



HPQ3 (S)

Hardware Manual

As part of our continuous product improvement policy, we are always pleased to receive your comments and suggestions about how we should develop our product range. We believe that the manual is an important part of the product and would welcome your feedback, particularly relating to any omissions or inaccuracies you may discover.

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EC Declaration of Conformity

MKS Instruments UK Ltd declares that the:

HPQ3 RGA (MKS114) control electronics package

Is in accordance with the following directives:

2004/108/EEC Electromagnetic Compatibility Directive

EN 61326-1:2006 Electrical equipment for measurement, control & laboratory use.

2006/95/EC Low Voltage Directive

EN 61010-1:2006 Safety requirements for electrical equipment for measurement, control & laboratory use.

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The unit complies with all essential requirements of the Directives.

Signed:

A handwritten signature in blue ink, appearing to read 'J.M. Higgins', written over a light blue horizontal line.

J.M.Higgins
General Manager
10th October 2009



Overview

The HPQ3 is the latest innovation in RGA technology from MKS Instruments allowing operation far beyond the $1e^{-4}$ mbar of conventional RGA's without the need for differential pumping.

The field proven analyser technology of the HPQ analyser coupled with the latest innovative electronics technology derived from the Microvision2 family give data quality not previously seen in this class of instrument. The resulting system is less complex, with reduced installation requirements, offering a higher level of reliability at a substantially lower cost.

In addition, the HPQ3S uses application validated correction algorithms to compensate for the sensitivity variation arising from ion-molecule interactions in the ion source at higher pressures. This allows reliable data to be obtained for specific gas species including water, oxygen, nitrogen, methane, helium and hydrogen in argon and other gas mixtures.

Features

Data acquisition through solid state, wide dynamic range, fast settling detector electronics.

Temperature stabilized critical components offering improved signal stability and drift.

Calibrations and configurations stored locally within the RGA.

Flexible I/O capability including a dedicated gauge port.

Further expandability of the I/O capabilities using add-in cards.

TCP/IP and ASCII protocol support

Operation

The HPQ3 is designed to be operated in several ways:

From a host computer – an IBM compatible PC or MAC running the MKS Process Eye Professional or EasyView software package.

PC or MAC using a web browser such as Internet Explorer or Safari.

Integration into existing systems controlling through the use of the ASCII protocol command set.

This manual focuses on HPQ3 hardware and should be used in conjunction with the relevant user interface manual during installation.

Any required network communications cards should be installed and configured prior to installing the HPQ3, or RGA software if supplied.

1. Specifications

1.1 Mechanical

HPQ3

Dimensions:

127mm wide x 127mm x 179mm deep, plus 46mm over analyser connector to face of CF flange.

Weight:

1.7 kg

24VDC Power Supply

Dimensions:

75mm wide x 45mm high x 146mm deep plus 30mm over strain relief.

Weight:

0.6 kg

Analyser

Max. Operating pressure

HPQ3 1e-3 Torr (1.3e-3 mbar)

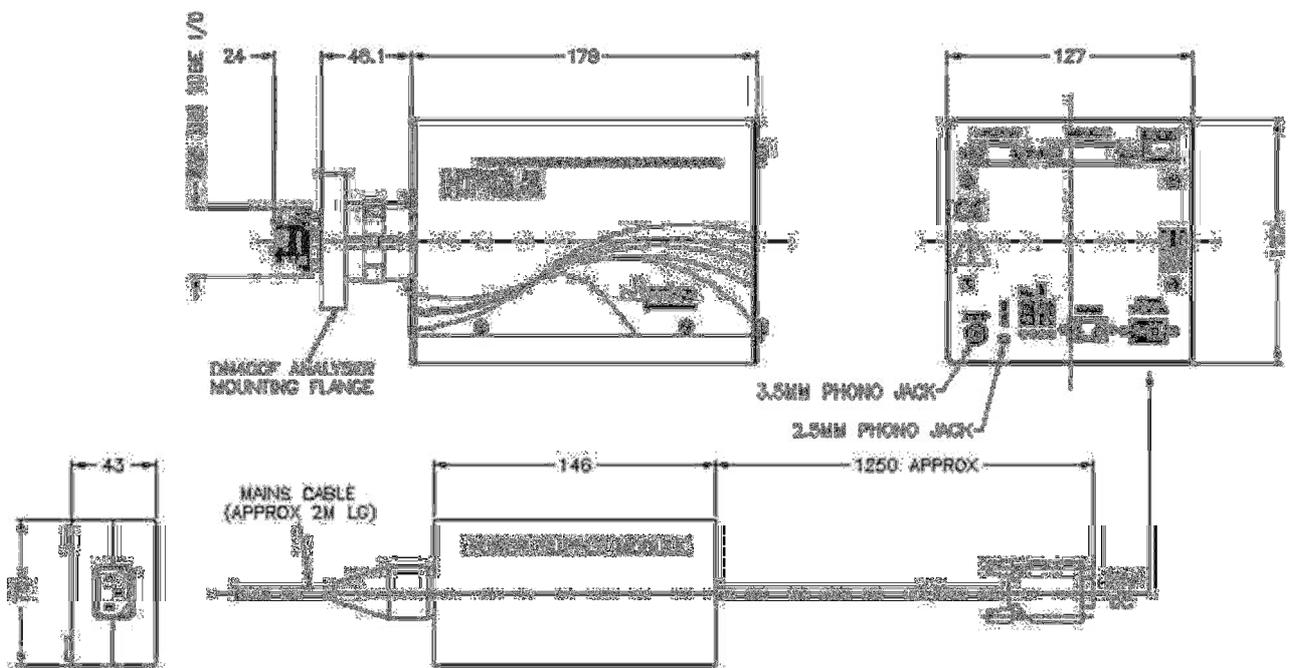
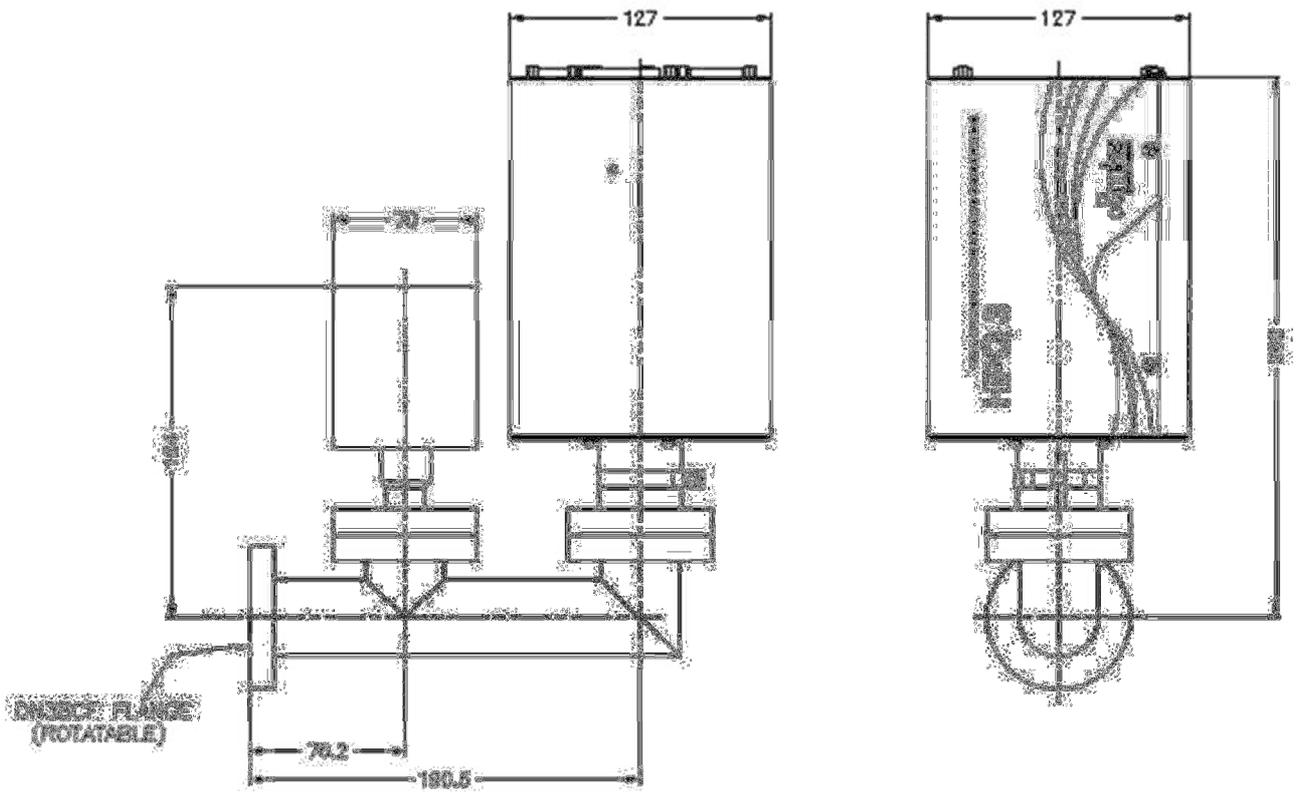
Dimensional Drawing —

Note: Unless otherwise specified, dimensions are nominal values mm.

HPQ3S 8e-3 Torr (1e-2 mbar) –
Application dependant

Maximum transient burst pressure

4e-2 Torr (5e-2 mbar) – gas dependant



1.2 Electrical

Power Supply

100 to 120, 200 to 240 VAC rms 47- 63Hz @ 2.1A rms
Installation category (over voltage category) II to IEC664
Fuses Internal, not user replaceable
Insulation Class I to IEC536

1.3 Environmental

Temperature range

0 to 40°C, 80%RH non-condensing, operating and storage
Pollution degree 2 to EN61010
Enclosure IP20 to EN60529

1.4 Safety

IP20 to EN60529

The protective earth conductor of the power cord must be connected to the power source protective earth terminal.

There are no operator replaceable parts within the 24VDC power supply unit or the HPQ3 unit.

1.5 Connectors

The connectors for external circuits are for use only with MKS equipment, or equipment which has no accessible hazardous live parts.

The external circuits must comply with the requirements of EN61010-1 section 6.6.1.

Ports for connection of accessories do not carry hazardous potentials.

Do not position the 24VDC power supply so that it is difficult to unplug the supply power cord.

Installation Category II comprises mains powered, local level appliances.

1.6 Warning labels



Refer to:

- a. Accessible hazardous voltages on analyser connector, when not mated to the analyser, which may result in a non-hazardous electric shock if touched.
- b. Tuning adjustment holes, which are not for operator use.



On the rear panel refers to:

- a. Read all instructions carefully before use.
- b. The control unit and signal ports are designed for connection to MKS accessories via MKS supplied cables.

There are no accessible hazardous voltages or currents on these ports.

MKS must be consulted before any non-MKS supplied cables or accessories are connected to these ports.

1.7 Ventilation

The openings in the sides and rear panels must not be obstructed.

Allow a minimum clearance of 50mm all round.

Do not exceed the maximum operating ambient temperature.

Additional Installation Maintenance and Operating Instructions

In order to comply with European regulations, the following procedures must be followed:

A) INSTALLATION

1. The installation procedures given in the operating and technical manuals must be followed in addition to these instructions.
2. The mains power cable must conform to local regulations and must have a protective earth (PE) conductor securely connected to the power plug protective earth contact.
3. The short earthing braid supplied with some products, must be fitted between the terminal on the RF head and one of the CF40 vacuum flange bolts.
4. Only cables supplied with the equipment may be used for interconnections. If extension cables are required to obtain a greater separation between control unit and RF head, or if longer serial communications cables are required, they must be supplied by MKS Instruments Ltd.
5. Cables attached to all other ancillary signal and control ports must have a length of less than 3 meters. If greater length is required, MKS Instruments Ltd. must be contacted for technical guidance on possible EMC and safety issues.
6. The vacuum system on which the analyser/RF head is mounted must be earthed, to a protective earth, preferably to the same protective earth as the control unit.

B) OPERATION

1. The equipment is not authorised for use as a critical component in a life support or safety critical system without the express written approval of MKS Instruments Ltd.

2. All instructions given in the operating manual must be followed.

3. Adjustments are strictly limited to those accessible from the control panel and computer keyboard and only when running software supplied by MKS Instruments Ltd.

C) MAINTENANCE



WARNING-DANGEROUS VOLTAGES EXIST INSIDE
THE EQUIPMENT

1. Maintenance functions must only be carried out by competent persons.

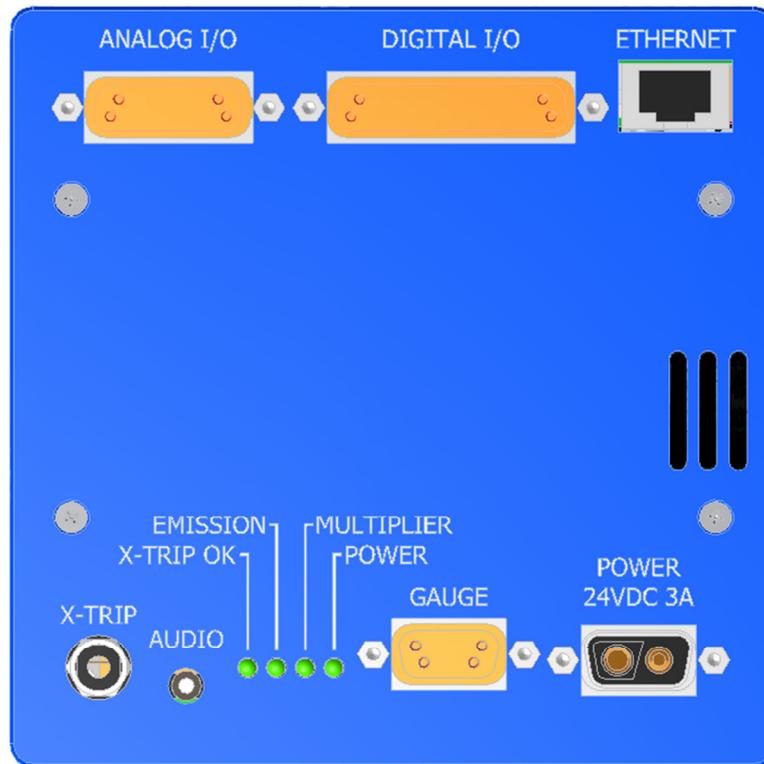
2. During the warranty period, faulty equipment must be returned to MKS Instruments, Spectra Products Ltd., unless special arrangements are made.

3. There are no user serviceable parts in the electronic equipment. Certain components are EMC and safety critical and must not be substituted. Replacement parts are available from MKS Instruments UK Ltd.

4. Equipment enclosures embody certain special fastenings and bonding devices that affect EMC and safety performance. These must be correctly re-fitted after servicing.

2. Rear Panel Connections

The rear panel incorporates all the connections required by the HPQ3 RGA. Details on these connectors and their use can be found in this section.



2.1 X-Trip

The X-Trip connector requires a special locking, stereo jack plug, which is supplied with the unit. Do not use a standard 3.5mm jack plug. Replacements are available from MKS Instruments if required.

The external trip feature is used to protect the filaments and electron multiplier from exposure to high pressures. It allows an independent total pressure gauge or signal from a vacuum control system to be connected to the HPQ3 as protection against accidental damage.

It is the most effective of the trips available and we would always recommend its use.

The external trip input can be driven in three ways:

1. Uncommitted relay contact

This is a low voltage (+5V, 1mA) contact. The contact should be closed for normal operation, open to trip the filaments, or if the protective equipment is switched off.

2. Open collector TTL drive

The output transistor should be on for normal operation, off for trip, or if the protective equipment is turned off.

3. Totem pole TTL drive

The signal should be low for normal operation, high for a trip condition, or if the protective equipment is switched off.

The external trip circuitry is galvanically isolated from the system ground. The maximum common mode voltage is 60V DC or peak AC, current limited to 2mA.

2.2 Audio Socket

This is a 2.5mm jack socket. It is used to connect headphones or an external amplified speaker so that audio tones generated in some of the modes can be heard. E.g. Leak checking tone and audio alarms.

The minimum load impedance should be 8 ohms and the power handling is 2 watts max.

2.3 Emission Indicator

The indicator is lit when a filament is active and within correct operating parameters.

2.4 Multiplier Indicator – N/A

2.5 Power Indicator

The indicator is lit when power is supplied to the HPQ3 unit.

2.6 Gauge Connector

A standard 9-way D-type socket used to interface to a total pressure gauge. This may be already in use depending on the type of RGA system purchased.

Pin	Function	Description
1	Gauge On	Open collector output from gauge
2	No connection	
3	24VDC Output	24VDC supply output, fused at 120mA
4	0V Ground	
5	Differential Signal Input High	Gauge pressure output
6	0V Ground	
7	No connection	
8	Differential Signal Input Low	Gauge pressure output
9	Gauge Enable	Open collector to gauge

Pin	Function	Description
1	24VDC	
A2	0V	

2.7 Power

A 2-pin D-type connector used to for the 24VDC power supply.

2.8 Analogue I/O Connector

A standard 15-way D-type socket used for interfacing with external equipment.

This may be already in use depending on the type of RGA system purchased.

This interface offers the following functionality:

Two analogue outputs 0 to +10V 12bit

Four, quasi-differential analogue inputs, -11 to +11V, with a maximum voltage on the return of $\pm 0.5V$

$\pm 15V$ power outputs both fused at 120mA, fuses are self-resetting.

Pin	Function	Description
1	-15V	-15V supply output, fused at 120mA
2	Analogue Input 4 Return	
3	Analogue Input 3 Return	
4	Analogue Input 2 Return	
5	Analogue Input 1	$\pm 11v$
6	Composite Return	Differential Output Return
7	Electrometer Differential Output	Direct Electrometer output from 50Meg feedback resistor
8	0V	
9	+15V	+15V supply output, fused at 120mA
10	Analogue Input 4	$\pm 11v$
11	Analogue Input 3	$\pm 11v$
12	Analogue Input 2	$\pm 11v$
13	Analogue Input 1 Return	
14	Analogue Output 2	0 – 10v
15	Analogue Output 1	0 – 10v

NOTE:

The 120mA maximum load for the power supply outputs is shared between the Digital and Analogue connectors.

2.9 Digital I/O Connector

See Interfacing Notes on Page 16 before making connections to this interface

A standard 25-way D-type socket used for interfacing with external equipment. This may be already in use depending on the type of RGA system purchased.

The Digital I/O connector can also be used to provide alarm output signals and process trip signals.

This interface offers the following functionality:

- 16 configurable I/O lines
- +3.3V power output fused at 120mA, fuses are self resetting
- ±15V power output fused at 120mA, fuses are self resetting
- +24V power output fused at 120mA, fuses are self resetting

Note: The total power consumption on each rail (+3.3V, ±15V & +24V) for both the Analogue and Digital I/O ports must not exceed 120mA.

Pin	Function	Description
1	Multiplier Trip	Dedicated to Multiplier Trip (Not available on HPQ3)
2	PA1	
3	PA3	
4	PA5	
5	PA7	
6	PB1	
7	PB3	
8	PB5	
9	PB7	
10	0V Digital	
11	0V Analogue	
12	-15V	-15V supply output, fused at 120mA
13	+15V	+15V supply output, fused at 120mA
14	PA0	
15	PA2	
16	PA4	
17	PA6	
18	PB0	
19	PB2	
20	PB4	
21	PB6	
22	+3.3V fused	+3.3V supply output, fused at 120mA
23	Not Connected	
24	GND	
25	+24V	+24V supply output, fused at 120mA

Important Interfacing Notes

The 120mA maximum load for the power supply outputs is shared between the Digital and Analogue connectors.

When interfacing digital signals between units the preferred method is to:-

- a) Have a pull-up resistor/current source on all inputs to the local power supply rail. Often this feature is provided by the digital input chip itself.
- b) Use an open collector/drain/contact closure to ground as the output drive signal.
- c) Where appropriate, arrange the hardware/software configuration so that an input Hi state is a safe condition. This ensures that if a connection should be unplugged the system will go into a fail-safe state.
- d) In cases where the external equipment is some distance away and/or is likely to have a different ground potential the fitting of opto-couplers on the interfacing should be implemented.

Using this approach allows for easily interfacing between different voltage levels and logic families.

2.10 Ethernet

A standard RJ45 type 10/100 Base-T Ethernet connector used to connect the HPQ3 to a host PC, hub, switch or network.

Ensure you read through the network scenarios starting on Page 23 before connecting the unit to your network

3. Analyser Installation

This section deals with getting the equipment out of its box and installing it on your system. If you have any questions or experience any difficulties, contact your local MKS Instruments representative who will be able to advise you.

3.1 Unpacking

When you receive the HPQ3 carefully check each item before removing the foam packaging and plastic wrapping, to ensure that no physical damage has occurred during shipment. Also, make sure all items have been received correctly by checking each item against the enclosed packing slip.

If there has been obvious damage during shipment, or if there are items listed on the packing slip as shipped which are not in the box, immediately contact your local MKS sales/service representative.

3.2 Inspecting the analyser

The analyser is both fragile and very easily contaminated by the slightest touch from your fingers or undesirable surfaces.

Handle the analyser **ONLY** at the vacuum flange.

Once you have inspected the analyser, return it to the protective envelope until you are ready for installation.

The analyser is supplied vacuum sealed inside a vac-formed plastic envelope for protection. Carefully unfold the envelope to allow access to the analyser. Do not discard this packaging.

Hold the analyser at the flange, with the quadrupole and ioniser structure vertically up. Carefully inspect all the observable insulators for damage.

Look at each lead from the flange to its termination point to ensure that it does not touch any other element of the analyser.

If any damage is noted, contact your local MKS representative for advice before fitting the quadrupole

3.3 Installing the analyser

The vacuum chamber in which you intend to mount the analyser must have a 2 .75 inch UHV Conflat® flange fitted with a tube of 35.0mm (1.378 ") minimum ID, inclusive of a good welded joint.

The distance from the end of the analyser to its mounting flange depends on the type of system. Refer to the analyser dimensions given on Page 6.

There must be at least the distances stated free of obstructions inside the vacuum chamber. If your chamber does not meet the above criteria, you should use a specially designed adapter so that the analyser may be mounted outside the chamber. Please contact your local MKS representative for assistance.

3.4 Checking the system pressure

Ensure your system is capable of meeting the pressure specifications below before operating your RGA.

Maximum recommended operating pressure

HPQ3 1e-3 Torr (1.3e-3 mbar)

HPQ3S 8e-3 Torr (1e-2 mbar) – Application dependant

Maximum transient burst pressure

4e-2 Torr (5e-2 mbar) – gas dependant

Operation above these limits will cause irreversible damage to the filaments and possibly the ion source.

Make use of the X-Trip interlock to prevent accidental damage to the analyser.

3.5 Mounting the analyser

The standard 2 ¾ " Conflat® flange on the analyser can be sealed to the vacuum chamber with either a copper gasket, or a Viton® gasket with a square cross section. Which one you choose depends on the ultimate pressure you expect in your system and whether you intend to bake the system.

If it is not already clean then clean the gasket with suitable solvent and dry it. Remove the analyser from its shipping envelope, slip the gasket over the quadrupole structure and set it in the grooves of the flange surface.

Carefully insert the analyser into the vacuum chamber ensuring that you do not allow the leads to touch the walls of the vacuum chamber. Make sure the gasket does not slip part way out of its slot as you push the two flanges together.

Rotate the flange until the locating key on the feedthrough housing tube is as close to 9 o'clock as the bolt holes will allow. This will ensure that the HPQ3 is in its preferred position, although it can be mounted in any orientation.

Bolt the feedthrough flange to the vacuum chamber flange using the torque appropriate for the gasket material used.

Do not discard the plastic shipping envelope or the two-piece foam packing surrounding it.

If in the future you need to return the analyser for service, it should be returned in its original packaging to avoid expensive damage.

4. HPQ3 Installation

To aid installation, the HPQ3 can be mounted in any orientation, but the cooling vents on the side panels and the exhaust vent on the rear panel must not be obstructed.

4.1 Installation

Rotate the locking ring on the stainless steel analyser connector so that the slot lines up with the keyway on the connector tube. Hold the HPQ3 unit so that the keyway lines up with the locating key on the analyser flange and gently slide the HPQ3 unit on to the analyser.

Take great care, the pins on the vacuum feedthrough are easily damaged.

DO NOT force the HPQ3 unit on to the analyser.

When all of the pins are engaged, push the HPQ3 firmly onto the analyser to ensure electrical continuity. The last 3mm (1/8") is important. When correctly fitted, the front face of the stainless steel analyser connector should butt up against the analyser flange.

If you cannot fully mate the HPQ3 to the analyser, slightly loosen the three cross-head screws placed around the mounting collar and try again. When a successful fit has been achieved, fully tighten the three screws and re-check the fit.

Finally, use the 5mm hex key to secure the HPQ3 in place.

4.2 Electrical connections

Insert the 2-way D-Type socket on the output lead of the 24VDC power supply unit into the 2-way D-Type connector labeled "POWER" on the rear panel of the HPQ3.

If used, connect your X-Trip signal cable to the socket marked "**X-TRIP**". For signal options, see Page 11.

Make any further connections required, such as equipment connecting to the digital or analog ports.

Finally attach the line cord to the power supply. The power supply will automatically set itself to operate with the local line voltage. When power is applied, the indicator on the rear of the HPQ3 will illuminate.

Care should be taken in routing and securing all cables. Avoid running any of the signal cables next to mains power cables or sources of electrical noise.

5. Connecting to the Ethernet Port

Before connecting a cat5 patch lead to the socket marked “ETHERNET” please take the time to read through the following sections.

If the HPQ3 is to be installed on your company network, then there are a number of different network configurations that must be considered before you continue.

There are four main network technologies employed in the distribution of network addresses (IP addresses) to network devices, the HPQ3 can be configured to use any of the following:

Auto-IP

A mechanism where in the absence of a DHCP or BOOTP server on the network, network entities can obtain their unique IP addresses by a process of arbitration between devices. If a DHCP or BOOTP server is present on the network, Auto-IP will obtain an IP address from the server.

DHCP

Short for Dynamic Host Configuration Protocol, a server running on the network is responsible for assigning dynamic IP addresses to devices on a network.

BOOTP

Short for Bootstrap Protocol, an Internet protocol that enables a diskless workstation to discover its own IP address and the IP address of a BOOTP server on the network.

Static

Each address is issued manually to each device by the network administrator.

By default the HPQ3 is configured for Auto-IP which is by far the simplest method if you are new to networking, or are installing the HPQ3 into an existing Auto-IP or DHCP network.

If you intend to connect a HPQ3 to an existing network, then you must consult your IT Specialist for advice on how the network assigns IP addresses.

Do not continue until you are certain of your network configuration

The following sections describe the different network connection options available to the user when installing the HPQ3 RGA.

5.1 Adding the HPQ3 to an existing network

The HPQ3 is to be connected to a network running **Auto-IP** or **DHCP**

Option - Use Auto-IP

If the HPQ3 is to be connected to a network where existing devices obtain their IP address automatically, then no further configuration is required.

You can safely connect the HPQ3 to your network.

The HPQ3 is to be connected to a network running **BOOTP**

Option - Use Auto-IP

If the HPQ3 is to be connected to a network running BOOTP, then your IT Specialist will need to perform certain tasks on the BOOTP Server to complete the installation.

Do not connect the HPQ3 to your network without involving your IT specialist.

The HPQ3 is to be connected to a network using **Static IP** addressing

See the Static IP Addressing section

For details on how to assign a static IP address to the HPQ3, please see the guide on Page 29.

You will need to be allocated an IP address for use by your IT Specialist, or have them perform the installation for you.

5.2 Directly connecting to the HPQ3

If your PC or MAC is not part of a network, you may choose to connect the HPQ3 directly to the Ethernet port or a local hub. The following section describes what is required to get your unit up and running.

As stated earlier, the HPQ3 is configured to use Auto-IP by default, all that is left to do is to ensure your PC or MAC is configured the same way.

Connect the HPQ3 to your PC, MAC or hub with a standard Cat5 STP cable (there is no need to use a dedicated cross-over cable) and power on the HPQ3 .

Next you need to check if your PC or MAC is configured for Auto-IP; most are by default.

Windows PC

Start / Connect To / Show All Connections

Click once on the connection hosting the HPQ3

Note the information displayed in the Task Pane



If the text “**Automatic Private Address**” is displayed, then the PC is ready to begin communications with the HPQ3 unit.

If the text “**Obtaining an IP address**” is displayed, then please wait a few moments for the sequence to complete.

If any other text is displayed, then you will need to make changes to the way your PC obtains IP addresses.

MAC

Apple Menu / System Preferences / Network

Ethernet / Configure

The option “**Using DHCP**” or “**Using Auto-IP**” should be displayed.

If your PC or MAC is not configured for Auto-IP, you can make the following changes to enable the function. You will need to have Administrative privileges.

Windows PC

Control Panel / Network Connections

Double-click the **Local Area Connection** used to host the RGA

Properties

Double-click **Internet Protocol (TCP/IP)** from the list.

Choose the following options:

Obtain an IP address automatically

Obtain DNS server address automatically

Click **OK**

MAC

Apple Menu / System Preferences / Network

Ethernet / Configure

Choose the option "**Using DHCP**" or "**Using Auto-IP**"

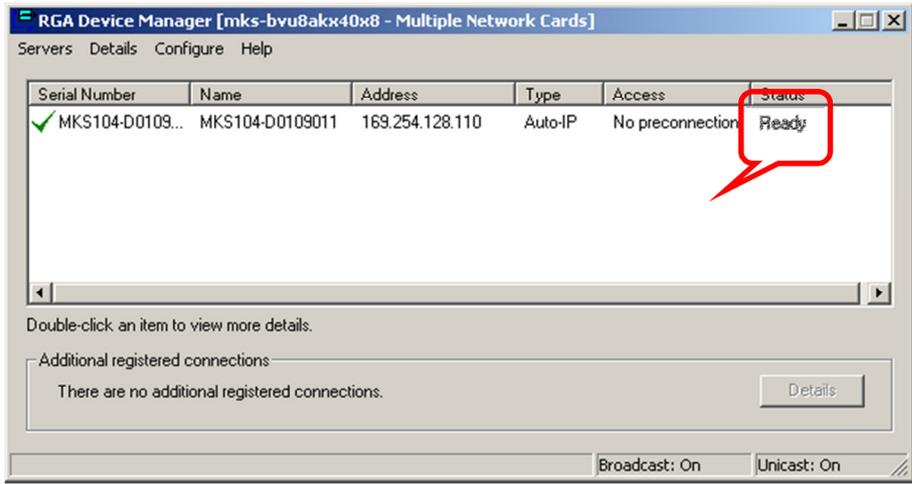
Click **Apply**

While the PC or MAC has been generating its automatic IP address, the HPQ3 will be attempting to generate a compatible address.

You may need to wait 30 seconds after the PC or MAC has an IP address before the HPQ3 is ready.

You can check the status of the HPQ3 by using the RGA Device Manager application on the supplied MKS Utilities CD.

Double-click the RGA Device Manager icon to start the application. After a few moments the following dialog appears displaying a list of all discovered MKS RGA's.



You can see that there is only one RGA displayed in the example, yours may contain many entries.

Ensure you choose the correct instrument from the list.

The status, current IP address and type of IP addressing can be checked in this dialog. Once "Ready" is displayed you can close RGA Device Manager and begin using the RGA.

5.3 Assigning a static IP Address

If you are connecting to a network where static IP addresses are used, or connecting directly to your PC or MAC and wish to use fixed addressing, you will need to assign an address to the HPQ3.

To help you understand this scenario, the following explanation may be of use:

You have your standalone or networked PC / MAC configured to use a fixed IP address, for example 192.168.0.1. When the HPQ3 is connected to the network, it will “ask” to be assigned an IP address from a DHCP server, as one will not be present in this type of network, the HPQ3 will use a default address in the range 169.254.xxx.xxx.

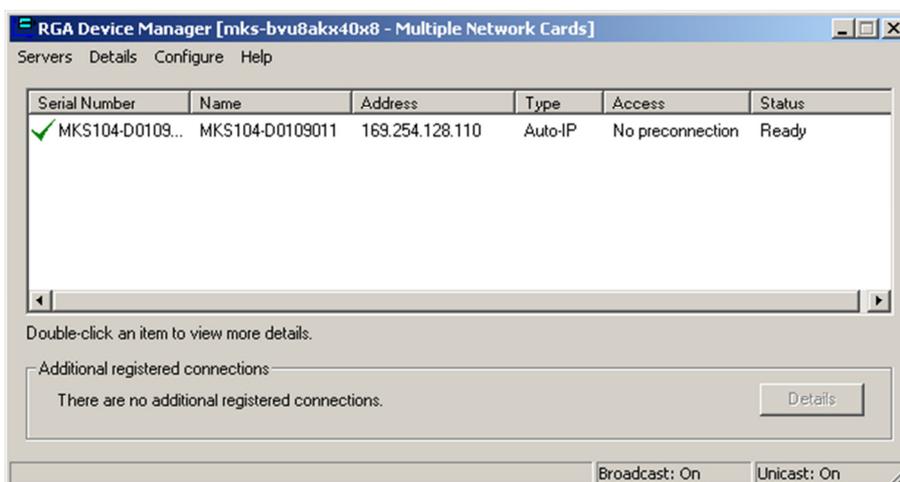
Because the host PC and HPQ3 are on entirely different IP ranges, communication between the two is impossible. We must issue the HPQ3 with an IP address in the same range as the host PC.

You will need to ask for an IP address and Subnet from your IT Specialist if you are installing on a network.

This is done using the RGA Device Manager Application found on the supplied MKS Utilities CD. This application does not require installation, but you will require administrative privileges to make changes to the Windows Firewall exceptions for the application to function correctly.

The RGA Device Manager application is designed to locate and retrieve information from any MKS RGA instrument, networked or otherwise. It does this by sending out a network broadcast, asking for information from any MKS RGAs discovered. It matters not that the host PC / MAC may be on an entirely different IP range than the HPQ3. Once connected by RGA Device Manager we can assign a new IP address to the HPQ3.

Double-click the RGA Device Manager icon to start the application. After a few moments the following dialog appears displaying a list of all discovered MKS RGA's.



You can see that there is only one RGA displayed in the example, yours may contain many entries.

Ensure you choose the correct instrument from the list.

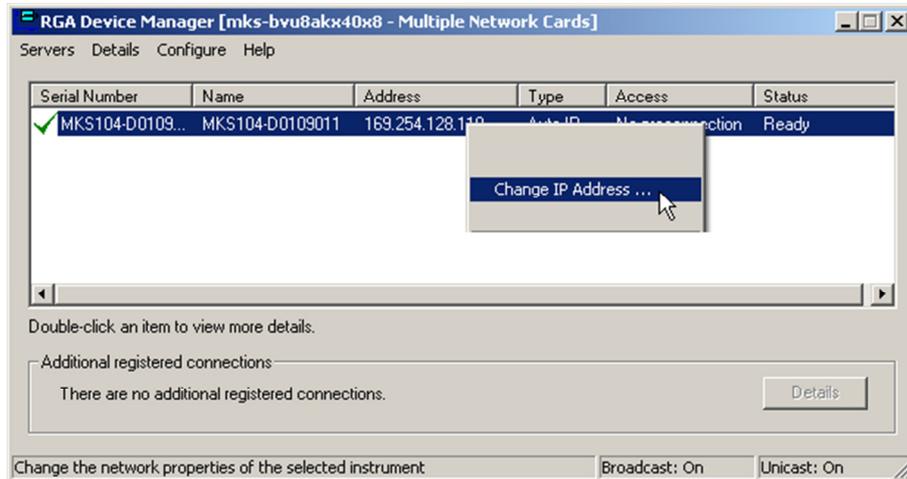
You can see that

Device Manager displays all the pertinent information on the RGA, of particular interest are the “Address” and “Type” fields:

The “Address” field is the currently assigned IP address of the HPQ3

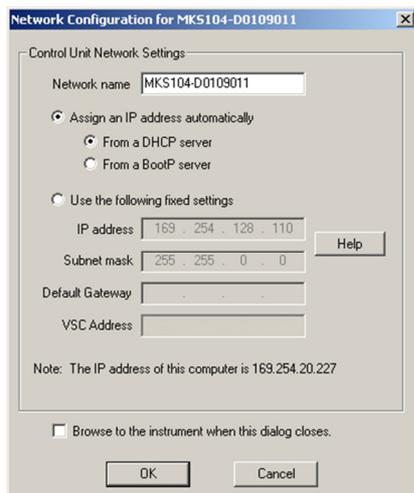
The “Type” field describes the scheme the HPQ3 is currently using to obtain an address.

Right-click the instrument and select “Change IP Address”.



You can see that the HPQ3 is configured to receive an IP address.

We must change this option to continue.



Select the “Use the following fixed settings” option.

Enter the IP address and the Subnet issued to you by your IT Specialist.

The “Default Gateway” is used in situations where multiple networks exist, or for connection to the HPQ3 from outside its local network. Your IT Specialist will instruct you on what to enter here, otherwise leave it blank.

Once the relevant information has been entered, click OK to store and commit the changes to the HPQ3.

6. Baking

The analyser may be baked up to 250°C with the electronics package (HPQ3) removed. Care should be taken to avoid exposing the ceramic feedthrough to sudden changes in temperature.

The analyser can be baked to 200°C with the electronics package attached if the package is not exposed to temperatures above 40°C.

If the analyser flange temperature exceeds 200°C the HPQ3 must be removed.

7. Analyser Maintenance

7.1 Overview

The quadrupole analyser is the front end of your mass-spectrometer, it produces electrical signals which, when presented to your electronics display the contents of your vacuum chamber in a meaningful fashion.

The analyser can be broken down into four separate areas by virtue of their function.

1. The ion source or ioniser

This is located at the top (furthest from the flange) of the analyser and its function is to take a representative sample of molecules and atoms from the vacuum chamber, convert them into ions and present them to the quadrupole filter.

2. The quadrupole filter

This is the centre section of the analyser. Its function is to take the ion beam generated in the source, separate the various ions by their mass to charge ratio (m/e) and present the single selected m/e to the collector.

3. The detector

This area of the quadrupole analyser is "hidden" inside the flanged housing. Its function is simply to convert the filtered ion beam presented by the quadrupole filter into a small electrical current, which can be passed to the electronics for amplification and subsequent display to the outside world.

4. The flanged housing

This is the only part of the analyser seen under normal operating conditions. Comprising of an industry standard 2.75" Conflat® flange with an electrical feedthrough carrying the various supplies and signals to and from the quadrupole analyser.

All quadrupole analysers require periodic maintenance, the regularity of which is determined by their use. The cleanliness of the vacuum, hours of operation and the type of sample being analysed all have an effect on the analyser's performance.

Apart from these considerations there are times when the analyser will require maintenance and these are when accidents happen i.e. the vacuum is vented with the filaments on, or someone forgets to turn on the water cooling for the oil diffusion pump.

Routinely there is only one area of the analyser that requires any maintenance, this is the ion source. The ion source contains two filaments, only one of which will be in use at any one time. The filament is heated to approximately 2000 deg K at which temperature it emits electrons, which are used to produce the ions required by the quadrupole filter. At this high temperature, there are two deleterious effects;

The filament material slowly evaporates and condenses upon the surrounding surfaces. This effect is extremely slow but would require, from time to time, the cleaning of the surrounding source plates and ceramics and the replacement of the filaments.

The second effect is similar to the first except that the vacuum, under which the source is operating, has either a high oxygen or water content. Then instead of metal being deposited upon the surrounding source plates, layers of metal oxides are deposited. Being insulators, these have a far more noticeable effect upon the performance of the source and therefore a more frequent cleaning program should be adopted.

You should not attempt repair other than replacing the filaments or cleaning / replacing the ion-source.

Further servicing may be carried out on-site, or on an RTB basis.

Please contact your local MKS representative for further information.

7.2 Ohmmeter analyser checks

There are a number of circumstances when carrying out some simple checks with an ohmmeter can be worthwhile. If you suspect a failed filament, or want to check for shorts-circuits following maintenance, performing some simple checks can save a great deal of time.

In carrying out these checks, we can legitimately accept two ranges of meter readings as possibly acceptable and anything outside these ranges as being a definite fail. Any readings less than 1 ohm we can assume as a short-circuit and any reading above 5 Meg Ohm (5×10^6 ohms) as being open circuit. The following assumes that the analyser is still on the vacuum system and details all the possible tests.

Tools required: Ohmmeter with leads

Please refer to Page 40 for analyser pin numbers.

1. Attach a meter lead to pin 1 of the analyser feedthrough.
2. Connect the other lead to the analyser flange, you should read a short circuit. If not, you have either a serious problem, or more likely a faulty meter/meter leads. If after checking your meter, an open circuit still exists, contact your nearest MKS service centre for advice.
3. Move the lead from the flange and connect to pins 2 through 12 on the analyser feedthrough in turn. Each one should give an open circuit. If not, you have a short to earth.

There are two types of short to earth, an internal short between one part of the analyser and an earthed part of the analyser, or more commonly, a short between part of the analyser and the vacuum chamber.

In either case, remove the analyser from the vacuum chamber and repeat the test. If the result is the same, then you have an internal short and should contact your local MKS facility for advice.

Otherwise, you have a short to the vacuum chamber, check the dimensions of the vacuum chamber around the quadrupole analyser against the dimensions provided on Page 6 of this manual, or try refitting the analyser in a slightly different orientation.

Repeat the ohmmeter tests before pumping down the vacuum chamber. Remember that the ion source gets very hot during operation and the stainless steel components will expand slightly. Sometimes a short will only develop when the analyser has been run for a while and is up to temperature.

4. Move the meter lead from pin 1 and attach it to pin 2 of the analyser feedthrough. Connect the other lead to pins 3 through 12 on the analyser feedthrough in turn. Each one should give an open circuit.

Now move the meter lead from pin 2 to pin 3 and check to pins 4 to 12. Proceed around the feedthrough until all possible connections have been checked.

All the pins should show an open circuit to all other pins, EXCEPT pin 4 to 8 and pin 8 to 10, which should show short-circuit as these are the filament connections.

If any of the pins read short-circuit to another pin, contact your local MKS service centre with the results of your tests and they will advise you how to proceed.

7.3 Checking filaments

The status of the filaments is constantly monitored by the HPQ3 and the operating software. This is achieved by measuring the flow of electrons emitted by the hot filament, referred to as the emission current, flowing to the ion source cage.

This is normally maintained at a fixed value of 1mA. The current flow through the filament is increased until the value of emission current is reached. If, however, the control electronics reaches the limit of its filament current supply capability and the emission current has still not reached 1mA, a filament fail condition will exist.

In the vast majority of cases this will be due to a blown filament, more correctly described as an open circuit filament. There are other conditions, such as a heavily contaminated ion source, which will result in a filament fail condition when the filament is not open circuit.

If you suspect a blown filament, carry out the following test before removing the analyser from the vacuum system.

Connect meter lead one to analyser feedthrough pin 8, which is the common connection to both the filaments.

Connect the second meter lead to pin 4 (Filament 1). You should read short-circuit.

Next connect the second meter lead to pin 10 (Filament 2), again your meter should indicate short-circuit.

If either or both filaments are blown, the meter will indicate an open-circuit and the filaments will need to be replaced.

If the meter reading suggests that the filament is good but the control unit shows a filament fail, the most likely cause would be a break down in electrical continuity or contamination of the ion source.

7.4 Changing filaments

Changing filaments is the most common maintenance event with quadrupole analysers. For this reason the HPQ3 analyser has been designed to make this task as quick and easy as possible.

Below is a list of the tools and equipment you will require. We recommend that you assemble the following items before you start. Remember that the instrument is supplied with a tool kit that contains some of the things you will need;

small jewelers screwdriver (2mm)

pair of tweezers

small pair of smooth jawed needle nosed pliers

pair of clean cotton gloves

clean bench on which to work

Ohmmeter

clean container in which to put small parts

replacement filament

a method of holding the analyser securely in an upright position, (a small bench vice is ideal).

pen and paper on which to make notes and sketches

7.4.1 Removing the filaments

1. Remove the analyser from the vacuum system making sure that you do not touch the exposed internal surfaces and place it on the bench in an upright position.
2. The filaments are located on the very top of the analyser, retained by two M2 x4 pan head screws. The electrical connections are made via two barrel connectors, one to each filament, see Fig.1.
3. Hold the barrel connectors highlighted in orange firmly with your pliers and slacken the screws highlighted in red until the barrel connector can be removed from the filament plate and the connecting lead, see Fig.2.
4. Remove the two M2 x4 pan head screws highlighted in red holding the filament plate in place, see Fig.3.
5. Remove the filament plate assembly. Carry out this step carefully so as not to damage the filaments or source cage, see Fig.4.

Refer to the views on the following page.

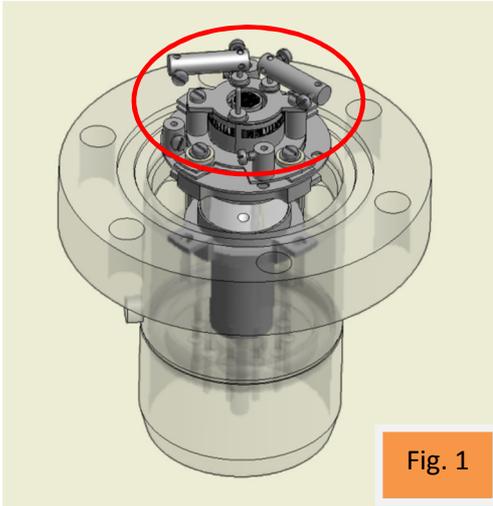


Fig. 1

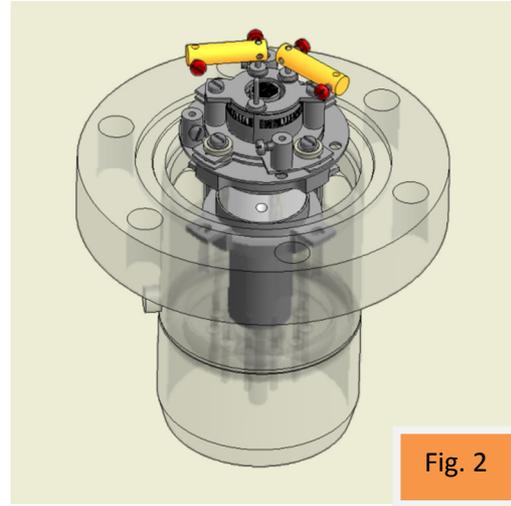


Fig. 2

It is worthwhile at this stage to see if the source requires any attention, especially if the filament(s) have broken because of an over pressure situation in your vacuum system.

With the filaments removed, you have a clear view of the source cage. The signs to look for are powdery deposits, which will vary in colour but may be brown, blue, canary yellow or white depending upon the precise circumstances which led to their formation.

If these oxides are present, it is recommended that you refer to the section on ion source cleaning on page 36 before proceeding.

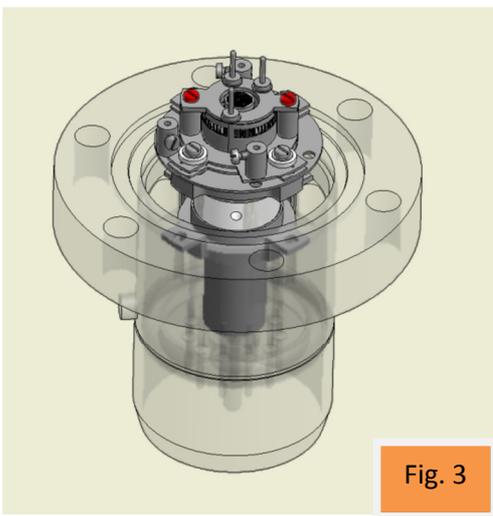


Fig. 3

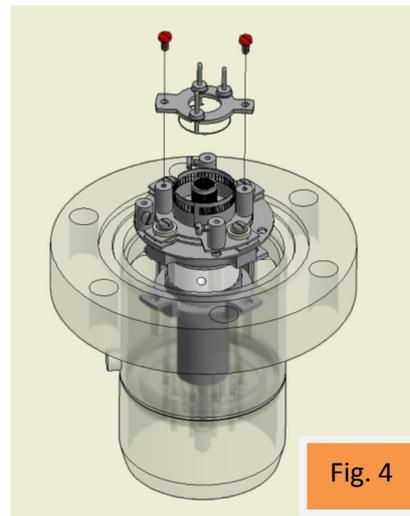


Fig. 4

7.4.2 Fitting filaments

The fitting of filaments is simply the reversal of the procedure for removing them. Care should be taken at all stages to ensure that no shorts are introduced and that the analyser is kept clean.

1. Note the design of the filament plate; it has different sized tabs to help orientate the plate correctly into the cut-out sections of the ion-source as shown in the diagram below.

Using tweezers, carefully place filament plate onto the mounting posts. Be careful not to touch the source cage with the filament.

2. Re-fit the two M2 x4 pan head screws through the filament plate and tighten securely. Do not over tighten.

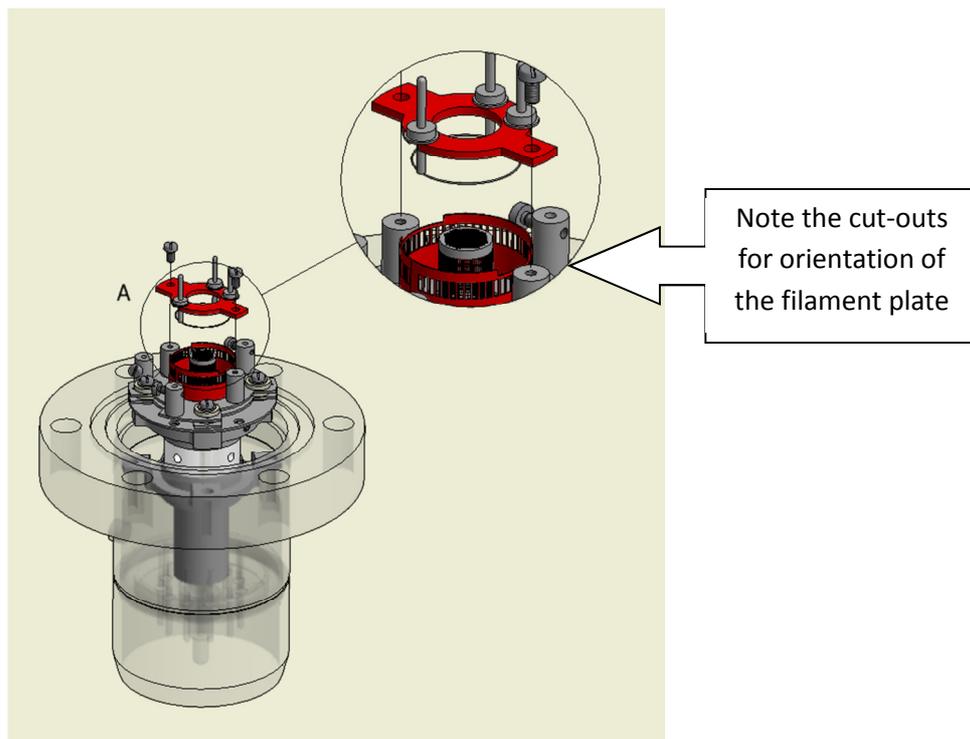
3. Re-fit each barrel connector in the same orientation as removed, sliding each barrel connector over the connecting lead and filament post and while holding the barrel connector firmly with pliers, tighten all screws.

Do not slide the barrel connector all the way down the filament post as you may short-circuit the insulating feedthrough. Leave 1- 2mm of clearance.

4. Before re-fitting the analyser to your vacuum chamber, refer to page 31 for details on how to check for any short circuits.

5. Replace the analyser into your vacuum housing and again check for shorts or grounding to the outer vacuum housing.

You are now ready to pump down and continue the operation of your quadrupole.



7.5 Ion Source cleaning

7.5.1 Cleaning while fitted to the analyser

Sometimes it is possible to clean the ion source without removing it from the analyser. For the user who has the necessary equipment available including a means to suitably dry the analyser, it is usually worth trying this method before removing or replacing the ion source.

However, it is likely only to be successful where the source is contaminated with loose or alcohol soluble deposits.

Insert the analyser into the measuring cylinder so that the knife edge side of the flange rests on the lip of the cylinder. Note the level which the ion source comes to on the measuring cylinder before removing the analyser and filling the measuring cylinder with sufficient iso-propyl-alcohol to cover the ion source only.

Note: the measuring cylinder should be of a diameter and length to accommodate the analyser.

Put the measuring cylinder into the ultra-sonic bath for 10 to 15 minutes.

Remove the analyser and allow any excess alcohol to drain off. Keep the analyser inverted (feedthrough upper most) until it is dry.

Do not let any alcohol run down the analyser into the flange assembly as this may lead to problems.

Check the condition of the ion source. A second or third wash may be required.

The ultra-sonic bath may loosen some of the screws in the ion source. Take care not to throw these away when discarding the alcohol.

The analyser must be dried of cleaning solution before it can be used. We recommend the use of a clean oven for this purpose. The oven should be set at 80°C and the analyser baked for at least two hours.

Check the documentation on your cleaning solution for guidelines on handling the substance and any fire or explosion risks involved.

After the bake period, check all the screws in the ion source are tight and re-fit the analyser to the vacuum chamber.

A further bake under vacuum will be required to drive off any remaining residue.

7.5.2 Removing the ion-source to clean or replace

The analyser design permits the removal of the ion source as one complete assembly for cleaning or replacement. The ion source is easily aligned to the main analyser assembly, allowing easy replacement without the need for special jigs.

Below is a list of the tools and equipment you will require. We recommend that you assemble the following items before you start. Remember that the instrument is supplied with a tool kit that contains some of the things you will need.

Small jeweler's screwdriver (2mm)

Pair of tweezers

Small pair of smooth jawed needle nosed pliers

Pair of clean cotton gloves

Clean bench on which to work

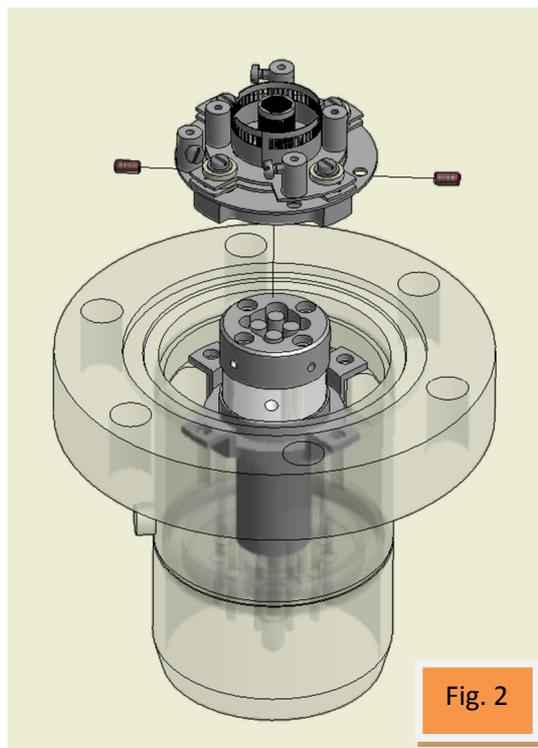
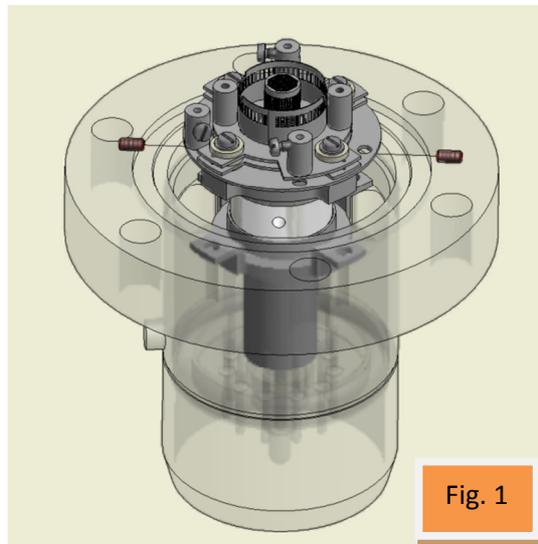
Ohmmeter

Clean container in which to put small parts

Pen and paper on which to make notes and sketches

1. Remove the analyser from the vacuum system, place it on the bench in an upright position (holding the analyser in a small bench vice or analyser support stand is recommended).
2. If you are cleaning the ion-source, then you should follow the steps on removing the filaments before continuing.
3. Loosen the M2 pan-head screws that secure the source connecting wires.
4. Loosen the two grub-screws highlighted in red that secure the ion-source, see Fig.1.
5. Carefully withdraw the source assembly from the filter, Fig.2.

Refer to the views on the following page.



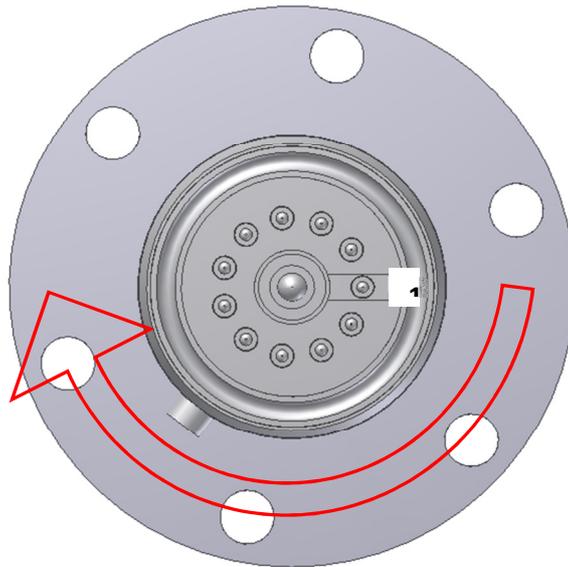
7.5.3 Refitting the ion source

Refitting the ion-source is simply the reversal of the procedure for removing it. Care should be taken at all stages to ensure that no shorts are introduced and that the analyser is kept clean.

8. Exploded Views

Analyser pin-outs

Pin 1 is easily identified as it is the only pin with a metalized contact running through it. The pins are numbered clockwise from this pin.



Pin Descriptions	
Pin	Connection
1	Earth
2	Source plate
3	Not Used
4	Filament 1
5	Extraction plate
6	Not Used
7	RF.1
8	Filament common
9	Not Used
10	Filament 2
11	RF.2

9. Spare Parts

Spare parts for your quadrupole analyser are available from your local MKS Instruments sales office under the part numbers detailed below.

Filaments are supplied in pairs, either on a single plate or on two plates depending on the analyser.

Replacement ion sources are supplied complete with filaments.

Filaments

Tungsten	Thoriated Iridium	Yttrium
842-070	842-071	842-073

Complete Ion-source

Fitted with -	Tungsten	Thoriated Iridium	Yttrium
	842-081	842-082	842-080

If you require a spare part not mentioned above, please contact your local MKS Instruments office for help on obtaining a part number.

10. Returning Your Unit for Service

If you wish to return your instrument for service, please follow these simple guidelines.

Contact your local MKS service facility to obtain a Returns Material Authorisation (RMA) number. We will require some instrument details, such as the serial numbers, date of purchase and a fault description.

Fill in the relevant sections of the Health and Safety Returns Form below, or we can provide you with a copy.

This form **MUST** accompany the instrument when returned, delays in providing this completed form will lead to delays in the servicing of the instrument.

Securely package all items to be returned, using the original packaging where possible and send to the address provided by the relevant service department.

Support Contact Numbers

Europe (UK) +44 (0) 1270 250150

USA +01 408-750-0347

RETURNS FORM

Please complete the form and send to the appropriate MKS facility. Please ensure that we have this information before we receive the equipment. A copy should also be given to the carrier.

FAILURE TO COMPLETE THIS FORM OR COMPLY WITH THE
PROCEDURE WILL LEAD TO DELAYS IN SERVICING THE
EQUIPMENT

Our RMA number:

Customer P.O. No.

Customer bill to address:

Customer return address (if different from above):

Name:

Contact number:

Equipment returned:

Item 1:

Serial No.:

Item 2:

Serial No.:

Item 3:

Serial No.:

Please describe the system fault in detail:

Details of substances pumped, or coming into contact with the returned equipment.

Chemical names:

Precautions to be taken in handling these substances:

Action to be taken in the event of human contact or spillage:

I hereby confirm that the only toxic or hazardous substances that the equipment specified above has been in contact with are named above, that the information given is correct and that the following actions have been taken:

1. The equipment has been securely packaged and labelled.
2. The carrier has been informed of the hazardous nature of the consignment if applicable.

Signed:

Title:

Date:

Phone No.: