Overview

The MAX300™-LG process mass spectrometer is a versatile real-time process analyzer capable of fully automatic operation. The MAX300™-LG and components are shipped in an appropriate crate to ensure no damage during shipment. When the instrument arrives, inventory of all equipment should be taken and any damage or discrepancies reported both to the freight carrier and Extrel CMS. If no damage is evident, the customer should prepare the instrument for start up via utility and communication connections discussed in this manual. The customer then assumes responsibility for any shipping damage. Obvious physical damage found at installation could void the warranty. As Extrel CMS does not generally inspect a site prior to installation, it is extremely important to provide the necessary support for the instrument to avoid significant delays. If a contract with Extrel CMS is purchased, a service representative may travel onsite to perform a five day installation. All utility and environmental requirements discussed must be fulfilled prior to the representative's arrival.

MAX300™-LG Description

MAX300™-LG has been designed for quantitative analysis of gases and vapors having molecular weights in the range of 2 to 300 amu. At the heart of the MAX300™-LG is a quadrupole mass spectrometer that can monitor any practical number of components in a sample stream. Streams are introduced into the analyzer through an inlet system that is under control of the data system. The MAX300™-LG major sub systems include the mass spectrometer hardware, electronic components to operate the spectrometer, vacuum pumps, heaters, sample inlet valves, a control computer and (optional) communication modules. Stream sampling valves are mounted on the front of the enclosure.

The MAX300™-LG can be connected to the local area network (LAN) and be accessed by any PC (client) with access to the LAN. Network access provides all the functions needed for normal instrument operation. Access is implemented by a web browser interface with no specialized software required to be installed on the client PC. Access is password protected and logged for security. Data can be stored in the control computer and sent to external devices via several communication options.

MAX300™-LG Specifications

Instrument

- Dimensions (in/cm) 23.5/59.7 H x 26.5/67.3 W x 19/48.3 D
- Weight ~165 lb (75 Kg)
- Ambient Temperature 55º F to 80º F (13°C to 27°C)

Quadrupole Mass Analyzer

• Type	Quadrupole
• Rod Size	3/4 inch (19mm)
• Operating Frequency	1.0MHz
• Power Level	200 watt
• Mass Range	2-250 amu
• Scan Speed	1 to 200 amu/sec
• Acquisition Modes	Scanning, full profile, selected ion monitoring (SIM)
• Maximum SIM Ions	(No practical limit)

Ion Generation

• Type	Electron impact ionization
• Filament	Tungsten or Yttrium Oxide coated Iridium (standard) Others on special request
• Ion Polarity	Positive

Ion Detector

• Type	Faraday or Faraday-Multiplier (optional)
• Multiplier Type	Continuous dynode
• Multiplier Operating Voltage	0 to 3000 V

Vacuum Chamber (Quadrupole Housing)

• Type	Single high vacuum pump chamber
• Primary Vacuum Pump	60 liter/second turbomolecular pump
• Secondary Vacuum Pump	1.4 CFM rotary vane pump
• Pressure Monitoring	Ion gauge (optional)

Electronics

- Extrel 5221 Card Cage and Control Modules

Control Computer

• Instrumentation Control PC with Questor5	Windows7 Pro or Windows10 Pro Desktop/Laptop software installed.

Minimum PC Requirements:

2 GHz or above CPU

2 GB or above RAM

50 GB free Hard Disk space

RS232 Serial Port for Valve Actuator (Or a USB 2.0 port with a USB to Serial converter)

A USB 2.0 or above port (Or an Ethernet port) for instrument communication.

MAX300™-LG Performance Specifications

- Mass Range — 2-250 amu
- Detectable Components — Gases or vapors with molecular weights or ions within the mass range of the instrument.
- Number of Components — (No Practical Limit)
- Upper Detection Limit — 100%
- Lower Detection Limit — 10 parts per million (ppm) with a Faraday Detector. 10 parts per billion (ppb) with an electron multiplier.
- Dynamic Range — 10^5 with a Faraday detector. Approximately 10^8 with a dual Faraday/multiplier detector.
- Stability — Better than 0.25% of component's concentration (no interference). Example: 2% CO_2 will vary from 1.995% to 2.005%.
- Analysis Repetition Rate — The average time required for analysis is 400 milliseconds per component
- Scan Mode — MAX300-LG is capable of scanning the entire mass range

MAX300™-LG Environment and Electrical Specifications

- Ambient Temperature Range — 55°F to 80° F; 13°C to 27°C
- Relative Humidity Range — 0-90 % (Non Condensing)

- Heat Dissipation 670 Watts (Mass Spec Only)
- Electrical Supply Power: (Mass Spec Only) 6.1 Amps at110 VAC 3.0 amps at 220 VAC

MAX300™-LG Mechanical Descriptions

Instrument Housing

The MAX300™-LG may be located in a laboratory or office type environment. The exhaust from the vacuum pumps may contain potentially hazardous or toxic substances and must be vented in a safe manner. Electrical power and signal wiring to the instrument must be consistent with conditions and meet all applicable local building codes. The MAX300™-LG is intended for "bench top" operation.

Mass Spectrometer Hardware

The analyzer section of the system is a quadrupole mass spectrometer. This device performs the ionization, mass filtering, and detection of the specified components. For proper operation the system must be kept under vacuum. The mass spectrometer portion of the MAX300™-LG can be accessed by removing the covers from the enclosure.

The instrument cover has two removable panels for user performed maintenance. To remove the top front cover, pull straight up to disengage the spring loaded latches. Once the top cover is removed, the right front cover may be pulled to the right to disengage its latches. If needed the rear cover can be detached after removing the 4 screws on the back of the instrument that hold it in place.

After removing the covers of the enclosure the internal mechanical assemblies can be accessed. The AC switch is located at the bottom left of the enclosure. The mass spectrometer's vacuum system is contained within the enclosure on a rotateable mounting system for easy maintenance. The enclosure contains the vacuum pumps (both mechanical and turbomolecular), quadrupole controller (QC), ionizer, mass filter, and detector(s).

Vacuum Chamber

The vacuum chamber has five all metal sealed high vacuum ports to connect components to the chamber. The ionizer assembly, detector and turbomolecular pump use 4 1/2inch flanges to connect to the chamber. The RF (electrical) connection for the quadrupole is a 3-3/8 inch flange on the top of the chamber. A port for the vacuum gauge is on the chamber side, in line with the turbo pump. To ensure proper operation, maintenance of the mass spectrometer hardware is required.

Vacuum Pumps

To maintain a high level of vacuum within the chamber, a Pfeiffer Duo 2.5 mechanical pump and a Pfeiffer TMU 071 turbo pump are used. The turbo pump is connected directly to the vacuum chamber, while a mechanical (roughing; fore) pump is connected to the turbo pump. The standard system is provided with a 60 L/s (N_2) turbo pump and a 1.4 CFM rotary vane pump. Figure 1 shows the location of these components.

Note: Pump vendor and/or specifications are subject to change without notice.

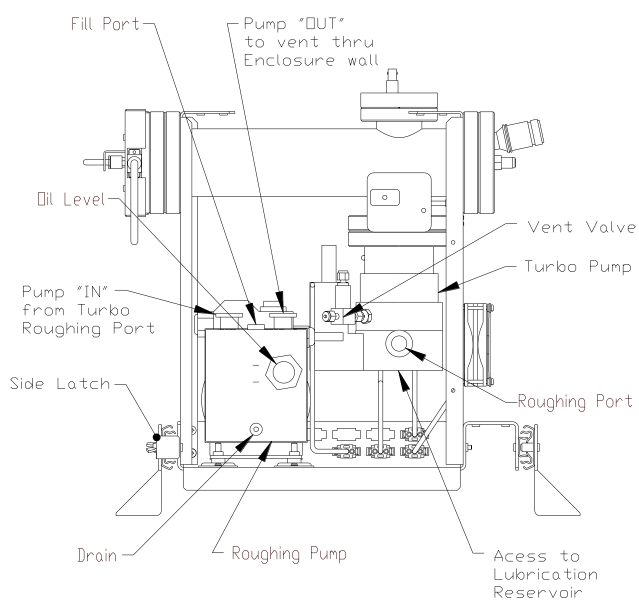


Figure 1: Pump Configuration

Note: Pump oil is considered a hazardous material and requires proper disposal procedures that conform to local regulations.

Optional Vacuum Gauge

An ionization pressure gauge is installed above the turbo pump. This device allows the user to monitor the pressure in the ionizer region of the vacuum chamber through the control computer software. The ionization type vacuum gauge requires no regular maintenance. It has a spare filament built in that is selectable with a switch labeled *Filament Select*. When both filaments have burned out the gauge must be replaced.

Analyzer Assembly

Contained within the vacuum chamber is the actual chamber assembly. This assembly consists of the ionizer, quadrupole mass filter, and detector, as in Figure 2.

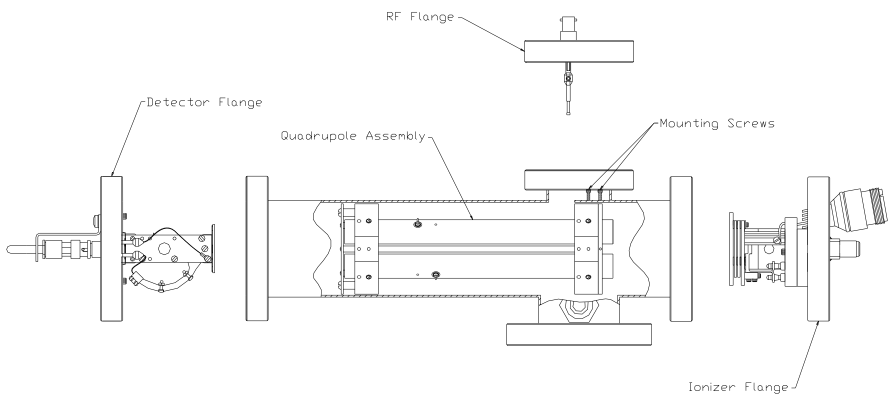


Figure 2: Analyzer Assembly

Ionizer and Filaments

The MAX300™-LG ionizer assembly, depicted in Figure 3, includes the most frequently serviced components of the ionizer into a single removable module. This module includes two filaments, the ion region and the lens stack.

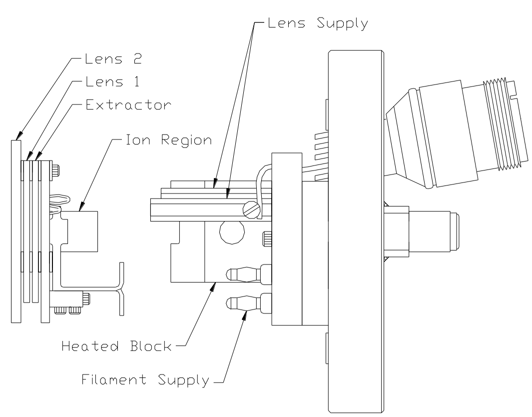


Figure 3: Ionizer

The ionizer assembly used in the MAX300™-LG has been designed for easy installation and servicing. Figure 4 below depicts the ionizer assembly mounted on the flange.

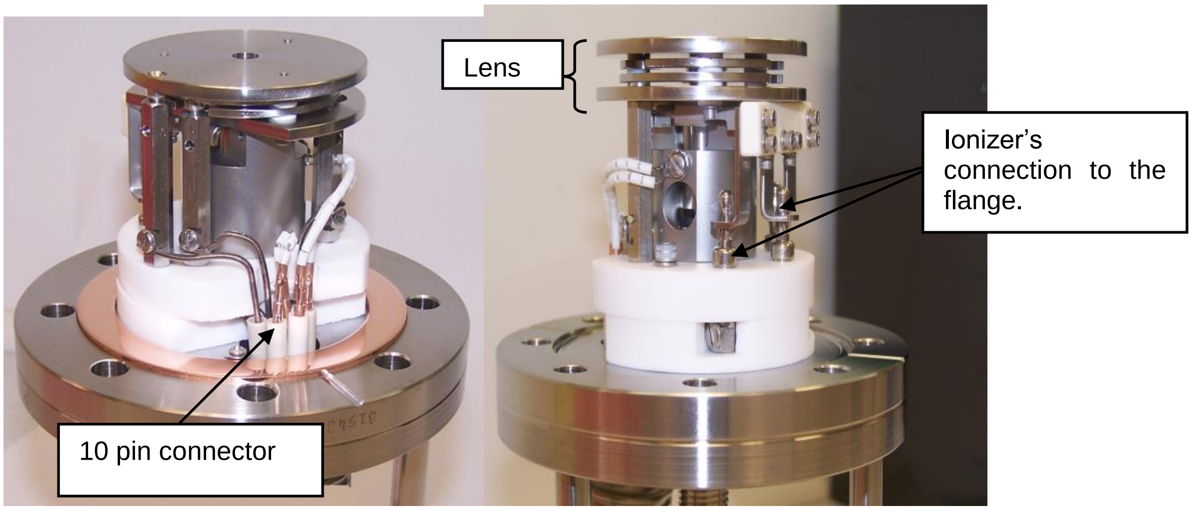


Figure 4: Ionizer Assembly Mounted on Flange

Tungsten or Yittra coated Iridium are available as the filament material. Two filaments are present in the assembly, located on each side of the ion volume. Only one filament is used at a time. When Filament 1 has reached the end of its useful life, Filament 2 will automatically be put into effect. However, the system will NOT transition automatically from Filament 2 to Filament 1. If both filaments have burned out, the entire ionizer assembly must be replaced.

Note: Because the ionizer may be hot, caution should be taken when removing the ionizer assembly from the vacuum chamber.

Quadrupole Mass Filter

The mass filtering device used in the MAX300™-LG is a quadrupole. This component is located directly behind the ionizer and utilizes the vacuum chamber as both its enclosure and mounting structure. The quadrupole is comprised of four 3/4in (19mm) stainless steel rods and provides a mass range of 2 to 300 amu.

Detector

Two different detector options are offered. The standard detector is the faraday plate. This component, located directly after the quadrupole, collects the signal of the ions. An optional electron multiplier detector assembly is available for increased dynamic range. It is recommended that the standard faraday detector be wiped off occasionally, especially for dirty applications.

Remaining Components in the Enclosure

In addition to the vacuum system components, the controlling electronics are also mounted in the enclosure, including the Quadrupole Controller (QC), the preamplifier and the card cage with its modules.

Sample Stream Inlet Hardware

The pressure reduction system is necessary to adjust the incoming sample stream to conditions suitable for introduction into the mass spectrometer. This involves reducing the sample stream pressure to an acceptable level.

Inlet Valves

The sample selection valve, the heated transfer line, and the inlet assembly deliver the sample stream to the instrument for analysis. The sample selection valve is used to select the sample stream to be analyzed while the transfer line connects the output of the desired stream to the pressure reduction system and the inlet assembly. The tee of the inlet is used to remove excess sample and decrease inlet clearing time. A small portion of the sample stream flows through the heated transfer line, into the inlet, and is admitted into the mass spectrometer. A flow switch (50 cc/min) is used to monitor for loss of sample flow at all times.

The transfer line, tee and inlet assembly can be heated to prevent condensation of stream components as the sample is transported into the mass spectrometer. The transfer line can heat the tubing from room temperature to 300°C. A heater located around the inlet heats the assembly.

The inlet requires no regular maintenance. The size of the fused silica inlet restrictor is dependent on the application. Particulates in the sample stream may clog the assembly and force it to be changed.

Inlet Heaters

The transfer line, the first tee, the restrictor tubing, the inlet tee and the Quick Inlet Assembly are heated. This is to prevent condensation of stream components as the sample stream is transported into the mass spectrometer.

The transfer line heats the tubing to approximately 300 degrees Celsius under typical operating conditions. A heater located around the Quick Inlet is used to heat the inlet assembly.

MAX300™-LG Installation Guide

Site Requirements

Environmental Requirements

The standard start-up requirements for the MAX300™-LG instrument are listed below. Meeting these requirements is the customer's responsibility. Failure to meet these requirements will void any and all warranties. Sufficient room for cooling ventilation, gas connections, vent connections, controlling computer and operator workspace should also be allowed for.

Utility Requirements

Power Requirements: The MAX300™-LG can be configured to use 110 or 220 VAC 50/60 Hz. If the control computer is supplied by Extrel CMS, it will be capable of using 110 or 220 VAC. The power consumption of the instrument (not including the control computer) is 6.1 Amps at 110 VAC and 3.0 Amps at 220 VAC. It is recommended that the instrument be connected to a dedicated circuit.

Control computer power consumption is approximately 4 Amps at 110 VAC and 2 Amps at 220 VAC.

Electrical Power Connection: The power cord enters the instrument via an IEC power cord at the rear of the instrument. If the operating voltage must be changed, be sure the new cord will support the voltage and current required.

Changing the Operating Voltage: The operating voltage of the basic MAX300-LG can be changed in the field by the user. To accomplish this, the power cord and fuse must be changed. Additionally, the user must manually switch the rough pump operating voltage by moving the switch on the right side of the pump's power input box to the appropriate setting.

NOTE: Other configurations, especially custom inlets, may require more extensive changes to use another voltage.

Control Computer Specifications

The MAX300™-LG is controlled by Questor5 software running on a Windows PC (Desktop or Laptop):

Operating System: Windows7 Pro or Windows10 Pro, 32bit or 64bit.

Memory: 2 GB (4 GB Recommended)

CPU: 1.7 GHz (Minimum)

Display: 1024 x 768 x 16 colors (Minimum)

Communications: (1) RS-232 serial port OR (1) USB 2.0 or above port with USB to Serial Converter (Valve Control)

(Note: External communications options may require additional Serial/USB ports)

(1) USB port OR Ethernet port (Required for communication with the instrument)

Hard Disk Space: The software itself will occupy about a 350 MB of disk space. However, the databases that store the operating parameters and data can grow quite large.

30 GB of free disk space may be considered the minimum for a functional system.

Note: Extrel recommends that a control PC supplied by the user be dedicated to this purpose and not be used for other tasks.

Installing the Software

If a control computer has been purchased from Extrel, the software will be pre-installed and configured.

Please review the system requirements before attempting to install the software.

The installation media (Thumb drive / CD ROM) supplied with the MAX300™-LG contains the software necessary to operate and control the mass spectrometer.

Please follow the Questor5 Software Manual in the Manuals folder of the Thumb drive/CD Rom supplied.

Communications

MAX300-LG communicates with the control PC via either USB or Ethernet, depending on the setup. Details on setting up either is available in the Questor5 Software Manual.

Optional External Communications

The MAX300-LG can use several **external** communications protocols. These communications protocols enable the MAX300™-LG to transmit data to outside controls or data systems. The MAX300™-LG can transmit instrument parameters, alarms and derived (calculated) values. In addition the MAX300™-LG can **receive** data from outside sources that can be incorporated into derived value tags or alarm tags to yield a final result that is more informative than the mass spectrometer data alone.

OPC

OPC stands for Object Linking and Embedding [*O*LE] for *P*rocess *C*ontrol. Support for OLE is built into the Windows® and Macintosh® operating systems. OPC treats data as collections of objects to be shared by applications supporting the OLE specification. OPC provides extensions to OLE to support process control data sharing. The MAX300™-LG's implementation of OPC communication option, an OPC server**,** is accessed on the local network via the instrument's Ethernet port.

Questor I/O

The native Questor I/O communications protocol is built into the MAX300-LG software and hardware. This communications protocol gives direct access to the digital I/O and analog inputs on the baseboard module at J-41. The digital channels will accept TTL level signals. Physical access to this communication channel is via connections on the rear of the instrument

Questor Modbus

The Modbus protocol, developed by Modicon Corporation, is a communication protocol for the software. The MAX300™-LG is capable of acting as Master and/or Slave type of device on any available serial port on the embedded server. If the Modbus TCP/IP option is purchased, the Modbus communication will be carried out through the same Ethernet connections as used for the LAN connection to the server PC. By using Modbus, data generated by the mass spectrometer are available to external control or data logging systems within seconds. Physical access to this communication channel is via an external chassis that connects to the controlling PC.

Varieties of Modbus communications

The MAX300™-LG can be equipped with a Modbus Master fieldbus I/O system capable of accepting a variety of modules that communicate with external devices. Some possible I/O options include:

- **Analog Inputs:** 4-20 mA
- **Analog Outputs:** 4-20mA
- **Digital Inputs:** 24VDC
- **Relay Outputs:** Contact ratings vary with the module installed

4-20 mA

The 4-20mA communications option is used to send or receive data over a loop of wire where the current in the loop is proportional to the signal being transmitted. This mode of communications is most often used over long distances, in an environment that might otherwise induce electrical noise in the cable. Data is scaled so 4 mA represents zero and 20 mA represents full scale. The MAX300™-LG software is capable of using this method to transmit data and instrument parameters to external monitors or controllers. The software can also use this method to receive parameters or instructions from an external source.

The software is capable of using this method to transmit data and instrument parameters to external monitors or controllers. The software can also use this method to receive parameters or instructions from an external source. Physical access to this communication channel is via an external chassis that connects to the controlling PC.

Digital I/O

The Digital **Output** in the *Digital I/O* communications option controls the state of relays the user can connect to external alarms, monitors, controllers or other devices. The triggers controling these relays can be various types of alarm conditions or instrument parameters. A common relay type is single pole double throw (SPDT) with contacts rated at 125 VAC/30 VDC with a maximum switched current of 5A.

The Digital **Input** in the *Digital I/O* communications provides MAX300™-LG with the ability to monitor digital input signals that conform to the “IEC 61131-2, type 1” specification. A digital “0” is –3 to 5 Volts and a digital “1” is 15 to 30 Volts. The inputs are supplied in individually configurable eight bit blocks. Physical access to this communication channel is via an external chassis that connects to the controlling PC.

Calibration Gases

Calibration gases must be suitable for the process stream. It is recommended that an Extrel CMS application chemist is consulted prior to start-up for help in selecting gas standards. Gas cylinders for housing calibration gases are typically 40-50 L or 1-2 ft^3, 9in diameter, 56in long, and filled to 2000 PSIG. If the vapor pressure of a compound limits the pressure in the cylinder, a larger cylinder may be required to increase the time between replacing them.

In general, three different classes of mixtures are used in calibration. The following are Extrel CMS's recommendations for purity and grade:

1. **Pure gases:** Should be at least 99.999% pure, where the gas contains no more than 10 ppm total impurities. For multiplier applications, the gas should be 99.9999% pure.

2. **Binary mixtures:** These two gas mixtures should be at least 99.999% pure. The accuracy of the reported concentrations is not critical unless the binary is also to be used for sensitivity calibration. This case occurs primarily when a particular component is not stable in the multiblend mixture. As a result, the sensitivity calibration for that component may be done in the binary gas instead.

3. **Multiblend mixtures:** Are intended to simulate the process stream. Consequently, they should be as free of impurities as possible and be certified to at least +/-2% relative.

Regulators

Two stage, high purity, medium flow regulators capable of handling 3000 PSIG inlet pressure (cylinder pressure) should be used. Delivery pressure should be 1-30 PSIG with a flow capacity of 300 scfh. The diaphragm, body and gauges should be stainless steel, with seats and seals of Teflon® or a similar material. The outlet of the regulator should have a shut off valve so flow can be stopped without depressurizing the regulator. Fittings to connect the regulator to the gas cylinder are defined by the gas contained in the cylinder. The gas supplier can advise as to the appropriate "CGA" fitting for various gases.

Calibration Gas Connections

Installation of hardware to connect the calibration gas tanks to the MAX300™-LG is the customers responsibility. The details of the connection may vary somewhat depending on the type of valve option installed, but all installations must perform the same function of getting the calibration gases to the instrument without contamination.

A common configuration is for the MAX300™-LG to be equipped with a Valco rotary valve using 1/16" fittings. For such a configuration each cylinder of calibration gas requires:

- High quality, low outlet pressure, two stage regulator with a stainless steel diaphragm and appropriate CGA fitting. Special regulators are required for particularly corrosive gases.
- 1/16" O.D. x 0.030" I.D. stainless steel tubing. Length as required to connect MAX300™-LG to the gas storage area.
- 1/16" stainless steel "Swagelok" union to connect 0.010" I.D. and 0.030" I.D. stainless steel tubing.
- 1/16" Valco nuts and ferrules (plugged), are supplied with the valve kit.
- Valco in-line filter.

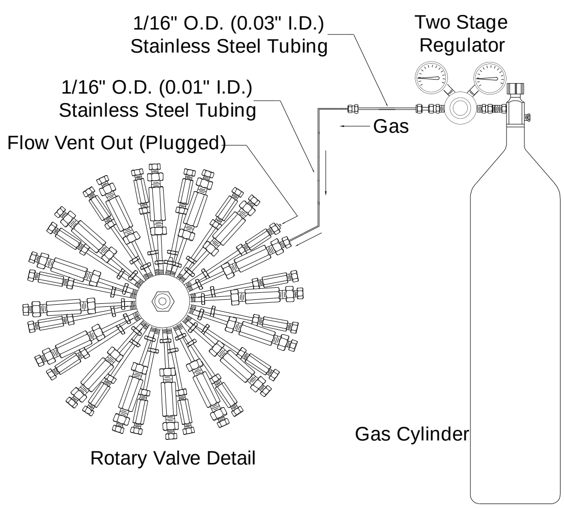


Figure 6: Calibration Gas Connection

Routine Maintenance

To ensure proper operation, maintenance of the mass spectrometer hardware is required.

Venting the Vacuum System

Required Tools

- (1) Flat blade screwdriver, ¼ inch

To perform maintenance on the pumps or components within the vacuum chamber, the system must first be cooled down and vented.

1. With the control software, choose *Control Parameters* under the *Configuration Tab*.

2. To turn off the *Filaments*, *Multiplier* and *Ion Gauge*, remove the check in the boxes next to them.

3. Under *Ionizer*, note the original temperature and set the *Temperature Setpoint* to 0°C.

4. Set the sample inlet valve to a stream not containing condensable components. The zero gas is usually suitable.

5. On the transfer line heater control panel, switch off the transfer line heater.

6. Unplug the heater, which is bolted to the ionizer flange and plugged into a plastic connector directly behind the ionizer, Figure 7.

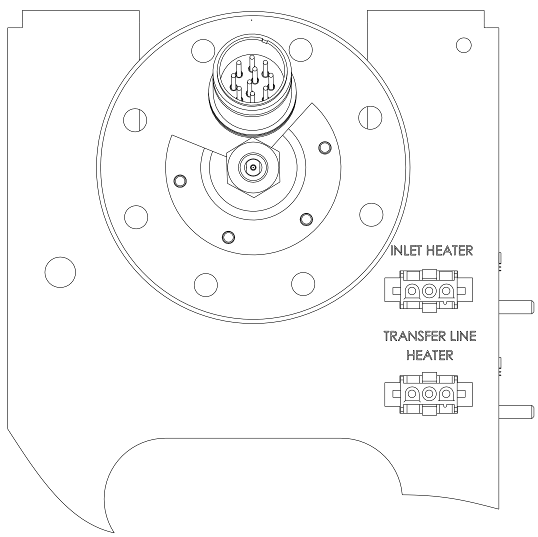


Figure 7: Ionizer Flange

7. Open *Instrument Status* and monitor the ionizer temperature.

8. When the ionizer temperature is below 100°C, remove the electronics power by unchecking the box for *Power* in the *Control Parameters* section of the *Configuration Tab*.

9. Turn off the pumps via the *Vac System & AC* switch visible in Figure 8 below.

10. Turn off the *Heater* switch also visible in Figure 8.

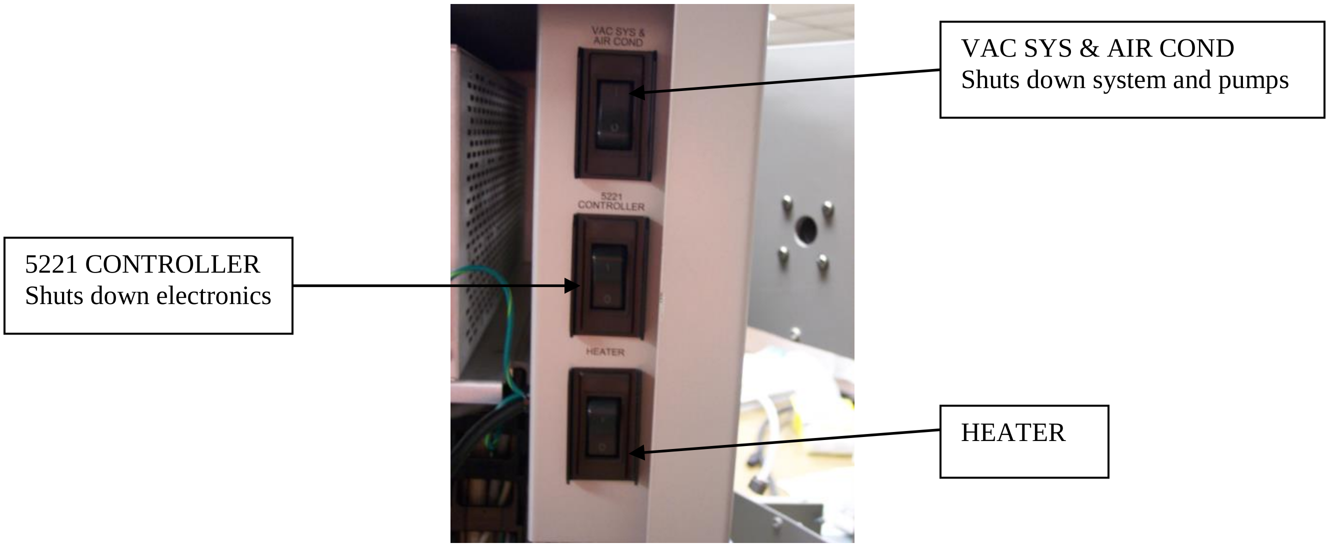


Figure 2: Enclosure Switches

Changing the Roughing Pump Oil

Required Tools

- (1) Oil Catch Pan
- (1) Flat Blade Screwdriver
- (1) 5mm Hex Key (Allen Wrench)
- (~500 ml) Roughing pump oil

Extrel CMS recommends that the oil in the roughing pump for the MAX300™-LG be changed every six months or if the oil is darker than a light amber color. The rate of oil deterioration will vary depending on the application. The first step in this procedure is to vent the vacuum system as described previously.

Both the roughing pump and its oil will be hot (up to 80°C). After venting the system, **disconnect the inlet line from the enclosure wall** and release the slide latch on the left side of the *VacTrac* assembly. Pull the *VacTrac* out of the enclosure far enough to place a catch pan under the drain plug of the roughing pump. The capacity of this pan should be considerably larger than the 450 ml (2 cup) capacity of the pump, shown in Figure 9.

Figure 9: Roughing Pump

Using a 5mm hex key, remove the drain plug on the front of the pump to allow the oil to drain into the catch pan. Loosening the fill plug will speed oil drainage. Once the oil has drained out of the pump, re-install the drain plug and tighten it. Note the color of the oil. If any of the following colors are present, be sure to flush out all of the old oil during the oil change:

1.) Yellow : Pump needs new oil (approximately six months of use)

2.) Dark Yellow : The oil should have been changed a few months ago. If this is the color of the oil in a six month period, there may be a slight leak in the vacuum system. Check periodically to make sure that the oil does not change in color again.

3.) Amber : A pump failure may be imminent. Check the pump oil every month.

Remove the oil fill plug located on top of the pump. Carefully pour new vacuum pump oil (appropriate for the pump and application) through the fill plug opening until the oil level in the site glass window is between the fill lines on the pump housing. Lastly, re-install the fill plug, remove the catch pan and properly dispose of the used pump oil.

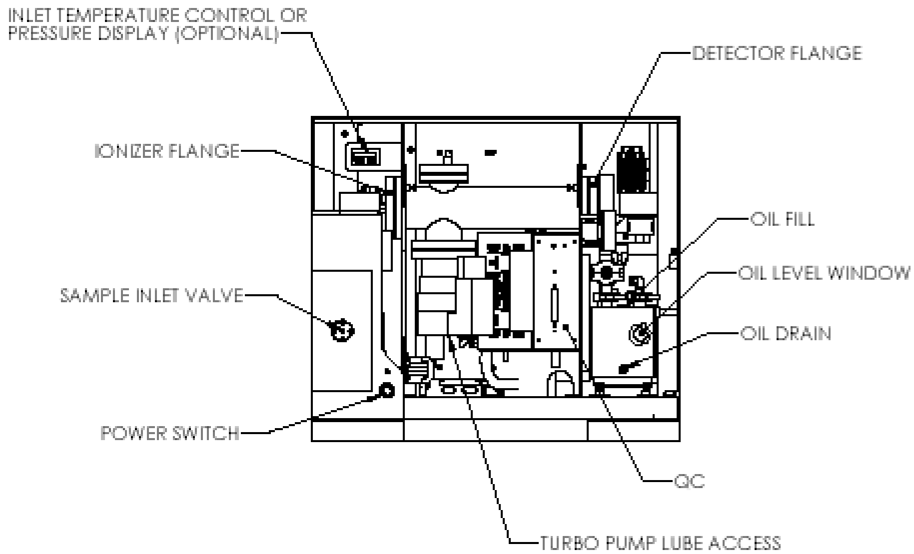


Figure 10:

Changing the Turbo Pump Oil Reservoir

Turbomolecular Vacuum Pump

Required Tools

- (2) Flat Blade Screwdrivers.
- (1) Turbo pump oil wick replacement
- (1)Turbo pump service tool
- (1) Small mirror (optional)

The turbo pump oil should be changed at least every year, as recommended by Pfeiffer. Before changing the turbo pump oil, vent the vacuum system as described previously. The oil is changed by replacing a self contained oil wick, included in the spare parts kit. Remove the rubber feet from the bottom of the turbo pump by unscrewing and discarding them. Engage the holes in the plastic plate on the bottom of the pump, Figure 11, with the pins on the provided service tool and unscrew the plate. The seal is made by an O-ring and the plate should be removable by hand. Wipe the plate clean of old oil using a lint free cloth and set aside.

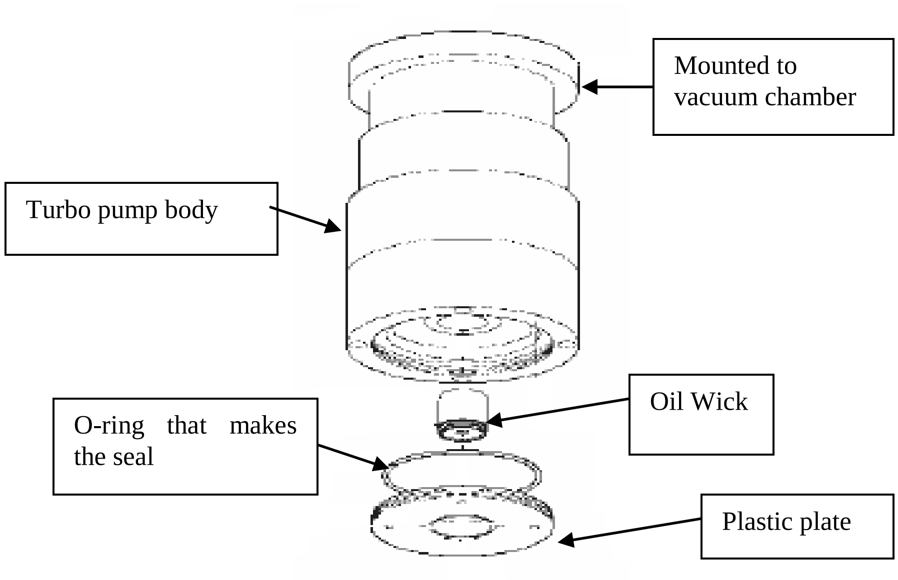


Figure 11: Turbo Pump

The lubricating oil for the pump is contained in an absorbent felt cup oil wick mounted in a plastic housing fitted into the bottom of the pump. The housing has a groove near the exposed end that can be used to pry it out of its recess. A small screwdriver is most often used for this procedure. When removing the oil wick, do not touch anything inside the turbo pump. Once the old oil reservoir is removed, wipe the old lubricant from the pump with a lint free cloth.

When inserting the new oil wick, take extreme care to not push it too far into the pump. This can result in pump failure. Insert the new oil wick into the bottom of the pump by seating it on the plastic plate until it is held in place by its O-ring. The lubricant reservoir is pre filled with the correct type and amount of oil. Do not add additional lubricant.

Screw the plastic plate back into the pump bottom. To avoid crossed threads, initially rotate this plate *counter* clockwise until a click is felt, and then reverse direction. If the plastic bottom is not properly seated, a leak could occur and result in pump failure.

For additional information or recommendations, please contact Pfeiffer directly.

The chamber is held in position by two captive spring loaded pins that engage the inner side of the right and left chamber flanges. Pulling these ~3/8 inch (10mm) towards the center of the chamber will allow the turbo pump to be rotated forward and upward. When the turbo pump is in the horizontal position the spring loaded pins will latch it in position.

While supporting the turbo pump to keep it from rotating too freely pull the spring pins towards the center of the chamber and lower the pump back into place. Reconnect the vacuum, sample and electrical lines to the chamber.

Changing the Ionizer Assembly

The first step in changing the ionizer assembly is to vent the vacuum system. Following this, disconnect the ionizer connection cable and remove the inlet. It may be convenient (though not required) to remove the ionizer's inlet tube by loosening the large central fitting on the ionizer flange, Figures 12 and 13. The hex closest to the flange (5/8 inch) is welded on. The outer hex nut (3/4 inch) can be rotated counter clockwise to loosen the fitting and remove the inlet. Be careful when loosening this fitting that the wrenches do not contact the ten pin vacuum feedthrough and damage it. Set the inlet aside where it will stay clean.

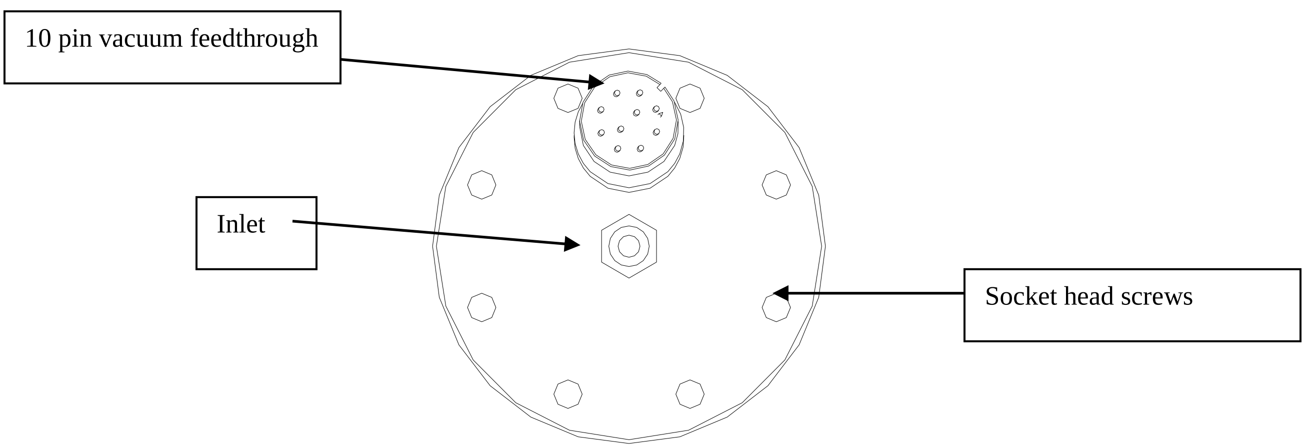


Figure 12: Ionizer Flange

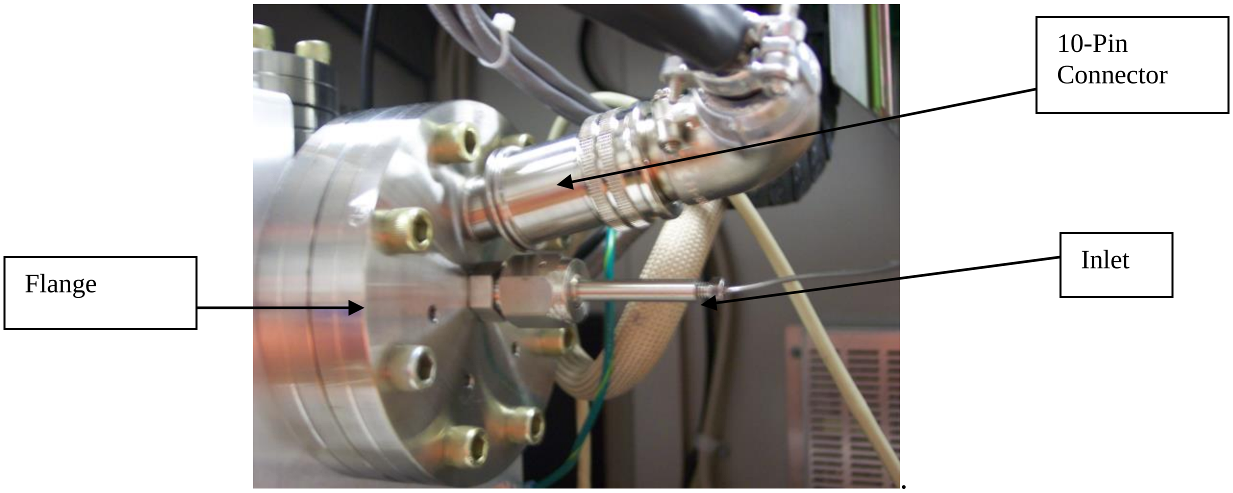


Figure 13: Ionizer flange with Inlet and 10-pin Connector

The ionizer flange is held to the chamber with eight socket head screws (1/4 inch hex key). Remove the flange and set it on a clean work surface. Remove and discard the nonreuseable copper gasket.

The ionizer assembly is held in place by spring loaded electrical connections. It can be removed by grasping the last lens and pulling the module straight from the flange. The new module is installed by inserting the central ion region into the flange mounted heated block, aligning the electrical connections and pushing it in place. If the assembly is properly installed, no gap should be visible between the fixed part of the ionizer block and the innermost plate of the ionizer. The total height of the assembly can be measured from the vacuum side of the flange and should be 2.50 inches (63.5 cm). If this dimension is more than 2.54 inches (64.67 cm), lens 2 will short to the quadrupole rods.

Using a new 4-1/2 inch copper gasket, install the ionizer flange onto the vacuum chamber. A threaded hole on one side of the electrical feedthrough, visible in Figure 14, can be used to hold the copper gasket in place. Install the bolts on the flange finger tight.

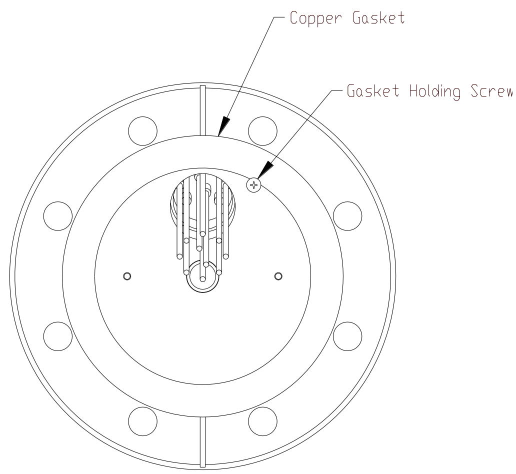


Figure 14: Reinstalling Ionizer Flange

Note: Never reuse a copper gasket. A scratch undetectable to the eye may be present and result in a vacuum chamber leak.

Use an ohm meter to verify proper installation of the ionizer before tightening the ionizer flange bolts. The filaments, thermocouple and heaters will read low resistance when measured. Check all the pins for shorts to ground (the chamber) and to each other. Also check for a short between lens 2 and either of the quadrupole connections on the top of the chamber. If the quadrupole has been removed for service, postpone this step until it has been reinstalled. Figure 15 below depicts the wiring for the ten pin vacuum feedthrough. Table 1 shows the function of each pin.

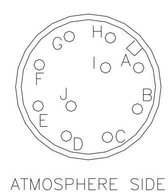


Figure 15: Inlet Flange 10 Pin feedthrough wiring

Table 1: 10-Pin Vacuum Feedthrough

Pin	Function
A	Thermocouple (+)
B	Extractor
C	Filament 1
D	Filament Common

E	Filament 2
F	Lens 2
G	Heater
H	Thermocouple (-)
I	Heater
J	Lens 1

When all the electrical tests have passed, tighten the flange bolts in a cross pattern to keep the flanges parallel, prevent leaks, and keep the copper gasket from becoming warped.

Quadrupole Removal

The mass filtering device used in the MAX300™-LG is a quadrupole. This component is located directly behind the ionizer and utilizes the vacuum chamber as both its enclosure and mounting structure. The quadrupole is comprised of four 3/4in (19mm) stainless steel rods and provides a mass range of 2 to 300 amu.

Quadrupole Removal

Required Tools

- (1) 1/8 inch (3 mm) Flat Blade Screwdriver
- (1) ¼ inch Hex Key
- (1) 5/64 inch “Allen” or Hex key
- (1) Pair Lint Free or Nylon Gloves

Note: When handling any clean vacuum chamber components, lint free or nylon gloves must be worn.

Note: The following procedure should be read in its entirety before attempting to remove the quadrupole assembly.

Before removing the quadrupole, the vacuum system must be vented. Slide the *VacTrac* assembly out of the enclosure by disconnecting the inlet line from the enclosure wall and releasing the slide latch on the left slide of the *VacTrac* assembly. Disconnect the RF cables from the feedthrough flange on the top of the vacuum chamber shown in Figure 16 by pushing down, rotating ~1/4 turn counterclockwise and then pulling. The RF connection flange assembly can then be detached from the vacuum chamber (1/4 inch hex key).

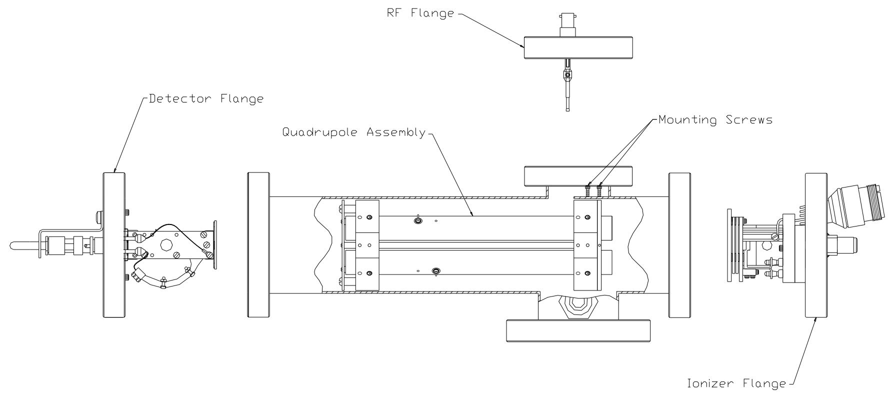


Figure 16: Quad Assembly and Vacuum Chamber

The quadrupole can be removed from either the ionizer end or detector end of the vacuum chamber. The detector end is nearest the wires that connect opposite poles. If the ionizer has also been removed for routine maintenance, the quadrupole can be pulled out the front of the chamber. If not, the assembly may be removed from the rear by detaching the detector mounting flange. In both cases, a ¼" hex key is required.

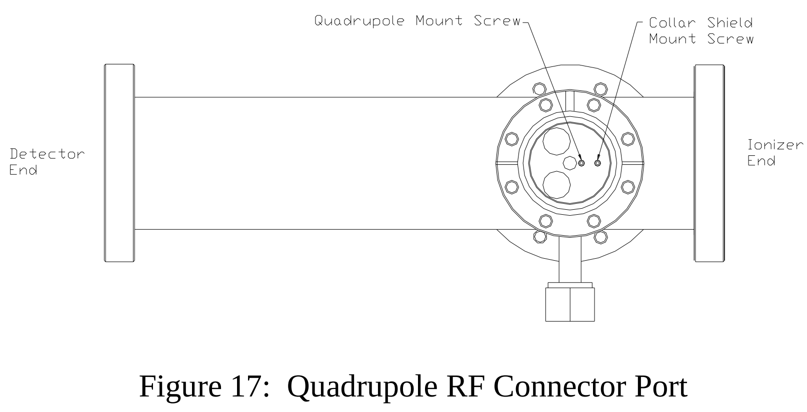


Figure 17: Quadrupole RF Connector Port

When looking down through the RF connector port of the chamber, as in Figure 17, the two 2-56 socket head screws (5/64 inch hex key) that secure the quadrupole mass filter assembly into the vacuum chamber are visible. By removing the collar shield screw and the quadrupole mount screw, the assembly can be pulled out of the chamber and placed in a clean area (a few Kimwipes placed on a level surface).

Note: do not force the quadrupole through the chamber! If it gets stuck, gently slide the assembly side to side and up and down until it is easily removed.

Quadrupole Collar Shield Disassembly

Required Tools

- (1) Pair Lint Free or Nylon Gloves
- (1) 1/8 inch (3mm) flat blade screwdriver

Once removed from the vacuum chamber, a partial disassembly of the quadrupole is necessary before cleaning. Place the quadrupole on a clean, level working surface before beginning the disassembly procedure.

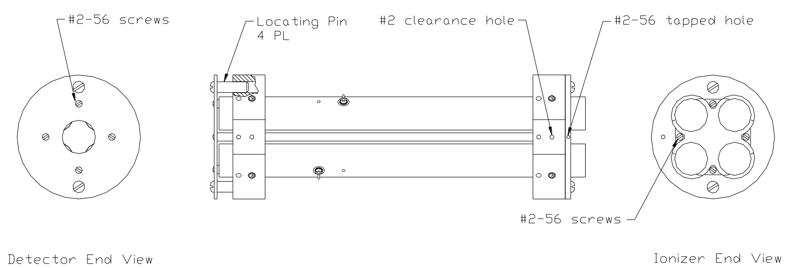


Figure 18: Quadrupole Collar Shield

Using the flat blade screwdriver, remove the four 2-56 pan head screws used to secure the ionizer end collar shield plate, visible on the right of Figure 18. Remove the collar shield by sliding the remaining components out of the detector end of the mass filter assembly. This is best performed by grasping the remaining collar shield plate and gently pulling. Locating pins are incorporated into the detector end plate to limit rotation of the assembly with respect to the quadrupole. These pins will pull out of the mass filter collar without any additional disassembly. (To clean the shield rod assembly, it is convenient to remove the four shield rods from the detector end by removing the remaining four pan head screws.) The wires connecting opposing poles can be left in place.

Note: **Under no circumstances** should the screws holding the quadrupole rods to the ceramic collars be removed, adjusted or checked for tightness.

Quadrupole Cleaning

Required Tools

- (1) ¾ - 1" Dia. bottle brush with the wire "knot" removed from the end and the handle covered in plastic.
- (~5) Cotton Swabs
- Small amount of Pumice
- Small amount of "Alconox"
- Hair Dryer
- (2) "Kimwipes"
- (1) Pair Powder-free Latex Gloves
- A source of clean tap water
- Distilled water (most convenient in a lab style "wash bottle")

Visible deposits will usually be confined to the first ¾ in (2 cm) at the ionizer end of the assembly, furthest from the wires that connect opposing poles.

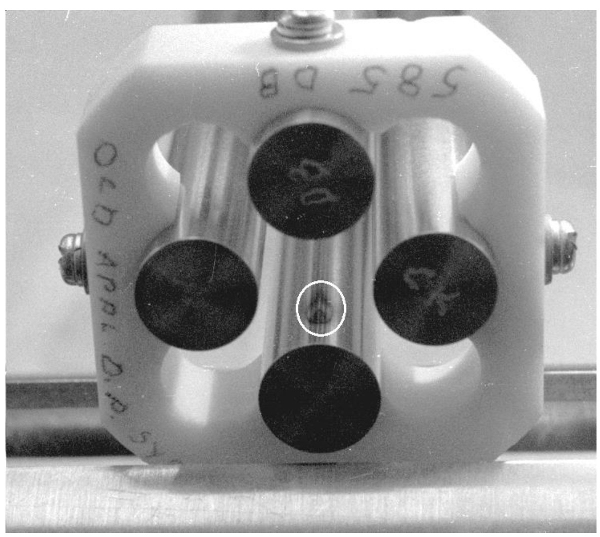


Figure 19: Visible Deposits

The highlighted area in Figure 19 above shows visible deposits on one of the poles. A similar deposit is present on the opposite pole. The most effective way of removing deposits from the quadrupole is to scrub the affected area with a cotton swab and paste of 95% pumice:5% "Alconox". Confine this scrubbing motion to the circumference of the poles, avoiding scrubbing in a longitudinal direction. **It is very important to avoid scratching the quadrupoles.**

When the deposits have been removed, the quadrupole will require a general overall scrubbing using the pumice/alconox paste. Use a brush of 3/4 to 1 inch diameter inserted along the axis of the assembly. This brush should have the wire knot at the end removed and the handle covered in plastic. Clean the inside of the quad by *rotating* the brush.

Rinse the assembly thoroughly in tap water followed by distilled water. Watch for the formation of a uniform, continuous film of water. Formation of individual droplets indicates the presence of a hydrocarbon film and will require the assembly to be cleaned again. When cleaning is completed, dry completely with an oven or hair dryer and place on a clean Kimwipe for reassembly.

Quadrupole Reassembly and Vacuum Chamber Installation

Required Tools

- (1) 5/64" Hex Wrench
- (1) Pair Lint Free or Nylon Gloves
- (1) New 3 3/8" Copper Gasket
- (1) New 4-1/2" Copper Gasket
- (1) 1/4" Hex Key
- (1) 1/8” Flat Blade Screwdriver

With the quadrupole cleaned, the collar shield assembly will be re-attached and the quad installed into the vacuum system. An ohmmeter will verify that nothing is shorted to ground before the system is pumped back down.

To re-attach the collar shield assembly, slide the detector end plate with the rods attached into the quadrupole from the detector end. The locating pins must fit into the holes of the ceramic mounting collars as shown in Figure 20 below.

Use the four 2-56 pan head screws to attach the ionizer end plate to the free ends of the shield rods at the ionizer end of the quad. Be sure to orient this plate properly. The recessed area faces outward and the threaded hole in the edge is aligned with the pair of holes in one of the corners of the ceramic collar.

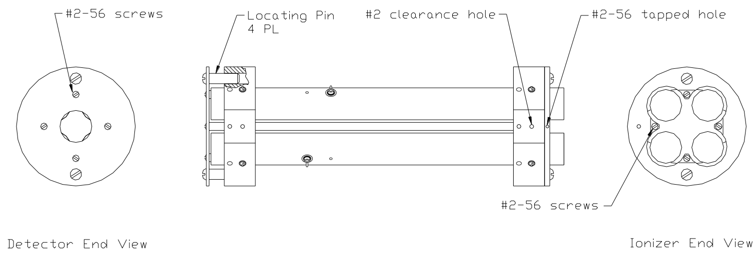


Figure 20: Locating Pins of Quadrupole

When this is completed, the quadrupole assembly can be inserted into the vacuum chamber. Be sure the ionizer end will face the ionizer and the detector end will face the the end nearest wires connecting opposite poles. Also, rotate the quad assembly so the threaded hole in the edge of the ionizer end plate is on top.

As noted previously, the quadrupole is secured within the vacuum system by two screws. One screw engages the ceramic mounting collar and one threads into the collar shield rod assembly. The quad assembly should be slid far enough into the chamber so the holes in the chamber for these screws line up with the matching holes in the quad assembly. This can be observed by looking into the RF connection flange mounting port on top of the vacuum system.

A bird's eye view depicting the location of these holes is shown in Figure 21. Two 2-56 socket head screws with lock washers and the 5/64" hex wrench will be needed to secure the assembly.

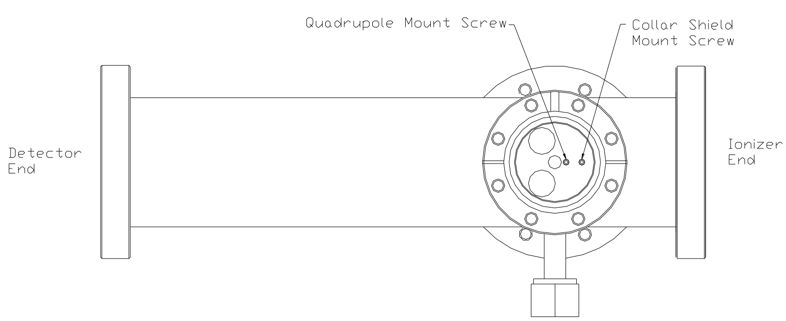


Figure 21: RF Connection Flange – Bird's Eye View

The RF connection flange assembly should then be installed onto the vacuum chamber with a new 3-3/8" copper gasket. The spring loaded contacts of the RF connection flange must make contact with the quadrupole rods, not the collar shield end plate or chamber. The vacuum feedthroughs on this flange, when properly installed, are offset toward the *detector* end of the chamber. Initially leave these screws finger tight.

Use the ohmmeter to check the continuity between the feedthrough contacts on the flange and the quadrupole rods and check for shorts to the chamber. Either the ionizer or the detector flange will have to be removed to accomplish this. Once verified that the electrical connections are correct, finish tightening the RF flange screws. The securing socket head screws (1/4" hex key) should be tightened in a crossing pattern that keeps the flanges parallel to each other.

If the ionizer mounting flange was removed, it should be re-installed using a new 4-1/2" copper gasket. The securing socket head screws will require a 1/4" hex wrench. Use the ohmmeter to check that the ionizer lenses are isolated from one another, the vacuum chamber and the quadrupole. If the detector mounting flange was removed, it will need to be re-attached using a new 4-1/2" copper gasket and the 1/4" hex key for the securing socket head screws. Position the detector mounting flange so that the HV feedthrough is towards the *back* of the vacuum chamber. Use the ohmmeter to check that the detector connection feedthrough(s) are isolated from both the vacuum chamber and the quadrupole rods.

Electron Multiplier Removal and Replacement

Instruments equipped with the optional electron multiplier detector will require replacement of this component after the required gain can no longer be achieved. When this occurs, the vacuum system will need to be vented as described at the beginning of this chapter before beginning the replacement procedure.

Required Tools:

(1) 1/4" Hex Key

(1) 3/32" Hex Key (Note: a “ball end” type is most convienent.)

(1) 4-1/2" Copper Gasket

(1) Pair Lint Free or Nylon Gloves

(1) #2 Phillips Screwdriver

After the system has been properly vented remove the cables on the detector flange (the multiplier HV cable, and the preamp cable). The preamp assembly is detached using the Phillips screwdriver to remove the two preamp securing screws.

Electron Multiplier Removal and Replacement

Required Tools

- 1/4" Hex Key
- 3/32" Hex Key

Note: a “ball end” type is most convenient.

- (1) 4-1/2" Copper Gasket
- Pair Lint Free or Nylon Gloves
- #2 Phillips Screwdriver

Instruments equipped with the optional electron multiplier detector will require replacement of this component after the required gain can no longer be achieved. When this occurs, the vacuum system must first be vented. After venting, disconnect the inlet line from the enclosure wall and release the slide latch on the left slide of the *VacTrac* assembly and extend the *VacTrac* out of the enclosure. Remove the connection cables on the detector flange (the multiplier HV cable, and the preamp cable). The preamp assembly is detached using the Phillips screwdriver to remove the two preamp securing screws. Figure 23 shows the preamp assembly.

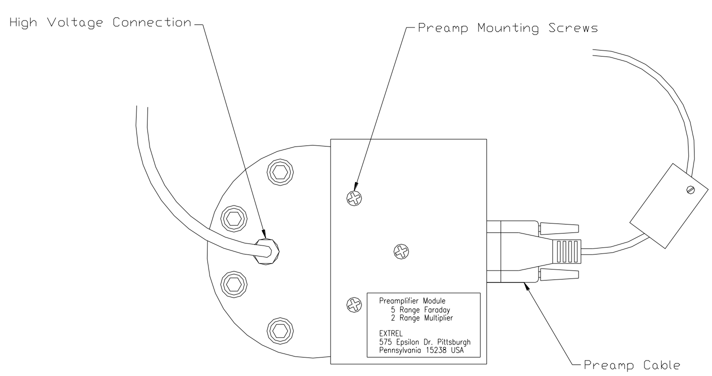


Figure 23: Preamp Assembly

The detector mounting flange can be detached from the vacuum chamber by removing the securing socket head screws using a 1/4" hex key. Discard the old copper gasket.

Note: Care must be taken when removing this flange to not damage the detector assembly as the securing screws are removed. Support the flange as the last screw is taken out and pull the assembly straight back from the vacuum chamber.

The replacement multiplier is a completely assembled multiplier with all the wires attached and the extended faraday plate installed. Remove the old detector assembly and install the new one on the flange. Place the detector mounting flange onto a clean level working surface to begin the replacement procedure.

The electrical connections can be pulled straight off the flange feedthroughs. The multiplier is held to the flange with two 4-40 screws that can be removed with a 3/32" hex key.

Install the new multiplier onto the flange in the same orientation as the old one using the 4-40 screws and connect the wires to the flange feedthroughs by pushing the connectors straight on. Refer to Figure 24 to verify that the wiring is correct.

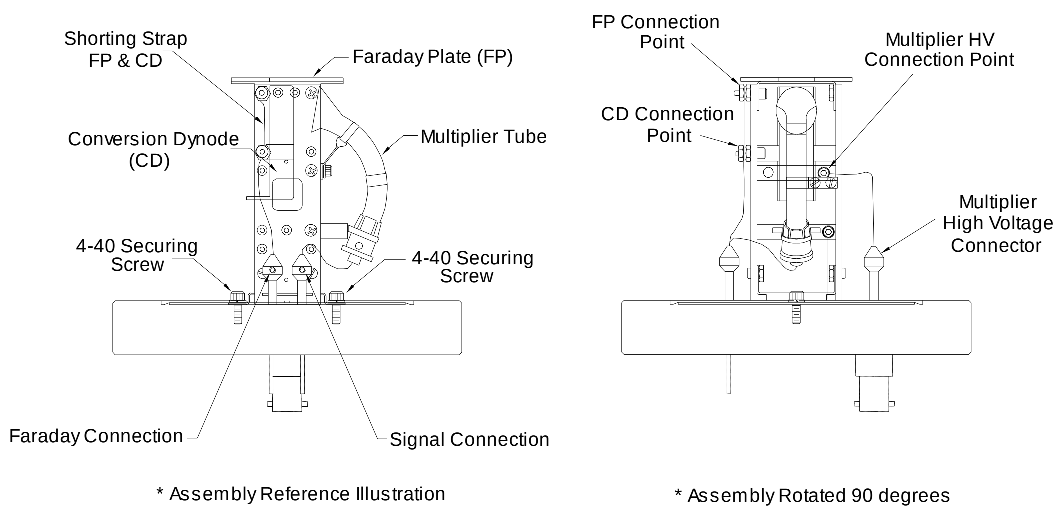


Figure 24: Multiplier Flange

Install the detector flange onto the vacuum chamber using a new 4-1/2" copper gasket in the same orientation it was originally. There are two threaded holes on the flange that can be used to hold the copper gasket in place. Initially tighten the bolts finger tight. Use an ohm meter to verify that each of the three detector electrical leads is isolated from each other, from ground and from the quadrupole.

Note: It is normal for the high voltage connection to show 80 megohms when measured to ground.

Once verified that the wiring is correct, tighten the flange bolts in a cross pattern. Start the turbo and roughing pump. When both are working correctly, attach the preamp to the flange and re-install the preamp and multiplier HV cables.

Changing the "QuickInlet"

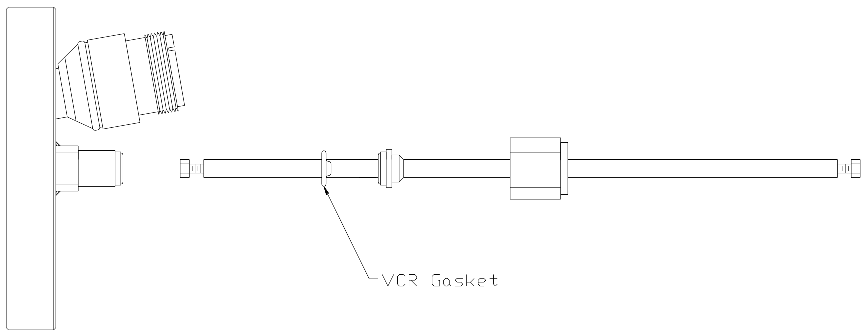
To change the "QuickInlet", the first step is to properly vent the vacuum system. Please refer to the beginning of this chapter for a detailed explanation of the venting procedure.

Tools Required:

(1) ¾ inch Open End Wrench **(1)** 5/8 inch Open End Wrench

After the system has been vented, remove the inlet heater from the ionizer mounting flange and any attached sample lines. To remove the QuickInlet loosen the large central fitting on the ionizer flange. The hex closest to the flange (5/8 inch) is welded to the flange. The outer hex nut (3/4 inch) can be rotated counterclockwise to loosen the fitting and remove the inlet. Be careful when loosing this fitting that your wrench does not contact the 10 pin vacuum feedthrough and damage it.

Withdraw the inlet from the flange and remove the ¾ inch hex nut from the inlet. Also remove the old metal gasket as these can not be reused.



Slide the nut over the long end of the replacement QuickInlet and install the metal gasket on the flange half of the fitting. Slide the short end of the inlet into the flange fitting and tighten the nut ¼ turn past finger tight.

Caution: over tightening this fitting may damage the sealing surfaces of the fitting.

Before connecting the sample line check that the new inlet is not touching the ion region. Use an ohm meter to verify that pin "A" on the ionizer feedthrough is not shorted to ground.

Reconnect the sample line to the new QuickInlet and start the vacuum pumps. The LED on the turbo pump power module should reach a steady green state within 5 minutes. If it continues to blink or turns red you most likely have a vacuum chamber leak and will have to find and fix it before proceeding further.

Sample Stream Rotary Inlet Valves

Sample introduction into the enclosure is performed by rotary valves. During the life of the rotary valve, a few common problems that may arise.

No flow

- A pressure of 5 PSIG above atmospheric pressure is usually sufficient to establish flow. Sampling sub atmospheric streams requires special techniques. If the sample line is not at sufficient pressure, the valve will not register flow.

- Each inlet to the rotary valve is equipped with a filter. If it becomes clogged, it should temporarily be removed. Do not operate continuously without a filter. Any particulates present in the sample will drastically shorten the valve's life.
- If the actuator loses proper alignment with the valve body, it may resemble a blocked valve.

Valve will not rotate

- May result from an improperly connected valve actuator, either the DC power cord or the *Serial COM* cable (three pin push on connector) that commands the actuator.
- A faulty valve actuator.
- A valve rotor that has seized.

Valve selects the wrong stream

- Indicates a problem with valve alignment. Refer to the *Multiposition Electric Actuator Instruction* manual for the procedure to align the valve.
- A badly scored rotor will allow "cross talk" between adjacent streams.