Instruction Manual
Extorr XTP Series RGA



Models
XTP-100, XTP-200, XTP-300 Faraday Cup
XTP-100M, XTP-200M, XTP-300M Faraday Cup and Electron Multiplier

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1. Safety Information

1.1. Limitation on Use of Compression Mounts

WARNING!

Do not use a compression mount (quick-connect) for attaching the Analyzer probe to the vacuum system in applications that may develop positive pressures. Positive pressures may cause the probe to be blown out of a compression fitting and damage equipment and injure personnel.

1.2. Electrical Shock Hazard



WARNING!

Hazardous voltages may be present inside the XTP CCU and on the probe whenever the XTP CCU is powered. Disconnect all power supplies before attaching the XTP CCU to the probe, removing it from the probe, or touching the probe. Make sure the vacuum chamber is properly grounded. Do not operate or power the XTP CCU without the box cover.

2. Overview

2.1. General Description

The Extorr XTP Series instruments are quadrupole residual gas analyzers which also include an enhanced Pirani gauge as well as a hot cathode Bayard / Alpert (B/A) ion gauge. The Pirani gauge makes vacuum measurements based on thermal conductivity of the gas environment. The B/A ion gauge uses electron impact ionization of residual gases to measure ion currents related to pressure. The quadrupole gas analyzer uses precision mechanics and electronics to measure ion currents due to the partial pressures of the residual gases in the vacuum chamber. The Pirani starts operation at atmospheric pressure, the B/A ion gauge at a nominal 10^{-2} torr and the quadrupole starts at a nominal 10^{-4} torr pressure. The B/A ion gauge will measure total pressures to its x-ray limit of $2x10^{-10}$ torr and the quadrupole can measure partial pressures well below 10^{-11} torr.

There are three XTP models. The XTP-100 operates from 1 to 100 amu. The XTP-200 operates from 1 to 200 amu. The XTP-300 operates from 1 to 300 amu. All three models have the standard Faraday Cup (FC) detector. With the inclusion of an electron multiplier (EM) detection option, an M is attached to each of these model numbers i.e. XTP-100M, XTP-200M and XTP-300M. These three models have both Faraday Cup (FC) and Electron Multiplier (EM) detectors.

All of the pressure gauging is done by the XTP Command and Control Unit (XTP CCU), which mounts directly on the probe flange and is powered by the included 24 volt, 2.5 amp supply. The XTP CCU contains the electronics that operate the Pirani gauge, the B/A ion gauge and the quadrupole. Each XTP CCU is tuned at the factory to its probe as a matched set.
The XTP CCU is controlled by the XTP Host, a built-in computer mounted on the back of the XTP CCU and powered by its own 5-volt 5-amp USB-C supply. The two are connected by a short RJ11 cable, which carries the RS-232 link between them. The XTP Host runs the XTP RGA on its own, with no separate computer or installed software. It stores every spectrum, configuration and output in its built-in database on a 1 TB (upgradable) solid state drive, time-stamped by a built-in real-time clock, so past data and the configurations used to collect it can always be recalled. Data can be exported in CSV format, and the database can be backed up to and restored from a single file.
The XTP Host can be used in two ways: through its built-in web interface, from any computer, tablet or phone with a modern web browser connected over Ethernet or Wi-Fi, or directly with an HDMI monitor, USB keyboard and USB mouse plugged into the XTP Host. Chapter 5 explains how to connect. Software updates are available at no cost from the Extorr website, www.extorr.com.

3. Dimensions and Specifications

3.1. Dimensions

The dimensions of the probe, the XTP CCU and the XTP Host, which mounts on the back of the XTP CCU, are given below in both metric and American Standard units. The mounting flange is a metal sealed DN 40 CF (2 ¾ Inch CF).

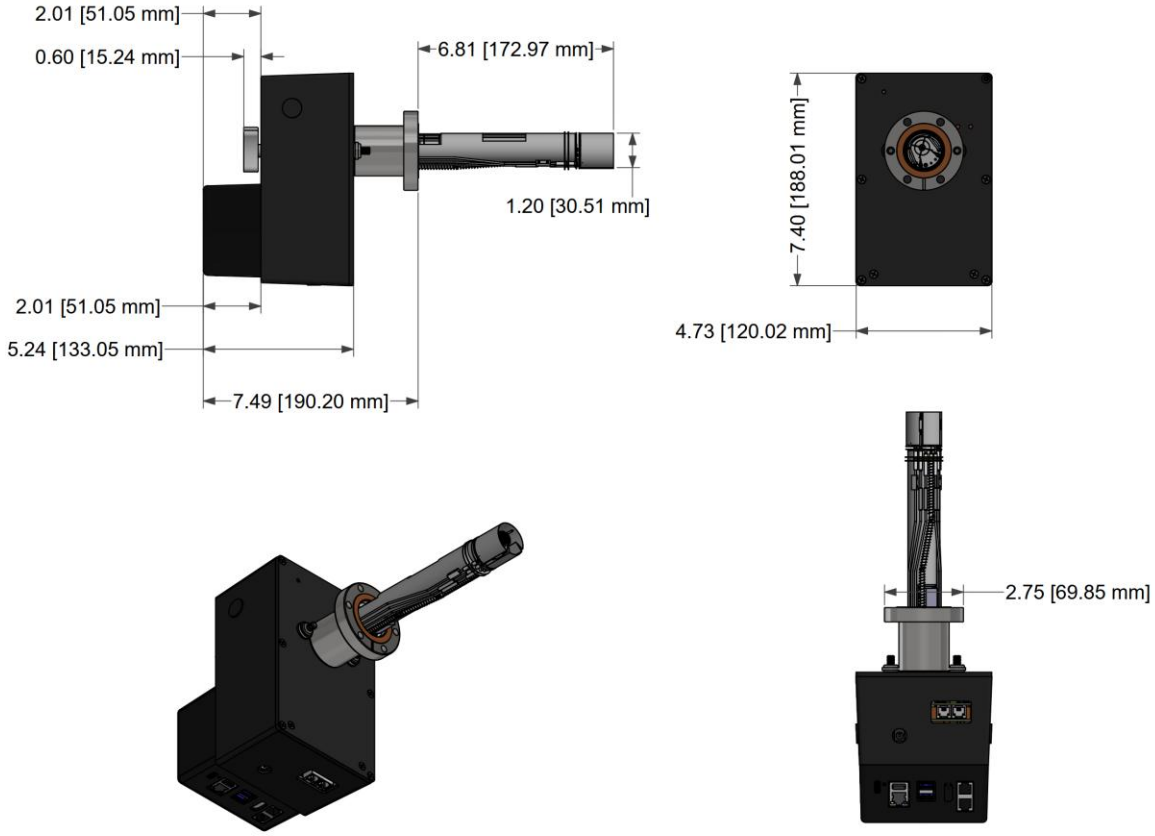


Figure 1. XTP Dimensions

3.2. Specifications

Mass range	
XTP-100	**1 to 100 amu Faraday Cup (FC)**
XTP-200	**1 to 200 amu Faraday Cup (FC)**
XTP-300	**1 to 300 amu Faraday Cup (FC)**
XTP-100M	**1 to 100 amu Faraday Cup (FC) and Electron Multiplier (EM)**
XTP-200M	**1 to 200 amu Faraday Cup (FC) and Electron Multiplier (EM)**
XTP-300M	**1 to 300 amu Faraday Cup (FC) and Electron Multiplier (EM)**
Mass filter type	**Quadrupole**
Detector type	**Faraday cup (FC), Electron Multiplier (EM) Optional**
Resolution	Better than 0.5 amu @ 10% peak height. Adjustable to constant peak width throughout the mass range.
Sensitivity (A/Torr)	6×10^{-4} into Faraday cup (FC). Measured with N_2 @ 28 amu with 1 amu full peak width, 10% height, 70 eV electron energy, 6 eV ion energy and 2 mA electron emission current.
Minimum detectable partial pressure	Faraday cup: 2.4×10^{-12} Torr (200 ms dwell), 5×10^{-13} Torr (5 s dwell). Electron multiplier: 1×10^{-14} Torr (200 ms dwell), 2×10^{-15} Torr (5 s dwell). One standard deviation of the baseline noise divided by the sensitivity for nitrogen. Using three standard deviations, the values are three times higher.
Operating pressure	UHV to Atmosphere. Pirani gauge 10^{-4} Torr to ATM, ion gauge below 5×10^{-3} Torr, RGA operation below 10^{-4} Torr.
Max. operating temp.	**50 °C Electronics, 100 °C Probe**
Bakeout temperature	300 °C (probe only, XTP CCU and XTP Host removed)
Total pressure measurement	10^{-4} Torr to ATM, Pirani gauge 2×10^{-10} Torr to 5×10^{-3} Torr, B/A ion gauge
Ionizer	
Design	**Open ion source , electron impact ionization.**
Dual Filament	**Thoria coated Iridium with firmware protection. Built-in 1 to 30 W degas ramp-up. Field replaceable.**
Electron energy	11 to 150 eV, programmable
Ion energy	1 to 12 eV, programmable
Focus voltage	**0 to 150 V, programmable**
Electron emission current	**0.1 to 4 mA, programmable**
General	
Materials of Probe Construction	**304SS, Kovar, Tungsten, Alumina, Iridium, Copper, Nickel, Thoria, Platinum**
Probe dimension	**6.8" from flange face to top of ionizer**
XTP CCU and XTP Host extension	7.5" from flange face to the back of the XTP Host, with mounting hardware
Minimum tube I.D.	**1.375"**
Probe mounting flange	**2.75" CF**

XTP CCU dimensions	3.3" x 4.8" x 7.4" (XTP CCU only; the XTP Host adds about 2" on the back). Easily separated from the probe for bake-out.
Warm-up time	**Mass stability ±0.1 amu after 30 minutes.**
Connectivity	Ethernet (link-local, DHCP or static IPv4) and Wi-Fi (access point or client), for use with a web browser. HDMI and USB for a monitor, keyboard and mouse.
Software	Built into the XTP Host (XTP interface). Software updates at no cost from www.extorr.com.
Data storage	Built-in 1 TB NVMe SSD (upgradable). All spectra, configurations and outputs saved with time stamps. CSV export; database backup and restore.
Computer requirements	Any computer, tablet or phone with a modern web browser, or standalone use with an HDMI monitor, USB keyboard and USB mouse.
Power requirement	XTP CCU: 24 VDC @ 2.5 A, 120/240 VAC adapter included. XTP Host: 5 VDC @ 5 A (USB-C), 120/240 VAC adapter included.
Weight	Probe, XTP CCU and XTP Host total 9 lbs.

See Appendix C for options and spare parts. Latest prices and spare parts are on the Extorr web site at www.extorr.com.

4. Installation

4.1. Unpack the XTP Shipment

Carefully unpack your XTP Unit. The shipment includes these components:

1. quadrupole probe and copper gasket
2. XTP CCU
3. XTP Host (attached to the back of the XTP CCU)
4. 4 inch (already connected) and additional 25 Foot RJ11 (6P4C) cable, the RS-232 link between the XTP Host and the XTP CCU
5. 24 V power supply and power cord (powers the XTP CCU)
6. 5 V USB-C power supply and power cord (powers the XTP Host)
7. USB to Ethernet adapter and Ethernet cable
8. flange mounting bolts
9. XTP CCU mounting bolts
10. plastic screw driver and Allen wrench
11. any spare parts or accessories included with this order



If your unit does not have all of these items, call Extorr Inc at 724-337-3000. If anything appears to have been damaged in shipment, contact the shipper as well.

The probe is sent in a custom shipping box with shock absorbing, vacuum formed plastic trays. To remove, carefully cut the tape sealing the box. Then carefully lift off and set aside the upper plastic tray. Next, touching only the non-vacuum side of the flange, carefully remove the probe from the lower plastic tray. Save this box in case the probe needs to be returned to the factory for repair.

4.2. Factors to Consider before Mounting the Probe

Find a DN 40 CF (2 ¾ inch) flange on your vacuum system. Carefully measure for the 7 inch (178 mm) clearance required for probe insertion. The port inside dimensions must be greater than 1.375 inches. The port flange must also be a true 90 degrees from the center line of the port tubing. If you require a smaller insertion length or need to convert to a different type of vacuum flange, place the appropriate extension/conversion nipple on the probe at this time. Typically, the XTP CCU hangs in a vertical position with the communications and power connections below the flange position. Although orientation of the XTP CCU is not a strict requirement for the quadrupole and B/A ion gauge, the Pirani gauge works best in this orientation. You may wish to apply this hanging orientation by rotating the flange so that the shielded pin, which is closest to the outside edge of the flange, is at the bottom. This is shown in Figure 2.

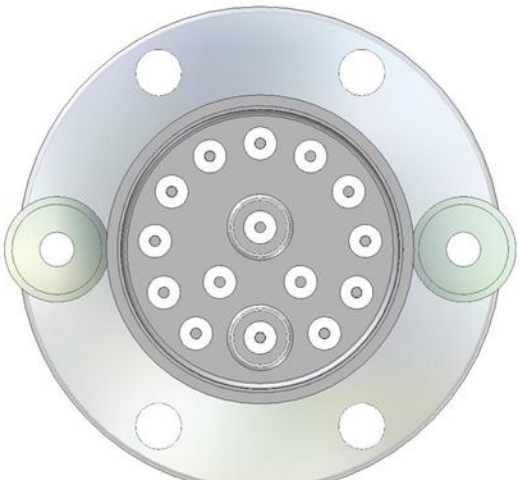


Figure 2. Outside View of Flange

4.2.1. Vacuum Probe Mounting Considerations to Avoid Electrical Short Circuits

For the RGA to work properly, the exposed electrical connections on the vacuum side of the Quadrupole Probe Assembly must not come in contact with the Vacuum Chamber walls. If any of the wires touch the chamber at any point along their length a short circuit will be created. A short circuit will also occur if the metal plates of the Ionizer come in contact with the chamber. A vacuum port with a minimum inside diameter of 1.375 inches (about 35 mm) and clearance inside the chamber to a depth of at least 7 inches (about 178 mm) is required for the Extorr Quadrupole Probe.

Most short circuits occur when the Probe is mounted in a long, close fitting vacuum nipple or tube. Although the Probe will fit through an opening with an inside diameter of just 1.375 inches (about 35 mm), a long vacuum nipple or port of this size must be made with the end flanges precisely perpendicular to the tube center line. An error of only a degree or so will cause the Ionizer end of the Probe to be as much as 1/8 inch (about 3 mm) off of the center line and may cause a short circuit. An unevenly compressed copper gasket could also cause improper alignment within a close fitting tube. For these reasons, always use the largest inside diameter tube possible.

To help prevent short circuits, the Extorr Quadrupole Probe has two built-in spacer rings near the Ionizer. The "Ionizer Spacer Rings" are larger in diameter than the rest of the Probe Assembly and are electrically connected to ground. These rings will usually come in contact with the vacuum chamber walls before the other parts of the ionizer or the connecting wires to the electrical feed-through pins.
See the figure below.

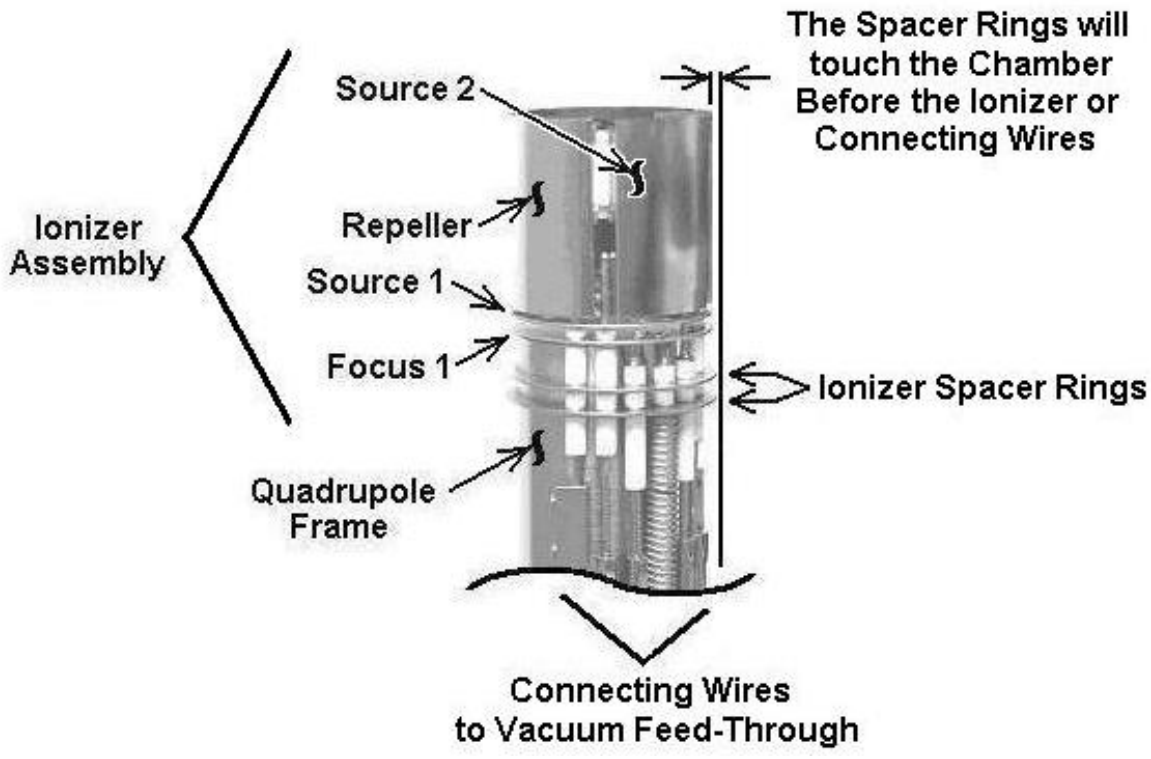


Figure 3. Ionizer Spacer Ring Location

4.2.1.1. Preferred Probe Mounting Arrangement

The preferred Probe mounting arrangement is a 2-3/4 inch CF (DN 40 CF) Flange on a Port that is up to 2-1/2 inches (about 64 mm) long and opens into a larger chamber. When mounted in this way, the Probe Ionizer and the electrical connections are far enough away from the Vacuum Chamber that short circuits are very unlikely. See the figure below.

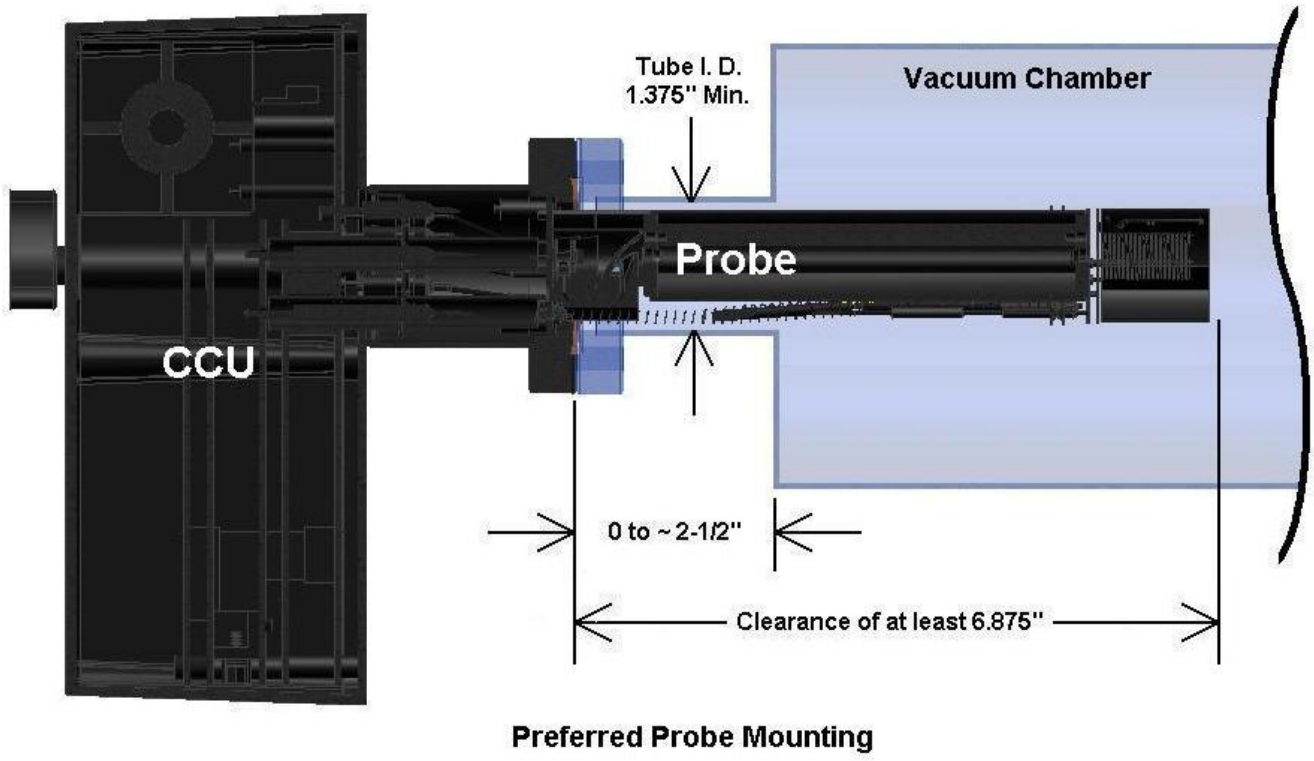


Figure 4. Preferred Probe Mounting Arrangement

4.2.1.2. Mounting the Probe Using a Vacuum Nipple

If the Probe must be mounted in a long, close fitting vacuum nipple, choose the length so that the Ionizer Spacer Rings are not in the connection between the nipple and the vacuum chamber.

A nipple that is 5 inches (about 127 mm) or less in length will put the Ionizer Spacer Rings inside the Vacuum Chamber. If there is a slight misalignment, the spacer rings will touch the vacuum chamber wall and keep the connecting wires and the Ionizer far enough away to prevent a short circuit.

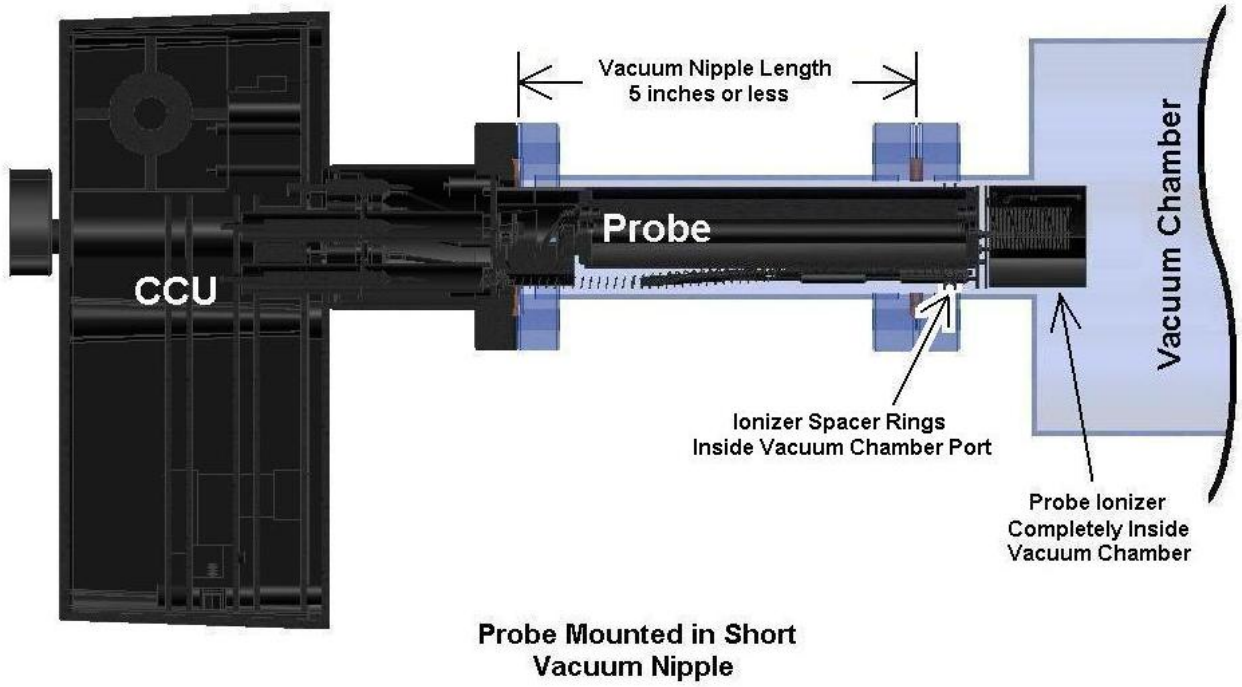


Figure 5. Probe Mounted with a Short Vacuum Nipple

If the nipple is 7 inches (about 178 mm) or more in length, the Ionizer Spacer Rings will be completely inside the nipple. If the end flanges are not accurately aligned to the tube or if the copper gasket is not evenly compressed, the spacer rings will touch the nipple wall and keep the other parts of the probe from shorting.

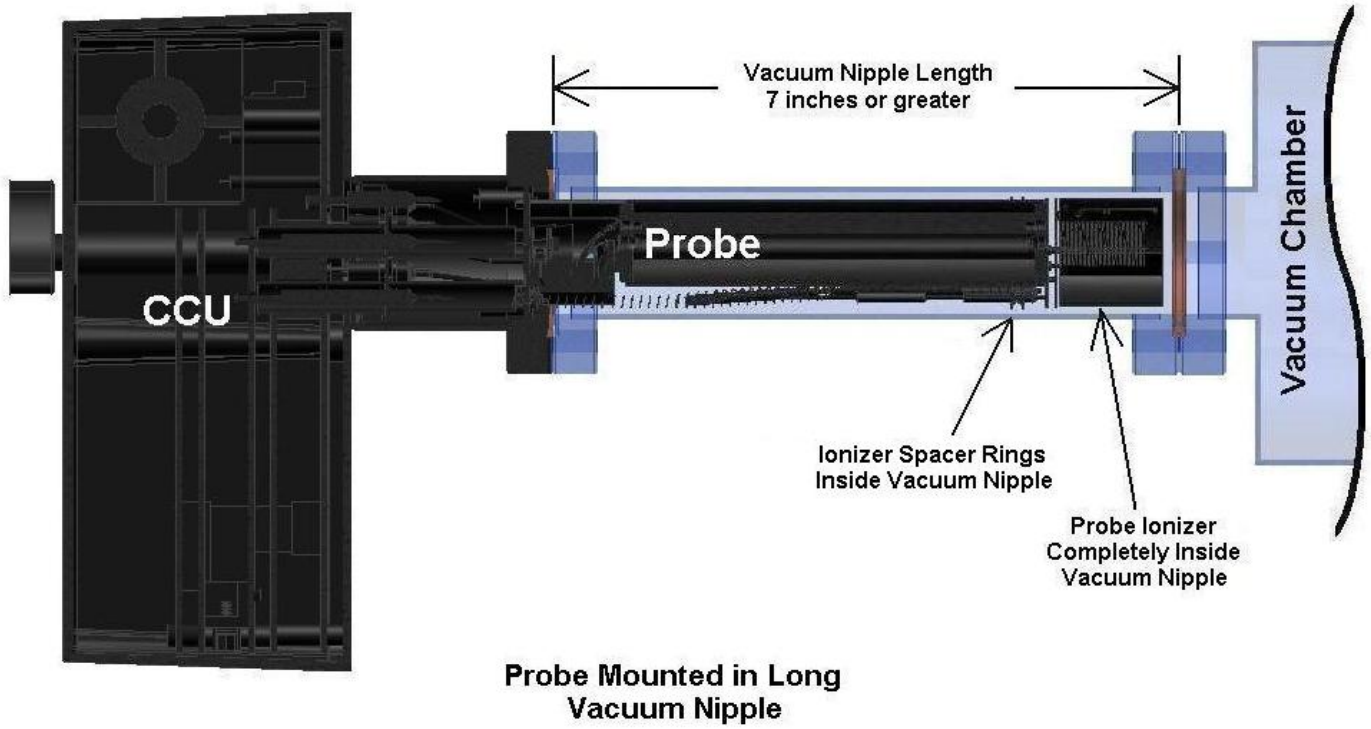


Figure 6. Probe Mounted with a Long Vacuum Nipple

Avoid using a nipple that is between 5 inches (about 127 mm) and 7 inches (about 178 mm) in length. A nipple of this length will put the Ionizer Spacer Rings in the connection between the nipple and the chamber in the area of the copper gasket. Because the inside diameter of the copper gasket is usually larger than the I.D. of the nipple, the spacer rings may not touch before the connecting wires or the ionizer, and a short circuit may occur.

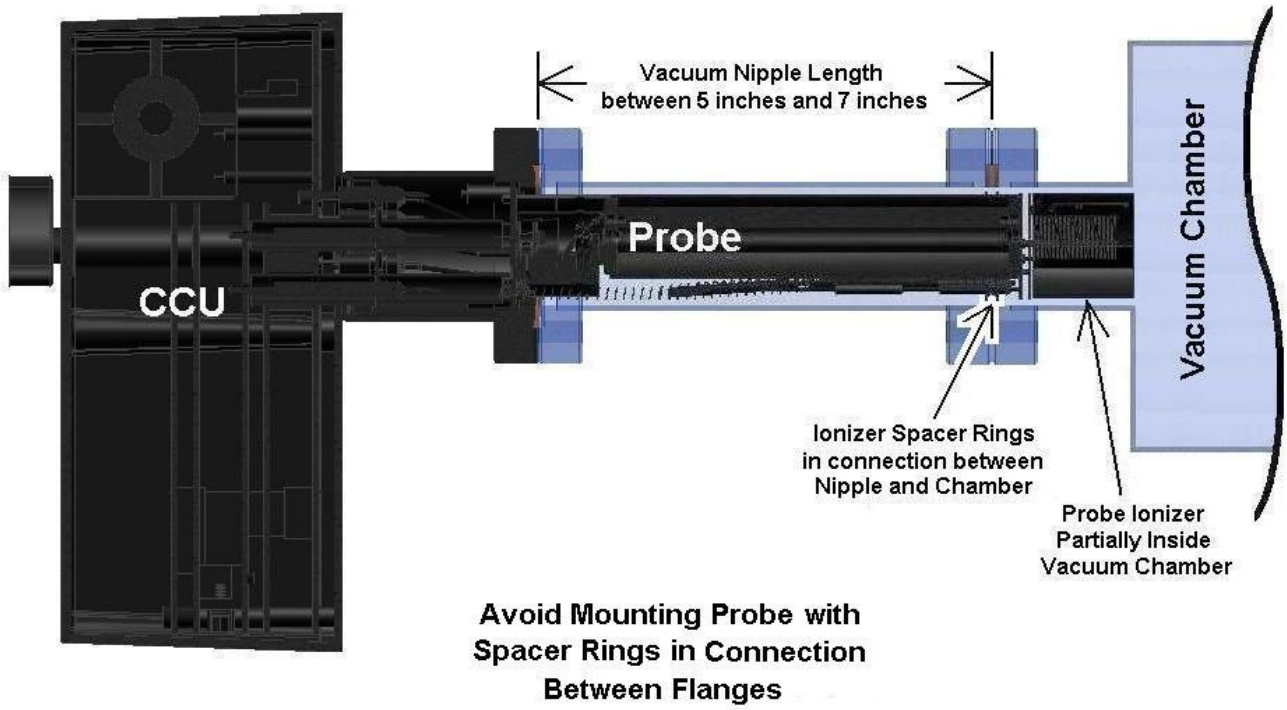


Figure 7. Probe Mounted with Spacer Rings inside Connection between Flanges

4.3. Mount the Probe

Now carefully attach the probe to your system making sure you do not bend or twist the probe as it is inserted into the port. Use the new copper gasket shipped with the unit. Take care in tightening the flange so that the gasket is evenly compressed. The probe is perpendicularly mounted on its flange with great precision but an unevenly compressed gasket could cause improper alignment within a long inlet tube.

As a check on probe integrity after being mounted, use an Ohm meter to check for shorts and filament breakage. Figure 8 shows the feed-through connections on the Extorr flange.

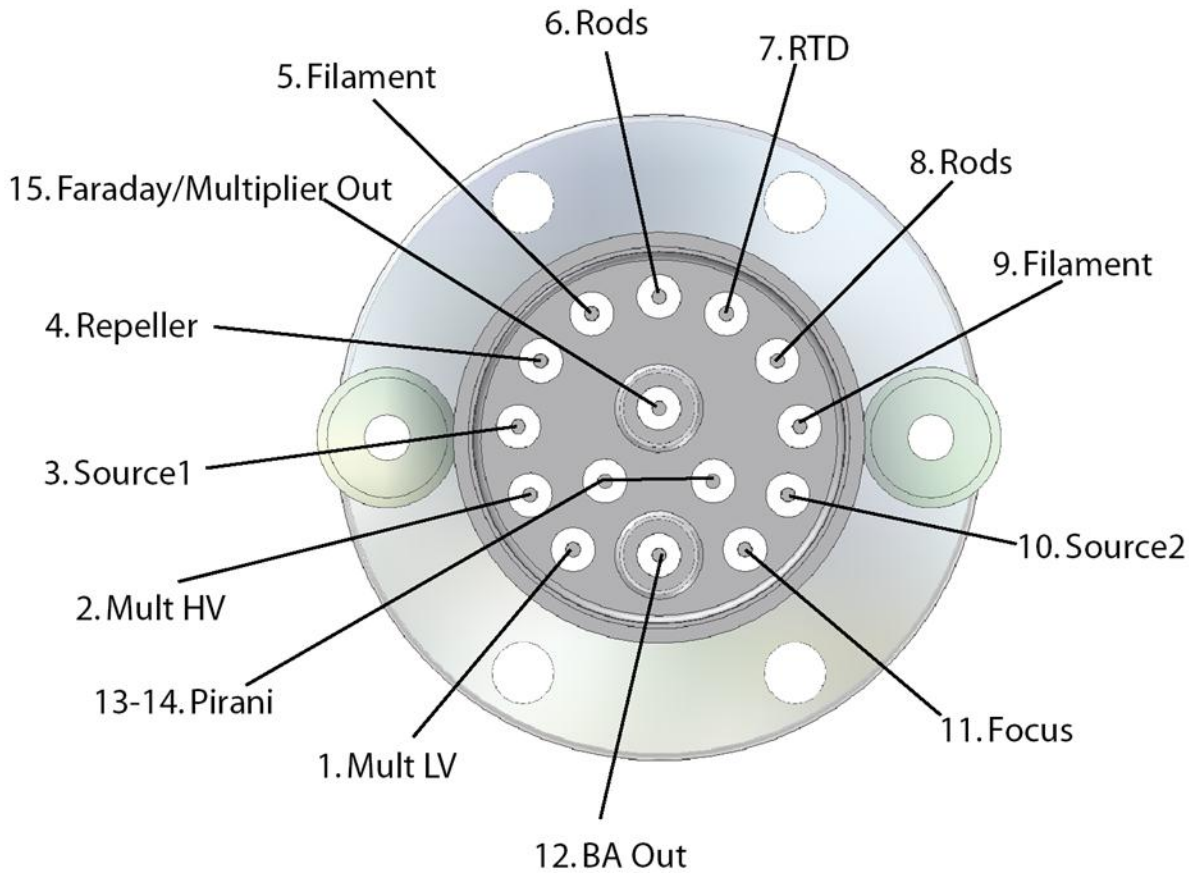


Figure 8. Flange Pin-Out

Use an Ohm meter to check the probe for shorts by measuring the resistance to ground of all pins. They should all have very high resistance (Mega ohms) to ground except for the RTD (pin7) which should be on the order of 1000 ohms to ground and the daisy chained Pirani Pins (13 & 14) which should be on the order of 5 ohms to ground. The resistance between filament leads should be low, perhaps half an ohm. If this checks out, your probe installation is most likely OK. If not, recheck the port inside diameter and port flange trueness to 90 degrees. The probe requires a port and/or nipple with an inside diameter of at least 1.375 inches. If the filaments are open, this will require a new filament assembly.

4.4. Connect the XTP CCU to the Probe and the XTP Host

Attach the XTP CCU to the back of the probe being careful to match up the flange pins to the socket on the XTP CCU. The XTP CCU should slip fairly easily onto the flange unless flange pins have been bent. Improper alignment may cause pins to bend further so do not use excessive force. Insert the XTP CCU mounting bolts through the holes in the XTP CCU. Carefully start the threads of the mounting bolts in the mounting ears of the probe. You may need to stop the threaded inserts in the mounting ears from spinning by placing a finger on the back of them while starting the XTP CCU mounting bolts. Hand tighten the XTP CCU mounting bolts and the XTP CCU will be firmly attached to the probe. These mounting bolts give electrical, mechanical, and thermal stability to the unit and must be installed and tightened.
The XTP Host comes screwed to the back of the XTP CCU. Connect the two with the supplied 4 inch RJ11 cable, from the port labeled **TO CTRL** on the bottom of the XTP Host to the port labeled **CTRL** on the bottom of the XTP CCU. This is the RS-232 link between them.
The XTP Host can optionally be removed and used elsewhere, for example at a desk away from the vacuum system. Remove the two Phillips screws holding it to the back of the XTP CCU and connect it with a longer RJ11 (6P4C) cable in place of the supplied 4 inch cable (see Section 5.4.3).

4.5. Connect the Power Supplies

Connect the **24 V power supply** (barrel jack) to the XTP CCU and the **5 V USB-C power supply** to the XTP Host, then plug both supplies into AC wall outlets. Both connect to the bottom of the units, and may be connected in any order. To confirm the XTP Host has power, look for the red or yellow light next to its USB-C power connector. Allow up to a minute after power-up before connecting to the RGA.

To view the XTP interface, connect to the XTP Host as described in Chapter 5. Sections 4.6 and 4.7 use the XTP interface.

4.6. Resonating RF Coil

The XTP CCU is tuned to its probe at the factory and ships ready to use, so resonating the RF coil is not normally needed during installation. It is only needed when an XTP CCU is moved to a different probe, or if the RGA is not reaching its full mass range. Tuning is done from the XTP interface (see Chapter 5).
Each Extorr probe and each XTP CCU is unique. When an Extorr system is delivered, the probe and XTP CCU are tuned for maximum performance in the factory test chambers as a matched set. When an XTP CCU is moved to a different probe, or the RGA is placed in a new vacuum system, the RF coil may be slightly off resonance and can be re-adjusted. This may be done when the system is at atmospheric pressure or at high vacuum.
Use the plastic screw driver supplied for tuning, and remove the two plastic plugs from the sides of the XTP CCU. In the XTP interface, set the configuration panel to **Advanced** using the Basic/Advanced switch at the top of the panel. Calibration settings are greyed out in Basic mode. Then set **Mode** in the Operating Parameters to “RFCalibrate” and click Apply. The graph shows a horizontal line that should measure between about 16 volts and 24 volts on the RF Mod Volts scale. If the line is near 0 volts, the RF circuitry in the XTP CCU is disabled, either by the Pirani gauge at atmospheric pressure or by the ion gauge at high vacuum.
If your vacuum system is at atmospheric pressure and the line is near 0 volts, the Pirani gauge may need to be recalibrated. Press the “Recalibrate” button next to the Pirani atmospheric pressure calibration parameter, then click Apply. This recalibrates the Pirani gauge at atmospheric pressure and should enable the RF circuitry. The line should then measure between 16 volts and 24 volts, and the RF coil is ready to be adjusted.
If your vacuum system is at high vacuum and the line is near 0 volts, make sure the filament is on. The filament indicator at the top of the XTP interface shows whether the filament is on, waiting or asleep; hover

over it for more detail. The filament goes to sleep when the pressure is above the Target Pressure setting, and immediately if the pressure is above $5x10^{-3}$ torr. Once the filament is on, the line should measure between 16 volts and 24 volts, and the RF coil is ready to be adjusted.
Using the plastic screw driver, slightly turn a tuning slug in one direction and note if the line goes up or down. If it goes up, turn in the other direction to make the line go down. After the line has gone down, do the same thing with the tuning slug on the other side of the XTP CCU. Go back and forth between slugs until the line is at its lowest position and all other turning just makes the line go up. The system is now RF tuned. Replace the plugs in the XTP CCU. When finished, set Mode back to “Sweep” and click Apply to leave the RFCalibrate mode.

4.7. Start Pump Down

The RGA starts making Pirani gauge measurements as soon as the XTP CCU is powered, and does not power any element that could be harmed at the current pressure. You may now start your pump down procedure. The Pirani and Total Pressure readings are shown at the top of the XTP interface.
When the pressure falls below $3x10^{-2}$ torr, the B/A ion gauge will start to operate and finally, when the pressure falls below $5x10^{-3}$ torr, the quadrupole will begin to operate.
The XTP interface shows the Mass Sweep graph, with the Pirani, Total Pressure and Target Pressure graph below it. The RGA scans in the Mass Sweep mode from 1 amu to the highest rated mass of the system.

5. Connecting to the XTP

To get up and running the quickest way, go straight to Section 5.1, Fast Track.

There are three ways to connect to the RGA, shown in Figure 9: **A. Wired (Ethernet)**, **B. Wi-Fi**, and **C. Standalone** (an HDMI monitor, USB keyboard and USB mouse plugged into the XTP Host). Wired and Wi-Fi each have two variations: A1 connects straight to a PC, A2 to an existing network, B1 to the XTP Host's own Wi-Fi network, and B2 through your facility's Wi-Fi network.

Out of the box, the XTP Host's Ethernet is set to Automatic (DHCP), so A1 and A2 work, and the XTP Host broadcasts its own Wi-Fi network (B1). It does not join your facility's Wi-Fi network (B2) until it has been set up to do so. If the RGA has been used before, someone may have changed these settings, and some methods may no longer work. This chapter covers both cases. If you are not sure how an RGA has been set up, use A1, which works no matter how the network settings have been changed.

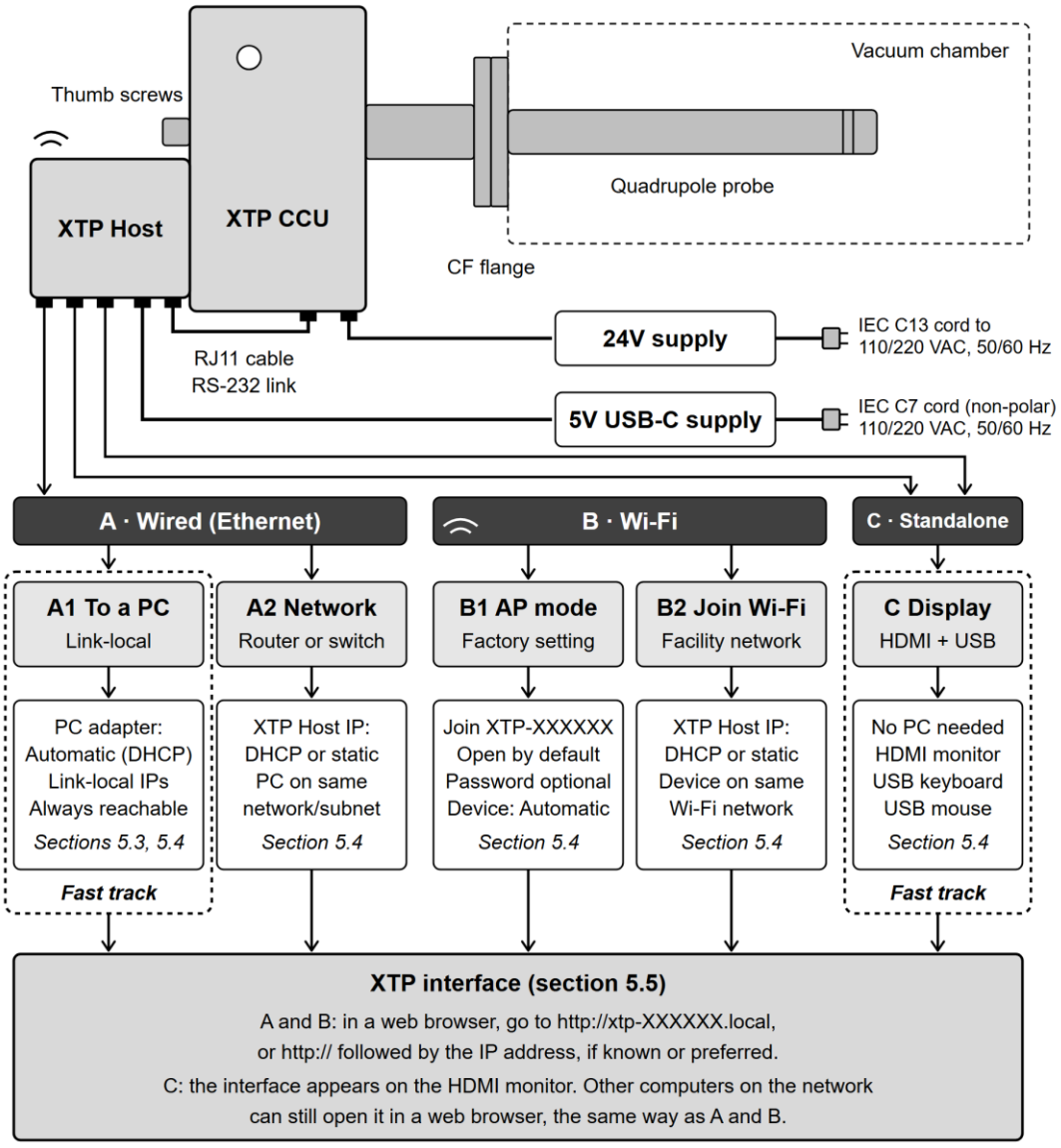


Figure 9. XTP RGA Hardware and Connection Methods

5.1. Fast Track

If you just want to get the RGA up and running, try one of these two methods first. Either can be used as a permanent setup. For other setups, such as connecting through an existing network or Wi-Fi, see Sections 5.2 to 5.7.

A1. Ethernet to a PC. Plug the supplied USB to Ethernet adapter into your computer, and connect it to the bottom of the XTP Host with the supplied Ethernet cable. Find the 6-digit Serial Number (S/N) on the label on the XTP Host. Open a web browser and go to http://xtp- followed by the Serial Number and .local.

For example, for S/N 123456, go to **http://xtp-123456.local**.

It can take up to a minute after the cable is connected for the connection to be set up, so if the page does not load straight away, wait and try again. If A1 does not connect, continue with Section 5.2.

C. Monitor, Keyboard and Mouse. Plug an HDMI monitor, a USB keyboard and a USB mouse into the bottom of the XTP Host. The XTP interface appears on the monitor once the XTP Host has started. Nothing else needs to be set up. If you would rather use the RGA from a desk away from the vacuum system, remove the two Phillips screws holding the XTP Host to the back of the XTP CCU, move the XTP Host, and connect it to the XTP CCU with a longer RJ11 (6P4C) cable.

5.2. Hostname and Network Settings

Each RGA has its own network name (hostname) in the form **xtp-XXXXXX**, where XXXXXX is the 6-digit Serial Number (S/N) of your RGA. The Serial Number is on the label on the XTP Host. The hostname cannot be changed.

All of the RGA's network settings are in the XTP interface under **System → Settings**, on the **Network** tab. From the factory they are:

Ethernet: Automatic (DHCP). The XTP Host gets an address from your network when it is plugged into one. The Ethernet port can instead be set to a static IP address. Either way, the XTP Host always keeps a link-local address (169.254.x.x) on its Ethernet port as well, which is what makes A1 work.

Wi-Fi: AP (access point) mode (B1). The XTP Host acts as an access point, broadcasting its own Wi-Fi network named XTP-XXXXXX, with no password. It can instead be set to join an existing Wi-Fi network (B2), with an automatic (DHCP) or static IP address, or turned off.

5.3. Computer Network Adapter Settings

Every network connection on your computer is a separate network adapter with its own settings. This includes the built-in Ethernet port, a USB to Ethernet adapter and Wi-Fi. Each adapter is set either to **Automatic (DHCP)**, which is the normal setting, or to a manual (static) IP address. The adapter you use to connect to the RGA should be set to Automatic (DHCP). Most computers are already set this way unless someone has changed them, but it is worth checking, since a wrong adapter setting is the most common reason a connection fails.

This matters most for A1. With no network present, an adapter set to Automatic (DHCP) gives itself a link-local address, which is how it finds the RGA. An adapter set to a static address does not. It will only reach the RGA if its static address happens to be on the same subnet as the RGA, and otherwise will not connect at all. Computers that have been used with other lab instruments often have an Ethernet port set to a static address. Before changing an adapter, write down its current settings so you can put them back later.

The supplied USB to Ethernet adapter is set to Automatic (DHCP) the first time it is plugged into a computer, unless it has been changed on that computer before. This makes it an easy way around a built-in Ethernet port that has been set to a static address.

Windows 11: Open Settings, select "Network & internet", then select the adapter (for example "Ethernet"). "IP assignment" should show "Automatic (DHCP)". If it shows "Manual", click "Edit" and choose "Automatic (DHCP)".

Windows 10: Open Settings, select "Network & Internet", select the adapter (for example "Ethernet"), then click the connection. Under "IP settings", "IP assignment" should show "Automatic (DHCP)". If it shows "Manual", click "Edit" and choose "Automatic (DHCP)".

Any version of Windows: Open Control Panel, select "Network and Sharing Center", then "Change adapter settings". This lists every network adapter on the computer. (A shortcut to the same list is to press the Windows key + R, type ncpa.cpl and press Enter.) Double-click the adapter you will use to open its Status window, click "Properties", then double-click "Internet Protocol Version 4 (TCP/IPv4)". "Obtain an IP address automatically" should be selected (Figure 10).

Finding the right adapter: if you are using a USB to Ethernet adapter, unplug it and plug it back in while watching the list of adapters. The one that disappears and comes back is the one to check. This does not work for a built-in Ethernet port.

macOS: Open System Settings, select Network, select the adapter, then click Details and TCP/IP. "Configure IPv4" should be set to "Using DHCP".

Linux: the steps depend on the distribution. For A2, B1 and B2, set the adapter's IPv4 method to Automatic (DHCP). For A1, note that some Linux systems do not fall back to a link-local address on their own; if A1 does not connect, set the adapter's IPv4 method to "Link-Local Only".

Changing adapter settings needs administrator rights. On a company-managed computer you may need your IT department to make the change, or you can use a different computer.

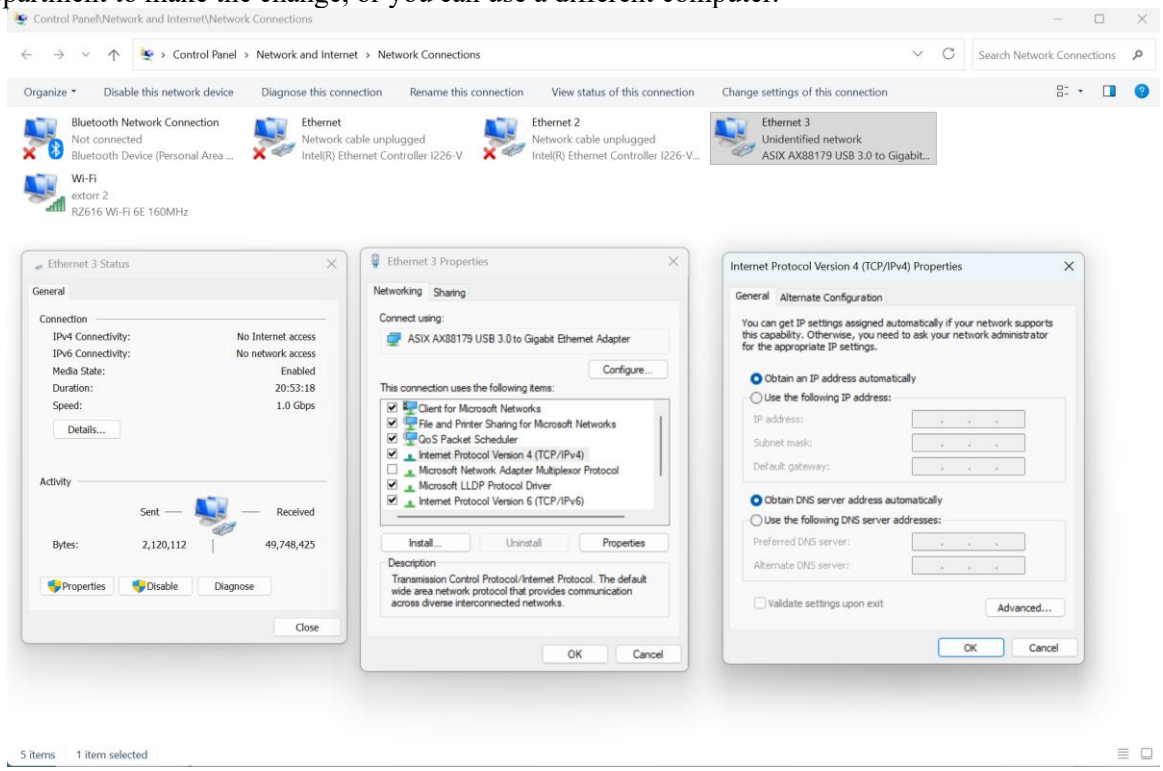


Figure 10. Windows adapter settings: the adapter (here a USB to Ethernet adapter), its Status and Properties windows, and IPv4 set to obtain an IP address automatically

5.4. Connection Methods

Use any of the methods below. All cables connect to the bottom of the XTP Host. The RGA uses IPv4 only.

5.4.1. Wired (Ethernet): A1 and A2

A1. To a PC (recommended). Plug one end of the supplied Ethernet cable into the XTP Host and the other end into your computer's Ethernet port, or into the supplied USB to Ethernet adapter. No router or network is needed. With your computer's adapter set to Automatic (DHCP) (Section 5.3), the XTP Host and your computer each give themselves a link-local address (169.254.x.x) and find each other by hostname. This can take up to about a minute after the cable is connected.

The XTP Host always keeps its link-local address, even if its Ethernet has been set to a static IP address or Wi-Fi has been turned off. This means A1 works no matter how the RGA has been set up. If it does

not work, the cause is almost always the computer's adapter settings (Section 5.3), or less often its name lookup (Section 5.5).

A2. To a Network. Connect the XTP Host to a router, network switch or wall jack with an Ethernet cable. Your computer must be on the same local network. How the RGA is reached depends on its Ethernet setting:

Automatic (DHCP), the factory setting: the XTP Host gets an address from the network's DHCP server and is reached by hostname.

Static IP address: the XTP Host uses the address it was given and is reached by hostname or by that address. The address must suit the network it is plugged into. If it does not, the RGA cannot be reached this way. Use A1 to correct the setting.

Some company networks block the hostname lookup used in Section 5.5. If you cannot reach the RGA by name, use its IP address (your IT department can find it), or use A1.

5.4.2. Wi-Fi: B1 and B2

Your computer, tablet or phone's Wi-Fi adapter must be set to Automatic (DHCP), which is almost always the case for Wi-Fi.

B1. AP Mode (factory setting). The XTP Host acts as a Wi-Fi access point (AP), broadcasting its own Wi-Fi network named XTP-XXXXXX. Open the Wi-Fi settings on your device and join it (Figure 11). From the factory there is no password. If someone has added one, you will need it, or use A1 or C. While connected to the RGA's Wi-Fi, your device may not have internet access.

B2. Join a Wi-Fi Network. The XTP Host joins your facility's Wi-Fi network instead of broadcasting its own. As with Ethernet, it gets its address from that network automatically (DHCP) or uses a static IP address, and is reached by hostname or IP address from devices on that network, as in A2.

To switch between B1 and B2, add a password to the RGA's own network, or turn Wi-Fi off, go to **System → Settings**, on the **Network** tab. Wi-Fi is turned off by setting the Wi-Fi drop-down to "Off".

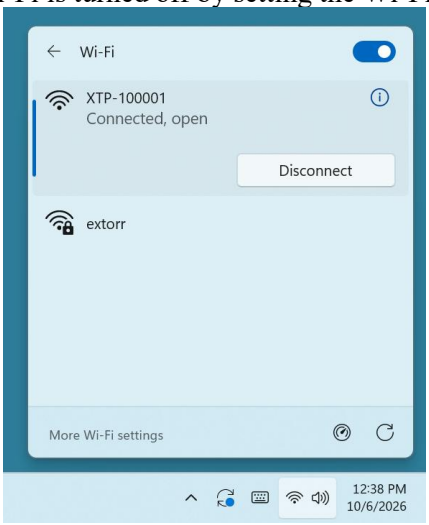


Figure 11. Windows connected to the Wi-Fi network of an RGA in AP mode (B1)

5.4.3. Standalone: C

No computer is needed. Plug an HDMI monitor, a USB keyboard and a USB mouse into the XTP Host. The XTP interface appears on the monitor. This works regardless of the network settings, and other computers can still connect using A or B.

To use the RGA from a desk away from the vacuum system, the XTP Host can be moved. Remove the two Phillips screws holding the XTP Host to the back of the XTP CCU, place the XTP Host where you want it, and connect it to the XTP CCU with a longer RJ11 (6P4C) cable in place of the supplied 4 inch cable.

5.5. Opening the XTP Interface

With C, the interface is already on the monitor. With A or B, open a web browser (Chrome, Edge, Firefox or Safari) and type **http://xtp-XXXXXX.local** into the address bar, replacing XXXXXX with your RGA's

Serial Number. If you know the RGA's IP address, or prefer to use it, type http:// followed by the address instead. Be sure to include "http://", otherwise some browsers will run a web search instead of opening the RGA. The XTP interface opens in the browser (Figure 12).
Windows 10 and 11, macOS, iOS and most Linux systems find ".local" names automatically. On older versions of Windows, try **http://xtp-XXXXXX** without the ".local". Windows 7 or newer with an up-to-date web browser is required. Finding the RGA by name relies on mDNS, which modern operating systems include by default. If the RGA can be reached by its IP address but not by name, name lookup on the computer is the likely cause.

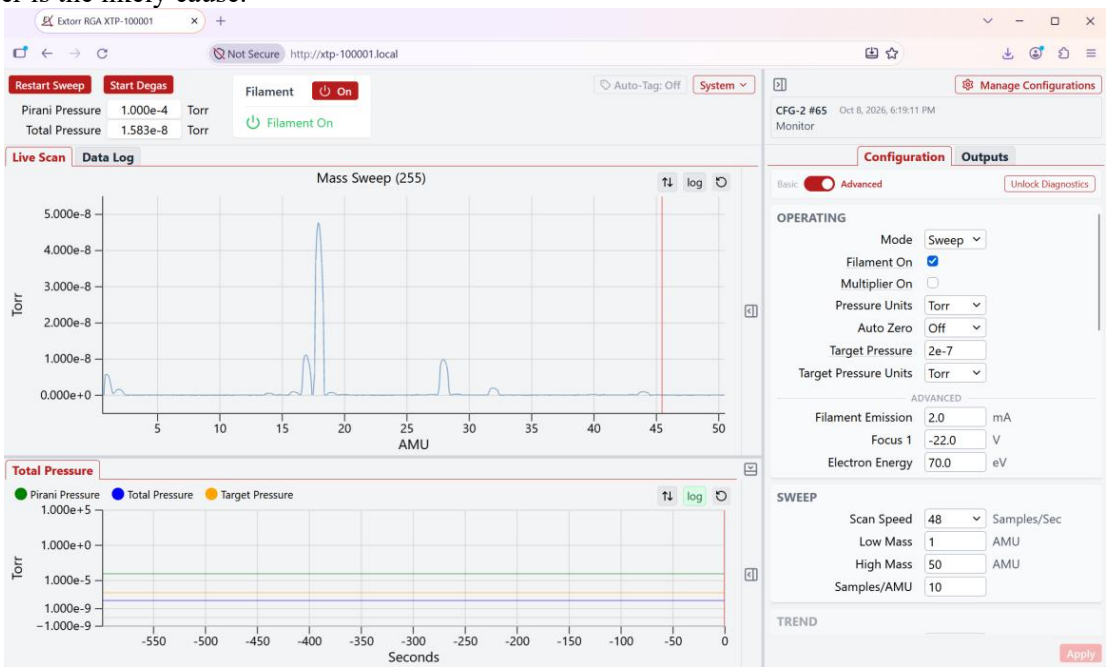


Figure 12. The XTP interface in a web browser at http://xtp-100001.local (S/N 100001)

A note on Wi-Fi: from the factory, the RGA's Wi-Fi network has no password, so anyone nearby can join it and use the RGA. Once you are up and running, add a Wi-Fi password, or turn Wi-Fi off if you do not use it. Either takes a minute under System → Settings, on the Network tab.

5.6. If You Cannot Connect

First check the basics. Make sure the Ethernet cable is connected at both ends and the XTP Host is powered, then wait a minute and try again. If your computer is connected to a VPN, disconnect it. When using A1, temporarily turn off your computer's Wi-Fi so that it does not look for the RGA on the wrong network.
If someone else has set up the RGA and you do not know its settings, use this table:

If the RGA is set to…	**Connect using…**
Factory settings (new RGA)	Any method: A1, A2, B1 or C.
Ethernet: Automatic (DHCP)	A1, or A2 on a network with a DHCP server.
Ethernet: static IP address	A1, or A2 from a computer on the same subnet (by hostname or IP address).
Wi-Fi: AP mode with a password	B1 with the password. If you do not know it, use A1 or C and change it.
Wi-Fi: joined to a network	B2 from a device on that Wi-Fi network, or A1 or C.
Wi-Fi: off	A1, A2 or C.
Unknown	**A1, with your computer's adapter set to Automatic (DHCP) (Section 5.3), or C.**

Once connected, you can view and change all of the RGA's network settings under System → Settings, on the Network tab.

5.7. Restoring the Network Settings to Factory Defaults

This should rarely be needed, since A1 works whatever the network settings are. To reset them, plug a USB keyboard into the XTP Host, power on the XTP Host and wait 20 seconds. Then press and hold **Left Ctrl + Left Shift + Left Alt + G + U + L** together. The light next to the XTP Host's power connector normally changes from yellow to red, and the XTP Host restarts on its own. This returns the network and time settings to their factory defaults. It does not affect the RGA configuration or saved spectra.

6. Principles of Operation

6.1. General theory of Operation

Vacuum measurement requires that some device, be it mechanical, thermal, or electrical, interact with the gases of the vacuum system to produce a voltage or a current which may be related to pressure. For the Extorr XTP systems, the highest pressure measuring device is the Pirani gauge. A thin, platinum wire with a precisely regulated current passing through it is located on the flange end of the probe. A precise measurement of the wire's temperature yields a reproducible function of gas pressure. This gauge is calibrated for nitrogen but is roughly the same for air. Other gases, such as pure argon, may cause misleading readouts. These may be corrected using a Pirani conversion chart.

At about 5 x 10^{-3} torr, the hot cathode B/A ion gauge starts into operation at a reduced emission level. Dual thoria coated iridium filaments produce electrons which are directed into a well defined volume. Within this volume, ions are produced and collected by a small diameter wire. The magnitude of this current is directly proportional to the pressure of the gas in the volume. Again this device is factory calibrated for nitrogen but the user may change the sensitivity factor for other vacuum gases as is given in Appendix B.

Finally after the B/A ion gauge measures a pressure below 1 x 10^{-4} torr, the quadrupole analyzer may be turned on. Now ions are extracted from a second volume. These ions are directed along the axis of a set of four parallel rods, precisely separated and aligned, to produce a nearly perfect hyperbolic field. With just the right combination of radio frequency (RF) potential and direct current (DC) potential, an ion, with just the right mass to charge ratio, will be directed through the rods to a Faraday cup ion collector. All other mass to charge ratios will be rejected long before the ion is collected. By carefully scanning the RF and DC potentials, a mass spectrum, consisting of a number of ion current peaks, may be generated. If the electron multiplier option was chosen, then the ion current may be converted to an amplified electron current. The amplified current will allow mass spectra to be generated at a far greater speed. The multiplier may also increase the ultimate detection sensitivity by a factor of over 1000.

All molecules have their own unique mass spectrum. Those familiar with residual gas analyzers will immediately recognize the mass spectral signatures of those gases frequently encountered. These people will immediately tell you that the cascading intensity of peaks from 18 to 17 to 16 is due to the presence of water. A four to one ratio of peak heights at 28 and 32 indicates that you have an air leak (or the residual air has not yet been pumped down). They would expect peak 44 in even a well sealed stainless chamber. A surprise peak or set of peaks may take longer to identify but commonly available data bases, and the information available on the Internet, make the solutions to many of these puzzles available to non-specialists. Often all that is required is to type "mass XXX peak" into an internet search engine.

Of course, in residual gas analysis, you must expect that a number of different gases will produce peaks at the same time. The residual gas spectra will be a combination of pure spectra. In fact, the user may see the mass spectrum of a pure compound only when the chamber is backfilled with that gas.

6.2. Pirani Readout



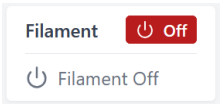
The Pirani gauge is used for measuring rough vacuum pressures from atmosphere down to about 10^{-4} torr and will operate when the filaments are off. The Pirani gauge is calibrated at the factory. It may be recalibrated in the future, at atmosphere and at high vacuum pressures, using Pirani 1 Atm and Pirani Zero in the Calibration Parameters (Section 7.5.4.3).

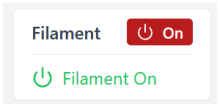
6.3. B/A Ion Gauge Readout



The B/A Ion Gauge readouts start when the pressure is below the Pirani measurement limits (about 5 x 10^{-3} torr). Once on, the Ion Gauge reads continually protecting the system from over pressure. The Ion Gauge pressure reading will always update at the beginning of a scan and may update more frequently if it can during a scan. A blank Ion Gauge reading indicates that the total pressure of the system is not known, for example when the filament is off.

6.4. Filament Activation Switch





The filaments, which produce electrons for both the B/A ion gauge and the quadrupole analyzer ion source, are turned on and off with the **Filament** switch in the top bar of the XTP interface, or with **Filament On** in the Operating Parameters section of the configuration panel.

When the filaments are turned on by either control, the RGA keeps them on for up to 120 seconds (2 minutes) so that the ion gauge can measure the vacuum chamber pressure. If the measured Total Pressure is greater than the "Target Pressure" setting in the Operating Parameters, the RGA turns the filaments off (puts them to sleep) to preserve the life of the filaments and ionizer. The filaments go to sleep immediately, without staying on for 120 seconds, if the Total Pressure is above about 5x10^{-3} torr.

The filament indicator in the top bar, below the Filament switch, always shows the current state in plain words, and hovering the mouse over it gives more detail. The text is also color coded, but the colors do not need to be memorized. The states are:

Off: the filaments are switched off. The Total Pressure reading is blank because the total pressure is not known.

Waiting for rough vacuum: the filaments are switched on, but the Pirani reading is above about 3x10^{-2} torr. The filaments stay off until the pressure is low enough for the ion gauge.

Waiting for high vacuum: the ion gauge is operating with the filaments at reduced emission, but the pressure is above about 5x10^{-3} torr, too high for the quadrupole.

Waiting for target pressure: the Total Pressure is above the Target Pressure setting, and the sleep countdown has started. The filaments go to sleep when the countdown reaches zero.

Asleep: the filaments have been turned off to protect them, because the pressure stayed above the Target Pressure. Turning the Filament switch off and on again starts a new 120 second attempt.

On: normal operation. The quadrupole is scanning.

Tripped: the filaments have been turned off because the XTP CCU detected a problem. To reset, turn the Filament switch off and then on again. If the filaments trip again, there may be a problem on the quadrupole probe or the filaments may be burned out; see Section 10.2, Filament Trip Diagnosis.

The filament setting is saved with the configuration. If the filaments are left on, the turn-on sequence runs automatically: when the Pirani reading falls below about 3x10^{-2} torr, the filaments turn on at a reduced emission level for the ion gauge, and when the ion gauge measures a pressure below about 5x10^{-3} torr, the quadrupole begins operation. The ion gauge continually monitors the vacuum and protects the RGA from over pressure.

6.5. High Pressure Operation

The RGA will operate at 10^{-4} torr and give meaningful results, but if the major components are water or oxygen, the stainless steel parts in the ionizer will oxidize. Chromium oxide (an insulator) will form on the ionizer surfaces because the temperature gets to about 200°C in normal operation. This will lead to low partial pressure sensitivity in as little as a few hours and may require replacement of the filament and ionizer to restore the sensitivity.

Lowering the operating pressure will slow down the oxidization of the ionizer surfaces.

For example it may take many weeks for the surfaces to oxidize at pressures between $1x10^{-6}$ torr and $1x10^{-7}$ torr. At pressures between $1x10^{-7}$ torr and $1x10^{-8}$ torr the ionizer surfaces will oxidize after many months of operation and at pressures below $1x10^{-8}$ torr, the ionizer should operate for many years.
It is not a good idea to leave the filament on at pressures above $1x10^{-5}$ torr for any longer than necessary. The total pressure will usually read correctly even if the partial pressure sensitivity is low. The B/A type gauge measuring the total pressure uses higher voltages and works with more energetic ions that are less susceptible to stray fields.
The life of the filament may also be shortened if operated at high pressures because it must run hotter to maintain the electron emission current speeding up the decomposition of the thoria coating.
Cleaning the ionizer is difficult if not impossible in most cases, so replacement is the remedy if the stainless steel surfaces have been oxidized.

Operating the RGA at a high pressure in an inert atmosphere such as Helium or Argon will not cause the ionizer surfaces to oxidize but the mass spectra will be distorted due to ion-molecule collisions. The mass graph baseline will also rise because of metastable ions reaching the detector.
The total pressure will also not read correctly because the gauge is calibrated for nitrogen. If the RGA is operated in mostly Argon, the total pressure will read about 10% higher than the actual pressure. In Helium, the actual pressure will be about a factor of 10 greater than the total pressure reading. See Appendix B Gauge Sensitivity to Differing Gasses for more information.
The life of the filament is also shortened if operated at high pressures because it must run hotter to maintain the electron emission current speeding up the decomposition of the thoria coating.

In many cases, a pressure reduction system made up of a vacuum pump, a manifold, and a glass capillary or small orifice may be the only practical way to analyze gasses at high pressures.

7. The XTP Interface

The XTP interface is the only software needed to operate the RGA. It runs on the XTP Host and is used either in a web browser (Chapter 5) or on a monitor connected to the XTP Host. All configurations, data and settings are stored on the XTP Host, so every computer that connects to the RGA sees the same data.

7.1. The Main Window

By default, the interface comes up displaying a graph of either an analog mass sweep or a trend line of single ion measurements, the total pressure history of the last 10 minutes, filament and pressure indicators, and the configuration panel on the right side.

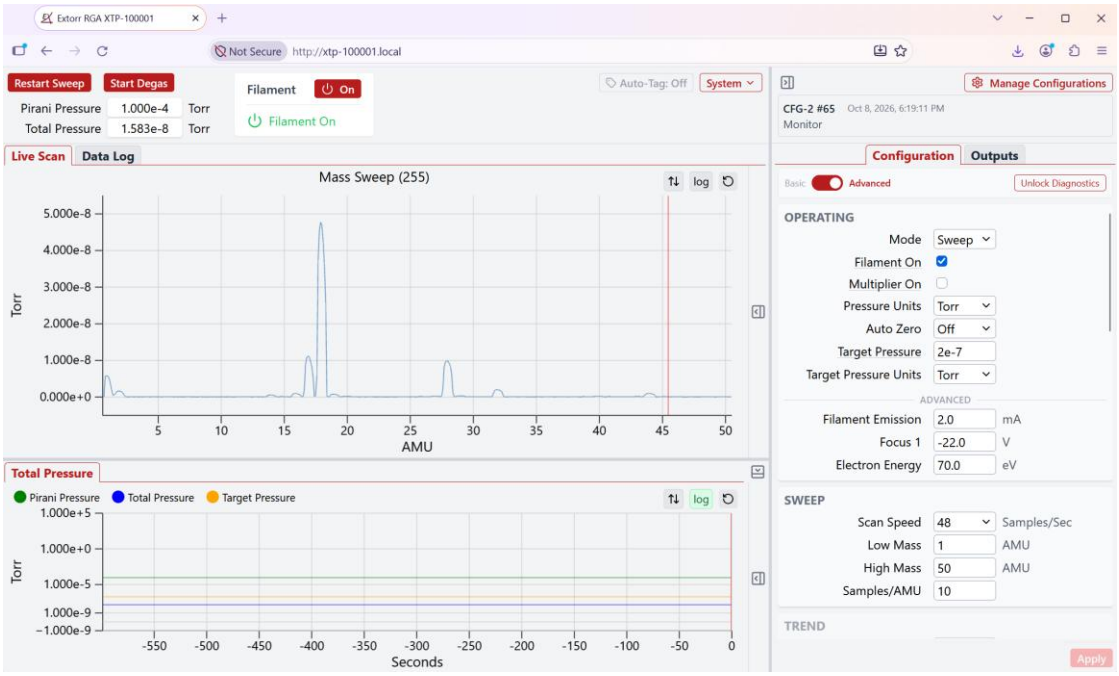


Figure 13. XTP Interface

The window is divided into four areas:

Top bar: Restart Sweep restarts the current sweep, and Start Degas starts an ionizer degas (Section 7.8). Next to them are the Pirani Pressure and Total Pressure readings, the Filament switch with the filament state indicator (Section 6.4), Auto-Tag (Section 7.7.2) and the System menu (Section 7.2).

Main graph area: Live Scan shows the current sweep or trend as it is measured. Data Log lists everything the RGA has recorded (Section 7.7).

Bottom panel: the Total Pressure tab shows the Pirani, Total and Target Pressure over the last several minutes. Sweeps and configurations opened from the Data Log or the Configuration Manager also open here as tabs, which can be closed with their ×.

Right panel: shows the applied configuration and the Manage Configurations button (Section 7.4), with the Configuration tab (Section 7.5) and the Outputs tab (Section 7.6). The panel can be collapsed to give the graphs more room.

7.1.1. Graph Controls

The graphs are controlled directly with the mouse. Scroll over a graph to zoom in or out, and drag to pan. Scrolling over an axis zooms that axis only, and dragging along an axis zooms it as well. The buttons above each graph turn automatic Y scaling on and off, switch between a linear and a logarithmic (log) Y axis, and reset the view.

7.2. System Menu

The System menu at the top right of the window holds the database, software and settings functions:

Backup to USB: copies the entire database, including all spectra, configurations, tags and logs, to a USB drive plugged into the XTP Host.
Restore from USB: restores the database from a backup on a USB drive plugged into the XTP Host. **This replaces the entire current database**, including all spectra, configurations and tags recorded since the backup was made. The interface warns before restoring and asks you to type DELETE to confirm. Make a fresh backup first if there is any data you want to keep.
Update from Browser: installs a software update file from the computer you are using. Software updates are available at no cost from www.extorr.com.
Update from USB: installs a software update from a USB drive plugged into the XTP Host.
Settings: opens the Settings window (Section 7.3).

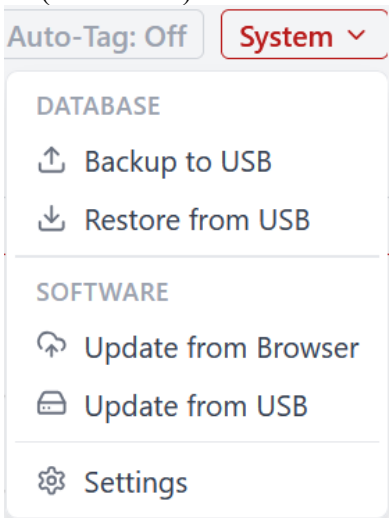


Figure 14. The System Menu

7.3. Settings

Settings opens from the System menu and has five tabs: About, Network, Date & Time, Hardware and Reset. Changes take effect when you click Save, or Apply on the Hardware tab.

7.3.1. About

The About tab shows the XTP Host software version, serial number, model and hostname, along with its CPU load, CPU temperature, memory and disk use. Below that it shows the serial number and model number of the XTP CCU, and whether it has an electron multiplier. This is the first place to look when Extorr asks for your serial numbers or software version.

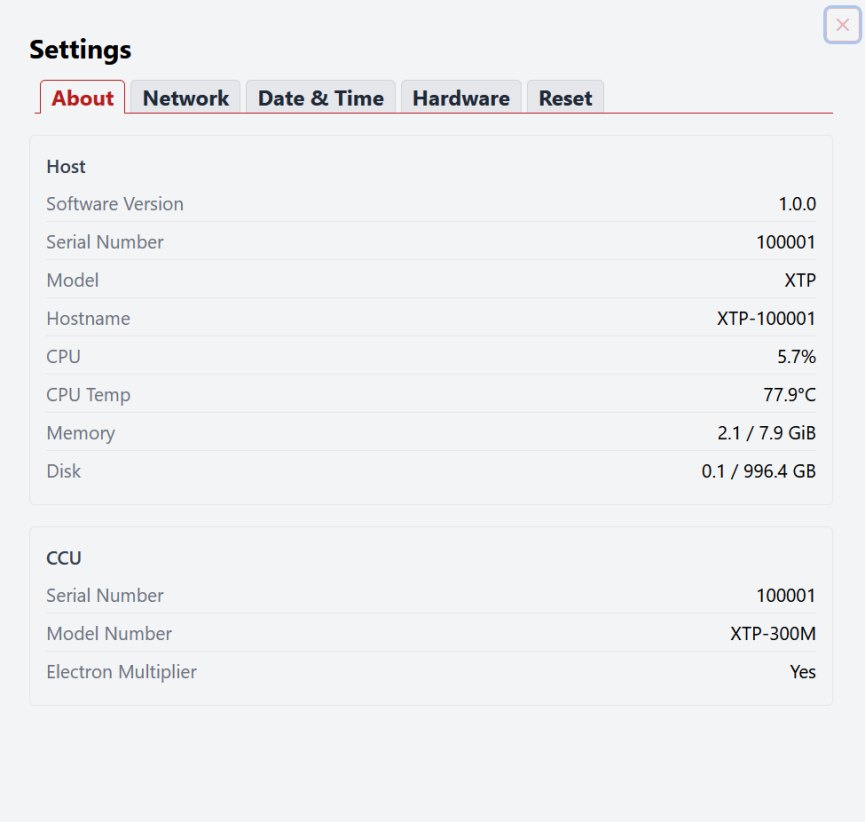


Figure 15. Settings, About Tab

7.3.2. Network

The Network tab shows the current connection status and the address of each interface, followed by the Ethernet and Wi-Fi settings:

Ethernet: IPv4 set to Automatic (DHCP) or Static. For Static, enter the Address with its prefix length (for example 192.168.1.50/24) and the Gateway. DNS servers are optional: separate several with commas, or leave the field blank to use the gateway for DNS. Whichever is chosen, the Ethernet port always keeps its link-local address as well.

Wi-Fi: Mode set to Access Point (the RGA's own network), Join Network (your facility's network) or Off. In Access Point mode an AP Password can be set; if it is left blank the network is open, and anyone in range can connect to the instrument. In Join Network mode, click Refresh to scan for networks (about 4 seconds), choose a network and enter its password, or use Other network for a hidden network. IPv4 can be Automatic (DHCP) or Static, as for Ethernet.

Changing network settings can disconnect the computer you are using. Chapter 5 explains which settings to use for each connection method and how to reconnect if the connection is lost.

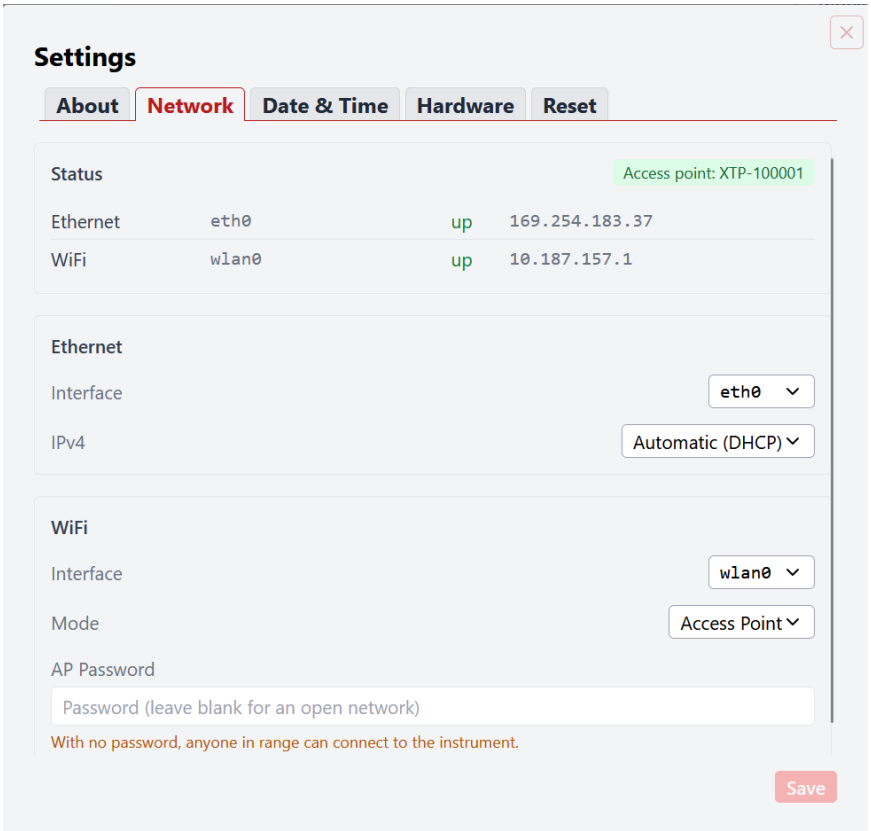


Figure 16. Settings, Network Tab (factory settings: Ethernet Automatic, Wi-Fi Access Point)



Figure 17. Static IP Address Settings

7.3.3. Date and Time

The Date & Time tab sets the time zone used to display dates and times throughout the interface; daylight saving adjusts automatically. It shows the XTP Host's clock next to your browser's clock, and the clock can be set manually. When a network with internet access is available, the XTP Host keeps its clock synchronized automatically (Network Time, NTP). Leave the NTP server blank to use the defaults, or enter a custom server for isolated or lab networks. The XTP Host has a built-in real-time clock, so all data is time-stamped correctly even without a network.

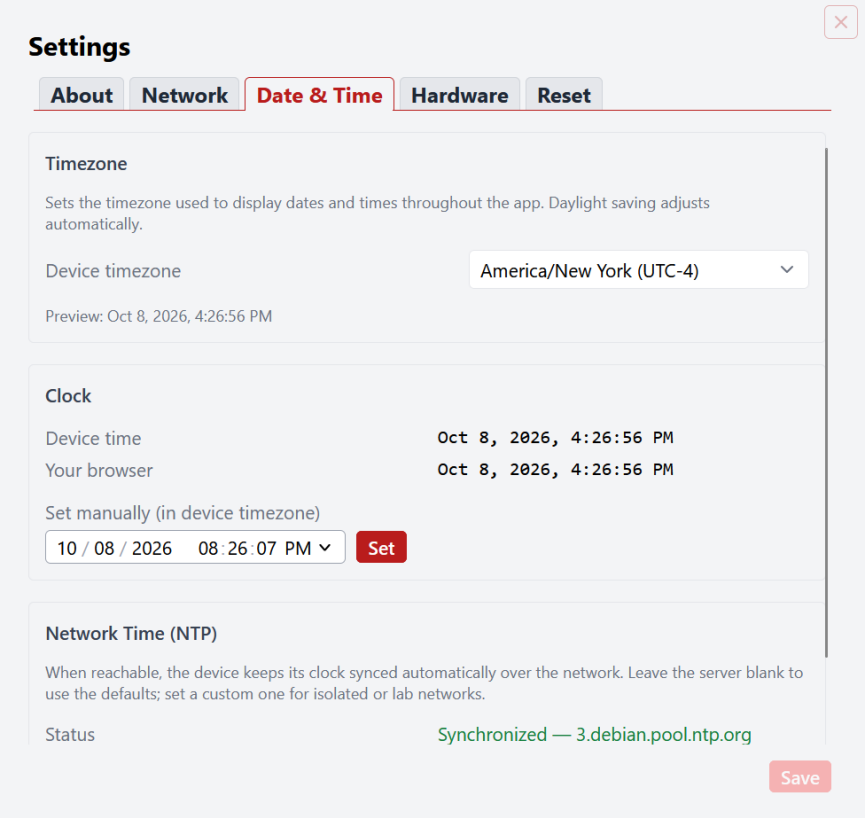


Figure 18. Settings, Date & Time Tab

7.3.4. Hardware

The Hardware tab sets the identity of the XTP CCU, such as whether the unit has an electron multiplier. These settings are made at the factory or when an option is installed and need a password from Extorr. Changing them will restart the XTP CCU.

If an electron multiplier is added to an RGA that was shipped without one, it is enabled here: check Unit has electron multiplier, enter the password from Extorr and click Apply. The password is specific to your XTP CCU; see Section 9.2.4, Enable the Electron Multiplier.

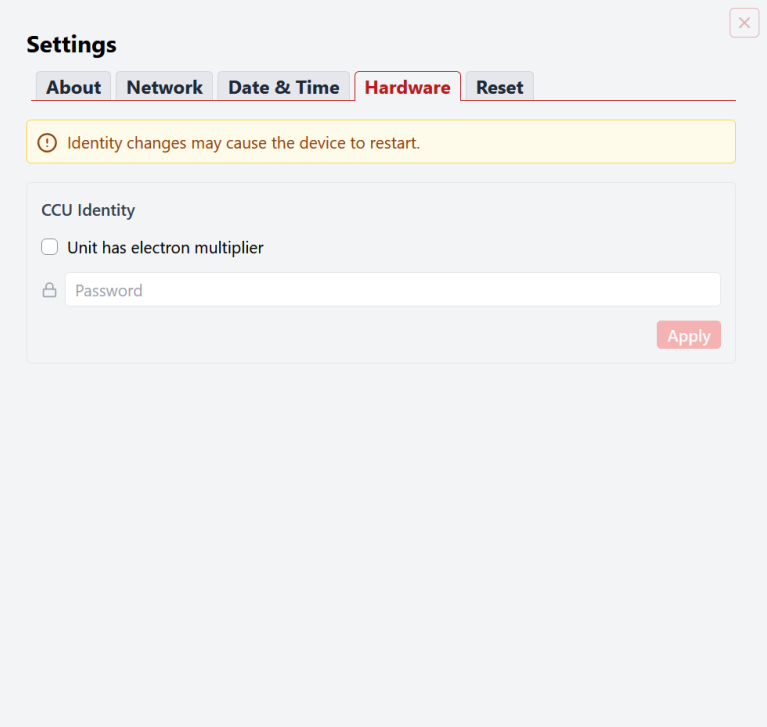


Figure 19. Settings, Hardware Tab

7.3.5. Reset

Factory Reset Settings returns the network and time settings to their factory defaults. The hardware identity, configurations, sweep data, etc. are not affected. If you cannot reach the interface at all, the same reset can be done with a USB keyboard (Section 5.7).

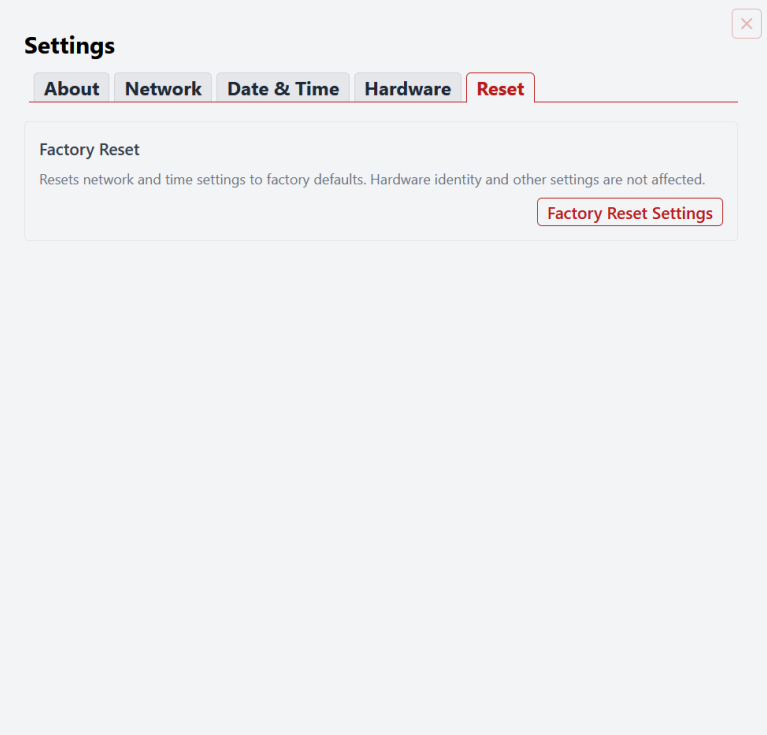


Figure 20. Settings, Reset Tab

7.4. Configurations

A configuration is a complete set of operating parameters: the mode, the sweep and trend settings, the calibration and everything else in the Configuration panel. Every time you click Apply, the change is saved as a new version of the applied configuration, so nothing is ever lost and any earlier version can be applied again.

Configurations make it easy to switch between setups. For example, you might keep one configuration for routine monitoring, another for leak checking, and another for a particular process or experiment, and apply whichever one you need.

The factory configuration, CFG-FAC1, is always present and cannot be changed or applied directly, but it can be viewed, copied and compared against. It is the factory tuning for your RGA. If the RGA is not behaving as expected, copy CFG-FAC1 and apply the copy; it is always a good baseline. None of the tuning parameters should be changed greatly from the factory settings, although slight changes may be needed over time.

7.4.1. Configuration Manager

Click **Manage Configurations** at the top of the right panel to open the Configuration Manager. The list on the left shows each configuration by number and name, with the applied one marked Applied; the others have an Apply button. Use the search box to find a configuration, and **New Config** to create one.

The ⋮ menu next to each configuration offers:

View: opens the configuration in the bottom panel (Section 7.4.2).

Rename: changes the name shown with the configuration number.

Copy: creates a new configuration with the same settings, for example to start from the factory configuration.

Archive: moves the configuration to the Archived tab, where it can be restored. Nothing is ever deleted. The applied configuration cannot be archived.

Selecting a configuration shows its Version History on the right: every version with its date, each with View and Apply buttons. Use Jump To, Older, Newer and Latest to move through a long history.

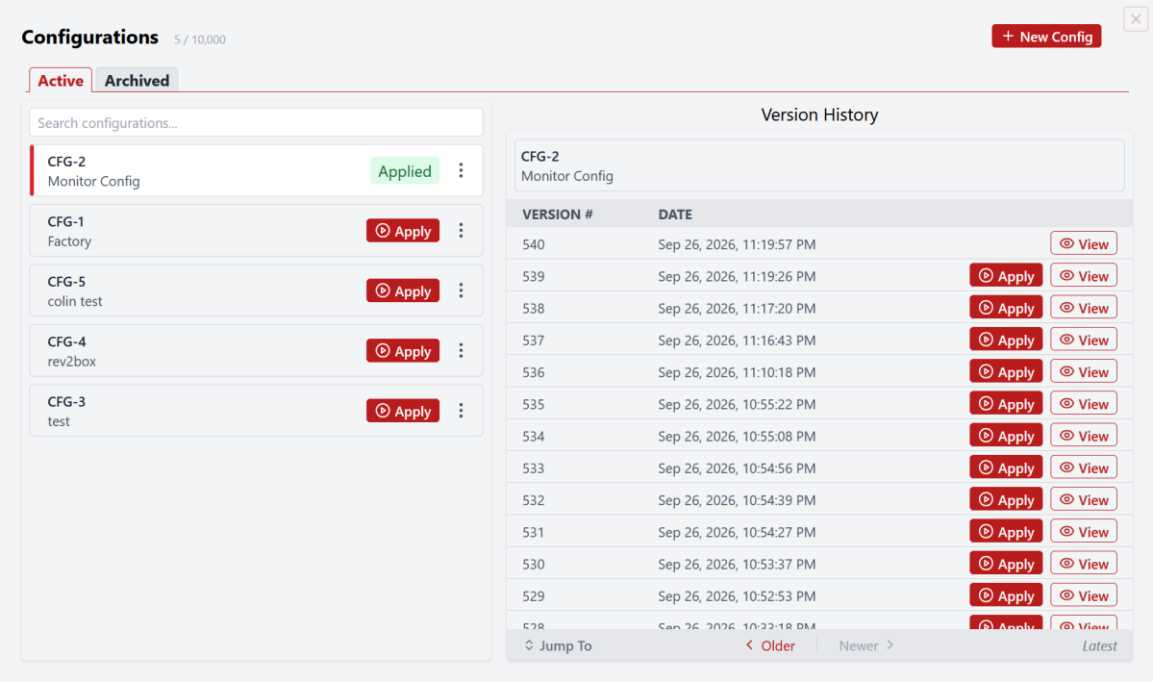


Figure 21. The Configuration Manager

7.4.2. Comparing Configurations

Viewing a configuration or version opens it as a tab in the bottom panel. The ≠ Applied column marks every parameter that differs from the configuration currently applied. Click **+ Diff With A Config** and choose

another configuration to add a second column, labeled with that configuration and version (for example ≠ CFG-2 #60), marking the differences from it as well.

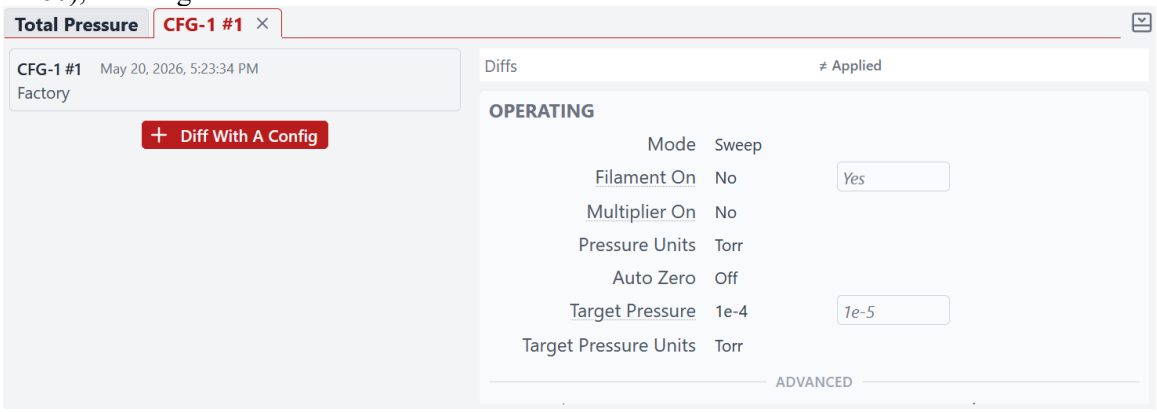


Figure 22. Viewing a Configuration: the ≠ Applied Column Shows Each Difference From the Applied Configuration

7.5. The Configuration Panel

The Configuration tab of the right panel shows every parameter of the applied configuration in one scrolling list, grouped into Operating, Sweep, Trend, Calibration and Diagnostics sections. Only the applied configuration can be edited; to edit a different configuration, apply it first. Changes take effect when you click **Apply** at the bottom of the panel, and each Apply is saved as a new version of the configuration (Section 7.4).

The **Basic / Advanced** switch at the top of the panel controls which parameters can be changed. In Basic mode, parameters that do not normally need adjusting are greyed out and marked with a lock; set the switch to Advanced to change them.

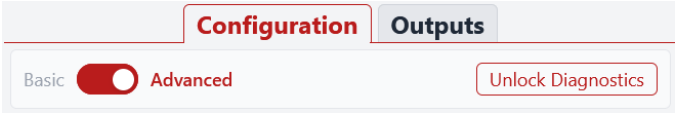


Figure 23. The Basic / Advanced Switch and Unlock Diagnostics

Parameters with a dotted underline show a description when you hold the mouse over them.

7.5.1. Operating Parameters

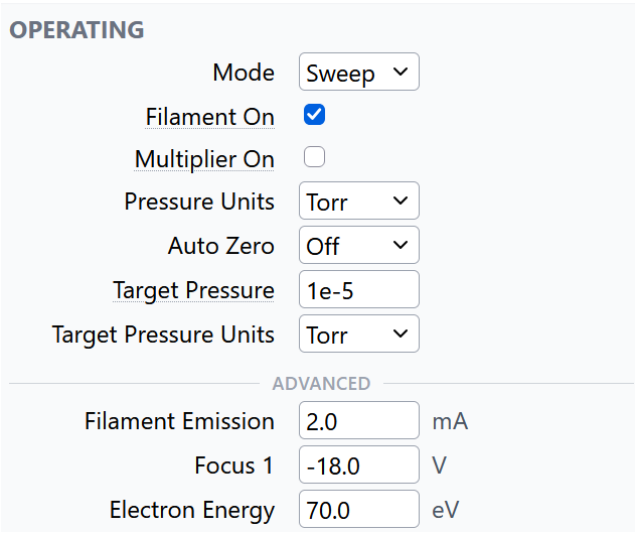


Figure 24. Operating Parameters (Advanced mode)

Mode: Sweep, Trend or RFCalibrate (Section 7.5.1.1).
Filament On: turns the filaments on and off, the same as the Filament switch in the top bar (Section 6.4).
Multiplier On: turns the optional electron multiplier on and off (Section 7.5.1.4).
Pressure Units and **Auto Zero:** see Sections 7.5.1.6 and 7.5.1.5.
Target Pressure and **Target Pressure Units:** see Section 7.5.1.7.
Filament Emission, Focus 1 and **Electron Energy** (Advanced): see Sections 7.5.1.2 and 7.5.1.3.

7.5.1.1. Mode

The Mode sets what the RGA measures:

Sweep: the analog mass sweep, set up in the Sweep Parameters (Section 7.5.2).
Trend: the intensities (partial pressures) of the masses in the Mass Table plotted against time, set up in the Trend Parameters (Section 7.5.3). Each trace uses its own color.
RFCalibrate: used to resonate the XTP CCU RF coil, as described in Section 4.6.

7.5.1.2. Focus

Focus controls the potential which draws the ions out of the ion source grid. It is factory set to give a standard response to a calibration compound at the factory. This may be set to suit the user's tastes especially as the probe ages but is recommended not to deviate too far from the factory setting.

7.5.1.3. Electron Energy and Emission Current

The "electron energy" is the potential placed between the filament and the ion source grid. It is factory set to 70 eV, which is the industry standard for residual gas library spectra. Emission current is the electron current leaving the filament and directed through the source grid. It is set at the factory for high sensitivity when operating with a 70 eV electron energy. The emission current may be set between 0.1 ma and 4 ma. The electron energy may be user set between 11 and 150 volts. However, not all combinations of emission current and electron energy may be set at once. At lower voltages, higher emission currents are not available and the software prompts the user when such a combination will not work. It should be noted that the "Electron Energy" is just the potential difference placed between filament and source grid. The true electron kinetic energy must be corrected for the contact potential difference between the thoria coated filament and the platinum coated source grid. This contact potential difference may place the electron kinetic energy as low as 3.7 eV below the "Electron Energy". There must also be a correction for the voltage drop across the filament.

7.5.1.4. Electron Multiplier

If the XTP model number ends in an "M", the unit was shipped with the electron multiplier option. The multiplier is turned on and off with Multiplier On. Its voltage and gain are calibration settings, found in the Calibration Parameters in Advanced mode (Section 7.5.4.1).

7.5.1.5. Auto Zero

When Auto Zero is set to Per Sample, the RGA makes a baseline measurement before each sample, at a time when the quadrupole does not allow ions to pass through it. This measurement is subtracted from the ion measurement, eliminating baseline offsets. Since extremely low current measurements can suffer from baseline drift due to thermal or other environmental factors, this reduces the effect as much as possible. Set Auto Zero to Off to turn it off.

AutoZero is important only when attempting to measure very small peaks. The price paid is a doubling of acquisition time.

7.5.1.6. Pressure Units

The system may display total pressures and partial pressures using a number of different units. The units chosen may be selected from the "Pressure Units" drop down list.

7.5.1.7. Target Pressure

The Target Pressure is the Total Pressure reading required for the filaments to enter the normal operating mode, where they stay on continuously. If the measured Total Pressure is greater than the Target Pressure, the RGA turns the filaments off (puts them to sleep) to preserve the life of the filaments and ionizer (Section 6.4).

The Pressure Units for the Target Pressure setting are selected from the drop down list to the right of the Target Pressure value.
The Target Pressure is set to 1e-7 torr at the factory and may need to be changed for your vacuum system. Use the lowest practical setting to preserve the life of the Filaments and Ionizer.

7.5.2. Sweep Parameters

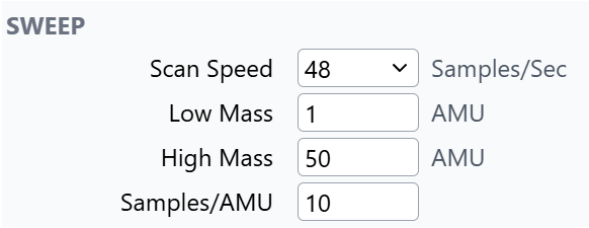


Figure 25. Sweep Parameters

The most fundamental quadrupole RGA output is the analog mass sweep. The graph generated is directly proportional to the ion current measured at each mass to charge ratio, with mass on the horizontal axis and pressure or ion current on the vertical axis. The Sweep Parameters are used when Mode is set to Sweep. The low mass must be less than the high mass and may not be set below 1, and the high mass may not be set above the mass range of the system. The sweep starts about half an amu below the Low Mass and stops about half an amu above the High Mass.
The Samples/amu setting is the number of evenly spaced samples taken within a one amu mass range. This value must be an integer between 6 and 20.
The Scan Speed is the number of samples measured per second. The user must choose from the values in the drop down menu.
The Samples/amu and Scan Speed settings together determine the time required for a scan. For example, a scan speed of 2/sec and a samples/amu setting of 10 would produce a scan rate of 1 amu in 5 seconds or 0.2 amu / second.
Click Apply for the changes to take effect.
The factory setting has the system scanning rapidly from mass one to the maximum mass for the unit (100, 200 or 300 amu). When looking at the residual gases during pump down, it may be useful to concentrate on only the first 50 amu. Do this by setting the low mass to 1 and the high mass to 50.
Since there is always a speed and “signal to noise” tradeoff, the user may wish to reduce the noise by decreasing the Scan speed value.

7.5.3. Trend Parameters

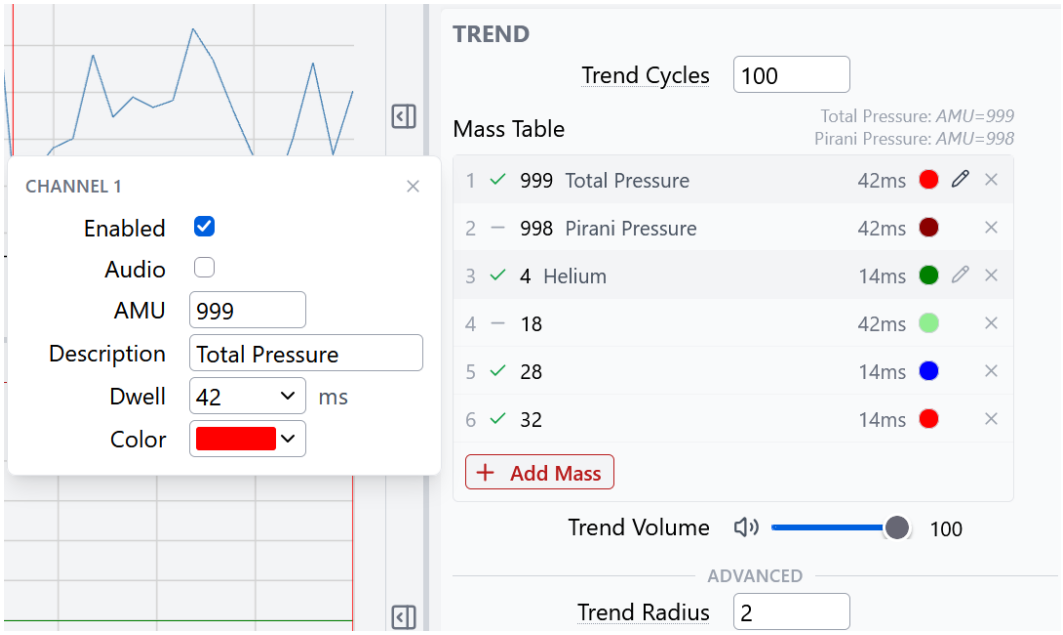


Figure 26. Trend Parameters, With the Settings of One Mass Table Channel Open

In the Trend mode the RGA monitors one or more selected masses over time, for example for leak detection or process monitoring. The masses are listed in the Mass Table, and the Trend Parameters are used when Mode is set to Trend.

Mass Table: each row (channel) is one mass, listed with its number, a check mark if it is enabled or a dash if it is disabled, its AMU and description, its dwell time and its trace color. Disabled channels are not measured. Click **Add Mass** to add a channel, the pencil to edit one, and the "x" to remove it. Editing a channel opens its settings: Enabled, Audio (Section 7.5.3.1), AMU, Description, Dwell (ms) and Color.

Trend Cycles: the number of passes through the Mass Table that make up one trend scan.

Trend Volume: the volume of the leak detect audio tone (Section 7.5.3.1).

Trend Radius (Advanced): the peak detect radius around each mass, which compensates for slight mass miscalibration. The RGA samples in steps of 0.125 AMU around each channel's AMU and reports the largest reading. A Trend Radius of 0 takes one sample at exactly the channel AMU, which may not be the true peak height if the calibration is slightly off. A Trend Radius of 2 takes five samples (AMU − 0.25, − 0.125, AMU, + 0.125 and + 0.25) and reports the largest. A higher Trend Radius makes each channel take longer: a radius of 2 takes five times the dwell time per channel. The recommended setting is 2.

The Pirani Pressure and Total Pressure readings may also be monitored in the Trend mode. Use the special Mass column value of 999 for the Total Pressure and 998 for the Pirani Pressure.

The dwell time is the time spent on each measurement, so with the recommended Trend Radius of 2 each channel takes five times its dwell time. The time for one trend data point is the sum of these times for all enabled channels. Use shorter dwell times and fewer masses for fast changing processes or for leak checking, and more masses and longer dwell times for slowly changing processes or to monitor pressure changes over long periods. Trend data is saved like all other data (Section 7.7).

7.5.3.1. Leak Detection

The Trend mode may be setup for vacuum leak checking with an audio output for the intensity of the leak detect gas. A leak may be found by listening to the audio tone instead of watching a mass peak on the screen. A leak detect gas such as Helium at Mass 4 is entered into the Mass Table. Helium is usually the gas chosen but any other leak detection gases may be used. The Mass Table below has the Helium and Air masses enabled for leak checking.

To turn on the audio tone, edit the channel of the leak detect gas in the Mass Table, check **Audio**, and click Apply. Set the volume with **Trend Volume**. Uncheck Audio (and Apply) to turn the tone off.
When the plot of the leak detect gas is near the bottom of the trend graph, the tone has a low frequency. As the signal intensity increases, the frequency increases. A leak is indicated by a rapid increase in frequency as the leak detect gas is applied at the location of the leak. Since the tone follows the intensity on the graph, use a linear rather than logarithmic Y axis.
If a multiplier unit is being used and the pressure is below 10^{-6} torr, a leak is best detected with the multiplier option turned on at a gain of about 10^{3}.
The Mass Table graph below shows Helium, Air, and Total Pressure plots during leak checking.

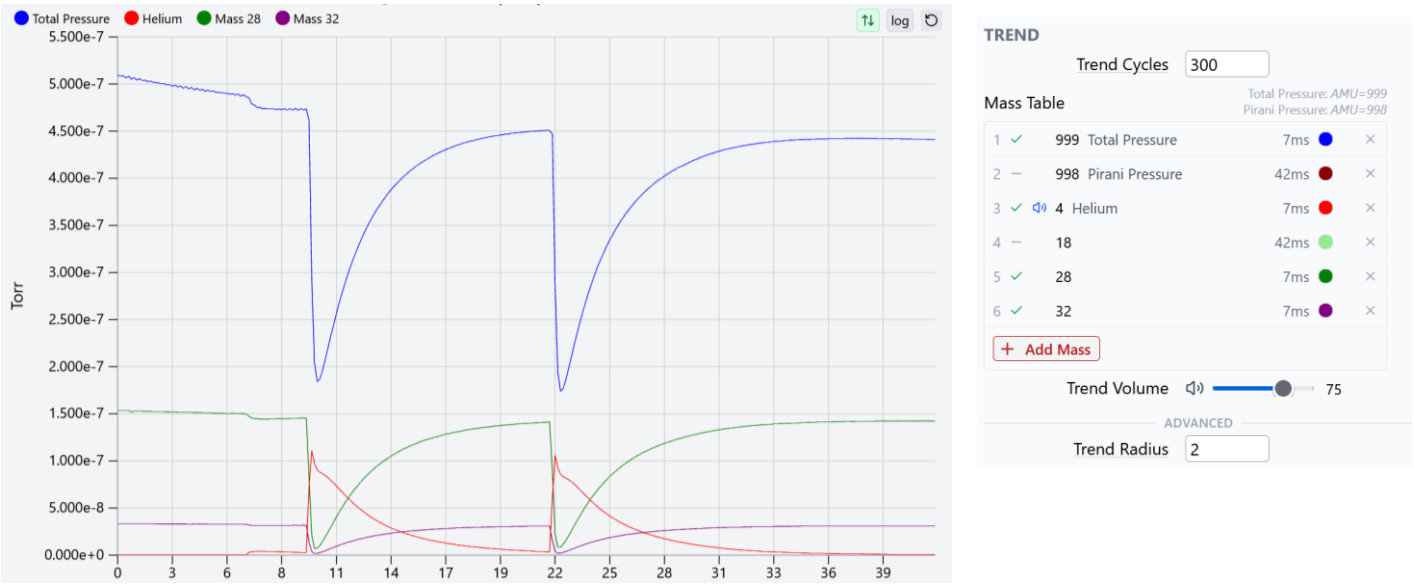


Figure 27. Mass Table Graph During Leak Checking

The dark blue plot line near the top shows a Total Pressure of about 5 x 10^{-7} torr with partial pressures of Mass 28 (N_2) of about 1.5 x 10^{-7} torr and Mass 32 (O_2) of about 4 x 10^{-8} torr. The ratio of Mass 28 to Mass 32 is about 4:1 indicating that an air leak is present (in air N_2 to O_2 is about 80:20). The partial pressure of Mass 4, Helium, starts out at zero on the graph and the audio output has a low frequency because its concentration in air is only about 5ppm.
When the helium is sprayed near the leak, its partial pressure and the sound frequency will increase.
As the helium flows into the leak, it excludes the air and so the partial pressures of both Mass 28 and Mass 32 decrease. The Total Pressure also decreases when the helium enters the leak because the B/A ion gauge has a lower sensitivity to helium than it does to nitrogen (see Appendix A, Gauge Sensitivity to Differing Gases). When the helium spray is moved away from the leak, air slowly replaces it and the partial pressure of helium (and the sound frequency) decreases as the partial pressures of nitrogen and oxygen increase as shown in the graph. The helium spray was then moved back over the leak a second time to pinpoint the location.

7.5.4. Calibration Parameters

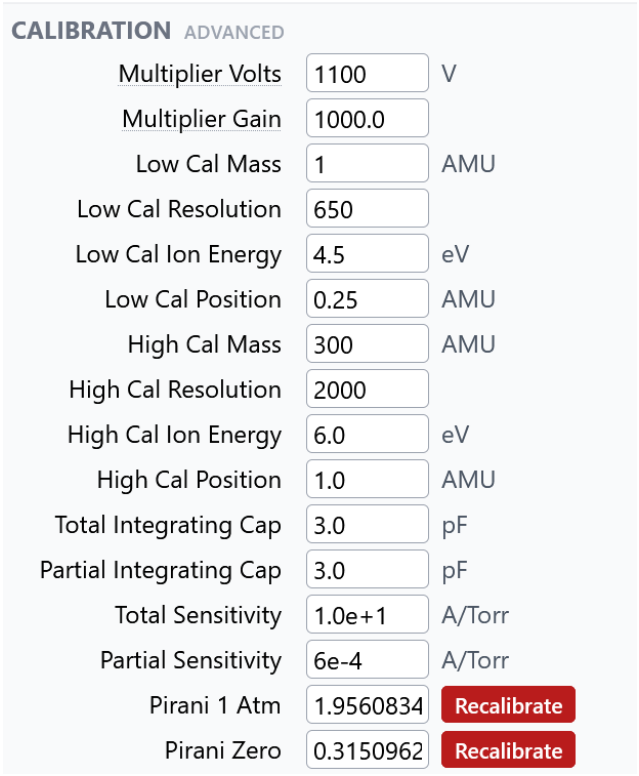


Figure 28. Calibration Parameters (Advanced mode)

The calibration parameters are shown in Advanced mode. They set the electron multiplier voltage and gain, the system resolution and sensitivity, and the Pirani gauge calibration. The factory tuning can always be re-established by applying a copy of the factory configuration, CFG-FAC1 (Section 7.4).

There are, however, times when a special tune may be helpful. An example of this may be when a very weak signal requires less than unit resolution or a fractional mass must be resolved from a peak next to it.

7.5.4.1. Multiplier Volts and Multiplier Gain

Multiplier Volts and Multiplier Gain are in the Calibration Parameters rather than the Operating Parameters because they seldom need to be changed. They should still be checked every now and then, because the gain of an electron multiplier falls as it ages: the same Multiplier Volts setting gives less and less gain, so the voltage has to be raised from time to time to bring the gain back. A rising Mult Ohms reading on the Outputs tab (Section 7.6) is another sign of an aging multiplier.

The Multiplier Gain setting corrects the reported partial pressures for the multiplier gain. This correction is applied to the partial pressures shown in the Sweep and Trend graphs and to the saved data.

To measure the multiplier gain, note the height of a relatively small peak with the multiplier off (using the Faraday cup). Turn Multiplier On, set Multiplier Volts to 900 V and Multiplier Gain to 1e3, and click Apply. After several sweeps have completed, compare the height of the same peak, and increase Multiplier Volts until the peak is the same height as with the Faraday cup. Click Apply after each change, and allow several sweeps between adjustments so the voltage can settle. Check by turning the multiplier off and on again, and adjust until the peak is the same height in both cases. The resulting Multiplier Volts setting gives a gain of 1000 (1e3). For a new multiplier this is between about 1000 V and 1200 V. The exact gain varies over time and with the mass of the ion observed.

Multiplier Volts is set at the factory for a gain of 1000 at m/z 18, and this is usually all the gain required for most RGA applications. As a general rule, to increase the lifetime of the multiplier, use the lowest multiplier voltage that gives the gain needed.

When the multiplier can no longer reach the gain needed, it should be replaced (Section 9.2).

7.5.4.2. Low Cal and High Cal

Because of the linearity and stability of the Extorr system, the resolution and sensitivity requires calibration at only two points within the mass range. These are the Low Cal and High Cal points along the mass axis. We designate their location by placing values in the Low Cal Mass and the High Cal Mass. All mass positions are linearly placed between these two points or extrapolated beyond these points. The Low Cal Position allows for an offset so that a known low mass peak may be placed in the correct mass scale position. Similarly, the High Cal Position can be used to place a known mass peak at its correct position. The mass scale will then be calibrated. Click Apply for the changes to take effect.

Residual gas analyzers are usually run with "unit resolution". This means that, throughout the system's mass range, the peaks are set so that the valley between two equal height adjacent peaks is about 10 % of the peak heights. Setting a low cal resolution, at the low mass position and a high cal resolution at the high mass position allows the user to adjust for this "unit resolution". The user may explore the resolution function by changing the values and observing the width and sensitivity of the resulting peaks. Remember to click Apply. Every applied change is saved as a new version of the configuration, so any earlier setting can be applied again (Section 7.4).

The intensity of the peaks may be changed by changing the ion energy. Greater sensitivity may be gained by increasing the ion energy. Unfortunately, the quality of the peak shapes tend to suffer when the ion energy becomes too high. Again, the ion energy is interpolated between and extrapolated beyond the two mass cal points.

A description of this tuning procedure is given in Appendix B of this manual.

7.5.4.3. Pirani Calibration

The Pirani gauge, located in the base of the Extorr probe, is factory calibrated. After a period of use, a two point calibration may be done. Press **Recalibrate** next to Pirani 1 Atm when the probe is at atmospheric pressure, and **Recalibrate** next to Pirani Zero when the probe is at a pressure below 10^{-4} torr. Click Apply after each recalibration.

7.5.4.4. Total and Partial Integrating Caps

The total and partial integrating capacitor values for the ultra-sensitive electrometer are set at the factory for optimum performance and should not be changed without consulting with the factory.

7.5.4.5. Total and Partial Sensitivity

The total and partial pressure sensitivities are factory set and should only be reset if trusted secondary pressure standards are presented to the probe. In general, the sum of the partial pressure peaks should roughly equal the total pressure. When adjusting these calibration numbers remember that total pressure is only displayed at the end of a scan. It is therefore important to setup for a scan which completes about once per second.

7.5.5. Diagnostics Parameters

The Diagnostics parameters are used by Extorr for troubleshooting and should only be changed under Extorr's direction. They are locked. To unlock them, contact Extorr for the password, click **Unlock Diagnostics** at the top of the Configuration panel and enter it.

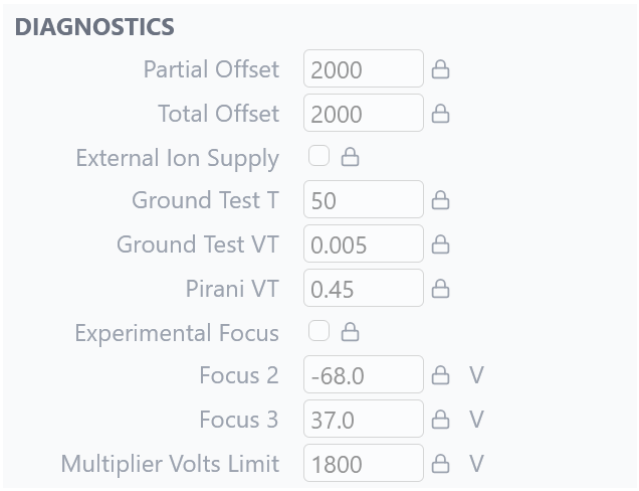


Figure 29. Diagnostics Parameters (locked)

7.6. Outputs Tab

The Outputs tab of the right panel shows live readings from the XTP CCU, headed by its model and serial number. The values are updated at the end of every scan. This information is very useful for troubleshooting, and Extorr support will ask for these values when helping to diagnose a problem.

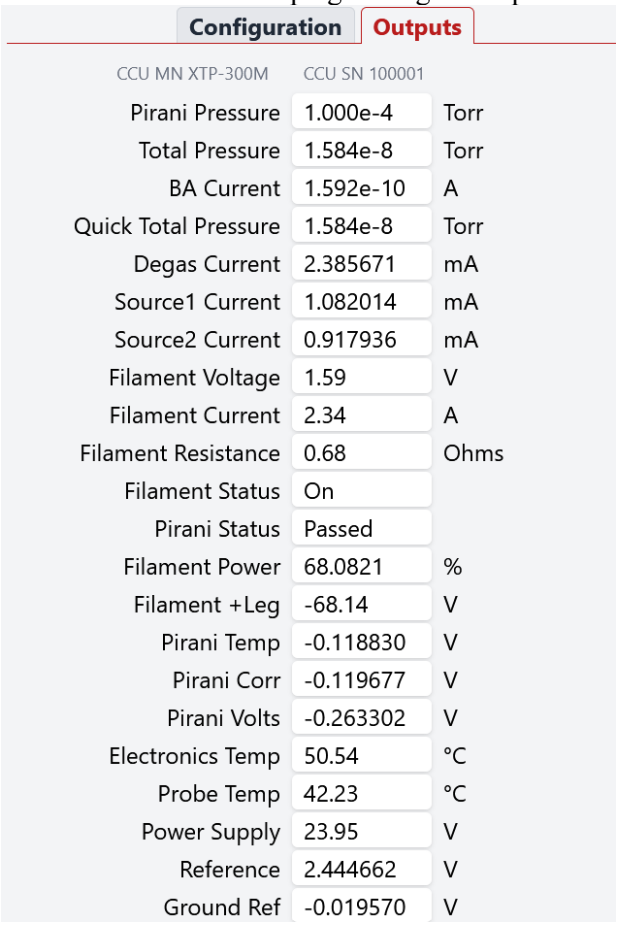


Figure 30. The Outputs Tab (top of the list)

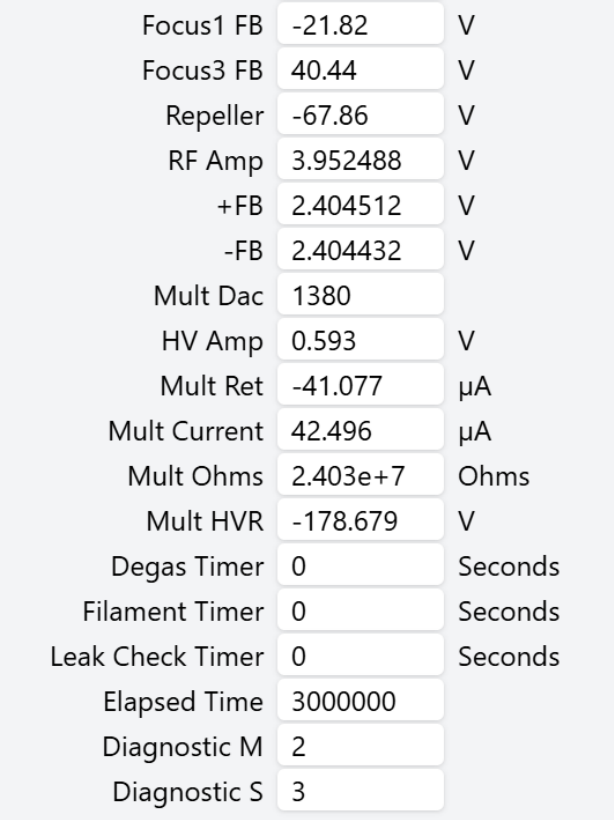


Figure 31. The Outputs Tab (bottom of the list)

7.6.1. Output Definitions

These readings are provided to aid in troubleshooting your RGA system.
NOTE: The "Reference" and "Ground Ref" parameters must be checked before any of the other readings are considered. These two parameters test the accuracy of the system Analog to Digital converter and must be correct or ALL the other readings on the "Outputs" tab will be wrong.

7.6.1.1. Reference

The Reference reading shows the result of the XTP CCU's internal Analog to Digital Converter measuring a precision reference voltage. If this reading and the "Ground Ref" reading are correct, the A to D Converter is working properly.
The Reference value must be in the range of 2.45 V to 2.55 V.

7.6.1.2. Ground Ref

The Ground Ref reading displays the result of the XTP CCU's internal Analog to Digital Converter measuring the system Ground. If this reading and the "Reference" reading are correct, the A to D Converter is working properly.
The Ground Ref value must be in the range of -0.02 V to +0.02 V.

If the "Reference" and "Ground Ref" values are correct, the other parameters should be as described below.

7.6.1.3. Degas Current

The Degas Current displays the total electron current emitted from the filament, measured in milliamps. When NOT in the Degas mode and with the Filament switch set to On, this reading will be about 0.5 mA greater than the Filament Emission setting in the Operating Parameters.
The Degas Current will read about 0 mA when the Filament switch is set to Off.

7.6.1.4. Electronics Temp

The Electronics Temp displays the temperature inside the Extorr XTP CCU electronics box in Degrees Celsius. When power is first applied to the XTP CCU, the Electronics Temp will be about equal to the ambient room temperature and will increase to about 40 ºC after operating for about an hour.

7.6.1.5. Power Supply

The Power Supply output displays the input voltage to the XTP CCU box from the AC to DC Power Supply. This reading should be about 24 VDC.

7.6.1.6. Filament Voltage

The Filament Voltage reading measures the potential applied across the Ionizer Filaments. The XTP CCU electronics vary this voltage to produce the desired emission current.

When NOT in the Degas mode and with the Filament switch set to On, this reading should be about 1.5 V to 2 V for the standard Extorr thoria coated dual filament operating at a Filament Emission current of 2.0 mA.

The Filament Voltage will read about 0.5 V when the Filament switch is set to Off.

If the Filaments have burned out and the Filament switch is set to On, the Filament Voltage reading will be greater than 5 V and the filament indicator will show Tripped.

7.6.1.7. Filament Current

The Filament Current is the current, in amps, flowing through the ionizer filament. The Filament Resistance is the Filament Voltage divided by this current.

7.6.1.8. Filament +Leg

The Filament +Leg reading is the voltage at the positive leg of the filament.

7.6.1.9. Filament Resistance

The Filament Resistance display is the calculated resistance of the Ionizer Filaments measured in Ohms.

The standard Extorr thoria coated dual filament in normal operation will give a Filament Resistance reading of about 0.5 Ohms.

If one of the filaments burns out, this reading will increase to about 1 Ohm.

A reading of 3 Ohms or more indicates that both filaments have burned out and will need to be replaced.

7.6.1.10. Probe Temp

The Probe Temp displays the temperature at the electrical feed through pins of the Quadrupole Probe. When power is first applied, the Probe Temp will be about equal to the ambient room temperature and will increase to about 40 ºC after operating for about an hour.

7.6.1.11. Source1 Current

The Source 1 Current is a measurement of the electron current, in milliamps, that arrives at the Ion Source Grid.

When NOT in the Degas mode and with the Filament switch set to On, this reading should be about 50% of the Filament Emission setting. The sum of this current and the “Source 2 Current” should be roughly equal to the Filament Emission setting in the Operating Parameters.

The factory default setting for the Filament Emission setting is 2.0 mA.

If Source 1 is shorted to the Vacuum Chamber (Ground) and the Filament switch is set to On, the Source 1 Current will be 0 mA and the filament indicator will show Tripped after several complete Mass Sweeps.

7.6.1.12. Source2 Current

The Source 2 Current displays the electron current, in milliamps, that arrives at the B/A Gauge section of the Ionizer.

When NOT in the Degas mode and with the Filament switch set to On, this reading should be about 50% of the Filament Emission setting. The sum of this current and the “Source 1 Current” should be roughly equal to the Filament Emission setting in the Operating Parameters.

The factory default setting for the Filament Emission setting is 2.0 mA.

If Source 2 is shorted to the Vacuum Chamber (Ground) and the Filament switch is set to On, the Source 2 Current will be 0 mA and the filament indicator will show Tripped after several complete Mass Sweeps.

7.6.1.13. RF Amp

The RF Amp displays a voltage reading in the Quadrupole RF section of the electronics that is roughly proportional to the High Mass setting in the Sweep Parameters.

An XTP-100 or XTP-100M system in the Mass Sweep Mode with Low Mass set to 1 and High Mass set to 100 produces a RF Amp reading of about 7.5V. The reading is updated at the end of every scan. If the RF Amp reading is greater than about 9V, try tuning the XTP CCU as described in Section 4.6, Resonating RF Coil.
An XTP-200 or XTP-200M system in the Mass Sweep Mode with Low Mass set to 1 and High Mass set to 200 produces a RF Amp reading of about 13.5V. The reading is updated at the end of every scan. If the RF Amp reading is greater than about 13V, try tuning the XTP CCU as described in Section 4.6, Resonating RF Coil.
An XTP-300 or XTP-300M system in the Mass Sweep Mode with Low Mass set to 1 and High Mass set to 300 produces a RF Amp reading of about 20V. The reading is updated at the end of every scan. If the RF Amp reading is greater than about 22.5V, try tuning the XTP CCU as described in Section 4.6, Resonating RF Coil.

7.6.1.14. Pirani Temp

The Pirani Temp is proportional to the Sensor temperature near the Pirani wire.
During normal operation the Pirani Temp reading will be in the range of -0.1 V to -1.0 V.

7.6.1.15. Pirani Corr

The Pirani Corr is proportional to the Pirani wire temperature.
During normal operation the Pirani Corr reading will be in the range of -0.1 V to -1.0 V.

7.6.1.16. Pirani Volts

The Pirani Volts is proportional to Pressure.
During normal operation the Pirani Volts reading will be in the range of -0.25 V to -2.5 V.

7.6.1.17. Pirani Status

The Pirani Status shows the result of the checks the RGA makes before the filaments may turn on:

Testing Ground: the RGA is checking the ground connection between the XTP CCU and the probe.
Ground Test Failed: the ground check failed, usually because the two thumb screws that hold the XTP CCU onto the probe are not tight enough. Tighten them (Section 4.4). While the ground test has failed, the filaments stay in Waiting Rough Vac, and the filament indicator at the top of the interface shows Ground Test Failed, with more detail when you hold the mouse over it.
Waiting Rough Vac: the ground check passed, and the RGA is waiting for the Pirani reading to fall low enough for the filaments to turn on.
Passed: all checks were successful, and the filaments may turn on.

If the filaments still will not turn on, see Section 10.3, Pirani Gauge Will Not Allow Filament to Turn On.

7.6.1.18. +FB

During normal operation the +FB reading will be in the range of 2.25 V to 2.5 V when the Quadrupole + DC Power Supply is operating correctly.

7.6.1.19. -FB

During normal operation the -FB reading will be in the range of 2.25 V to 2.5 V when the Quadrupole - DC Power Supply is operating correctly.

7.6.1.20. Focus1 FB

The Focus 1 FB reading shows the feedback voltage of the Focus 1 circuit.
This reading should be roughly equal to the value of the Focus 1 setting in the Operating Parameters.
The factory setting for the Focus 1 setting is typically -20 V.
If Focus 1 is touching the vacuum chamber (shorted to Ground), this reading will be about -150 V. See Section 4.3 for the Probe Pin Out and instructions for testing for shorts.

7.6.1.21. Repeller

The Repeller value is the feedback voltage of the Repeller circuit.
This reading is typically about -68 V, which is roughly 2 volts less than the value of the Electron Energy setting in the Operating Parameters.
If the Repeller is touching the vacuum chamber (shorted to Ground), this reading will be about -150 V. See Section 4.3 for the Probe Pin Out and instructions for testing for shorts.

7.6.1.22. Filament Power
The Filament Power display indicates how much of the available power is currently being used by the filament.
When NOT in the Degas mode and with the Filament switch set to On, this reading should be about 60%. The Filament Power will read about 5% when the Filament switch is set to Off.
7.6.1.23. Filament Status
The Filament Status shows the operating state of the filaments: Off, Waiting Rough Vac, Waiting High Vac, Waiting For Target, Asleep, On or Tripped. These are the same states shown by the filament indicator at the top of the interface and described in Section 6.4.
7.6.1.24. Degas Timer
The Degas Timer shows the time remaining, in seconds, in the ten minute automatic degas cycle after Start Degas is clicked. It is 0 when no degas is running.
7.6.1.25. BA Current
The BA current value is the ion current measured in Amps at the collector wire in the B/A Ion Gauge section of the ionizer.
7.6.1.26. Total Pressure
The Total Pressure value shows the same information as the Total Pressure readout at the top of the XTP interface. The value here is undefined when the Filaments are not at full operating emission.
7.6.1.27. Quick Total Pressure
The Quick Total Pressure is a fast total pressure reading that the RGA uses for over pressure protection. It is shown whenever it can be measured; at times it cannot, for example when the BA current is too low for an accurate reading. It is combined automatically into the Total Pressure reading.
7.6.1.28. Pirani Pressure
The Pirani Pressure value shows the same information as the Pirani Pressure readout at the top of the XTP interface.
7.6.1.29. Mult Current
The Mult Current is the current, in microamps, flowing through the electron multiplier. It is blank when it cannot be measured, for example on a unit without an electron multiplier.
7.6.1.30. Mult Ohms
The Mult Ohms reading is the resistance of the electron multiplier. A new multiplier is typically in the tens of megohms. The resistance rises as the multiplier ages, making it less effective, and can reach hundreds of megohms. A steadily rising Mult Ohms reading is a sign that the multiplier will need replacing (Section 9.2).
7.6.1.31. Leak Check Timer
When the filaments would otherwise go to sleep, the filament control at the top of the interface offers a button that keeps them on for 10 minutes, for leak checking. The Leak Check Timer shows the time remaining, in seconds. The same countdown is shown on the filament control, with a description when you hold the mouse over it.
7.6.1.32. Diagnostic Readings
Focus3 FB, HV Amp, Mult Dac, Mult Ret, Mult HVR, Filament Timer, Elapsed Time, Diagnostic M and Diagnostic S are diagnostic readings used by Extorr when troubleshooting. They need no action from the user, but Extorr support may ask for their values.

7.7. Data Log

The XTP Host permanently logs everything that happens on the RGA: every sweep and trend, every configuration version, system events such as filament state changes, and tag events such as a tag being added to a sweep. The Data Log tab of the main graph area lists these records with their date and time, newest first, and each sweep is shown with its tags. Nothing is ever deleted.

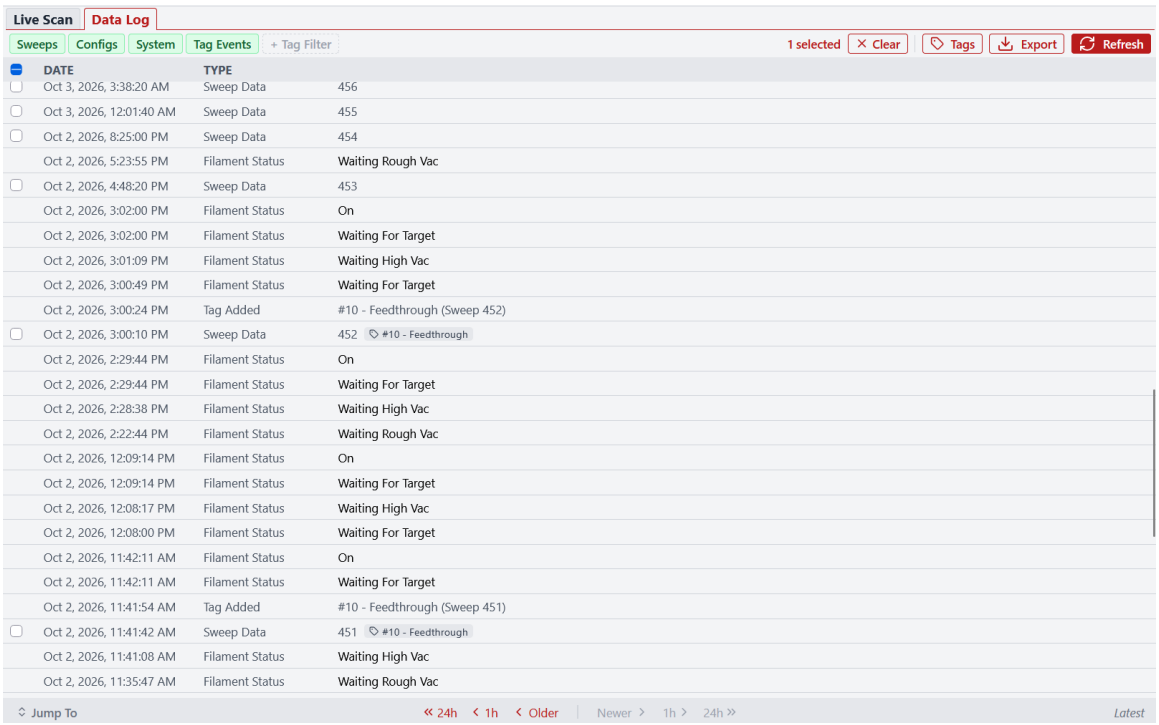


Figure 32. The Data Log, Showing Sweeps, Filament State Changes and Tags

Filters: the Sweeps, Configs, System and Tag Events buttons choose which kinds of records are listed, and + **Tag Filter** lists only sweeps with a chosen tag.
Moving through the log: use the 24h, 1h, Older and Newer buttons, Jump To for a particular date or sweep, and Latest to return to the newest records. Refresh updates the list.
Viewing records: click a sweep or configuration to preview it in the bottom panel. A sweep is shown with its graph, and the panel beside it can show the Configuration used to make it (with its ≠ Applied differences), the Outputs at the time, or a Data Table of the values. To compare several sweeps, drag them to the top panel, where they are shown stacked.
Selecting sweeps: use the check boxes to select sweeps for tagging or export; Clear removes the selection.

7.7.1. Tags

Tags mark sweeps so they are easy to find later, for example “Bakeout” or “Feedthrough”. Each tag has a number and a name, such as #8 - Bakeout.
To tag sweeps, select them in the Data Log with their check boxes and click **Tags**. The Tags window shows how many sweeps are selected and lists every tag. Click + next to a tag to add it to the selected sweeps, or − to remove it from them. Where some of the selected sweeps already have a tag, the count next to it shows how many (for example “1 of 1”). **New Tag** creates a tag, the search box finds one, and the ⋮ menu next to each tag manages it. Like configurations, tags can be archived but are never deleted. Every tag created, renamed, added or removed is recorded in the Data Log as a tag event. The number associated with the tag is a unique identifier, a rename of that tag will apply to all sweeps that have been tagged with that specific identifier. The identifier number will never change, while the description is allowed to change.

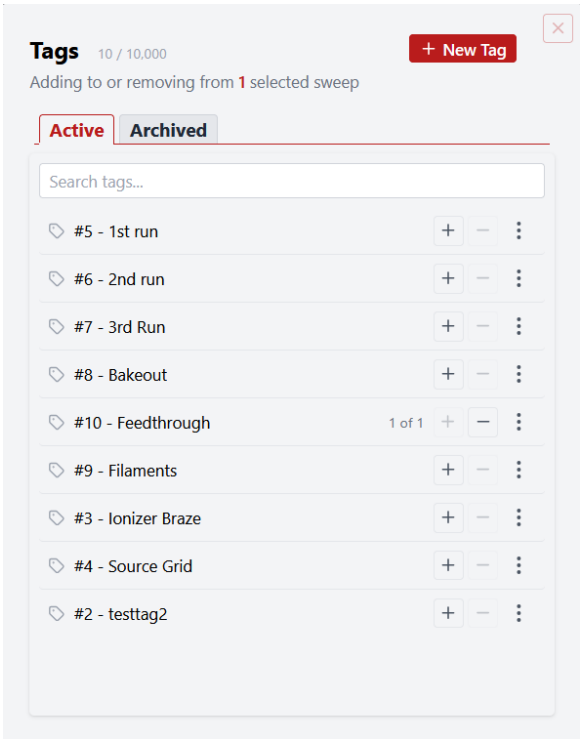


Figure 33. The Tags Window

7.7.2. Auto-Tag

Auto-Tag in the top bar applies a chosen tag to every new sweep while it is on, for example for the duration of an experiment. Click Auto-Tag, choose or create a tag, and new sweeps are tagged until Auto-Tag is turned off.

7.7.3. Exporting Data

Click **Export** to download sweeps to the computer you are using, as a CSV file that can be opened in a spreadsheet such as Microsoft Excel (Chapter 8). Choose the sweeps to export (the selected sweeps, a date range or a sweep range), which sweep types to include (Mass Sweep, Mass Trend, Calibration), and whether to include the outputs and the configuration with each sweep, then click **Download CSV**.

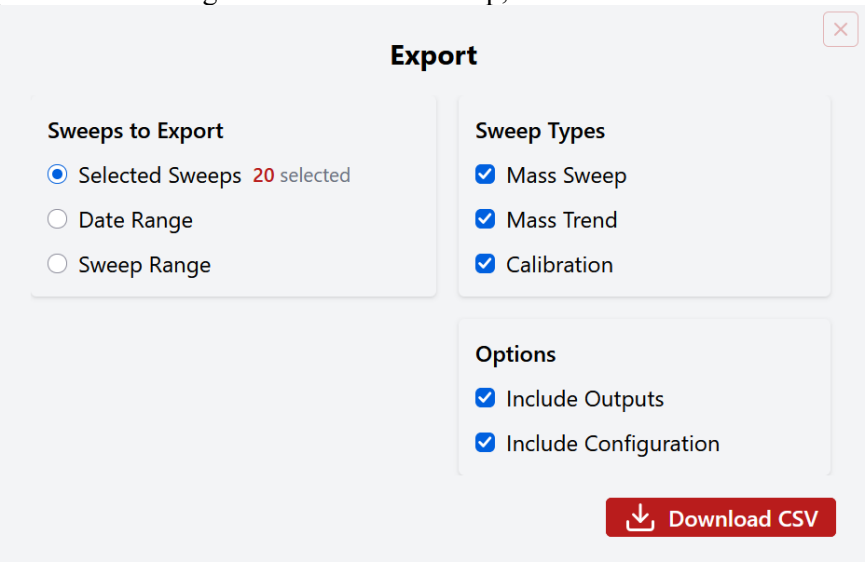


Figure 34. The Export Window

7.8. Degas

Degas increases the electron energy to nearly 400 volts, the electron emission to nearly 30 ma, and the ion energy to 200 volts. The purpose of degas is to clean the ionizer. If the system loses sensitivity due to contamination, a degas of a few minutes duration, will often restore the sensitivity.

Click **Start Degas** in the top bar to start a degas. While it runs, the button shows **Stop Degas** with the time remaining; click it to end the degas early. The degas ends automatically after ten minutes, and the Degas Timer on the Outputs tab also shows the time remaining. Hold the mouse over the button for a short description.

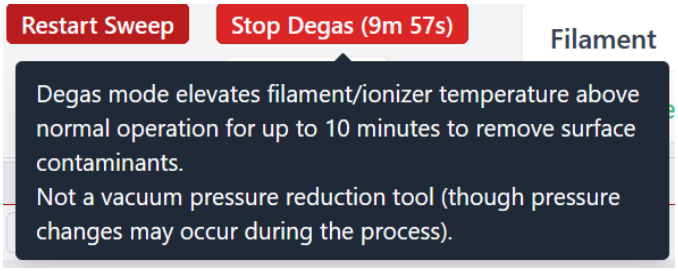


Figure 35. Stop Degas Button and Description During a Degas

Degas only takes place while the filaments are on. If the filaments are off, the degas does not run, although the timer still counts down. Degas is a cleaning process for the ionizer; it is not a way to lower the vacuum pressure, although the pressure may change while it runs.

8. Working with Data

8.1. First Mass Spectrum

As the vacuum system is first pumped down, the Pirani gauge output will decrease (hopefully rapidly) to pressures in the 10^{-2} torr range. If the filaments are left on in the configuration, the filament indicator shows Waiting for rough vacuum while only the Pirani is active. As the pressure drops below 3 x 10^{-2} torr, the B/A ion gauge starts to operate with a reduced electron emission. In this situation the filament indicator shows Waiting for high vacuum. In this pressure region, the B/A ion gauge yields the more accurate pressure measurements than the Pirani. As the pressure falls below about 5x10^{-3} torr, the electron emission for the B/A ion gauge and the quadrupole analyzer ion source are increased to the value set in the configuration (see Filament Emission in the Operating Parameters, Section 7.5.1.3). At this point, the filament indicator shows On and the quadrupole starts operation. For long term operation, the pressure should be below about 1x10^{-4} torr.

The factory setting for the quadrupole is a sweep from mass 1 to the highest rated mass of the system. This usually makes for a rather cramped spectrum making the assignment of peaks to masses difficult. The spectrum may be stretched out either by changing the mass range or by zooming in on the graph with the mouse (Section 7.1.1).

If you are pumping down from atmosphere, the dominant peaks will be the water peaks at masses 18, 17 and 16. The mass spectrum usually consists of a molecular ion, parent peak or M peak. Then there will also be one or more fragments of the molecule. A mass spectrum which includes H_2O is shown in Figure 36. The largest peak is the molecular ion, H_2O^+, with a mass of 18. The next most abundant ion is the fragment OH^+ at mass 17. The next most abundant fragment is O^+ at mass 16. Note that the fragments are formed by the removal of an atom or group of atoms from the molecular ion. The molecular weight of the molecular ion and the particular fragment of the molecule both are used in the identification of the molecule

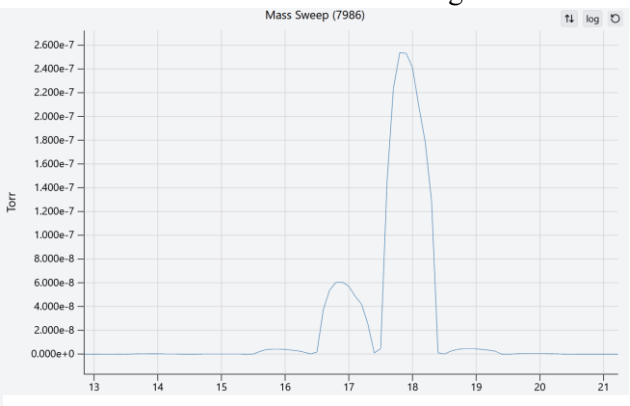


Figure 36. Water Vapor in Mass Spectrum

A closer examination of a pure water spectrum would also show peaks at mass 19 and mass 20 but these peaks are on the order of 1000 times less than the peak at mass 18.
These peaks arise because some of the H_2O molecules contain ^{17}O and ^{18}O isotopes. Ordinary oxygen contains 99.756% of the mass 16 isotope, 0.039% of the mass 17 isotope, and 0.205% of the mass 18 isotope. The peak at mass 18 is called the molecular, or M, peak of water vapor while those at peaks 19 and 20 are called the M + 1 and M + 2 peak respectively.
The other two peaks which are expected to be in these first mass spectra are the peaks due to the other main constituents of air which are nitrogen, oxygen, and argon. The molecular peaks of these gases are at 28 amu, 32 amu and 40 amu. The ratios of these peaks are 4 to 1 to 1/20. If these same ratios persist for a length of time, you most likely have an air leak.
As the pumping continues, these peaks will become smaller until there is virtually no mass 32 peak. The nature of the pumps used and the material of vacuum system construction will determine the mass spectrum at the lowest pressures. There are many sources of mass spectra in libraries on the Internet such as the NIST database on their website. Some common residual gases first encountered on pump down are given below. The numbers are rough percentage intensities with respect to the largest peak for each source.

Source Mass↓	Air	Nitrogen	Oxygen	Argon	Water vapor	Hydrocarbon fragment	Carbon dioxide	Carbon monoxide	Hydrogen
1						x			5
2									100
12						x	6	5	
13						x			
14	7	7							
15									
16	3		11		2		9	2	
17					25				
18					100				
20				10					
24						x			
26						x			
28	100	100				x	11	100	
29		1				x			
30						x			
32	25		100						
36						x			
37						x			
38						x			
39						x			
40	1			100		x			
41						x			
42						x			
43						x			
44						x	100		

Figure 37. Table of Common Mass Peaks

Note that hydrocarbons tend to produce peaks virtually everywhere but they tend to group in bunches which are separated by the CH_2 fragment, a mass of 14. If you look deep enough into every unbaked system you will most likely find hydrocarbon peaks. An example of a hydrocarbon group is shown in Figure 38.

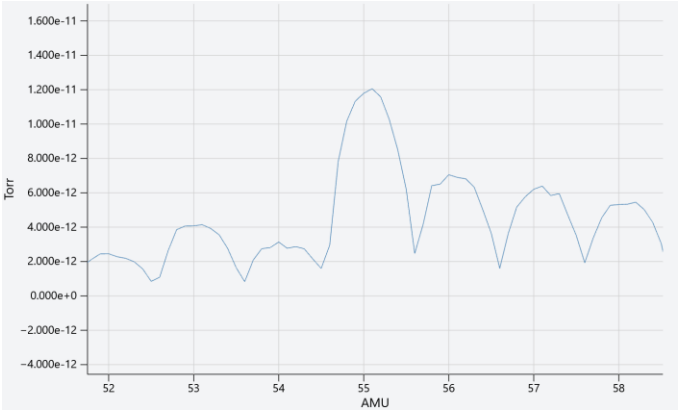


Figure 38. Low Level Hydrocarbons

Beyond these first “pump down” peaks, the residual gases which are most likely to be found are those probably best known to the user of the vacuum system. The user knows the processes carried out in the chamber and the chemical species involved.

There are other tricks to help in identification of residual gas peaks. For instance, the intensities of the various isotopic peaks can be used to help identify molecules. For instance, a molecule containing a single Cl atom is going to have a molecular peak (due to ^{35}Cl) and an M + 2 peak (due to ^{37}Cl). The intensity of the M + 2 peak is about 33% of that of the M peak. A molecule containing a single Br atom will have M and M + 2 peaks of about equal intensity.

Armed with a few cracking patterns of common residual gasses, a periodic table and a knowledge of how your chamber is used, the user should have little trouble identifying the gases in the system. If stumped, a google or AI search such as “what is mass spectral peak xxx?” or “peak at m/z XXX” may yield good results.

8.2. Determination of Partial Pressures

Of all the vacuum measurements, the partial pressure measurements are the most difficult because they depend on so many different things. As in the B/A ion gauge, the residual gas molecules are electron impact ionized. Unlike the B/A ion gauge which just measures total ion current, the quadrupole separates all the ions produced into their mass to charge ratios and measures the current from each of the ions. These ions may be molecular fragments or from a mixture of molecules. So not only is the ionization cross section important, so is the "cracking pattern" of each molecule. We can then add to this the mass to charge discrimination inherent to any mass spectrometer system. When used, the response of an electron multiplier to differing ions must also be taken into account.

The system may be calibrated to take most of these factors into account. For most purposes, an extremely accurate partial pressure measurement is not required. If we know the cracking pattern, of the molecule, at a given ion energy, and we have a single peak which is free of chemical interferences, then a measure of the partial pressure of the molecule may be derived by comparing its peak height divided by the fraction of the total current produced by the molecule. The B/A ion gauge sensitivity factor, although measured at a different electron energy, may be used to get a rough idea of the partial pressure. As an example, let's say that we have a peak at mass 20 due to Ar^{++}. We look at the cracking pattern of Argon and find that 10 % of ionized argon becomes Ar^{++}. So we measure the current $i(Ar^{++})$ divide by 0.10. The partial pressure is then given by $i(Ar^{++})/(i_e *k(Ar))$ where i_e is the electron emission current in the ionizer. Putting numbers into this example, suppose the 20 amu signal was 1×10^{-11} amps, the ionizer electron current was 2×10^{-3} amps so $P(Ar)= 1 \times 10^{-11}$ amps/$(2 \times 10^{-3}$ amps$*0.10*27.9$ torr$^{-1}) = 1.8 \times 10^{-9}$ torr.
Again it should be emphasized that we have made a number of gross assumptions here which add to the uncertainty in this value. Another factor is the relative quadrupole transmission for differing masses. If the simplest tuning provisions are made, a quadrupole has a transmission which falls off in direct proportion to the inverse of the mass. In an RGA such transmission factors are usually normalized to the transmission at mass 28. Mass 20 would therefore have a current 28/20 times more than mass 28 if the same number of ions is produced per unit time in the ionizer. So the 1.8×10^{-9} torr should be multiplied by 20/28 to get 1.3×10^{-9} torr. If exact partial pressures are required, it is still best to calibrate by applying pure gases to your vacuum system.

A few cracking patterns for some common molecules are given in the Figure below.

Ar		**CO_2**		**He**		**H_2**		**Kr**		**N_2**		**O_2**		**H_2O**	
Mass	%	Mass	%	Mass	%	Mass	%	Mass	%	Mass	%	Mass	%	Mass	%
40	100	44	100	4	100	2	100	84	100	28	100	32	100	18	100
20	10	28	11			1	5	86	31	14	7	16	11	17	25
		16	9					82	20	29	1			1	6
		12	6					83	20					16	2

Figure 39. Cracking Patterns for Some Common Molecules

9. Maintenance

9.1. Servicing the RGA probe

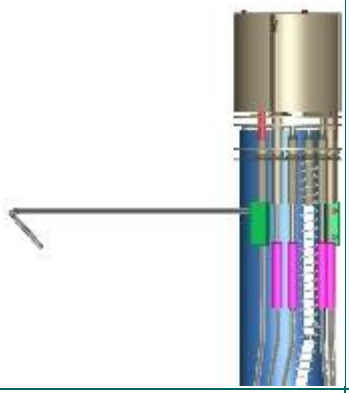
9.1.1. Ionizer /Dual Filament Replacement

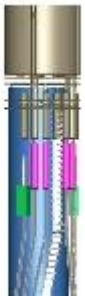
A filament will eventually fail after years of operation even in a clean UHV system due to the thoria coating on it eventually decomposing and evaporating. The Extorr RGA uses two thoria coated iridium filaments that operate in parallel. Unlike what may occur with other residual gas analyzers, the Extorr's filaments will not fail due to exposure to high pressures because they are protected by both ion and Pirani gauge outputs. A complete filament failure can be verified by looking at the readings on the Outputs tab. If there is an open filament, the filament voltage will read > 5 volts and the filament resistance will be > 3 Ohms. The filament indicator at the top of the interface will not stay On (Section 6.4). If only one of the filaments is burned out, the instrument will operate normally but the filament resistance will read about 1 Ohm.

The ionizer normally will last for years without attention in a UHV environment. There is nothing to wear out, but the metal surfaces can become contaminated. The results of contamination could cause low sensitivity for partial pressure readings. It generally takes a very severe contamination to cause the total pressure readings to be low because the B/A type gauge uses higher voltages and works with more energetic ions that are less susceptible to stray fields. If you have a total pressure reading of 10^{-7} torr for example, the sum of your partial pressure readings should be roughly the same. A number of factors such as the relative sensitivities of different compounds and the cracking of molecules into ion fragments makes it unlikely that they will add up exactly, but as the ionizer contamination increases, you may see a an order of magnitude or more difference between the total pressure and the sum of partial pressures. Cleaning the ionizer is difficult if not impossible in most cases, so replacement is the remedy. It is also likely that some contamination will make it to the rods of the quadrupole. So, when replacing the ionizer due to low sensitivity, it is a good idea to clean the quadrupole rods as well.

Always handle the probe with clean gloves, or you will see the results of your contamination on the next scan. A fingerprint will outgas and cause peaks at virtually every amu until it is evaporated or turned into low vapor pressure compounds in your vacuum system. Of course other sources of contamination such as diffusion or mechanical pump oil could cause similar problems. Even after the volatiles are gone, the residue may cause the probe to operate improperly by leaving behind either insulating compounds or secondary electron emitting surfaces. This can cause a charge from electrons to build up and disturb the electric fields in the ionizer or the mass filter, leading to low sensitivity.
At the factory, all parts are mechanically cleaned, then vacuum baked, and then plasma cleaned. If you are doing UHV work and demand the best cleanliness, you can send the analyzer to the factory for refurbishment, but many customers have had good success with cleaning in the field. The rods are best cleaned with an abrasive method, such as 1200 grit abrasive paper polishing, followed by an Alconox ultrasonic bath and several rinses with distilled water. The Extorr probe was designed to allow easy cleaning and ionizer/filament replacement. The only tool required is an Allen wrench to loosen the set screws that hold the ionizer to the probe. This tool is supplied with all new ionizers.

The following steps will usually restore the XTP system to proper operation:

Step 1			Placing the analyzer onto the XTP CCU without the thumbscrews makes a good stand for the repair. Loosen the top set screws on the 2 barrel connectors that connect the filament wires. Remove and discard the old filament assembly. If you are only replacing the filament, skip to step 7.
Step 2			Loosen the bottom set screws on each barrel connector and slide them down the wires towards the feedthrough. Remove the ionizer by pulling upward, a gentle twisting action may be necessary.
Step 3			Using a hook made from some .062 diameter wire, pull the mass filter.

Step 4			Pull the mass filter out of the frame.
Step 5			Clean the surfaces of the rods with 1200 grit alumina abrasive paper until they are bright. Using a waterproof paper with water works well. Be careful not to bend the electrical contacts. Then clean in Alconox detergent using an ultrasonic cleaner at 40 kHz. Rinse well with distilled water in the ultrasonic bath several times, then dry at 75 degrees C.
Step 6			Next insert the mass filter into the probe, being careful to line up the 2 wires with the two holes in the end of the mass filter that make the electrical contact.
Step 7		Slide the 4 tubular spring connectors completely up onto the ionizer wires.	Using a small pair of needle nose pliers or a strong pair of tweezers, remove the 4 tubular spring connectors from the old ionizer and push them onto the respective pins on the new ionizer. Push the new ionizer down onto the probe, carefully engaging the center pin and BA shield spring until the focus plate is flush with the top of the quadrupole.

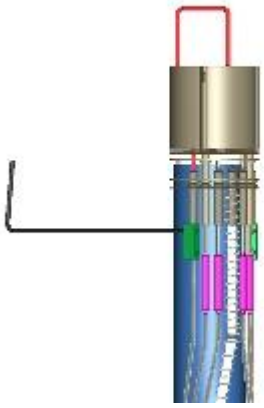
Step 8			Slide the four 4 tubular spring connectors down to engage the respective feedthrough wires. Insert the new filament assembly and while holding down on the filament, slide the barrel connectors into place and tighten both set screws on each barrel connector. Be careful that the wires do not short to each other or the frame. You can bend the wires from the feedthrough easily if necessary, but do not bend the wires from the ionizer or you may crack the ceramics.
Step 9			Finally, break off the top of the filament assembly and discard.

Figure 40. Servicing the Probe

More detailed Photographs are available on the Extorr web site at www.extorr.com.

9.2. Electron Multiplier Installation

An electron multiplier can be added to any XTP RGA that was shipped without one. The electron multiplier mounts on the high vacuum side of the probe flange. Its high voltage supply is already built into the XTP CCU, so nothing has to be installed inside the XTP CCU. Once the multiplier is installed, it is enabled in software with a password from Extorr (Section 9.2.4).

9.2.1. Unpack the Shipment

Carefully unpack the shipment. It includes these components:

1. Electron Multiplier in Sealed Plastic Bag
2. Glove
3. Copper Gasket

If your shipment does not have all of these items, call Extorr Inc at 724-337-3000. If anything appears to have been damaged in shipment, contact the shipper as well.

The Electron Multiplier is sealed in a plastic bag containing dry nitrogen. Leave the multiplier in its shipping bag until you are ready to install it.

9.2.2. Preparation

Prepare to remove the probe from your vacuum system by turning the Filament switch at the top of the XTP interface off. Allow the ionizer to cool for at least 30 minutes before venting your vacuum system. Unplug the 24 V power supply from the XTP CCU. If the XTP Host has been moved away from the XTP CCU, also unplug the RJ11 cable from the CTRL port on the XTP CCU. Loosen the two thumb screws and remove the XTP CCU from the probe flange, being careful not to bend the flange pins. After the ionizer has cooled, vent your vacuum system and remove the probe from the vacuum chamber.

ATTENTION!

Always handle the vacuum side of the probe and the electron multiplier with clean gloves, or you will see the results of your contamination on the next scan. A fingerprint will outgas and cause peaks at virtually every amu until it is evaporated or turned into low vapor pressure compounds in your vacuum system. Of course other sources of contamination such as diffusion or mechanical pump oil could cause similar problems. Even after the volatiles are gone, the residue may cause the probe to operate improperly by leaving behind either insulating compounds or secondary electron emitting surfaces. This can cause charge from electrons to build up and disturb the electric fields in the ionizer, or the mass filter, leading to low sensitivity

9.2.3. Install Electron Multiplier

The Electron Multiplier will be installed on the high vacuum side of the Quadrupole Probe assembly. It fits in the open space at the base of the quadrupole near the Faraday Detector – See the figure below.

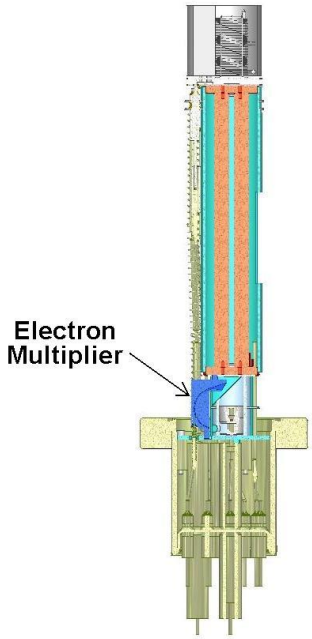


Figure 41. Electron Multiplier Location

Wearing a clean glove, remove the Electron Multiplier from the sealed plastic bag and identify the Top and Bottom Mounting Tabs and the Contact Spring Sockets – See the figure below.

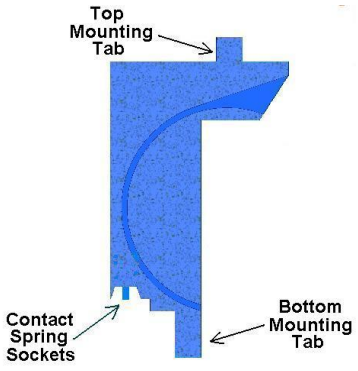


Figure 42. Electron Multiplier Mounting Tabs

Hold the multiplier at an angle with the Bottom Mounting Tab facing in toward the Faraday Cup as shown in Figure 43. Align the two Spring Contacts on the flange with the Sockets on the

multiplier and carefully insert the Bottom Mounting Tab into the lower slot on the flange. Compress the Contact Springs but make sure they stay in the sockets on the multiplier.

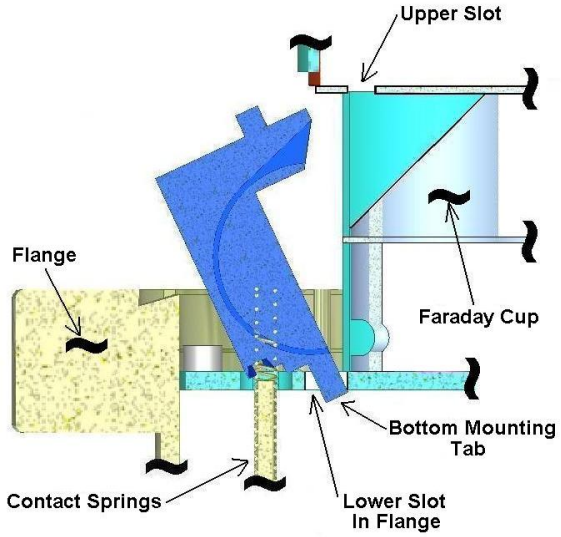


Figure 43. Insert Multiplier Bottom Tab

Push the top of the multiplier in toward the Faraday Cup and insert the Top Mounting Tab into the upper slot in the Faraday Cup Assembly. The Top Mounting Tab should snap into the upper slot. Check the position of the Top Tab to make sure it is inside the upper slot (Figure 44). Check that the two Contact Springs are still in the sockets on the multiplier.

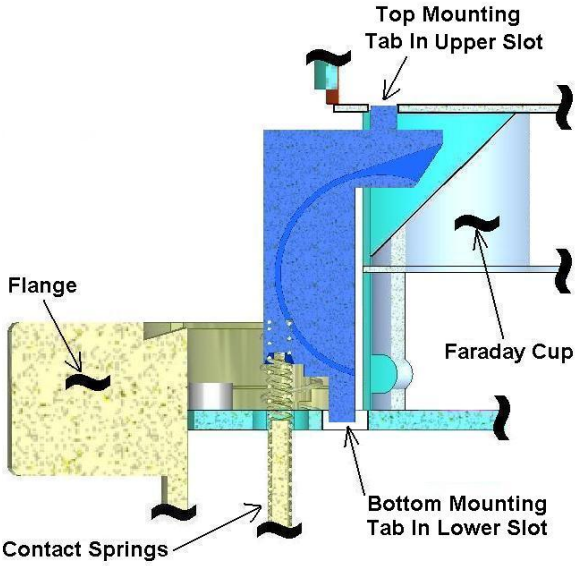


Figure 44. Insert Multiplier Top Tab

Re-install the probe into your vacuum system and reconnect the XTP CCU and power as described in Sections 4.3 to 4.5.

9.2.4. Enable the Electron Multiplier

The XTP CCU only uses the electron multiplier once it has been enabled on the Hardware tab of Settings (Section 7.3.4). This needs a password from Extorr. The password is specific to your

XTP CCU, so when you contact Extorr have the XTP CCU serial number, and the “Diagnostic M” Output reading ready. The XTP serial number can be found in the About tab in the system settings (Section 7.3.1). “Diagnostic M” Output is near the end of the outputs.

1. Power up the RGA and open the XTP interface.
2. Open the System menu, choose Settings and select the Hardware tab.
3. Check Unit has electron multiplier, enter the password from Extorr and click Apply. The XTP CCU restarts.
4. Open the About tab again and check that it now shows the electron multiplier.
5. Pump down, then set Multiplier Volts and Multiplier Gain as described in Section 7.5.4.1 before using the multiplier.

10. Troubleshooting

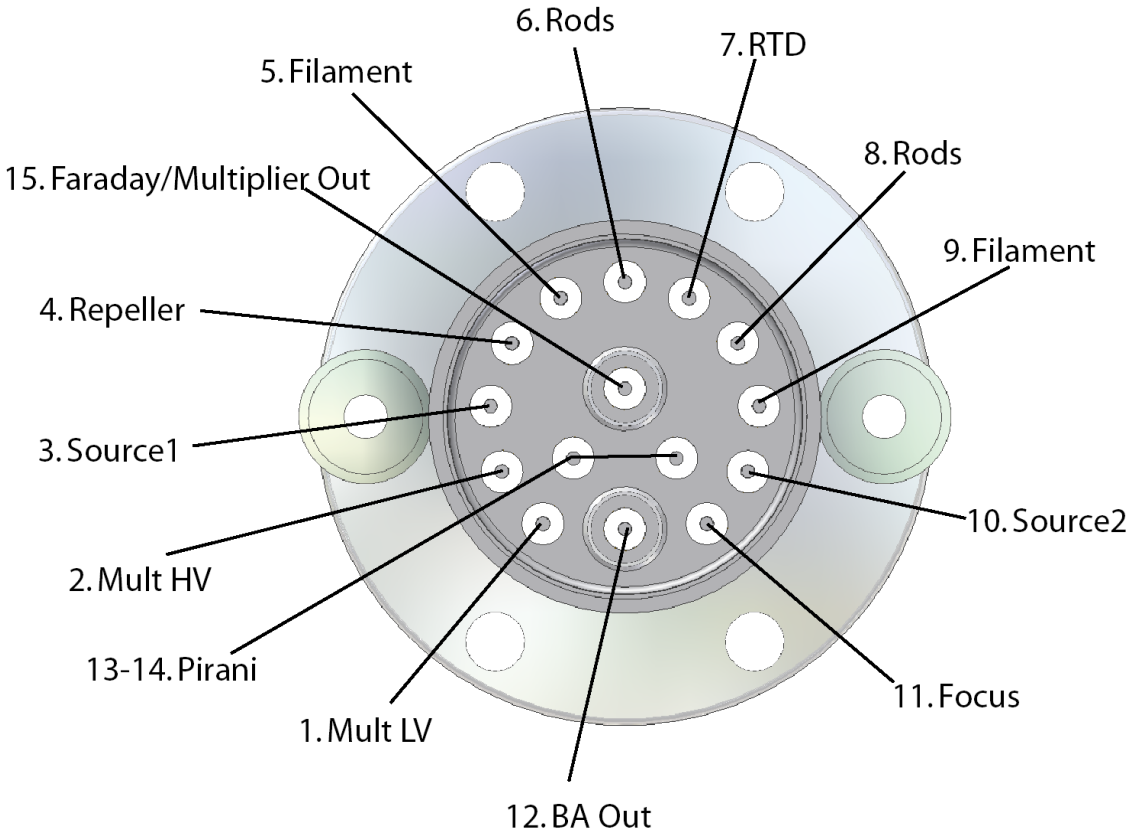


Figure 45. Flange Pin-Out

10.1. Finding Electrical Short Circuits Caused by Damage to the Probe

Short circuits may occur if the probe is damaged during installation. The ionizer elements or the connecting wires may bend if they touch the sides of the chamber, the opposite wall of the chamber, or another obstruction inside the vacuum system.

If you think you may have damaged the probe, first check for short circuits as described in Section 4.3. If a short is found, remove the probe from your chamber and inspect the Ionizer and the connecting wires. See the drawings that follow.

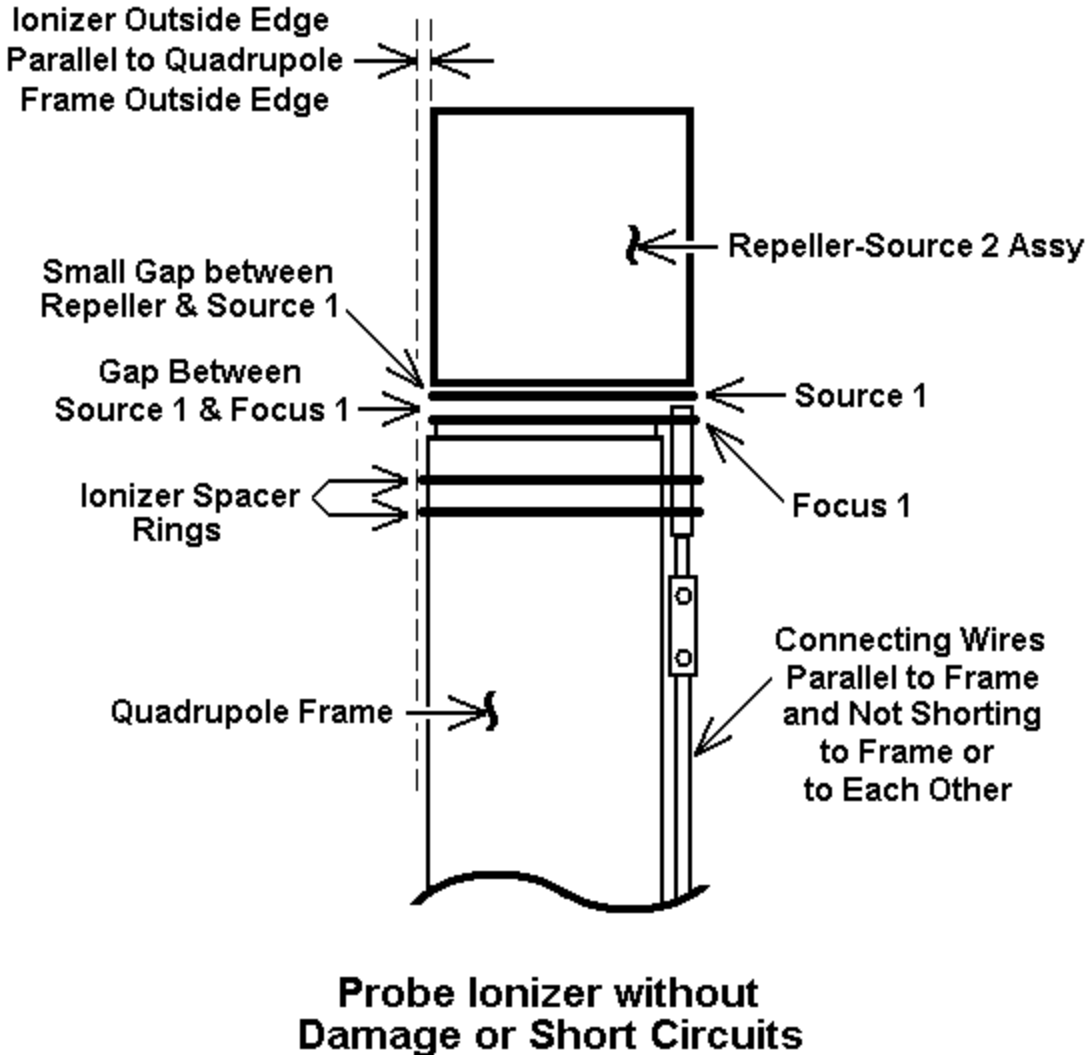


Figure 46. Ionizer without Damage

Use an Ohm meter to check for an open circuit (>20MΩ with XTP CCU disconnected) between the Repeller-Source2 Assembly and Source 1 plate, and between Source 1 and Focus 1. Also check for shorts between the Filaments and the Repeller-Source2 Assembly or the Filaments and the Source 1 plate. See Section 4.3

If a short circuit was measured with the probe installed in the vacuum chamber but it is not found after it is removed, the probe is probably touching the inside of the chamber. See Section 4.2.1.

If the probe has damage to the Repeller-Source 2 Assembly, there may be a short circuit between this assembly and the Source 1 plate. A bent Repeller-Source 2 Assembly may also short to the chamber wall in a close fitting tube. See the drawing below.

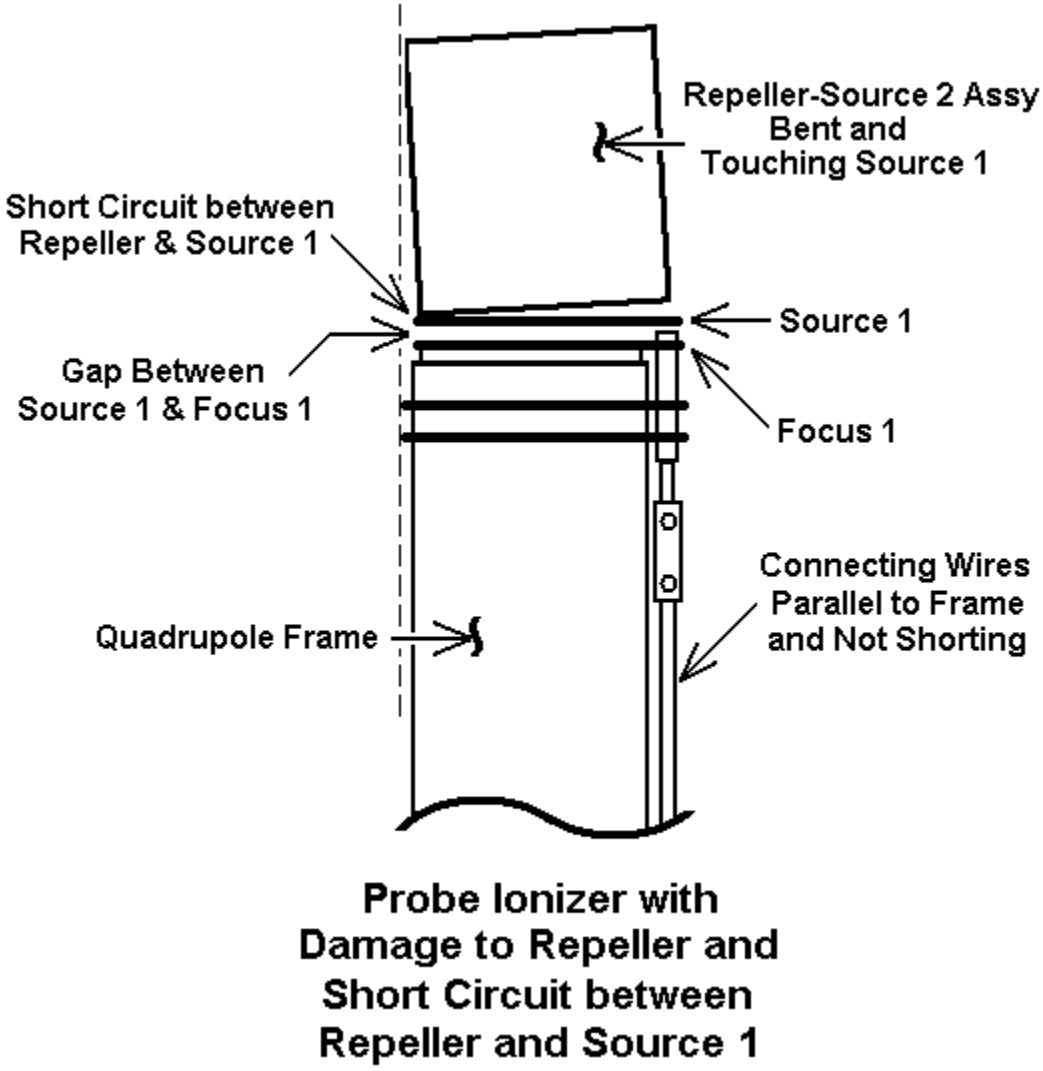


Figure 47. Short Circuit between Repeller and Source 1

Gently bend the Repeller-Source2 Assembly away from the Source 1 plate to remove the short circuit. If possible, bend the Repeller-Source 2 Assembly back so that its outside edge is parallel to the Quadrupole Frame. See the drawing for the un-damaged probe above.

Use an Ohm meter to check for an open circuit (>20MΩ with XTP CCU disconnected) between the Repeller-Source2 Assembly and Source 1 plate. Also check for shorts between the Filaments and the Repeller-Source2 Assembly or the Filaments and the Source 1 plate. See Section 4.3.

If the Repeller-Source 2 Assembly is bent far enough, it may bend the Source 1 plate until it touches Focus 1. This creates a short circuit between the Repeller-Source 2 Assembly, the Source 1 plate and the Focus 1 plate. A bent Repeller-Source 2 Assembly may also short to the chamber wall in a close fitting tube. See the drawing below.

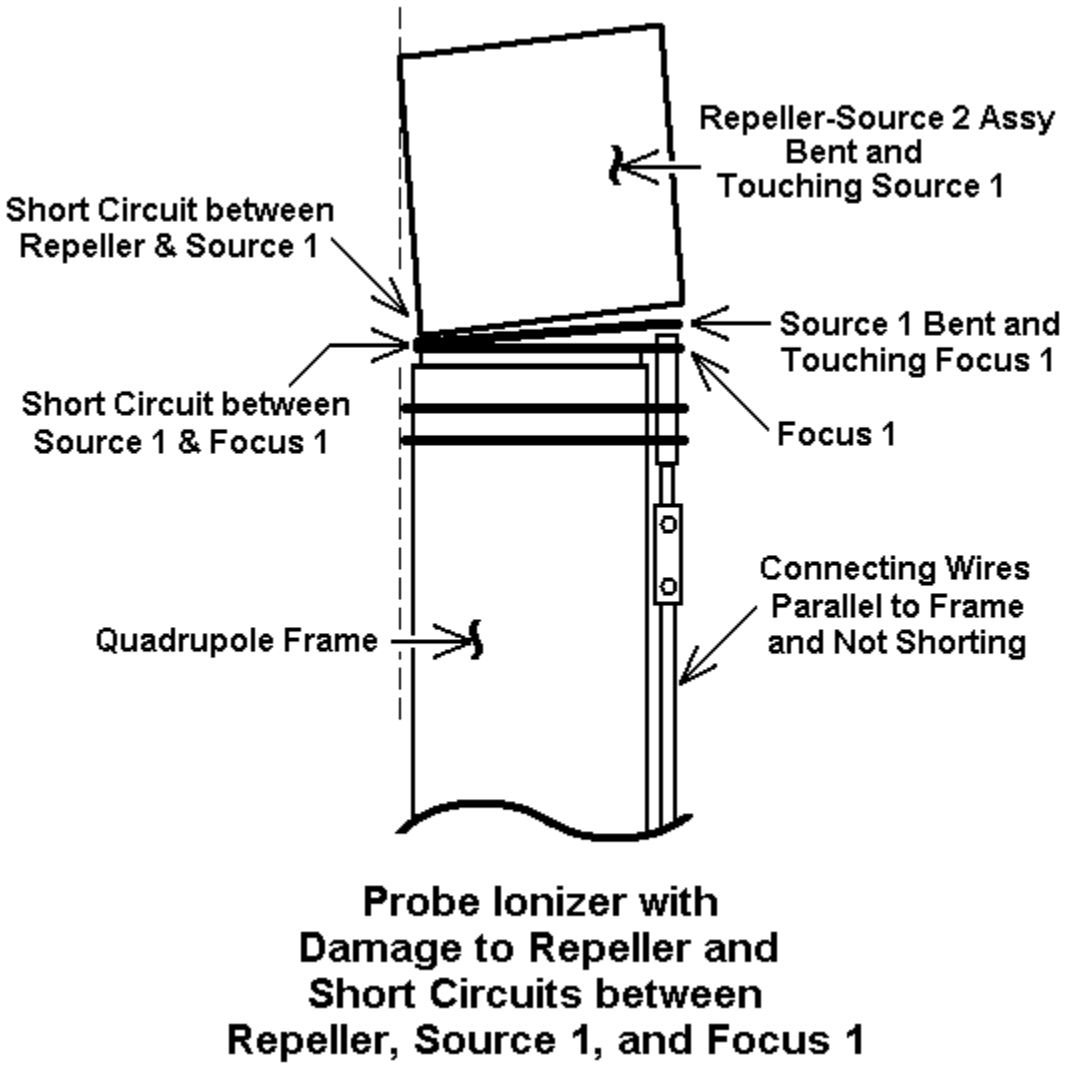


Figure 48. Short Circuit between Repeller, Source 1, and Focus 1

To repair the short, first gently bend the Repeller-Source2 Assembly away from the Source 1 plate. If possible, bend the Repeller-Source 2 Assembly back so that its outside edge is parallel to the Quadrupole Frame. Next carefully bend the Source 1 plate to remove the short circuit between Source 1 and Focus 1. Bend the Repeller-Source2 Assembly and the Source 1 plates until there are gaps between them as shown in the un-damaged probe drawing above. Use an Ohm meter to check for an open circuit (>20MΩ with XTP CCU disconnected) between the Repeller-Source2 Assembly and Source 1 plate, then check for an open circuit between Source 1 and Focus 1. Also check for shorts between the Filaments and the Repeller-Source2 Assembly or the Filaments and the Source 1 plate. See Section 4.3.

If the Source 1 plate is bent, there may be a short circuit between the Source 1 plate and Focus 1. See the drawing below.

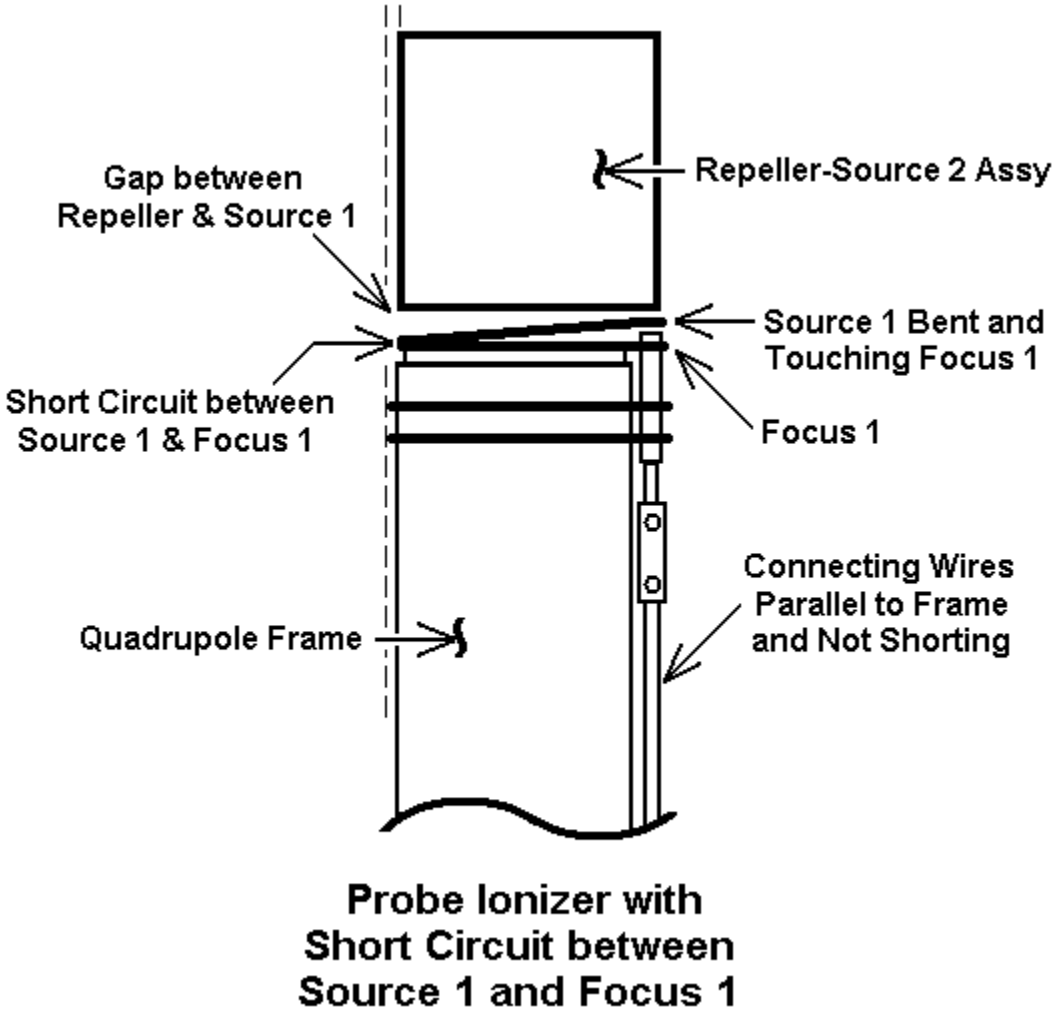


Figure 49. Short Circuit between Source 1 and Focus 1

If a short is found, gently bend the Source 1 plate away from the Focus 1 plate. Use an Ohm meter to check for an open circuit (>20MΩ with XTP CCU disconnected) between Source 1 and Focus 1. Also check for shorts between the Filaments and the Repeller-Source2 Assembly or the Filaments and the Source 1 plate. See Section 4.3.

If any of the Connecting Wires between the Ionizer and Vacuum Feed-Through are bent, they may touch the Quadrupole Frame (or the Vacuum Chamber wall) and create a short circuit. Sometimes a bent wire will cause the Barrel Connectors on the Filament Wires or the Tubular Spring Connectors on the other wires to touch the Frame (or the Chamber) and create a short circuit. See the drawing below.

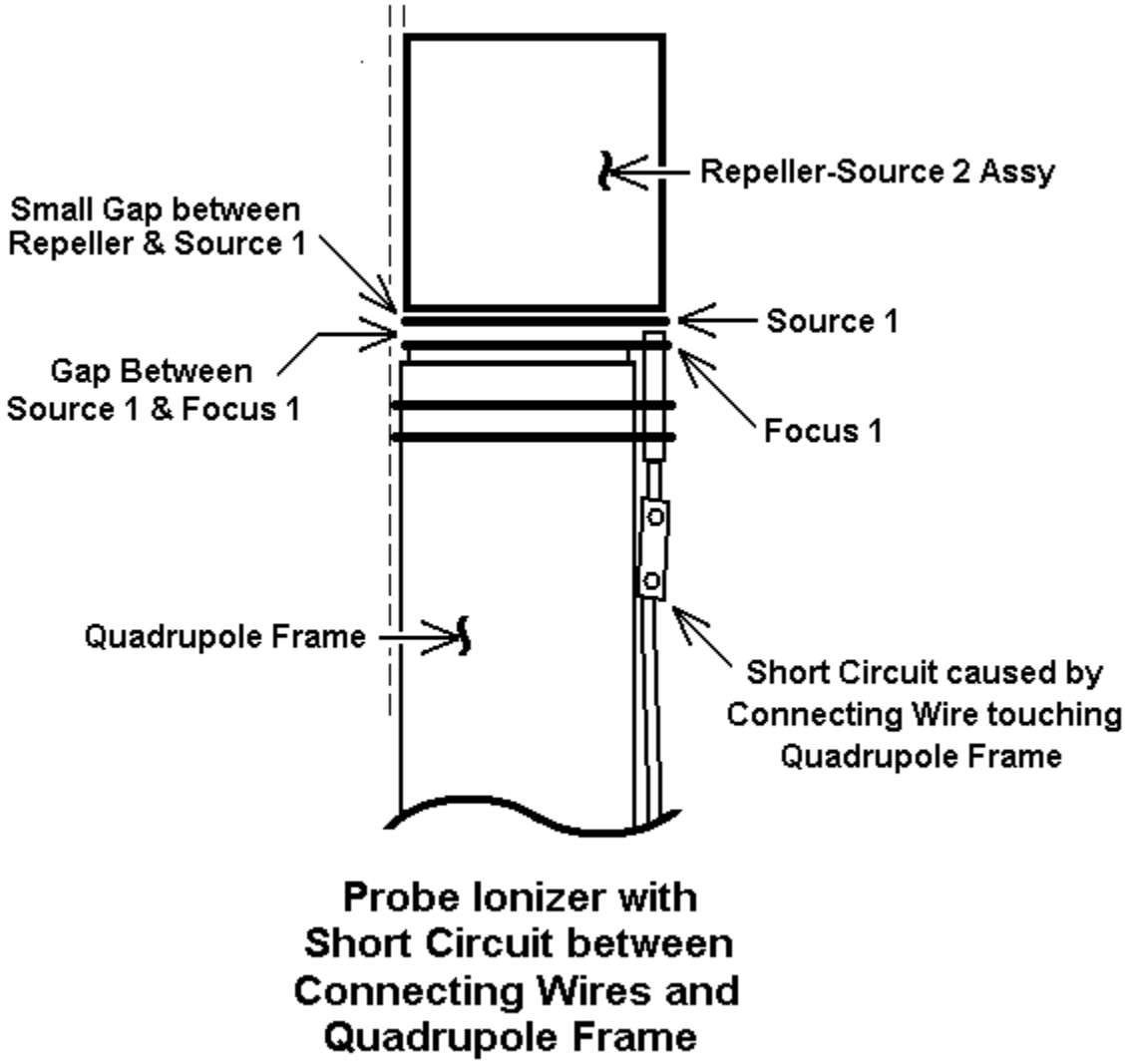


Figure 50. Probe Connecting Wire Short Circuits

Examine the wires along their entire length and if necessary, carefully bend the wires away from the Quadrupole Frame to remove the short circuit. Do not bend the wires too far or they might short to the vacuum chamber wall. Also check for adjacent wires shorted to each other. If necessary, bend the wires away from each other to remove the short circuit.

Use an Ohm meter to check for an open circuit (>20MΩ with XTP CCU disconnected) between Quadrupole Frame and all six wires. Also check for shorts between adjacent wires. See Section 4.3.

10.2. Filament Trip Diagnosis

The ionizer has two filaments that operate in parallel. The filaments are made from Iridium metal and are positioned about 2 mm from the platinum source grid in the ionizer. Iridium does not emit electrons at a low enough temperature to be useful, so it is coated with thoria, a powdery white substance.
The XTP CCU electronics apply a voltage across the filaments to heat them until electrons are boiled off of the thoria coating. This electron emission current flows from the filaments to the platinum source grid (Source 1) and a portion of the current makes it to the other side of the ionizer to the Source 2 plate. Both the Source 1 and Source 2 currents are measured by the electronics and are displayed on the Outputs tab.
The electronics will increase the filament voltage until the sum of the Source 1 and Source 2 currents is equal to the Filament Emission setting in the Operating Parameters, this is usually set to 2 mA. The voltage is increased over the course of about 5 seconds when the filament is first switched on. You can monitor the filament voltage by choosing a fast scan speed or a small mass range so that the Outputs tab values update every second or so. If the Filament Emission setting is not reached with the maximum filament voltage, the software will report that the filament tripped and will reduce the filament voltage back down to about 0.1 volts.

The most common cause for a filament trip is an electrical short circuit from one of the probe elements to the vacuum chamber wall (electrical ground).
A short circuit usually occurs when the exposed electrical connections on the vacuum side of the probe come in contact with the chamber or there is damage to the ionizer assembly.
It is also possible that both of the filaments have burned out.
See Section 10.1, Finding Electrical Short Circuits Caused by Damage to the Probe, and Section 4.3 for details on how to diagnose these problems.

Another cause for the filament trip could be a filament that has lost the emissive thoria coating. The thoria coating will decompose over time and the electronics will adjust the filament voltage to compensate. At some point the electronics will no longer be able to obtain the desired emission current and the filament will trip.
Rinsing the probe in a solvent to remove oil contamination may wash the thoria coating off of the filament. The thoria powder may also come off due to continuous large amplitude mechanical vibrations. The filament will have to be replaced in these cases. See Section 9.1 for detailed instructions on replacing the filament.

The filament may also trip if a non-conductive coating is on the source grid. The coating may not allow the full 2 mA of emission to be produced and the filament will trip after only a few seconds of operation. Try reducing the Filament Emission to 0.1 mA in the Operating Parameters to see if the filament will turn on. Even a very dirty source grid will usually be able to support 0.1 mA of emission. If the filament turns on at the reduced emission, the mass peaks will be much smaller, but the contamination may burn off as the ionizer heats up.
Leave the filaments on for a minute or so and then try to degas for about 1 minute. After degassing, set the Filament Emission in the Operating Parameters back up to 2 mA. If the filament still does not turn on, the ionizer may need to be replaced. See Section 9.1 for detailed instructions on replacing the ionizer and filament.

The ionizer may become contaminated over time causing the filaments to trip. Operating the ionizer in an oxidizing environment for long periods of time will form an insulating coating on the surfaces and the sensitivity will decrease. The RGA will operate at 10^{-4} torr and give meaningful results, but if the major components are water or oxygen, the stainless steel parts will form chromium oxide (an insulator) on their surfaces because the ionizer temperature gets to about 200°C in normal operation

An insulating substance could also be deposited on the ionizer in the vacuum system. Oil back streaming is common when using a rotary vane pump without proper precautions such as a molecular sieve oil trap. The oil may produce either insulating compounds or secondary electron emitting surfaces in the ionizer. This can cause a charge from electrons to build up and disturb the electric fields in the ionizer or the mass filter, leading to low sensitivity.
Deposition systems can also deposit insulating materials on the vacuum probe surfaces.
In the case of oxidation, replacing the filament and ionizer will usually restore proper operation because the quadrupole mass filter does not get hot enough to oxidize. In the case of contamination from outside sources, the quadrupole will probably need to be cleaned in addition to the replacement of the filament and ionizer. See Section 9.1 for detailed instructions for cleaning the quadrupole and replacing the ionizer and filament.

Another reason for the filament tripping could be that the RGA vacuum feed thru pins have become oxidized from a high temperature bake out. The pins are made of nickel alloy and form nickel oxide at high temperatures increasing the contact resistance. In normal operation the resistance of filaments is only about 0.5 Ohms so even a small increase in the contact resistance of the pins is important. It takes about 2V at 4A to generate 2mA of electron emission in normal operation.
The probe pins may be carefully cleaned with a fine (400-600 grit) sandpaper to remove the oxide. A finger nail emery board may also be used. The oxide coating is a dull greenish grey so sand the pins until they are bright, it usually takes just a few minutes.
Pay most attention to the filament pins, pins 5 and 9, on the feed thru. See Figure 45, Flange Pin-Out.
The Filament Voltage on the Outputs tab should read about 2 volts after cleaning.

10.3. Pirani Gauge Will Not Allow Filament to Turn On

The Extorr RGA is protected from turning on unless the pressure is low enough for the filament to operate without damage. The Pirani gauge reads from atmosphere down to about $1x10^{-4}$ torr. It is constructed from a fine platinum wire in the base of the probe that is heated to about 150 °C and the heat loss to the surrounding gas molecules is measured.
In rare cases where it fails, the RGA will not allow the filament to turn on because the Pirani gauge will read a high pressure, probably atmosphere.
In one case exposing the heated wire to certain CVD gasses resulted in deposits forming on the wire producing incorrect readings.

If you suspect that the Pirani is reading incorrectly, please contact Extorr support, and we can properly diagnose the problem. The Pirani parameters can be overridden via diagnostics if that is the case.

11. Service and Return

If, for any reason, you need to return your XTP system to Extorr Inc. for service, first call 1-724-337-3000 to obtain a Returned Material Authorization (RMA) number. Then pack the instrument securely, using the original packaging if it is available.
Be sure that the RMA number is clearly marked on the outside of the shipping box.

Many Probes returned to Extorr for repair are damaged in shipping because of poor packaging by the customer.
If the Vacuum Feed Thru Pins are broken in shipping, the feed thru must be replaced at the cost of a new one.
To avoid damage use the original Probe Shipping Box (or clear plastic shipping tube) if possible. The factory shipping box (or clear plastic shipping tube) supports and protects the probe to help prevent damage.

Please contact the factory for instructions on properly packaging your probe.

Appendix A. Gauge Sensitivity to Differing Gases

A.1. Pirani Gauge

Thermal conductivity of a gas is directly related to both the mass of the gas molecules and the pressure. The Pirani readout is calibrated for air. Pressures in other gases may vary considerably from the results due to air.

The characteristic voltage vs. pressure response curve for the Pirani is shown to the right. The voltage read at atmospheric pressure and that read when pressures are below 10^{-2} torr will establish the voltage pressure relationship between these two points.

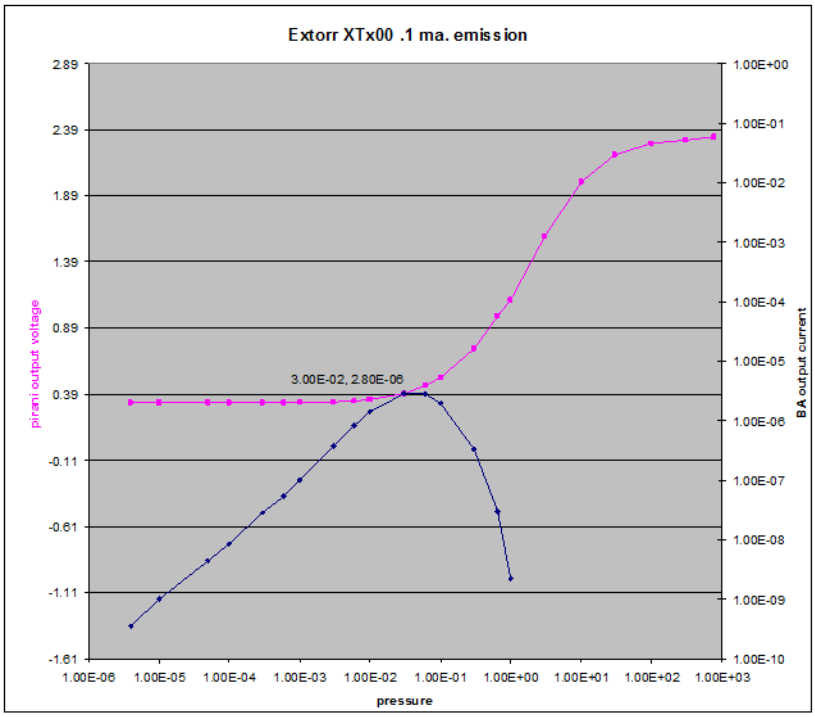


Figure 51. Pirani & B/A Ion Gauge Operation

A.2. B/A Ion Gauge Corrections

The B/A ion gauge is also calibrated for nitrogen. In the B/A ion gauge pressure realm, the ion current depends on the probability that an electron ionizes a molecule to make an ion. This probability (actually a cross section for ionization) is strongly dependent on the molecular structure. The pressure is defined by the ratio of ion current, i, to electron current, e, times a sensitivity number, k. That is P= i/ (k*e). k must have units of inverse pressure. This k can vary widely depending on the molecular make-up of the gas. The table below gives this k value for most common vacuum gases.

The table gives this result in inverse torr, inverse mbar and inverse pascals. A relative sensitivity is also given with respect to nitrogen. This is the number used to convert a nitrogen gauge reading to a reading for the gas in question. This is done by dividing by the relative sensitivity number, k_r.

Gas	k,Sens ($mbar^{-1}$)	k,Sens ($torr^{-1}$)	k,Sens (Pa^{-1})	k_r, Relative Sensitivity
Air	19.0	25.3	0.19	1.00
H_2O	19.0	25.3	0.19	1.00
O_2	21.0	27.9	0.21	1.11
D_2	6.6	8.8	0.07	0.35
H_2	6.2	8.2	0.06	0.33
He	2.4	3.2	0.02	0.13
Ar	21.0	27.9	0.21	1.11
N_2	19.0	25.3	0.19	1.00
NO	22.0	29.3	0.22	1.16
CO	19.0	25.3	0.19	1.00
CO_2	27.0	35.9	0.27	1.42
Ne	5.4	7.2	0.05	0.28
CH_4	27.0	35.9	0.27	1.42
Kr	37.0	49.2	0.37	1.95
Xe	54.0	71.8	0.54	2.84
SF_6	48.0	63.8	0.48	2.53

Figure 52. B/A Ion Gauge Relative Sensitivities

Here we divide the nitrogen reading by the relative sensitivities above to get the pressure of that pure gas. A gas mixture will give some intermediate result.

Appendix B. Manual Tuning of an RGA

The Extorr XTP Residual Gas Analyzer (RGA) comes with its default tune. This was set at the factory for a nominal unit mass resolution at the proper mass positions throughout the mass range. This default tune may always be assumed to be either fairly exact or a good starting point for a user calibration.

The user can override this tune by changing the tuning parameters in the Configuration panel (Section 7.5). Most of them are shown only in Advanced mode. Each change takes effect when Apply is clicked and is saved as a new version of the configuration, so an earlier tune can always be applied again (Section 7.4). This may be done to give special measurement capabilities to certain spectral regions, for instance to look at a particular weak spectral region with enhanced sensitivity or look at a portion of the spectrum with higher resolution to look at "half mass" peaks, or peaks which suffer mass defects.

The tuning parameters which may be controlled and their functions are:

1. Electron Energy, which controls sensitivity.
2. Filament Emission, which controls the amount of electrons available for ionization.
3. Low Cal Ion Energy and High Cal Ion Energy, which control sensitivity and peak shape.
4. Focus 1, which can affect sensitivity and peak shape.
5. Low Cal Mass and High Cal Mass, which set the points on the mass scale from which the Ion Energy, Position and Resolution values are interpolated and extrapolated.
6. Low Cal Position and High Cal Position, which fine tune where peaks are placed on the mass scale (an offset in amu at each Cal Mass).
7. Low Cal Resolution and High Cal Resolution, which control spectrum wide resolution, peak shape, and sensitivity.

Quadrupole rods act as a mass filter. For a given mass to charge ratio, a large number of combinations of RF and DC voltage will allow that ion through the length of the rods. In fact all combinations of RF and DC below a unique, nearly triangular, graph will allow that ion through. This is called the quadrupole stability diagram. Note that this graph is reflected in the Extorr logo. A second ion, say with half the mass to charge ratio as the first, will have a completely similar stability diagram as shown in Figure 70. We can now see how this arrangement can be used to produce a mass spectrometer. Clearly, if we have combinations of RF and DC voltages in the region A, neither of the ions will make it through the rods. In the D region both ions make it through the

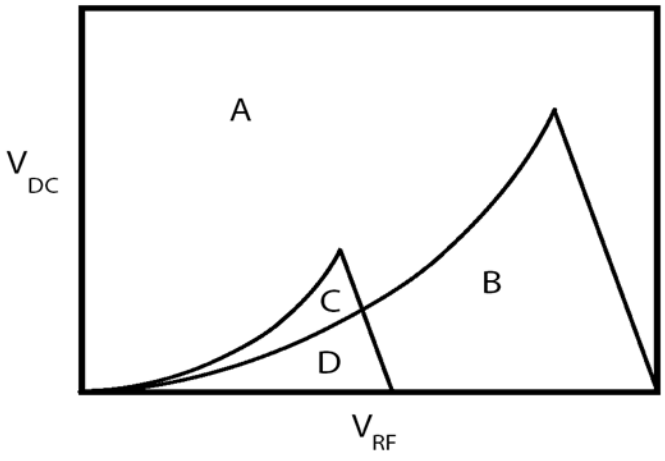


Figure 53. Stability Diagrams

rods. In the B region only the high mass ion makes it through the rods and in C only the low mass ion makes it through the rods.

A second example of this concept is of the stability diagrams of the first 5 masses. Note the 5 similar stability diagrams for the first 5 ion masses. If we sweep the RF and DC voltages along line A, we get the mass spectrum shown as a. Note that the peaks are flat topped and thin. I have chosen an ion abundance at each mass such that mass 1 is larger, mass 2, 3 and 5 are about half this size and mass 4 is the largest peak. When we sweep along B we get the spectrum shown as b. The peaks are now uniformly wider. So we can control the peak widths with our sweep line. If we want to change peak widths, we could sweep as in C and get the mass spectrum c. Note that the mass 1 peak is no longer as tall as mass 2. This is the situation when a peak is said to be over-resolved.

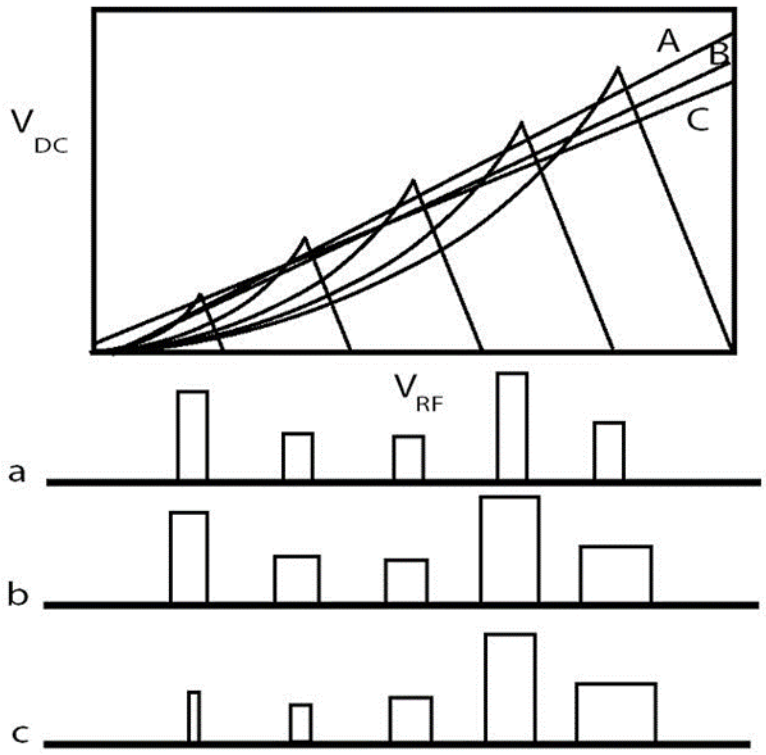


Figure 54. Stability Diagrams and Mass Spectra

You may note that theses peaks do not look like real world peaks. They are indeed idealized. In the real world the corners are smoothed.

Armed with these ideas of how mass sweeps work, we can look at how the parameter settings can change individual peak heights, shapes and widths. Always remember you can go back to the factory tune by copying the factory configuration, CFG-FAC1, and applying the copy, and you can compare any configuration against it to see what has been changed (Section 7.4).

Electron energy, set with Electron Energy in the Operating Parameters, is the energy, in electron volts, that the electrons have as they move through the ionization volume. The probability that the electron produces an ion from a molecule moving within this volume depends on the electron's energy and the nature of the molecule. Ionization depends on the electron energy ionization threshold below which no ionization is produced. After this threshold, ionization probabilities increase to a maximum and then decrease as electron energies are advanced beyond this maximum. This electron impact ionization "cross section" curve is unique to each molecule but, for production of singly charged ions, the maximum is near 70 eV. This is the normal setting for RGA electron energy. If, for some reason, it is desirable to reduce the intensity of doubly charged ions, a reduction of electron energy will usually help.

Filament emission, set with Filament Emission in the Operating Parameters, controls the amount of electrons available for ionization. Peak height can be adjusted using this parameter. When operating at pressures above 10^{-5} torr, filament and ionizer lifetime will be increased if the filament emission is decreased by a factor of 10. Note that partial pressure readings will read low unless Partial Sensitivity in the Calibration Parameters is changed to match.

The mass scale set points, Low Cal Mass and High Cal Mass, are in the Calibration Parameters. These set points are usually set to mass 1 and the highest nominal mass for the XTP unit. That is, for an XTP-100 the set points are 1 and 100, for an XTP-200 the points are 1 and 200, and so on. They may, however, be set anywhere in the mass range of the RGA. These set points control, by extrapolation and interpolation, the values of Ion Energy, Mass Position, and Resolution at each individual point along the mass axis.

Ion energy is set in the Calibration Parameters. It is controlled by extrapolation and interpolation from the High Cal Ion Energy and Low Cal Ion Energy set points. It is the parameter which controls the speed of the ion through the quadrupole. As the speed is increased so is the probability of the ion making it from the ionization volume to the ion detector. Ion energy is therefore a way of controlling peak height. The lower the ion energy, the lower are the number of ions detected. The higher the energy, the greater are the number of ions detected. Unfortunately, as the ions increase their speed, they are less likely to be properly selected by the RF field of the quadrupole and peak splitting occurs. In the Extorr RGA, an “Ion Energy” between 3 to 6 volts usually gives the best sensitivity without peak shape distortion. Also note that higher masses have less speed than do lower masses at the same energy.

The focus voltage, set with Focus 1 in the Operating Parameters, controls how the ions are extracted from the ionization region. Any particular tune setting may be optimized by a change in this voltage. As ionizers age by contamination, sensitivity may be increased by an increase in magnitude of this negative voltage.

Mass calibration is set in the Calibration Parameters. Low Cal Mass and High Cal Mass are the reference masses: the peaks used as the two calibration points. Low Cal Position and High Cal Position are the offsets, in amu, that place those peaks at their correct positions, and the positions of all other masses are interpolated and extrapolated from them. Changing a Cal Mass also moves the mass scale, but it is not intended for fine tuning; the Cal Positions are the parameters that fine tune the exact position of the mass peaks. The resolution settings also interact a little with the position. As resolution is increased (peak width decreased), the mass peak will change width more on the low mass side than the high mass side. The peak maximum will therefore have been shifted. The High Cal Position and Low Cal Position may be adjusted to place the peak top back at the proper mass position.

Mass peak resolution is also set in the Calibration Parameters. It is controlled by extrapolation and interpolation from the High Cal Resolution and Low Cal Resolution set points. These are the parameters which control the width of the mass peak. As resolution is increased the peak widths are decreased. Decreasing the resolution allows more ions through the quadrupole and increasing the resolution allows less. Therefore, peak heights may also be controlled by the resolution settings.

Quadrupole tuning is somewhat an acquired art. The more the user “plays” with different tunes, the more adept the user will become at achieving customized purposes. We again emphasize that for 99% of RGA operations, the factory tune is more than adequate. Remember you can go back

to this tune at any time by copying CFG-FAC1 and applying the copy, or see exactly what has been changed by comparing your configuration against it (Section 7.4.2).

Appendix C. Options and Spare Parts

An up-to-date and complete list of spare parts for the XTP Series RGA can be found on the Extorr website: https://www.extorr.com/products/xtp-series-rga/parts-list

Warranty

XTP products of Extorr Inc. are warranted to be free of defects in material and workmanship for a period of one year from the date of shipment. At our option, we will repair or replace products which prove to be defective during the warranty period. Liability under this warranty is limited to repair or replacement of the defective items. Shipping damage is excluded from the scope of this warranty.

If this product is returned to Extorr for warranty service, Buyer will prepay shipping charges and will pay all duties and taxes for products returned to Extorr. Extorr will pay for return of products to Buyer, except for products returned to a Buyer from a country other than the United States.

LIMITATION OF WARRANTY: The foregoing warranty does not apply to the defects resulting from unauthorized modification or misuse or operation outside the specifications of the product.

THE WARRANTY SET FORTH ABOVE IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. Extorr DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES: The remedies provided herein are Buyer's sole and exclusive remedies. In no event will Extorr be liable for direct, indirect, special, incidental, or consequential damages, including loss of profits, whether based on contract, tort, or any other legal theory.