenses (Figure 73). The slide valve moves between these two sets of lenses to seal the vacuum chamber.

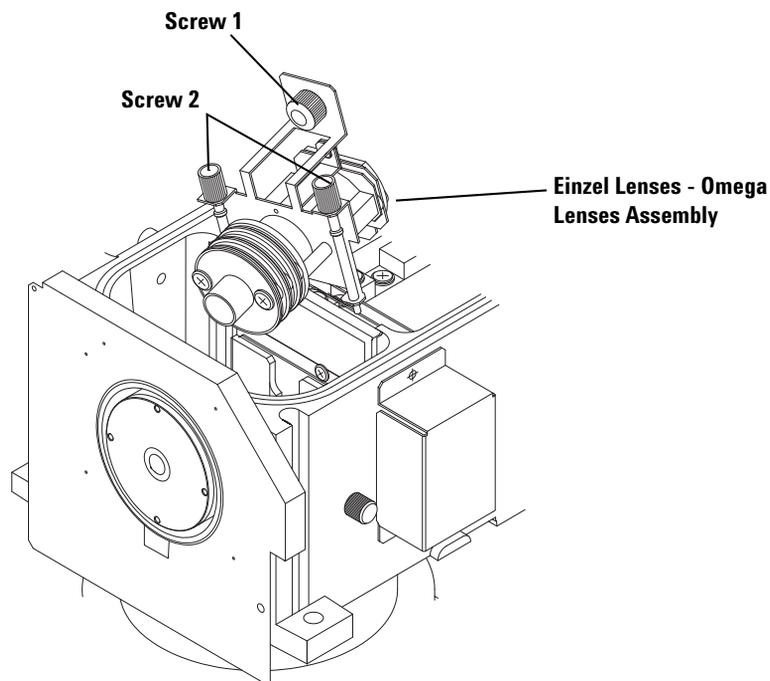


Figure 73 Einzel Lens - Omega Lens Assembly

CAUTION

Disassemble in a dust-free place.

To remove the Einzel lens - Omega lens assembly, complete the following steps:

1 Shut down the Agilent 7500.

See Chapter 3, “[Startup, Shutdown and Status](#)” in this manual.

WARNING

This procedure exposes you to the high voltages of the Agilent 7500, which can be lethal. Shut the instrument down completely before proceeding.

2 Vent the analyzer vacuum and remove the vacuum cover.

See “[Working Inside the Vacuum Chamber](#)” earlier in this chapter.

3 Remove the Einzel lens - Omega lens assembly.

Wearing gloves, loosen the three screws (screw 1 and screw 2 in [Figure 73](#)) in the lens base plate. Lift the lenses assembly to a higher place in a slanting direction like the figure. Set down the Einzel lens assembly on a clean surface. Place the cover on the vacuum chamber after the lens assembly has been removed.

To remove the Plate Bias Lens, refer to “[Removing Plate Bias Lens](#)”.

CAUTION

Be careful not to bump into the electrode on the bottom when lifting the lenses assembly.

4 Disassemble the Einzel lens - Omega lens assembly.

Disassemble the lens assembly so the orientation matches the following diagram. (Figure 74)

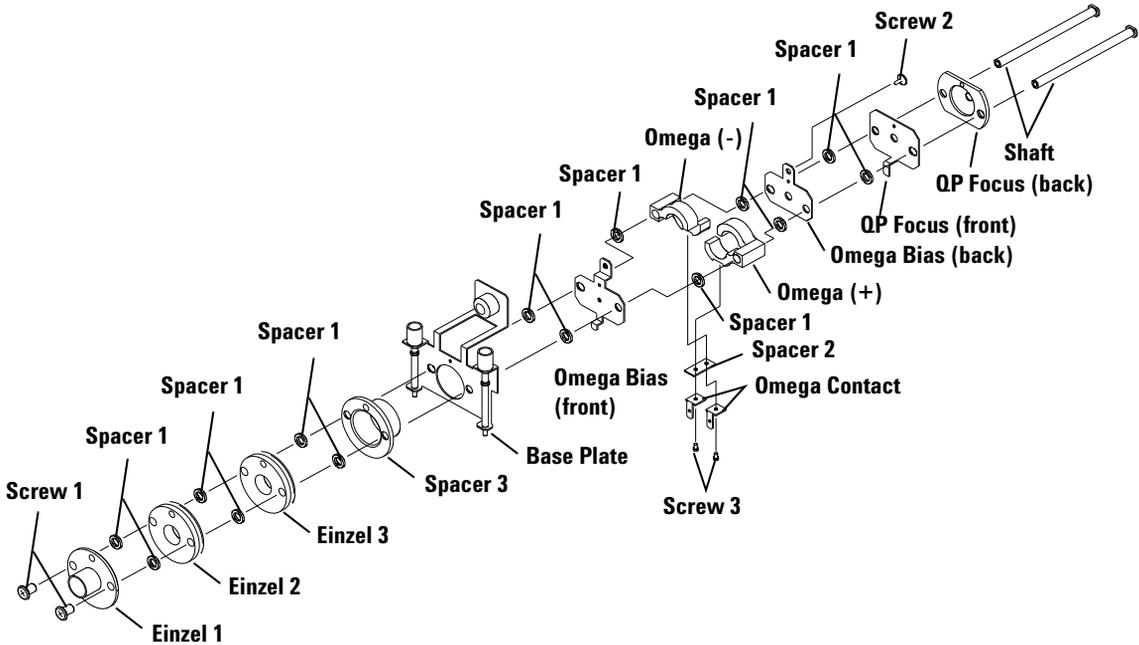


Figure 74 Expanded View of Einzel Lens - Omega lens assembly

Leave the lens base plate, spacers and screws in their disassembled locations while cleaning the Einzel lens and the Omega lens. Einzel 2 and Einzel 3 are identical.

Removing Plate Bias Lens

The plate bias lens is located between the Einzel lens-Omega lens assembly and the quadrupole mass filter. (Figure 75)

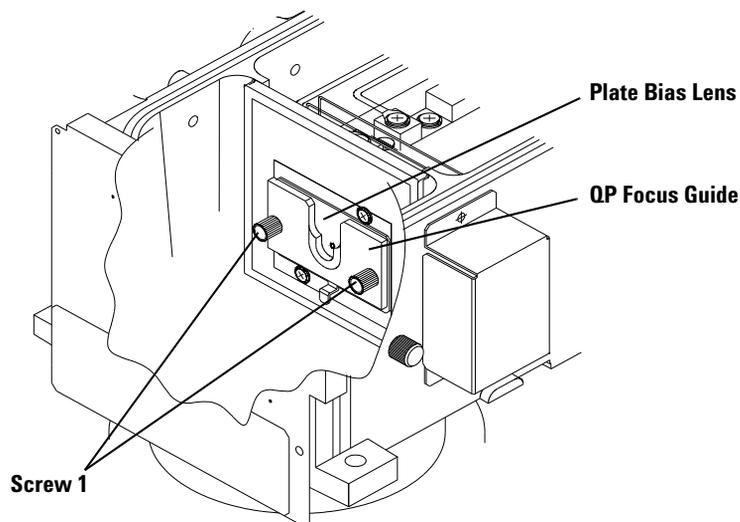


Figure 75 Position of Plate Bias (after removing Einzel lens-Omega lens assembly)

CAUTION

Disassemble in a dust-free place.

It is necessary to remove the Einzel lens- Omega lens assembly before removing the plate bias lens.

To remove the plate bias lens, complete the following steps:

1 Remove the Einzel lens- Omega lens assembly.

For the method regarding the removal of the Einzel lens- Omega lens assembly, see the preceding section.

2 Remove the plate bias lens.

Remove the screw fixing the plate bias lens and the QP focus guide (Screw 1), and remove the QP focus guide and the plate bias (Figure 76). Put the plate bias lens on a clean surface. Put the cover on the vacuum chamber after removing the lens.

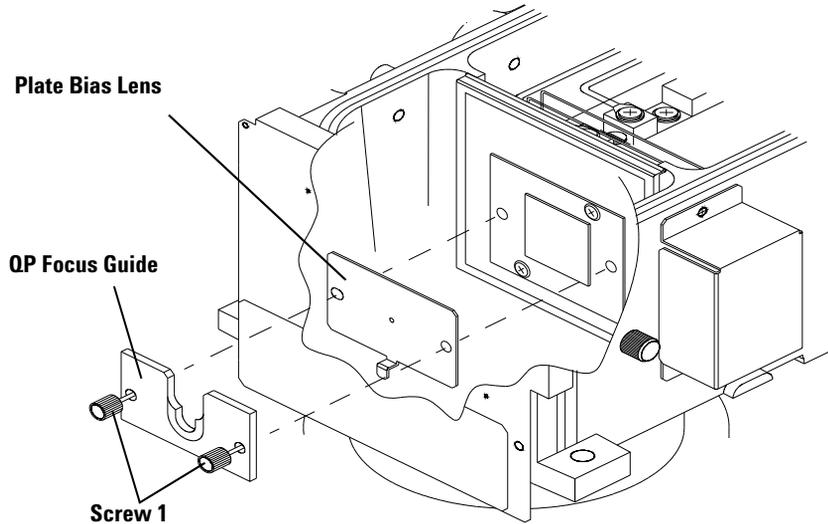


Figure 76 Plate Bias Lens

Cleaning the Lenses

The extraction, Einzel, Omega, and plate bias lenses can be cleaned separately or together. Complete the following steps:

1 Clean each lens orifice.

Polish the orifice of each lens with 400 grade polishing paper, which is provided in the maintenance kit, until any discoloration is removed. Polishing must be performed on the entire surface of the lenses; especially the inner surface of the holes where the ion beam passes through. Cleaning the entire surface of the extraction lens is difficult, so just cleaning the inner and outer conical surfaces is acceptable. Clean the entire curved surface of the Omega(+) and Omega(-) lens. Be careful not to deform the tip of the extraction lenses by mishandling it.

CAUTION

When cleaning a lens it is especially important to thoroughly polish the holes where the ions will pass through.

Do not polish the flange surface of the skimmer base.

2 Polish each lens orifice.

Polish the orifice of each lens with alumina abrasive powder.

3 Wash and rinse each lens.

First, wash the polished lenses with plenty of pure water. Ultrasonic the lenses in a 2% detergent solution for 5 minutes. Rinse the polished lenses with plenty of pure water and ultrasonic for an additional 5 minutes in pure water.

4 Dry the lenses and screws.

Place the lenses in pure water and then lay them on a clean laboratory tissue. Let them dry by evaporation; do not wipe them dry.

Ensure that the spacers, screws, and shaft are kept clean. Do not touch them with bare hands. If necessary, soak the spacers, screws, and shaft in methanol for 5 minutes and rinse with pure water. Allow the components to air dry. Do not wipe the components dry. It is not necessary to polish or abrasively clean these components.

CAUTION

Completely dry all parts. If the parts are dried incompletely and are connected to the vacuum chamber, a very long time will be needed to pump down to the Standby mode. Clean the skimmer wrench with methanol and dry.

Do not use any solvent (methanol or acetone) to dry the Ion Lens parts. A small amount of solvent left on the surface of the lenses will cause hydrocarbon to adhere to the lenses.

The opposite surface of the skimmer wrench can be used as the assembling stand for the lens assembly. Clean it beforehand.

CAUTION

Do not use acetone to clean the skimmer wrench.

Refitting the Plate Bias Lens

To install the Plate Bias Lens in the vacuum chamber, start with the plate bias lens. This must be installed before installing the Einzel lens- Omega lens assembly. Otherwise, it will be impossible to install the plate bias lens.

To install the plate bias lens, wear gloves and complete the following steps:

1 Install the plate bias lens and the QP focus guide to the vacuum chamber.

Install the plate bias lens in the orientation as shown in [Figure 76](#).

2 Fix the plate bias lens and the QP focus guide with Screw #1.

Tighten Screw #1 firmly.

After finishing the installation of the plate bias lens, refit the Einzel lens- Omega lens assembly.

Refitting the Einzel Lens - Omega Lens Assembly

It is easiest to reattach the two sets of lenses in the reverse order of disassembly. Therefore, if cleaning all three sets of lenses, reassemble the Einzel Lens - Omega lens first.

To refit the Einzel Lens - Omega lens assembly, wear gloves and complete the following steps:

1 Reassemble the Einzel Lens - Omega lens assembly.

To reassemble, complete the following steps:

- 1 Insert two shafts into the QP focus (back) in the position shown in [Figure 74](#). Perfectly insert them so the shaft brim fits into the groove of the QP focus (back). Put this on the skimmer wrench so the shaft is vertical to the tools. Continue assembly using this as a stand.

- 2 Put the parts into the shaft one by one.

Refer to [Figure 74](#). The concave surface of the lenses should be up for assembly. Do not insert spacer 1 between the QP focus (back) and the QP focus (front) or between the base plate and spacer 3.

- QP focus (back)
- QP focus (front)
- Spacer 1
- Omega bias (back)
- Spacer 1
- Omega(+), Omega(-)
- Spacer 1
- Omega bias (front)
- Spacer 1
- base plate
- Spacer 3
- Spacer 1
- Einzel Lens 3
- Spacer 1
- Einzel Lens 2
- Spacer 1
- Einzel Lens 1

NOTE

The Einzel Lens 2 and the Einzel Lens 3 are the same part.

3 Tighten Screw 1 slowly.

Tighten Screw 1, then unscrew about 1 turn. Be careful not to tighten too firmly, as it may become impossible to install other parts after this.

4 Fix Spacer 2 and Omega contact to Omega(+) and Omega(-) in this order and tighten them firmly with Screw 3.**5** Re-tighten Screw 1.

Tightening screws too firmly may damage the threads of the resin screw. Do not over tighten.

6 Firmly tighten Screw 2.

- 7 Test the electrical resistance of this compound lens with an Ohm meter before continuing.

Ensure continuity between the Omega bias (front) and Omega bias (back), QP focus (front) and QP focus (back), and the base plate and spacer 3. Also ensure that there is no continuity between the base plate (ground) and each electrode.

- 2 **Attach the Einzel Lens - Omega lens assembly into the instrument.**

Remove the vacuum chamber cover. Put the Einzel lens- Omega lens assembly in the vacuum chamber as shown in [Figure 73](#). Insert the Einzel lens 1 into the wall hole on the sampling cone side.

Firmly tighten Screw 1 to fix the lens assembly to the vacuum chamber. Then, tighten (two) Screw 2 firmly to fix the print board to the lens assembly.

- 3 **Pump Down the System.**

See “[Working Inside the Vacuum Chamber](#)” earlier in this chapter.

Refitting the Extraction Lenses

The extraction lenses are circular with notches in the perimeters. To reattach the lenses and fit them back into the instrument, complete the following steps:

- 1 **Reattach the extraction lenses.**

Use [Figure 72](#) to correctly orient each piece when reassembling the extraction lenses onto the skimmer base. Then tighten each Screw 2.

Ensure that there is no continuity between the skimmer base (ground) and each leader electrode.

- 2 **Place the extraction lens assembly in the instrument.**

Tilt the extraction lens assembly vertically. Place the lens assembly through the interface into the cavity outside the vacuum chamber. Align the top hole with the guide pin.

- 3 **Attach the extraction lens assembly to the instrument.**

Adjusting the holes to the shaft on the body side and tightening (three) of Screw 1 with an Allen wrench. If the extraction lens assembly fails to form a seal with the interface chamber, operating vacuum pressures will not be achieved.

- 4 **Reattach the cone.**

See “[Maintaining the Cones](#)” earlier in this chapter for information on how to screw the cones into the instrument.

Testing the Lenses

Perform the basic test after maintenance. See “[Testing After Maintenance](#)” at the end of this chapter. If the analyzer vacuum does not achieve its correct level ($< 6 \times 10^{-4}$ Pa), check that the lenses are attached tightly enough to seal with the vacuum chamber.

Maintaining the Lenses (Agilent 7500cs or 7500cx)

The Agilent 7500 models are categorized in the following table based on the configuration of the ion lenses used.

Table 10 Agilent 7500 Ion Lenses

Ion Lens Configuration	Model
Extraction Lens Einzel Lens Omega Lens	Agilent 7500a
Extraction Lens Omega Lens-ce Reaction Cell	Agilent 7500cx
Extraction Lens Omega Lens-cs Reaction Cell	Agilent 7500cs

This procedure explains the removal, disassembly, and cleaning method for individual lenses, and the reassembly of the ion lens used in the Agilent 7500cs or 7500cx.

NOTE

If you are using the Agilent 7500a, refer to “[Maintaining the Lenses \(Agilent 7500a\)](#)” on page 4-75.

The Agilent 7500cs or 7500cx Main Lens assembly consists of 2 ion lens assemblies: the Extraction Lens- Omega Lens assembly and the Reaction Cell assembly. The Extraction Lens- Omega Lens assembly consists of the Extraction Lens and the Omega Lens. The Extraction Lens- Omega Lens and Reaction Cell assemblies can be cleaned separately. The ion lenses must be reassembled in their original configuration after cleaning. Make sure the workspace is free of contamination and large enough to lay out the dismantled components in order.

It is necessary to open the vacuum chamber to clean the Reaction cell. Refer to the procedure [“Working Inside the Vacuum Chamber”](#) on page 4- 77 for an explanation of the correct method for this procedure.

In addition to the recommended cleaning frequency in the maintenance schedule, the lenses should be cleaned if any of the following symptoms are observed:

- The signal is unstable. For example, more than 10% signal drift in an hour. This may also be caused by other parts such as sample introduction.
- The lens voltage is changed in the MassHunter Workstation (or ChemStation) software, and the resulting signal changes very slowly. For example, if you change the parameters drastically step by step, it will take more than 1 second for the signal to stabilize.
- When changing the parameters during tuning, the response speed of the signal is different when changing the value from the plus direction and changing it from the minus direction.

It is necessary to clean the Octopole if there is a signal drift, or a longer than normal period of time is required for the signal to stabilize when switching from hydrogen to standard mode.

To minimize maintenance time, clean the Reaction cell first. While cleaning the cell, replace the chamber cover and start the pumps. After cleaning, reassemble and install the reaction cell assembly, clean the Extraction Lens- Omega Lens assembly.

CAUTION

Before opening the vacuum chamber to clean the Reaction cell or for other purposes, always switch off the power to the Agilent 7500.

Perform maintenance on the following ion lens:

- Extraction Lens- Omega Lens assembly
- Reaction cell assembly

Locating Tools and Supplies

You will need the following equipment when maintaining the ion lenses:

- Safety glasses
- Pure water
- 2% detergent solution
- Methanol (HPLC grade) or acetone (EL grade) for cleaning the tools
- Polishing paper (#400, #1200 grit P/N: G1833- 65404)
- Laboratory gloves
- Allen wrench (included in the tool kit)
- Jewel driver (Phillips)
- Ultrasonic bath
- Ohm meter
- Laboratory tissue
- Screwdriver (included in the tool kit)
- Alumina abrasive powder (P/N: 8660- 0791)
- Glass beaker (large/small)
- Tweezers
- Cotton swabs (P/N: 9300- 2574)
- Plastic tray
- * Use clean and degreased tools.
- * Use close- fitting laboratory gloves that are powder free and tolerant for handling organic solvents (methanol).

NOTE

Pure water used for cleaning is indicated as water that has been generated using the ion-exchange method and a membrane filter, and has an electrical resistance of at least 18 M Ω .

CAUTION

Do not allow the parts in the vacuum chamber to become stained in any way. Always use clean laboratory gloves and handle the components in a contamination free place.

Avoid contaminating or damaging the O-ring and flange surfaces. Contaminants and damage may cause the vacuum to leak.

Working Inside the Vacuum Chamber

The vacuum chamber must be completely sealed to achieve high vacuum required by the Q-pole. Poor vacuum will affect its performance. This procedure explains how to break vacuum and how to achieve a good vacuum after the chamber has been opened. The vacuum chamber must be kept clean by wearing laboratory gloves while performing maintenance. When you are not working directly inside the vacuum chamber, keep the cover on.

NOTE

It is necessary to open the vacuum chamber when removing the Reaction cell. It is not necessary to open the vacuum chamber when you are removing the Extraction Lens-Omega Lens assembly. For more information on removing the Extraction Lens-Omega Lens and Reaction cell assemblies, refer to procedures titled [“Removing the Extraction Lens-Omega Lens Assembly”](#) on page 4-97 and [“Removing the Reaction Cell Assembly”](#) on page 4-102.

Opening the Vacuum Chamber

Wear laboratory gloves when working inside the vacuum chamber. The following procedure describes how to open the vacuum chamber:

1 Place the Agilent 7500 in shutdown mode and switch off the power.

Refer to [Chapter 3, “Startup, Shutdown and Status”](#).

2 Loosen the vacuum vent valve on the right side.

Loosen the vent valve located on the front right side of the vacuum chamber 1 turn. This allows air to slowly enter the chamber. (See [Figure 77](#) for the location of the vent valve) While air is flowing into the chamber, you should hear a soft hissing sound.

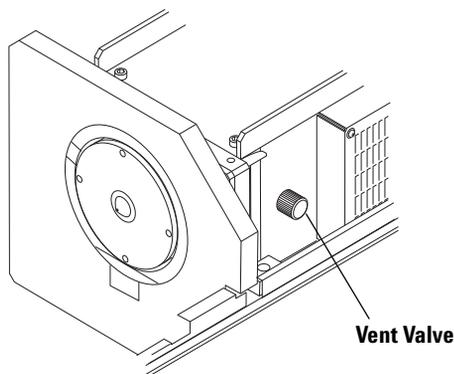


Figure 77 Vent Valve

3 Remove the screws that secure the upper cover of the vacuum chamber.

While waiting for the vacuum chamber pressure to equalize, use an Allen wrench to remove the screws on the upper cover. It will take approximately 1 minute for the chamber pressure to equalize.

4 Once the vacuum chamber has equalized, remove the cover.

When the vacuum chamber pressure has equalized, the soft hissing noise of air flowing into the chamber will stop.

5 Refit the vent valve.

Screw the vent valve back into the side of the vacuum chamber, and make sure it is closed tightly.

6 Cover the chamber with the upper cover when you are not working inside the vacuum chamber.

If the cover is left open, dust will enter into the vacuum chamber. To maintain a clean vacuum environment, cover the vacuum chamber with the upper cover when not working inside the chamber.

NOTE

During longer maintenance periods such as when cleaning the ion lens, close the upper cover on the vacuum chamber and pump down the Agilent 7500 to Standby mode.

Sealing the Vacuum Chamber and Pumping Down the System Wear laboratory gloves when working inside the vacuum chamber. The following procedure explains how to seal the vacuum chamber:

1 Check and clean the O- ring.

Replace the O- ring if it is cracked or compressed. Otherwise, wipe it down with pure water.

2 Place the O- ring in the groove in the vacuum chamber.

Place the O- ring in the upper groove so that it fits snugly.

CAUTION

Do not grease the O-ring of the vacuum chamber cover.

If you accidentally get grease on your gloves while you are working, you can potentially contaminate the lens and other components.

3 Wipe off any contaminants.

Using pure water and a laboratory tissue, wipe away any contaminants found in the vacuum chamber and on the cover.

4 Close the cover on the vacuum chamber.

Place the cover on the vacuum chamber and secure the screws in sequence, working from one side to the other with the Allen wrench.

5 Make sure the vacuum vent valve is closed.

Re-check the vent valve to make sure it is securely tightened.

6 Close the hoods.

7 Pump down the system.

- Turn on the power.
- Re-start the ICP- MS Top window from MassHunter Workstation (or ChemStation). If the ICP- MS Top window is already active, completely close the session and re-start the ICP- MS Top window.
- Select **Instrument>>Instrument Control** from the ICP- MS Top window.
- On the instrument control window, select **Vacuum>>Vacuum ON**. After a short delay the pump will be operating and the pump down will start. At that point, the O- ring will compress and the upper cover will drop slightly. Secure the screws on the upper cover one more time.

CAUTION

When the upper cover is opened for a long period of time, or the humidity is high, it can take longer for the Agilent 7500 to reach Standby mode if any components have been replaced or cleaned.

If the Agilent 7500 does not reach Standby mode within 5 hours an error will be generated. After acknowledging the error, change the Agilent 7500 to Standby mode again.

Removing the Extraction Lens-Omega Lens Assembly

The Extraction Lens- Omega Lens assembly is located through the interface behind the Skimmer Cone. The Sampling and Skimmer Cones must be removed before removing the Extraction Lens- Omega Lens assembly.

NOTE

This procedure assumes that the Agilent 7500 is in Standby mode and the Sampling and Skimmer Cones have been removed. For information on removing the Sampling and Skimmer Cones, refer to [“Maintaining the Cones”](#) in the previous section.

When removing the Extraction Lens-Omega Lens assembly, it is not necessary to open the vacuum chamber.

CAUTION

Dismantle the lens in an area free of contamination.

The following procedure describes how to remove the Extraction Lens-Omega Lens assembly:

1 Locate the Extraction Lens- Omega Lens assembly.

The Extraction Lens- Omega Lens assembly is located behind the skimmer cone (refer to [Figure 78](#) for the 7500cx and [Figure 79](#) for the 7500cs).

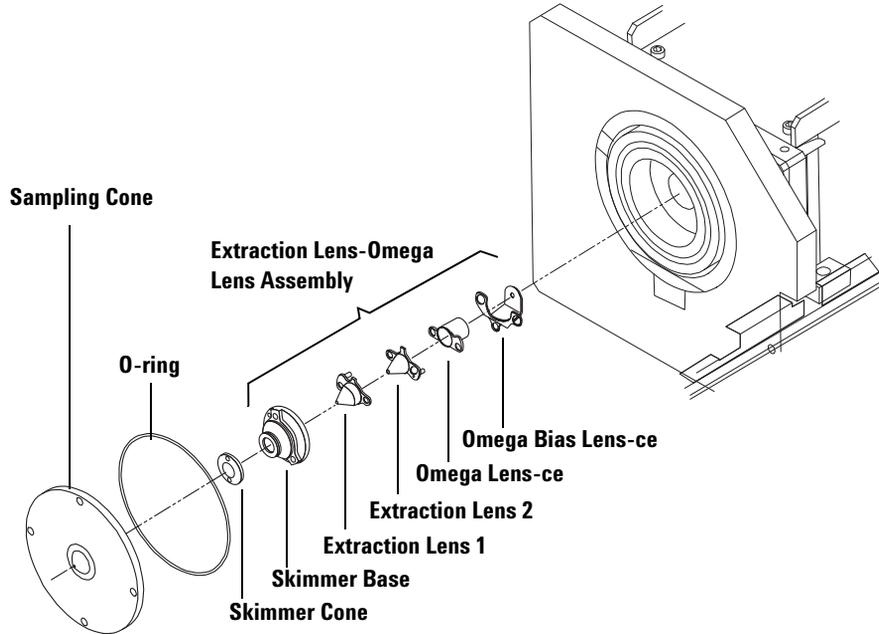


Figure 78 Sampling Cone, Skimmer Cone and Extraction Lens-Omega Lens Assembly (7500cx)

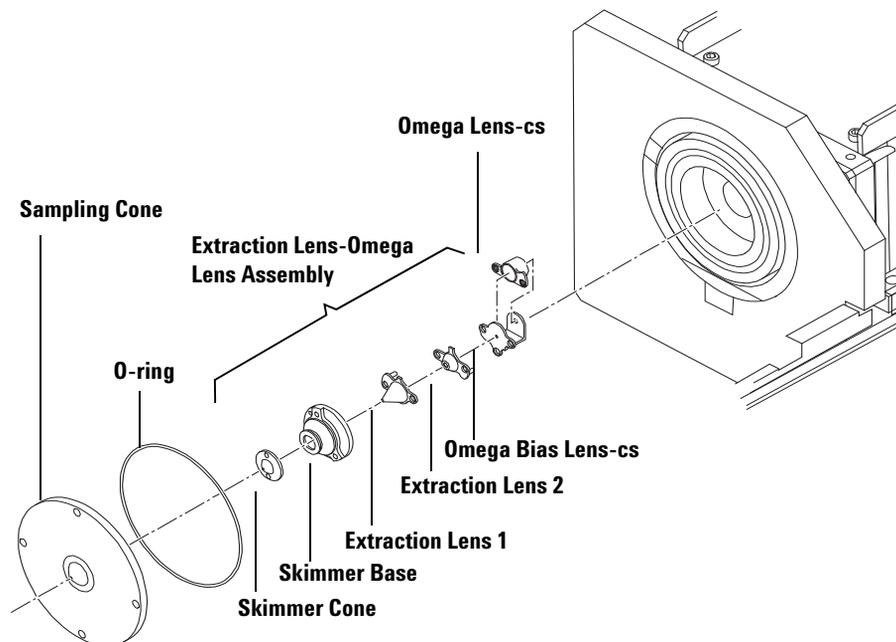


Figure 79 Sampling Cone, Skimmer Cone and Extraction Lens-Omega Lens Assembly (7500cs)

2 Remove the Extraction Lens- Omega Lens assembly.

Using an Allen wrench, loosen the 3 screws securing the Skimmer Base. Wear laboratory gloves while removing the lens assembly with the Skimmer Base. Place the component on a clean surface.

3 Disassemble the Extraction Lens- Omega Lens assembly.

Disassemble the Extraction Lens- Omega Lens assembly, with reference to the figure (refer to [Figure 80](#) for the 7500cx and [Figure 81](#) for the 7500cs.) for the orientation and location of the components.

Use the skimmer wrench as a platform during disassembly. Clean the skimmer wrench using methanol and a laboratory tissue. Place the lens assembly on top of the skimmer wrench. Adjust the skimmer base screws if it is unstable.

NOTE

When cleaning the lens, there is no need to remove the Omega Bias Guide or the Omega Bias Guide screw.

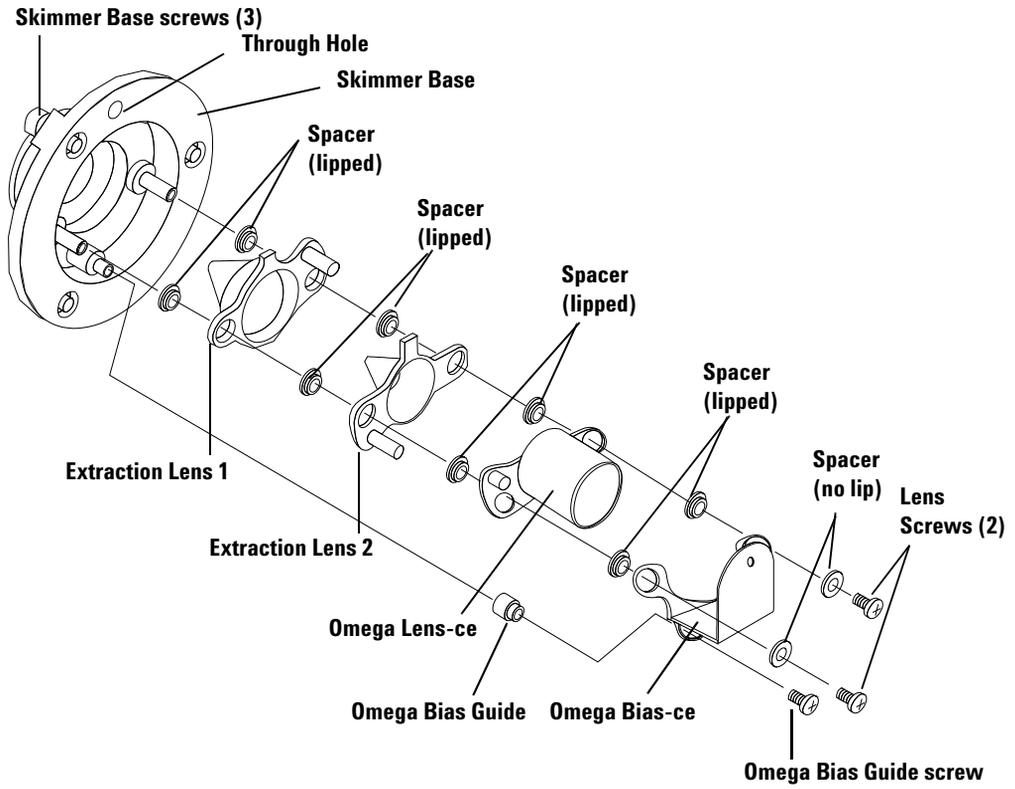


Figure 80 Expanded View of the Extraction Lens-Omega Lens Assembly (7500cx)

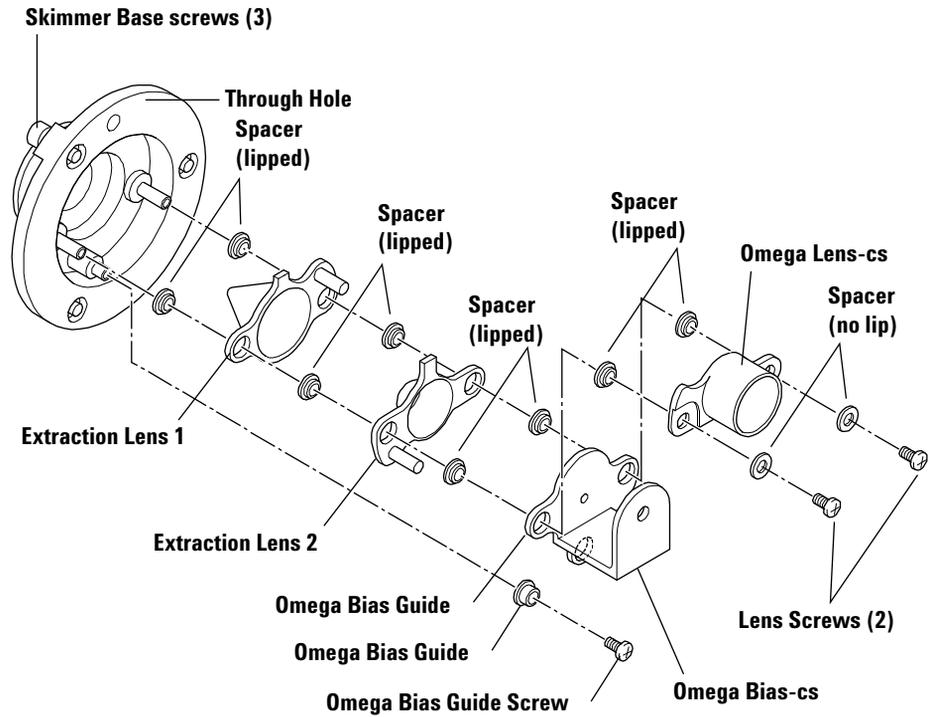


Figure 81 Expanded View of the Extraction Lens-Omega Lens Assembly (7500cs)

Removing the Reaction Cell Assembly

The Reaction cell assembly is located inside the vacuum chamber, behind the gate valve assembly. (Figure 82)

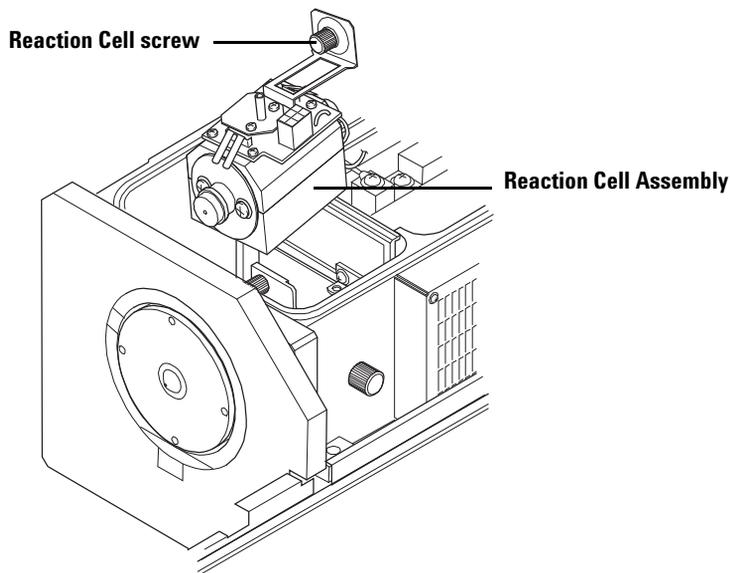


Figure 82 Reaction Cell Assembly

CAUTION

Disassemble the Reaction cell in an area free of contamination.

The following procedure describes how to remove the Reaction cell assembly:

- 1 Set the Agilent 7500 to shutdown mode and switch off the power.

Refer to [Chapter 3, “Startup, Shutdown and Status”](#) for details.

WARNING

Turn off the power to the Agilent 7500 before removing the Reaction Cell assembly from the vacuum chamber. Otherwise, you could expose yourself to the extreme danger of coming in contact with high voltage electricity.

2 Equalize the pressure in the vacuum chamber and remove the chamber cover.

Refer to “Working Inside the Vacuum Chamber” on page 4-94 in this chapter.

3 Remove the tube.

Remove the reaction gas tube from the Reaction cell assembly.

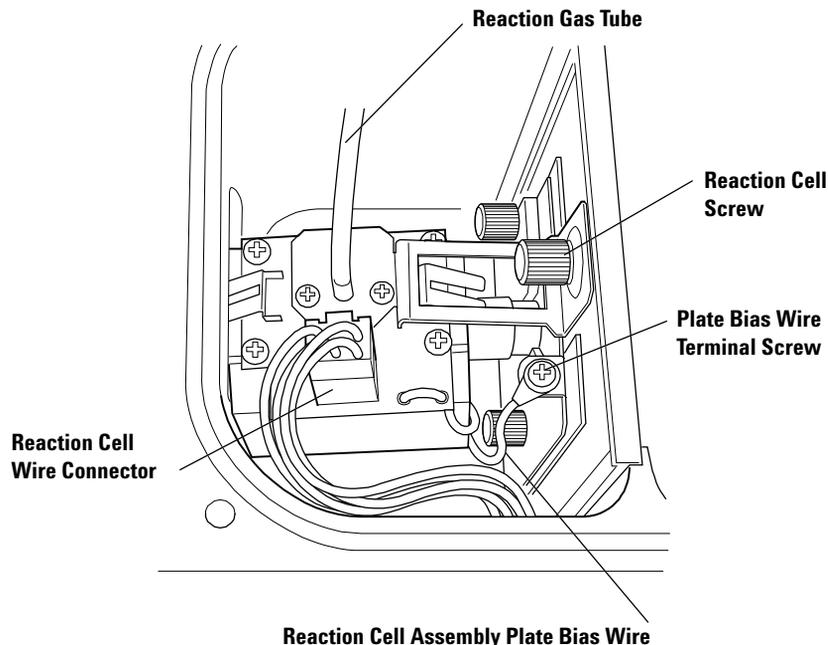


Figure 83 Reaction Cell as Refitted

4 Remove the connector.

Remove the wire connector from the Reaction cell assembly.

5 Remove the plate bias wire terminal.

Loosen the screw securing the plate bias wire terminal. Remove the plate bias wire of the Reaction cell assembly from the terminal.

6 Remove the Reaction cell assembly.

Loosen the screw for the Reaction cell. Lift the Reaction cell assembly at an angle, as illustrated in Figure 82. Place the Reaction cell assembly on a clean surface. After removing the assembly, return the cover to the vacuum chamber.

Disassembling the Reaction Cell Assembly

Disassemble the Reaction cell assembly after you have removed it from the vacuum chamber.

CAUTION

Disassemble the Reaction cell assembly in an area free of contamination and while wearing laboratory gloves.

1 Remove the Plate Bias wire.

Loosen the 2 Plate Bias wire relay screws from the Cell Exit lens. Remove the 2 Plate Bias wires from the Cell Exit lens (Figure 84).

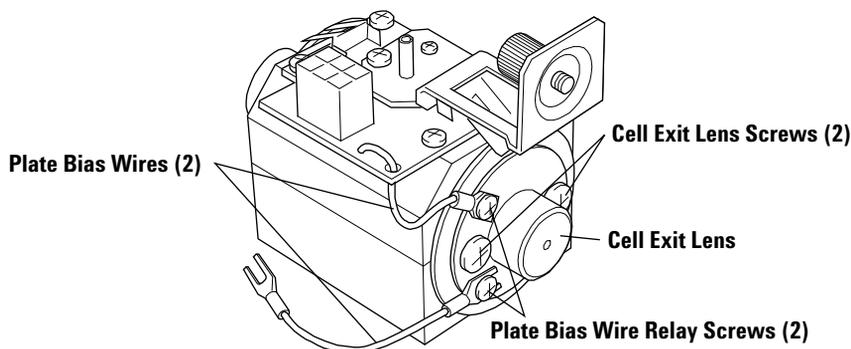


Figure 84 Plate Bias Wire

NOTE

When cleaning the Reaction Cell assembly, lay out the dismantled components in the order of their original configuration.

2 Loosen the Cell Entrance and Exit Lens assembly screws a quarter turn.

To avoid damage to the Octopole from force applied while dismantling the Octopole in the next procedure, loosen the Cell Exit Lens assembly screw (Figure 84) and the Cell Entrance Lens assembly screw (Figure 85) a quarter turn prior to disassembly.

NOTE

Only loosen the Cell Entrance and Exit Lens assembly screw a quarter turn. Loosening the screws more than that could cause the components to come apart and make the task more difficult.

3 Remove the cell assembly screws.

Remove the 4 screws located on the bottom side of the Reaction cell assembly to open the Reaction cell. Remove the upper block allowing the Octopole assembly to remain on the lower block.

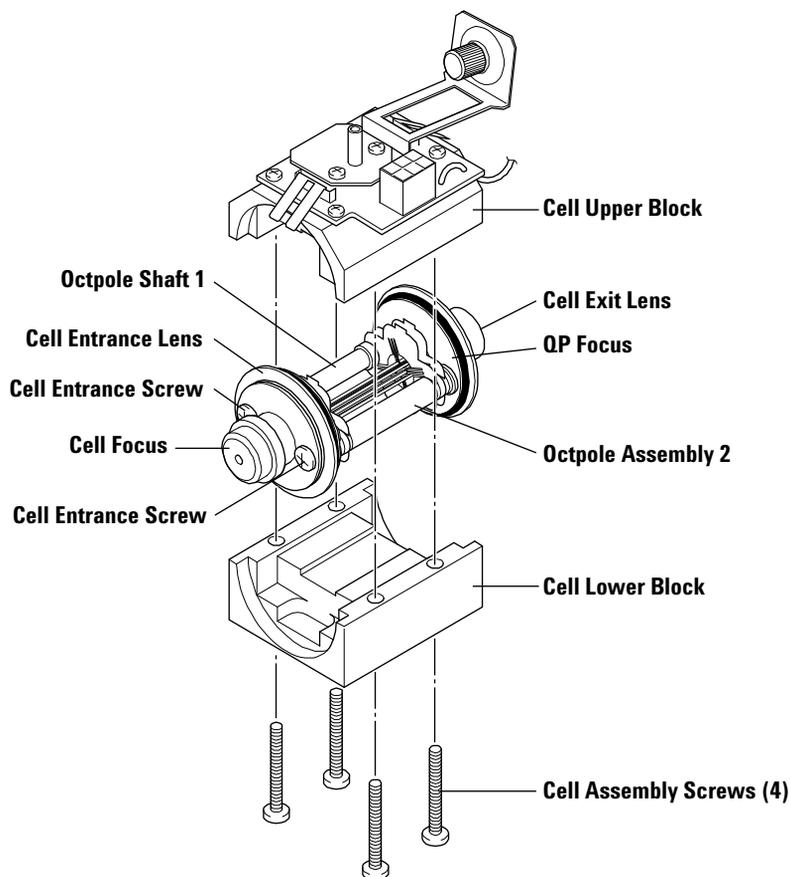


Figure 85 Reaction Cell Assembly Dismantled

NOTE

When cleaning the Reaction cell assembly, be sure to line up the components as they are dismantled to assure they will be refitted in the same order.

The diameter of Octopole shaft 1 differs from Octopole shaft 2. You can determine the direction of assembly by matching them up with the shoulder height of the cell upper and lower cell block.

4 Remove the Cell Focus, Cell Entrance Lens, and Spacer.

The Cell Focus, Cell Entrance Lens, and spacer are layered together and secured with the Cell Entrance Lens assembly screw.

Loosen the Cell Entrance Lens assembly screw to remove the Cell Focus, Cell Entrance Lens, and spacer from the Octopole assembly.

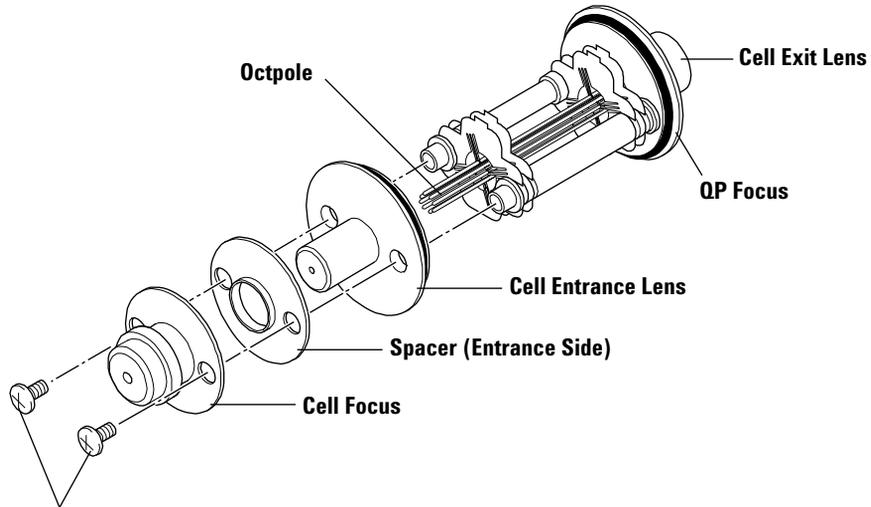
CAUTION

The Cell Focus, Cell Entrance Lens, QP Focus, Cell Exit Lens and spacer are located on either side of the Octopole. When removing the Cell Entrance Lens or Cell Exit Lens, only remove one at a time, leaving the other Lens or Octopole plate assembled. This will prevent you from potentially mis-assembling the lenses to the wrong side.

Do not directly touch the poles of the Octopole. You may accidentally mis-align the Octopole.

NOTE

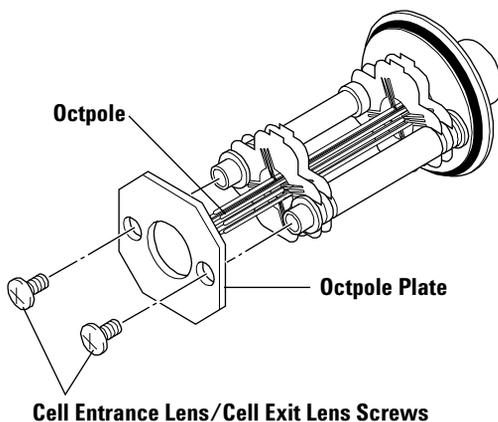
The Cell Focus, Cell Entrance Lens, QP Focus, Cell Exit Lens, and two spacers are shaped and structured differently.



Cell Entrance Lens Screws
Figure 86 Removing the Cell Entrance Lens

5 Secure the Octopole plate.

Secure the Octopole Plate to the location from which you removed the Cell Focus and Cell Entrance Lens.



Cell Entrance Lens/Cell Exit Lens Screws

Figure 87 Securing the Octopole Plate

6 Remove the Cell Exit Lens, QP Focus, and Spacer.

The Cell Exit Lens, QP Focus, and spacer are layered together and secured with the Cell Exit Lens assembly screw.

Remove the Cell Exit Lens assembly screw to remove all 3 components.

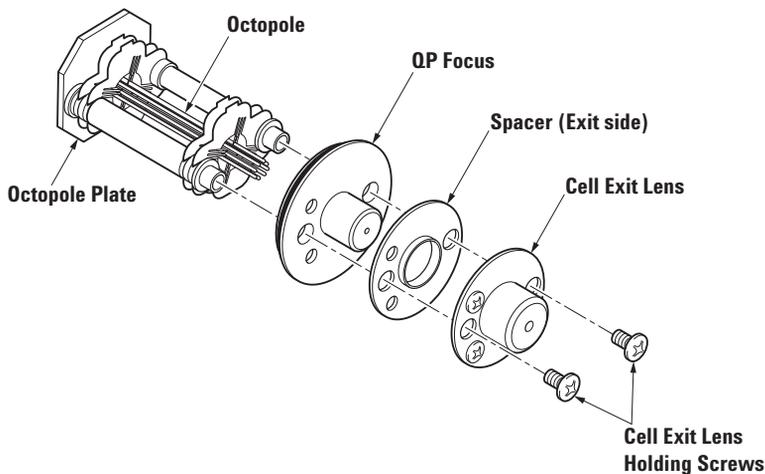


Figure 88 Removing the Cell Exit Lens

7 Secure the Octopole plate.

Secure the Octopole plate to the location from which you removed the Cell Exit Lens and QP Focus. Remove the two plate bias relay screws from the Cell Exit Lens.

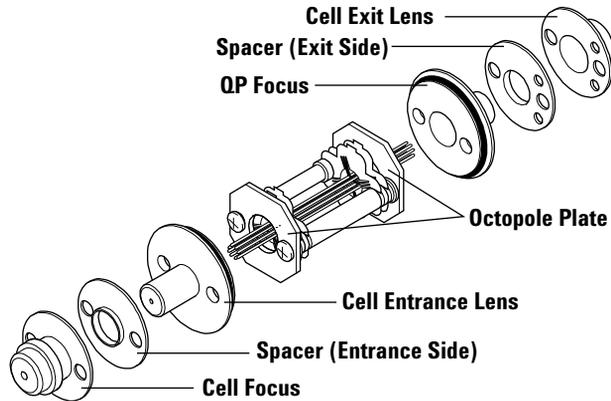


Figure 89 The Octopole with the Cell Entrance Lens and Cell Exit Lens Removed

8 Remove the 2 plate bias relay screws from the cell exit lens.

Removing the Plate Bias Lens

The Plate Bias Lens is located in the vacuum chamber, between the Reaction cell assembly and the Q- pole. (Figure 90)

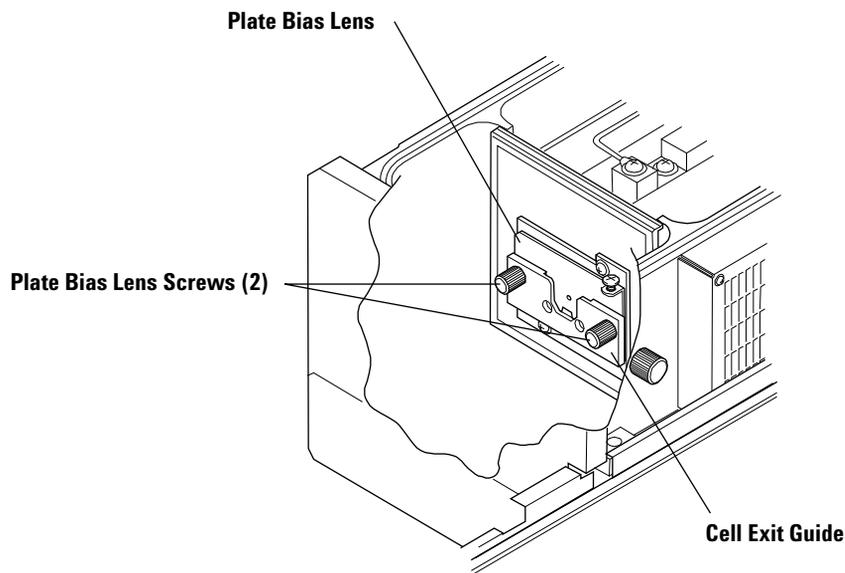


Figure 90 Plate Bias Lens Location (with the Reaction Cell Assembly Removed)

CAUTION

Always perform these maintenance in a contamination-free area.

It is necessary to remove the Reaction cell assembly before removing the Plate Bias Lens.

The following procedure describes how to remove the Plate Bias Lens.

1 Remove the Reaction cell assembly.

For information on removing the Reaction cell assembly, refer to the previous procedure entitled “[Removing the Reaction Cell Assembly](#)” on page 4- 102.

2 Remove the Plate Bias Lens.

Loosen the 2 screws securing the Plate Bias Lens and remove the Cell Exit Guide and Plate Bias Lens. (Figure 91) Place the Plate Bias Lens on a clean surface. Return the cover to the vacuum chamber after removing the lens.

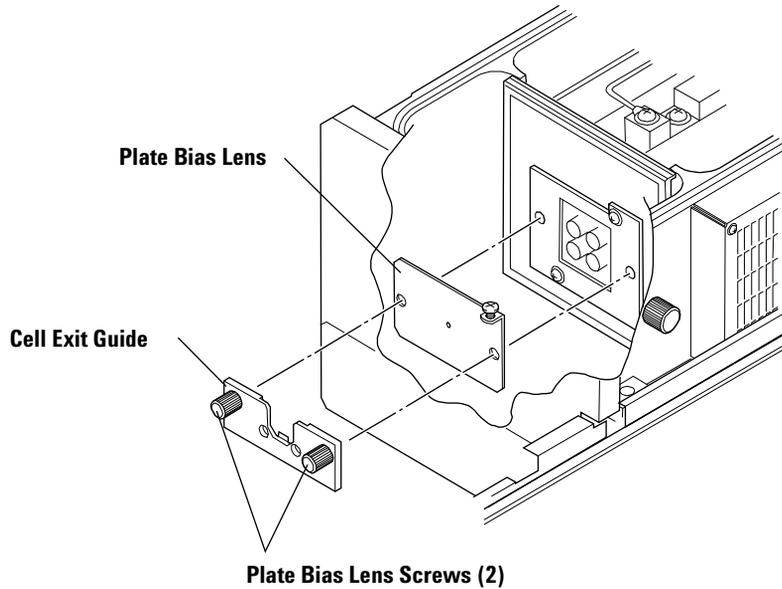


Figure 91 Plate Bias Lens

Cleaning the Extraction and Omega Lenses

It is possible to clean the Extraction Lens, Omega Lens- ce (- cs), and Omega Bias- ce (- cs) separately, but it is more efficient to clean them together.

There is normally no need to clean the spacers and screws. Be careful not to touch the spacers and screws with your bare hands.

Perform the following procedure when cleaning the Extraction and Omega Lenses.

WARNING

Do not clean with methanol or acetone. Using these in an ultrasonic bath presents a fire hazard.

1 Polish with polishing paper (#400).

The polishing paper can be used either wet or dry. Wet polishing paper is easier to use when polishing the surfaces.

Polish the inner and outer surfaces of the cone, removing discoloration. Roll the polishing paper into a cone when polishing the inside portions.

CAUTION

Do not deform the tip of the Extraction Lens.

Do not polish the skimmer base flange.

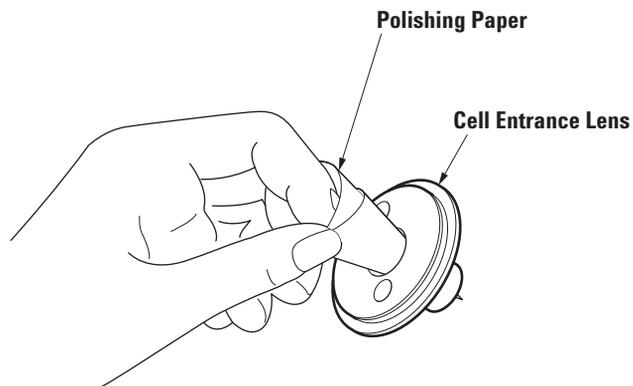


Figure 92 Example of Rolling the Polishing Paper into a Cone

2 Polish with polishing paper (#1200).

3 Clean the orifice of each lens using an alumina powder slurry.

Use a mixture of alumina powder and pure water as a polishing solution.

Dip a cotton swab in the polishing solution and clean the inner and outer surfaces of the lenses. Pay particular attention to the holes.

4 Rinse with pure water after cleaning.

5 Ultrasonic the lenses in a 2% detergent solution for 5 minutes after cleaning.

6 Rinse with pure water.

7 Ultrasonic the lenses in pure water for an additional 5 minutes.

8 Dry on a clean surface.

Allow the lenses to air dry, do not wipe.

CAUTION

Do not clean plastic components (spacers) with acetone. The plastic will be damaged or deformed if it comes in contact with acetone.

Completely dry all components. If components are connected to the vacuum chamber before they have completely dried, it will take an extraordinarily long time for the chamber to pump down to Standby mode. Also, if the Extraction Lens and Omega Lens are assembled before they are completely dried it can have a potentially critical impact on the components when the plasma is ignited.

NOTE

It is not normally necessary to clean the Skimmer Base. However, if it comes into contact with your bare hands or oil, clean it with alcohol.

Cleaning the Reaction Cell Lenses

The parts of the Reaction cell that need to be cleaned are the Cell Entrance, Cell Focus, Exit, QP Focus, and Plate Bias Lens. Remove the O-rings from the Cell Entrance and QP Focus lenses when cleaning.

It is possible to clean the lenses separately, but it is more efficient to clean them together.

There is normally no need to clean the spacers and screws. Be careful not to touch the spacers and screws with your bare hands.

Perform the following procedure when cleaning the lenses.

WARNING

Do not clean with methanol or acetone. Using these in an ultrasonic bath presents a fire hazard.

1 Polish with polishing paper (#400).

The polishing paper can be used either wet or dry. Wet polishing paper is easier to use when polishing the surfaces.

Polish the inner and outer surfaces of the lenses. Be careful not to deform the inside of the lens. Deformation will affect instrument performance. Pay particular attention to the hole in the plate bias lens as this is where the ion beam passes through.

2 Polish with polishing paper (#1200).

3 Polish the lenses with an alumina powder slurry.

Use a mixture of alumina powder and pure water as a polishing solution.

Dip a cotton swab in the polishing solution and clean the inner and outer surfaces of the lenses. Pay particular attention to the holes.

4 Rinse with pure water after cleaning.

5 Ultrasonic the lenses in a 2% detergent solution for 5 minutes after cleaning.

6 Rinse with pure water.

7 Ultrasonic the lenses in pure water for an additional 5 minutes.

8 Dry on a clean surface.

Allow the lenses to air dry, do not wipe.

CAUTION

Do not clean plastic components (spacers) with acetone. The plastic will be damaged or deformed if it comes in contact with acetone.

Completely dry all components. If components are connected to the vacuum chamber before they have completely dried, it will take an extraordinarily long time for the chamber to pump down to Standby mode.

If the printed circuit board has been removed from the Cell's upper cover, pay attention to the direction when re-attaching it. If it is incorrectly installed, the bottom connector of the printed circuit board will hit the Cell's upper cover and cannot be attached properly.

NOTE

It is not normally necessary to clean the Cell's upper and lower covers.

However, if these have been touched by bare hands or have oil on them, wipe clean with alcohol (IPA, ethanol or methanol).

Remove the printed circuit board from the Cell's upper and lower cover and allow it to dry thoroughly.

Cleaning the Octopole

It is necessary to clean the Octopole if there is a signal drift, or a longer than normal period of time is required for the signal to stabilize when switching from hydrogen to standard mode.

Clean the Octopole after disassembling the Reaction cell and attaching the Octopole holding fixtures.

Perform the following procedure when cleaning the Octopole.

- 1 With the Octopole holding fixtures attached, ultrasonic for 5 minutes in IPA.**
- 2 Rinse with pure water.**

NOTE

Use a large beaker to prevent the poles of the Octopole is contact with the wall of the beaker. The Octopole may become misaligned.

- 3 Ultrasonic for an additional 5 minutes in pure water.**
- 4 Dry.**

Refitting the Plate Bias Lens

When refitting lenses in the vacuum chamber, begin with the Plate Bias Lens. If you refit the Reaction cell assembly first, you will not be able to install the Plate Bias Lens.

Always wear laboratory gloves when refitting the Plate Bias Lens. The following procedure explains how to refit the lens:

1 Install the Plate Bias Lens and Cell Exit Guide in the vacuum chamber.

Install the Plate Bias Lens in the direction illustrated in [Figure 91](#).

2 Secure the Plate Bias Lens and Cell Exit Guide with screws.

Securely tighten the Plate Bias Lens with 2 screws.

After you have finished installing the Plate Bias Lens, refit the Reaction cell assembly.

Refitting the Reaction Cell Assembly

It is easiest to refit the Extraction Lens- Omega Lens assembly and the Reaction cell assembly in the reverse order to which they were dismantled. After all the lenses are cleaned, begin with the Reaction cell assembly.

Be sure to wear laboratory gloves when refitting the Reaction cell assembly. The following procedure explains how to refit the assembly. (Refer to [Figure 85](#))

1 Insert the O- ring.

Insert the O- ring on the Cell Entrance Lens, QP Focus. If the O- ring has cracks or is compressed, replace it with a new one.

NOTE

The Cell Focus, Cell Entrance Lens, QP Focus, and Cell Exit Lens are different.

2 Install the Octopole Assembly.

Reassemble the Cell Focus, Cell Entrance Lens, QP Focus, and Cell Exit Lens on both sides of the Octopole assembly in their original order.

Reassemble the Cell Entrance Lens together with the Entrance side spacer and Cell Focus. Reassemble the QP Focus together with the Exit side spacer and Cell Exit Lens. (Refer to [Figure 89](#))

The dimensions of the Octopole are different on the Entrance and Exit sides, so make sure it is assembled in the correct direction.

CAUTION

The two shafts on the Octopole are of different diameters to prevent the Cell Entrance Lens and Cell Exit Lens from being mis-assembled. Incorrectly assembled, the lenses may be damaged by contact with the Octopole. Pay careful attention to the direction of the lenses when assembling.

Always remove only one Octopole plate (located on both sides of the Octopole assembly) at a time, leaving the other plate assembled to the other Cell Entrance Lens / Cell Exit Lens. Removing both at the same time can lead to confusion when it comes time to refit the instrument.

Do not directly contact the poles of the Octopole. The Octopole may become misaligned.

3 Install the Octopole Assembly to the lower cell block.

Confirm the diameter of the Octopole shafts with the depths of the cell lower block to ensure that the Octopole assembly is refitted in the correct direction on the cell lower block. The contoured side of the Octopole holder should be facing up. If any of these components are installed in the wrong direction, the cell upper block will not mate correctly with the cell lower block and a gap will remain between the two, preventing the instrument from being correctly refitted.

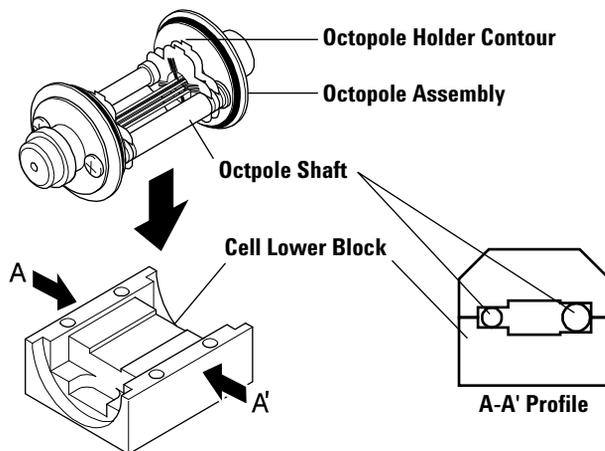


Figure 93 Reaction cell assembly

4 Place the cell upper block on the cell lower block.

Confirm that the cell upper block is covering the Octopole assembly and is correctly installed over the cell lower block.

5 Tighten the cell assembly screws.

Tighten the 4 cell assembly screws from the bottom side of the cell lower block. (Refer to [Figure 94](#))

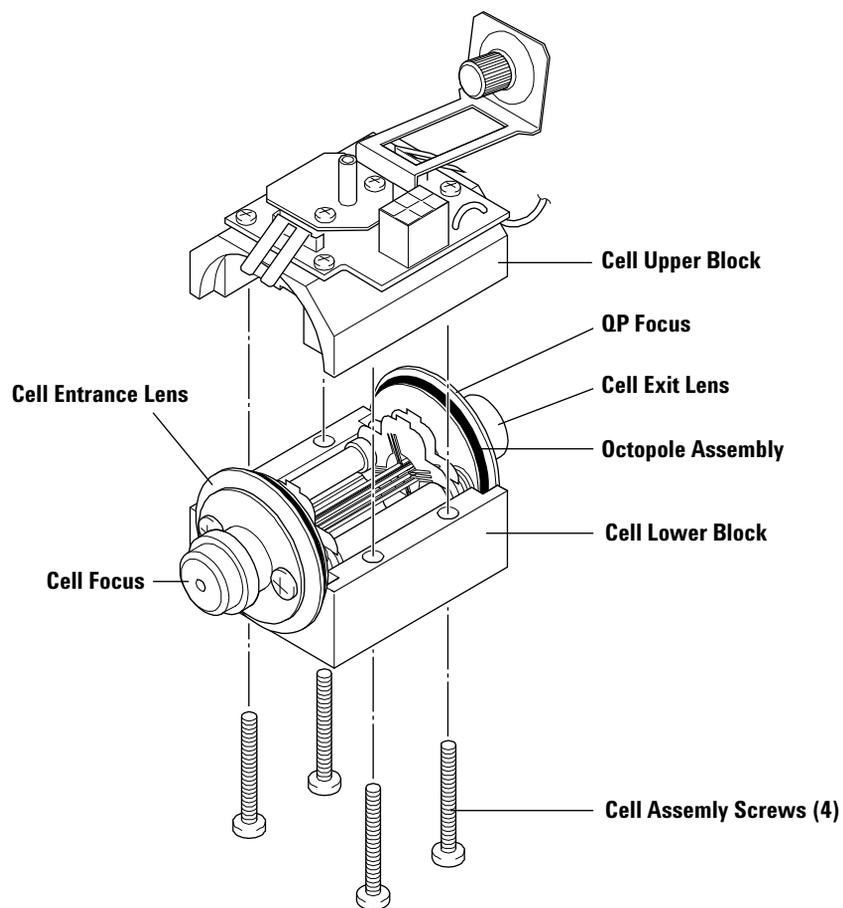


Figure 94 Reaction cell and cell assembly screws

6 Connect the Plate Bias wires.

Connect the 2 Plate Bias wires to the 2 Plate Bias wire relay screws on the Cell Exit Lens.(Refer to [Figure 95](#))

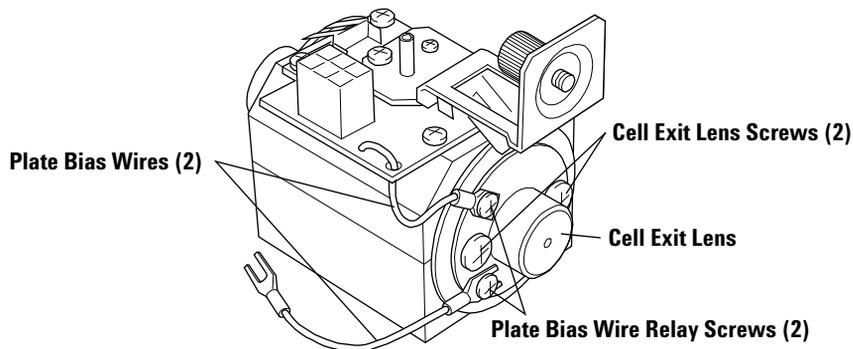


Figure 95 Plate Bias Wires

7 Check for electrical continuity.

Using an Ohm meter, confirm there is no continuity between the cell lower block (ground) and each electrode on the Reaction cell wire connector.

Make sure there is no continuity between the pins on the Cell Focus and Reaction Cell wire connector.

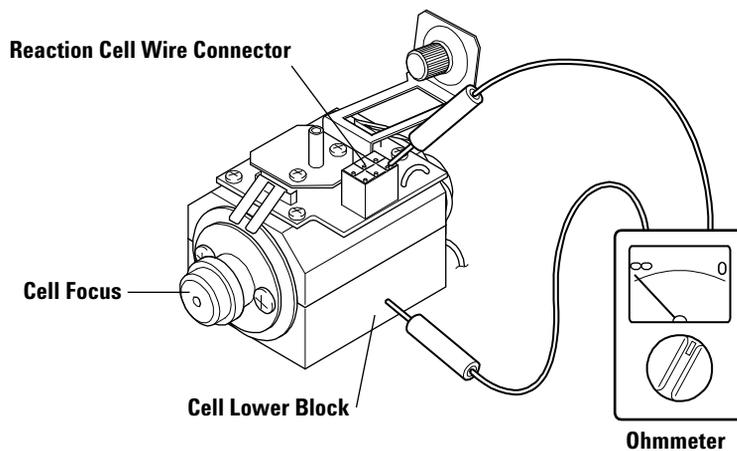


Figure 96 Checking the continuity (Cell Lower Block and Connector Electrodes)

Check for no continuity between the 6 electrodes on the Reaction cell wire connector.

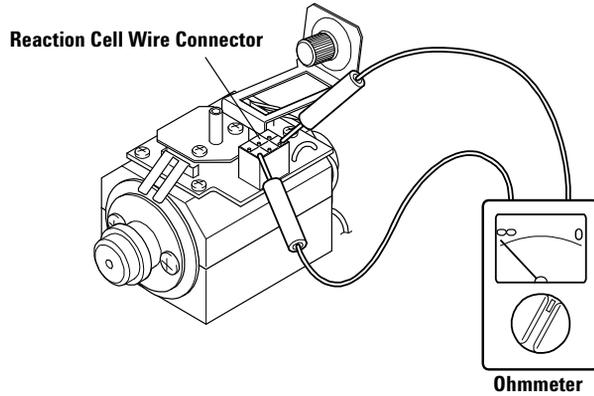


Figure 97 Checking the continuity (connector and individual electrodes)

8 Check the continuity.

Using an Ohm meter, confirm that there is continuity between all wire connector electrodes and the Cell Entrance Lens, QP Focus, and Cell Exit Lens.

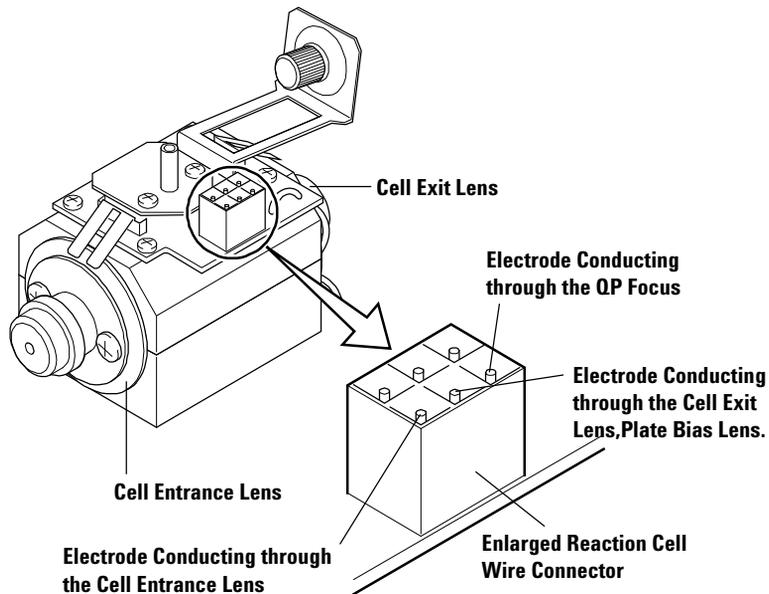


Figure 98 Checking the electrical connections

Refitting the Reaction Cell Assembly

Wear laboratory gloves when refitting the Reaction cell assembly. The following procedure explains how to refit the Reaction cell assembly.

1 Install the Reaction cell assembly to the instrument.

Remove the vacuum chamber cover. Place the Reaction cell assembly in the vacuum chamber as illustrated in [Figure 82](#). When doing this, make sure the Cell Entrance Lens is inserted into the guide located on the back of the gate valve.

Make sure not to catch the Reaction Cell assembly on the uneven surface of the Cell Focus while installing.

Securely tighten the screws that hold the Reaction cell assembly to the vacuum chamber.

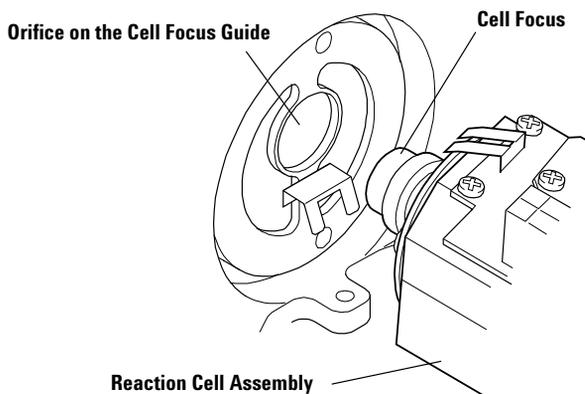


Figure 99 Installing the Reaction cell assembly

2 Secure the plate bias wire terminal.

Tighten the screw holding the plate bias wire terminal until it is secure. (Refer to [Figure 83](#))

3 Connect the wire connector.

Connect the wire connectors to the Reaction cell assembly.

4 Connect the tube.

Connect the reaction gas tube to the Reaction cell assembly.

5 Pump down the system.

Refer to the procedure in this chapter titled “[Sealing the Vacuum Chamber and Pumping Down the System](#)”.

Refitting the Extraction Lens-Omega Lens Assembly

Wear laboratory gloves when refitting the Extraction Lens-Omega Lens assembly and refitting it to the instrument. The following procedure explains how to assemble and refit the lens to the instrument.

1 Refit the Extraction Lens- Omega Lens assembly.

When refitting the Extraction and Omega Lenses to the Skimmer Base, refer to the figure (7500cx: [Figure 100](#), 7500cs: [Figure 101](#)) for the correct location and orientation of the components. After completing the re-assembly, securely tighten the 2 lens screws.

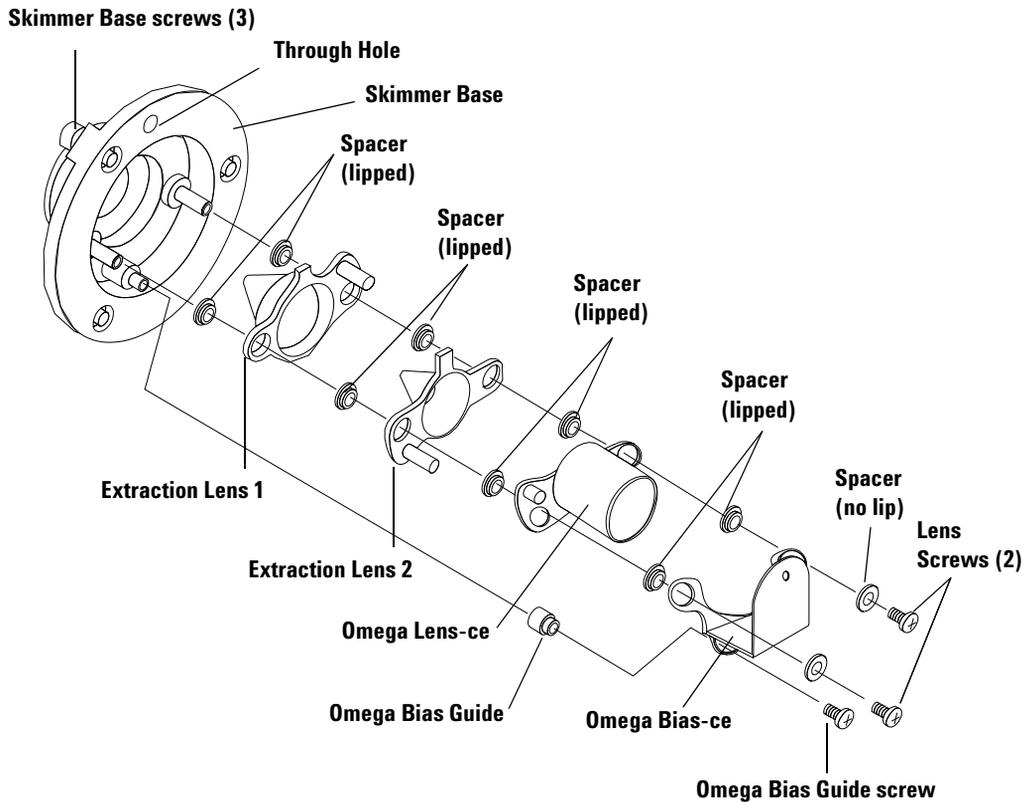


Figure 100 Expanded View of the Extraction Lens-Omega Lens Assembly (7500cx)

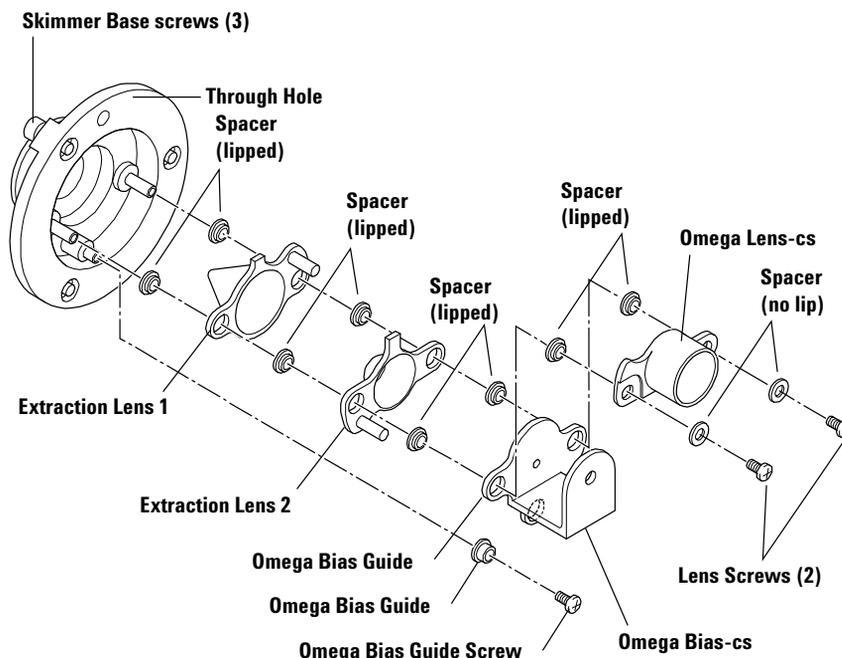


Figure 101 Expanded View of the Extraction Lens-Omega Lens Assembly (7500cs)

2 Using an Ohm meter, check for no continuity between the Skimmer Base (ground), Extraction Lens, and Omega Lenses.

3 Insert the Extraction Lens- Omega Lens assembly into the instrument.

Hold the lens assembly vertically. Line the through hole near the rim of the Skimmer Base with the guide pin on the interface assembly and insert the assembly into the interface chamber.

4 Install the Extraction Lens- Omega Lens assembly into the instrument.

Using an Allen wrench, securely tighten the 3 screws that hold the Skimmer Base. If the Extraction Lens- Omega Lens assembly is not securely installed in the interface chamber, the vacuum may not reach the required level in analysis mode.

5 Install the Skimmer Cone and Sampling Cone.

For details on installing the Skimmer Cone and Sampling Cone, see [“Maintaining the Cones”](#) on page 4-66.

Changing the Hardware Information

There are two types of the Extraction- Omega Lens Assembly, one for the 7500cx and another for the 7500cs.

It is necessary to change the hardware information when a different type of Ion Lens is installed.

To change the hardware information for the Ion Lens, complete the following steps:

- 1 Select **Maintenance>>Hardware Setting** on the ICP- MS Instrument Control window. The **Hardware Settings** dialog box appears.
- 2 **Confirm the Ion Lens type.**

This dialog box will show the following Ion Lens types.

- **"ce" Lens:** Extraction- Omega Lens Assembly for 7500cx
- **"cs" Lens:** Extraction- Omega Lens Assembly for 7500cs

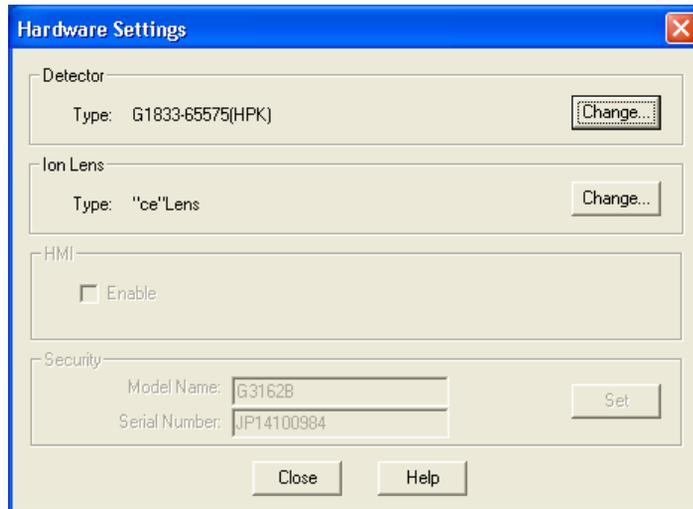


Figure 102 Hardware Settings dialog box (example for 7500cx)

- 3** If the correct ion lens is not shown in the dialog box, click the *Change* button. The *Change Ion Lens Type* dialog box appears.

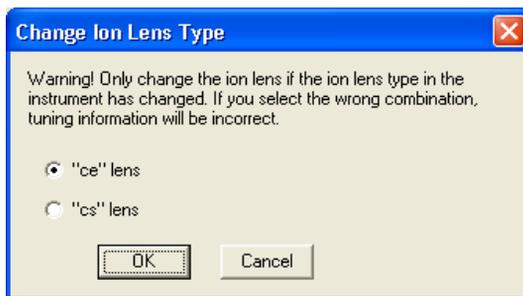


Figure 103 Change Ion Lens Type dialog box

- 4** Select the correct ion lens and then click *OK*.
- 5** Exit the MassHunter Workstation (or ChemStation) software.

When changing the ion lens, refer to the following section for tuning.

- **"ce" Lens:** Tuning for Sensitivity (Agilent 7500cx) in chapter 1 of the *Agilent 7500 Series ICP- MS Tuning and Application Handbook*
- **"cs" Lens:** Tuning for Sensitivity (Agilent 7500cs) in chapter 1 of the *Agilent 7500 Series ICP- MS Tuning and Application Handbook*

Adjusting the Octopole

After performing maintenance on the Reaction cell, it is necessary to match the impedance between the Octopole and the Octopole RF power source. The following procedure explains how to adjust the Octopole.

1 Check the following:

The Agilent 7500 is at the appropriate \vacuum level and is in Standby mode.

For pumping down the system, refer to “[Sealing the Vacuum Chamber and Pumping Down the System](#)” in this section.

2 Close the right and left hoods.

You cannot perform the adjustment with these covers open.

3 In the MassHunter Workstation's (or ChemStation's) ICP-MS Instrument Control window, select *Maintenance*>>*Octopole*.

The Octopole Setup dialog box will appear on the screen.

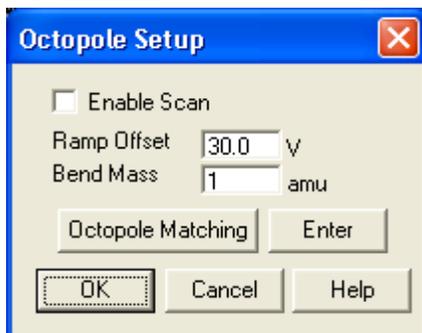


Figure 104 Octopole Setup dialog box

4 In the *Octopole Setup* dialog box, click the *Octopole Matching* button.

The Octopole Setup dialog box will close and the Octopole will begin adjusting. This function will begin automatically.

5 After the adjustment is complete, a message will appear in the message line of the *ICP-MS Instrument Control* window. Check the content of the message.

- If the Octopole matching has finished normally, proceed to the next step.
- If an error message appears, there is the possibility that the Reaction cell is incorrectly assembled, or the Reaction cell is not properly installed to the main unit. Refer to “[Refitting the Reaction Cell Assembly](#)” on page 4- 115 and “[Refitting the Reaction Cell Assembly](#)” on page 4- 121 and check the assembly and Refitting of the components. After you have completed that, repeat the Octopole adjustment.

NOTE

For the parameters for **Enable Scan**, **Ramp Offset**, and **Bend Mass**, refer to chapter 1 on tuning in the *Agilent 7500 Series ICP-MS Tuning and Application Handbook*.

Reaction Gas Line Maintenance

The **Reaction Gas Line Maintenance** dialog box controls the reaction gas, this allows the reaction gas to be purged during maintenance and start-up.

CAUTION

Hydrogen gas is explosive. Follow the **Hydrogen Safety Guide** and use special caution when handling this gas.

To open the **Reaction Gas Line Maintenance** dialog box, complete the following steps:

- 1 Select **Instrument**>>**Instrument Control** from ICP- MS Top. The ICP- MS Instrument Control window appears.
- 2 Select **Maintenance**>>**Reaction Gas** from the ICP- MS Instrument Control window.
- 3 If a warning message is displayed, check the content and then click **OK**. The **Reaction Gas Line Maintenance** dialog box appears.

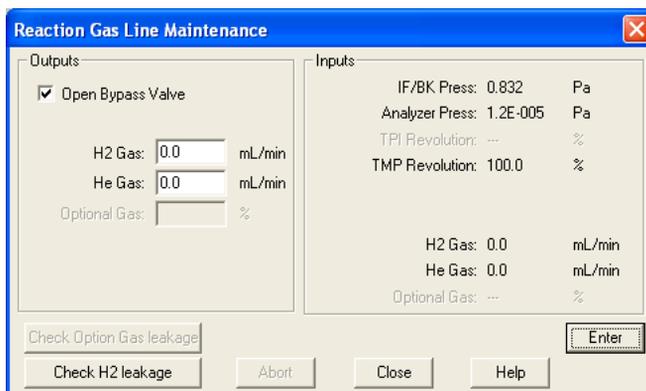


Figure 105 Reaction Gas Line Maintenance dialog box

The following information is displayed in the Reaction Gas Line Maintenance dialog box.

- **Output:** Set each reaction gas flow rate.
- **Open Bypass Valve:** When this dialog box is open, **Open Bypass Valve** is always selected and the bypass valve is open.
- **H₂ Gas:** H₂ gas flow rate setting. Enter the flow rate value in the text box and click the **Enter** button.
- **He Gas:** He gas flow rate setting. Enter the flow rate value in the text box and click the **Enter** button.

- **Optional Gas:** Optional gas flow rate setting. Enter the flow rate value in the text box and click the **Enter** button.

NOTE

Optional Gas is available when the optional gas line is installed.

H₂ gas is optional for the 7500cx. If an H₂ gas line is not connected, H₂-gas-related items are grayed out and cannot be selected.

- **Input:** Current value of the parameter related to vacuum and gas flow.
- **Close:** Close **Reaction Gas Line Maintenance** dialog box. All Reaction Gas flow is set to 0 when this window is closed.

The maximum flow rate of each gas is as follows:

- H₂ gas: 7.0 (mL/min)
- He gas: 10.0 (mL/min)
- Optional gas: 100.0 (%)

CAUTION

Excessive amounts of reaction gas raises the pressure in the vacuum chamber and the instrument safety feature will put the instrument in to shutdown mode. When introducing the reaction gas, increase the gas flow rate gradually maintaining a good operating vacuum pressure.

Testing the Lenses

After you are finished servicing the Agilent 7500cs/cx, perform the basic test. See [“Testing After Maintenance”](#) on page 4- 152, found at the end of this chapter.

If the analyzer chamber does not achieve the appropriate vacuum pressure ($< 6 \times 10^{-4}$ Pa), check to make sure the lens is securely sealed to the vacuum chamber.

Maintaining the Electron Multiplier

The detector used in the Agilent 7500 is an Electron Multiplier (EM).

The EM converts incident ions into an electric current and amplifies the current so the ion signal can be measured. As the voltage applied to the EM increases, the amplification factor (gain) of the current also increases. The EM outputs electric currents in pulses corresponding to each of the incident ions.

CAUTION

The EM is designed to be used under high vacuum and rapidly deteriorates if it is contaminated with organic substances or left in an environment with high humidity. Always wear clean gloves when handling the EM, complete the necessary work in the open as quickly as possible and place it under a vacuum as soon as possible. If the EM is to be stored for a long time in the open, place it in a desiccator.

Replacing the EM

There are two EM voltage parameters, **Analog HV** and **Pulse HV**.

The EM will need replacing when the **Analog HV** reaches about 3300 V or the **Pulse HV** reaches about 1800 V after adjusting the EM voltage.

NOTE

To adjust the EM voltage, refer to the 'Tuning' chapter in the *Agilent 7500 Series ICP-MS Tuning and Application Handbook*.

To replace the EM, complete the following steps:

1 Set both Analog HV and Pulse HV to 0 V

Select **Instrument>>Tuning** from the Top menu to display the tuning window.

Set **0 V** into both **Analog HV** and **Pulse HV** in the tuning parameters.

2 Shut down the Agilent 7500.

See [Chapter 3, "Startup, Shutdown and Status"](#) in this manual.

WARNING

The Agilent 7500 has many interlocks to protect the system and the operator, we suggest you switch off the power before working on the system.

3 Vent the analyzer vacuum and remove the vacuum cover.

Refer to “Working Inside the Vacuum Chamber” in this chapter.

4 Remove the three screws securing the EM cover and slide the cover away from the EM (Figure 106).

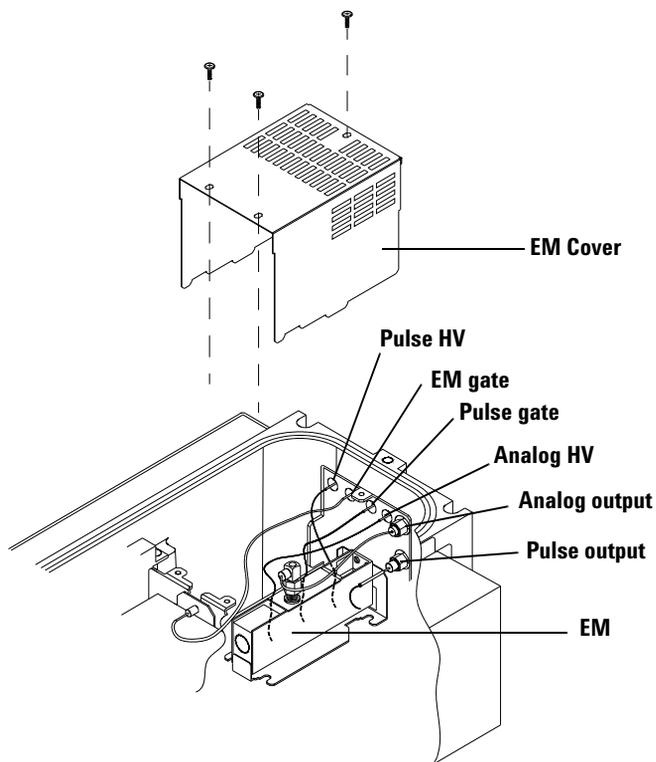


Figure 106 EM and EM Cover

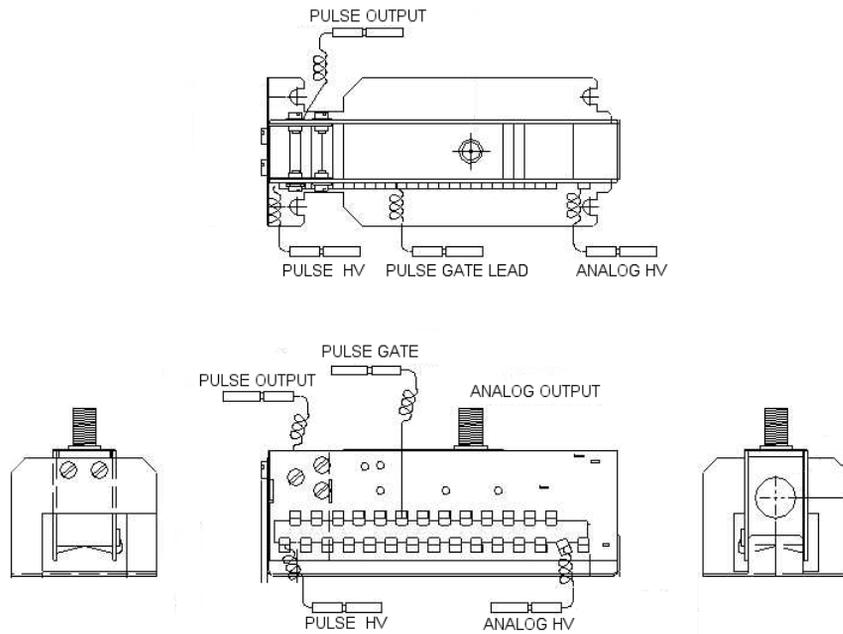


Figure 107 EM

- 5 Loosen the four screws securing the EM, slide it back and remove the EM.

There is no need to remove the screws. (Figure 108)

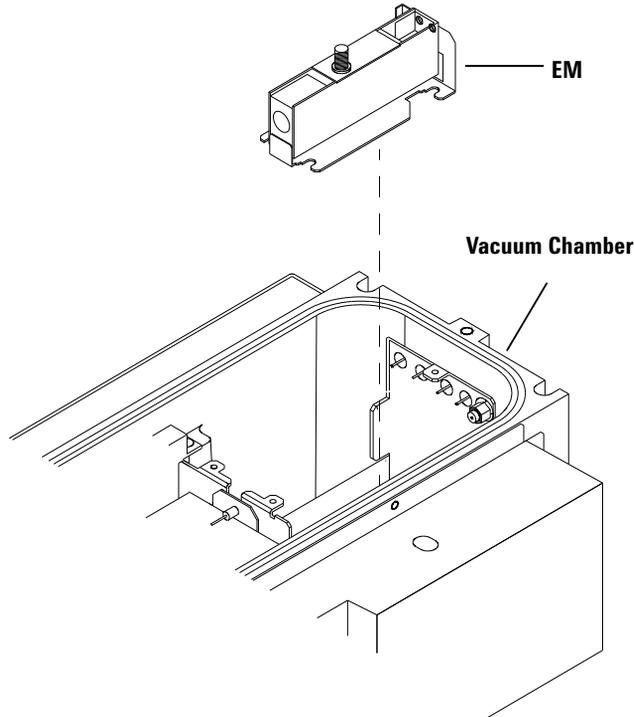


Figure 108 EM and Vacuum Chamber

- 6 Install a new EM and secure with the 4 screws, connect the feedthrough leads.
- 7 Ensure that the electrical leads are positioned well clear of the surrounding wall and the EM body. This is important to avoid any chance of a short-circuit occurring.
- 8 Carefully slide the EM cover back into place and secure with the 3 screws.
- 9 Pump Down the System.
Refer to “Working Inside the Vacuum Chamber” in this chapter.
- 10 After replacing, reset EM total current in the *Running Time* dialog box.
Refer to the section “Maintenance Clocks” in this chapter.

Changing the Hardware Information

There are two types of detectors, 5184- 1983 (ETP AF222) / G1833- 65420 (ETP AF220) and G1833- 65575 (HPK). When a different type of detector is installed, it is necessary to change the hardware information. Both types of detector have a unique method to optimize the supplied High Voltage. It is necessary to identify which detector is installed, then its optimization method is automatically selected. When the detector G1833- 65420 (ETP AF220) is replaced with 5184- 1983 (ETP AF222), it is not necessary to execute this.

NOTE

HPK Detector needs the following hardware:

- Ethernet communication between the Agilent 7500 ICP-MS and the MassHunter Workstation (or ChemStation).
- In the case of using ChemStation: Revision B.01.03 or later, or Patch File revision: B.01.02.002 or later.

If your instrument has GPIB communication interface you can only install 5184-1983 (ETP AF222) / G1833-65420 (ETP AF220).

Please complete the following steps, to change the hardware information:

- 1 Select *Maintenance*>>*Hardware Settings* on the ICP- MS Instrument Control window. The *Hardware Settings* dialog box appears.**

2 Confirm the Detector Type.

This dialog box shows the type of Detector. There are two types of detector, 5184- 1983 (ETP AF222) / G1833- 65420 (ETP AF220) and G1833- 65575 (HPK). In this block, click **Change** after installation and select the detector you have installed.

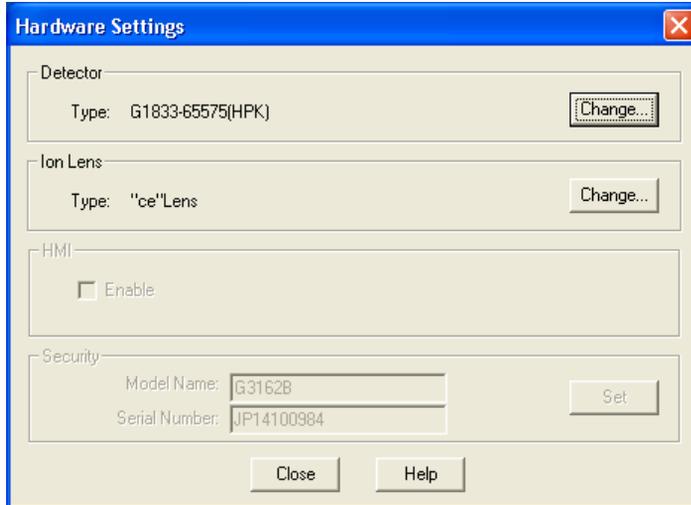


Figure 109 Hardware Settings dialog box

3 If the right detector is not shown in this dialog box, click *Change* button. The Change Detector Type dialog box appears.



Figure 110 Change Detector Type dialog box

4 Select the right detector from this dialog box and click OK.

Adjustment Procedure after Replacing the EM

After replacing the EM, put the instrument into **Analysis mode** and adjust the discriminator and EM voltage.

To adjust the EM, complete the following steps:

- 1 Put the instrument into Analysis mode.**
- 2 Set the EM voltage (Analog HV, Pulse HV) to the appropriate value as shown below.**

- Analog HV: 1800 V
- Pulse HV: 900 V

Select **Instrument>>Tuning** from the Top menu to display the tuning window.

Set **1800 Volt** for **Analog HV** and **900 Volt** for **Pulse HV** in the tuning parameters

- 3 Using the Autotune, adjust the discriminator and EM voltage.**

Refer to the ‘Tuning’ chapter in the *Agilent 7500 Series ICP- MS Tuning and Application Handbook* to adjust the **discriminator** and **EM voltage** using the **Autotune**.

NOTE

The P/A Factor adjustment must be performed after EM tuning.

Dead Time Calibration

This section describes how to execute the Dead Time Calibration using an erbium (Er) solution. Indium (In) is also available for dead time calibration.

To execute Dead Time calibration, follow the next procedure.

NOTE

Dead time calibration must be performed after replacement of the electron multiplier.

- 1 Perform a new EM and Adjust Discriminator tune.
- 2 Prepare the calibration standard solution for Dead Time Calibration.
For example, 50ppb Er and 1ppm Er.
- 3 Select the *Use Dead Time Calibration* in the *ICP-MS Configuration* dialog box. The *ICP-MS configuration* dialog box is displayed by selecting *Start >> All Programs >> ICP-MS MassHunter Workstation (or ICP-MS Chemstation) >> Configuration >> Miscellaneous*.

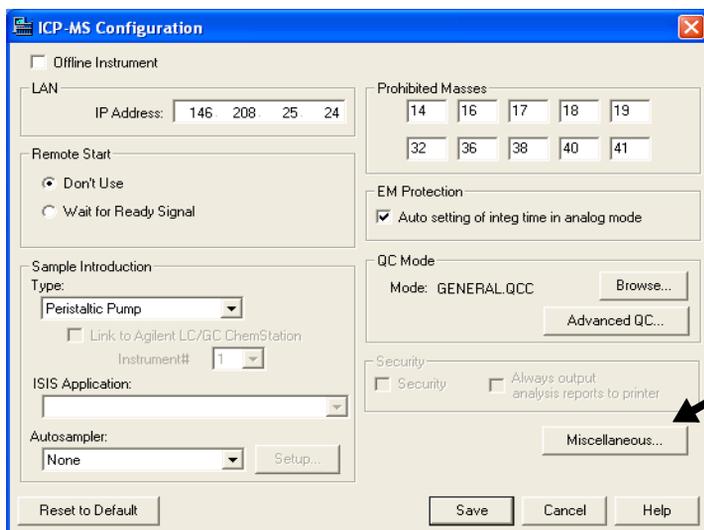


Figure 111 ICP-MS Configuration Window

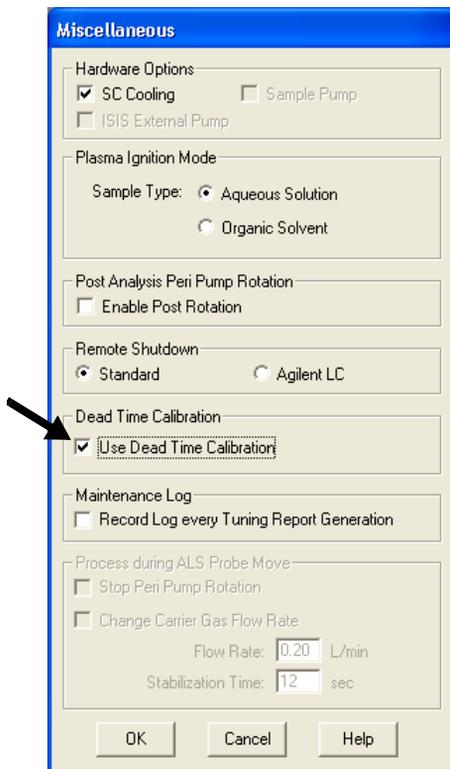


Figure 112 Select Use Dead Time Calibration.

4 Introduce the 50ppb Er solution.

Tune the sensitivity to make the count of the major isotope ^{166}Er in the range of 50,000 - 1,000,000 count / 0.1 sec.

5 Select *Tune >> Dead time calibration.*

The *Select Element for EM Dead time Calibration* dialog box is displayed.

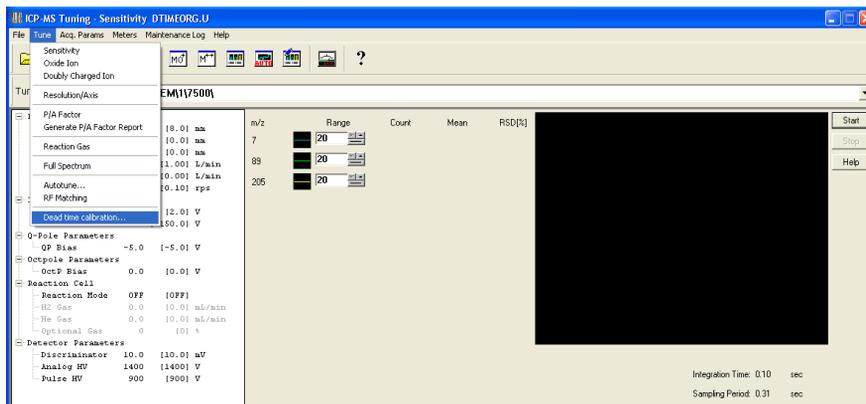


Figure 113

6 Select *Er[164/166]* then click *OK.*

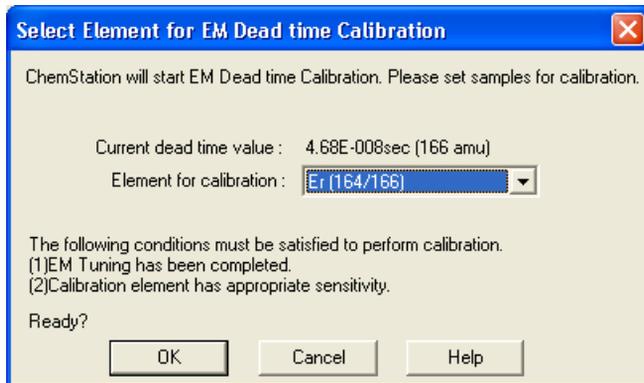


Figure 114 Select Element for EM Dead time Calibration dialog box

7 Check sensitivity for 50ppb Er.

Select **Check**. The sensitivity must be above 50,000 counts. Select **OK** then **Run..**

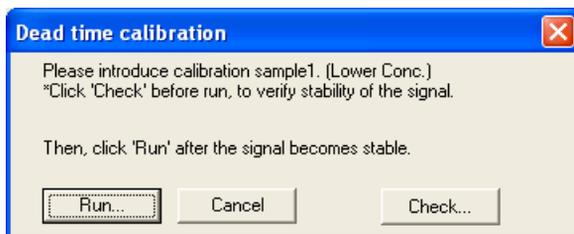


Figure 115

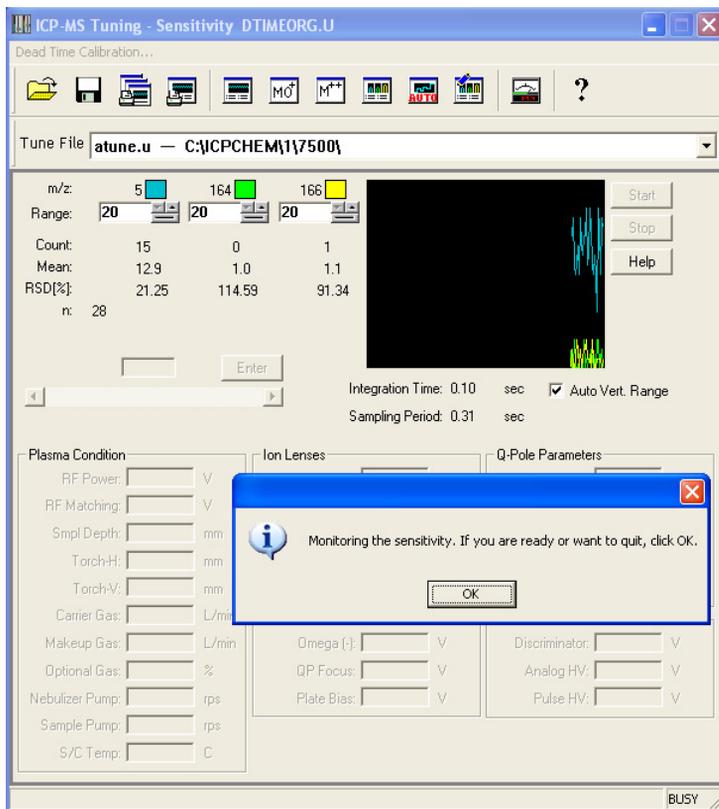


Figure 116 50ppb check.

4 Maintenance

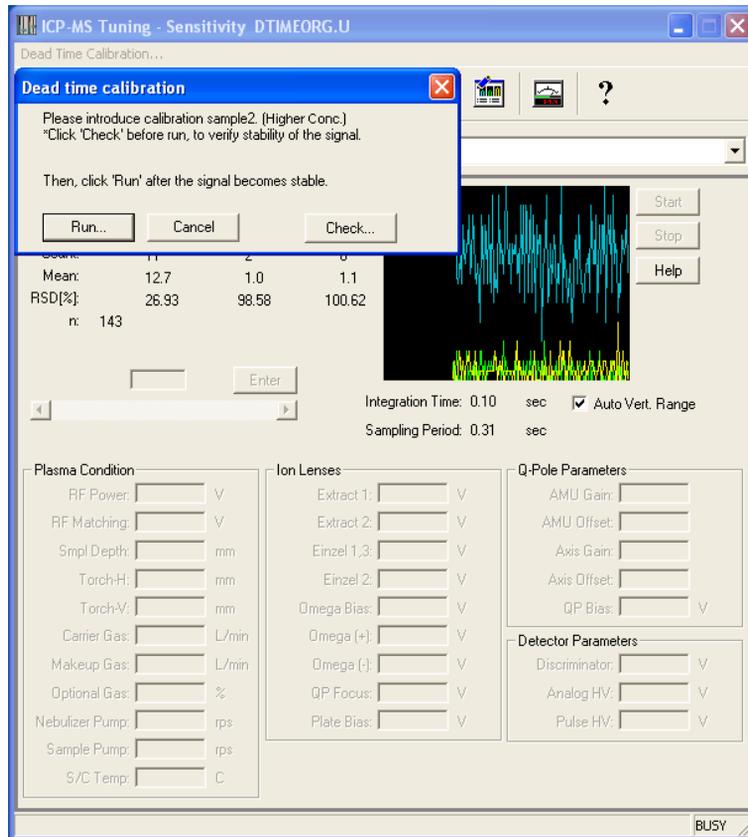


Figure 117 50ppb finished.

8 Introduce the 1ppm Er solution. Check sensitivity for 1ppm Er.

Select **Check**. Note the increase in sensitivity with this higher concentration. Select **OK** then **Run..**

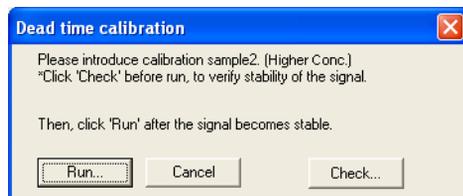


Figure 118

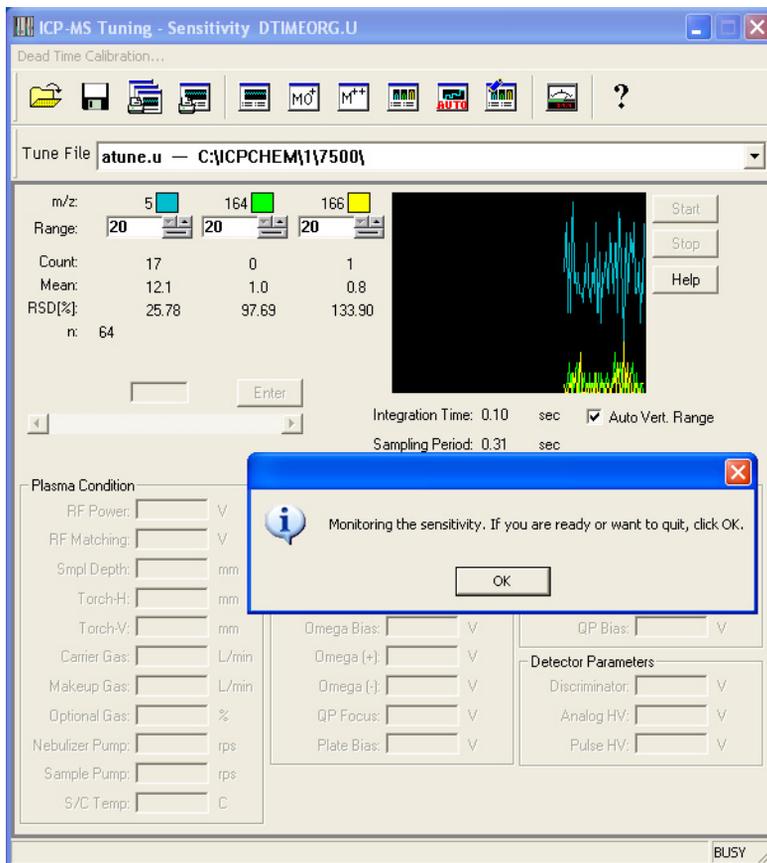


Figure 119 1ppm Check.

9 Select OK to save the new dead time.

Typical Dead Time 30 - 60 nano seconds

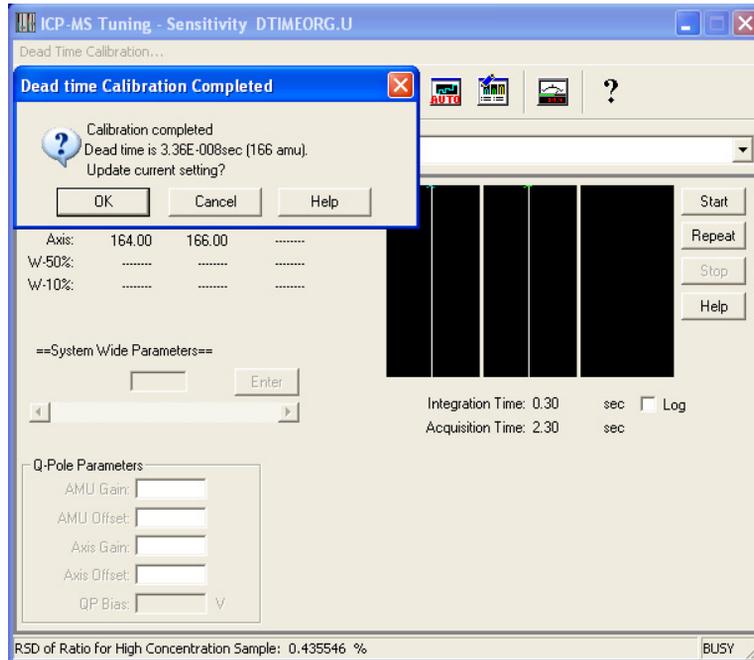


Figure 120 Calibration complete

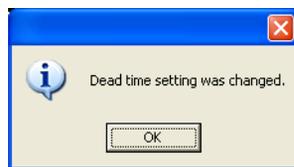


Figure 121

Troubleshooting

No signal

- Check that the connections of the feedthrough leads are correct.
- Check the feedthrough leads do not short-circuit by touching the surround wall such as the EM cover.

Maintaining the Penning Gauge

The Penning gauge carries a high voltage as it monitors the analyzer vacuum. Before maintaining the Penning gauge, shut down and unplug the instrument. You need to clean this gauge if there is a sudden fluctuation in the (AN) vacuum meter reading of more than 5×10^{-3} Pa while you are monitoring the meter. In this block, the typical change of the meter value is more than $\pm 10\%$. Spiking signals are another indication of the need to maintain the Penning gauge.

Locating Tools and Supplies

To replace the body tube of the Penning gauge, you need the following tools and supplies:

- Safety glasses and protective lab gloves

To properly maintain the Penning gauge, it is recommended to replace the body. However if you clean and polish the parts inside the body tube, you also need more tools and supplies. The tools you need to clean the Penning gauge are not included in the tool kit. However, the tool kit, including a flat spanner and a circlip pliers can be purchased from Agilent Technologies. The tools and supplies you need are as follows:

- Flat spanner
- Circlip pliers (pointed nose pliers)
- Fluoro- elastomer O- ring
- Jewel driver or feeler gauge
- Polishing paper (#400 P/N: G1833- 65404)
- 2% detergent solution
- Pure water
- Laboratory tissue

Removing the Penning Gauge

Use a clean dry surface and gloves. To disassemble the Penning gauge, complete the following steps:

1 Shut down the instrument.

Refer to [Chapter 3, “Startup, Shutdown and Status”](#).

WARNING

This procedure can expose you to the high voltages of the Agilent 7500, which can be lethal. Before proceeding, completely shut down the instrument.

2 Open the right hood and vent the analyzer vacuum.

Refer to [“Working Inside the Vacuum Chamber”](#) in this chapter.

3 Confirm the location of the Penning gauge.

The Penning gauge has a red (with black base) cylinder shaped housing which fits over the penning gauge tube. The assembly is installed on the back of the vacuum chamber.

4 Disconnect the Penning gauge cable.

Unplug the connecting cable from the Penning gauge.

5 Remove the Penning gauge from the instrument.

Turn the black base of the Penning gauge housing counterclockwise to unlock. Then pull the housing out from the Penning gauge tube.

NOTE

If the pressure in the vacuum chamber is not equal to the atmospheric pressure, it may be difficult to remove the Penning gauge.

6 Loosen the 3 screws of the plate which locks the Penning gauge tube in place.

7 Slide the Penning gauge tube down to free it from the locking plate and remove the tube.

For disassembly and cleaning of the Penning gauge refer to the section [“Cleaning the Penning Gauge”](#).

Replacing the body tube is recommended in maintaining the Penning gauge. If you clean and polish the parts inside the body tube, refer to the [“Cleaning the Penning Gauge”](#).

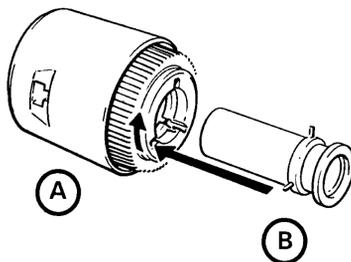


Figure 122 Penning Gauge (A: Magnet Housing, B: Body Tube)

Refitting the Penning Gauge

Reassemble the Penning gauge in the reverse order of removal. Use gloves and a clean surface as you complete the following steps:

- 1 Reconfirm that the O- ring is still in place in the manifold (on the back of the vacuum chamber where the Penning gauge fits).**
- 2 With the flange end of the tube toward the vacuum chamber, slide the tube back into the locking plate from below.**
- 3 Tighten the 3 screws of the locking plate.**

Alternatively tighten the 3 screws several times to keep tightening pressure equal.

- 4 Install the Penning gauge housing.**

Gently slide the Penning gauge housing over the tube and, holding the black base of the housing, turn clockwise to lock.

- 5 Connect the Penning gauge cable by plugging back into the Penning gauge housing.**
- 6 Start the instrument.**

Please refer to [Chapter 3, “Startup, Shutdown and Status”](#).

Cleaning the Penning Gauge

Replacing the body tube is recommended in the maintenance of the Penning gauge. However, to clean the anode assembly, cathode tube, cathode plate, and body tube, complete the following steps:

1 Remove the electrode from the body tube

Using a flat spanner unscrew and remove the collar. Then, using the circlip pliers, remove the anode assembly, cathode plate, and cathode tube from the body tube (Figure 123 on page 4-146).

CAUTION

Do not bend the anode when you slide the anode assembly from the cathode.

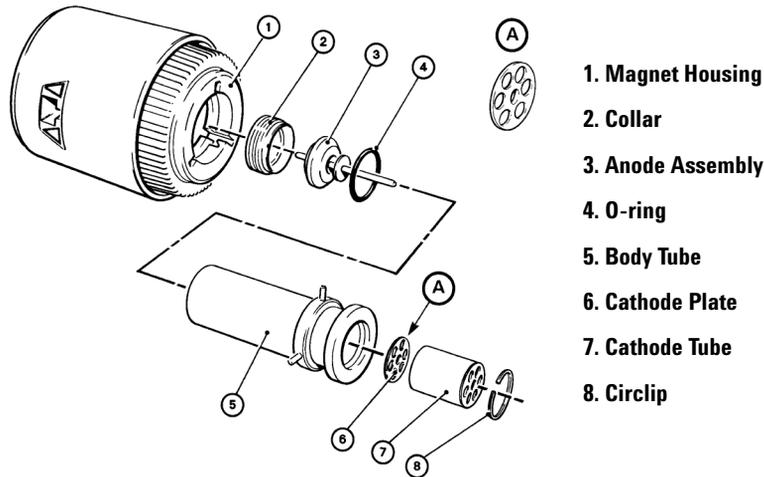


Figure 123 Expanded View of Penning Gauge

2 Clean the anode assembly and the inside of the cathode tube

Polish the bar of the anode assembly, the gap between the shield disk and the striker 2, and the inside of the cathode tube with 400 grade polishing paper (Figure 124).

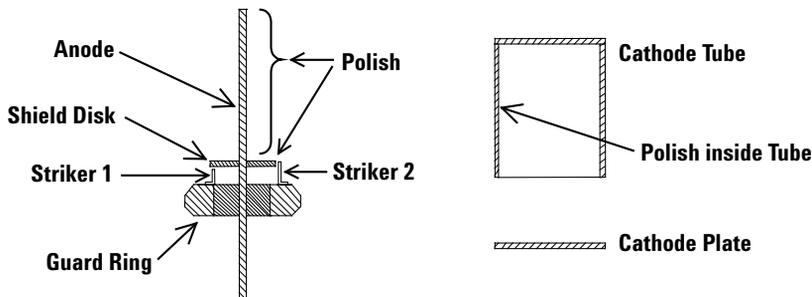


Figure 124 Anode Assembly (left), Cathode Tube and Cathode Plate (right)

3 Wash and rinse each of the parts.

Wash the polished parts with plenty of pure water. Wash the anode assembly, the cathode tube, the cathode plate, and the body tube in a 2% detergent solution. After washing, ultrasonic for 5 minutes in pure water. Wash these parts with plenty of pure water. Soak these parts in pure water and ultrasonic for an additional 5 minutes.

4 Dry the parts.

Allow the parts to air dry on a laboratory tissue. Let them dry by evaporation; do not wipe them dry.

5 Maintain the gap between the shield disk and the striker.

Ensure the gap between the shield disk and the striker is 0.25 ± 0.1 mm.

CAUTION

Failure to maintain the gap between the shield disk and striker will negatively affect the performance of the gauge.

6 Reassemble the body tube.

Refer to the [Figure 123](#). To fit the anode and cathode in the body tube, complete the following steps:

- a Slide the cathode plate, cathode tube, and circlip into the top (flange end) of the body tube.

Use circlip pliers to position the circlip.

- b Insert the O- ring into the bottom of the body tube

Wipe the O- ring to remove any lint and insert it into the bottom of the body tube.

- c Insert the anode assembly into the bottom of the body tube using your fingers.

Do not bend the anode as you insert it through the cathode.

- d Screw the collar into the bottom of the body tube.

Center the anode inside the body tube before tightening the collar. Fit the flat spanner into the collar and twist it clockwise until it is tight.

- 7 **After reassembling the body tube, refer to the “Refitting the Penning Gauge” section.**

Maintaining the Rotary Pumps

The rotary vane pumps are located on the floor, which facilitates the changing of its oil and emptying its mist filters.

Check the pump's color and oil level on a monthly basis. It is necessary that the oil level be between the **Minimum** and the **Maximum** on the level gauge. If the oil is too low, add more oil. If it is above the **Maximum**, take some out. Using the tag for oil color reference, check the color of oil. If oil color is bad, change it. The standard period of time to change the pump oil is about 6 months, though it depends on the daily sample throughput, the type of sample, the concentration of the sample, etc. Use the MassHunter Workstation (or ChemStation) maintenance clocks to help determine when to change the oil. See the section entitled “**Maintenance Clocks**” earlier in this chapter for information. The standard period of time to change the mist filter element and the odor element in the filter element is about one year. If the filter is not maintained and the element becomes blocked, a pressure relief valve in the filter will operate and allow dangerous unfiltered exhaust gasses to pass through the filter.

Locating Tools and Supplies

To change the oil and empty the oil mist filter, the following supplies are needed:

- Rotary pump oil
- Waste oil container, at least 1 liter in size
- Oil funnel
- Paper towel

Changing the Rotary Pump Oil

To change the rotary pump oil, complete the following steps:

1 Shut down the instrument.

See [Chapter 3, “Startup, Shutdown and Status”](#) for directions to turn off the instrument and pump.

2 Be sure to switch off the two breakers labeled *ROTARY PUMP* on the rear side of the Agilent 7500. (Switch the breaker down to the O side (down).)

3 Remove the used oil.

Place the waste oil container under the drain hole located on the end of the pump. Remove the drain cap and the oil fill cap. Screw on the drain cap when oil stops dripping out ([Figure 125](#)).

WARNING

The pump oil may be hot. Direct skin contact may result in burns.

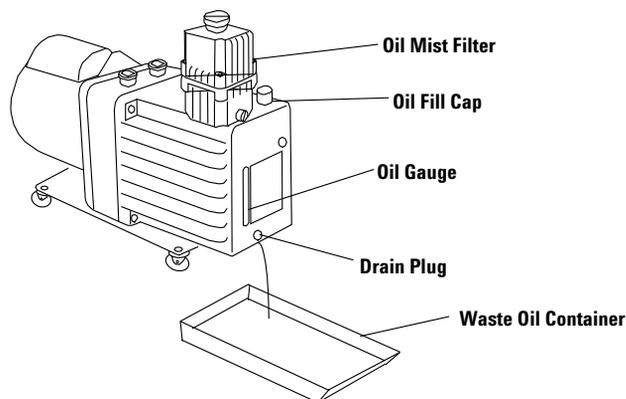


Figure 125 Rotary Pump and Waste Oil Container

4 Discard the used oil.

Dispose of the used oil using the correct laboratory procedures.

5 Add the new oil.

Remove the oil fill cap on top of the pump and insert the funnel. Pour in the oil until the sight glass registers between **Minimum** and **Maximum** (about 1 L). Replace the cap.

CAUTION

Use only Agilent recommended oil for the rotary pump.

6 Tighten any loose hose connections.

7 Switch the breaker down to the I side (up) to restore rotary pump power.

See [Chapter 3, “Startup, Shutdown and Status”](#)

8 Reset the rotary pump oil clock.

See [“Resetting the Maintenance Clocks”](#) earlier in this chapter.

Once operation time has been reset it is impossible to restore its original value. Reset with care.

Changing the Oil Mist Filter and Odor Element

The oil mist filter traps the fine oil mist preventing emission into the atmosphere. In addition, the odor element traps odor.

Check the oil level sight on the side of the bottom filter assembly and open the gas ballast valve to return the oil to the pump once the level has been reached.

The gas ballast valve should normally be kept open 2.5 turns to allow oil to return to the pump naturally.

Perform the Agilent recommended method and timing when changing the filter elements.

Perform the following procedure when changing the filter elements.

1 Put the Agilent 7500 into Shutdown mode.

Refer to [Chapter 3, “Startup, Shutdown and Status”](#) for details.

2 Switch off the two breakers labeled “ROTARY PUMP” on the rear of the instrument. (Switch the breaker down to the ‘O’ side.)**3 Remove the four screws securing the upper body to the lower body and remove the upper body.****4 Remove the filter elements.**

Discard the used filters according to correct laboratory procedures.

5 Wipe the oil from the inside of the block using a paper towel.

Do not remove the ‘D’ seal from the mating surface of the lower body. Check the O-ring located in the filter attachment area of the lower body for deterioration and cracks.

6 Install new filter elements.

Confirm that the O-ring is correctly positioned. After inserting the new elements, check the foam seal rings on the top and bottom of the filters.

7 Replace the top cover and tighten the 4 screws.**8 Start the Agilent 7500 and rotary pump.**

See [“Startup, Shutdown and Status”](#).

Testing the Rotary Pump

After restarting the pump, check that there are no loose hosing connections and that the oil cap is tightly closed if there are any oil spills or leaks.

Maintaining the Water Strainer

A strainer is attached to the fitting connector in order for the cooling water chiller to provide clean cooling water. Prolonged strainer use results in clogging and water stains. Remove and inspect the strainer annually, cleaning when necessary.

Locating Tools and Supplies

To replace the water strainer you need the following supplies:

- Drip pan and sponge

Cleaning the Water Strainer

Perform the following procedure when cleaning the water strainer:

1 Turn off the cold water source.

Turn OFF the cooling water chiller and close the valve, if present.

2 Remove the water strainer cap.

Place the drip pan under the working area as cooling water will spill out.

3 Remove the strainer.

4 Check the condition of the strainer and clean if necessary.

The strainer is metallic. Clean with tap water. Replace the strainer if it is corroded.

5 Replace the strainer.

6 Replace the cooling water strainer cap.

There is an O- ring attached to the cap. Replace if it is cracked or deformed.

7 Check for leaks.

Open the valve, if present. Turn the cooling water chiller power switch ON.

Testing After Maintenance

Testing is important after maintenance on any components. In this section, the procedure of the basic test after the maintenance is described. Some components require specific tests, which are listed in their section procedures.

To perform the basic maintenance test, complete the following steps:

1 If completely shut down, restart the instrument.

See Chapter 3, “**Startup, Shutdown and Status**” in this manual.

2 Check the status of the instrument meters.

See Chapter 3, “**Startup, Shutdown and Status**” in this manual.

3 Change the instrument to Analysis mode.

See Chapter 3, “**Startup, Shutdown and Status**” in this manual.

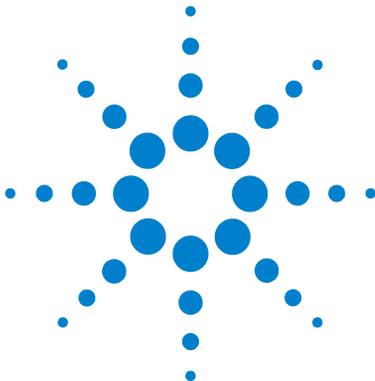
4 Tune the instrument.

Refer to chapter 1 ‘Tuning’ in the *Agilent 7500 Series ICP- MS Tuning and Application Handbook*.

5 Run a standard solution and examine the results.

Refer to the *Agilent 7500 ICP- MS MassHunter Workstation Operator's Manual (or ChemStation Operator's Manual)*.

4 Maintenance



5 Troubleshooting

Viewing and Clearing the Error Log [5-2](#)

Error Messages [5-3](#)

Alarm Messages [5-45](#)

Items to Be Checked in Case of Low Sensitivity [5-51](#)

Items to Be Checked in Standby Mode [5-51](#)

Items to Be Checked in Analysis Mode [5-52](#)

This chapter describes how to check the error log and the error log's contents, in order to help you resolve Agilent 7500 MassHunter Workstation (or ChemStation) problems efficiently and effectively.

To resolve problems with a peripheral, such as the autosampler or chiller, refer to the respective hardware manual.



Viewing and Clearing the Error Log

The error log is useful when working to resolve a problem with the Agilent 7500. See the following section for a list of the MassHunter Workstation (and ChemStation) error messages and appropriate responses. Use the following procedures to view and clear the error log.

NOTE

The error log can become very large and so it must be cleared periodically or it will take up a large amount of disk space. Because of its potential size, do not try to print the entire error log. All the error logs are copied to the maintenance log. Refer to the “[Maintenance Log](#)” in the [Chapter 4](#).

Viewing the Error Log

To view the error log, complete the following steps:

- 1 Select *Instrument*>>*Instrument Control* from the Top menu.

The **Instrument Control** window appears.

- 2 Select *Diagnostics*>>*View Error Log*.

The error log appears. You can use the page keys or the scroll bar to view the error messages.

Clearing the Error Log

To clear the error log, complete the following steps:

- 1 Select *Instrument*>>*Instrument Control* from the Top menu.

The **Instrument Control** window appears.

- 2 Select *Diagnostics*>>*Clear Error Log*.

The dialog box appears.



Figure 126

- 3 Click *OK*.

All error messages are erased from the error log file. The **Instrument Control** window is in the foreground.

Error Messages

The following messages can appear in the MassHunter Workstation (and ChemStation) green message bar when you operate the Agilent 7500. When an error message is displayed, the instrument runs a safety sequence.

NOTE

An * (asterisk) indicates that error number has multiple messages and contents. Please check the error message and error number to properly identify the problem.

1000 Execution Error: Instrument is busy- Between Transition Modes

Attempted to execute a command that cannot be executed during mode transition. Transitioning modes.

1001 Execution Error: Instrument is busy- Igniting plasma

Attempted to execute a command that cannot be executed while executing the plasma ignition sequence. The instrument is now executing the plasma ignition sequence.

1002 Execution Error: Instrument is busy- Plasma off sequence is running

Attempted to execute a command that cannot be executed during the plasma off sequence. Instrument is now executing the plasma off sequence.

1003 Execution Error: Can not execute during Plasma on

Attempted to execute a command that cannot be executed while the plasma is on. The plasma is on now.

1004 Execution Error: Instrument is busy- Updating parameters

Attempted to execute a command that cannot be executed while updating the parameters. Instrument is now busy updating parameters.

1005 Execution Error: Instrument is now in Shutdown mode

Attempted to execute a command that cannot be executed during Shutdown mode. The instrument is now in Shutdown mode.

1006* Execution Error: Cooling water (IF) flow rate is too low.

The designated command cannot be executed because the cooling water flow rate (IF) is below the limit.

Check cooling water flow rate (IF). The following causes are inferred.

- The power of the cooling water chiller is not switched on.
- The valve of either the ICP- MS or the cooling water chiller is closed.
- The cooling strainer is clogged.

- The cooling water is insufficient (possibility of a water leak).
- The tubing in the ICP- MS is clogged and the electromagnetic valve is defective.
- Either the flow rate sensor or the System I/O board is out of order.

1006* Execution Error: Cooling water (RF/WC/IF) flow rate is too low.

The designated command cannot be executed because the cooling water flow rate (RF/WC/IF) is below the limit.

Check cooling water flow rate (RF/WC/IF). The following causes are inferred.

- The power of the cooling water chiller is not switched on.
- The valve of either the ICP- MS or the cooling water chiller is closed.
- The cooling strainer is clogged.
- The cooling water is insufficient (possibility of a water leak).
- The tubing in the ICP- MS is clogged and the electromagnetic valve is defective.
- Either the flow rate sensor or the System I/O board is out of order.

1007 Execution Error: Instrument is not in Shutdown mode

Attempted to execute a command only available in Shutdown mode. It is not in Shutdown mode now.

1008 Execution Error: Cooling water (RF) flow rate is too low.

The designated command cannot be executed because the cooling water flow rate (RF) is below the limit.

Check the cooling water flow rate (RF). The following causes are inferred.

- The power of the cooling water chiller is not switched on.
- The valve of either the ICP- MS or the cooling water chiller is closed.
- The cooling strainer is clogged.
- The cooling water is insufficient (possibility of a water leak).
- The tubing in the ICP- MS is clogged and the electromagnetic valve is defective.
- Either the flow rate sensor or the System I/O board is out of order.

1009* Execution Error: Vacuum pressure (BK) is too high.

The turbomolecular pump cannot work because the vacuum pressure (BK) exceeds the limit (When the instrument is changing from the Shutdown Mode to the Standby Mode).

Check the back line pressure. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.

- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- There is a fault in the backing Pirani gauge or the System I/O Board.

1009* Execution Error: Vacuum pressure (IF/BK) is too high.

The turbomolecular pump cannot work because the vacuum pressure (IF/BK) exceeds the limit (When the instrument is changing from the Shutdown Mode to the Standby Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1010* Execution Error: Vacuum pressure (IF) is too high.

The gate valve cannot be opened because the vacuum pressure (IF) exceeds the limit (When the instrument is changing from the Standby Mode to the Analysis Mode).

Check the interface line pressure. The following causes are inferred.

- The orifice of the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring)
- The plasma is too far from the sampling cone.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- A drop of water was introduced into the vacuum chamber.
- There is a fault in the Pirani gauge (IF) or the System I/O Board.

1010* Execution Error: Vacuum pressure (IF/BK) is too high.

The gate valve cannot be opened because the vacuum pressure (IF/BK) exceeds the limit (When the instrument is changing from the Standby Mode to the Analysis Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The orifice of the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring)
- The plasma is too far from the sampling cone.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.

- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- A drop of water was introduced into the vacuum chamber.
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1011 Execution Error: Can not execute because the Gate valve is open.

Attempted to execute a command that cannot be executed when the gate valve is open. The gate valve is open now.

1012* Execution Error: Can not execute because the Turbo pump (A) is ON.

Attempted to execute a command that cannot be executed when the turbomolecular pump (A) is ON. The turbomolecular pump (A) is ON.

1012* Execution Error: Can not execute because the Turbo pump is ON.

Attempted to execute a command that cannot be executed when the turbomolecular pump is ON. The turbomolecular pump is ON.

1013 Execution Error: Can not execute because the Turbo pump (I) is ON.

Attempted to execute a command that cannot be executed when the turbomolecular pump (I) is ON. The turbomolecular pump (I) is ON.

1014 Execution Error: Can not execute because the 24V power supply is ON.

Attempted to execute a command that cannot be executed when the 24V power supply is ON. The 24V power supply is ON.

1015 Execution Error: Can not execute while the Spray chamber control is ON.

Attempted to execute a command that cannot be executed when the spray chamber temperature control is ON. The spray chamber temperature control is ON now.

1016* Execution Error: Vacuum pressure (BK) is too high to turn on the Penning gauge (AN).

The Penning gauge cannot work because the vacuum pressure (BK) exceeds the limit (When the instrument is changing from the Shutdown Mode to the Standby Mode).

Check the back line pressure. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.

- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- There is a fault in the backing Pirani gauge or the System I/O Board.

1016* Execution Error: Vacuum pressure (IF/BK) is too high to turn on the Penning gauge (AN).

The Penning gauge cannot work because the vacuum pressure (IF/BK) exceeds the limit. (When the instrument is changing from the Shutdown Mode to the Standby Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1017 Execution Error: Torch position X- axis is out of range.

The torch cannot be moved to the designated position because the X- axis position of the torch is out of range or the small cover is closed.

Ensure that the X axis position of the torch is within range. If the small cover is not opened completely, the movable sphere of the X- axis of the torch will be smaller.

1018 Execution Error: Lens calibration must be done in Standby mode.

The lens calibration command is only available in the Standby mode. It is not in Standby mode now. The command was not executed.

1019 Error: Lens Slope Calibration can not complete due to hardware failure.

The lens calibration command was to be executed but the lens slope calibration was not done due to some failure.

The following causes are inferred.

- Either the large cover or the small cover is opened, or S24V is not supplied for other reason- - - check the voltage of the S24V.
- The lenses or the lens and the chamber are touching each other.
- There is a fault in the HV driver board.

1020 Error: Lens 0 volt offset Calibration can not complete due to hardware failure.

The lens calibration command was attempted, but the lens offset calibration was not done due to hardware failure.

The following causes are inferred.

- Either the large cover or the small cover is opened, or S24V is not supplied for other reason - - check the voltage of the S24V.
- The lenses or the lens and the chamber are touching each other.
- There is a fault in the HV driver board.

1021 Execution Error: Turbos slow speed must be done in Standby mode and Vacuum pressure (AN) is low.

As the vacuum pressure (AN) exceeds the limit, the turbomolecular pump cannot be changed to the operation mode (slow speed) (In Standby Mode).

- Check the pressure of the analyzer chamber. The following causes are inferred.
- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the Penning gauge or the System I/O Board

1022 Execution Error: Can not open bypass valve because of high cell pressure.

The bypass valve cannot work because the reaction cell pressure is too high.

The following causes are inferred.

- Reaction gas is supplied.

1023 Execution Error: Reaction mode can be turned on and off only in Analysis mode.

Attempted to execute a command only available in Analysis mode. It is not in Analysis mode now.

1024 Execution Error: Reaction mode can not be turned on/off during transitional period of Reaction- Standard transition.

Reaction mode can not be turned on/off during Reaction- Standard transition. The mode is under transition now.

1025 Execution Error: Reaction gas can be flowed only in Analysis mode.

Reaction gas can flow only in Analysis mode. It is not in Analysis mode now.

1026 Execution Error: Can not turn on 24V power supply because of RF cable disconnection.

The designated command cannot be executed because the cable in the RF generator is not connected or damaged connector. It is possible that the plasma RF generator is faulty.

1027 Execution Error: Can not ignite plasma because of RF cable disconnection.

The designated command cannot be executed because the cable in the RF generator is not connected or damaged connector. It is possible that the plasma RF generator is faulty.

1028 Command Execution Error: Exhaust assist valve cannot be turned on for turbo pump protection.

The exhaust assist valve for reaction gas cannot be opened for the protection of the turbo pump.

1090 Error: EEPROM contents Error.

The contents of the memory maintaining instrument intrinsic information and the adjusted condition are lost. This instrument may not function properly from now on.

Call an Agilent Technologies engineer.

1091 Error: Z80 Boot Error.

The Z80 firmware does not start. The following causes are inferred:

- Flash ROM is damaged
 - Z80 firmware is not downloaded
 - Z80 firmware download failed
- (Contact an Agilent Technologies engineer)

1092 **Error: Flash ROM write error.**

Flash ROM error occurred during writing. The following causes are inferred:

- Flash ROM is damaged
- Flash ROM is not installed
- Flash ROM erase is not possible
- Flash ROM cannot write to the firmware
(Contact an Agilent Technologies engineer)

1099 **Execution Error: Instrument is busy- Between Transition Modes.**

Attempted to execute a command that cannot be executed during mode transition. The mode is under transition now.

1100 **Error: Pirani gauge (BK) malfunction (Open).**

Fault in the backing of the Pirani gauge or the System I/O Board (When the instrument is changing from Shutdown Mode to Standby Mode).

1101* **Error: Vacuum (BK) time out, vacuum too high to start turbo pump.**

The turbomolecular pump cannot work because the vacuum pressure (BK) was not managed below the limit within the prescribed time (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the backing line pressure. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- There is a fault in the backing Pirani gauge or the System I/O Board

1101* **Error: Vacuum (IF/BK) time out, vacuum too high to start turbo pump.**

The turbomolecular pump cannot work because the vacuum pressure (IF/BK) was not managed below the limit within the prescribed time (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1102* Error: Vacuum (BK) time out, vacuum too high to switch on Penning gauge (AN).

The Penning gauge cannot be turned on because the vacuum pressure (BK) was not managed below the limit within the prescribed time (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the backing line pressure. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the backing Pirani gauge or the System I/O Board.

1102* Error: Vacuum (IF/BK) time out, vacuum too high to switch on Penning gauge (AN).

The Penning gauge cannot be turned on because the vacuum pressure (IF/BK) was not managed below the limit within the prescribed time (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board

1103* Error: Vacuum pressure (BK) increased above turbo ON limit.

The turbomolecular pump cannot be turned ON because the vacuum pressure (BK) exceeds the limit or the turbomolecular pump was turned OFF because the vacuum pressure rose abnormal (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the backing line pressure. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- There is a fault in the backing Pirani gauge or the System I/O Board

1103* Error: Vacuum pressure (IF/BK) increased above turbo ON limit.

The turbomolecular pump cannot be turned ON because the vacuum pressure (IF/BK) exceeds the limit or the turbomolecular pump was turned OFF because the vacuum pressure rose abnormally. (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1104* Error: Vacuum pressure (BK) is too high to keep the Penning gauge (AN) ON.

The Penning gauge cannot be turned ON because the vacuum pressure (BK) exceeds the limit or the Penning gauge was turned OFF because the vacuum pressure rose abnormally (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the backing line pressure. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- There is a fault in the backing Pirani gauge or the System I/O Board.

1104* Error: Vacuum pressure (IF/BK) is too high to keep the Penning gauge (AN) ON.

The Penning gauge cannot be turned ON because the vacuum pressure (IF/BK) exceeds the limit or the Penning gauge was turned OFF because the vacuum pressure rose abnormally (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board

1105 Error: Pirani gauge (BK) malfunction (Open).

There is a fault in the backing of the Pirani gauge or the System I/O Board (When the instrument is changing from Standby Mode to Analysis Mode).

1109* Error: Vacuum pressure (BK) is too high to keep the Penning gauge (AN) ON.

The Penning gauge cannot be turned ON because the vacuum pressure (BK) exceeds the limit or the Penning gauge was turned OFF because the vacuum pressure rose abnormally.

Check the backing line pressure. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the backing Pirani gauge or the System I/O Board.

1109* Error: Vacuum pressure (IF/BK) is too high to keep the Penning gauge (AN) on.

The Penning gauge cannot be turned ON because the vacuum pressure (IF/BK) exceeds the limit or the Penning gauge was turned OFF because the vacuum pressure rose abnormally.

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1110* Error: Pirani gauge (BK) malfunction (Open).

There is a fault in the backing Pirani gauge or the System I/O Board (In Standby Mode).

1110* Error: Pirani gauge (IF/BK) malfunction (Open).

There is a fault in the Pirani gauge (IF/BK) or the System I/O Board (In Standby Mode).

1111* Error: Vacuum pressure (BK) is too high to keep the Penning gauge (AN) ON.

The Penning gauge cannot be turned ON because the vacuum pressure (BK) exceeds the limit or the Penning gauge was turned OFF because the vacuum pressure rose abnormally (In the Standby Mode).

Check the backing line pressure. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the backing Pirani gauge or the System I/O Board.

1111* Error: Vacuum pressure (IF/BK) is too high to keep the Penning gauge (AN) ON.

The Penning gauge cannot be turned ON because the vacuum pressure (IF/BK) exceeds the limit or the Penning gauge was turned OFF because the vacuum pressure rose abnormally (In Standby Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.

- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1112* Error: Pirani gauge (BK) malfunction (Open).

There is a fault in the backing Pirani gauge or the System I/O Board (In Analysis Mode).

1112* Error: Pirani gauge (IF/BK) malfunction (Open).

There is a fault in the Pirani gauge (IF/BK) or the System I/O Board (In Analysis Mode).

1113* Error: Vacuum pressure (BK) is too high to keep the Penning gauge (AN) ON.

The Penning gauge cannot be turned ON because the vacuum pressure (BK) exceeds the limit or the Penning gauge was turned OFF because the vacuum pressure rose abnormally (In the Analysis Mode).

Check the backing line pressure. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the backing Pirani gauge or the System I/O Board.

1113* Error: Vacuum pressure (IF/BK) is too high to keep the Penning gauge (AN) ON.

The Penning gauge cannot be turned ON because the vacuum pressure (IF/BK) exceeds the limit or the Penning gauge was turned OFF because the vacuum pressure rose abnormally (In Analysis Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1114 Error: Pirani gauge (BK) malfunction (Open).

There is a fault in the backing of the Pirani gauge or the System I/O Board (When the instrument is changing from Analysis Mode to Standby Mode).

1115* Error: Vacuum pressure (BK) is too high to keep the Penning gauge (AN) ON.

The Penning gauge cannot be turned ON because the vacuum pressure (BK) exceeds the limit or the Penning gauge was turned OFF because the vacuum pressure rose abnormally (When the instrument is changing from Analysis Mode to Standby Mode).

Check the backing line pressure. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the backing Pirani gauge or the System I/O Board.

1115* Error: Vacuum pressure (IF/BK) is too high to keep the Penning gauge (AN) ON.

The Penning gauge cannot be turned ON because the vacuum pressure (IF/BK) exceeds the limit or the Penning gauge was turned OFF because the vacuum pressure rose abnormally (When the instrument is changing from Analysis Mode to Standby Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1116* Error: Pirani gauge (BK) malfunction (Open).

There is a fault in the backing of the Pirani gauge or the System I/O Board.

1116* Error: Pirani gauge (IF/BK) malfunction (Open).

There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1117 Error: Pirani gauge (IF) malfunction (Open).

There is a fault in the interface of the Pirani gauge or the System I/O Board (When the instrument is changing from Standby Mode to Analysis Mode).

1118* Error: Vacuum pressure (IF) time out vacuum too high to open the gate valve.

The gate valve cannot be opened because the vacuum pressure (IF) was not managed lower than the limit within the prescribed time (When the instrument is changing from Standby Mode to Analysis Mode).

Check the interface line pressure. The following causes are inferred.

- A drop of water was introduced into the vacuum chamber.
- The diameter of the hole in the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the interface of the Pirani gauge or the System I/O Board.

1118* Error: Vacuum pressure (IF/BK) time out vacuum too high to open the gate valve.

The gate valve cannot be opened because the vacuum pressure (IF/BK) was not managed lower than the limit within the prescribed time (When the instrument is changing from Standby Mode to Analysis Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- A drop of water was introduced into the vacuum chamber.
- The diameter of the hole in the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1119* Error: Vacuum pressure (IF) is too high to open gate valve.

The gate valve cannot be opened because the vacuum pressure (IF) exceeds the limit or the vacuum pressure (IF) rose abnormally (When the instrument is changing from Standby Mode to Analysis Mode).

Check the interface line pressure. The following causes are inferred.

- The diameter of the hole in the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).

- The plasma is too far from the sampling cone.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- A drop of water was introduced into the vacuum chamber.

1119* Error: Vacuum pressure (IF/BK) is too high to open gate valve.

The gate valve cannot be opened because the vacuum pressure (IF/BK) exceeds the limit or the vacuum pressure (IF/BK) rose abnormally (When the instrument is changing from Standby Mode to Analysis Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The diameter of the hole in the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- A drop of water was introduced into the vacuum chamber.

1120* Error: Vacuum pressure (IF) is too high to stay in Analysis Mode.

Analysis mode cannot be maintained because the vacuum pressure (IF) exceeds the limit (In Analysis Mode).

Check the interface line pressure. The following causes are inferred.

- The diameter of the hole in the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- A drop of water was introduced into the vacuum chamber.

1120* Error: Vacuum pressure (IF/BK) is too high to stay in Analysis Mode.

Analysis mode cannot be maintained because the vacuum pressure (IF/BK) exceeds the limit (In Analysis Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The diameter of the hole in the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.

- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- A drop of water was introduced into the vacuum chamber.

1121* Error: Pirani gauge (BK) malfunction (Open).

There is a fault in the interface of the Pirani gauge or in the Pirani gauge control circuit (In Analysis Mode).

1121* Error: Pirani gauge (IF/BK) malfunction (Open).

There is a fault in the Pirani gauge (IF/BK) or in the Pirani gauge control circuit (In Analysis Mode).

1122 Error: Penning gauge (AN) malfunction.

The Penning gauge works abnormally (When the instrument is changing from Shutdown Mode to Standby Mode).

The Penning gauge may be recovered if you change to Shutdown mode, loosen the vent valve, and release the vacuum chamber to the air.

1123 Error: Vacuum pressure (AN) time out, vacuum too high to enter to Standby Mode.

The instrument cannot transit to Standby mode because the vacuum pressure (AN) was not managed below the limit within the prescribed time (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the pressure of the analyzer chamber. The following causes are inferred. Also this error is generated when a vacuum pump is not used for a long time. In this case, turn on the vacuum ON again.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- The vacuum pressure (AN) cannot be measured correctly due to a fault in the Penning gauge.
- There is a fault in the turbomolecular pump.
- Some of the parts in the vacuum chamber are not completely dry.

1124 Error: Vacuum pressure (AN) time out, vacuum too high to enter to Analysis Mode.

Vacuum pressure (AN) was not managed below the limit within the prescribed time. Therefore, the instrument could not transit to the Analysis mode (When the instrument is changing from Standby Mode to Analysis Mode).

Check the pressure of the analyzer chamber and the interface line. The following causes are inferred.

- The orifice of the sampling cone is too big.
- The seal the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The diameter of the hole in the skimmer cone is too big.
- The installation of the skimmer cone and skimmer base is incomplete.
- The installation of the ion lenses is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- The vacuum pressure (AN) cannot be measured correctly due a failure in the Penning gauge.

1125 Error: Penning gauge (AN) malfunction.

The Penning gauge is working abnormally (When the instrument is changing from Standby Mode to Shutdown Mode).

1126 Error: Penning gauge (AN) malfunction.

The Penning gauge is working abnormally (In Standby Mode).

1127 Error: Vacuum pressure (AN) is too high to stay in Standby mode.

Standby mode cannot be maintained because the vacuum pressure (AN) exceeds the limit or the vacuum pressure (AN) rose abnormally (In Standby Mode).

Check the pressure of the analyzer chamber. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a leak in the gate valve.
- The vacuum pressure (AN) cannot be measured correctly due to a fault in the Penning gauge.
- There is a fault in the turbomolecular pump.

1128 Error: Penning gauge (AN) malfunction.

The Penning gauge is working abnormally (In Analysis Mode).

1129 Error: Vacuum pressure (AN) is too high to stay in Analysis mode.

The Analysis mode cannot be maintained because the vacuum pressure (AN) is below the limit or the vacuum pressure (AN) rose abnormally (In Analysis Mode).

Check the pressure of the analyzer chamber and the interface line. The following causes are inferred.

- The diameter of the hole in the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The diameter of the hole in the skimmer cone is too big.
- Installation of the skimmer cone and skimmer base is incomplete.
- Installation of the ion lenses is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- The vacuum pressure (AN) cannot measure correctly due to the failure of the Penning gauge.
- A drop of water was introduced into the vacuum chamber.

1130 Error: Penning gauge (AN) malfunction.

The Penning gauge is working abnormally (When the instrument is changing from Analysis Mode to Standby Mode).

1131 Error: Vacuum pressure (AN) time out, Vacuum too high after the gate valve closed.

The vacuum pressure (AN) exceeds the limit. The instrument cannot transit to Standby mode (When the instrument is changing from the Analysis Mode to Standby Mode).

Check the pressure of the analyzer chamber. The following causes are inferred.

- There is a leak in the gate valve.

1132 Error: Turbo pump (I) not at desired speed.

The number of revolutions of the turbomolecular pump (I) went below the limit (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the number of revolutions and the current of the turbomolecular pump (I), vacuum pressure (IF), vacuum pressure (BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure
- The connector of the turbomolecular pump (I) came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump (I) or turbomolecular pump controller (I).
- There is a fault in the System I/O Board.

1133* Error: Turbo pump (A) not at desired speed.

The number of revolutions of the turbomolecular pump (A) went below the limit (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the number of revolutions and the current of the turbomolecular pump (A), vacuum pressure (AN), vacuum pressure (BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.
- The connector of the turbomolecular pump (A) came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump (A) or turbomolecular pump controller (A).
- There is a fault in the System I/O Board.

1133* Error: Turbo pump not at desired speed.

The number of revolutions of the turbomolecular pump went below the limit (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the number of revolutions and the current of the turbomolecular pump, vacuum pressure (AN), vacuum pressure (IF/BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.
- The connector of the turbomolecular pump came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump or turbomolecular pump controller.
- There is a fault in the System I/O Board.

1134 Error: Gate valve did not open.

When the instrument transits the Standby mode to Analysis mode, it failed to open the gate valve (When the instrument is changing from Standby Mode to Analysis Mode).

Check the operation of the gate valve. The following causes are inferred.

- The gate valve connector came off.
- The gate valve is defective.
- There is a fault in the System I/O Board or the gate valve connector board.

1135 Error: Gate valve malfunction, Valve closed after open.

The gate valve closes when the instrument is changing from Standby Mode to Analysis mode.

This could happen when the plasma is suddenly extinguished and the interlock system automatically closes the gate valve. If the gate valve closes while the plasma is on, check the gate valve operation. The following causes are inferred.

- The optical cable of the plasma sensor came off.
- The optical cable of the plasma sensor is defective.
- The gate valve connector came off.
- There is a fault in the System I/O Board or the gate valve connector board.

1136 Error: Turbo Pump (I) not at desired speed.

The number of revolutions of the turbomolecular pump (I) went below the limit (When the instrument is changing from Standby Mode to Analysis Mode).

Check the number of revolutions and the current of the turbomolecular pump (I), vacuum pressure (IF), vacuum pressure (BK) and S75 power voltage. The following causes are inferred.

- A rise of vacuum pressure.
- The connector of the turbomolecular pump (I) came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump (I) or turbomolecular pump controller (I).
- There is a fault in the System I/O Board.

1137 Error: Turbo Pump (A) not at desired speed.

The number of revolutions of the turbomolecular pump (A) went below the limit (When the instrument is changing from Standby Mode to Analysis Mode).

Check the number of revolutions and the current of the turbomolecular pump (A), vacuum pressure (AN), vacuum pressure (BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.
- The connector of the turbomolecular pump (A) came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump (A) or turbomolecular pump controller (A).
- There is a fault in the System I/O Board.

1138 Error: Turbo Pump (I) not at desired speed.

The number of revolutions of the turbomolecular pump (I) went below the limit in Standby Mode.

Check the number of revolutions and the current of the turbomolecular pump (I), vacuum pressure (IF), vacuum pressure (BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.
- The connector of the turbomolecular pump (I) came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump (I) or turbomolecular pump controller (I).
- There is a fault in the System I/O Board.

1139* Error: Turbo Pump (A) not at desired speed.

The number of revolutions of the turbomolecular pump (A) went below the limit (In Standby Mode).

Check the number of revolutions and the current of the turbomolecular pump (A), vacuum pressure (AN), vacuum pressure (BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.
- The connector of the turbomolecular pump (A) came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump (A) or turbomolecular pump controller (A).
- There is a fault in the System I/O Board.

1139* Error: Turbo Pump not at desired speed.

The number of revolutions of the turbomolecular pump went below the limit (In Standby Mode).

Check the number of revolutions and the current of the turbomolecular pump, vacuum pressure (AN), vacuum pressure (IF/BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.
- The connector of the turbomolecular pump came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump or turbomolecular pump controller.
- There is a fault in the System I/O Board.

1140 Error: Turbo pump cooling fan malfunction.

The number of revolutions of the turbomolecular pump cooling fan went down abnormally or stopped (In Standby Mode).

Check the turbomolecular pump cooling fan. The following causes are inferred.

- The cooling connector of the cooling fan came off.
- Faulty cooling fan.
- There is a fault in the System I/O Board.

1141 Error: Gate valve is closed due to an error while in Analysis Mode.

The gate valve is closed during the Analysis mode.

Check the gate valve. The following causes are inferred.

- The connector of the gate valve came off.
- Faulty gate valve.
- There is a fault in the System I/O Board or the gate valve connector board.
- The Plasma was shut off.

1142 Error: Turbo pump (I) not at desired speed.

The number of revolutions of the turbomolecular pump (I) went below the limit (In Analysis Mode).

Check the number of revolutions and the current of the turbomolecular pump (I), vacuum pressure (IF), vacuum pressure (BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.
- The connector of the turbomolecular pump (I) came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump (I) or turbomolecular pump controller (I).
- There is a fault in the System I/O Board.

1143* Error: Turbo pump (A) not at desired speed.

The number of revolutions of the turbomolecular pump (A) went below the limit (In Analysis Mode).

Check the number of revolutions and the current of the turbomolecular pump (A), vacuum pressure (AN), vacuum pressure (BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.
- The connector of the turbomolecular pump (A) came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump (A) or turbomolecular pump controller (A).
- There is a fault in the System I/O Board.

1143* Error: Turbo pump not at desired speed.

The number of revolutions of the turbomolecular pump went below the limit (In Analysis Mode).

Check the number of revolutions and the current of the turbomolecular pump, vacuum pressure (AN), vacuum pressure (IF/BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.
- The connector of the turbomolecular pump came off.
- Fault of the power (S75) of the turbomolecular pump.
- Fault of the turbomolecular pump or the turbomolecular pump controller.
- There is a fault in the System I/O Board.

1144 Error: Turbo pump cooling fan malfunction.

The number of revolutions of the turbomolecular pump cooling fan went down abnormally or stopped (In Analysis Mode).

1145 Error: Turbo pump (I) not at desired speed.

The number of revolutions of the turbomolecular pump (I) went below the limit (When the instrument is changing from Analysis Mode to Standby Mode).

Check the number of revolutions and the current of the turbomolecular pump (I), vacuum pressure (IF), vacuum pressure (BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.
- The connector of the turbomolecular pump (I) came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump (I) or turbomolecular pump controller (I).
- There is a fault in the System I/O Board.

1146 Error: Turbo pump (A) not at desired speed.

The number of revolutions of the turbomolecular pump (A) went below the limit (When the instrument is changing from Analysis Mode to Standby Mode).

Check the number of revolutions and the current of the turbomolecular pump (A), vacuum pressure (AN), vacuum pressure (BK), and S75 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.

- The connector of the turbomolecular pump (A) came off.
- Faulty turbomolecular pump power (S75).
- Faulty turbomolecular pump (A) or turbomolecular pump controller (A).
- There is a fault in the System I/O Board.

1147 **Error: Gate valve did not close when Plasma off.**

The gate valve does not close when plasma is extinguished.

Check the operation of the gate valve. The following causes are inferred.

- Faulty gate valve.
- There is a fault in the System I/O Board or the gate valve connector board.

1148 **Error: Turbo pump cooling fan malfunction.**

The number of revolutions of the turbomolecular pump cooling fan went down abnormally or stopped (In Standby Mode).

1149* **Error: Vacuum pressure (BK) is too high to keep the turbos on.**

As vacuum pressure (BK) exceeds the limit, the turbomolecular pump cannot be kept on (In Standby Mode).

Check the backing line pressure. The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
(When the instrument is changing from Analysis Mode to Standby Mode).
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the backing Pirani gauge or the System I/O Board.

1149* **Error: Vacuum pressure (IF/BK) is too high to keep the turbos ON.**

As vacuum pressure (IF/BK) exceeds the limit, the turbomolecular pump cannot be kept on (In Standby Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- There is a leak in the gate valve.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- There is a fault in the Pirani gauge (IF/BK) or the System I/O Board.

1150 Error: Penning gauge (AN) fails to strike.

The Penning gauge cannot strike.

Check the pressure of the analyzer chamber. The following causes are inferred.

- The Penning gauge electrode is dirty.
- Faulty Penning gauge.
- Fault of the System I/O Board.

1151* Error: Turbo Pump (A, I) not at desired speed during penning gauge turn ON.

When making a retry of the Penning gauge, the number of revolutions of the turbomolecular pump (A/I) was not within the prescribed range.

Shutdown the instrument and then the vacuum turns ON.

1151* Error: Turbo Pump not at desired speed during penning gauge turn ON.

When making a retry of the Penning gauge, the number of revolutions of the turbomolecular pump was not within the prescribed range.

Shutdown the instrument and then the vacuum turns ON.

1152 Error: Backing solenoid valve (SVBK) did not open.

When the instrument transits from Shutdown mode to Standby mode, it failed to open the backing solenoid valve (SVBK). (When the instrument is changing from Shutdown Mode to Standby Mode).

Check the operation of the backing solenoid valve (SVBK). The following causes are inferred.

- The backing solenoid valve connector came off.
- The backing solenoid valve is defective.
- There is a fault in the System I/O Board.

1153 Error: Interface solenoid valve (SVIF) did not open.

When the instrument transits from Standby mode to Analysis mode, it failed to open the interface solenoid valve (SVIF) (When the instrument is changing from Standby Mode to Analysis Mode).

Check the operation of the interface solenoid valve (SVIF). The following causes are inferred.

- The interface solenoid valve connector came off.
- The interface solenoid valve is defective.
- There is a fault in the System I/O Board.

1200 Error: Shunt capacitor time out, did not reach desired value.

The Shunt capacitor was not controlled properly. Setting could not be done within the prescribed time.

Check the operation of the Shunt capacitor. The following causes are inferred.

- Defective drive mechanism of the Shunt capacitor, such as loosened screws.
- Defective potentiometer to detect the position of the Shunt capacitor.
- Fault in the wiring of the Shunt capacitor drive motor or the potentiometer.
- Faulty MNBXYZ Board.

1201 Error: Series capacitor time out did not reach desired value.

The Series capacitor to control was not managed properly. The setting could not be done within the prescribed time.

Check the operation of Series capacitor. The following causes are inferred.

- Defective drive mechanism of the Series capacitor, such as loosened screws.
- Defective potentiometer to detect the position of Series capacitor.
- Fault in the wiring of the Series capacitor drive motor or the potentiometer.
- Faulty MNBXYZ Board.

1202 Error: RF reflected power time out, did not get below pre match limit.

The Plasma RF reflected power does not go below the limit (When the instrument is changing from Standby Mode to Analysis Mode).

Check the plasma RF reflected power. The following causes are inferred.

- The installation of the torch, bonnet, and shield plate is faulty.
- The limits of the tuning parameters for RF Matching are inappropriate.
- The limits of the system parameters for the Shunt condenser and the Series condenser-related items are inappropriate.
- The Plasma RF cable came off or the cables are defective.
- Malfunction of Shunt condenser and the Series condenser (Faulty XYZMN Board is also probable).

1203 Error: Plasma did not come ON.

The Plasma did not ignite (When the instrument is changing from Standby Mode to Analysis Mode).

Check the plasma RF forward power and reflected power, argon gas line pressure, and flow rate. The following causes are inferred.

- The installation of the torch, bonnet, and shield plate is faulty.
- The work coil position is mis-aligned (refer to page 4-58).
- Argon gas is not supplied or there is a leak in the gas line.
- The air is mixed with argon gas.
- The limits of the tuning parameters for the RF Matching are inappropriate.
- The limits of the system parameters for the Shunt condenser and Series condenser-related items are inappropriate.

- The Plasma RF cable came off or the cables are defective.
- Malfunction of the Shunt condenser and Series condenser (Faulty XYZMN Board is also probable).
- The power cable to the plasma RF generator comes off.
- Faulty plasma RF generator.

1204 Error: Turbo is not slowing at Ar purge.

During the argon purge, the number of revolutions of the turbomolecular pump did not go below the limit within the prescribed time. The power of the turbomolecular pump was forcibly switched off (When the instrument is changing from Standby Mode to Shutdown Mode).

Check the number of revolutions and the current of the turbomolecular pump. After detecting this error, the display of the number of revolutions and the current of the turbomolecular pump will be incorrect. To check the number of revolutions and current, start from Standby mode again.

During the argon purge, if the number of revolutions of the turbomolecular pump does not go down, the following causes are inferred.

- Faulty turbo pump controller.
- Faulty System I/O Board.

1205 Error: Turbo is not slowing at Air purge.

During the air purge, the number of revolutions of the turbomolecular pump did not go below the limit within the prescribed time. The power of the turbomolecular pump was forcibly switched off (When the instrument is changing from Standby Mode to Shutdown Mode).

Check the number of revolutions and the current of the turbomolecular pump. After detecting this error, the display of the number of revolutions and current of the turbomolecular pump will be incorrect. To check the number of revolutions and the current, start from Standby mode again.

During the air purge, if the number of revolutions of the turbomolecular pump does not go down, the following causes are inferred.

- Faulty turbo pump controller.
- Faulty System I/O Board.

1206 Error: Turbo speed did not drop down following purge cycle.

After the purge, the number of revolutions of the turbomolecular pump did not go below the limit within the prescribed time. The power of the turbomolecular pump was forcibly switched off (When the instrument is changing from Standby Mode to Shutdown Mode).

Check the number of revolutions and the current of the turbomolecular pump. After detecting this error, the display of the number of revolutions and the current of the turbomolecular pump will be incorrect. To check the number of revolutions and the current, start from Standby mode again.

After the purge, if the number of revolutions of the turbomolecular pump does not go down, the following causes are inferred.

- Faulty turbo pump controller.
- Faulty System I/O Board.

1208* Error: Interface Pressure remained high following gate valve opening.

After opening the gate valve, the vacuum pressure (IF) did not go below the limit (When the instrument is changing from Standby Mode to Analysis Mode).

Check vacuum pressure (IF), the number of revolutions and current of the turbomolecular pump (I). The following causes are inferred.

- The orifice of the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- Faulty turbomolecular pump (I) or the turbomolecular pump controller.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- A drop of water was introduced into the vacuum chamber.
- There is a fault in the Pirani gauge (IF) or System I/O Board.

1208* Error: IF/BK Pressure remained high following gate valve opening.

After opening the gate valve, the vacuum pressure (IF/BK) did not go below the limit (When the instrument is changing from Standby Mode to Analysis Mode).

Check vacuum pressure (IF/BK), the number of revolutions and current of the turbomolecular pump. The following causes are inferred.

- The orifice of the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- Faulty turbomolecular pump or turbomolecular pump controller.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring.)
- A drop of water was introduced into the vacuum chamber.
- There is a fault in the Pirani gauge (IF/BK) or System I/O Board.

1209 Error: Shunt capacitor time out, did not reach desired value.

The Shunt capacitor was not controlled properly. Setting could not be done within the prescribed time.

Check the operation of Shunt capacitor. The following causes are inferred.

- Defective drive mechanism of Shunt capacitor such as loosened screws.
- Defective potentiometer to detect the position of Shunt capacitor.

- Fault in the wiring of the Shunt capacitor drive motor or the potentiometer.
- Faulty MNBXYZ Board.

1210 Error: RF amp FET drain current is too high.

The output of the FET drain current of the plasma RF amps exceed the limit.

Check the plasma RF amp output FET drain current, the plasma RF forward power, the reflected power, the argon gas line pressure, and flow rate. When the Plasma RF Reflected Power is high, reduce the Reflected Power by using the automatic adjustment (Tune >> RF Matching on Tuning Window). The following causes are inferred.

- The installation of torch, bonnet, and shield plate is faulty.
- The Argon gas is not supplied or there is a leak in the gas line.
- The air is mixed with argon gas.
- The limits of the tuning parameters for the RF Matching are inappropriate.
- The limits of the system parameters for the Shunt condenser and Series condenser- related items are inappropriate.
- The Plasma RF cable came off or the cables are defective.
- Malfunction of the Shunt condenser and Series condenser. (A faulty XYZMN Board is also probable.), faulty Matching network.
- Faulty plasma RF generator

1211* Error: RF Feedback error.

The power control of the plasma RF generator does not work properly. It is possible that the plasma RF generator is faulty.

1211* Error: DC/DC converter (24/12V) of RF generator malfunction.

The DC/DC converter of the plasma RF generator does not work properly.

Check the output voltage of the DC/DC converter (Local 12V) of the plasma RF generator. It is possible that the plasma RF driver board is faulty.

1212 Error: RF48V power voltage is too high.

The voltage of RF 48V exceeds the limit.

Check the voltage of RF 48V power supply. RF 48V is supplied with S24V. The following causes are inferred.

- Faulty Power Supply
- Faulty RF generator

1213 Error: RF48V power voltage is too low.

The voltage of RF 48V drops below the limit.

Check the voltage of RF 48V power supply. RF 48V is supplied with S24V. The following causes are inferred.

- The hood is opened in the Analysis Mode.
- The plasma is turned off suddenly.
- Faulty Power Supply
- Faulty RF generator

1214 Error: RF amp FET over temperature.

Output FET temperature exceeds the limit.

Check plasma RF amp temperature, plasma RF cooling water flow rate, plasma RF forward power, reflected power, argon gas line pressure and flow rate. The following causes are inferred.

- A shortage of the cooling water flow rate, thus, increasing the temperature of the cooling water
- The air is mixed with argon gas.
- The limits of the tuning parameters for the RF Matching are inappropriate.
- The limits of the system parameters for Shunt condenser and Series condenser-related items are inappropriate.
- The Plasma RF cable came off or the cables are defective.
- Malfunction of the Shunt condenser and Series condenser. (A faulty XYZMN Board is also probable.), faulty Matching network.
- The installation of the plasma RF generator output FET is faulty (the conductive heat compound is degraded).
- Faulty plasma RF generator.

1215* Error: RF Drain voltage is too high.

The output of the FET drain voltage of the plasma RF amps exceed the limit.

When the Plasma RF Reflected Power is high, reduce the Reflected Power by using the automatic adjustment (Tune >> RF Matching on Tuning Window).

Check the output of the FET drain voltage of the plasma RF amp, plasma RF forward power, reflected power, argon gas line pressure, and flow rate. The following causes are inferred.

- Poor connection of the RF amp directional coupler (connector comes off)
- The installation of the torch, bonnet, and shield plate is faulty.
- The Argon gas is not supplied or there is a leak in the gas line.
- The air or N₂ is mixed with argon gas.
- The limits of the tuning parameters for the RF Matching are inappropriate.
- The limits of the system parameters for the Shunt capacitor and Series capacitor - related items are inappropriate.
- The Plasma RF cable came off or the cables are defective.
- The malfunction of the Shunt capacitor and Series capacitor. (A faulty XYZMN Board is also probable.), faulty Matching network.
- Faulty plasma RF generator

1215* Error: RF amp FET drain voltage is too high.

The output of the FET drain voltage of the plasma RF amps exceed the limit. When the Plasma RF Reflected Power is high, reduce the Reflected Power by using the automatic adjustment (Tune >> RF Matching on Tuning Windows).

Check the output of the FET drain voltage of the plasma RF amp, plasma RF forward power, reflected power, argon gas line pressure, and flow rate. The following causes are inferred.

- Poor connection of the RF amp directional coupler (connector comes off).
- The installation of the torch, bonnet, and shield plate is faulty.
- The Argon gas is not supplied or there is a leak in the gas line.
- The air or N₂ is mixed with argon gas.
- The limits of the tuning parameters for the RF Matching are inappropriate.
- The limits of the system parameters for the Shunt capacitor and Series capacitor - related items are inappropriate.
- The Plasma RF cable came off or the cables are defective.
- The malfunction of the Shunt condenser and Series condenser (A faulty XYZMN Board is also probable.), faulty Matching network.
- Faulty plasma RF generator.

1216 Error: RF power is unbalanced.

The Plasma RF amp output is unbalanced.

Check the plasma RF forward power, reflected power, argon gas line pressure, and flow rate. The following causes are inferred.

- Poor connection of the RF amp directional coupler (the connector came off).
- The installation of the torch, bonnet, and shield plate is faulty.
- Faulty plasma RF generator

1217 **Error: Matching box fan failure.**

The number of revolutions of the matching box cooling fan went below the limit.

Check the number of revolutions of the matching box cooling fan. The cooling fan, cooling fan wiring or MNBXY board is abnormal.

1218 **Error: Plasma was shut off. (Plasma RF Monitor).**

The plasma has extinguished (In Analysis mode or during maintenance).

Check the argon gas line pressure and flow rate. The following causes are inferred.

- The installation of the torch, bonnet, and shield plate is faulty.
- The Argon gas is not supplied or there is a leak in the gas line.
- The air is mixed with argon gas.
- The limits of the tuning parameters for the RF Matching are inappropriate.
- The Plasma RF cable came off or the cables are defective.
- Malfunction of the Shunt condenser and Series condenser (A faulty XYZMN Board is also probable).
- Power cable to the plasma RF generator came off.
- Faulty plasma RF generator.
- Faulty DC Power Supply.
- Faulty plasma sensor optical cable

1219* **Error: Plasma was shut off during vacuum (IF) ON.**

The plasma has extinguished (When the instrument is changing from Standby Mode to Analysis Mode).

Check the argon gas line pressure and flow rate. The following causes are inferred.

- The installation of the torch, bonnet, and shield plate is faulty.
- The Argon gas is not supplied or there is a leak in the gas line.
- The air is mixed with argon gas.
- The Plasma RF cable came off or the cables are defective.
- Malfunction of the Shunt condenser and Series condenser (A faulty XYZMN Board is also probable).
- Power cable to the plasma RF generator came off.
- Faulty plasma RF generator.

1219* **Error: Plasma was shut off during vacuum (IF/BK) ON.**

The plasma has extinguished (When the instrument is changing from Standby Mode to Analysis Mode).

Check the argon gas line pressure and flow rate. The following causes are inferred.

- The installation of the torch, bonnet, and shield plate is faulty.
- The Argon gas is not supplied or there is a leak in the gas line.

- The air is mixed with argon gas.
- The Plasma RF cable came off or the cables are defective.
- Malfunction of the Shunt condenser and Series condenser (A faulty XYZMN Board is also probable).
- Power cable to the plasma RF generator came off.
- Faulty plasma RF generator

1220 Error: Plasma was shut off during Analysis. (Vac)

The plasma has extinguished (In Analysis Mode or during Maintenance).
Check the argon gas line pressure and flow rate. The following causes are inferred.

- The installation of the torch, bonnet, and shield plate is faulty.
- The Argon gas is not supplied or there is a leak in the gas line.
- The air is mixed with argon gas.
- The limits of the tuning parameters for the RF Matching are inappropriate.
- The Plasma RF cable came off or the cables are defective.
- Malfunction of the Shunt condenser and Series condenser (A faulty XYZMN Board is also probable).
- Power cable to the plasma RF generator came off.
- Faulty plasma RF generator.
- Faulty DC Power Supply.

1221* Error: RF Cable Connection error.

The cable in the RF generator is not connected or damaged connector.

1221* Error: Directional coupler (DCP) feedback cable is open.

The directional coupler is not connected or there are faults in the directional coupler/ plasma RF driver board.

1222 Error: Large or small top Cover opened.

Either of the top covers of the instrument is not closed completely.

1223 Error: RF Drain voltage is too low.

The output of the FET drain voltage of the RF generator went below the limit.
The following causes are inferred.

- The hood is opened in Analysis Mode.
- The plasma is turned off suddenly.
- Faulty RF generator

1226 Error: RF amp fan malfunction.

The number of revolutions of the plasma RF generator cooling fan went below the limit.

Check the number of the revolutions of the plasma RF generator cooling fan.
Either the cooling fan, cooling fan wiring, or plasma RF board is abnormal.

1300 Error: QP fan malfunction

The number of revolutions of the QP driver unit cooling fan went below the limit.

Check the number of the revolutions of the QP driver unit cooling fan. Either the cooling fan, cooling fan wiring, or the QP driver board is abnormal.

1301 Error: QP control (Feedback circuit) malfunction.

The V voltage of the QP cannot be controlled.

Check the V voltage of the QP and QP- RF forward power, reflected RF power. The following causes are inferred.

- S24V is not supplied (Cover is open).
- QP- related cabling came off.
- QP rod, or QP- related wiring (including the vacuum chamber) causes a short in other metallic parts.
- QP Matching frequency is not appropriate.
- Faulty QF tank board (QP tank coil burn).
- Either the QP RF amp board, QP pickup board or QP driver board is faulty.
- Faulty DC Power Supply.

1302 Error: +600V power supply voltage is too low.

The voltage of the DC/DC converter (+600V) of the QP driver unit went below the limit.

Check the QP driver +600V power voltage. The following causes are inferred.

Note: To restart, turn off the plasma once.

- S24V is not supplied (Cover is open).
- QP- related cabling came off.
- QP rod, or QP- related wiring (including the vacuum chamber) causes a short in other metallic parts.
- Either the QP power board or QP driver board is faulty.

1303 Error: +600V power supply voltage is too high.

The voltage of the DC/DC converter (+600V) of the QP driver unit exceeds the limit.

Check the QP driver +600V power voltage. Either the QP power board or the QP driver board may be faulty.

1304 Error: - 600V power supply voltage is too low.

The voltage of the DC/DC converter (- 600 V) of the QP driver unit went below the limit.

Check the QP driver - 600 V power voltage. The following causes are inferred.

Note: To restart, turn off the plasma once.

- S24V is not supplied (Cover is open).
- QP- related cabling came off.

- QP rod, or QP-related wiring (including the vacuum chamber) causes a short in other metallic parts.
- Either the QP power board or the QP driver board is faulty.

1305 Error: - 600V power supply voltage is too high.

The voltage of the DC/DC converter (- 600 V) of the QP driver unit exceeds the limit.

Check the QP driver - 600 V power voltage. Either the QP power board or QP driver board may be faulty.

1306 Error: QP amp temperature is too high.

The output FET temperature of the QP- RF amp exceeds the limit.

Check the RF forward power, reflected power, and the QP- RF amp temperature. The following causes are inferred.

- The limit of the system parameter for the QP Matching Frequency is inappropriate.
- Installation of the QP RF amp output FET is faulty (The conductive heat compound is degraded).
- Abnormal increase of the temperature inside the instrument.
- QP RF amp is faulty.

1307 Error: Lens and EM power supply cannot come into operation.

The high voltage power supply is not in operating condition. The prescribed voltage is not approved for the lens and EM.

The following causes are inferred.

- Either the large cover or the small cover is not closed.
- The HV driver board cabling came off or board is faulty.

1308 Error: Octopole drain current Error.

The output of the Octopole drain current is abnormal.

Check the Octopole drain current. A faulty OctP driver board may be the cause.

1309 Error: Octopole control malfunction.

The RF voltage of the Octopole cannot be controlled.

Check the RF voltage of the Octopole. The following causes are inferred.

- S24V is not supplied (Cover is open).
- Octopole rod or reaction cell- related wiring (including the vacuum chamber) causes a short in other metallic parts.
- Octopole Matching frequency is not appropriate.
- Fault of the Octopole board.

1400* Error: Cooling water (IF,RF) flow rate is too low.

The flow rate of the cooling water (IF, RF) is below the limit.

Check the flow rate of the cooling water. The following causes are inferred.

- The power of the cooling water chiller is OFF.
- Cooling water valve is closed.
- Cooling water is insufficient (possibility of a water leak).
- Cooling pipes are clogged or leaked.
- Cooling water strainer is clogged.
- Cooling chiller is faulty.

1400* Error: Cooling water (RF/WC/IF) flow rate is too low.

The flow rate of the cooling water (RF/WC/IF) is below the limit.

Check the flow rate of the cooling water. The following causes are inferred.

- The power of the cooling water chiller is OFF.
- Cooling water valve is closed.
- Cooling water is insufficient. (a possibility of a water leak).
- Cooling pipes are clogged or leaked.
- Cooling water strainer is clogged.
- Cooling chiller is faulty.

1402 Error: Cooling water temperature is too high.

The temperature of the cooling water exceeds the limit.

Check the temperature of the cooling water. The following causes are inferred.

- The power of the cooling water chiller is OFF.
- The setting of the cooling water chiller is not correct or the circular is faulty.

1410 Error: Torch position X- axis limit SW malfunction.

The X- axis limit switch is faulty.

Limit switch of either the H or L of X- axis or the XYZMN board is faulty.

1411 Error: Torch position Y- axis limit SW malfunction.

The Y- axis limit switch is faulty.

Limit switch of either the H or L of Y- axis or the XYZMN board is faulty.

1413 Error: Torch position X- axis time out occur.

Time out occurs during the torch position moving on the X- axis.

The torch position may not be correct. Initialize the torch box. If Time out occurs repeatedly, the XYZMN board may be faulty.

1414 Error: Torch position Y- axis time out occur.

Time out occurs during the torch position moving on the Y- axis.

The torch position may not be correct. Initialize the torch box. If Time out occurs repeatedly, the XYZMN board may be faulty.

1415 Error: Torch position Z- axis time out occur.

Time out occurs during the torch position moving on the Z- axis.

The torch position may not be correct. Initialize the torch box. If Time out occurs repeatedly, the XYZMN board may be faulty.

1416 Error: Torch position X- axis initialization failed.

Initializing the X- axis has failed. Now, the torch position is not correct.

Check if the limit switch of the X- axis works properly and if there is any cause for malfunction, such as something stuck in a direction of the X- axis origin point. If any cause is found, get rid of it to initialize again.

1417 Error: Torch position Y- axis initialization failed.

Initializing the Y- axis has failed. Now, the torch position is not correct.

Check if the limit switch of the Y- axis works properly and if there is any cause for malfunction such as something stuck in a direction of the Y- axis origin point. If any cause is found, get rid of it to initialize again.

1418 Error: Torch position Z- axis initialization failed.

Initializing the Z- axis has failed. Now, the torch position is not correct.

Check if the limit switch of the Z- axis works properly and if there is any cause for malfunction such as something stuck in a direction of the Z- axis origin point. If any cause is found, get rid of it to initialize again.

1422 Error: Torch position initialization time out occur.

The initialization of the torch position has not finished within the limit. The initialization of the XYZ stage cannot be performed. Check all the communication lines and the power line are connected properly. Faulty communication lines or XYZMN board is inferred as the causes.

1430 Error: Air intake temperature is too high.

The temperature of the intake port located at the rear side of the instrument exceeds the limit.

Check the inlet temperature. The following causes are inferred.

- The temperature near the intake port increased due to the heater.
- Intake port is clogged.
- Faulty intake temperature sensor or the System I/O board.

1432 Error: Exhaust temperature is too high.

The temperature of exhaust duct exceeds the limit.

Check the exhaust temperature. The following causes are inferred.

- A shortage of the duct flow rate.
- Sampling cone is not tightened enough.
- Faulty exhaust temperature sensor or the System I/O board.

1433 Error: 24V power supply malfunction.

The 24V power supply malfunction.

Check the output voltage of the 24V power supply. The following causes are inferred.

- The main power supply is faulty.
- The board in the instrument is faulty.
- The wiring is abnormal.

1434 Error: QP 48V power supply malfunction.

The QP 48V power supply malfunction.

Check the output voltage of the QP 48V power supply. The following causes are inferred.

- The main power supply is faulty.
- The System I/O board or QP AMP unit is faulty.
- The wiring is abnormal.

1435 Error: Plasma RF 48V power supply malfunction.

The Plasma RF 48V power supply malfunction.

Check the output voltage of the Plasma RF 48V power supply. The following causes are inferred.

- The main power supply is faulty.
- The plasma RF generator unit is faulty.
- The wiring is abnormal.

1436 Error: 75V power supply malfunction.

The 75V power supply malfunction.

Check the output voltage of the 75V power supply. The following causes are inferred.

- The main power supply is faulty.
- The System I/O board is faulty.
- The turbo pump is faulty.
- The wiring is abnormal.

1440* Error: Cooling water (IF) flow rate is too low. Spray chamber temperature control turned OFF.

The flow rate of the cooling water (IF) is below the limit, and the cooling of the spray chamber is stopped.

Check the flow rate of the cooling water. The following causes are inferred.

- The power of the cooling water chiller is not switched on.
- The cooling water valve is closed.
- The cooling water is insufficient (possibility of a water leak).
- Clogged cooling water tubing and a leak.
- The cooling strainer is clogged.
- Faulty cooling water chiller.

1440* Error: Cooling water (RF/WC/IF) flow rate is too low. Spray chamber temperature control turned OFF.

The flow rate of the cooling water (RF/WC/IF) is below the limit, and the cooling of the spray chamber is stopped.

Check the flow rate of the cooling water. The following causes are inferred.

- The power of the cooling water chiller is not switched on.
- The cooling water valve is closed.
- The cooling water is insufficient (possibility of a water leak).
- Clogged cooling water tubing and a leak.
- The cooling strainer is clogged.
- Faulty cooling water chiller.

1441 Error: Spray chamber temperature (L) is too high.

The temperature of the spray chamber (L) exceeds the limit.

Check the temperature of the spray chamber (L). The following causes are inferred.

- The cooling water connector for spray chamber came off.
- Faulty spray chamber.
- Faulty Introduction board.

1442 Error: Spray chamber temperature (L) is too low.

The temperature of the spray chamber (L) is below the limit.

Check the temperature of the spray chamber (L). The following causes are inferred.

- Faulty spray chamber.
- Faulty Introduction board.

1443 Error: Spray chamber temperature control malfunction.

The temperature of the spray chamber (L) cannot be controlled properly.

Check the temperature of the spray chamber (L) and the room temperature.

The following causes are inferred.

- The room temperature is lower than the set temperature of the spray chamber, so the temperature of the spray chamber (L) cannot be controlled. The spray chamber has no heating function.
- Faulty spray chamber.
- Faulty Introduction board.

1445 Error: Plasma gas flow rate is too low.

Plasma gas flow rate is below the limit.

Check the flow rate of the plasma gas. Also check the pressure of the argon tank. The following causes are inferred.

- The pressure of the argon tank went down.
- Faulty gas line such as clogging or coming off

- Faulty argon gas electromagnetic valve (Connector came off).
- Faulty mass flow controller connector.
- Faulty mass flow controller.
- Faulty Introduction board.

1446 Error: Aux gas flow rate is too low.

The Auxiliary gas flow rate is below the limit.

Check the flow rate of the auxiliary gas. Also check the pressure of the argon tank. The following causes are inferred.

- The pressure of the argon tank went down.
- Faulty gas line such as clogging or coming off
- Faulty argon gas electromagnetic valve (Connector came off).
- Faulty mass flow controller connector.
- Faulty mass flow controller.
- Faulty Introduction board.

1449 Error: Spray chamber temperature (H) is too high.

The temperature of the spray chamber (H) has risen abnormally.

Check the temperature of the spray chamber (H) and the flow rate of the cooling water. The following causes are inferred.

- Decrease of the spray chamber cooling water (Tubing is clogged or came off).
- Faulty spray chamber connector (Connector came off).
- Faulty spray chamber.
- Faulty Introduction board.

1450 Error: Spray chamber temperature (H) is too low.

The temperature of the spray chamber (H) has abnormally dropped.

Check the temperature of the spray chamber (H) and the flow rate of the cooling water. The following causes are inferred.

- The temperature of the cooling water is abnormally low.
- Faulty spray chamber connector.
- Faulty spray chamber.
- Faulty Introduction board.

1451 Error Plasma gas MFC zero adjustment malfunction.

The Mass flow controller has failed in zero adjustment.

Check the pressure of the argon tank gas. The following causes are inferred.

- Faulty mass flow controller (Connector came off or internal fault).
- Faulty Introduction board.

1452 Error: Aux gas MFC zero adjustment malfunction.

The Mass flow controller has failed in zero adjustment.

Check the pressure of argon gas tank. The following causes are inferred.

- Faulty mass flow controller (Connector came off or internal fault).
- Faulty Introduction board.

1453 Error: Carrier gas MFC zero adjustment malfunction.

The Mass flow controller has failed in zero adjustment.

Check the pressure of argon gas tank. The following causes are inferred.

- Faulty mass flow controller (Connector came off or internal fault).
- Faulty Introduction board.

1454 Error Makeup gas MFC zero adjustment malfunction.

The Mass flow controller has failed in zero adjustment.

Check the pressure of argon gas tank. The following causes are inferred.

- Faulty mass flow controller (Connector came off or internal fault).
- Faulty Introduction board.

1455 Error: Optional gas MFC zero adjustment malfunction.

The Mass flow controller has failed in zero adjustment.

Check the pressure of optional gas tank. The following causes are inferred.

- Faulty mass flow controller (Connector came off or internal fault).
- Faulty Introduction board.

1456 Error: Ar gas controller (AMFC) malfunction.

Error from AMFC gas module during calibration check of instrument.

Verify error by restarting the instrument. The following causes are inferred.

- Disconnected, poorly connected or malfunctioning cable.
- Fault in the AMFC gas module.

1518 Error: Main Board controller communication Error.

The communication between the boards cannot be performed properly.

Check that all the communication lines and the power line are connected properly. Faulty communication lines or Main board is inferred as the cause.

1519 Error: XYZ MN Board controller communication Error.

The communication between the boards cannot be performed properly.

Check that all the communication lines and the power line are connected properly. Faulty communication lines or XYZMN board is inferred as the cause.

1520 Error: Introduction Board controller communication Error.

The communication between the boards cannot be performed properly.

Check that all the communication lines and the power line are connected properly. Faulty communication lines or Introduction board is inferred as the cause.

1521 Error: System I/O Board controller communication Error.

The communication between the boards cannot be performed properly.

Check that all the communication lines and the power line are connected properly. Faulty communication lines or Introduction board is inferred as the cause.

1522 Error: QP Driver Board controller communication Error.

The communication between the boards cannot be performed properly.

Check that all the communication lines and the power line are connected properly. Faulty communication lines or Introduction board is inferred as the cause.

1523 Error: RF Driver Board controller communication Error.

The communication between the boards cannot be performed properly.

Check that all the communication lines and the power line are connected properly. Faulty communication lines or Introduction board is inferred as the cause.

1524 Error: HV Driver Board controller communication Error.

The communication between the boards cannot be performed properly.

Check that all the communication lines and the power line are connected properly. Faulty communication lines or Introduction board is inferred as the cause.

1525 Error: OctP Driver Board controller communication Error.

The communication between the boards cannot be performed properly.

Check that all the communication lines and the power line are connected properly. Faulty communication lines or Introduction board is inferred as the cause.

1526 Error: Reaction Cell Board controller communication Error.

The communication between the boards cannot be performed properly.

Check that all the communication lines and the power line are connected properly. Faulty communication lines or Introduction board is inferred as the cause.

Alarm Messages

The following alarm messages can appear in the MassHunter Workstation (and ChemStation) green message bar when you operate the Agilent 7500. When an alarm message is displayed, the instrument runs a safety sequence.

2150* Warning: Interface Vacuum is too low.

The interface line pressure is below the limit (In Analysis Mode).

Check the interface line pressure. The following causes are inferred.

- The orifice of the sampling cone is too small or clogged.
- The orifice of the skimmer cone is too small or clogged.

2150* Warning: Vacuum (IF/BK) is too low.

The vacuum pressure (IF/BK) is below the limit (In Analysis Mode).

Check the vacuum pressure (IF/BK). The following causes are inferred.

- The orifice of the sampling cone is too small or clogged.
- The orifice of the skimmer cone is too small or clogged.

2151* Warning: Interface Vacuum is too high.

The interface line pressure exceeds the limit (In Analysis Mode).

Check the interface line pressure. The following causes are inferred.

- The orifice of the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring). A drop of water was introduced into the vacuum chamber.

2151* Warning: Vacuum (IF/BK) is too high.

The vacuum pressure (IF/BK) exceeds the limit (In Analysis Mode).

Check vacuum pressure (IF/BK). The following causes are inferred.

- The orifice of the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring). A drop of water was introduced into the vacuum chamber.

2152 Warning: Analyzer Vacuum is too high.

The vacuum pressure (AN) exceeds the limit (In Analysis Mode).

Check the vacuum pressure (AN). The following causes are inferred.

- The orifice of the sampling cone is too big.
- The seal of the sampling cone is incomplete (Defective O- ring).
- The plasma is too far from the sampling cone.
- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- A drop of water was introduced into the vacuum chamber.
- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- There is a leak in the gate valve.
- There is a fault in the Penning gauge or the System I/O Board.
- The reaction gas flow rate is too high.

2153 Warning: Analyzer Vacuum is too high.

The vacuum pressure (AN) exceeds the limit (In Standby Mode).

Check the vacuum pressure (AN). The following causes are inferred.

- The power of the rotary pump is not connected or the breaker is OFF.
- The rotary pump oil level is low or the oil is dirty.
- The vacuum tubing has failed (the tubing is off, or a leak is caused by an incomplete seal such as a pin hole or a defective O- ring).
- The vent valve is not closed or the seal is incomplete.
- The cover of the vacuum chamber is not closed or the seal is incomplete.
- There is a leak in the gate valve.
- There is a fault in the Penning gauge or the System I/O Board.

2400* Warning: Cooling water (IF) flow rate is low.

The flow rate of the cooling water (IF) is below the limit.

Check the flow rate of the cooling water. The following causes are inferred.

- The power of the cooling water chiller is OFF.
- Cooling water valve is closed.
- Cooling water is insufficient (possibility of a water leak).
- Cooling pipes are clogged or leaked.
- Cooling water strainer is clogged.
- Cooling chiller is faulty.

2400* Warning: Cooling water (RF/WC/IF) flow rate is low.

The flow rate of the cooling water (RF/WC/IF) is below the limit.

Check the flow rate of the cooling water. The following causes are inferred.

- The power of the cooling water chiller is OFF.
- Cooling water valve is closed.
- Cooling water is insufficient (possibility of a water leak).
- Cooling pipes are clogged or leaked.
- Cooling water strainer is clogged.

- Cooling chiller is faulty.

2402 Warning: Cooling water (RF) flow rate is low.

The flow rate of the cooling water (RF) is below the limit.

Check the flow rate of the cooling water. The following causes are inferred.

- The power of the cooling water chiller is OFF.
- Cooling water valve is closed.
- Cooling water is insufficient (possibility of a water leak).
- Cooling pipes are clogged or leaked.
- Cooling water strainer is clogged.
- Cooling chiller is faulty.

2403 Warning: Cooling water temperature is high.

The temperature of the cooling water exceeds the limit.

Check the temperature of the cooling water. The following causes are inferred.

- The power of the cooling water chiller is OFF.
- The setting of the cooling chiller is not correct or faulty.

2404 **Warning: Cooling water temperature is low.**

The temperature of the cooling water is below the limit.

Check the temperature of the cooling water. When the setting of the cooling chiller is not correct or faulty, this error may be generated.

2405 **Warning: RF Driver voltage is high.**

The voltage of RF Driver exceeds the limit. It is possible that the output power of the RF generator is not controlled properly.

The following causes are inferred.

- The value of the RF Matching (Tuning Parameter) is inappropriate.
- The matching network box or the work coil is abnormal.
- Faulty Matching Network Box.
- Faulty RF generator.

2412 **Warning: Plasma gas flow rate is low.**

The flow rate of the plasma gas is below the limit.

Check the flow rate of the plasma gas. Check the pressure of the argon tank.

The following causes are inferred.

- The pressure of the argon tank fell.
- Gas line fault such as clogging or coming off.
- Faulty argon gas electromagnetic valve (Connector came off).
- Faulty mass flow controller connector.
- Faulty mass flow controller.
- Faulty Introduction board

2413 **Warning: Aux gas flow rate is low.**

The flow rate of the auxiliary gas is below the limit (When the instrument is changing from Standby Mode to Analysis Mode).

Check the flow rate of the auxiliary gas. Check the pressure of the argon tank.

The following causes are inferred.

- The pressure of the argon tank fell.
- Gas line fault such as clogging or coming off.
- Faulty argon gas electromagnetic valve (Connector came off).
- Faulty mass flow controller connector.
- Faulty mass flow controller.
- Faulty Introduction board.

2414 **Warning: Carrier gas flow rate is low.**

The flow rate of the carrier gas is below the limit.

Check the flow rate and the pressure of the carrier gas. Check the pressure of the argon tank. The following causes are inferred.

- The pressure of the argon tank fell.
- Gas line fault such as clogging or coming off

- Faulty argon gas electromagnetic valve (Connector came off).
- Faulty mass flow controller connector.
- Faulty mass flow controller.
- Faulty Introduction board.

2415 Warning: Makeup gas flow rate is low.

The flow rate of the makeup gas is below the limit.

Check the flow rate of the makeup gas. Check the pressure of the argon tank. The following causes are inferred.

- The pressure of the argon tank fell.
- Gas line fault such as clogging or coming off.
- Faulty argon gas electromagnetic valve (Connector came off).
- Faulty mass flow controller connector.
- Faulty mass flow controller.
- Faulty Introduction board.

2416 Warning: Optional gas flow rate is low.

The flow rate of the optional gas is below the limit.

Check the flow rate and the pressure of the optional gas. Check the pressure of the optional gas tank. The following causes are inferred.

- Gas line fault such as clogging or coming off.
- Faulty argon gas electromagnetic valve (Connector came off).
- Faulty mass flow controller connector.
- Faulty mass flow controller.
- Faulty Introduction board.

2433 Warning: Air intake temperature is high.

The temperature of intake port located at the rear side of the instrument exceeds the limit.

Check the inlet temperature. The following causes are inferred.

- The temperature near the intake port increased due to the heater.
- Intake port is clogged.
- Faulty intake temperature sensor or System I/O board.

2435 Warning: Exhaust temperature is high.

The temperature of exhaust duct exceeds the limit.

Check the exhaust temperature. The following causes are inferred.

- A shortage of the duct flow rate.
- Sampling cone is not tightened enough.
- Faulty exhaust temperature sensor or System I/O board.

2605 Warning: Y- axis Torch position is outside the warning limit.

The Y- axis torch position moved beyond the warning limit.

2606 Warning: Z- axis Torch position is outside the warning limit.

The Z- axis torch position moved beyond the warning limit.

2607 Warning: Y- Axis movement disabled due to partially closed top cover.

The torch box tried to move, but failed because the small cover was not opened fully.

Try it again after opening the small cover fully. There may be a fault in the small cover Full Open Sensor or a fault in the System I/O board.

2608 Warning: Torch position initialization failed.

The torch failed to initialize its position. The torch cannot be controlled.

The XYZ stage was not managed to control properly. The following causes are inferred.

- The connector of the XYZMN stage came off.
- Faulty XYZMN stage.
- Faulty XYZMN board.

2609 Warning: Penning gauge (AN) did not strike the first time. Will retry within 120 seconds.

The Penning gauge failed to strike the first time. Retrying.

2610 Warning: Torch position hasn't initialized.

The Torch position (XYZ stage) is not initialized. The Torch position may be incorrect.

Initialize the XYZ stage.

3000 The SC2 firmware has been successfully downloaded.

The firmware of the main CPU has finished being downloaded.

3001 The Z80 firmware has been successfully downloaded.

The firmware of the sub- CPU has finished being downloaded.

3002 Plasma OFF emergency switch was pushed.

The Plasma was extinguished urgently because the plasma OFF emergency switch was pushed.

3003 Shutdown emergency switch was pushed.

The instrument starts the Shutdown sequence because the Shutdown emergency switch was pushed. MassHunter Workstation (or ChemStation) cannot control the instrument.

NOTE: After finishing the Shutdown emergency sequence, the MassHunter Workstation (or ChemStation) cannot control the instrument unless the instrument power is switched OFF. Check that the status lamp (LED) turns off and switch off the power.

3004 Power Failure occurred.

After the power was switched OFF, it was switched ON again.

Items to Be Checked in Case of Low Sensitivity

If the sensitivity is low, conduct the troubleshooting described in the following “[Items to Be Checked in Standby Mode](#)” and “[Items to Be Checked in Analysis Mode](#)” sections.

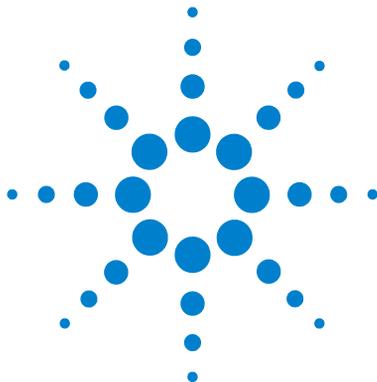
If the described procedure does not restore the sensitivity, contact our Customer Contact Center. When calling the Customer Contact Center, be sure to have the tuning report at hand.

Items to Be Checked in Standby Mode

- If sample cannot be correctly introduced, check the following three points.
 - 1** Check to make sure that the peristaltic pump has been adjusted properly. Refer to “[Peristaltic Pump Tubing](#)” on page 4- 15 in this manual.
 - 2** Check to make sure that the nebulizer is not clogged. See the “Nebulizer Test” section in the *Agilent 7500 Series ICP- MS MassHunter Workstation Operator's Manual (or ChemStation Operator's Manual)*.
 - 3** Check to make sure that there is no leak at the tube connector or sample line connector.
- Check to make sure that the shield plate is in firm contact with the metal plate on the torch holder.
- Check to make sure that the torch (injector) is not clogged.
- Check to make sure that the diameters and shapes of the holes in the sampling cone or skimmer cone have not changed. Refer to “[Check the Orifice](#)” on page 4- 72 in this manual.
- Check the lens. See the “Ion Lens Test” section in the *Agilent 7500 Series ICP- MS MassHunter Workstation Operator's Manual (or ChemStation Operator's Manual)*.

Items to Be Checked in Analysis Mode

- Check to make sure that the torch is positioned correctly.
Using Autotune, adjust the torch vertical/horizontal position
- Check to make sure that the mass axis is adjusted correctly.
Using Autotune, adjust the Resolution/Axis.
- Execute the EM voltage adjustment.
Using the Autotune, adjust the EM/discriminator.
- Check to make sure that the lens is responding.
Check to make sure that the signal changes when the lens voltage is varied.
- Check to make sure that sensitivity is acceptable in no gas mode.
If the sensitivity is acceptable in no gas mode and it is too low in He or H₂ mode, the problem may be caused by the purity level of the reaction gas.
- Check the sensitivity with mass 76 in no gas mode.
_____ cps
- Set the tuning parameter as they were when the sensitivity was normal;
then re-check the sensitivity.



6 Technical Information

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In this chapter the hardware components of the Agilent 7500 ICP-MS are reviewed, and some descriptions of the theory for operation are included.



Peristaltic Pump and Tubing

The standard peristaltic pump of the Agilent 7500 has three channels to set tubing for the sample solution, internal standard solution, and the spray chamber drain.

There are three types of peristaltic pump tubing:

- Tygon for sample uptake (white/black, 1.02 mm i.d.)
- PharMed for the drain (yellow/blue, 1.524 mm i.d.)
- Tygon for the internal standard (orange/red, 0.19 mm i.d.)

The colors refer to the peristaltic pump head- stops bonded to the tubing.

The Tygon and PharMed tubing are standard issue. The Tygon tubing can be used for almost all reagents including HF. However, there is a minor contamination problem with Sn; about 100 ppt Sn was measured when 1% HNO₃ was analyzed after being pumped through new Tygon tubing. Sn elution can be reduced to a negligible level by washing with HNO₃ or HCl before use.

The lifetime of the Tygon tubing is about two to three weeks when 1% (v/v) HNO₃ is pumped; it depends on the acid concentration analyzed and on the shoe pressure of the peristaltic pump. When higher concentrations of acid are introduced, the tubing swells and becomes white in color. However, this change of color does not cause any contamination or affect the analysis.

PharMed is a good material for use with almost all reagents and has a lifetime about 10 times longer than silicone. However, there are many impurities in it, therefore it cannot be used for sample introduction, only for the spray chamber drain.

CAUTION

Some chemicals attack the peristaltic pump tube. This might cause leakage in the sample introduction and drain lines and corrosion of the sample introduction system.

The sample uptake rate at 0.1 rps peristaltic pump speed is about 0.4 mL/min with 1.02 mm i.d. tubing. The sample uptake rate linearly increases as a function of the peristaltic pump speed up to 0.5 rps; 2.0 mL/min is the maximum sample uptake rate. 0.1 rps is recommended as the standard peristaltic pump speed, and 0.5 rps for faster sample exchange and wash out.

When the ASX500 Autosampler is used, it takes about 25 seconds for the sample exchange and 15 - 30 seconds for stabilizing the signal. Use 30 seconds on fast pump followed by 20 - 40 seconds stabilization time when the ASX500 is used.

The inner diameter of the sample transfer tube (Teflon) is 0.5 mm. A tube smaller than 0.5 mm i.d. can cause the generation of bubbles in samples. This problem may occur due to highly pressurized tap water that contains gases (drinking water samples). It degasses when depressurized. In this case, the sample has to be degassed prior to introduction.

The orange/red Tygon tubing (0.19 mm i.d.) is used for the internal standard solution. The sample uptake rate at 0.1 rps is about 20 $\mu\text{L}/\text{min}$. When the internal standard solution is added to the sample by the peristaltic pump, the concentration of the internal standard is diluted about 20 times. Therefore, a 1 ppm internal standard solution in 5% (v/v) HNO_3 is recommended.

NOTE

The orange/red tube (0.19 mm i.d.) is very soft and easily stretched. This sometimes causes an instability of the sample uptake rate when the peristaltic pump speed is varied drastically: the tube stretches at higher peristaltic pump speeds and does not recover to its original length immediately when the peristaltic pump speed is reduced to 0.1 rps. If the higher pump speed is not used, it takes about 2 minutes for sample exchange at 0.1 rps.

When the internal standard is added to a sample by means of the peristaltic pump, the maximum peristaltic pump speed should be 0.3 rps. When this fast pump speed is applied in order to reduce sample exchange time, a longer stabilization time is required. Use 0.3 rps fast pump for 50 sec and 50 sec stabilization time.

When orange/red Tygon tubing (0.19 mm i.d.) is used, some adsorption can occur on the walls of the tubing. Some elements such as Au, Ag, Pd and Pt are adsorbed onto the Tygon and it takes a long time to get stable signals. Alkali, alkali-earth, and transition metals are not adsorbed. This adsorption may occur with the white/black (1.02 mm i.d.) tubing as well, but the sample uptake rate is much larger than with the orange/red tubing making the adsorption negligible. In order to minimize this problem, HNO_3 has to be added to the samples and standard solutions; a concentration of at least 1% (v/v) HNO_3 is required and preferably 5% (v/v) HNO_3 .

Self-aspiration is a good way to avoid contamination from the peristaltic pump tube and the adsorption problem, when an autosampler is not used and the sample volume is sufficient. The concentric nebulizer, the crossflow nebulizer and the micro flow nebulizer will self-aspirate, but not the Babington nebulizer. It must be noted that self-aspiration may cause the

sample uptake rate to vary, when sample viscosity and sample head volume above the level of the sample aspiration tube change and it can only be used when the sample matrix is similar to that of the standard solution.

Nebulizer

There are five types of nebulizers available:

- 1 Babington nebulizer (BN)
- 2 Concentric nebulizer (CN)
- 3 Micro flow nebulizer
- 4 PFA Concentric Nebulizer
- 5 Crossflow nebulizer (CF)

The carrier gas is supplied to the nebulizer and the make-up gas is supplied to the spray chamber end cap. The typical total gas flow rate of the carrier gas and the make-up gas is 1.2 ± 0.1 L/min for normal plasma conditions. The carrier gas pressure depends on the nebulizer. The optimal flow rate depends on the diameter of the torch injector; $\phi 2.5$ mm is used as the standard torch, but if $\phi 1.5$ mm is used, the optimal flow rate is about 0.85 L/min. The make-up gas, in general, is not required; it will normally only be added to the spray chamber when the cool plasma conditions are used or the carrier gas pressure is not high enough.

The Ar gas supply pressure is set to 700kPa. The tubing used for the carrier and make-up gas lines is $\phi 4.0$ mm (0.5 mm thickness) PFA.

Tubing inserts must be used for connecting the tubes to the connector.

Babington Nebulizer (BN)

The BN is made of PEEK (polyetheretherketone), which resists almost all acid and alkali solutions except for concentrated H_2SO_4 . This nebulizer allows the introduction of higher matrix samples such as seawater, because of its large sample orifice. The principle of nebulization is very simple: there are two holes for sample and carrier gas lines, the sample (delivered by a peristaltic pump) comes out of the upper hole and the carrier gas comes out of a small orifice below the sample hole and nebulizes the sample. The Ar gas supply

pressure has to be 500 to 600 kPa (72 to 87 psi), giving about 1.2 L/min carrier gas flow. A 1.0 L/min carrier gas flow rate is recommended and the make-up gas has to be added to the carrier gas to achieve optimal conditions.

The recommended sample uptake rate is about 0.4 mL/min, which requires a 0.1 rps peristaltic pump speed. Higher peristaltic pump speeds may increase sensitivity for lighter masses, but lose sensitivity for heavier masses and increase oxide ions; sensitivity for mid masses may not be affected as much. Refer to the Ion Lens section later in this chapter.

When a memory problem is severe, cleaning is required.

Concentric Nebulizer (CN)

The concentric nebulizer is one of the most popular nebulizers. This nebulizer is made of quartz.

The sample is introduced into a small capillary tube by the peristaltic pump. The carrier gas, which comes out around the capillary, nebulizes the sample. The sample can also be introduced by self-aspiration.

Because of its inert material, the CN resists almost all chemicals, except HF and higher concentrations of alkaline solutions. It especially offers good resistivity against aqua regia. A disadvantage of the CN is the possibility of clogging at the tip of the nebulizer when higher concentrations of dissolved solids are introduced. Other problems are the fragility of glass and higher boron background from Pyrex glass.

A typical carrier gas pressure is about 200 to 300 kPa (29 to 44 psi) at 1.2 L/min carrier gas flow rate. The Ar gas supply pressure has to be set to 700 kPa (100 psi). The behavior of the sample uptake rate is similar to that of the BN.

When the signal is unstable, the capillary may be blocked by particles from a dirty sample. In this case, to clean the capillary, you place the tip of the CN in pure water and reverse the flow of the peristaltic pump so that the peristaltic pump aspirates water from the nebulizer. Do not use a wire - the capillary can be broken easily. When all other methods have failed, as a last resort a small wire could be used to try to free the blockage.

Another possible problem is leakage of the Ar gas line and sample line; if the O-rings for the sample tube are not tightened enough, air leaks will occur (Figure 127). This will often be indicated by a higher signal for N, N₂ and ArN at m/z 14, 28 and 54, respectively, higher sensitivity for lighter masses and lower sensitivity for heavier masses.

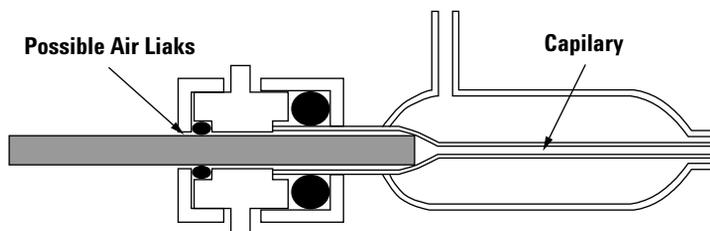


Figure 127 Cross-Section of Concentric Nebulizer

Micro Flow Nebulizer

This nebulizer is similar to the concentric nebulizer except for the diameter of the capillary and the gap for the Ar gas, which is smaller than that of the concentric nebulizer. This nebulizer consists of only PFA. The sample is introduced by self-aspiration.

This nebulizer has the following unique features:

- The sample uptake rate is 50 to 150 $\mu\text{L}/\text{min}$ but it gives almost the same sensitivity as the CN, CF, and BN. It allows analysis of ultra trace levels in small volumes of a sample, such as impurities in silicon wafers.
- The range of the carrier gas flow rate is 0.4 to 1.1 L/min.
- As the sample is introduced by self-aspiration, the sample uptake rate is changed by the carrier gas flow rate.
- As this nebulizer consists of only PFA, it is used for various types of samples such as strong acid, strong base, and organic solvent. However, a strong base may negatively affect the torch.

Since the sample uptake rate is low and the diameter of the capillary and the gap for the Ar gas are very small, take care when handling it. For ultra trace levels analysis, it is recommended that the nebulizer is used for ultra low-level samples only. If particles are included in the sample or argon gas, it may cause nebulizer to clog.

Refer to the “*Agilent Micro Flow Nebulizer, Nebulizer Installation Guide*” in detail.

PFA Concentric Nebulizer

The nebulizer is made of fluorocarbon resin (PFA) and the sample is introduced by self- aspiration. The PFA concentric nebulizer can be used in the same way as the concentric nebulizer and, since it is made of fluorocarbon resin, it can be used for various types of samples such as strong acid, strong base and organic solvent. However, when such samples are introduced, please use the Inert Sample Introduction Kit.

Sample uptake is 200 $\mu\text{L}/\text{min}$ and carrier gas should be adjusted in the range of 0.6 ~ 1.2 L/min. Please use PFA sample tubing of the following specifications with the PFA concentric nebulizer:

OD 1.6 mm with length of approximately 700 mm.

OD 1.6 mm with length of approximately 700 mm with I- AS probe attachment.

Crossflow Nebulizer (CF)

This nebulizer is used as standard for the HF resistant introduction system. The CF consists of a Pt sample injector tube and a sapphire carrier gas orifice, and it can be used for almost all reagents except aqua regia and H_2O_2 . The sample is introduced by the peristaltic pump or by self- aspiration. The typical carrier gas pressure is about 300 to 400 kPa (43 to 58 psi) at a 1.2 L/min carrier gas flow rate. The Ar gas supply pressure has to be set to 700 kPa (100 psi).

Behavior of the sample uptake rate is similar to those of the BN and the CN. Special attention must be paid to the Pt sample injector tube when the sample tubing is connected to it. Iridium is mixed with Pt to increase hardness, but it is still very fragile.

Nebulizer Endcap

Each nebulizer has a dedicated endcap made of Teflon. Except for the CF, the nebulizer can be removed from the endcap. The make-up gas is introduced into the spray chamber through the endcap giving a tangential flow around the nebulizer, except for the CF.

Spray Chamber

There are several types of spray chambers for ICP-MS. The most commonly used type is the Scott double pass spray chamber, which is employed in the Agilent 7500. The Agilent 7500 spray chamber is available in the following materials:

- Quartz (QZ)
- Polypropylene (PP)
- Teflon (PFA)

The spray chamber is mounted in an aluminum block and cooled by a Peltier thermoelectric module. The spray chamber temperature is maintained at 2 °C for aqueous samples, and can go down to -5 °C for organic solvents or higher vapor pressure samples. When the spray chamber temperature is unstable, water loading to the plasma is affected, causing signal instability. Higher spray chamber temperatures increase the oxide ion level as well. A drain tube is connected to the spray chamber by means of a special cap that allows easy attachment and detachment.

Quartz (QZ)

The QZ is made of pure silica and it can be used for acids and organic solvents, but not for HF or strong alkaline solutions. To reduce memory effects, soak the QZ spray chamber in a 5% NH₄OH (v/v) solution for 2 hours prior to use, followed by washing with pure water.

Polypropylene (PP)

This spray chamber is mainly designed for analysis of samples containing HF. It can also be used for other acids and alkaline solutions. For analysis of boron at trace levels, the PP spray chamber is recommended. Only a few organic

solvents attack PP. Since PP is a plastic type material, wettability is not as good as for the QZ and PG. When a PP spray chamber is not in use, it must be kept in an acid bath to maintain wettability. A 5%(v/v) HNO₃ bath is recommended.

Teflon (PFA)

This PFA spray chamber is the standard spray chamber for the inert sample introduction kit, and is used when aspirating hydrofluoric acid.

[Reference] Pyrex Glass (PG)

It can be used for acids and organic solvents, but not for HF or strong alkaline solutions. Pyrex glass contains % levels of Na, B, Al and Ca, which are leached out in acids. Therefore, it is difficult to avoid contamination from this spray chamber when low ppt levels of these elements are analyzed.

ICP Torch

The Agilent 7500 employs a Fassel type torch, which is the most common torch design and used for almost all ICP instruments. There are three Ar gas lines: plasma gas, auxiliary gas, and carrier gas. The plasma gas flow is tangentially introduced into the outer sheath of the torch at about 15 L/min. Its role is to cool the torch itself and to sustain the plasma. The auxiliary gas is also tangentially introduced into the middle sheath of the torch at about 1 L/min. Its role is to push the plasma forward in order to avoid melting the sample injector tip. The carrier gas is introduced into the center of the torch through the injector.

In the case of the Agilent 7500, the standard torch is a one-piece design and is made of quartz. The inner diameter of the injector is 2.5 mm. For HF solutions, a platinum (or sapphire) injector is used as the inert introduction system. The injector is removable and a demountable torch is used.

The optimal carrier and make-up gas flows depend on the diameter of the injector; about 1.2 L/min for ϕ 2.5 mm and about 1 L/min for ϕ 2.0 mm, when an aqueous sample is analyzed.

Interface

Ions in the plasma are extracted into the vacuum chamber through a sampling cone and a skimmer cone. The orifice size of the sampling cone is $\phi 1.0$ mm and that of the skimmer cone is $\phi 0.4$ mm. There are two types of material used, nickel (Ni) and platinum (Pt).

The base material of the sampling cone is Cu and the tip of the cone is Ni. The skimmer cone is all Ni. Pt has to be used for HF solutions and higher concentration of acids. The base material is Cu and the tip of the cones is Pt for the sampling and skimmer cone.

There are two types of skimmer base: stainless steel and brass. The brass base can be used for both the Ni and Pt skimmer cones. The stainless steel base is only used and recommended for the Ni skimmer cone.

When H_2SO_4 and H_3PO_4 are analyzed, the Pt interfaces should be used.

NOTE

When 10% H_2SO_4 or 1% H_3PO_4 are analyzed continually, a sampling cone with a larger diameter (18 mm) Pt insert (available from Spectron) is recommended.

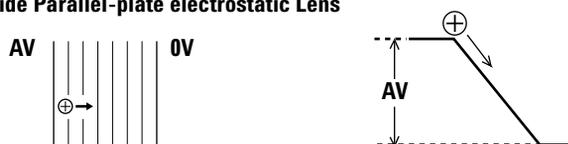
Each interface normally lasts more than one year, although it depends on the type of samples analyzed and the plasma conditions. If the interface is removed and cleaned more often, for example when switching between clean and dirty matrices, the interface lifetime will be reduced due to physical wear.

Ion Lenses - Principles of Operation

There are three ion lens main components: Extraction lens, Einzel lens and Omega lens.

To understand the mechanism of the ion lens, consider equipotential lines of an electrical field (Figure 128). When the electrical field is in parallel and at A volts above the ground level, a positive ion is accelerated as a function of voltage. The Einzel lens consists of three circular-hole lenses, which create the electrical field, see Figure 128.

Ions inside Parallel-plate electrostatic Lens



Examples of Field-effect Ion Lens Used in ICP-MS

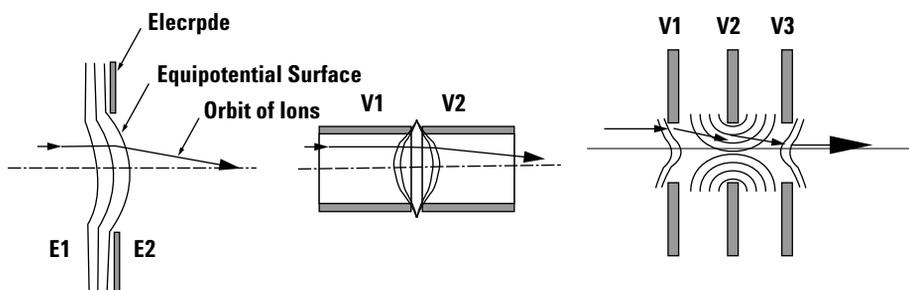


Figure 128 Ion Lens Focusing

The focal point depends on the ion energy. As the energy of a lighter mass ion is different from that of a heavier mass ion in the ICP-MS, mass discrimination occurs.

The ion energy is a sum of the potential energy and the kinetic energy. The plasma and the interface mainly determine the potential energy. When the plasma is completely coupled with the RF coil inductively, the plasma has only a slight DC potential and there is little potential difference between the plasma and the interface, which is at the ground level. However, there is

capacitive coupling between the plasma and the RF coil, which creates a potential in the plasma (Figure 129). The potential in the plasma is oscillating at the radio frequency of the plasma.

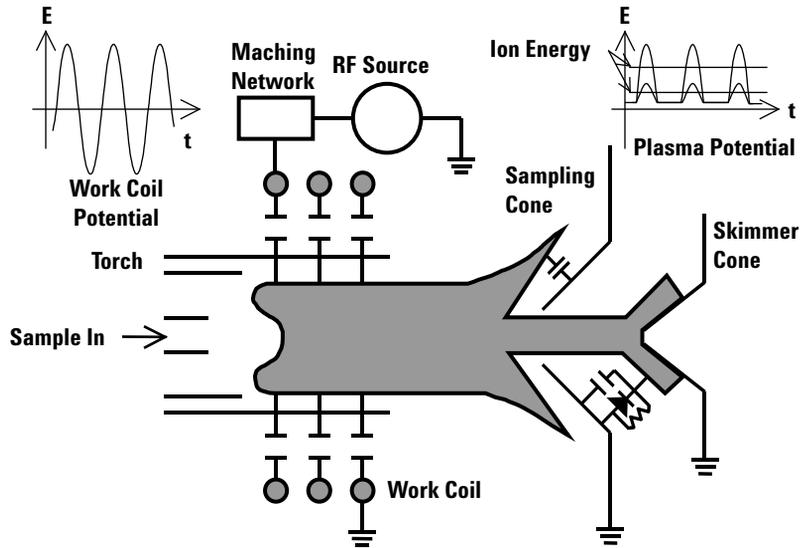


Figure 129 Electrical Model of the Plasma and the Interface Region

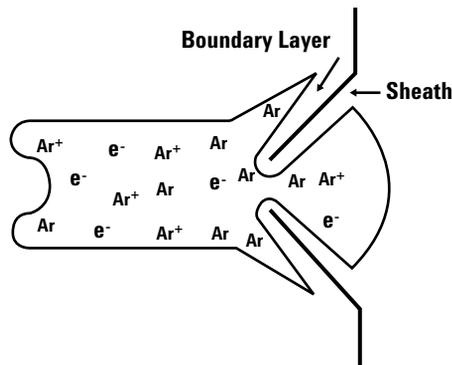


Figure 130 Distribution of Ions and Electrons around the Interface

Now, consider the inside of the plasma. Since the plasma temperature is high, about 7,000 K under the normal operating conditions, positive ions and electrons exist in the plasma. The number of positive ions and electrons is the same, so, the plasma is electrically neutral. Since the interface is cooled by water, the plasma temperature decreases drastically when the plasma comes close to the interface. So, positive ions and electrons cannot exist any more and the neutral Ar atom is dominant (Figure 130) and it creates a sheath between the interface and the plasma.

The sheath acts as a condenser and the plasma potential is grounded to the interface and vacuum chamber through the sheath. Here the so-called secondary discharge occurs, because the plasma potential is hard to ground. The plasma potential is divided by two capacitances: one is between the plasma and the RF coil and the second is between the plasma and the interface. Behind the sampling cone, the ions and the electrons are oscillating, and the movement of the electrons is much faster than that of the ions, so that the RF potential is rectified.

The thicker the sheath, the smaller the capacitance. If the capacitance between the plasma and the RF coil is constant, the plasma potential is increased when the sheath becomes thick. The plasma potential can be considered as the initial potential energy of the ions.

The kinetic energy of ions is expressed as $(mv^2)/2$, where m is the mass of the ion and v is the velocity of the ion. During the expansion process behind the sampling cone, the speed and direction of all ions tend to become the same since neutral Ar dominates them. When the ion speed is the same for all ions, the kinetic energy of lighter masses is smaller than that of heavier masses. Therefore the distribution of ion energy can be expressed as in Figure 131; actual distribution will be narrower.

Since the Q- pole accepts a wide range of ion directions, the optimal lens setting has a band range. When the ion lens is optimized for Y, other ions such as Li and Tl can also be accepted by the Q- pole. When the plasma temperature is reduced by reducing the RF power or by increasing the carrier gas flow, the thickness of the sheath increases, which increases the plasma potential and the potential energy of ions. Consequently the distribution of the ion energy of each element shifts toward higher values. Then, the values of the optimal lens setting for middle or higher masses become those for lighter masses (Figure 131). And even lighter masses have enough ion energy to go through the ion lenses, although many ions might diffuse, due to low ion energy, before the lens. As a result, the sensitivity of lighter masses increases rather than those of middle and higher masses. Actually, there might be other parameters,

such as the position of the mach disc, that are affected by the plasma temperature; a lighter mass penetrates through the skimmer cone easier than a heavier mass.

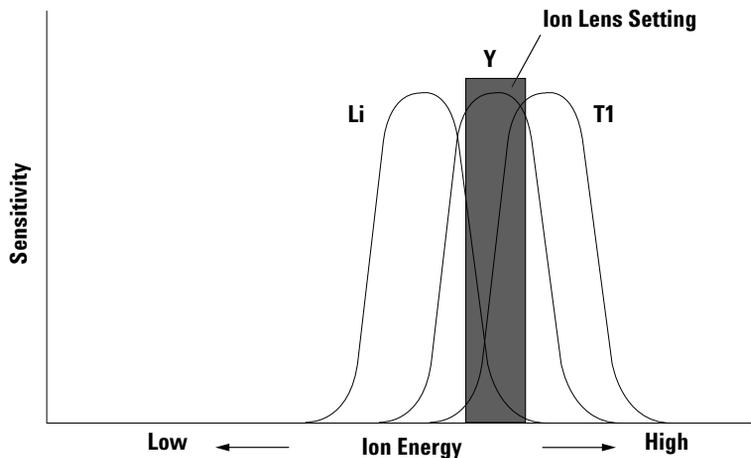


Figure 131 Distribution of Ion Energy

Extraction Lens

This lens assembly is placed just behind the skimmer cone and mounted on the skimmer base. Its purpose is to extract ions passed through the skimmer cone and to accelerate them to the Einzel lens. Two lenses are driven at negative voltage. After the skimmer cone, there are positive ions, electrons, and neutral atoms. When the positive ions come close to the extraction lenses, the ions are accelerated. On the other hand, electrons are repelled by the extraction lenses and go to ground via the skimmer cone and the chamber wall.

Since the extraction lenses are placed very close to the plasma, they can become contaminated. When the signal response in the tuning mode is slow after changing the lens voltage, the lens may have become dirty and cleaning will be required.

Einzel Lens

The purpose of this lens assembly is to focus the ions that are accelerated by the extraction lenses.

The Einzel lens consists of three lens plates. The same voltage is applied to the first and the third lens plates (E1 and E3) to get the same potential at the entrance and exit of the lens, - 100V, it should not normally be adjusted during tuning. Changing the voltage of the middle lens, the Einzel 2 lens, affects the focal point of the ions.

Omega Lens

This lens block consists of 5 lenses; Omega bias, Omega (+), Omega (-), QP focus and Plate bias. The purpose of this lens assembly is to separate photons and ions and to steer the ions onto the Q- pole.

The Omega (+) and (-) lenses are placed between two Omega bias lens plates. The same voltage is given to the Omega bias lenses. In general, the Omega bias must be used at voltages more positive than - 40V, e.g. - 20 V. The more negative the voltage, the higher the sensitivity that can be obtained, but the background signal might also be increased.

The Omega (+) and (-) lenses consist of two pairs of crescent- shaped lenses; the Omega (+) Front and the Omega (+) Back which are alternately placed and driven at the same voltage, and the Omega (-) Front and Omega (-) Back which are placed alternately and driven at the same voltage. The ions are bent by the Omega (+) Front and the Omega (-) Front toward the Omega (-) Front direction, then the ions are bent again by the Omega (-) Back and the Omega (+) Back toward the Omega (-) direction. While the ions are bent, photons remain unaffected and hit the Omega bias back plate (Figure 132). This is sometimes called the off- axis ion lens system. The Omega lens bends the focused ions and steers them into the Q- pole, so the loss of ions is minimized.

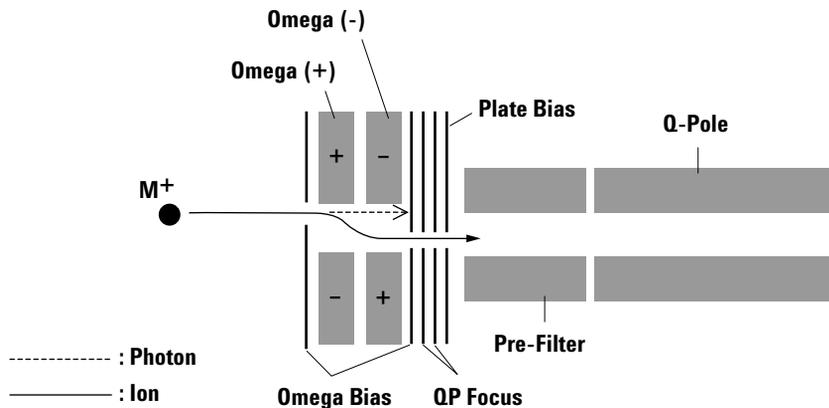


Figure 132 Schematic Diagram of Omega Lens

The ions then pass through the QP focus and the Plate bias. The purpose of these lenses is to decelerate ion speed and to focus the ions. The QP focus and the Plate bias are operated at zero or slightly positive voltage.

When the ion lens voltage is changed drastically and the signal, in the sensitivity tuning mode, does not change rapidly or when the signal is unstable and reproducibility is poor, the ion lens may be dirty and cleaning is required. Frequency of cleaning depends on the samples analyzed. For example, if the instrument is used for tap water analysis 8 hours/day and 7 days/week, cleaning of the Extraction lens will be required every 2 months and that of the Einzel and Omega lenses will be every 4 to 6 months. If samples are cleaner than tap water (e.g. semiconductor), the frequency of lens cleaning will decrease. When the ion lenses become dirty, ions burn into the surface of the lens, often observed as a brown color on the extraction lenses.

Octopole Reaction System

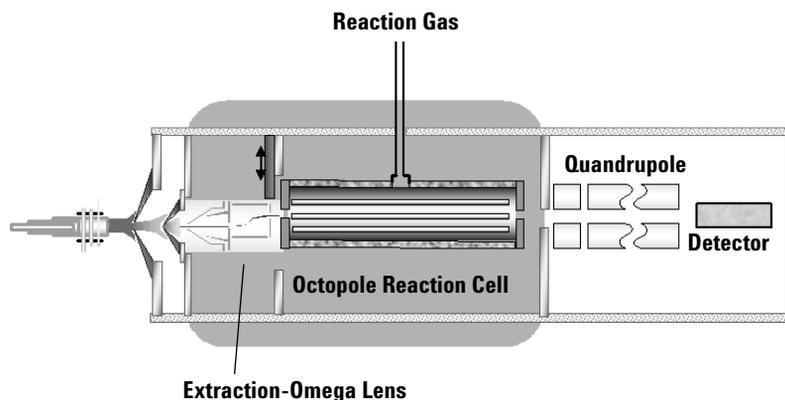


Figure 133 Off-axis Ion Lens + Octopole Reaction Cell

The Octopole Reaction System (ORS) is an octopole ion guide contained within a stainless steel vessel and pressurized with a gas, most often H₂ or He. The ORS is positioned between the ion lens assembly and the quadrupole mass filter. As ions from the sample enter this cell, they interact with the gas, resulting in the reduction of the molecular interference normally below the level of the blank solution.

The ORS Eliminates key interferences arising from the sample matrix that are not argon based and cannot be eliminated using “traditional” approaches.

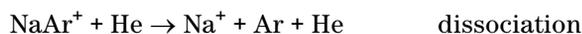
Why the octopole ion guide?

The octopole ion guide is driven by a voltage of fixed amplitude and frequency in order to assure stable signals. The frequency of 10 MHz brings about wiggle-less motion of ion near the flat bottom of the effective potential well, which is difficult to achieve with lower order multipoles or low-frequency voltage²⁾. The addition of reaction gas minimizes the endothermic reaction that leads to loss of analyte ions, and also lowers the energy of the new background species produced through reaction or declustering of polyatomic ions. These new background species are easily removed because of their lower kinetic energy compared with analyte ions.

2) *D. Gerlich, Inhomogeneous RF Fields: A Versatile Tool for the Study of Processes with Slow Ions, Advances in Chemical Physics Series, Vol.LXXXII, 1992 John Wiley & Sons, Inc.*

Why H₂ and He?

Three gases are available: hydrogen (H₂), helium (He) and an optional gas offered upon request. In most cases, pure H₂ or pure He are sufficient for performing the analysis of most of the elements. Generally, H₂ should be used to suppress plasma based polyatomic ions such as ArO and Ar₂; He is preferable to suppress the species derived from sample matrices, such as ClO, NaAr and ArCl, which interfere with ⁵¹V, ⁶³Cu and ⁷⁵As. For example, H₂ molecules react with Ar₂ ions, but do not with Se ions. Allowing Se to be detected with low A₂⁺ background. Unlike other more reactive gases, the ionization potential of H₂ (15.5eV) is much higher than metals, the loss of analyte ion through charge transfer does not take place. However, this does not necessarily mean that all types of reaction between H₂ and the analyte ions are negligible. When the H₂ flow rate is increased, H₂ begins to react with Cu and As, however the loss of those ions is relatively small compared with the loss caused by other more reactive gases. If the background level is so high as to need a high flow rate of H₂, the use of less reactive gas such as He can be more effective. For example, He efficiently dissociates NaAr because of its low bonding energy, while it does not cause a reactive loss of Cu ion.



Gas Flow Tuning

Flow rates of the reaction gases are set in the tuning window of Agilent's MassHunter Workstation (or ChemStation) Software. Due to the 'MultiTune' capability of MassHunter Workstation (or ChemStation), reaction gases can also be automatically switched during the analysis.

Q-pole

The Q- pole of the Agilent 7500 consists of a pre- filter and a main filter. The inner surface of the Q- pole rods is hyperbolic giving an ideal electrical field inside the Q- pole.

Only RF voltage is supplied to the Q- pole pre- filter, while RF and DC voltage is supplied to the main Q- pole filter. The purpose of the pre- filter is to direct ions from the Omega lens along the right path into the Q- pole main filter. To the Q- pole main filter, both about 3 MHz of RF voltage (V) and DC voltage (U) are supplied (Figure 134). When the highest mass 260 is analyzed, 559 V of DC voltage and 3,338 V of RF voltage are supplied. The maximum voltage is $\pm 3,897$ V.

In addition, the pole bias (PB) is supplied to the Q- pole. When the pole bias is at 0 V, this is the ground level, if the pole bias is used at + 2 V, the average voltage shifts +2V. A positive pole bias voltage reduces the ion speed, which gives a better peak shape. Therefore, the pole bias can be used when the peak shape becomes poor. Pole bias values up to + 5 V may be used. Excessively high pole bias reduces sensitivity for lighter masses drastically, so if the peak shape is still poor at higher than a +5 V pole bias, the Q- pole should be cleaned. When the ShieldTorch system is used, the ion energy is lower than the normal system, therefore, the pole bias can be used at negative voltage as low as - 10 V is acceptable.

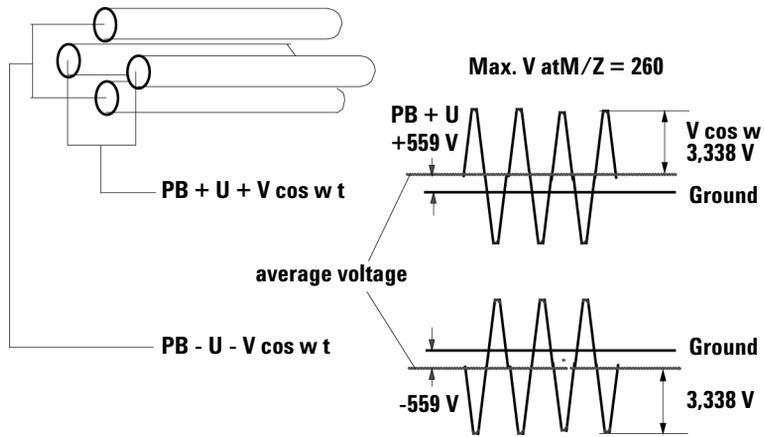


Figure 134 Q-pole Mass Filter

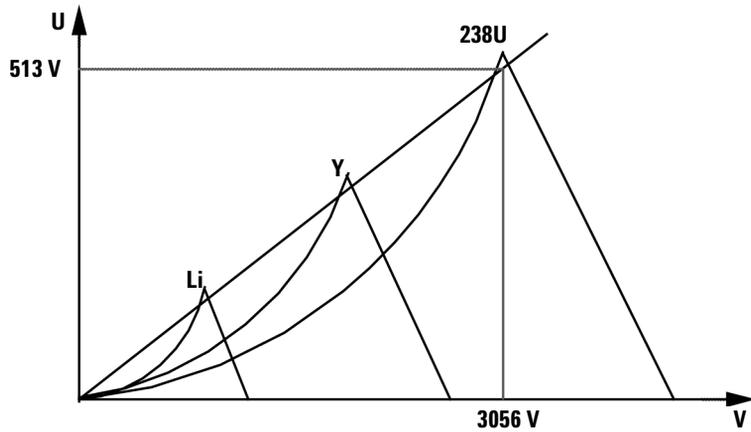


Figure 135 Scan Line of Q-pole Mass Filter

The scan line of a Q- pole is represented in [Figure 135](#). Lower voltages of U and V select lighter masses while higher voltages select heavier masses.

Resolution can be expressed as follows:

$$\text{Resolutions} \propto f^2 L^2 / V$$

f : Frequency

L : Length of Q- Pole

V : Speed of Ion

So, higher ion speed, shorter Q- pole length or lower frequency results in poorer resolution.

When the Q- pole becomes dirty, the peak shape will be poor even if a higher pole bias is applied. In this case, the cleaning of the Q- pole pre- filter and/or main filter will be required. Only an Agilent Technologies engineer should perform the Q- pole cleaning.

Electron Multiplier (EM)

The EM used in the Agilent 7500 is a discrete dynode type manufactured by ETP, operated in both pulse count and analog modes. A brief description of the principle of operation follows: when an ion enters the EM, the ion hits the first dynode and a shower of electrons is generated. The electrons hit the next dynode generating more electrons. This small signal is amplified and a higher pulse signal is obtained: electrons are multiplied about 10^6 times. Finally, the pulse generated is detected by the collector. The pulse width is about 10 nsec. At this moment, the output signal from the amplifier contains electrical noise and the pulse signal. After the amplifier, a discriminator circuit eliminates the electrical noise. Then, pulse signals higher than the discriminator voltage is converted to an ideal pulse shape. This pulse is measured as one count ([Figure 136](#)).

When the concentration of ions is too high, ions will not be measured separately and result in only one pulse count. In general, this phenomenon becomes more critical when the number of ions is greater than several million counts/sec (cps). When the number of ions is high, the electrical current at the collector becomes measurable by the analog mode. Since the signal of a high count rate causes a shorter lifetime, the current for the analog mode is collected at the halfway point of the dynodes. The current is converted to log- voltage by the log amp. Then it is sampled by the A/D converter, and is

accumulated by the accumulator. The accumulated value is then converted to pulse counts by the P/A factor (Figure 136). They are generally called dual mode.

For adjustment of the dual mode, a P/A factor must be set.

When data acquisition starts, the Smart Card and the CPU board automatically select which masses are analyzed by the pulse mode and by the analog mode; the switching level is about 1×10^6 cps. If the signal is exceeded the EM limit value, this mass will be skipped automatically.

When the EM mode is set to AUTO in method and the signal exceeds the threshold of the pulse protection, the pulse mode protection works and the signal is measured by analog mode only. If the high signals, which cannot be measured even by analog mode, are entered, this mass will be skipped automatically to prevent the EM. After finishing data acquisition, the data is transferred to the MassHunter Workstation (or ChemStation) for analysis.

The lifetime of the EM is determined by the EM voltage (Analog HV and Pulse HV) after adjusting the voltage of the EM. The EM will need replacing when the Analog HV reaches about 3300 V or the Pulse HV reaches about 1800 V after adjusting the EM voltage.

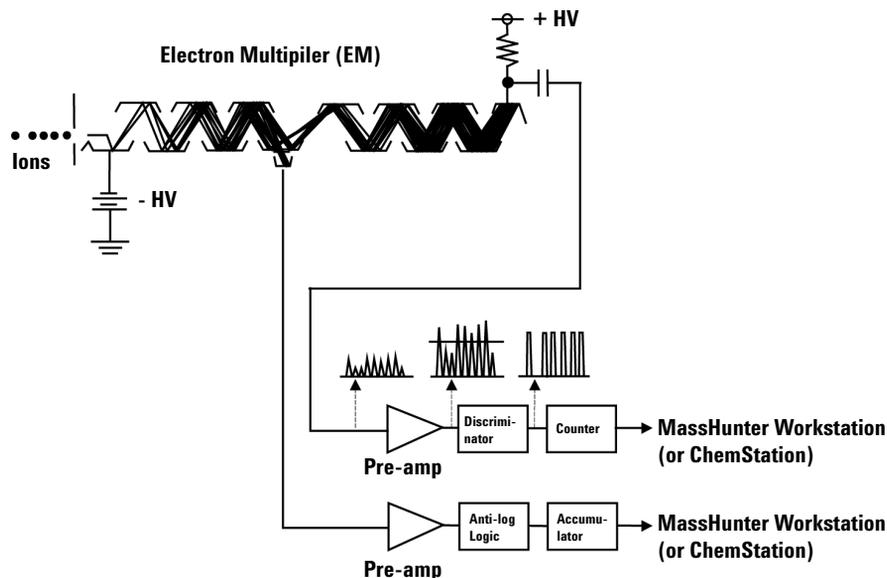


Figure 136 Ion Detection System

APG remote interface

The following functions are available on the Agilent 7500 MassHunter Workstation (or ChemStation) APG remote interface.

- Inform the current instrument mode (Standby or Analysis mode)
- Setting the instrument to the Standby mode
- Starting data acquisition

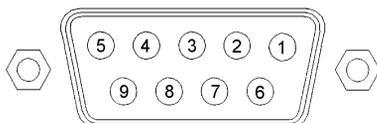


Figure 137 APG Remote Connector

Table 11 Remote Signals

Pin	Signal	Active
1	Digital ground	
2	N/A	
3	Start	Low
4	Shutdown	Low
5	N/A	
6	N/A	
7	N/A	
8	N/A	
9	N/A	

N/A: Not Applicable

Pin 3, Start: Request to start run. Start the Data Acquisition.

Pin4, Shutdown:

When **Standard** is selected in the **Remote Shutdown** section of the **Miscellaneous** dialog box. The **Miscellaneous** dialog box appears when *Setup* is clicked in the **Miscellaneous** area of the **ICP- MS Configuration** dialog box.

Receive: When the instrument is in the Analysis mode and the signal is changed to LOW, the instrument goes to the Standby mode.

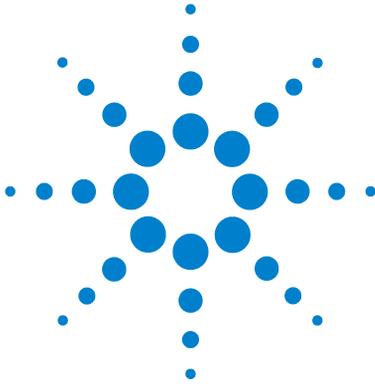
Send: When the instrument is in the Analysis mode, the shutdown signal is HIGH.

When **Agilent LC** is selected.

Receive: When there is any hardware error on the LC, a shutdown signal is changed to LOW, which will turn off the ICP- MS plasma and switch the instrument from Analysis mode to Standby mode.

Send: When there is a hardware error on the ICP- MS, or when the plasma is turned off via sequencing, the shutdown signal is changed to LOW.

“Send” is defined as an open collector. “Receive” is defined as TTL level.



Appendix

Appendix A. Organic Solvent Kit	A-2
Organic Solvent Kit	A-2
Replacing the torch and connector	A-5
Drain kit for Organic Solvent	A-7
Warning Label	A-11



Appendix A. Organic Solvent Kit

Organic Solvent Kit

General

When analyzing organic solvents, Oxygen must be added in to the carrier gas line to burn the carbon in the organic solvent. This will avoid depositing the carbon on to the interface (Sampling cone / Skimmer cone). If the deposition is allowed to build up the interface cones can clog.

A 1.5mm (or 1mm) I.D torch is used for organic solvent samples to maintain good plasma conditions. The drain volume when introducing the organic solvent is smaller than when introducing aqueous solutions and most of the organic solvent sample is introduced into the torch and it may extinguish the plasma easily. So, it is necessary to use 1.5mm I.D torch to reduce the sample loading on the plasma.

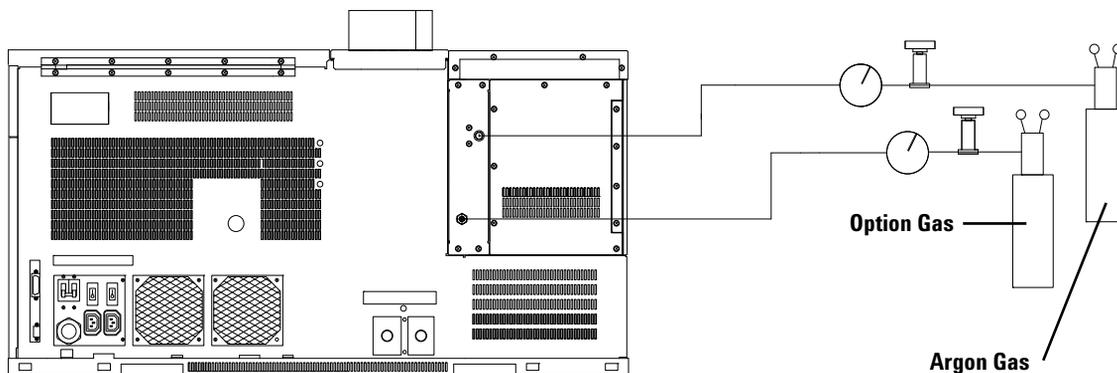
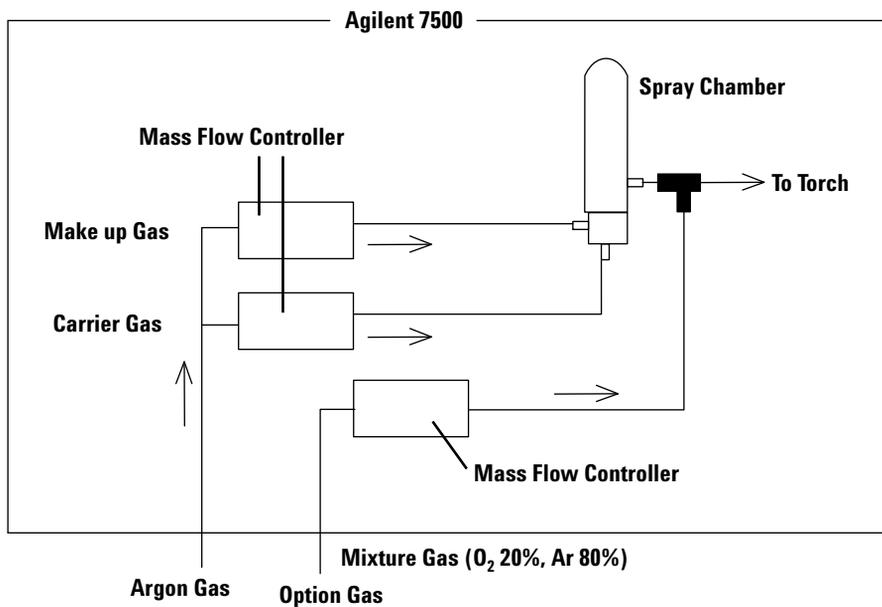


Figure 138

The Mass Flow controller in the 7500 will control the flow of the option gas flow. An Argon / Oxygen mix must be used as option Gas.

**CAUTION**

Set the Option Mass Flow tank Pressure at 350kPa.

WARNING

Use 20% Oxygen and 80% Ar gas mixture. There is an increased risk of explosion or fire if higher concentrations of Oxygen are used.

If the equipment is used connected to highly concentrated oxygen gas, and the oxygen gas keeps flowing due to the above-mentioned irregularities, dangers arise as detailed below.

- **Inflammability, explosibility, etc. of oxygen**
 - **Since oxygen is an ignitable gas, oxygen does not burn by itself, but it assists the combustion of other substances.**
 - **Oxygen is a strong oxidizing agent and reacts with inflammable substances and deoxidizing substances, thereby giving rise the danger of fire or explosion.**
 - **When heated, a rise in pressure results, which is accompanied by the danger of bursting.**
 - **Influence on the human body**
 - **Oxygen is toxic and inhalation of it may cause coughing, dizziness, sore throat, and damage to eyesight.**
 - **As for influences resulting from exposure for a short time, oxygen may cause irritation of the respiratory tract and may have an influence on the central nervous system, lungs, and eyes.**

The concentration of oxygen that is the safety limit of toxication symptoms due to high concentration of oxygen for a short time period is 46 vol%, which causes a decrease in the activation of oxidizing enzymes in cells, resulting in oxygen toxication symptoms such as epilepsy-like convulsions throughout the whole body, dizziness, nausea, difficulty breathing, muscular convulsions, confusion, auditory hallucination, damage to eyesight, or sharp pain in the toes.
 - **As for influences resulting from exposure for a long time or repeated exposure, the concentration of oxygen that is the safety limit of toxication symptoms due to high concentration of oxygen for an extended period is 36 vol%.**

The safety range is 18 - 25 vol%.
-

CAUTION

Be sure to wear solvent resistant gloves and protective glasses when handling organic solvents.

Replacing the torch and connector

- 1 Locate and open the torch box.
- 2 Remove the existing torch and connector.
- 3 Install the Connectors for Optional Gas Introduction and 1.5mm (or 1mm) I.D. Torch.



- 4 Insert the Inner Sleeve into the Option gas Line and connect the option gas line to the Connectors for Optional Gas Introduction using the L type Teflon connector.

**CAUTION**

Connect the Teflon tubing to the connector securely.

O-ring for Nebulizer and Endcap

Replace the O- ring for the Nebulizer and End Cap with O- ring's that are resistant to organic solvents.

	QTY	P/N
O-ring for Organic Solvent (Nebulizer)	1	G1820-65520
O-ring for Organic Solvent (Endcap)	1	G1820-65518

These O- rings are included in Organic Solvent Kit (G1833- 65424).

CAUTION

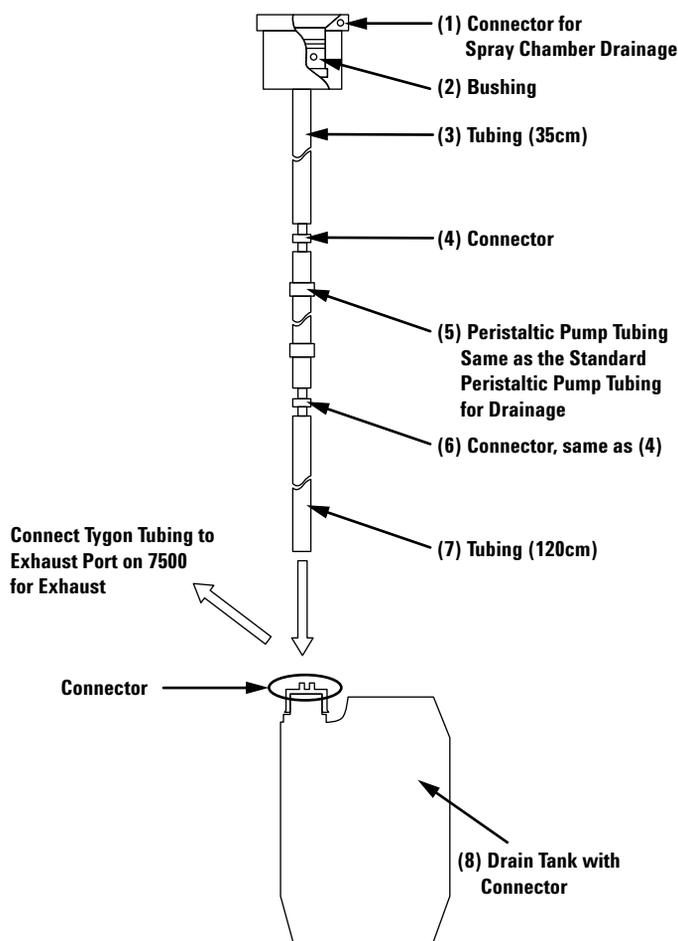
Neither the standard O-rings nor the solvent resistant O-rings are color coded. Keep the O-rings separately and do not mix them.

Drain kit for Organic Solvent

Organic Solvent drains via the Drain Line from the Spray Chamber. All parts on the drain line should be resistant to organic solvents. Otherwise there could be leakage and it can increase the risk of explosion.

WARNING

When Introducing the Organic Solvent, use the Organic Solvent Kit. Otherwise there could be leakage and it can increase the risk of explosion.



The following explains the different points between the standard drain kit and the drain kit for Organic Solvent.

- (2) Bushing: Material is different.
- (3) Tubing: Material and ID / OD are different.
- (4)(6) Connector: OD to connect the Tubing (3) / (7) is different.
- (7) Tubing: Material and ID / OD are different.
- (8) Connector of Drain Tank: Material and OD to connect Tubing (7) is different.

No in Drain	Description
1	Connector for Spray Chamber Drainage
2	Bushing (Per flour)
3	Tubing (Polyethylene) ID 4.0mm OD 5.6mm length 35cm
7	Tubing (Polyethylene) ID 4.0mm OD 5.6mm length 120cm
4,6	Connector OD to connect (3) / (7) is 3.5mm
5	Peristaltic Pump Tubing (PharMed)
8	Drain Tank (with Polypropylene Connector)

Drain Kit replacement Procedure

- 1 Select Instrument >> Instrument Control.**
- 2 Select Maintenance >> Sample Introduction.**
- 3 Set Nebulizer Pump at 0.1 rps and pump out the solvent in the drain line.**
- 4 Remove Spray Chamber.**
- 5 Remove the drain tubing from the Spray Chamber.**
- 6 Replace the existing bushing in the connector with bushing (2) for Organic Solvents.**
- 7 Replace all of tubing, peristaltic Pump tubing and connectors between Spray Chamber connector (1) to Drain tank (8) for Organic solvents.**
- 8 Connect Tubing (7) to the Drain Tank for Organic Solvents.**
- 9 Connect the Drain Kit to the Spray Chamber.**

10 Install the Spray Chamber.

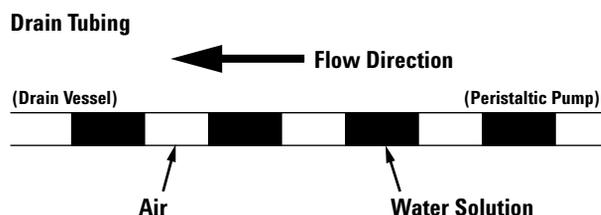
11 Connect tubing between the Drain Tank and Exhaust Port on Backside of 7500.

WARNING

Confirm there is no leakage at all of the Drain Lines (e.g. outlet of Spray Chamber). If there is leakage, there is increased a risk of explosion.

Adjustment of clamp tension for Drain tubing

- 1 Make sure the drain tubing is not damaged. Replace the drain tubing when it is damaged.
- 2 Select Instrument >> Instrument Control.
- 3 Select Maintenance >> Sample Introduction.
- 4 Set Nebulizer Pump at 0.3 rps.
- 5 Set carrier gas flow to 1.0 and aspirate pure water.
- 6 Gradually loosen the knob applying pressure to the peristaltic pump clamp for the drain until the peristaltic pump stops drawing up he drain line. Gradually tighten the knob until the peristaltic pump begins to draw up the drain line again. Continue to tighten the knob of the drain uptake an additional 2- 3 turns.



- When no flow is observed in the drain line, readjust the clamp tension for drain tubing or replace the drain tubing.
- There is normally liquid and air as shown above. When there is only liquid, tighten the clamp an additional turn or reduce sample uptake volume by decreasing the carrier gas flow.

WARNING

Confirm that the drainage is flowing. Check that the tube from the drain peristaltic pump to the drain bottle is properly connected. You should see a regular pattern of liquid and air as shown above.

WARNING

When the spray chamber drain is not pumped properly, excess flammable solvents in the spray chamber may ignite and become explosive. Ensure that the spray chamber drain is being pumped properly during analysis.

When introducing a sample that has a tendency to solidify, such as photoresist, ensure that the spray chamber drain is being pumped properly and that the torch injector is not becoming clogged.

WARNING

Drain tubing damage depends on the organic solvent type. It is strongly recommended to replace every day before introducing organic solvent samples.

WARNING

Check that the drain tubing is not damaged every day. Otherwise there is an increased risk of explosion.

WARNING

Pump out the solvent in the drain line after analysis. The lifetime of the tubing is drastically reduced if organic solvent remains in the drain tubing.

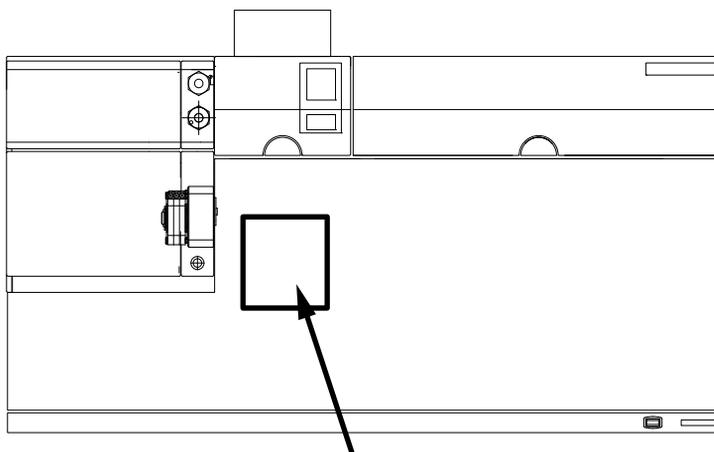
WARNING

When pulling out the drain connector, remove it slowly so that the solvent left inside the tubing does not scatter.

Pump out the solvent in the sample introduction lines, spray chamber, and drain line after you finish an analysis. When solvent is left, the deterioration of the tubing is hastened.

Warning Label

Put the warning label from the kit onto the front panel.



⚠ WARNING

When using Organic solvents, extra caution should be observed.

If the spray chamber drain is not pumped properly, the excess flammable solvents in the spray chamber may ignite and become explosive.

If the torch injector clogs, the increased pressure in the spray chamber may cause the end cap to blow off exposing the solvent to ignition.

Refer to the instruction manual for proper operation.

⚠ ATTENTION

Lors de l'analyse de solvants organiques, use attention toute particuliere doit etre prise.

Si le drain de la chambre de nebulisation n'est pas evacue correctement, l'excédant des solvants inflammables dans celle-ci peuvent devenir explosifs.

Si l'injecteur de la torche se bouche, l'evlevation de la pression dans la chambre de nebulisation pourrait faire sauter le bouchon de la chambre de nebulisation, exposant ainsi le solvant a des temperatures extremes.

Se referer au manuel d' operation pour une utilisation correcte.

⚠ 警 告

有機溶媒の導入・分析は、爆発の危険を伴います。

有機溶媒の導入・分析の際に、スプレイチャンバからの排液が詰まると、引火・爆発の危険があります。また、トーチ内部が詰まると、スプレイチャンバ部が破裂し、引火する可能性があります。取扱説明書をご参照の上、お使いください。

Appendix

Table 12 Organic solvents having confirmed methods for the Agilent 7500 ICP-MS (Nebulizer; Concentric)

Organic solvent	Dilution factor	*Sample tubing id (mm)	Torch injector id (mm)	Oxygen % in total carrier & make-up gas
iso-propyl alcohol (IPA)	direct	0.2	1.5	2%
methyl alcohol (Methanol)	direct	0.16	1.0	3%
ethyl alcohol (Ethanol)	direct	0.3	1.5	3%
2,2 aminoethoxy ethanol	1:41% nitric acid	0.5	1.5	None
ethyl acetate	1:1 NMP	0.3	1.5	3%
buthl acetate	1:1 NMP	0.3	1.5	3%
Propylene glycol mono-methyl acetate (PGMEA)	direct	0.3	1.5	3%
N-methyl-2-pyrrolidone (NMP)	direct	0.3	1.5	3%
methyl iso- buty ketone (MIBK)	direct	0.3	1.5	8%
methy n-amyl ketone	direct	0.3	1.5	8%
acetone	direct	0.16	1.0	5%
ethyl lactate	direct	0.3	1.5	3%
hydroxyl amine	1:41% nitric acid	0.3	1.5	None
xyluene	direct	0.3	1.5	10%
toluene	direct	0.3	1.5	12%
kerosene	direct	0.3	1.5	5%
3-para-diethyl benzene (PDEB)	1:1 NMP	0.3	1.5	5%

* Sample tubing length: 500 to 700 mm

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In This Book

The *Agilent 7500 Series ICP-MS Hardware Manual* provides an instrument overview, safety precautions and procedures for optimization, maintenance and troubleshooting.

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