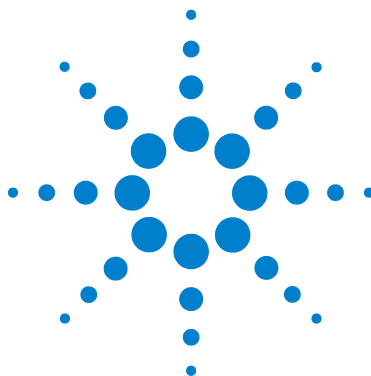




Agilent 7700 Series ICP-MS

Hardware Maintenance Manual



Agilent Technologies

Notices

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WARNING

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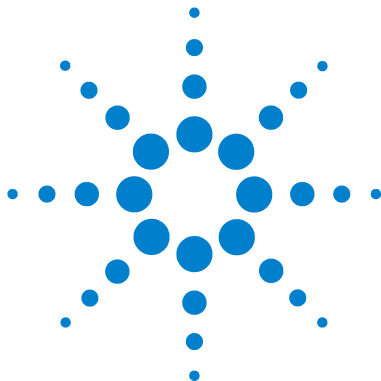
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7700s, 7700x with H2 line, and ORS upgrade with H2 line are licensed under U.S. Patents 5,767,512; 6,259,091 and associated counterparts.



Instrument Components and Part Names for Agilent 7700

Instrument Components

This section describes the instrument components, starting with a general overview of the operating principles of the Agilent 7700.

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

- | | |
|---------------------------------|---|
| 1 ICP-MS Instrument | Agilent 7700 ICP-MS |
| 2 MassHunter Workstation | MassHunter Workstation controls the Agilent 7700 ICP-MS, acquires data, and analyzes the acquired data. |
| 3 Printer | Printer outputs the analysis results. |
| 4 Foreline Pump | <p>Stand-alone The Foreline pump is used. The foreline pump is used as the backing pump for the turbomolecular pump. It is also used to pump the interface chamber in analysis mode.</p> <p>The electric power for the pump is supplied from the Agilent 7700. MassHunter Workstation controls the pump's ON/OFF control.</p> |
| 5 Autosampler | MassHunter Workstation 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 generator and the work coil. For more information, refer to the water chiller manual. |

Brief Overview

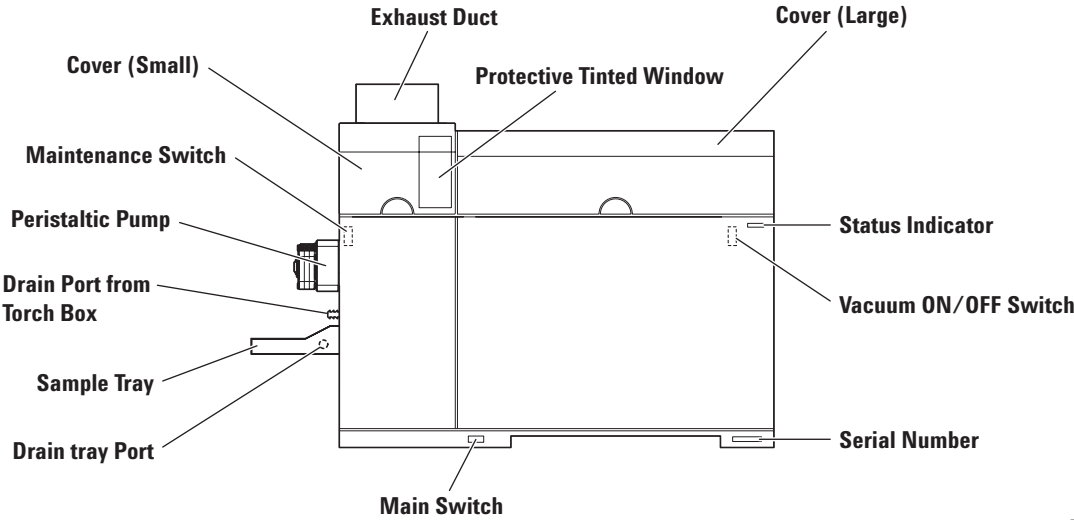
The following steps provide a brief overview of how the Agilent 7700 analyzes a sample. More detail is provided in later sections.

- 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. The ions are focused into the analyzer where they are separated by their mass-to-charge ratio (m/z).
- 4** The ion concentration of a specific mass-to-charge ratio is measured by an electron multiplier detector.
- 5** 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).

Part Names

The names of the parts of the Agilent 7700 are described in this section.

Front View



7700 0065

Figure 1 Front View

Cover (Small) This cover is used to cover the ICP area and interface area during operation.

Cover (Large) This cover 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.

Status Indicator The status 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

Main Switch	Main power switch of Agilent 7700. Before turning on this switch, you need to turn ON the power breaker switch located on the rear side. When the power is turn ON, the green indicator in the center of the switch lights green.
Vacuum ON/OFF Switch	When the MassHunter Workstation is not running, it is possible to shift from shutdown mode to standby mode by pressing the vacuum ON/OFF switch for about 4 sec.. It is also possible to shift from standby mode to shutdown mode. When operating this switch, it is necessary to open the cover (large).
Drain port from Torch box	It protects the instrument inside from cooling water leak from the work coil connection by some rare accident.
Sample Tray	It is possible to place a bottle for the sample. If the sample spills, this can also function as a tray.
Drain Tray Overflow Port	This port allows chemical spills to be safely drained.
Maintenance Switch	By pressing the maintenance switch for about 4 sec. when the Agilent 7700 is in the shutdown mode or standby mode, it is possible to move the torch box in the front and back directions to perform maintenance of the interface area.
Serial Number	Each Agilent 7700 comes with a unique serial number.

NOTE

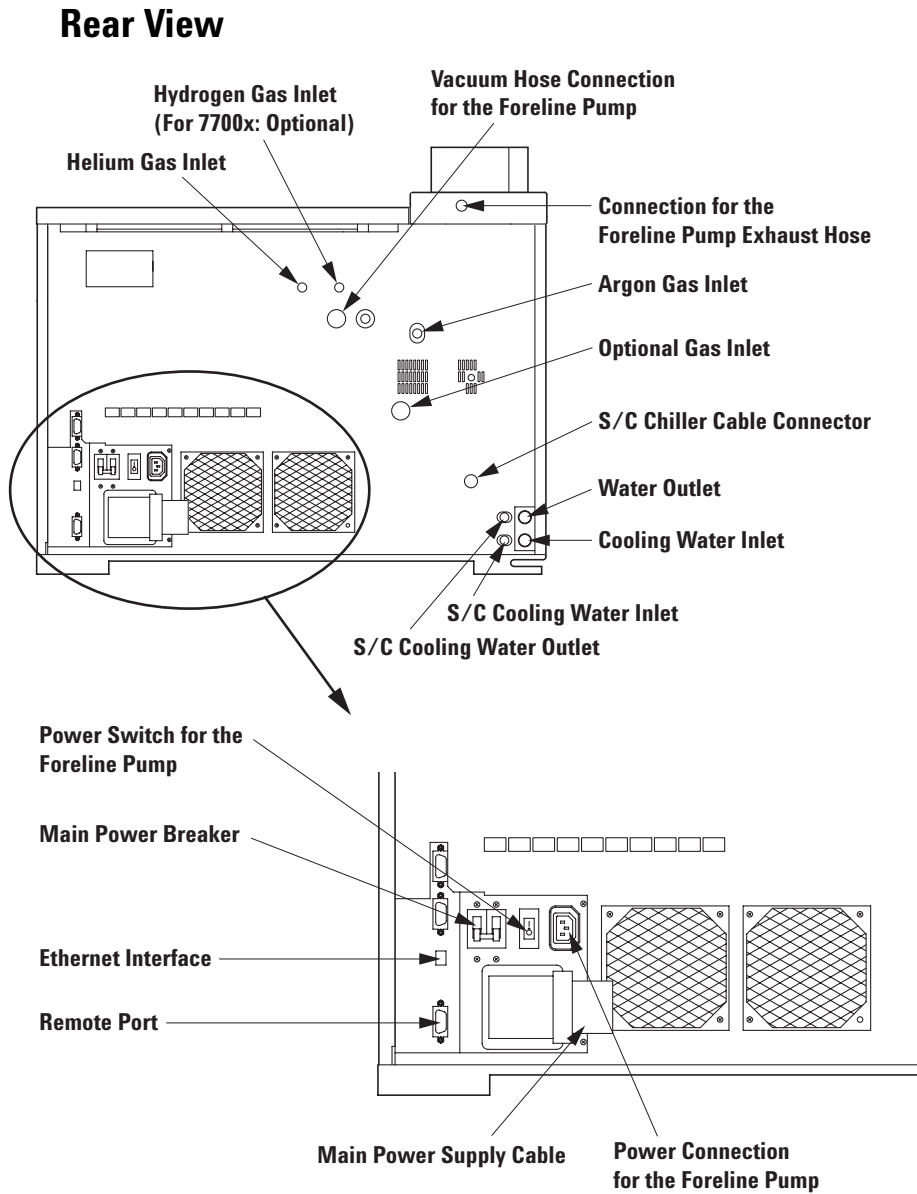
The tubing must have a vertical drop to assist gravity drain. Connect the tubing from the overflow port to the chemical waste container and avoid any restriction of flow.

WARNING

When the plasma is lit, make sure never to open the top covers. Normally, for safety reasons, the plasma will turn off automatically when the top covers are opened.

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.



7700_0066

Figure 2 Rear View

Cooling Water Inlet/Outlet	Cooling water inlet and outlet port
Spray Chamber Cooling Water Inlet/Outlet	Cooling water inlet and outlet port for Spray Chamber
Spray Chamber Chiller Cable Connector	Connect the S/C chiller cablr.
Argon Gas Inlet	Argon gas inlet port
Optional Gas Inlet	Optional gas inlet port
Main Power Supply Cable	Power cable
Helium Gas Inlet	Helium gas inlet port for Agilent 7700s, 7700x
Hydrogen Gas Inlet	Hydrogen gas inlet port for Agilent 7700s. Optional for 7700x.
Main Power Breaker	The main power supply circuit breaker. Generally, this breaker remains ON, and the main switch (front side of the instrument) is used for power ON/OFF.
Power Supply connection for the Foreline Pump	Power connections for the foreline pump.
Power Switch for Foreline Pump	The foreline pump instrument circuit breaker. Generally, this switch is kept ON because MassHunter Workstation control the foreline pump power ON/OFF.
Vacuum Hose Connection from Foreline Pump	Connection for the foreline pump vacuum hose.
Connection of Foreline Pump Exhaust Hose	Connection for the foreline pump exhaust hose.
Ethernet Interface	The connection port for the Ethernet Cable. The Ethernet cable is connected between the Agilent 7700 and the PC.
Remote Port	The Connection port for the APG Remote cable. It is possible for the Agilent 7700 to give notification regarding completion of measurement preparations using contact output, and for the Agilent 7700 to start measurement using contact input with respect to a connected device (LC, etc.).

NOTE

On the bottom side of the instrument, there are handles that can be used when carrying the instrument.

Name of Gas Piping and Cooling Water Tubing

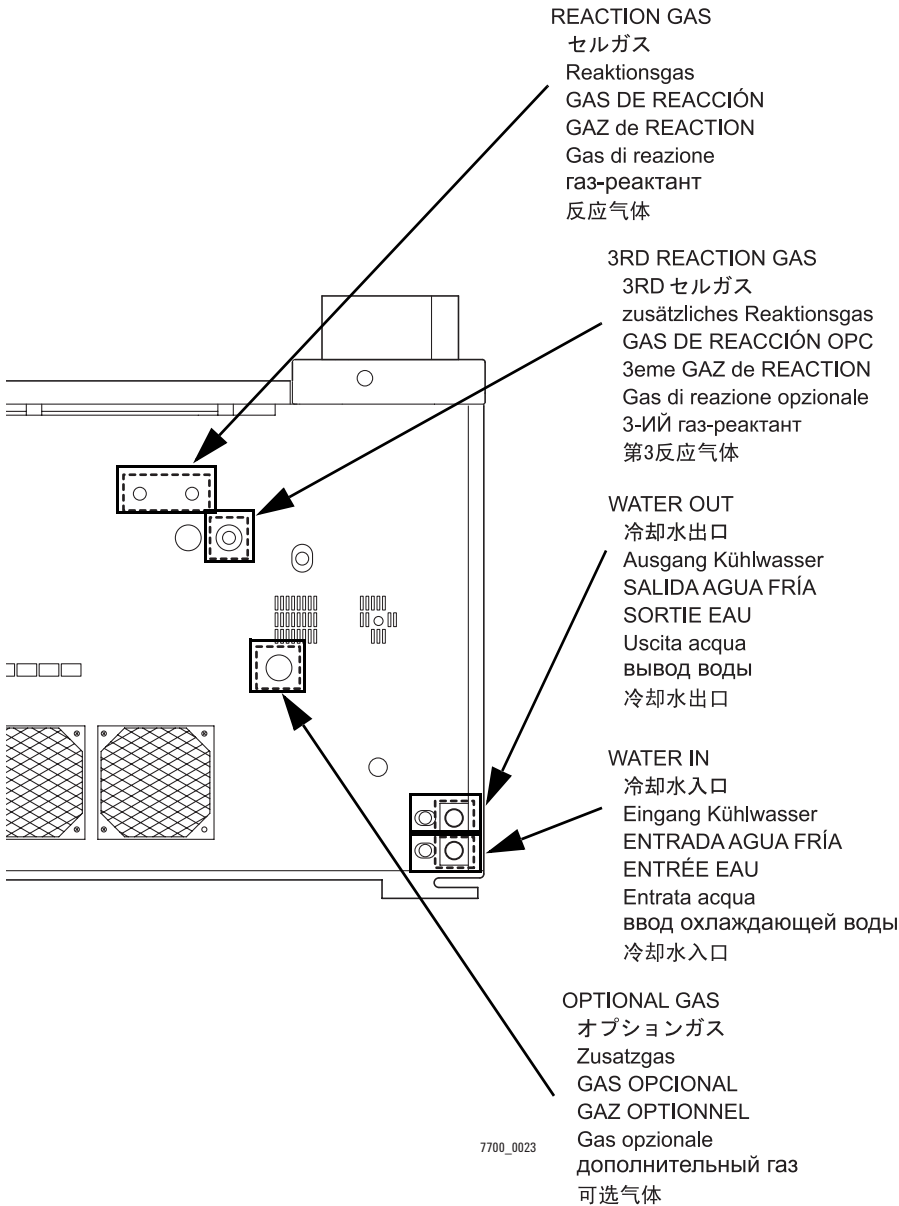
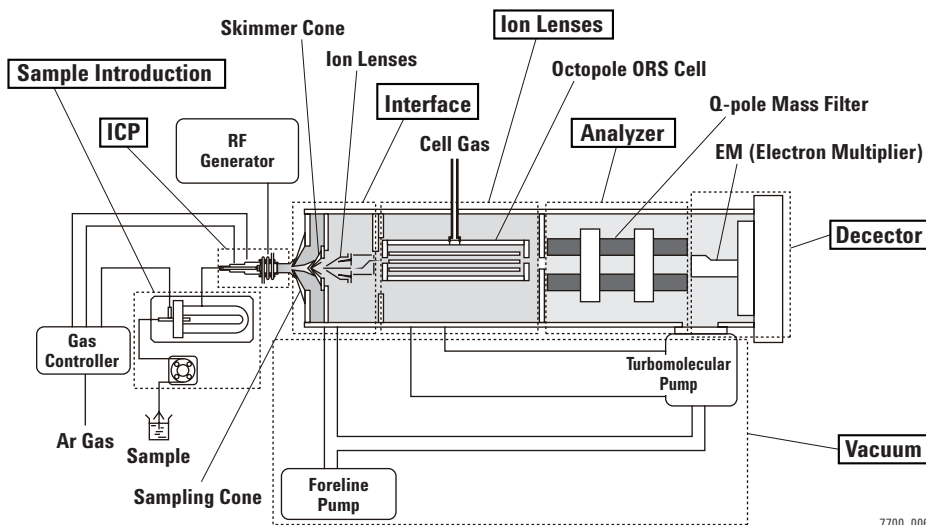


Figure 3 Name of Gas Piping and Cooling Water Tubing

Function of Components

This section describes the components of the Agilent 7700 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



7700_0067

Figure 4 System Diagram

Sample Introduction

The Agilent 7700 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.

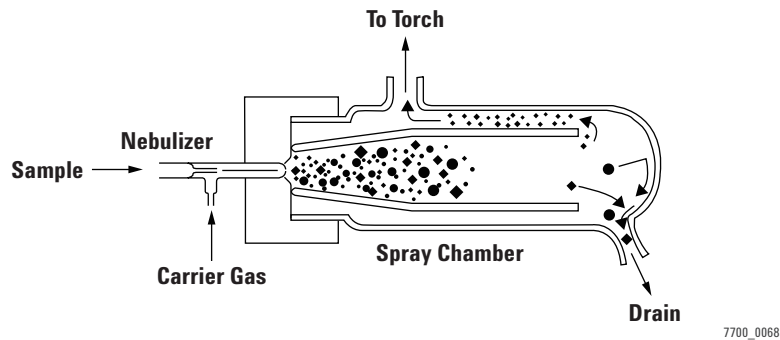


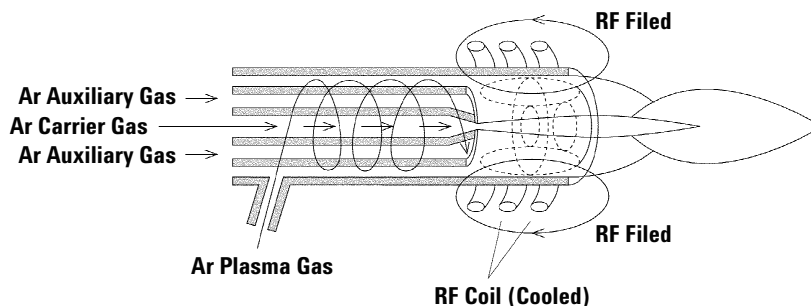
Figure 5 Nebulizer and Spray Chamber (Concentric type)

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 7700 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. These three gas streams are referred to as the plasma gas, auxiliary gas and nebulizer (carrier) gas.



7700_0069

Figure 6 ICP Torch and Load Coil

The end of the torch is situated inside the 4-turn RF coil, through which a radio frequency (RF) current 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 8000 to 10000K. 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.

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).

All the Argon gas supplies is gas controller controlled. This contributes to very good signal stability.

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.

Interface/Vacuum System

After the analyte ions are formed, they are extracted into the first vacuum stage through a hole in the front plate of the vacuum chamber referred to as the sampling cone. Ions pass through the sampling cone into the interface, which is an expansion region evacuated by a foreline pump. The ions then pass through a second orifice called the skimmer cone, which acts as a differential aperture between the interface and intermediate vacuum stage. Ions are extracted from the interface stage and collimated by two conical extraction lenses prior to focusing by the ion optics. The intermediate stage contains the ion optic system and is evacuated by a turbomolecular pump.

Ion Lenses

To achieve high signal sensitivity, the ion beam must be focused before entering the quadrupole mass analyzer. The ion lenses perform the dual role of focusing the ion beam and preventing photons and neutral species (arising from the plasma) from reaching the detector, giving the Agilent 7700 very low random background.

Although electron multipliers are very sensitive ion detectors, they are also sensitive to photons. To eliminate photon noise, the quadrupole and detector are mounted off-axis to the ion beam entering the system from the interface.

ORS

The 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. 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.

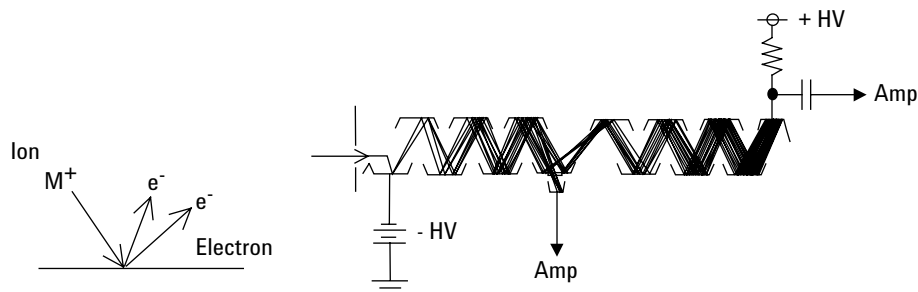


Figure 7 Electron Multiplier

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 7700 has a 3-stage vacuum system which consists of the interface chamber, the ion lens chamber, and the analyzer chamber.

Interface Chamber

The interface chamber is located between the sampling cone and the skimmer cone. A foreline 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 foreline pump is also used for pumping the turbomolecular pump.

RF Generator

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



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



General Precautions

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 7700 Series ICP-MS (Agilent 7700) is a very safe instrument with many built-in protective features:

- A safety interlock prevents opening of the top covers 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 7700, 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, instrument inside, 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, foreline 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 main switch located on the lower center side of the front panel. To switch the instrument to Standby mode and/or Shutdown mode without using MassHunter Workstation, a “**Vacuum ON/OFF Switch**” is available on the front panel inside.

CAUTION

- A sensor monitors the radio frequency (RF) generator and shuts it down if it is improperly matched to the RF 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 7700 MassHunter Workstation 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 7700:

- Check acid concentration. Continuous aspiration of a highly concentrated acid might attack the inside of the instrument.
- Close the instrument covers 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 *MassHunter Workstation Online Help*.

Precautions for Use

Protective Earth

WARNING

Connecting the Agilent 7700 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 7700 or defeating the power cord ground creates a shock hazard for the operator and can damage the instrument.

Closing the Instrument Panels and Covers

Close the instrument top covers 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 cover after the plasma is ignited. In addition, a safety interlock shuts off the plasma if the cover 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 7700 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-side cover. 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

Please make sure the ventilation system is always in operation because of the next reasons.

- There is continuous oil mist from the foreline pump, even when the instrument is not in Analysis mode.
 - Harmful hydrogen may remain even when not analyzing so the ventilation system should always be on, even in Standby mode.
 - Condensation might occur due to reverse flow through the exhaust duct.
-

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 7700 must have the capacity to maintain positive extraction of 5 to 7 m³/min.

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.
- 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.
 - 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 Gas 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.
-

Other Gas

WARNING

Read the "Hydrogen Safety Guide"(G1833-90028) and "Ammonia Safety Guide"(G3270-90019) and pay careful attention to safety management when using these gases.

- 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.

Foreline Pump

WARNING

Foreline Pump oil is flammable. Keep away from fire.

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

Air Intake

CAUTION

Do not cover the holes for air intake on the Agilent 7700.

Beryllium Compounds

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. Agilent 7700 instruments use the following parts, which are known to contain beryllium compounds:

Agilent P/N	Description
G3280-60460	Wire Assy for Quad Cable1
G3280-60407	Wire Assy for Quad Cable2
G3280-60408	Wire Assy for Pre-Filter Cable1
G3280-60490	Wire Assy for Pre-Filter Cable2
G3280-40460	Feedthrough for Quad

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 7700

CAUTION

Stated below are precautions you should observe when you want to move your Agilent 7700.

- Make sure the Agilent 7700 Main Power Breaker (located on the rear side) is turned OFF before moving the Agilent 7700.
- 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 7700 is heavy (about 115 kg), so if there is a need to lift the Agilent 7700, 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.

Symbols Used on the Agilent 7700

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)



: Power ON/OFF Switch



: 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.

Environmental Conditions and Utility Requirements

Temperature and Humidity Ranges

The Agilent 7700 should be operated and stored under the temperature and humidity ranges described below:

Operation condition:

- Temperature: 15 to 30°C (59 to 86°F)
- Relative humidity: 20 to 80% (non-condensing)
- Altitude: Up to 2000m
- 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 to 60°C
- Relative humidity: 15 to 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)

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

Supply voltage fluctuations are not exceed 10% of the nominal supply voltage.

Argon Gas Supply

Minimum Purity:	99.99%
Maximum Flow Rate:	20L/min
Supply Pressure:	500 to 700kPa

Reaction Gas Supply

Gas:	Helium, Hydrogen (optional for 7700x)
Minimum Purity:	99.999%
Maximum Flow Rate:	He 12mL/min, H ₂ 10mL/min
Typical Pressure:	He 90-130kPa, H ₂ 20-60kPa

Cooling Water

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

Exhaust Duct

Extraction Flow Rate:	5 to 7m ³ /min
-----------------------	---------------------------



3 Maintenance

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This chapter contains operator maintenance procedures for the Agilent 7700.

Scheduling Maintenance

Performing maintenance periodically enables for the operating life of the components to be extended, and for the performance of the Agilent 7700 to be fully exhibited.

The following table indicates the maintenance items that are performed for the Agilent 7700, and the standard cycle (frequency) at which they are carried out.

Table 1 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	Foreline Pump	Check oil level and color. Check the exhaust hose from foreline pump is not damages, not clogged, and surely connected.	
	Nebulizer	Run Nebulizer test, take appropriate action as indicated	
	Shield contact, Torch box contact plate	Clean	
	Cooling water	Check water level and condition	
3 ~ 6 Months	Extraction/Omega Lenses*	Clean	
6 Months	Cell entrance lens, Cell exit lens, Plate bias lens, Deflect lens	Clean	7700s, 7700x
	Foreline Pump	Change oil	

Table 1 Maintenance Schedule (continued)

Frequency	Component	Task/Action	Remarks
Annually	Foreline Pump oil mist filter	Check / replace mist filter	
	Water strainer	Check and clean	
	Octopole	Clean	
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
	Graphite gasket	Replace	Replace when surface or shape is damaged.

NOTE

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.

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.

This chapter contains operator maintenance procedures for the Agilent 7700. A summary table of tasks is given, followed by the procedures by component. To repair any Agilent 7700 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.

Managing the Maintenance

Maintenance Clocks

Use the MassHunter Workstation 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 foreline pump oil, cleaning the ion lenses, etc. MassHunter Workstation 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 foreline 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 Online Help for additional information on each value displayed.

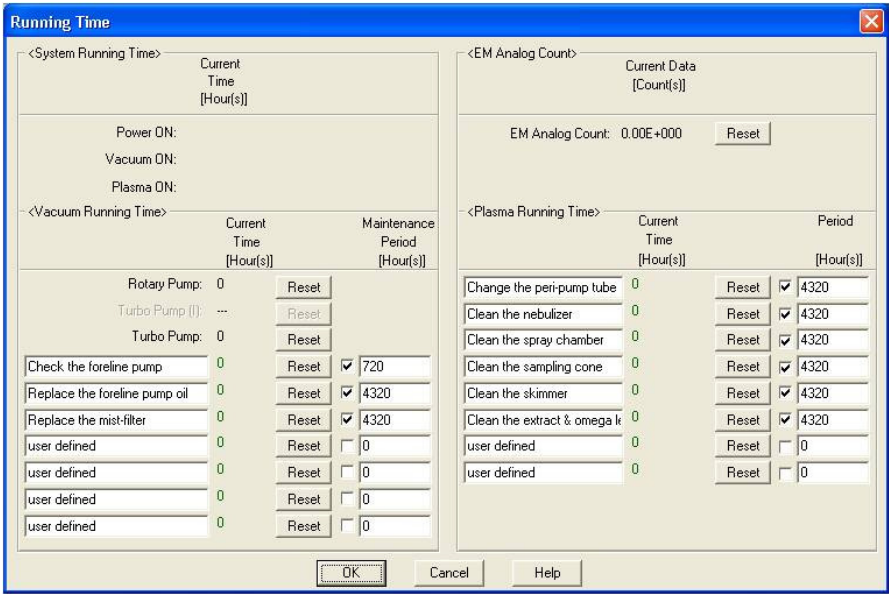


Figure 8 Running Time Dialog Box

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**.

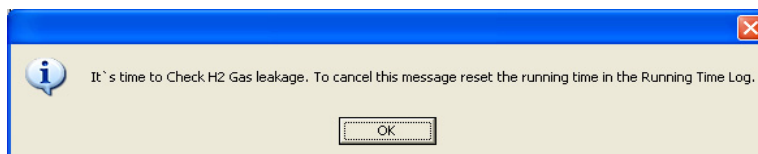


Figure 9 The Example of the Message

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.**
When a check is displayed, the message will be displayed when the maintenance period elapses.
Click the checkbox again to clear the check. The message will not be displayed even when the maintenance period elapses.

Resetting the Maintenance Clocks

To accurately monitor instrument usage, reset the maintenance clocks or counters using the MassHunter Workstation software. Reset the clocks whenever operators finish the following maintenance tasks for examples:

- Cleaning/Replacing ion lenses
- Changing foreline pump oil
- 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.
- 3 **Click *Reset*.**
The **message dialog** box appears.
- 4 **Click *Yes*.**
The time is reset to zero. See MassHunter Workstation Online Help.

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

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.

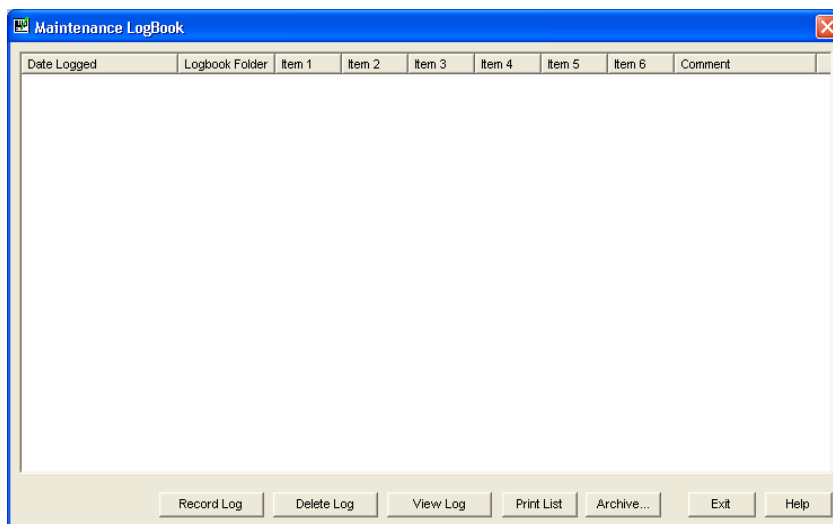


Figure 10 Maintenance LogBook window

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.

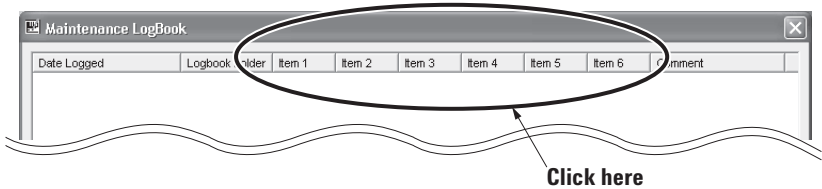


Figure 11 The displayed item area of the *Maintenance LogBook* window

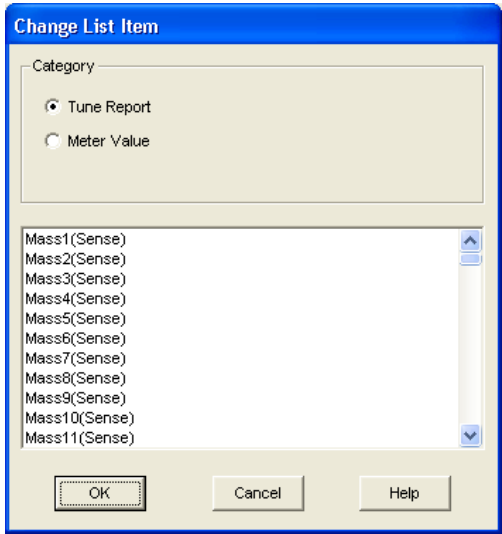


Figure 12 *Change List Item* Dialog Box.

- 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.

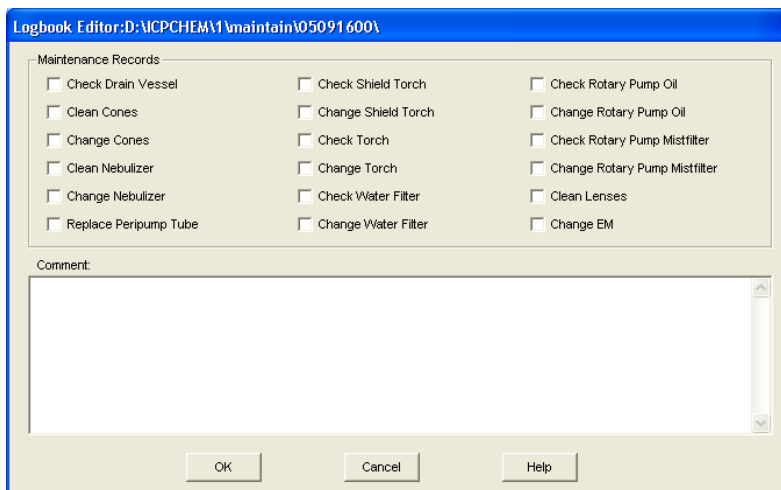


Figure 13 *Logbook Editor* dialog box

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*.

The **Logbook Viewer** dialog box appears.

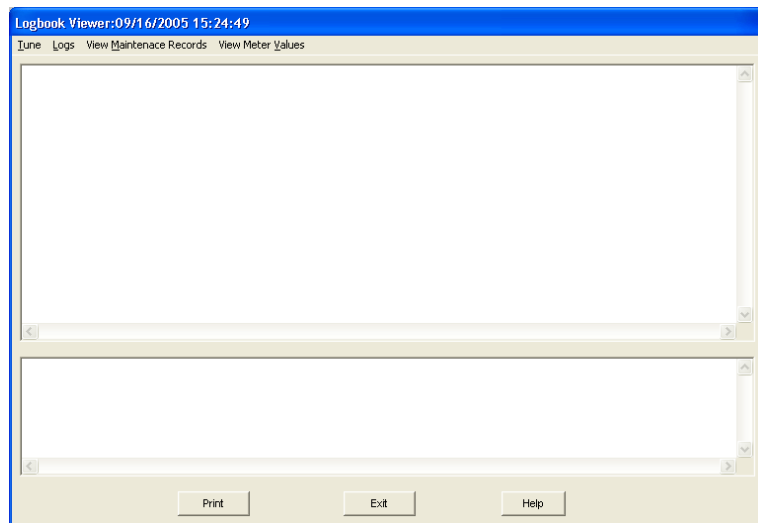


Figure 14 *Logbook Viewer* Dialog Box

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.

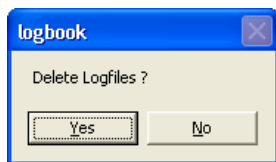


Figure 15

- 2 Click *Yes*.

Maintaining Sample Introduction

In sample introduction area, maintain the following items:

- 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 1-5% contamination-free Nitric Acid solution in Analysis mode to clean the sample introduction parts. Set peristaltic pump speed at 0.3 to 0.5rps.

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.

Explanations regarding installation of the sample line connector block and installation of the on-line internal kit are also provided in this 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 MΩ.

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 signal is unstable due to the pulsation.
- 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: white-black, 1.02mm i.d.
- Internal standard tube: orange-blue, 0.25mm i.d.
 - * Set the maximum number of pump revolutions for the internal standard tube at 0.3rps.
- Drain the tube: 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 0.1rps 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.

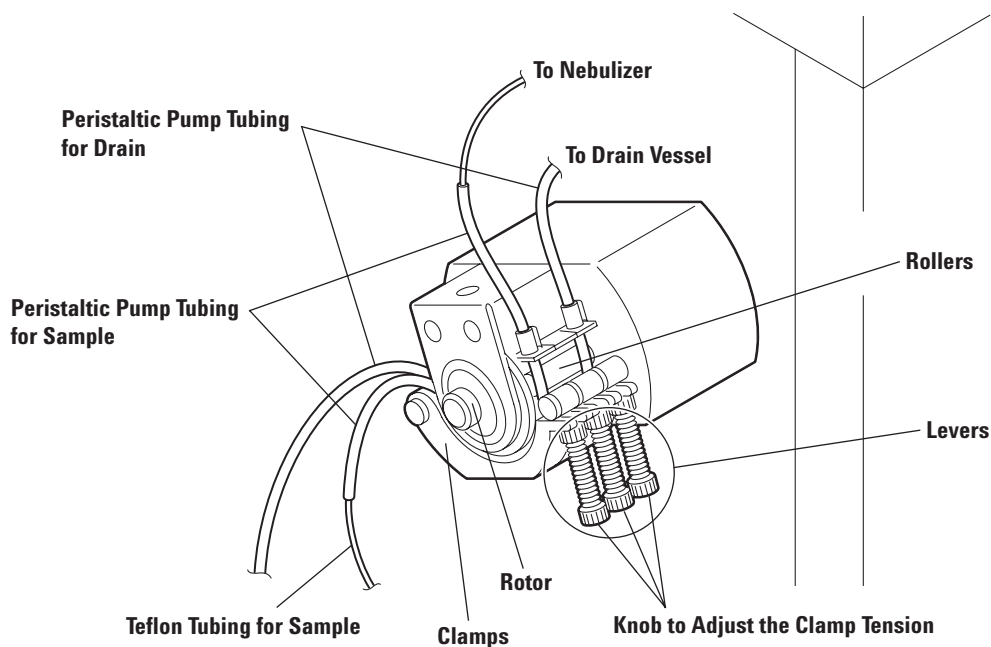
1 Place the instrument in Standby mode.

2 Remove the tubing from the peristaltic pump.

Open the clamps and lift the tubing from the pump heads. Refer to [Figure 16](#). Examine the tubing for wear and replace any tube that is compressed or damaged.

3 Installing tubes on the peristaltic pump.

- a Connect a sample tube from both ends of the pump tube.
- b Referring to [Figure 16](#), 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.
- c Clamp the tubes in place.



7700_0070

Figure 16 Peristaltic Pump

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.

- a From the **Instrument Control** window, select **Maintenance>>Sample Introduction**. (Figure 17). Allow the peristaltic pump (Nebulizer Pump in the PeriPump area in Figure 17) to draw up pure water by setting the speed to about 0.1rps.

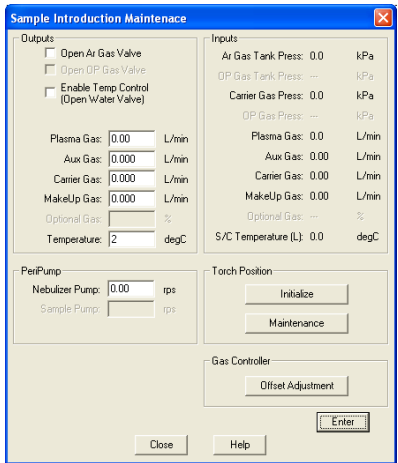
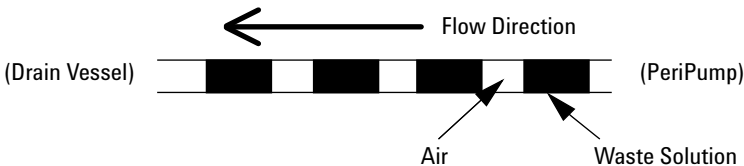


Figure 17 Sample Introduction Maintenance dialog box

- b Gradually loosen the knob applying pressure to the peristaltic pump clamp until the peristaltic pump stops drawing up water.
- c 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.

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.

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 MicroMist and PFA Concentric nebulizers, as well as the standard and inert spray chambers.

In this section, the following two kinds of nebulizers are described. The required argon gas pressure is 500 to 700kPa.

- MicroMist 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. Be careful to prevent leaks.

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

WARNING

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

NOTE

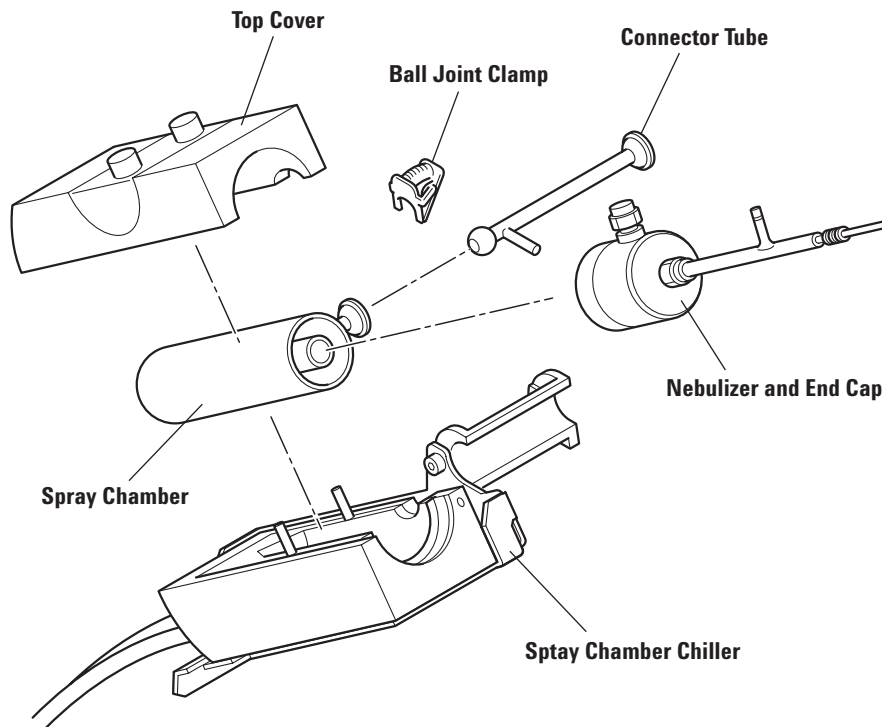
Pure water used for cleaning is indicated as water that has been generated using the ion-exchange method and a membrane filter, and has an electrical resistance of at least 18M Ω .

Removing 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.
-



7700_0071

Figure 18 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 (or Shutdown mode).**
- 2 Remove the sample transfer line.**

Remove the ball joint clamp and disconnect the connector tube (Figure 18).

If it is difficult to remove them, loosen the plastic screw-in locking bolt on the underside of the spray chamber chiller block, and move a little to the left.

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. 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.

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.

CAUTION

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

The carrier gas pressure is generally 200 to 300kPa at a 1.0L/min carrier gas flow rate. The argon gas supply pressure has to be set to 500 to 700kPa. If the carrier gas pressure rises to more than 300kPa, the nebulizer may become clogged.

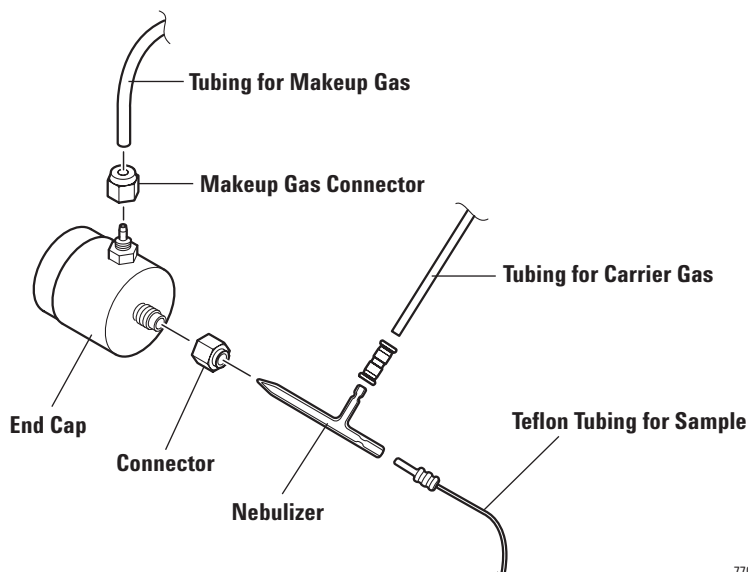
CAUTION

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

Disconnecting

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.



7700_0072

Figure 19 MicroMist Nebulizer and End Cap

Cleaning

To clean a clogged nebulizer, complete the following steps:

- 1 Disconnect the nebulizer from 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.

NOTE

If the gas tubing and sample introduction around the nebulizer leaky even a small amount, it causes a sharp signal fluctuation. Be careful to prevent leaks.

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

1 Disconnect the nebulizer from 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.

NOTE

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

If the gas tubing and sample introduction around the nebulizer leak even a small amount, it causes a sharp signal fluctuation. Be careful to prevent leaks.

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

4 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.

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.

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. Be careful to prevent leaks.

Replacing or Refitting

1 Reinsert the nebulizer into 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 twisting the nebulizer. Lubricating the nebulizer with pure water helps the nebulizer slide. 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.

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.

PFA Concentric Nebulizer

The carrier gas pressure is generally 200 to 300kPa at a 1.0L/min carrier gas flow rate. The argon gas supply pressure has to be set to 500 to 700kPa. If the carrier gas pressure rises to more than 300kPa, 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.

Removal

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.

To clean the end cap, see next section.

Cleaning

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.

- 1 **Disconnect the nebulizer from the end cap.**
- 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 1.0L/min.
 - Using a mixture of 5% nitric acid and 5% hydrofluoric acid, pump with the peripump for 8 hours.

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.**

Installing

1 Insert the nebulizer into 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 twisting the nebulizer. Insert the nebulizer into the end cap until the tip of the nebulizer is flush with the inside surface of the end cap.

2 Tighten the nebulizer holder nut so that it is finger tight.

Cleaning the Spray Chamber and the Connector Tube

To clean the spray chamber and the connector tube, complete the following steps:

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

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.

CAUTION

- Do not use chemicals such as Hydrofluoric Acid (HF), which erodes quartz, to clean the spray chamber.

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 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 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.

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.

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 gas controller.

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. 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 connector tube.

Attach the connector tube from the end of the torch to the spray chamber exhaust port. Use the clamp provided.

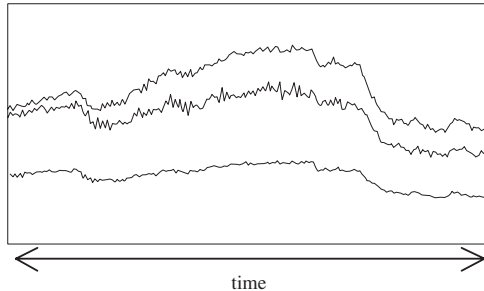
Testing the Nebulizer and Spray Chamber

Check the following items:

- 1 Check the gas pressures and flow rates in the Instrument Control window to determine if the gas hoses are connected tightly.**
- 2 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.**

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 7700 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

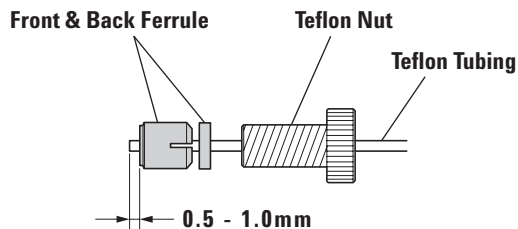
The connector block may be left in place when the block is bypassed.

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

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



7700_0074

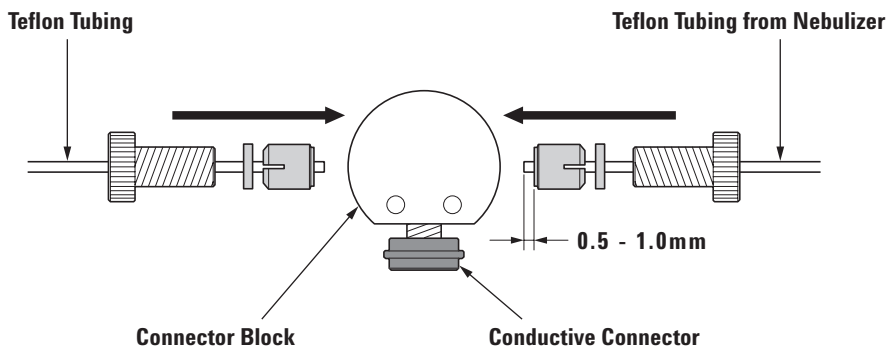
Figure 20 Teflon Nut, Front and Back Ferrule

- 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.

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

- 4 Complete steps 1-3 for both the tube from the nebulizer and the supplied sample tube.



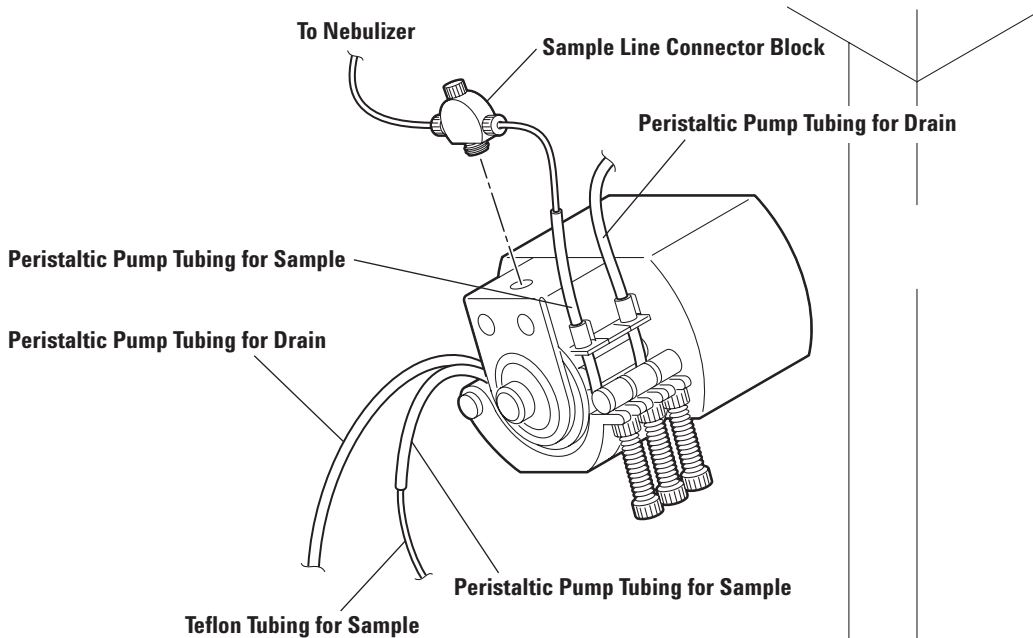
7700_0075

Figure 21 Sample Line Connector Block

NOTE

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

- 5 Insert the block into the ground. The conducive connector fits in the ground clamp, making an electrical contact between the sample and the chassis. Check for leaks.

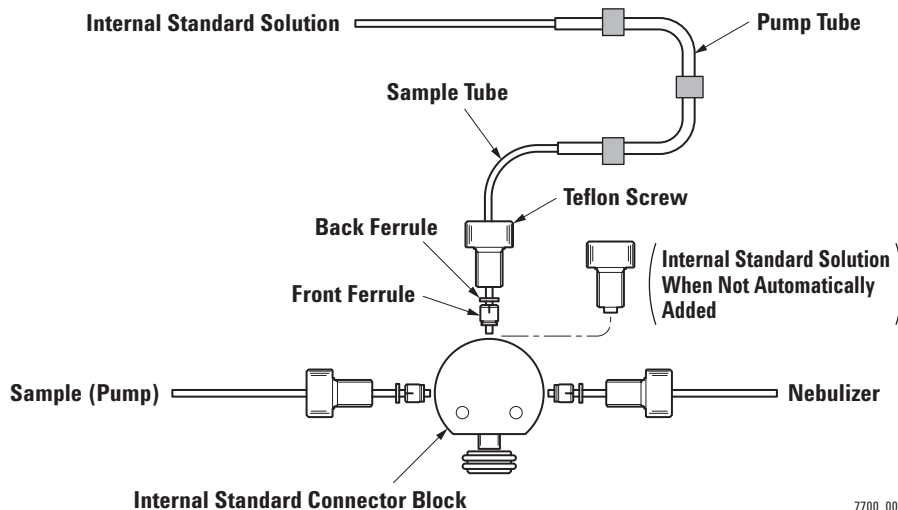


7700_0076

Figure 22

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. This kit also serves as the “sample line connector block” at the same time.

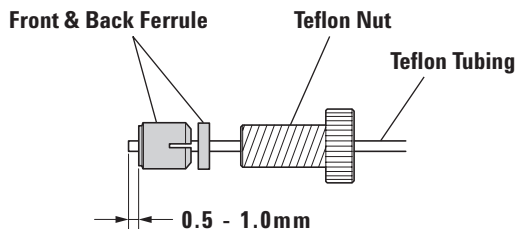


7700_0077

Figure 23 Tubing Diagram

To attach this kit, complete the following steps:

- 1 Connect the sample tube (for internal standard solution) to pump tube.**
- 2 Perform the following procedure for non-pump tube connections.**
 - a** Cut the ends of the tubing at a 90-degree angle to prevent leakage or blockage.
 - b** Slide a Teflon nut, back ferrule and front ferrule on to the tubing. The tubing should protrude between 0.5 and 1.0mm beyond the front ferrule.

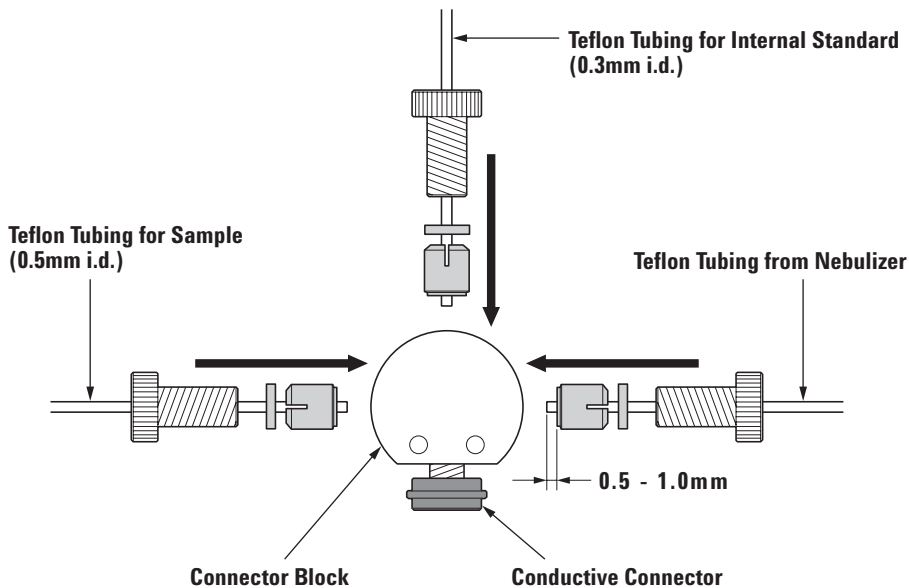


7700_0074

Figure 24 Teflon Nut, Front and Back Ferrule

- c** 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.



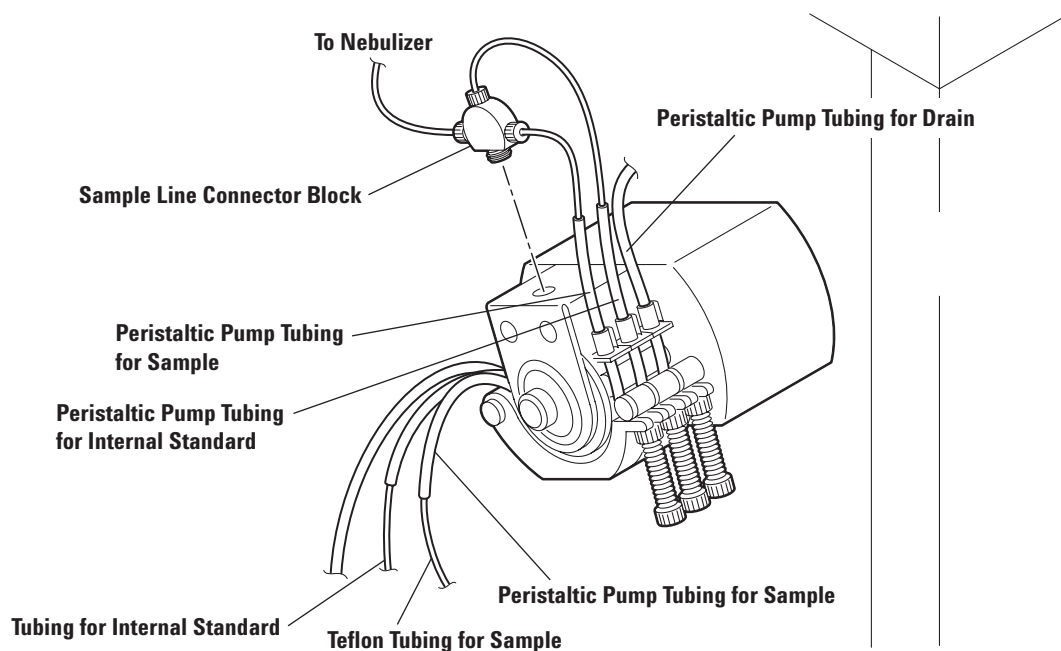
7700_0078

Figure 25 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.



7700_0079

Figure 26

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 Shield Torch

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

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.

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
- Methanol (HPLC grade)
- Cotton swabs (P/N: 9300-2574)
- 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 18M Ω .

An explanation is also given on the method for checking the position of the RF coil.

Shield Torch

Removing and Checking the Torch

To remove the ICP torch, complete the following steps:

1 Put the instrument in Standby mode (or Shurdown mode).

WARNING

The torch and interface remain hot after the plasme is turned OFF. To avoid burns, wait 10 minutes after switching off the plasma before opening the instrument.

2 Open the torch box.

Open the cover, loosen the torch box screws and remove the torch box cover. 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 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.

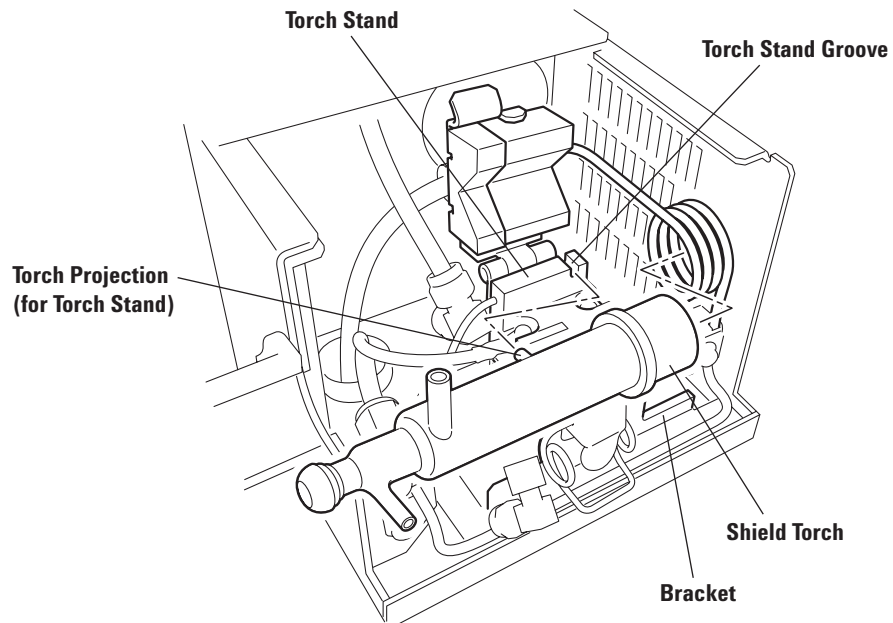
5 Remove the torch.

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 27](#).

CAUTION

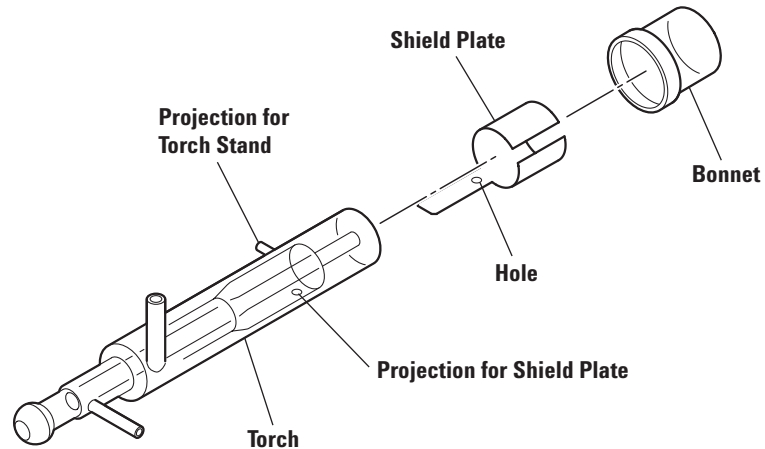
When removing the torch, the bonnet may fall and break if the torch is not held level. Hold the torch level while removing it, or hold the bonnet to prevent it from falling off when removing the torch.



7700_0080

Figure 27 ICP Torch

6 Disassemble the torch, shield plate, and bonnet.



7700_0081

Figure 28 Torch, Shield Plate and Bonnet

7 Checking the torch.

Check whether the torch is dirty. If the torch is cracked, chipped, or largely deformed due to heating, replace the 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

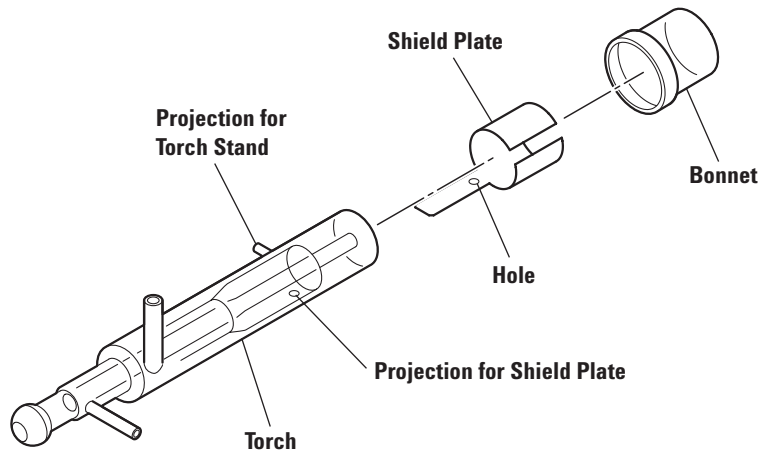
If the torch is still wet when it's installed, it will break or may cause difficulty igniting the plasma.

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.



7700_0081

Figure 29 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

To install the ShieldTorch, complete the following steps:

- 1 Place the torch in its holder.**

Carefully slide its open end inside the RF coil and at the same time align the projection for the torch stand into the torch stand fitting position.

- 2 Secure the torch using the torch stand clip.**

- 3 Connect the connector tube.**

Connect the spray chamber and the torch using a connector tube, and secure them in place using a clip.

- 4 Attach the hoses.**

After connecting the gas hoses, tighten the nuts on the fittings.

CAUTION

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

- 5 Close the torch box and instrument.**

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

CAUTION

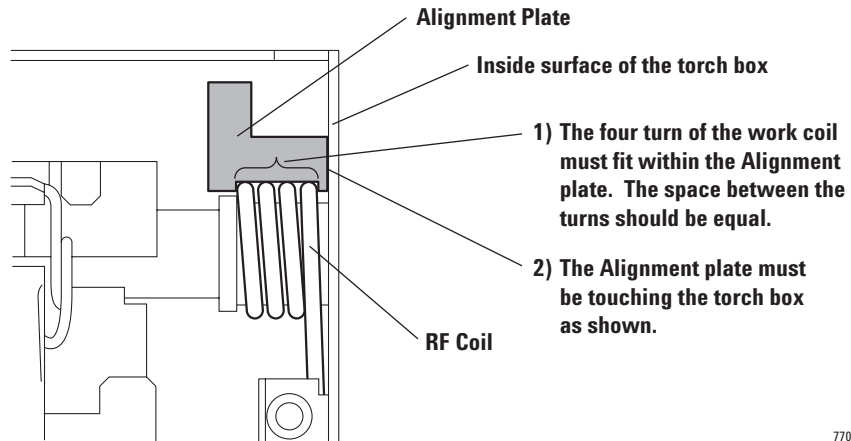
The torch cover must be on while using the torch. This cover reduces the emission of noise from the plasma.

Testing the Torch

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 RF Coil

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



7700_0082

Figure 30

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 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 $5.0 \times 10^2 \text{ Pa}$.

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

CAUTION

If opening the vacuum chamber such as when washing the ion lens, do so after turning the main switch of the Agilent 7700 OFF.

Maintenance of the following parts will be performed for the interface.

- Washing and replacing the sampling cone
- Washing and replacing the skimmer cone

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 graphite gasket (if needed)
- 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

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 18M Ω .

Maintaining the Sampling Cone and Skimmer Cone

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.
- 2 Open the left cover.

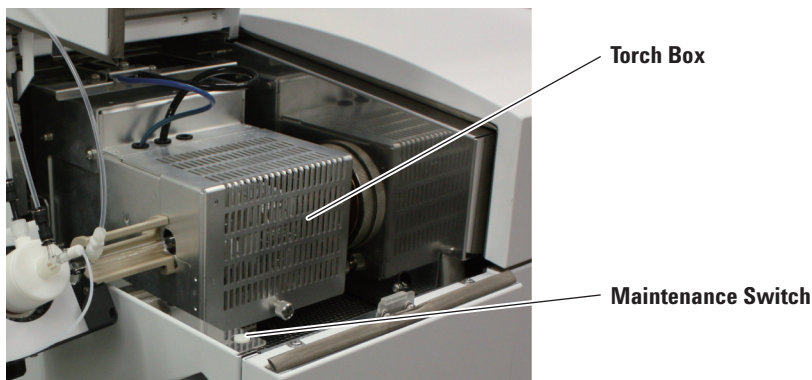
WARNING

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

3 Move the torch box assembly to its maintenance position.

To move the torch box assembly to its maintenance position, carry out one of the following steps.

- Press the maintenance switch for about 4 sec. to move the torch box to the maintenance position.



7700_0083

Figure 31 Maintenance Switch

NOTE

The torch box moves to/back from the maintenance position each time the maintenance switch is pressed.

- Carry out the following procedure from MassHunter Workstation.
 - Select **Instrument>>Instrument Control** from the ICP-MS Top window.
The **Instrument Control** window appears.
 - Select **Maintenance>>Sample Introduction**.
The **Sample Introduction Maintenance** dialog box appears.

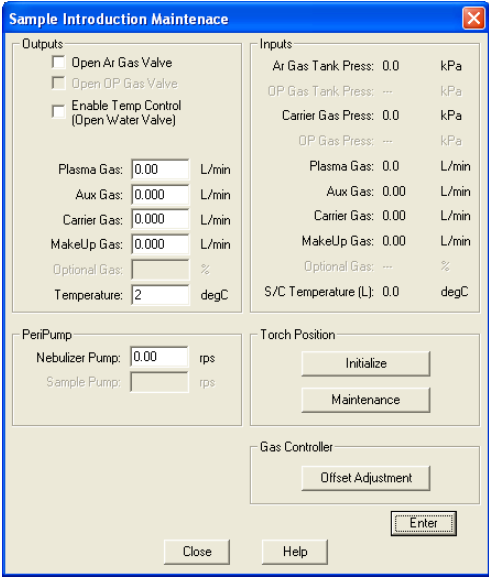


Figure 32 Sample Introduction Maintenance Dialog Box

c Click **Maintenance**.

The torch box moves away for easy interface access.

4 Remove the sampling cone.

Remove the retaining ring manually by turning it counterclockwise, and remove the sampling cone. If the retaining ring is tight, loosen it by using tools for the sampling cone.

CAUTION

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

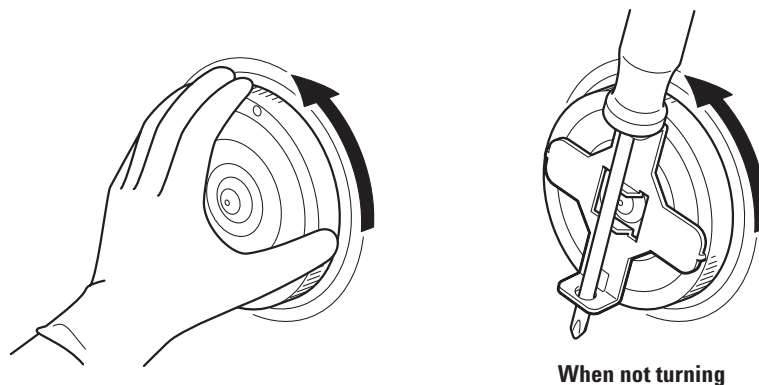


Figure 33 Removing the Sampling Cone

7700_0084

5 Holding the periphery of the sampling cone, pull and remove the sampling cone slowly to the axis.

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.

Take care not to damage the backside surface (sealing surface) of sampling cone.

6 Check the condition of the graphite gasket.

If the graphite gasket is deteriorated, or if it becomes scratched, cracked, or creased when removing the sampling cone, it is necessary to replace the graphite gasket. If replacing the graphite gasket, remove the graphite gasket at this point in time.

CAUTION

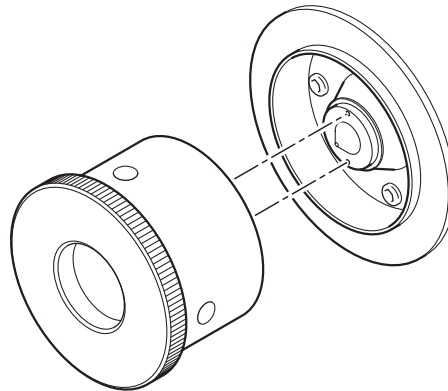
If the condition of the graphite gasket is normal and it is not necessary to remove the graphite gasket, carry out the work for installing and removing the sampling cone and skimmer cone while the graphite gasket is installed, taking sufficient care not to damage it, etc.

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 34). 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.



7700_0042

Figure 34 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 Clean with pure water (Step 1)

- a 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.
- b Rinse with pure water.
- c Ultrasonic the cone in pure water for 2 to 3 minutes.

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

- a Ultrasonic the cone in a 2% Citranox solution for 2 to 3 minutes.
- b Rinse with pure water.

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

- a 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.
- b Rinse with pure water.

4 Clean with alumina powder and Citranox (Step 4)

- a 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.
- b Rinse with pure water.
- c Ultrasonic the cone in a 2% Citranox solution for 2 minutes.
- d Rinse in pure water.
- e 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 1.0mm, replace the cone. If the skimmer orifice is larger than 0.4mm, 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, [“Maintaining the Sampling Cone and Skimmer Cone”](#) 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 34).

CAUTION

Firmly install the sampling cone and the skimmer on the base. If the sampling cone and the skimmer are not tightly installed on the base, the sampling cone and skimmer are not cooled enough and may cause bad effect on the analytical performance, or the vacuum does not reach the standard value and it cannot change to Standby mode.

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

- a** Check to make sure that the graphite gasket is installed correctly. If faulty, replace the graphite gasket.
- b** Install the sampling cone to the interface. At this time, support it manually until the retaining ring is tightened.
- c** Tighten the retaining ring. Tighten manually, without using any tools.

3 Move the torch box back to the original position, and close the cover.

Testing the Cones

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

This procedure explains the removal, disassembly, and cleaning method for individual lenses, and the reassembly of the ion lens used in the Agilent 7700x or 7700s.

The Agilent 7700x or 7700s Main Lens assembly consists of 2 ion lens assemblies: the Extraction Lens-Omega Lens assembly and the ORS Cell assembly. The Extraction Lens-Omega Lens assembly consists of the Extraction Lens and the Omega Lens. The Extraction Lens-Omega Lens and ORS 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 ORS cell. Refer to the procedure [“Working Inside the Vacuum Chamber”](#) on page 3-54 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 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 ORS cell first. While cleaning the cell, replace the chamber cover and start the pumps. After cleaning, reassemble and install the ORS cell assembly, clean the Extraction Lens-Omega Lens assembly.

CAUTION

Before opening the vacuum chamber to clean the ORS cell or for other purposes, always switch OFF the power to the Agilent 7700.

Perform maintenance on the following ion lens:

- Extraction Lens-Omega Lens assembly
- ORS cell assembly

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)
- TORX driver (T8, T10, T20)
- 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 ORS 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 ORS cell assemblies, refer to procedures titled [“Removing the Extraction Lens-Omega Lens Assembly”](#) on page 3-58 and [“Removing the ORS Cell Assembly”](#) on page 3-63.

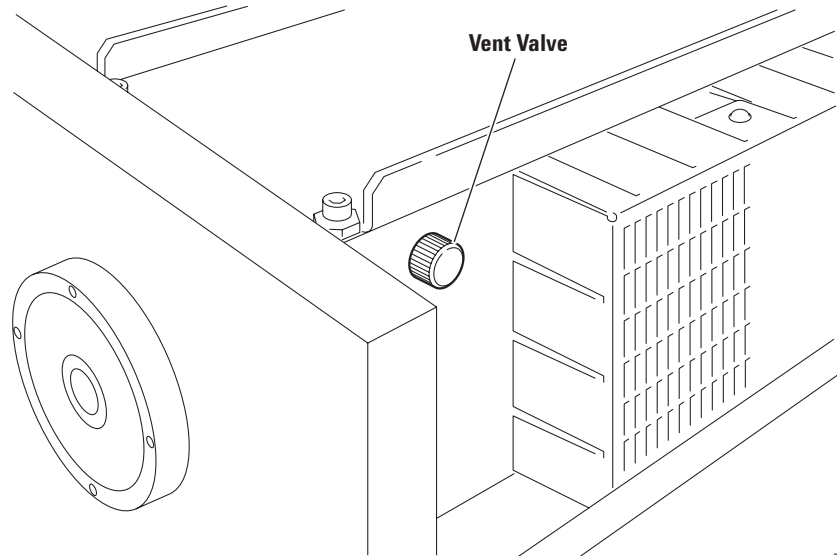
Opening the Vacuum Chamber

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

- 1 Place the Agilent 7700 in shutdown mode and close the MassHunter Workstation. Turn OFF the main switch of the Agilent 7700.**

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 35](#) for the location of the vent valve) While air is flowing into the chamber, you should hear a soft hissing sound.



7700_0086

Figure 35 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 lid. It will take approximately 1 minute for the chamber pressure to equalize.

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

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 lid when you are not working inside the vacuum chamber.

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

NOTE

During longer maintenance periods such as when cleaning the ion lens, close the lid on the vacuum chamber and pump down the Agilent 7700 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 lid on the vacuum chamber.

Place the lid 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 Pump down by turning ON the main switch, waiting until the red light of status indicator turns off and carrying out one of the following methods.

- Press the vacuum ON/OFF switch for about 4 sec.
- Re-start the ICP-MS Top window from MassHunter Workstation. Select **Instrument >> Instrument Control** from 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. (Changing from Shutdown mode to Standby mode)

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 7700 to reach Standby mode if any components have been replaced or cleaned.

If the Agilent 7700 does not reach Standby mode within 5 hours an error will be generated. After acknowledging the error, change the Agilent 7700 to Standby mode again.

7 When pump down starts, the O-ring on the lid will compress and the lid will drop. Retighten the screws on the lid.

8 Close the top cover.

Maintaining the Extraction Lens-Omega Lens Assembly

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 7700 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.

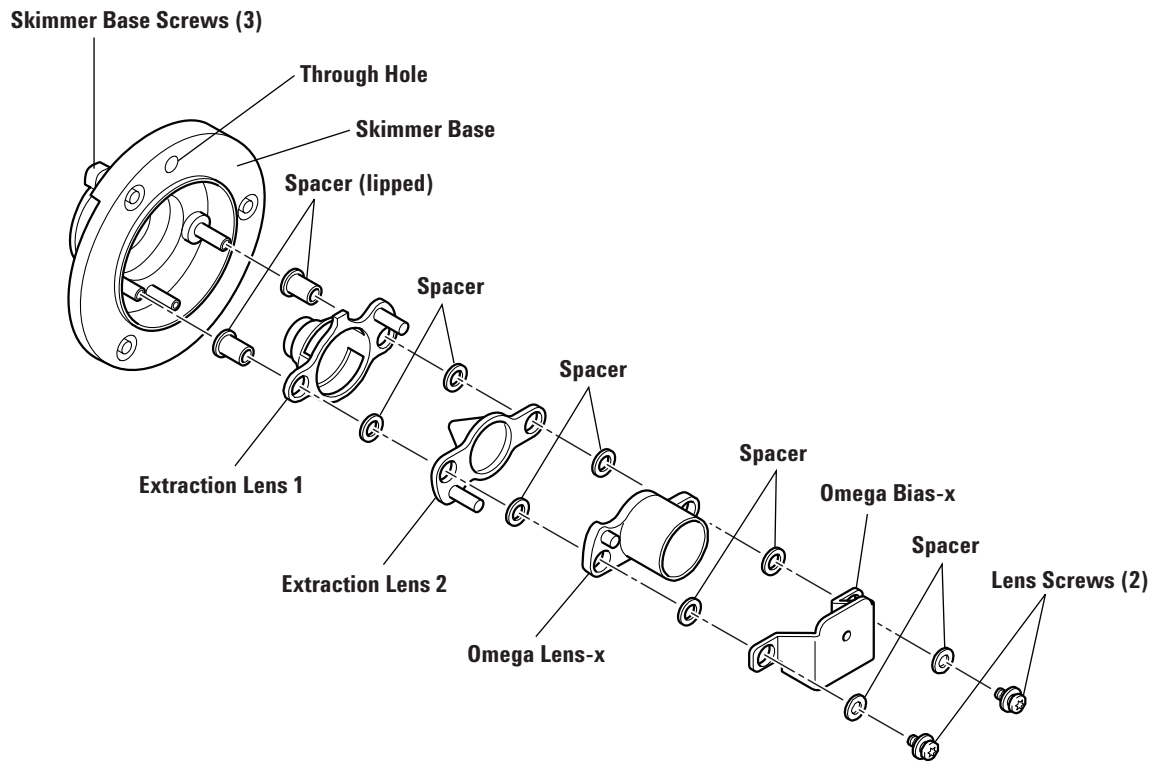
2 Remove the Extraction Lens-Omega Lens assembly.

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 36](#) for the 7700x and [Figure 37](#) for the 7700s.) 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.



7700_0087

Figure 36 Expanded View of the Extraction Lens-Omega Lens Assembly (7700x)

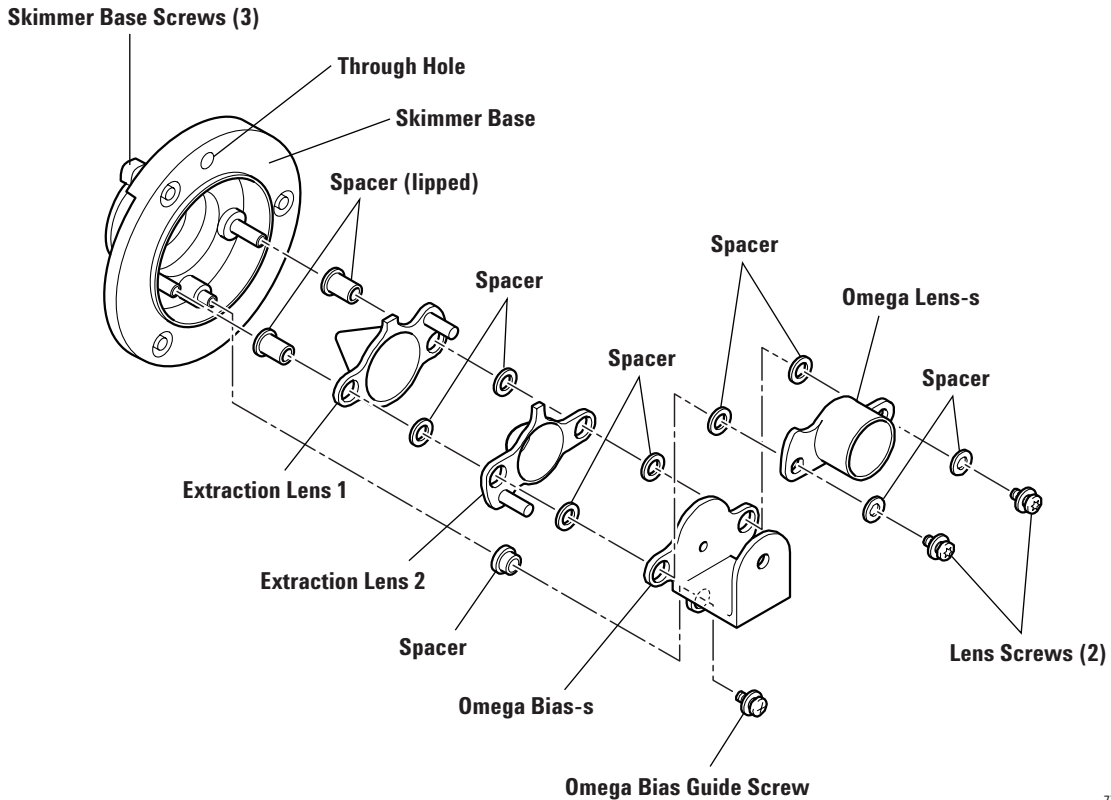


Figure 37 Expanded View of the Extraction Lens-Omega Lens Assembly (7700s)

Cleaning the Extraction and Omega Lenses

It is possible to clean the Extraction Lens, Omega Lens-x (-s), and Omega Bias-x (-s) 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).

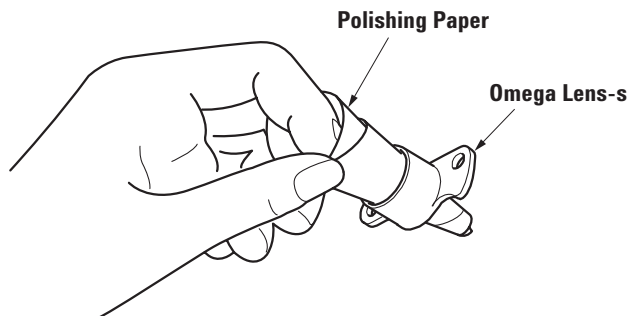
The polishing paper can be used either wet or dry. Wet polishing paper is easier to use when polishing the surfaces.

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.



7700_0089

Figure 38 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.

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 (7700x: [Figure 36](#), 7700s: [Figure 37](#)) for the correct location and orientation of the components. After completing the re-assembly, securely tighten the 2 lens screws.

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 3-43.

Maintaining the ORS Cell Assembly Area

Removing the ORS Cell Assembly

The ORS cell assembly is located inside the vacuum chamber, behind the gate valve assembly.

CAUTION

Disassemble the ORS cell in an area free of contamination.

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

WARNING

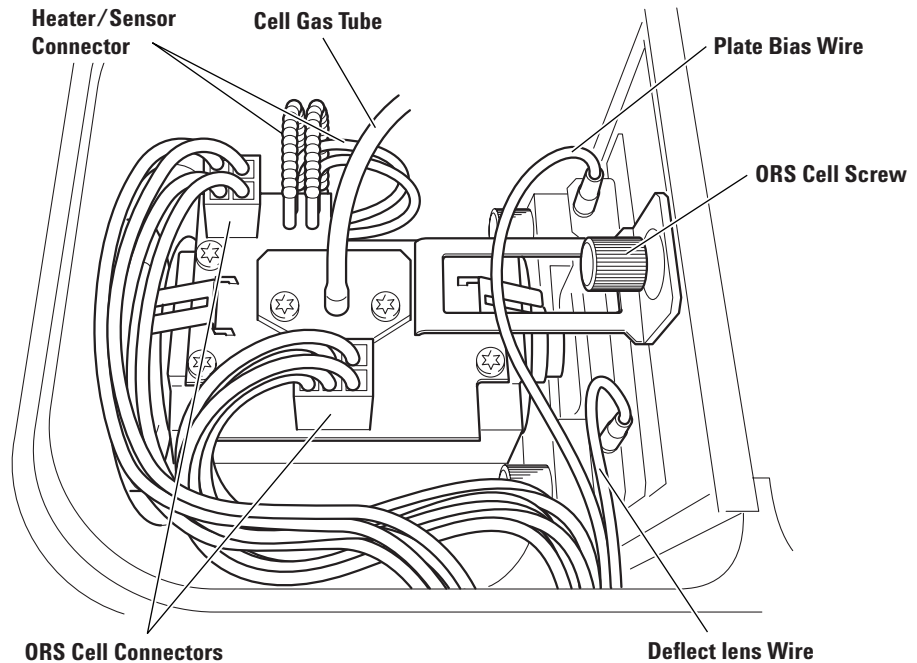
Turn OFF the power to the Agilent 7700 before removing the ORS Cell assembly from the vacuum chamber. Otherwise, you could expose yourself to the extreme danger of coming in contact with high voltage electricity.

- 1 Set the Agilent 7700 to shutdown mode and close the MassHunter Workstation. Turn OFF the main switch of the Agilent 7700.
- 2 Open the vent valve to equalize the pressure in the vacuum chamber and remove the chamber lid.

Refer to [“Working Inside the Vacuum Chamber”](#) on page 3-54 in this chapter.

3 Remove the tube.

Remove the cell gas tube from the ORS cell assembly.



7700_0090

Figure 39 ORS Cell as Refitted

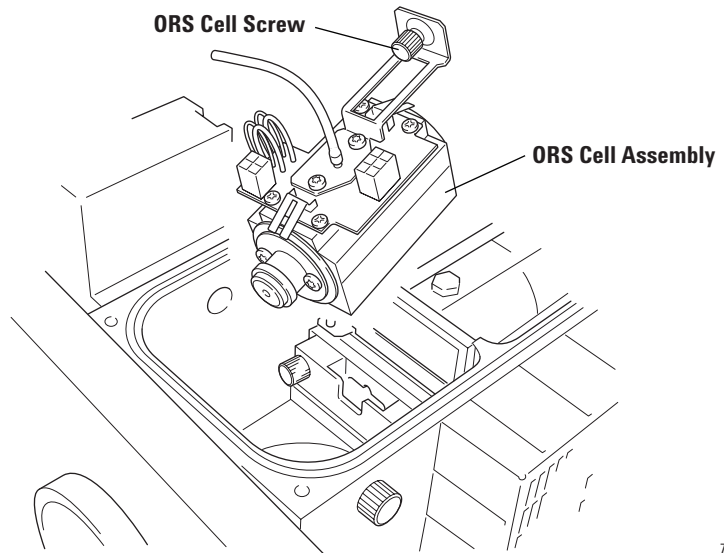
4 Disconnect the connectors and cell gas tubing.

Disconnect the ORS Cell Connectors (two) from the ORS cell assembly. And disconnect the cell gas tube from the vacuum chamber.

5 Disconnect the plate bias wire and deflect lens wire.

6 Remove the ORS cell assembly.

Loosen the screw for the ORS cell. Lift the ORS cell assembly at an angle, as illustrated in [Figure 40](#). Place the ORS cell assembly on a clean surface. After removing the assembly, return the lid to the vacuum chamber.



7700_0091

Figure 40 ORS Cell Assembly

Disassembling the ORS Cell Assembly

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

CAUTION

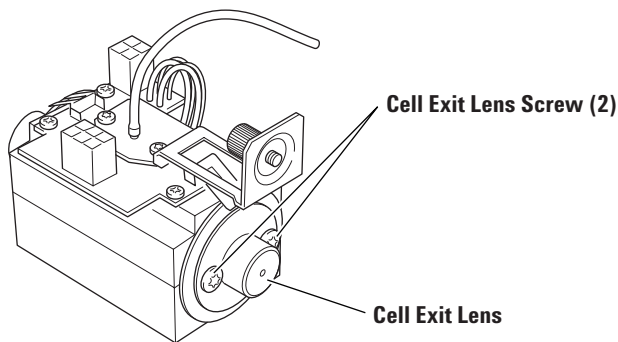
Disassemble the ORS cell assembly in an area free of contamination and while wearing clean laboratory gloves and use only clean tools.

NOTE

When cleaning the ORS cell assembly, lay out the dismantled components in the order of their original configuration.

1 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 41) and the Cell Entrance Lens assembly screw (Figure 42) a quarter turn prior to disassembly.



7700_0092

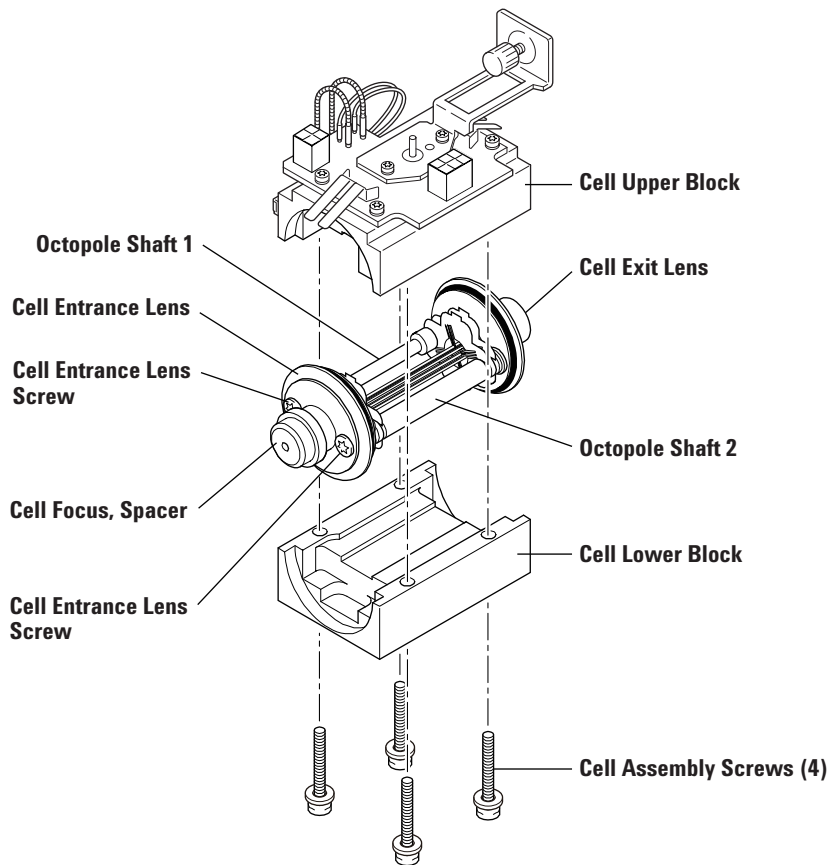
Figure 41 ORS cell assembly

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.

2 Remove the cell assembly screws.

Remove the 4 screws located on the bottom side of the ORS cell assembly to open the ORS cell. Remove the upper block allowing the Octopole assembly to remain on the lower block.



7700_0093

Figure 42 ORS Cell Assembly Dismantled

NOTE

The diameter of Octopole shaft 1 differs from Octopole shaft 2.

3 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.

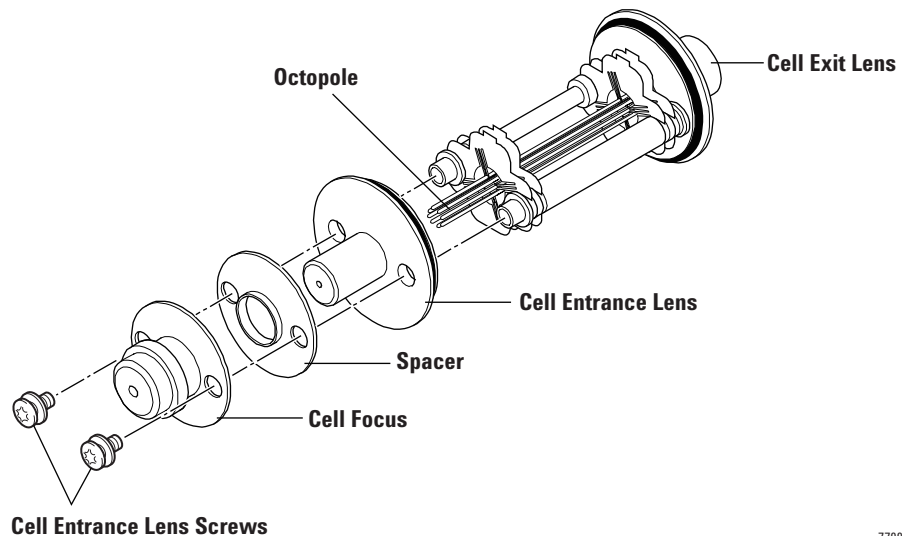
CAUTION

The Cell Focus, Cell Entrance Lens, 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 rods of the Octopole. You may accidentally mis-align the Octopole.

NOTE

The Cell Focus, Cell Entrance Lens, Cell Exit Lens, and two spacers are shaped and structured differently.

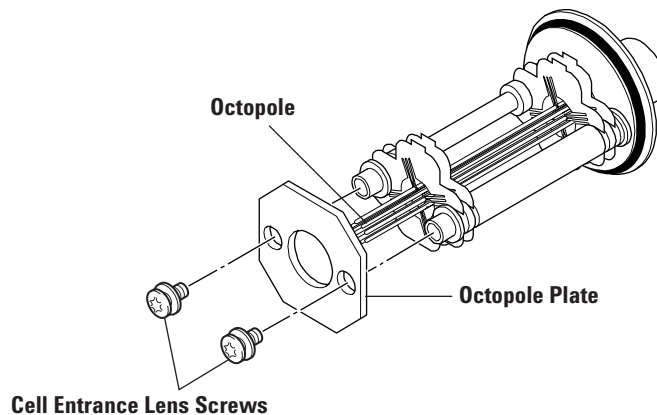


7700_0094

Figure 43 Removing the Cell Entrance Lens

4 Secure the Octopole plate.

Secure the Octopole Plate (included in the mainframe accessory) to the location from which you removed the Cell Focus and Cell Entrance Lens.

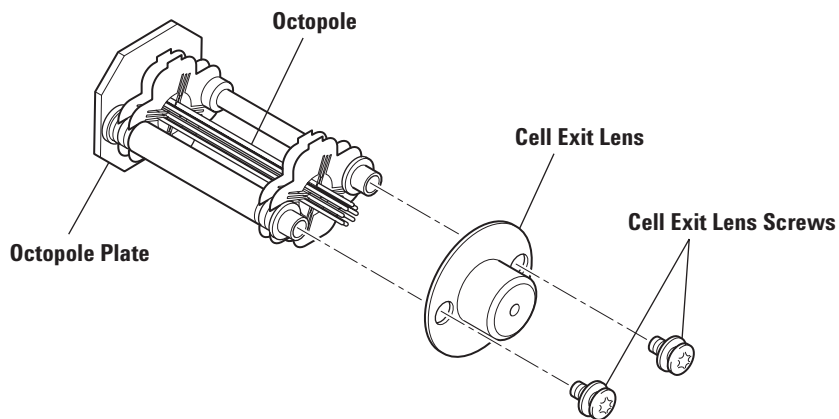


7700_0095

Figure 44 Securing the Octopole Plate

5 Remove the Cell Exit Lens.

Remove the Cell Exit Lens screw to remove the Cell Exit Lens.

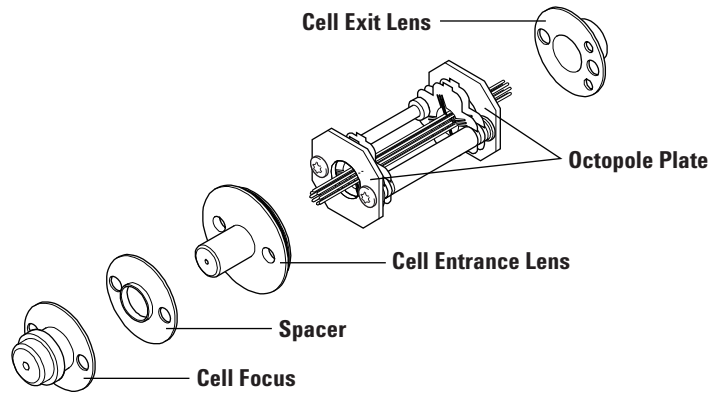


7700_0096

Figure 45 Removing the Cell Exit Lens

6 Secure the Octopole plate.

Secure the Octopole plate to the location from which you removed the Cell Exit Lens.

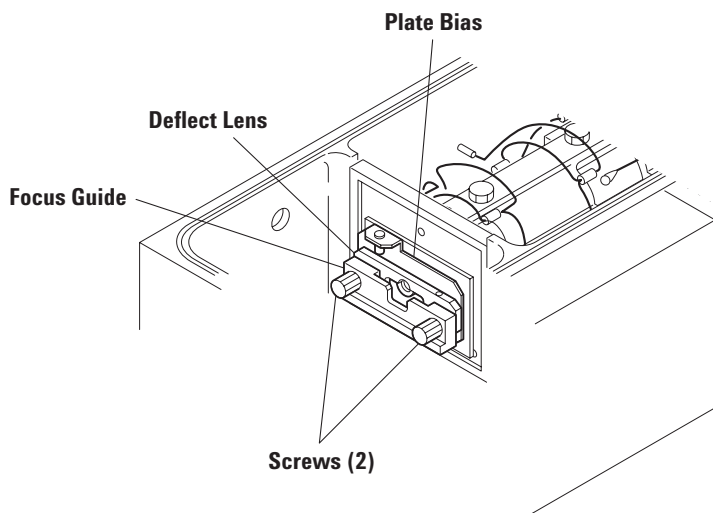


7700_0097

Figure 46 The Octopole with the Cell Entrance Lens and Cell Exit Lens Removed

Removing the Deflect Lens and Plate Bias Lens

The Deflect Lens and Plate Bias Lens is located in the vacuum chamber, between the ORS cell assembly and the Q-pole. (Figure 47)



7700_0098

Figure 47 Location of the Deflect Lens and Plate Bias Lens (with the ORS Cell Assembly Removed)

CAUTION

Always perform these maintenance in a contamination-free area.

It is necessary to remove the ORS cell assembly before removing the Plate Bias Lens.

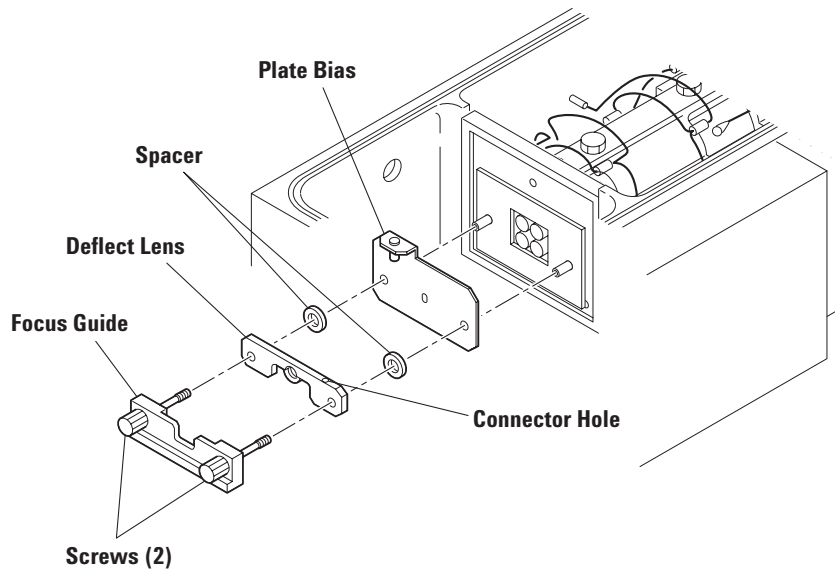
The following procedure describes how to remove the Plate Bias Lens.

1 Remove the ORS cell assembly.

For information on removing the ORS cell assembly, refer to the previous procedure entitled “[Removing the ORS Cell Assembly](#)” on page 3-63.

2 Remove the Deflect Lens and Plate Bias Lens.

Loosen the 2 screws securing the Deflect Lens and Plate Bias Lens and remove the Cell Exit Guide, Deflect Lens, Spacer and Plate Bias Lens. ([Figure 48](#)) Place the removed parts on a clean surface. Return the lid to the vacuum chamber after removing the lens.



7700_0099

Figure 48 Deflect Lens and Plate Bias Lens

Cleaning the ORS Cell Lenses

The parts of the ORS cell that need to be cleaned are the Cell Entrance, Cell Focus, Exit, Deflect lens and Plate Bias Lens. Remove the O-rings from the Cell Entrance and Cell Exit Lens 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 organic solvents.

1 Polish with polishing paper (blue, #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 (yellow, #1200).

3 Polish the lenses with an alumina powder slurry.

Use a mixture of alumia 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 organic solvents. The plastic will be damaged or deformed if it comes in contact with organic solvents.

Completely dry all components. If components are connected to the vacuum chamber before they have completely dried, it will take an extraordinarily long time 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 or ethanol).

Remove the heater, temperature sensor and printed circuit board from the Cell's upper cover and allow it to dry thoroughly.

Cleaning the Octopole

It is necessary to clean the Octopole if there is 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 ORS cell and attach 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 rods of the Octopole are 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 Deflect Lens and Plate Bias Lens

When refitting lenses in the vacuum chamber, begin with Deflect Lens and Plate Bias Lens. If you refit the ORS cell assembly first, you will not be able to install them.

Always wear laboratory gloves when refitting Deflect Lens and Plate Bias Lens. The following procedure explains how to refit the lens:

1 Install the Plate Bias Lens, Spacer, Cylinder Lens and Cell Exit Guide in the vacuum chamber.

Install Deflect Lens and Plate Bias Lens in the direction illustrated in [Figure 48](#).

2 Secure the Plate Bias Lens and Cell Exit Guide with screws.

Securely tighten Deflect Lens and Plate Bias Lens with 2 screws.

After you have finished installing the Plate Bias Lens, refit the ORS cell assembly.

Refitting the ORS Cell Assembly

It is easiest to refit the Extraction Lens-Omega Lens assembly and the ORS cell assembly in the reverse order to which they were dismantled. After all the lenses are cleaned, begin with the ORS cell assembly.

Be sure to wear laboratory gloves when refitting the ORS cell assembly. The following procedure explains how to refit the assembly. (Refer to [Figure 42](#))

1 Insert the O-ring.

Insert the O-ring on the Cell Entrance Lens and Cell Exit Lens. If the O-ring has cracks or is compressed, replace it with a new one.

NOTE

The Cell Focus, Cell Entrance Lens, and Cell Exit Lens are different.

2 Install the Octopole Assembly.

Reassemble the Cell Focus, Cell Entrance Lens, 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.

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. Pay careful attention to the direction of the lenses when assembling.

Always remove only one Octopole support plate (located on both sides of the Octopole assembly) at a time, leaving the other support 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 rods of the Octopole. The Octopole may become misaligned.

3 Install the Octopole Assembly to the lower cell block.

Place the Octopole assembly in the correct direction on the lower cover of the cell. 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.

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 49](#))

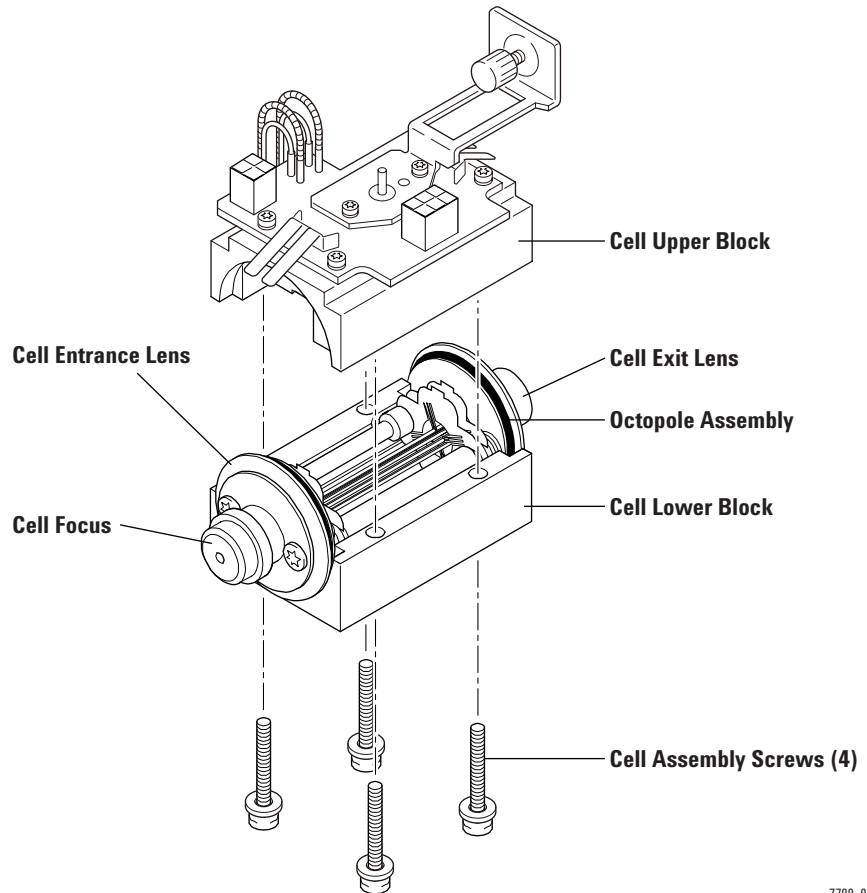


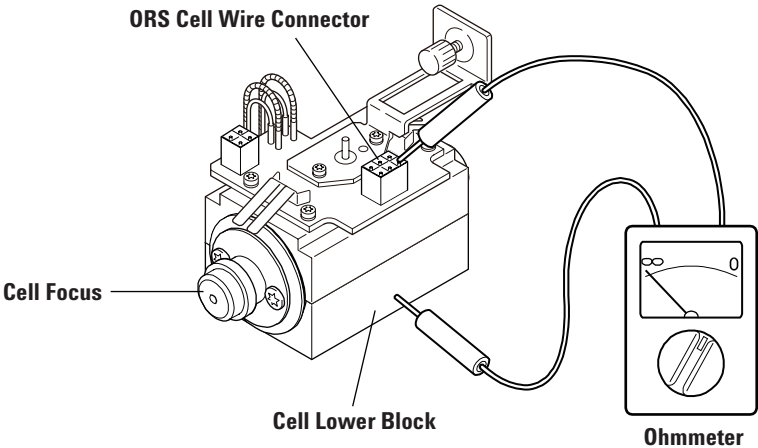
Figure 49 ORS cell and cell assembly screws

7700_0100

6 Check for electrical continuity.

Using an Ohm meter, confirm there is no continuity between the cell lower block (ground) and each electrode on the ORS cell wire connector.

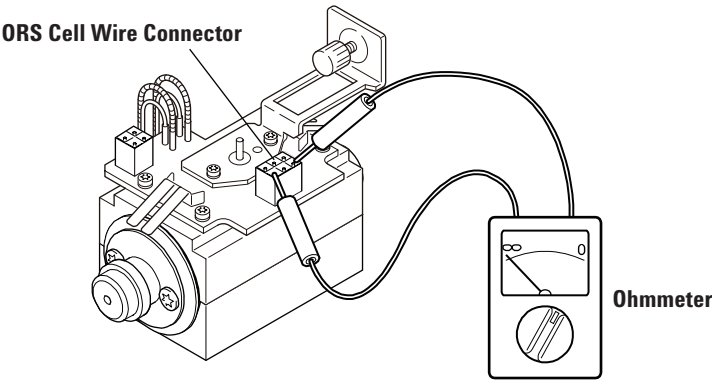
Make sure there is no continuity between the pins on the Cell Focus and ORS Cell wire connector.



7700_0101

Figure 50 Checking the continuity (Cell Lower Block and Connector Electrodes)

Check for no continuity between the 6 electrodes on the ORS cell wire connector.



7700_0102

Figure 51 Checking the continuity (connector and individual electrodes)

7 Check the continuity.

Using an Ohm meter, confirm that there is continuity between all wire connector electrodes and the Cell Entrance Lens, and Cell Exit Lens.

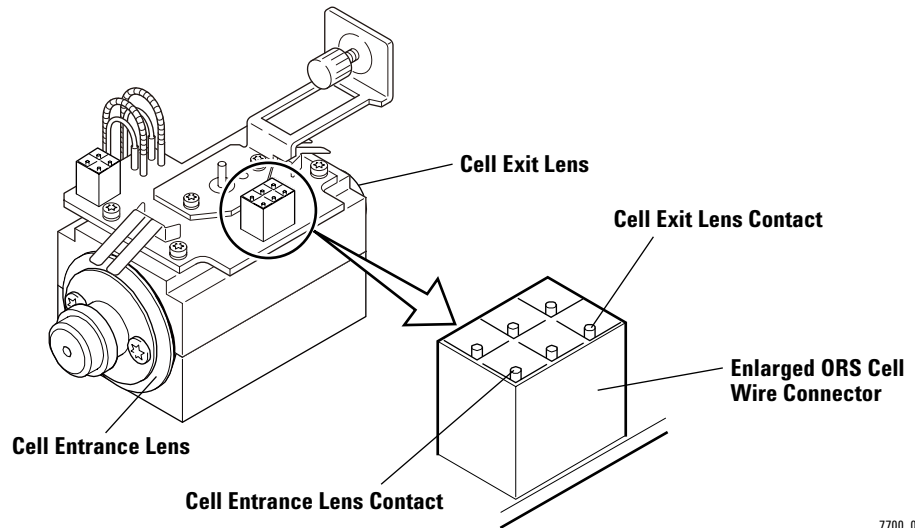


Figure 52 Checking the electrical connections

Refitting the ORS Cell Assembly

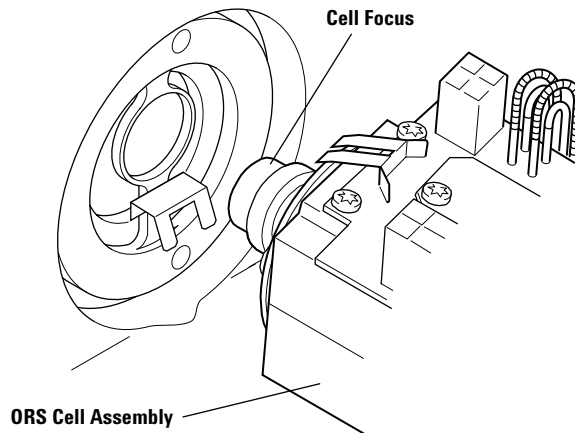
Wear laboratory gloves when refitting the ORS cell assembly. The following procedure explains how to refit the ORS cell assembly.

1 Install the ORS cell assembly to the instrument.

Remove the vacuum chamber cover. Place the ORS cell assembly in the vacuum chamber as illustrated in [Figure 40](#). 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 ORS Cell assembly on the uneven surface of the Cell Focus while installing.

Securely tighten the screws that hold the ORS cell assembly to the vacuum chamber.



7700_0104

Figure 53 Installing the ORS cell assembly

2 Connect the wire.

Insert the wire leading to the plate bias lens and the wire leading to the Deflect lens into the terminal installation section.

3 Connect the wire connectors.

Connect the heater/sensor and ORS cell connectors to the ORS cell assembly.

4 Connect the tube.

Connect the cell gas tube to the ORS cell assembly.

NOTE

Before installing the vacuum chamber lid, check the heater cable and temperature sensor cable are connected to the terminals on the cell.

5 Pump down the system.

Refer to the procedure in this chapter titled [“Sealing the Vacuum Chamber and Pumping Down the System”](#).

Changing the Hardware Information

There are two types of the Extraction-Omega Lens Assembly, one for the 7700x and another for the 7700s.

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.

- **“x” Lens:** Extraction-Omega Lens Assembly for 7700x
- **“s” Lens:** Extraction-Omega Lens Assembly for 7700s

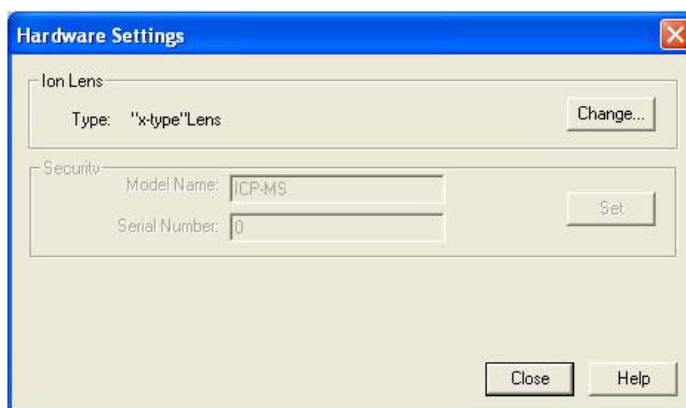


Figure 54 Hardware Settings dialog box (example for 7700x)

- 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.
- 4 Select the correct ion lens and then click **OK**.
- 5 Exit the MassHunter Workstation software.

When changing the ion lens, refer to MassHunter Workstation Online Help.

Adjusting the Octopole

After performing maintenance on the ORS 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 7700 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 covers.**

You cannot perform the adjustment with these covers open.

- 3 **In the MassHunter Workstation’s *ICP-MS Instrument Control* window, select *Maintenance>>Octopole*.**

The Octopole Setup dialog box will appear on the screen.



Figure 55 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 ORS cell is incorrectly assembled, or the ORS cell is not properly installed to the main unit. Refer to “[Refitting the ORS Cell Assembly](#)” on page 3-75 and “[Refitting the ORS Cell Assembly](#)” on page 3-80 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 MassHunter Workstation Online Help.

Cell Gas Line Maintenance

The **Reaction Gas Line Maintenance** dialog box controls the cell gas, this allows the cell gas to be purged during maintenance and start-up.

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.

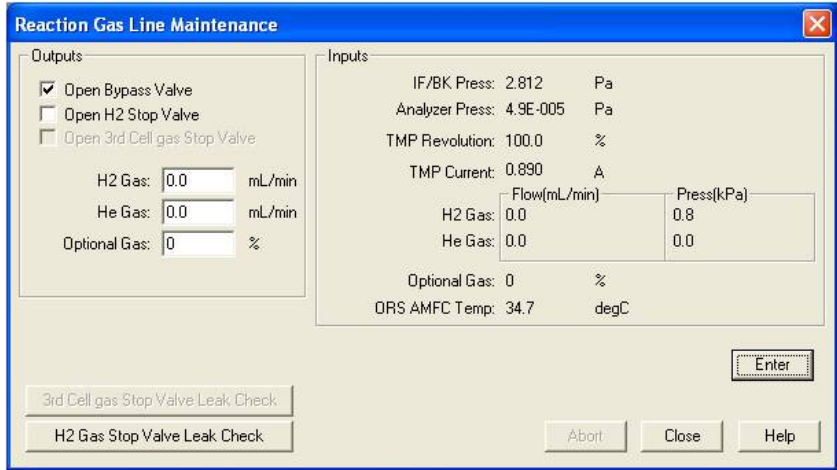


Figure 56 Reaction Gas Line Maintenance dialog box

The following information is displayed in the Reaction Gas Line Maintenance dialog box.

- **Output:** Set each reaction gas flow rate.
- **Open Valve:** When this dialog box is open, the 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 7700x. If an H₂ gas line is not connected, H₂-gas-related items are grayed out and cannot be selected.

- **Input:** Current value.
- **Leak Check:** Check for gas leaks. After pushing the gas leak check button, click the Enter button to automatically check for gas leaks.
- **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: 10 (mL/min)
- He gas: 12 (mL/min)
- Optional gas: 100 (%)

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

If the analyzer chamber does not achieve the appropriate vacuum pressure ($< 5 \times 10^{-4}$ Pa), check to make sure the lens is securely sealed to the vacuum chamber.

Maintaining the Other Parts

Maintaining the Electron Multiplier

The detector used in the Agilent 7700 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 3300V or the **Pulse HV** reaches about 1900V after adjusting the EM voltage.

To replace the EM, complete the following steps:

1 Set both Analog HV and Pulse HV to 0V

Select **Instrument>>Tuning** from the Top menu to display the tuning window.

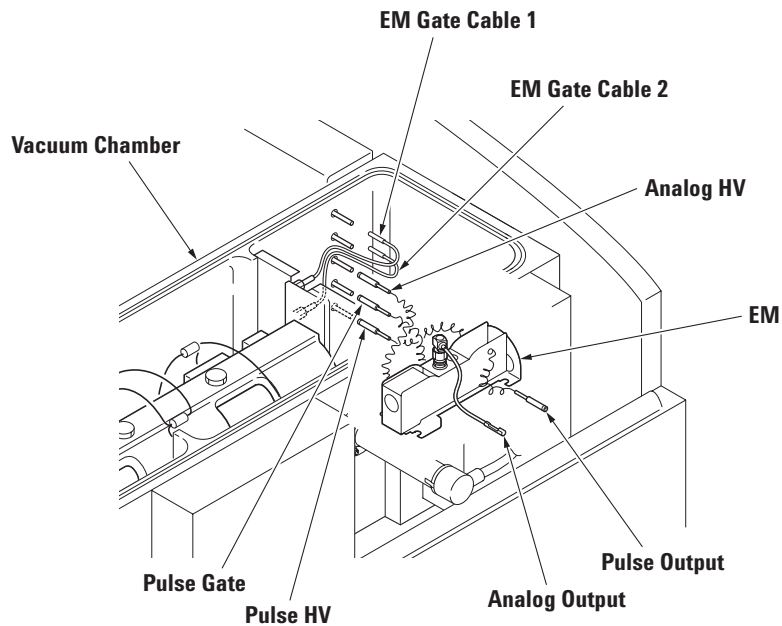
Set **0V** into both **Analog HV** and **Pulse HV** in the tuning parameters.

2 Set the Agilent 7700 to Shutdown mode and close the MassHunter Workstation. Turn OFF the main switch of the Agilent 7700.

WARNING

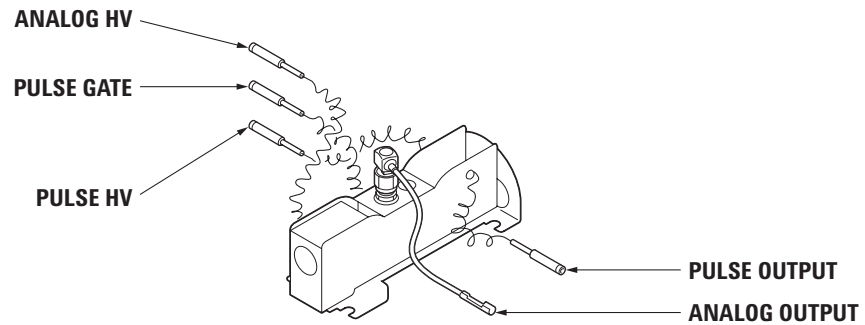
The Agilent 7700 has many interlocks to protect the system and the operator, we suggest you switch off the power before working on the system.

- 3 Vent the analyzer vacuum and remove the vacuum chamber lid.
Refer to “[Working Inside the Vacuum Chamber](#)” in this chapter.
- 4 Disconnect the feedthrough leads of the EM, and coaxial connector on the EM.



7700_0105

Figure 57 Location of EM

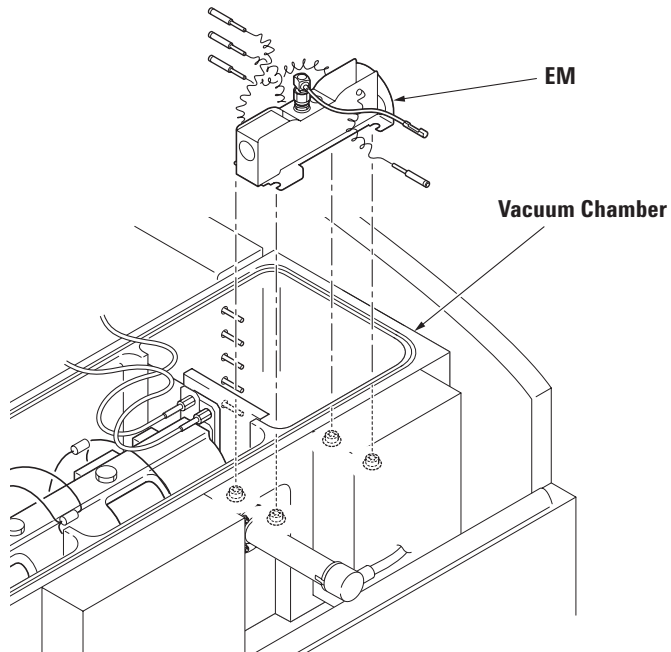


7700_0106

Figure 58 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 59)



7700_0107

Figure 59 EM and Vacuum Chamber

- 6 Install a new EM and secure with the 4 screws, connect the feedthrough leads, connect the coaxial connector.
- 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 Install the chamber lid, and pump down the system.
Refer to “[Working Inside the Vacuum Chamber](#)” in this chapter.
- 9 After replacing, reset EM total current in the *Running Time* dialog box.
Refer to the section “[Maintenance Clocks](#)” in this chapter.

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 Make sure the Analog HV and Pulse HV are set to 0V.
- 3 Using the Autotune, adjust the discriminator and EM voltage.

Refer to the “*MassHunter Workstation Online Help*” 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.

About Dead Time Calibration, refer to “MassHunter Workstation Online Help”.

NOTE

Dead time calibration must be performed after replacement of the electron multiplier.

Maintaining the Foreline Pump

The foreline pump is 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 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.

CAUTION

- Do not make a wrong connection for the inlet and outlet of foreline pump.
- Connect the exhaust hose from foreline pump surely by hose band.

To change the oil and empty the oil mist filter, the following supplies are needed:

- Foreline Pump oil
- Waste oil container, at least 1 liter in size
- Oil funnel
- Paper towels

Changing the Foreline Pump Oil

To change the foreline pump oil, complete the following steps:

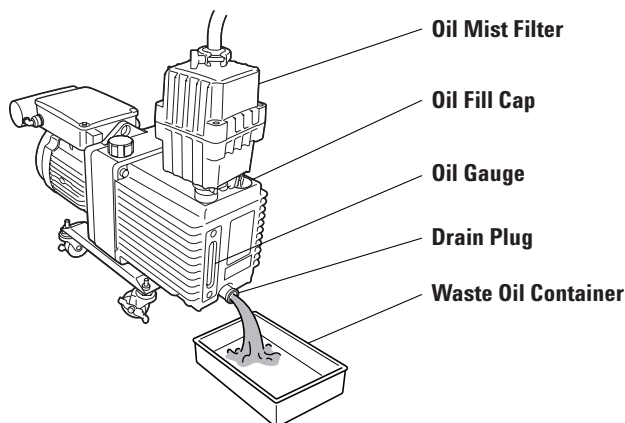
- 1 **Shutdown the instrument.**
- 2 **Be sure to switch off the breaker labeled *FORELINE PUMP* on the rear side of the Agilent 7700. (Switch the breaker down to the O side (down).)**

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 60).

WARNING

The pump oil may be hot. Direct skin contact may result in burns.



7700_0108

Figure 60 Foreline 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 foreline pump.

6 Tighten any loose hose connections.

7 Switch the breaker down to the I side (up) to restore foreline pump power.

8 Reset the foreline 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 7700 into Shutdown mode.**
- 2 Switch off the breaker labeled “FORELINE 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 7700 and foreline pump.**

Testing the Foreline 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.

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 Refit the strainer.

6 Tighten the cooling water strainer cap.

7 Check for leaks.

Open the valve, if present. Turn the cooling water chiller power switch ON.



4 Troubleshooting

Viewing and Clearing the Error Log [4-2](#)

Viewing the Error Log [4-2](#)

Clearing the Error Log [4-2](#)

Error Log [4-3](#)

Error Messages [4-3](#)

Alarm Messages [4-28](#)

Items to Be Checked in Case of Low Sensitivity [4-32](#)

Items to Be Checked in Standby Mode [4-32](#)

Items to Be Checked in Analysis Mode [4-33](#)

This chapter describes how to check the error log and the error log's contents, in order to help you resolve Agilent 7700 MassHunter Workstation 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 7700. See the following section for a list of the MassHunter Workstation 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 3](#).

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.

- 3 Click **OK**.

All error messages are erased from the error log file. The **Instrument Control** window is in the foreground.

Error Log

Error Messages

The following messages can appear in the MassHunter Workstation green message bar when you operate the Agilent 7700. When an error message is displayed, the instrument runs a safety sequence.

CAUTION

With regard to the error numbers and the causes behind the error messages, only those that the customer can clear are listed.

Depending on the error, there are some where the cause is associated with repairs. For errors that you cannot clear, please contact an Agilent Technologies engineer.

1000 Execution Error: Instrument is busy- Between Transition Modes

Attempted to execute a command that cannot be executed during mode transition. (e.g. Standby mode → Analysis mode)

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 (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).

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.

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 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

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 Standby mode to 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 gasket).
- The plasma is too far from the sampling cone.
- The power of the foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.
- A drop of water was introduced into the vacuum chamber.

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.

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.

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.

1022 Execution Error: Can not open bypass valve because of high cell pressure.

The bypass valve cannot work because the ORS cell pressure is too high.

The following causes are inferred.

- Cell 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.

Cell 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. It is possible that the 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. It is possible that the 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.

1091 Error: Z80 Boot Error.

The Z80 firmware does not start.

1092 Error: Flash ROM write error.

Flash ROM error occurred during writing.

1099 Execution Error: Instrument is busy- Between Transition Modes.

Attempted to execute a command that cannot be executed during mode transition. The mode is transitioning now.

1100 Error: Pirani gauge (BK) malfunction (Open).

Fault in the backing Pirani gauge or the Connection PCA (When the instrument is changing from Shutdown mode to Standby mode).

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) is not 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

1102 Error: Vacuum (IF/BK) time out, vacuum too high to switch on Ion gauge (AN).

The Ion gauge cannot be turned ON because the vacuum pressure (IF/BK) is not 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

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 increased 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

1104 Error: Vacuum pressure (IF/BK) is too high to keep the Ion gauge (AN) ON.

The Ion gauge cannot be turned ON because the vacuum pressure (IF/BK) exceeds the limit or the Ion gauge was turned OFF because the vacuum pressure increased 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

1105 Error: Pirani gauge (BK) malfunction (Open).

There is a fault in the backing Pirani gauge or the Connection PCA (When the instrument is changing from Standby mode to Analysis mode).

1110 Error: Pirani gauge (IF/BK) malfunction (Open).

There is a fault in the Pirani gauge (IF/BK) or the Connection PCA (In Standby mode).

1111 Error: Vacuum pressure (IF/BK) is too high to keep the Ion gauge (AN) ON.

The Ion gauge cannot be turned ON because the vacuum pressure (IF/BK) exceeds the limit or the Ion gauge was turned OFF because the vacuum pressure increased 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

1112 Error: Pirani gauge (IF/BK) malfunction (Open).

There is a fault in the Pirani gauge (IF/BK) or the Connection PCA (In Analysis mode).

1113 Error: Vacuum pressure (IF/BK) is too high to keep the Ion gauge (AN) ON.

The Ion gauge cannot be turned ON because the vacuum pressure (IF/BK) exceeds the limit or the Ion gauge was turned OFF because the vacuum pressure increased 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

1114 Error: Pirani gauge (BK) malfunction (Open).

There is a fault in the backing Pirani gauge or the Connection PCA (When the instrument is changing from Analysis mode to Standby mode).

1115 Error: Vacuum pressure (IF/BK) is too high to keep the Ion gauge (AN) ON.

The Ion gauge cannot be turned ON because the vacuum pressure (IF/BK) exceeds the limit or the Ion gauge was turned OFF because the vacuum pressure increased 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

1116 Error: Pirani gauge (IF/BK) malfunction (Open).

There is a fault in the Pirani gauge (IF/BK) or the Connection PCA.

1117 Error: Pirani gauge (IF) malfunction (Open).

There is a fault in the interface Pirani gauge or the Connection PCA (When the instrument is changing from Standby mode to Analysis mode).

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) is not 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 gasket)
- The plasma is too far from the sampling cone.
- The power of the foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

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) increased 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 gasket).
- The plasma is too far from the sampling cone.
- The power of the foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.
- 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 gasket).
- The plasma is too far from the sampling cone.
- The power of the foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.
- A drop of water was introduced into the vacuum chamber.

1122 **Error: Ion gauge (AN) malfunction.**

The Ion gauge works abnormally (When the instrument is changing from Shutdown mode to Standby mode).

The Ion gauge may be recovered if you change to Shutdown mode, loosen the vent valve for 2 seconds to introduce air, restart vacuum.

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) is not 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.
- 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) is not 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 gasket).
- 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

1125 Error: Ion gauge (AN) malfunction.

The Ion gauge is working abnormally (When the instrument is changing from Standby mode to Shutdown mode).

1126 Error: Ion gauge (AN) malfunction.

The Ion 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) increased 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

1128 Error: Ion gauge (AN) malfunction.

The Ion 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) increased 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 gasket).
- 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.
- A drop of water was introduced into the vacuum chamber.

1130 Error: Ion gauge (AN) malfunction.

The Ion 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).

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 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.

1134 Error: Gate valve did not open.

When the instrument transits from Standby mode to Analysis mode, it failed to open the gate valve (When the instrument is changing from Standby mode to Analysis mode).

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.

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 power voltage. The following causes are inferred.

- A rise of vacuum pressure.

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 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.

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 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.

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 Plasma was shut off.

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 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.

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 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.

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 power voltage. The following causes are inferred.

- A rise in the vacuum pressure.

1147 Error: Gate valve did not close when Plasma off.

The gate valve does not close when plasma is extinguished.

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 (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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

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).

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).

1154 Error: Analyzer chamber pressure is high after closing the gate valve.

The analyzer chamber vacuum fails to decrease completely after the gate valve closes.

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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

1155 Error: Turbo pump not at desired speed (Standby -> Shutdown). Turn off main power to reset.

The speed of the turbo pump does not decrease during the transition to Shutdown.

When this error is displayed, turn OFF the main switch.

1158 Error: Ion gauge meter reading out of normal range (5E-6 to 1E-0Pa)

The vacuum pressure value from the Ion gauge is not within the range of specified values (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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.

1159 Error: Can not turn on Ion gauge, backing pressure is too high.

The reading value on the Pirani gauge is not within the usage range for the Ion gauge.

1160 Error: HV for Ion gauge is out of range (Shutdown -> Standby).

The Ion gauge driver for the Connection PCA reads that 180V High-voltage is not supplied from the HV driver module, and the Main PCA determines that 180V high-voltage is not being supplied (When the instrument is changing from Shutdown mode to Standby mode).

This error is displayed for more than 210V or less than 150V.

1161 Error: Current of Ion gauge is out of the range (Shutdown -> Standby).

There is no flow of emission current. The Ion gauge driver of the Connection PCA monitors the current, and the Main PCA determines the current (When the instrument is changing from Shutdown mode to Standby mode).

This error is displayed at more than 8 μ A or less than 3 μ A during regular operation and at 280 μ A or at 120 μ A or lower during high-sensitivity operation.

1162 Error: HV for Ion gauge is out of range (Standby -> Analysis).

The Ion gauge driver for the Connection PCA reads that 180V High-voltage is not supplied from the HV driver module, and the Main PCA determines that 180V High-voltage is not being supplied (When the instrument is changing from Standby mode to Analysis mode).

This error is displayed for more than 210V or less than 150V.

1163 Error: Current of Ion gauge is out of the range (Standby -> Analysis).

There is no flow of emission current. The Ion gauge driver of the Connection PCA monitors the current, and the Main PCA determines the current (When the instrument is changing from Standby mode to Analysis mode).

This error is displayed at more than 8 μ A or less than 3 μ A during regular operation and at 280 μ A or at 120 μ A or lower during high-sensitivity operation.

1164 Error: HV for Ion gauge is out of range (Analysis -> Standby).

The Ion gauge driver for the Connection PCA reads that 180V High-voltage is not supplied from the HV driver module, and the Main PCA determines that 180V High-voltage is not being supplied (When the instrument is changing from Analysis mode to Standby mode).

This error is displayed for more than 210V or less than 150V.

1165 Error: Current of Ion gauge is out of the range (Analysis -> Standby).

There is no flow of emission current. The Ion gauge driver of the Connection PCA monitors the current, and the Main PCA determines the current (When the instrument is changing from Analysis mode to Standby mode).

This error is displayed at more than 8 μ A or less than 3 μ A during regular operation and at 280 μ A or at 120 μ A or lower during high-sensitivity operation.

1166 Error: HV for Ion gauge is out of range (Standby).

The Ion gauge driver for the Connection PCA reads that 180V High-voltage is not supplied from the HV driver module, and the Main PCA determines that 180V High-voltage is not being supplied (In Standby mode).

This error is displayed for more than 210V or less than 150V.

1167 Error: Current of Ion gauge is out of the range (Standby).

There is no flow of emission current. The Ion gauge driver of the Connection PCA monitors the current, and the Main PCA determines the current (In Shutdown mode).

This error is displayed at more than 8 μ A or less than 3 μ A during regular operation and at 280 μ A or at 120 μ A or lower during high-sensitivity operation.

1168 Error: HV for Ion gauge is out of range (Analysis).

The Ion gauge driver for the Connection PCA reads that 180V High-voltage is not supplied from the HV driver module, and the Main PCA determines that 180V High-voltage is not being supplied (In Analysis mode).

This error is displayed for more than 210V or less than 150V.

1169 Error: Current of Ion gauge is out of the range (Analysis).

There is no flow of emission current. The Ion gauge driver of the Connection PCA monitors the current, and the Main PCA determines the current (In Analysis mode).

This error is displayed at more than 8 μ A or less than 3 μ A during regular operation and at 280 μ A or at 120 μ A or lower during high-sensitivity operation.

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.

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.

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.
- 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.

1205 Error: Turbo is not slowing during purge cycle.

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.

1206 Error: Turbo is not slowing after 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.

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 gasket).
- The plasma is too far from the sampling cone.
- The power of the foreline pump is not connected or the breaker is OFF.

- The foreline pump oil level is low or the oil is dirty.
- A drop of water was introduced into the vacuum chamber.

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.

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.

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.

1212 Error: RF48V power voltage is too high.

The voltage of RF 48V exceeds the limit.

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.

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.

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.

- 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.

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.

- The installation of the torch, bonnet, and shield plate is faulty.

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/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.

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.

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 cover is opened in Analysis mode.
- The plasma is turned off suddenly.

1226 Error: RF amp fan malfunction.

The number of revolutions of the Plasma RF generator cooling fan went below the limit.

1300 Error: QP fan malfunction

The number of revolutions of the QP driver unit cooling fan went below the limit.

1301 Error: QP control (Feedback circuit) malfunction.

The V voltage of the QP cannot be controlled.

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.

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.

1304 Error: -720V power supply voltage is too low.

The voltage of the DC/DC converter (-720V) of the QP driver unit went below the limit.

1305 Error: -720V power supply voltage is too high.

The voltage of the DC/DC converter (-720V) of the QP driver unit exceeds the limit.

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.

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.

1308 Error: Octopole drain current Error.

The output of the Octopole drain current is abnormal.

1309 Error: Octopole control malfunction.

The RF voltage of the Octopole cannot be controlled.

The following causes are inferred.

- Octopole rod or reaction cell-related wiring (including the vacuum chamber) causes a short in other metallic parts.
- Octopole Matching frequency is not appropriate.

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.

1411 Error: Torch position Y-axis limit SW malfunction.

The Y-axis limit switch 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.

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.

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.

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.

1425 Error: DC power supply malfunction. Check for air flow restrictions at the rear of the instrument.

Upon conducting a self-diagnosis, the DC power supply detected an abnormality and the internal temperature increased abnormally.

Turn the main switch OFF, and restart after waiting for awhile. If an error is displayed again, replace the DC power supply.

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.

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.

1433 Error: 24V power supply malfunction.

The 24V power supply malfunction.

1434 Error: QP 48V power supply malfunction.

The QP 48V power supply malfunction.

1435 Error: Plasma RF 48V power supply malfunction.

The Plasma RF 48V power supply malfunction.

1436 Error: 75V power supply malfunction.

The 75V power supply malfunction.

1438 Error: Replace ORS AMFC assy. The valve for H₂ gas in the AMFC assy is not closing completely.

There is a gas leak from the H₂ gas system. Switch to Standby mode, close the H₂ gas valve, and confirm the flow rate to make sure that gas is flowing at a rate of at least 0.35mL/min.

Check for leaks from the gas piping system. The following causes are inferred.

- Leak from the connection sections of the gas piping.
- Deterioration or damage of the gas pipe or hose.

1439 Error: Replace ORS AMFC assy. The valve for option gas (NH₃) in the AMFC assy is not closing completely.

There is a gas leak from the Option gas system. Switch to Standby mode, close the Option gas valve, and confirm the flow rate to make sure that gas is flowing at a rate of at least 0.35mL/min.

Check for leaks from the gas piping system. The following causes are inferred.

- Leak from the connection sections of the gas piping.
- Deterioration and damage of the gas pipe or hose.

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.

1442 Error: Spray chamber temperature (L) is too low.

The temperature of the spray chamber (L) is below the limit.

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.

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 disconnection.

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 disconnection.

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 disconnected).

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.

1456 Error: Ar gas controller (AMFC) malfunction.

Error from Argon gas controller during calibration check of instrument.

1457 Error: AMFC operating parameters are out of range. Replace AMFC.

When the default adjusted values for the ORS controller are read by the Main PCA, there is an abnormality in the adjusted values (e.g. extreme values such as 000 and FFF).

1458 Error: QP BD operating parameters are out of range. Replace QP BD.

When the default adjusted values for the QP driver PCAs are read by the Main PCA, there is an abnormality in the adjusted values (e.g. extreme values such as 000 and FFF).

1518 Error: Main Board controller communication Error.

The communication between the boards cannot be performed properly.

1519 Error: XYZ MN Board controller communication Error.

The communication between the boards cannot be performed properly.

1520 Error: Introduction Board controller communication Error.

The communication between the boards cannot be performed properly.

1521 Error: System I/O Board controller communication Error.

The communication between the boards cannot be performed properly.

1522 Error: QP Driver Board controller communication Error.

The communication between the boards cannot be performed properly.

1523 Error: RF Driver Board controller communication Error.

The communication between the boards cannot be performed properly.

1524 Error: HV Driver Board controller communication Error.

The communication between the boards cannot be performed properly.

1525 Error: OctP Driver Board controller communication Error.

The communication between the boards cannot be performed properly.

1526 Error: ORS Cell Board controller communication Error.

The communication between the boards cannot be performed properly.

Alarm Messages

The following alarm messages can appear in the MassHunter Workstation green message bar when you operate the Agilent 7700. When an alarm message is displayed, the instrument runs a safety sequence.

CAUTION

With regard to the alarm numbers and the causes behind the alarm messages, only those that the customer can clear are listed.

Depending on the alarm message, there are some where the cause is associated with repairs. For alarm messages that you cannot clear, please contact Agilent Technologies.

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: 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 foreline pump oil level is low or the oil is dirty.
- 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 gasket).
- The plasma is too far from the sampling cone.
- The power of the foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.
- 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.
- The cell 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 foreline pump is not connected or the breaker is OFF.
- The foreline pump oil level is low or the oil is dirty.
- 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.

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.

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 RF coil is abnormal.

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 disconnection.

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 disconnection.

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 disconnection.

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 disconnection.

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 disconnection.

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.

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.

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.

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.

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 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.
 - a** Check to make sure that the peristaltic pump has been adjusted properly. Refer to [“Peristaltic Pump Tubing”](#) in this manual.
 - b** Check to make sure that the nebulizer is not clogged. See the “Nebulizer Test” section in the *MassHunter Workstation Online Help*.
 - c** Check to make sure that there is no leak at the tube connector or sample line connector.
- 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”](#) in this manual.
- Check the lens. See the “Ion Lens Test” section in the *MassHunter Workstation Online Help*.

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.
- Set the tuning parameter as they were when the sensitivity was normal; then re-check the sensitivity.



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Appendix A. Technical Information

Peristaltic Pump and Tubing

The standard peristaltic pump of the Agilent 7700 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, 1.02mm i.d.)
- PharMed for the drain (yellow/blue, 1.52mm i.d.)
- Tygon for the internal standard (orange-blue, 0.25mm 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 100ppt 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 0.1rps peristaltic pump speed is about 0.4mL/min with 1.02mm i.d. tubing. The sample uptake rate linearly increases as a function of the peristaltic pump speed up to 0.5rps; 2.0mL/min is the maximum sample uptake rate. 0.1rps is recommended as the standard peristaltic pump speed, and 0.5rps 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 0.5mm. A tube smaller than 0.5mm 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/blue Tygon tubing (0.25mm i.d.) is used for the internal standard solution. The sample uptake rate at 0.1rps is about 40 μ L/min. When the internal standard solution is added to the sample by the peristaltic pump, the concentration of the internal standard is diluted about 10 times. Therefore, a 1ppm internal standard solution in 5% (v/v) HNO₃ is recommended.

NOTE

The orange/blue tube (0.25mm i.d.) is very soft and easily stretched. This sometimes causes a 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 0.1rps. If the higher pump speed is not used, it takes about 2 minutes for sample exchange at 0.1rps.

When the internal standard is added to a sample by means of the peristaltic pump, the maximum peristaltic pump speed should be 0.3rps. When this fast pump speed is applied in order to reduce sample exchange time, a longer stabilization time is required. Use 0.3rps fast pump for 50 sec and 50 sec stabilization time.

When orange/blue Tygon tubing (0.25mm 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 (1.02mm 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. 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.

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 7700. The Agilent 7700 spray chamber is available in the following materials:

- Quartz (QZ)
- 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

The quartz 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 quartz spray chamber in a 5% NH_4OH (v/v) solution for 2 hours prior to use, followed by washing with pure water.

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 7700 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 15L/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 1L/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 7700, the standard torch is a one-piece design and is made of quartz. The inner diameter of the injector is 2.5mm. 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 1.2L/min for $\phi 2.5\text{mm}$ and about 1L/min for $\phi 2.0\text{mm}$, 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 $\phi 1.0\text{mm}$ and that of the skimmer cone is $\phi 0.4\text{mm}$. 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 (18mm) 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.

ORS

The ORS is an octopole ion guide contained within a stainless steel vessel and pressurized with a gas, most often H_2 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.

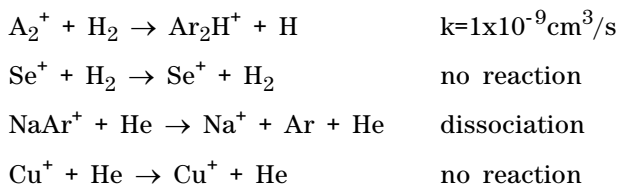
Why the octopole ion guide?

The octopole ion guide is driven by a voltage of fixed amplitude and frequency in order to assure stable signals. The frequency of 10MHz 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 means 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 Software. Due to the 'MultiTune' capability of MassHunter Workstation, cell gases can also be automatically switched during the analysis.

Q-pole

The Q-pole of the Agilent 7700 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 3MHz of RF voltage (V) and DC voltage (U) are supplied ([Figure 61](#)). When the highest mass 260 is analyzed, 559V of DC voltage and 3,338V of RF voltage are supplied. The maximum voltage is $\pm 3,897V$.

In addition, the pole bias (PB) is supplied to the Q-pole. When the pole bias is at 0V, this is the ground level, if the pole bias is used at +2V, 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 +5V 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 +5V 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 -10V is acceptable.

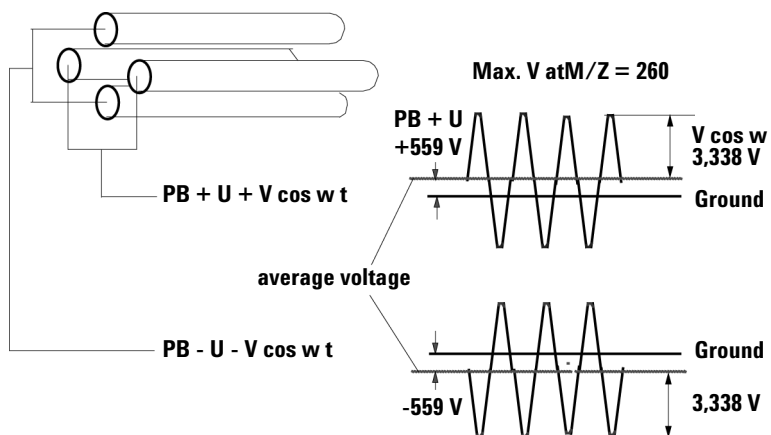


Figure 61 Q-pole Mass Filter

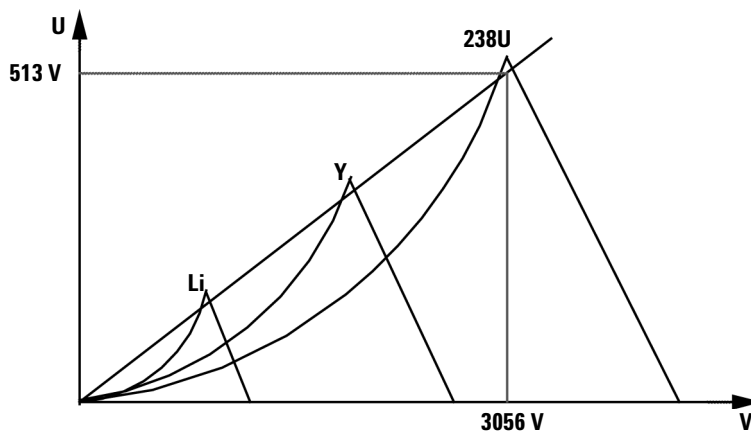


Figure 62 Scan Line of Q-pole Mass Filter

The scan line of a Q-pole is represented in [Figure 62](#). 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 7700 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 63](#)).

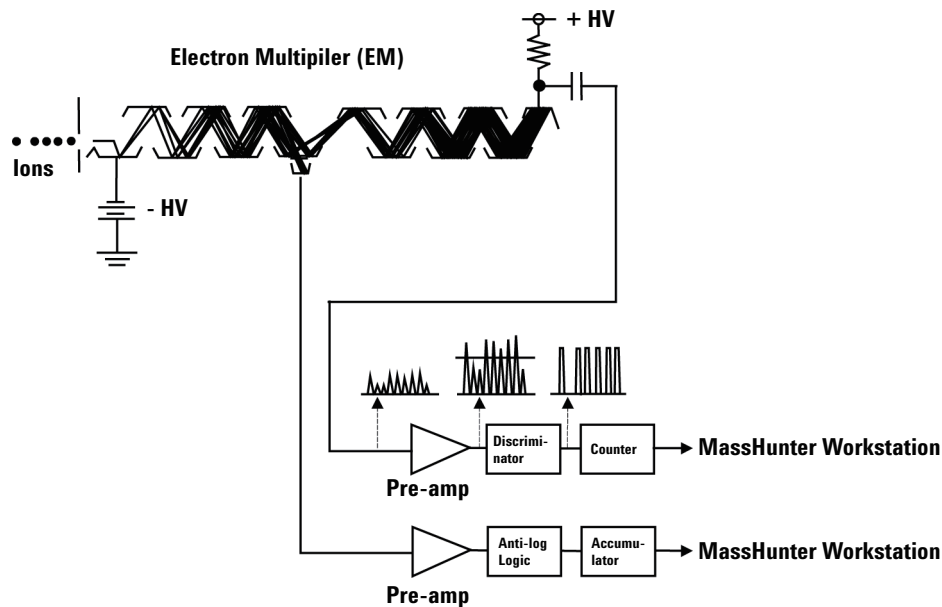
When the concentration of ions is too high, ions will not be measured separately and result in only one pulse count. In general, this phenomenon becomes more critical when the number of ions is greater than several million counts/sec (cps). When the number of ions is high, the electrical current at the 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 63). 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 exceed 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 3300V or the Pulse HV reaches about 1800V after adjusting the EM voltage.



7700_0109

Figure 63 Ion Detection System

APG remote interface

The following functions are available on the Agilent 7700 MassHunter Workstation APG remote interface.

- Inform the current instrument mode (Standby or Analysis mode)
- Setting the instrument to the Standby mode
- Starting data acquisition

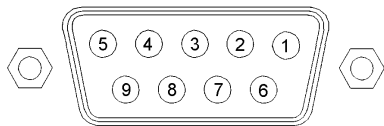


Figure 64 APG Remote Connector

Table 2 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 B. 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.

CAUTION

Set the Option Mass Flow tank Pressure at 10-100kPa.

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.

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 0.3rps.
- 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 the 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.

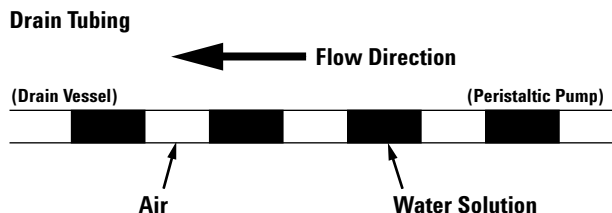


Figure 65

- 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 in the kit on the front panel.

Table 3 Organic solvents having confirmed methods for the Agilent 7700 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 700mm

Appendix C. Inert Sample Introduction Kit Installation Instructions

Please read this document carefully prior to installation.

This document explains the installation of the Inert Sample Introduction Kit. Improper installation of the kit may cause damage to the parts. Be sure to wear appropriate gloves during installation.

Table 4 Kit Parts List

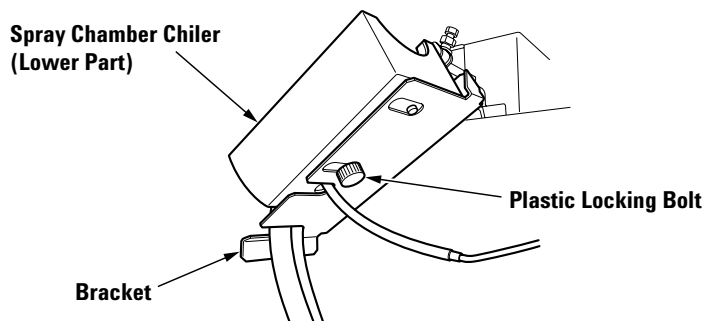
Item	Q'ty
End Cap and Spray Chamber Assy	1
Drain Tube Assy	1
Connector Tube	1
Injector Assy (With O-ring)	1
Torch	1

1 First, turn power off and then remove the following parts from the instrument.

- Connector tube clips and connector tube
- Torch
- Spray chamber and the connected tubes
- Spray chamber chiller (upper and lower parts) and connector
- Bracket (if change of bracket is necessary, see 2 below)

NOTE

There is a plastic screw-in locking bolt on the underside of the spray chamber chiller which fixes the spray chamber chiller (lower part) to the bracket. Remove this locking bolt.



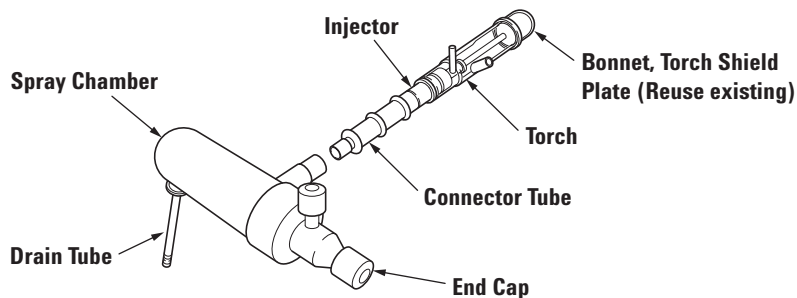
7700_0219

Figure 66

- 2 Assemble the parts as shown in the following figures. Please fit the parts together with care, but firmly.

NOTE

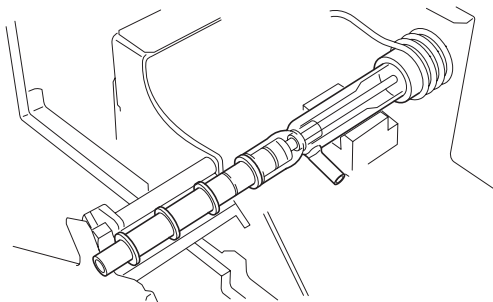
Continue to use the existing torch shield plate and bonnet.



7700_0217

Figure 67

- 3 When the torch, injector and connector tube are assembled, install in the instrument.



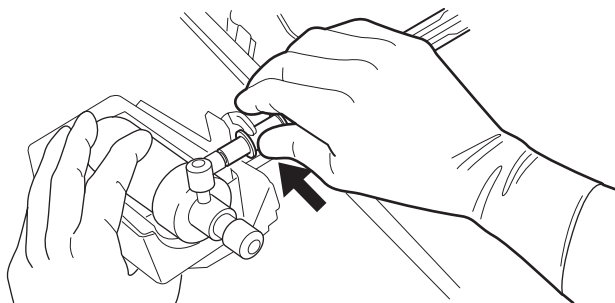
7700_0218

Figure 68

4 Install the lower part of the spray chamber chiller and the spray chamber.

NOTE

On installing the spray chamber, connect to the injector while gently but firmly holding the connector tube against the connector tube guide. Be careful as any pressure applied on the torch could cause breakage.

**Figure 69**

5 Connect the chilled water hose and reattach the plastic locking bolt.

6 Connect the plasma gas and auxiliary gas tubing to the torch.

NOTE

When the DILUTION / OPTION GAS is not used, remove the tubing from the instrument.

7 Install the upper part of the spray chamber chiller and connect the makeup gas tubing and drain tubing. Install the nebulizer and connect the sample tubing and carrier gas tubing.

8 Installation is now complete. Please note the following:

NOTE

For removal of the inert kit, please simply follow the reverse procedure. PFA parts only (not torch parts) can be washed in a solution of 5% nitric acid and 5% hydrofluoric acid by soaking for 8 hours.

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In This Book

The Agilent 7700 Series

ICP-MS Hardware

Maintenance Manual

provides an instrument
overview, safety precautions
and procedures for
optimization, maintenance
and troubleshooting.

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