TELEMARK

XIAD, ST-55, ST-3000
SAINTECH ION BEAM SYSTEM

INSTALLATION MANUAL

This manual covers the Installation and Maintenance of these Ion Beam Systems; XIAD, ST-55, ST-3000. For information on operational procedures, refer to separate Operations Manual.

January, 2013

www.telemark.com

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WARRANTY

Telemark warrants the company's products to be free of functional defects in material workmanship for a period of twelve (12) months from date of first delivery.

The abovementioned warranty is conditional upon the product being installed and operated in accordance with instructions provided by Saintech Ion Beam Systems

This warranty is in lieu of all other warranties, expressed or implied and constitutes fulfillment of Telemark's liabilities to the purchaser. Telemark does not warrant the product for use in applications other than that implied by the product specifications.

USER RESPONSIBILITY

The user is responsible for proper operation and ordinary maintenance of the equipment following procedures described in this manual including reference documents. Proper operation includes timely replacement of parts that are missing, broken, or plainly worn. If the user has a reasonable doubt about understanding the use or installation of a component, Telemark or your local representative should be called.

It is vitally important that the user properly install the equipment as described in this manual, with particular attention to the correct grounding methods described.

The Warranty will be void if the equipment is improperly installed and/or grounded.

CUSTOMER SERVICE INFORMATION

When contacting the above for service, please provide the Source Model Number and Serial Number and the Power Unit Serial Number. The source model and serial numbers are engraved on the source shroud. To assist with the diagnosis of any problems it is useful to include all operating parameters such as anode voltage, gas flows as well as the mode of operation. For example; **Pulse** or **Continuous Beam, anode voltages, chamber pressure, gas flow and species of gas**, etc.

EXPLANATION OF COMMENTS

Throughout this manual there will be various Cautions, Warnings and Recommendations. These are intended to draw the attention of the operator to potential hazards to personnel and equipment and to provide assistance with the general operation of the system.

WARNING

Warnings are used whenever there is risk of injury to operators or personnel who may be servicing equipment

WARNINGS SHOULD ALWAYS BE OBSERVED

CAUTION

Cautions are used wherever operational procedures could result in damage to equipment

CAUTIONS SHOULD BE OBSERVED

RECOMMENDATION

Recommendations are provided as suggestions for operational or setup procedures only. A reason for the recommendation will often be provided to assist with decision

Safety First

All standard safety procedures associated with the safe handling of electrical equipment must be observed at all times. This equipment presents severe electrical hazard. Always disconnect input power from the power supply when working with covers removed. Only qualified personnel should attempt equipment servicing.

IMPORTANT NOTE

Each Saintech Ion Beam System is factory fitted with a Water Flow Monitor. This device is provided to protect the equipment against use of the Ion Beam Equipment in the event of insufficient cooling-water flowing. The devices are factory-set for the flow considered to be the minimum required to ensure damage will not occur within the power range of the Ion Beam System.

The equipment is not warranted against damage that may occur should the water flow device be removed or tampered with, set-points altered, disconnected or improperly installed and maintained.

Picture shows an ST55 anode after running the source for a few minutes without cooling water. The anode was not repairable and the rare earth magnet and anode insulator required replacement

SAFETY REQUIREMENTS

The equipment used in this process produces voltages and electrical currents at levels high enough to present extreme hazard. Only persons suitably qualified to work on such equipment should do so.

The Power Supply is equipped with an interlock system which disables the supply if all connected interlocks are not enabled e.g. vacuum and chamber door interlocks.

The interlock system is provided to protect both personnel and equipment. It is highly recommended that the interlock system should never be bypassed *See Section on Installation*

1

INSTALLATION NOTES

The ion generating plasma of the ion source produces very high power densities. To avoid damage to the ion source various protections have been built in to the power supply.

Notes:

1. **Water Flow Monitoring**. The ion source will be damaged if insufficient cooling water is flowing in the anode. To prevent this situation, the water flow is directly and continuously monitored by an integrated Water Flow Monitor (WFM). The WFM produces a pulsed electronic output signal with the pulse frequency directly proportional to water flow. To enable the power supply to power ON, the WFM must register a minimum flow. The minimum flow for each model is listed in the following table. Below this limit, the power supply will not power on and an audible alarm will sound. For the correct installation and monitoring of the WFM, see below in this manual.

Model	Min. Flow (litre/min)
XIAD	2.0
ST55	2.5
ST3000	4.5

2. **Correct Filaments**. The source requires tungsten wire of 0.020” diameter. While straight wire filaments can be used, to obtain optimum performance it is recommended to use multi-coiled filaments – see further information below.
3. **Ion Beam Power Display**. The power supply provides monitoring of the ion beam power. The power is displayed on the top right hand side of the touch screen as a bar graph. The bar graph display will be fully lit when the power supply is delivering close to the maximum. When maximum power is reached, the display will “flash”. Any attempt to increase power beyond the set limit will result in a decrease of power.

4. **Grounding of Power Supply**. Neither of the filament leads should be earthed. When installing the ion source, make sure that the neither of the filament legs are connected to earth (ground). If either filament leg is earthed, an audible buzzer will sound when the power is applied. No damage will result although the ion beam system will not function correctly and the filament circuit breaker on the left-hand front panel may disengage. Check for the correct installation below in this manual.
5. **Cooling Water Requirements**. The temperature of the process cooling water should not exceed 25 degrees Centigrade and be not lower than the dew point* for the ambient conditions. Typically, the lower temperature limit will be approximately 16 to 18 Cº. If water is observed to be condensing on water-cooled fittings, the water temperature should be increased or consideration should be given to shutting off the water flow while the vacuum chamber is open to atmosphere. Interlocks should always be installed to ensure flow is re-started before the process begins again.

* The dew point is the temperature below which atmospheric water vapor will condense on metallic surfaces maintained at that temperature.

2

INSTALLATION OF WATER FLOW MONITOR

The system comes equipped with a water flow monitor – see photo below. This device is provided to protect the ion beam system in the event of insufficient water flow. The WFM produces a pulsed output that is proportional to the water flow. The signal is passed to the power supply which interprets and calculates the instantaneous water flow. The power supply is factory-set to disable the START function if the water flow is below the set limit.

Notes on Installation:

1. The WFM is intended to be mounted directly in the cooling water lines on the air-side of the water feedthrough.
2. Do not connect the WFM in parallel flow with any other device e.g. electron guns, crystal monitors, etc.
3. The water flow monitors can register correct flow independent of direction of flow. It is best practice to monitor the flow of water leaving the ion source.
4. Connection is by appropriate compression fittings such as Swagelock straight unions as indicated in the photo below. For convenience of dis-assembly, Teflon or Nylon ferrules may be used.
5. When tightening any compression fittings, do not apply excessive force to the plastic WFM body – use recommended manufacturers procedures
6. There are no serviceable parts inside of the WFM
7. Do not apply too much force to the cable as the electronics inside the WFM may be damaged

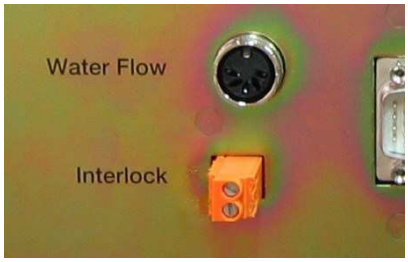
Above figure shows the water flow monitor in relative position to the vacuum feedthrough and connected using a Swagelock straight union. Note that the actual WFM shown above may be of different design or manufacture to that supplied.

3

INTERLOCK CONNECTION & RACK MOUNTING

The power supply is fitted with an interlock connector on rear panel. The interlock circuitry is to be connected in series.

Figure at right shows the WFM connector mounted on the rear panel of the power supply. The vacuum and chamber door interlocks are connected at the terminal block.



Installation of Power Supply in racks.

The power supply is intended to be installed in properly constructed instrument racks as shown in the photo below.

The Ion Beam System should not be used without correct installation in these electrical equipment enclosures

Figure above shows the power supply installed into a conventional 19” instrument rack. The tilting touch screen allows the power supply to be mounted low in the rack and still provide good visibility for convenient operation.

4

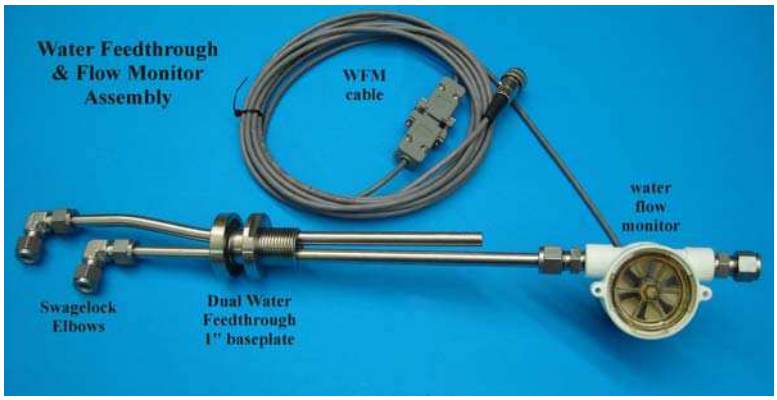
SYSTEM INSTALLATION

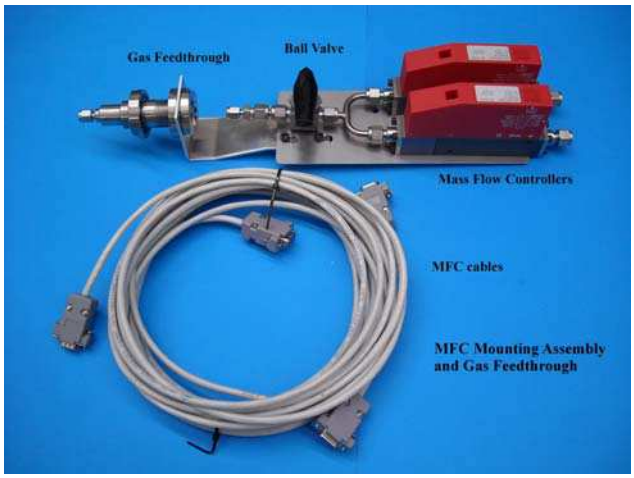
To complete the installation of the Saintech Ion Beam System you will need:

1. Sufficient lengths of" stainless steel tubing – short lengths of both sizes are supplied.
2. Various compression (Swagelock, or similar) fittings.
3. Source of High or Ultra-high purity gases
4. Gas regulator(s) suited to delivery and control of high purity gases
5. Bellows tubing is recommended to allow some flexibility to the ion source mounting

What we Supply

The complete system package supplied by Saintech Ion Beam Systems contains all of the required components and fittings to complete the installation. The figures below show the majority of the components and sub-systems typically included in the shipment. Please refer to shipping documents for actual inclusions.





Mounting Ion Source

The ion source can be mounted in any orientation within the vacuum environment with the following exception:

> CAUTION
> The ion source should not be mounted in close proximity to any extended source of ferromagnetic material or strong magnetic fields. This includes permanent or electro-magnets as in magnetron sputtering heads and electron beam evaporators. A minimum separation of approximately 100 mm should be maintained from such magnetic sources. Failure to do so may affect the operation of the ion source

A mounting bracket spigot is provided on the shroud of the source and it is recommended that this should be the principal means of attachment and support. The mounting bracket should be made from non-magnetic material such as aluminum or stainless steel – see figure below.

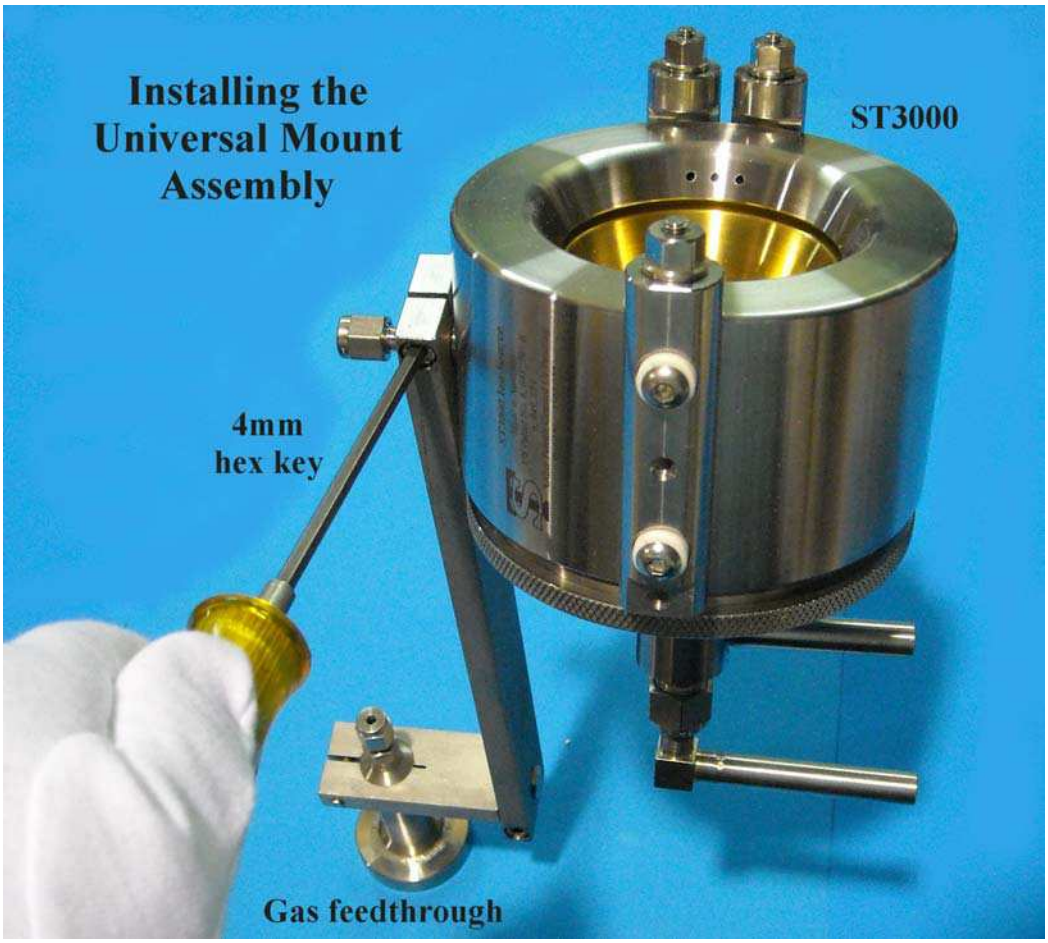


Figure shows use of the optional Mounting Brackets to secure the ion source to special gas feedthrough. Note that mounting bracket hardware is available from Saintech. The brackets can be supplied in a range of lengths and offsets.

Water and Gas Connections – Ion Source

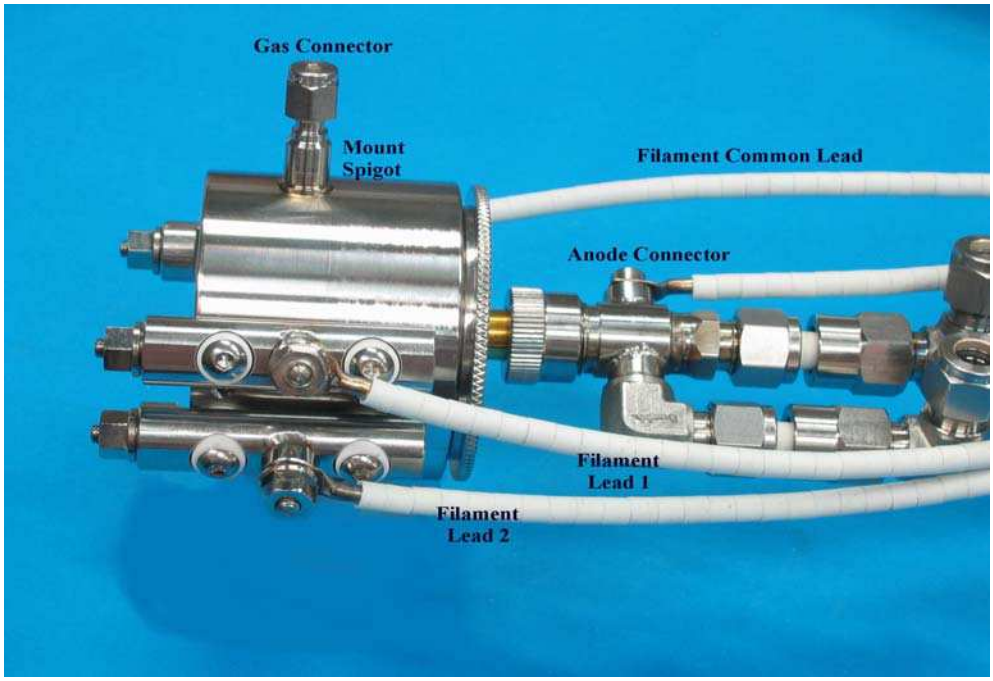
Stainless steel tubing (or bellows type stainless tubing terminations) should be used between the water vacuum chamber feedthrough and the ion source. The water delivery tubes are electrically connected to the anode so that a **suitable electric break is required (supplied)**. It is recommended that ceramic breaks should not be mounted directly to the ion source as they can be easily damaged if regularly dismounted. When installing or demounting the compression fittings always use the recommended procedures of the manufacturer (Swagelock). Due to the rigidity of the larger sizes of stainless steel tubing, it is recommended that short stainless steel bellows be used between the feedthrough and ion source.

For gas connections, all models use 1/8” diameter stainless steel tubing between the vacuum feedthrough and the ion source. Bending of the 1/8” tubing can be easily accomplished by hand.

Note that electrical breaks are NOT required in the gas line as the gas line is at ground potential.

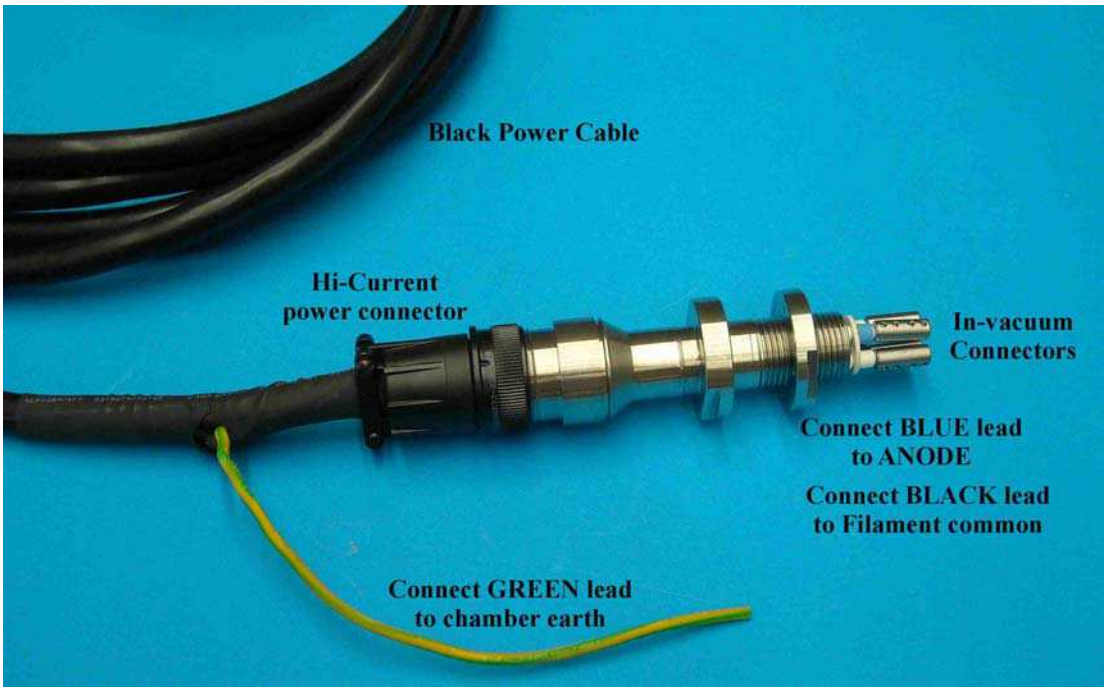
It is recommended that stainless steel ferrules should be used for all Swagelock connectors. However, for ease of disassembly, nylon or Teflon ferrules could be used on the gas line fittings

Care should be taken to ensure that the water and gas lines are not strained by the mounting. To avoid chance of this it is preferable to use stainless steel bellows in the water lines.



Picture shows the main electrical connections to an ion source head. The Mounting Bracket attaches to the Mount Spigot. It is good practice to periodically apply a small amount of vacuum compatible lubricant to the screw threads. This includes the filament clamp nuts and the filament leads. Ideal lubricants are moly-disulphide or copper-based dry lubricants.

Installation of Electrical Feedthrough



The ion beam system is supplied with an electrical feedthrough assembly to ensure ease of installation and safe and secure operation. The assembly comprises a 1" (or 32mm) standard baseplate 4-pin electrical feedthrough and a high current power connector. Figure above shows the complete assembly.

Take note of the location slot in the feedthrough. The slot ensures correct orientation of the feedthrough adapter when connection is made.

Installation procedures

1. Install 4-pin feedthrough to the chamber baseplate port. Secure feedthrough with spanner.
2. Connect the Power Cable to the feedthrough. Take care to ensure the connector is properly aligned with the slot. Gently push the connector onto the feedthrough pins until it stops. The coupling sleeve can now be screwed to the feedthrough.. Do not tighten with anything other than finger pressure.
3. Connect the green wire coming from the power cable to the chamber earth. Make sure a sound connection is established. Most vacuum chambers have a single earthing stud and it is preferred to use this earth point.
4. The other end of the power cable can now be connected to the connector on the rear of the power supply

Note: The vacuum side of the electrical feedthrough has four (4) connectors. One of the connectors is fitted with a BLUE sleeve. This connector is connected to the ANODE connection on the

base of the ion source head. The opposite connector has a BLACK sleeve fitted and this one is connected to the FILAMENT COMMON, i.e. the one filament post by itself. The other two connectors can be attached to either of the two filament posts.

Electrical Connections – Ion Source

Electrical connections to the ion source are by the cables supplied. For the Dual Filament Ion Source (ST55 & ST3000 only), three of the copper connecting wires (supplied) are terminated at the three filament legs. The filament leads attach to the 5mm cap screws on the side of the filament legs. The anode lead connects to the water manifold as shown in the above picture. The other ends of the cables are secured to the vacuum-side conductors of the vacuum feedthrough using the screwed BeCu connectors provided. Ceramic insulator beads (supplied) should be used to protect the copper leads of the vacuum feedthrough.

Note that, when installing the electrical connections between the electrical feedthrough and the ion source connection points:

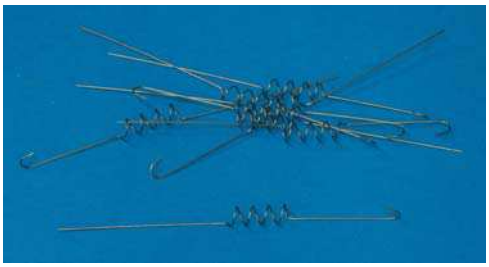
- determine the shortest length of the copper wires and cut to length. Do not leave excess length of wire as this can be the cause of instability.
- Do not remove the enamel insulation from the copper wires except at the end where they are connected to the feedthrough
- Once the length of each wire is determined and cut, feed ceramic beads along the complete length.
- Try to route the filament and anode wires together between the ion source and the feedthrough.

Installing a Dual Filament

Use only the 10mm nut driver supplied. Finger pressure is only required. While straight 0.020" tungsten wire filaments may be used in the ST55, for optimum performance and extended filament life, the use of approved coiled filaments should be used. Following is the installation procedures for both types.

CAUTION
DO NOT USE SPANNERS – DO NOT USE EXCESSIVE FORCE TO TIGHTEN THE FILAMENT POSTS – DAMAGE MAY RESULT

Dual Filament Installation – using approved coiled filaments (ST55 & ST3000)



The figure to the right shows the installation of coiled filaments to the ST3000.

The figure below shows the Saintech coiled filaments for the ST55. They have a hook on one end and straight on the other. When installing dual filaments, it is important to secure the straight wire end to the common filament post, i.e. the post that terminates both filaments. Start by locating the hooks of each filament around the filament post and secure both clamps using a 10mm tube spanner. The straight ends are then located one each on either side of the screw post. Before clamping the common filament post, apply a small extension to both filaments by gently pulling on the wires so that the coils are slightly stretched. While applying the tension, secure the common filament clamp post. The reason for this is to avoid distortion of the filaments when first heated.

Installation of the Mass Flow Controller (MFC)

Note that the following instructions for the single MFC system are still relevant to the Dual MFC installation. The single gas system is provided with one Mass Flow Controller.

MFC mounting using Mounting Hardware (MB) supplied

If using the MB supplied, the mounting hardware will be as shown below. The special mounting hardware is designed to simplify the MFC installation while ensuring that a minimal internal volume is provided between the MFC and the ion source.

The mounting kit is designed for installation immediately below the baseplate feedthrough (shown to the right of the figure). Note that the vacuum side of the gas feedthrough also provides mounting for the ion source head. Correct procedures for mounting the MFC assembly are as follows:

1. Install the gas feedthrough into the relevant baseplate feedthrough port and secure in place. Remove the 1/8” Swagelock nut and ferrules from the vacuum side of the fitting.
2. On the air-side of the feedthrough, attach the bracket under the nut provided – as indicated in above photo.
3. Assemble the MFC to the mounting bracket provided using two screws. **Note that the correct gas flow direction is maintained** (refer to above figure).
4. Mount the ¼” ball shut-off valve (supplied) to a short length (approx. 30mm) of ¼” stainless steel tubing. This is followed by the ¼” x 1/8” straight reducer (Swagelock – supplied). Note that these components are normally delivered pre-assembled.
5. To the 1/8” Swagelock fitting, secure the 1/8” tube.
6. The complete assembly can now be installed with the 1/8” tubing passing up through the gas feedthrough. The MFC bracket is mounted onto the metal bracket, using the four mounting screws, by using the key-hole shaped holes. Lightly secure the four cap screws.
7. In the vacuum chamber, re-install the Swagelock ferrules and nut to the fitting on the feedthrough - check for the correct orientation of both ferrules. Bend the 1/8” gas tube to the Swagelock fitting located on the end of the mounting lug on the side of the ion source shroud and cut the tube to length. Terminate the gas tube into the Swagelock fitting.
8. Install the ¼” stainless steel tube(s) from the gas regulators to the delivery side of the MFC
9. Check that all connections have been secured and check for leaks in the complete assembly.

Installation without Optional Mounting Hardware MB

The single MFC should be mounted as close as practicable to the vacuum feedthrough. The ball valve and reducing union are supplied pre-assembled and the MFC should be mounted onto a firm base using the appropriate screws – check the MFC manufacturer's installation manual supplied.

Secure the 1/8" stainless steel tube into the reducing union and pass the tube through the 1/8" Swagelock fitting that is welded into the combined water and gas feedthrough.

Dual Gas Option (DG)

If the Dual Gas option (DG) is purchased, the special mounting bracket hardware will be provided as shown below. The two MFCs will be shipped ready mounted and tested. Care should always be taken when handling the MFCs -they are precision and sensitive instruments

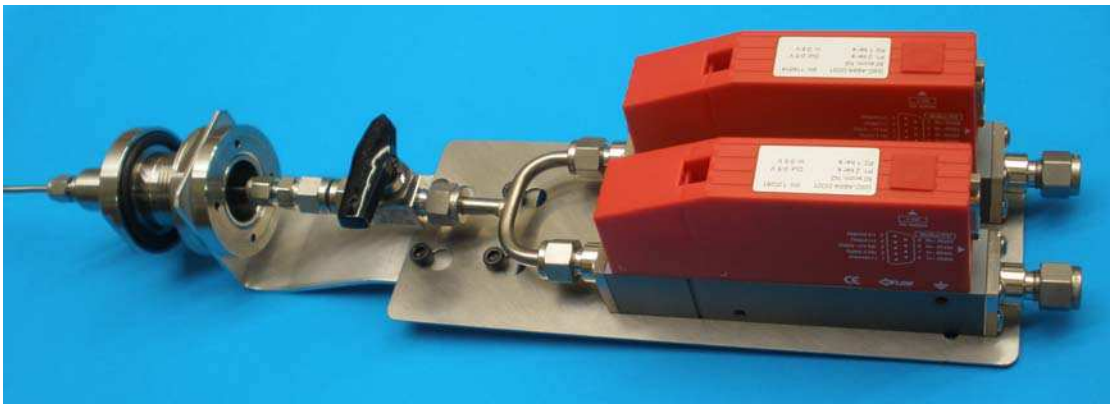


Figure shows a Dual gas module using two Vogtlin MFCs. The MFCs should be mounted as close as practicable to the vacuum feedthrough to minimize the gas delivery volume between the MFCs and the ion source. This is particularly important for optimum operation of the system during Pulse operation and when changing gases during operation

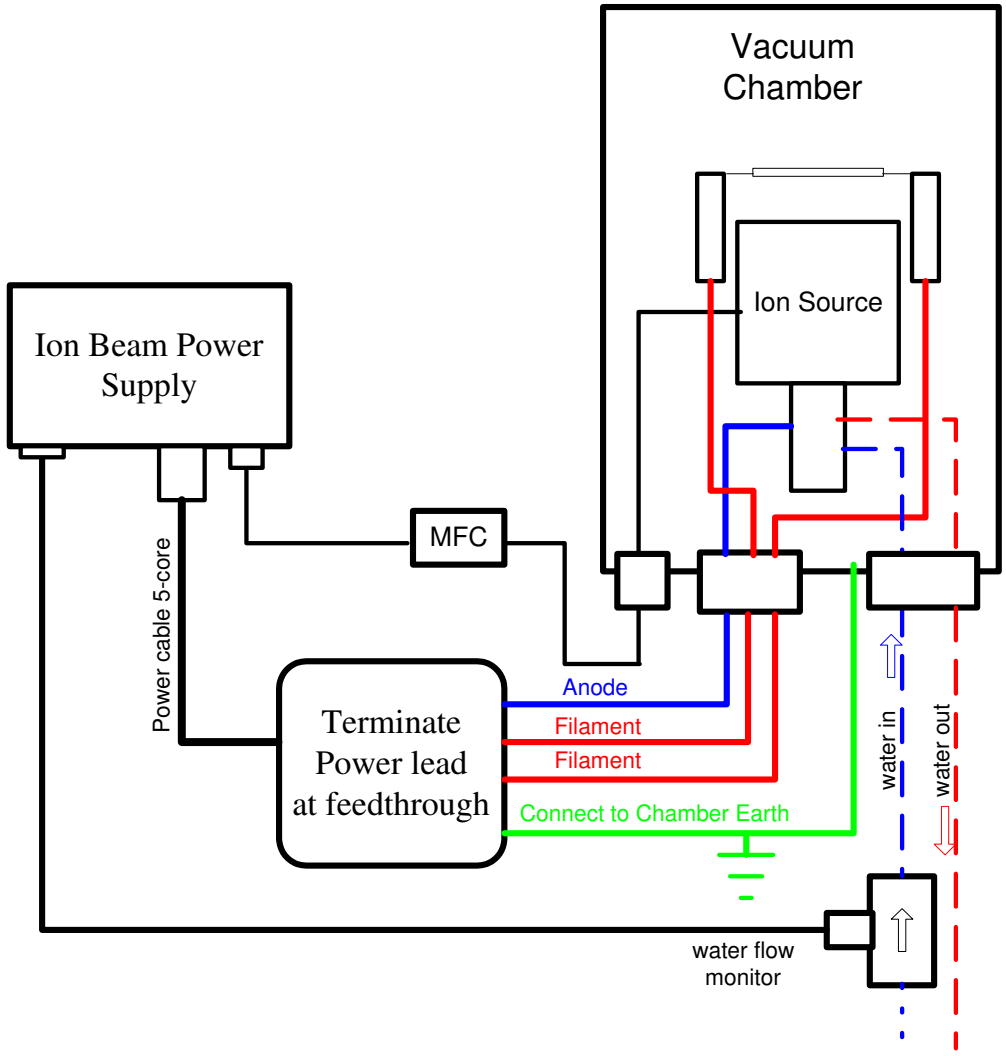
Installation of the Power Supply

The power supply should be properly mounted and secured into a standard 19" instrument rack. The power supply should be mounted at a suitable height to ensure ease of operation and avoid operator fatigue. The tilting touch screen still provides good visibility if it is required to mount the power supply low in the rack.

Check that the rear of the cabinet provides ease of connection for the cables to route to the vacuum chamber, MFC, water flow monitor, etc.

The power supply does not require forced ventilation (cabinet fans, etc) as very little heat is generated within the power supply however there should be adequate clearance above and below the power supply to provide natural convective ventilation

Connecting the Power Supply to Vacuum System Schematic



Make sure that neither of the filament connections are connected to earth. If either are connected, there will be an audible warning that will sound until the earth connection is removed.

Procedure for Connecting the Power Supply (refer to above schematic)

1. **Mass Flow Controller** (or MFCs if Dual gas option supplied).

The appropriate connecting cable(s) will be supplied depending on the particular MFC(s) supplied.

2. **Ion Source Power**. Connect the black cable with the 5-pin Amphenol connector to the 5-pin outlet (marked **'Ion Source Power'**) on the rear of the power supply see figure below. The other end of the power cable terminates at the vacuum feedthrough. See instruction earlier in this manual

Figure shows the rear panel connections for a Dual Gas System.

3. **Water Flow Monitor and Interlock**. The Water Flow Monitor (WFM) is intended to be mounted directly in series with the cooling water inlet pipe. The white cable from the WFM is connected to the black connector marked “Water Flow”. It is essential that the WFM is correctly installed otherwise the system will not operate correctly..
4. **Mains Power Connection**. Provision is made for an international IEC mains power connection on the rear panel – see above figure. Each power supply is factory set to one of two mains voltages ranges, e.g. 200 to 220VAC and 220 to 240 VAC. Check the rear panel of each power supply to check the particular power requirements. If your mains AC voltage is outside of the range from that indicated on the rear panel, check with Saintech before proceeding.
5. **Vacuum & Chamber Door Interlock**. It is strongly recommended that the Power Supply Interlock is connected to appropriate vacuum and chamber door interlock switches. See WARNING and CAUTION below. To connect the interlock circuit, first remove the link that comes factory-fitted at the rear panel as shown above. The various safety interlocks are then connected in series with the Interlock Circuit.

WARNING

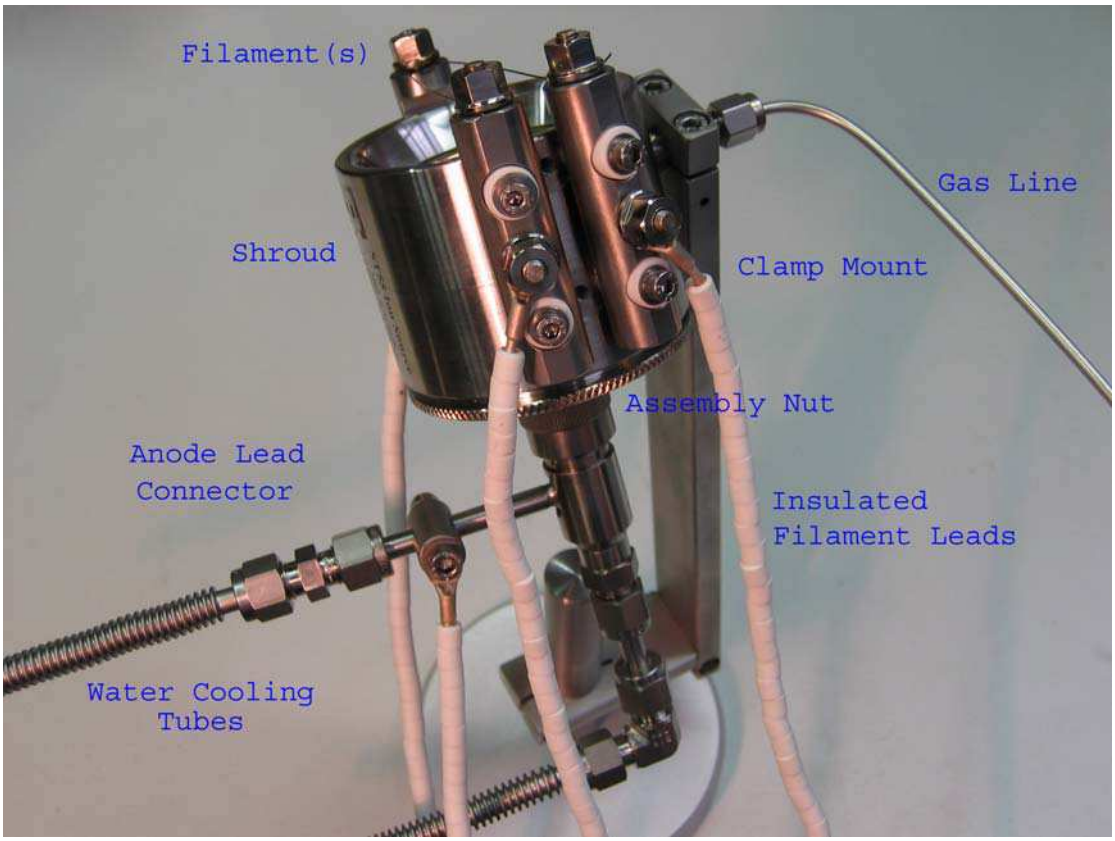
Failure to connect the Power Supply Interlock to vacuum and chamber door switches may risk personal injury to operators. Lethal voltages are connected to some exposed elements of the ion source

5

MAINTENANCE

In general, the source requires little routine maintenance. Apart from regular replacement of filaments, it is only required to periodically clean the anode. Occasionally, the anode will require cleaning to remove any build-up of scattered coating materials and contaminants.

> CAUTION
> When cleaning the anode, NEVER USE SOLVENTS. If alcohol or acetone is used on the anode, fluid may penetrate the gas injection ports. The source will become unstable due to outgassing and the desorbed hydrocarbon gases will likely degrade the performance of coatings for some time following.



Removal of the Ion Source from Mounting

If it is required to dismantle the ion source the following points should be observed:

1. Check that the power supply is safely shut down (remove the IEC (mains) plug). As an extra precaution, unscrew and remove the Amphenol cable connection between the power supply and the deposition chamber.
2. Turn off the cooling water. Use compressed gas to blow through any remaining water from the cooling lines otherwise cooling fluid may leak into the vacuum chamber when fittings are disconnected.
3. Disconnect the anode lead and filament leads – two for a Single Filament assembly and three for a Dual Filament assembly (as shown above).
4. Disconnect the Swagelock gas entry connector from the mounting bracket of the ion source. Note, this is not necessary if it is not required to remove the shroud.
5. Do not disconnect the fittings of the ceramic water breaks. Breakage of the ceramic tube may result. Support the ion source by hand while removing the clamp screws from the mounting bracket.
6. Remove the ion source from the vacuum chamber

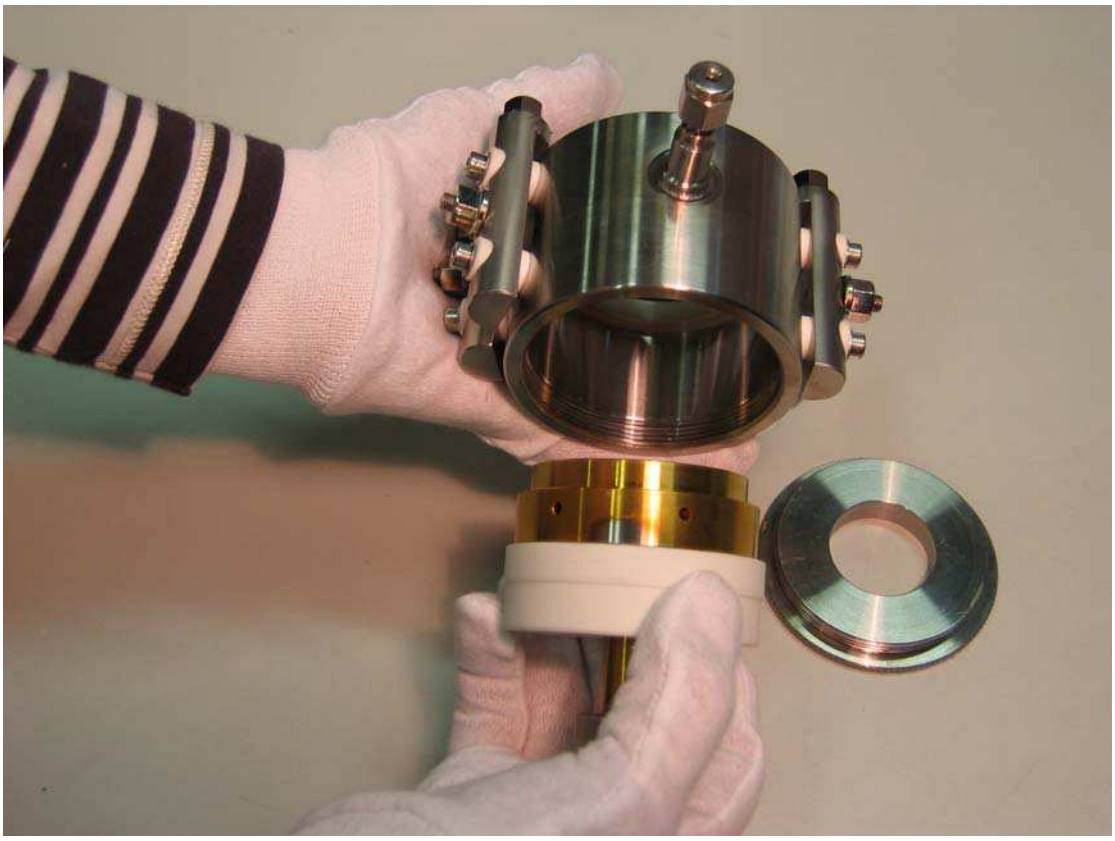
Disassembly

With the ion source removed from the mounting brackets. Disassemble the ion source over a clean flat surface. First remove the knurled nut from the water assembly as shown in the photo below

Step 1 Remove water assembly. The water manifold remains attached to anode assembly by circlip. See below for disassembly of the water manifold assembly.

Step 2. Unscrew the knurled assembly nut from the base of the ion source

With the large stainless nut removed, carefully withdraw the anode assembly from the shroud. Take care that the ceramic ring (anode insulator) does not drop. It is very brittle and may shatter if dropped on a hard surface.



The anode (TiN coated – 'gold' coloured component) can now be lifted away from the base insulator.

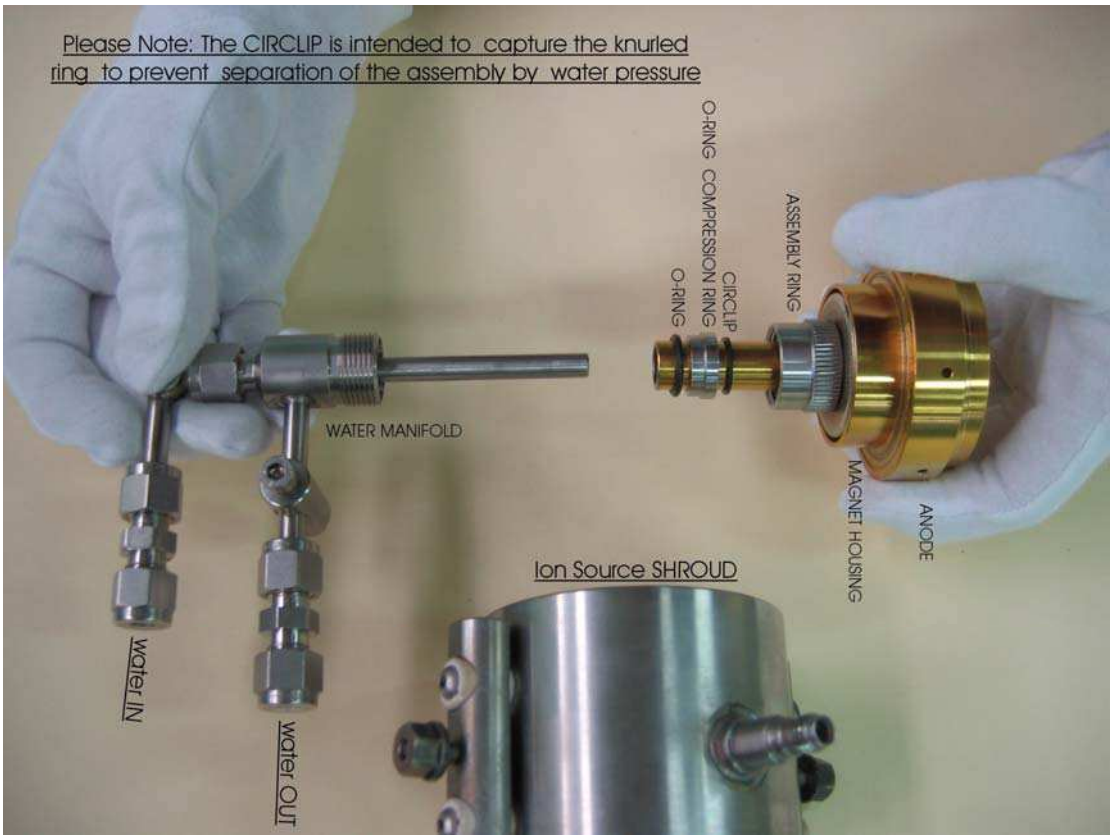
Dismantling the Water Flow Manifold Assembly and Magnet

Under normal operation of the ion beam system, there should be no need to remove the magnet from its position in the rear of the anode and it is generally much safer to leave it in its housing. However, should it be necessary to remove the magnet, first remove the circlip from the stainless steel tubing – use suitable external circlip pliers. With the circlip removed, the knurled nut of the compression-seal fitting can be removed followed by the Teflon plasma shield (if installed). The magnet can now be withdrawn from its housing in the back of the anode. See photo below showing an exploded view of the anode and water manifold.

Take care not to drop the magnet or to allow it too close to other magnetic material as it will SNAP on very firmly and is likely to break.

Caution

Take care in handling the magnet. Personal injury can result if fingers etc get between the magnet and magnetic material. Keep the magnet away from other electronic devices eg watches, computers, magnetic storage media, etc.



Inspection and Cleaning of the ion source

1. Check the anode insulator for coating deposits on the inner face. Providing the deposits are electrically non-conducting no cleaning should be necessary.
2. Clean the conical face of the anode. DO NOT USE SOLVENTS. ScotchBrite scouring pads can be used dry or, alternatively, fine (400 or 600 grit) abrasive paper (as used in the automobile body finishing industry) can be used. Vacuum clean the anode to remove any dust and/or blow with compressed gas to remove dust.
3. Check for any build-up of 'sludge' inside the electrical water breaks. Build-up will reduce the water flow. Clean as appropriate. If the electrical water breaks require disassembly it will be necessary to replace the Nylon ferrules in the Swagelock fitting. only use 3/8" nylon ferrules and back washers for sealing to the ceramic. The assembled breaks may require helium leak-checking following assembly.

Re-assembly of the Source Head

Re-assembly is essentially the reverse of the above procedures taking note of the following:

1. Replace anode into base insulator
2. Replace ring anode insulator (annulus) on to anode. It may be easier to first locate the ceramic anode insulator into the shroud.
3. Slide the stainless steel shroud over the anode assembly. Re-secure the large locking ring hand tight only – DO NOT USE OTHER MECHANICAL DEVICES otherwise damage to the assembly will result.
4. Install the filament legs. It is recommended that a small amount of molybdenum or copper-based vacuum grease can be applied to all screws prior to assembly.
5. Install the ST55 into the chamber using the mounting bracket.
6. Secure both water-cooling lines and the gas line. Use recommended procedures for the Swagelock fittings.
7. **Make sure that the water-cooling supply has been reconnected and turned on before applying power**. Check for water leaks before pumping chamber.
8. **Connect anode and filament leads**.

Special Note for Dual Filament System. Make certain that the correct lead is attached to the common filament leg.

9. Install a new filament(s). Use nut driver supplied – do not use excessive force.

Note that after removal and cleaning, the source may outgas. Until normal operation can be established it may be necessary to use a lower Beam Voltage on the anode (say, 140 volts) until the source has run for several minutes and stabilized. It may be useful to run the filament without any gas flow for say 5 minutes to warm the assembly.

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DESCRIPTION OF POWER CONTROL ELECTRONICS

The Saintech Series III power supply comprises two dedicated microprocessor units. The ‘Power controller’ a.k.a. Back Panel controller handles the operation of the Mass Flow Controllers, the Ion Source filament control, the Ion Source anode voltage selection, monitoring Ion Source water flow, monitoring of internal and external interlocks. The ‘Control controller’ a.k.a. Front Panel controller handles communication with the touch screen, remote RS232 control and communication with the ‘Power controller’.

The ‘Power controller’ is also known as the Back Panel controller because it physically resides on the back panel PCB. The ‘Control controller’ is also known as the Front Panel controller because it physically resides on the front panel of the box.

When the Power controller is powered on, a buzzer located on the Power controller PCB will sound for sixteen half power cycle times; i.e. at 50Hz buzzer sounds for 0.16 seconds, 60Hz buzzer sounds for 0.13 seconds. This will indicate that the zero crossing detect circuits are working correctly.

Approximately 2.2 seconds after the Power controller is powered on, water flow status is deemed valid. The Control controller will now request transmission of the Power controller ‘REGISTERS’, these are EEPROM stored parameters specific to a particular model. Once these REGISTERS have been received the buzzer will sound for 0.2 seconds.

The Touch screen requires approximately 4 seconds to power up correctly; the Control controller will start communications with the touch screen after 6 seconds from power up. No user response is possible until this time has elapsed.

Note: If the power supply is turned off for any reason, please allow at least 5 seconds for the internal storage capacitors to discharge before turning back on, otherwise the above mentioned power up sequences may not occur and the power supply may not function correctly.

The Power controller and Control controller will initiate program check sum verification after power up. If the check sum does not verify, control is passed to the BOOT LOADER software which will attempt to receive a new control program. New

versions of control programs are down loaded via the supplied Visual Basic “Boot Loader” program (version 2.5). This potential problem of the check sum not verifying would normally only occur if there was a disruption during a program download.

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ALARM MESSAGES

All alarms except [“Anode power limiter active”, and ICM (Ion Current Monitor)] forcibly STOP the power supply. Alarms with an asteric “*” MUST remove the source of the alarm before the power supply can be re-started, these alarm messages are displayed in red on the touch screen. A red ring with a slash overlays the ‘START’ button to indicate non-access. Alarm messages that do not show an asteric may restart the power supply; the alarm will be removed when the restart occurs. If the alarm re-occurs, the problem will need to be resolved.

All alarms that forcibly stop the power supply except “External interlock open” will sound the Power controller buzzer; the buzzer will be on for 0.3 seconds and off for 0.7 seconds, this on/off duty cycle will repeat until the alarm is removed.

The buzzer will sound continuously if the Power controller losses communications with the Control controller.

ICM input clipping

Occurs when the Ion Current Monitor input current signal clips by 100% of full scale, for more than 0.2 seconds. The ion current display value is not updated.

ICM input current is ELECTRON

Occurs when the Ion Current Monitor input signal is negative due to electron pickup and NOT positive, i.e. giving up electrons. This usually indicates the bias voltage is set too low. The ion current display value is not updated.

ICM bias power supply too low

Occurs when the Ion Current Monitor bias power supply has too great an instantaneous load. This would only occur if the ion current exceeds the bias supply delivery current, this can only occur on the highest range under severe conditions. The ion current display value is not updated.

ICM EEPROM check sum error

Occurs when the Ion Current Monitor is powered on and the calibration settings check sum does not verify. A default set of values is used and normal operation is resumed.

The ion current display value is updated but could be in error by as much as ten percent.

Filament open circuit

Occurs when the change over to the second filament has failed (Single filament IAD Head) or the second filament has expired. A new filament or filaments are required.

Filament shorted to ground

Occurs when one leg of the filament gets connected to earth/ground. This can occur during system installation or when the filament gets hot and starts to move toward a grounded object due to thermal expansion. If for any reason BOTH filament legs are hard shorted to earth/ground the Filament primary circuit breaker will trip.

Filament current too large

Occurs when a straight wire filament is given too large a set-point value when the filament feedback mode is POWER. If you must use straight wire filaments, find an appropriate power setting by manually increasing from zero until you find the setting you need.

Anode power limiter active

Occurs when the anode power level exceeds the threshold level set for the anode voltage setting. The power supply will attempt to servo the gas controls to keep the anode power level at or about the threshold. Reduce your gas set-point(s) to remove the alarm.

Power controller EEPROM calibrate err.

Occurs when the Power controller is started (power applied or BootLoad complete) and the EEPROM Calibrate check sum does not verify. The only way to over come this error is to BootLoad known EEPROM calibrate settings to the Power controller using the supplied Windows BootLoader program(version 2.5, tick BP calibrate, un-tick CODE include) and specifying the Power controller release .HEX file located on supplied CD under d:/SAINTECH/RELEASE/BP_XX release x_x.HEX. When this error occurs, a default set of parameters are used and normal operation is resumed. The accuracy of any touch screen readings may be out by as much as ten percent.

*Power controller EEPROM registers err.

Occurs when the Power controller is started (power applied or BootLoad complete) and the EEPROM Register check sum does not verify. The only way to over come this error is to BootLoad known EEPROM registers to the Power controller using the supplied Windows BootLoader program(version 2.5, tick BP registers, un-tick CODE include) and specifying the Power controller release .HEX file located on supplied CD under d:/SAINTECH/RELEASE/BP_XX release x_x.HEX.

*Filament primary circuit breaker open

Occurs when there is too great a load on the filament power transformer, usually due to both filament legs shorted to earth/ground.

*External interlock open

Occurs when the two-wire circuit loop is broken, or either wire is connected to earth/ground. The maximum compliance voltage is 24Vdc and maximum current is 2.5mA.

*Water flow too low

Occurs when the water flow to the IAD Head is below the set threshold.

*Internal temperature too high

Occurs when the internal temperature of the Power controller, as measured near the Touch screen or LCD screen at the front of the unit, exceeds 42.5 +/-3 degrees Celsius. This indicates there is insufficient ventilation for the Touch screen.

*Fan failure

Occurs when the forced air flow fan stops or stalls. This fan is only installed in models with a power rating greater than 1500 Watts.

*Anode primary circuit breaker open

Occurs when there is too great a load on the anode power transformer, usually due to continuous excessive anode current. This can result from chamber short circuits to earth/ground or the filament. It can also result from a grossly under-neutralised beam, giving rise to plasma oscillations.

*No Registers received

Occurs when the Control controller is started (power applied or BootLoad complete) and the Power controller EEPROM Registers have not been transferred, usually due to a “Power controller receive comms timeout” alarm, see below; and/or “Power controller EEEPROM registers err.” alarm, see above.

*Power controller receive comms timeout

Occurs when the Control controller does not receive status or command response from the Power controller, usually due to the communications cable being unplugged; internally as with combined low power units or externally if separate hardware chassis components for high power systems.

*Ion current monitor receive timeout

Occurs when the Control controller does not receive data from the Saintech Ion Current Monitor when enabled in the MODE CONFIGURATION set-up screen. Usually due to the communications cable being unplugged.

*HMI receive comms timeout

Occurs when the Control controller does not receive data from the Touch screen when it should, usually a timing issue introduced by the software author but can include an unplugged cable.

*Remote receive comms timeout

Occurs when remote lock out is active (see command 20) and the Control controller does not receive a valid remote command from the remote system within one second from the previous command. See command 48 to disable remote receive timeout. The default condition at power up is disabled.

Mass Flow Controller1 timeout

Occurs when the Power Supply has not received any flow data from the Oxygen MFC. This would normally only occur if the MFC cable is not plugged in.

Mass Flow Controller2 timeout

Occurs when the Power Supply has not received any flow data from the Argon MFC. This would normally only occur if the MFC cable is not plugged in.

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PIN ASSIGNMENTS

Touch Screen comms connector pin assignments

Access to this facility is via the DB9F connector located on the top right hand side of the front panel

DB9F Pin Assignments

PIN1 NOT to be connected, RS485 RXD-

PIN2 NOT to be connected, RS485 RXD+

PIN3 NOT to be connected, RS485 TXD-

PIN4 NOT to be connected, RS485 TXD-

PIN5 RS232 ground

PIN6 no connection

PIN7 TX232 data transmit output

PIN8 RX232 data receive input

PIN9 no connection

This connector is only used if the Touch Screen software is to be upgraded. It is suggested that a small length (12 inches) adapter cable be made to connect onto the remote RS232 communications cable. The ends of the adapter cable will have to be marked as to where they are connected, as both are male.

DB9M Touch Screen		**DB9M Remote RS232 cable**
PIN1		PIN1
PIN2		PIN2 RX to PIN8 of T/S
PIN3		PIN3 TX to PIN7 of T/S
PIN4		PIN4
PIN5	---------- GROUND ----------	PIN5
PIN6		PIN6

PIN7	TX connect to PIN2 of remote	PIN7
PIN8	RX connect to PIN3 of remote	PIN8
PIN9		PIN9

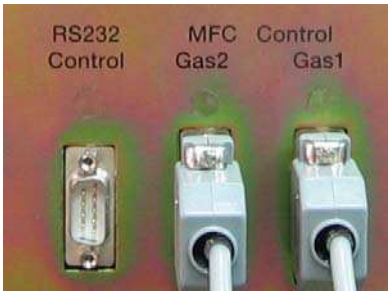
Power Cable To Vacuum Chamber

Black covered 5-core cable

BLACK	Filament common	- Connect to feedthrough
WHITE	Filament one	- Connect to feedthrough
BROWN	Filament two	- connect to feedthrough
BLUE	+ANODE VOLTS	- connect to feedthrough
GREEN	CHAMBER EARTH	- connect to chamber earth (on air-side of chamber)

Remote comms pin assignments

Connection is via a DB9 connector located on the rear panel.



PIN1 not used

PIN2 RX232 data receive input

PIN3 TX232 data transmit output

PIN4 Power ground

PIN5 RS232 ground

PIN6 not used

PIN7 not used

PIN8 Power ground

PIN9 +10V Power source (150mA maximum), pins 4 and 8 are ground reference.

Recommendation

It is suggested for the remote RS232 communications cable that two DB9F connectors be null modem configured so that is does not matter which end is connected to where.

PIN1, PIN4 and PIN6 joined, on both DB9s.

PIN7 and PIN8 joined, on both DB9s.

PIN2 of power supply end connects to PIN3 of remote end.

PIN3 of power supply end connects to PIN2 of remote end.

DB15F Mass Flow Controller connector pin assignments.

PIN1	0…5 volt control
PIN2	+15 volts power
PIN3	-15 volts power
PIN4	Power ground
PIN5	not used
PIN6	not used
PIN7	0…5 volt flow monitor
PIN8	not used
PIN9	reserved
PIN10	+24 volts power
PIN11	Power ground
PIN12	Remote Sense Ground, connected to power ground at MFC end.
PIN13	not used
PIN14	not used
PIN15	not used

Only one (1) “MKS” brand of mass flow controller can be connected.

DB9F Mass Flow Controller connector pin assignments, on back panel.

PIN1	not used	PIN6	RS485 TX+
PIN2	Power ground	PIN7	RS485 TX-
PIN3	+24V Power	PIN8	RS485 RX-
PIN4	Power ground	PIN9	RS485 RX+
PIN5	Power ground		

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REMOTE CONTROL

Remote access to ST series III power supplies requires transmission of a command record. The Power Supply will acknowledge by transmitting an acknowledge record. The format of a command or acknowledge record is:

':'	Header character, ASCII colon.
0x01...0x41	Record data Length (at least one), dependant on command.
0x00…0x3F	Command code, maximum of 64 commands.
DataBytes[]	Data bytes specific to command or acknowledge.
0x00…0xFF	CheckSum, Negative of (Sum MOD 256)
	Sum = 0
	Sum += Record data length
	Sum += Command code
	Sum += DataBytes[0] + … DataBytes[n]
	CheckSum = (-Sum) AND 0xFF

Each byte of the record (i.e. what comes after the colon header character) is transmitted as two ASCII hexadecimal characters. E.g. sending ASCII character '3' followed by 'F' means transmitting data byte 0x3F.

ASCII nulls, carriage returns and line feeds are ignored

The header character (ASCII colon) defines the start of the record. Upon receipt, you have 80mS to complete the record transfer otherwise the record is discarded and search for a new record commences. See also Lock command for Alarm timeout details. The search for a new record requires a dead time of at least 13mS. I.e. there must be no character received for at least 13mS before the search proper commences, this requires a delay of no more than 13mS between each transmitted character.

The Record data Length includes the command code plus any data bytes for that command or acknowledge; if greater than 1+64 the record is discarded and search for a new record commences.

Commands acknowledge when completed, NOT necessarily in order of reception.

The minimum time between commands is 20mS, i.e. the minimum time between the last byte of command N and the first byte of command N+1; this allows the receive buffer to be flushed if any errors. NB: The receive buffer is only 255 bytes in length.

There are a maximum of 64 user commands, 0x00…0x3F. If a command is valid the power supply will respond with an acknowledge record whose command = your command plus 0x40. Errors and alarms have their own codes beginning at 0x80. If alarm conditions persist; an alarm record will be sent every second, if enabled. See command 49.

If a command code is not recognised the acknowledge command = 192 with the first data byte = command code in question.

If a command parameter value is out of range the acknowledge command = 193 with the first data byte = command code. If a command is issued while a previous command has not completed, the acknowledge command = 194 with the first data byte = command code. It may be necessary to check the alarm and/or status bits before issuing a command. Commands that change set points or modes will update the touch screen settings to reflect those changes, also when remote locked. Any changes remain static when power is removed.

To establish a connection to the power supply, use the following settings/procedure. The coding is not elegant or linguistically correct; BUT…

BAUD RATE = 19200

8 DATA BITS

NO PARITY

1 STOP BIT

NO FLOW CONTROL

Tries = 0

Do

{

Transmit command Ping0 to power supply _

‘:’, ‘0’, ‘1’, ‘0’, ‘0’, ‘F’, ‘F’

Wait 150mS capture time.

If first DataByte[] received is equal to 0x00+0x40

```
        {
                Exit Do         // Received valid acknowledge.
        ELSE
```

```
            Tries += 1
            If Tries == 3 goto cannot connect
        }
}
Engage…
```

Command code, p1, p2, p3

Where p1, p2, p3 are parameters if required by the command.

A parameter designated by B means a byte value {0…255}.

A parameter designated by W means a word value {0…65535), LOW byte followed by HIGH byte.

Values enclosed within curly brackets designate the valid range for the command, if outside this range an “INVALID_DATA” response command of 193 is returned.

0…2

Ping0…2.

No functional action other than to acknowledge.

3

Ping_No_pong.

No functional action other than to NOT acknowledge.

4, W{0…15}

Load program W into touch screen.

If a program is loaded when remote locked, PURGE and CLEAN modes are disabled.

5, W{0…15}

Save touch screen settings to program W.

6, W{0…15}

Download program W to remote. DataBytes[] sent as follows:

B[64] An array of 64 bytes, the first 28 being the ASCII name.

7

Upload program to touch screen. DataBytes[] returned as follows:

B[64] An array of 64 bytes, the first 28 being the ASCII name.

8

Turn auto anode beam current control ON.

9

Reserved for future use.

10

Disable auto beam control.

11, W{1…1000}, W{0…1000}, W{0…1000}

Set the Kdamping, Kproportional, Kderivative Gain coefficients.

12, W{0…200}

Set the auto anode current set-point {Amps*10}

13

Reserved for future use.

14

Reserved for future use.

15

Reserved for future use.

16

Boot the Control controller with new code. Used by Windows BootLoader program.

17

Boot the Power controller with new code. Used by Windows BootLoader program.

18

Boot the Power controller manually with new code. Used by Windows BootLoader program.

19

Boot the Control controller manually with new code. Used by Windows BootLoader program.

20

Lock out the touch screen. The user cannot adjust set points; any set-point changes made by remote are reflected to the touch screen for display. The default conditions and set points are as per the current manual settings, except that the PURGE and

CLEAN modes are disabled; Auto mode and PULSE mode are turned off. The power supply is STOPPED if it is already started. A command must be received within every second, otherwise a timeout alarm is generated and the power supply will stop. See command 48 on disabling timeout.

21

Release touch screen lockout. The power supply is STOPPED if already started.

22

STOP the power supply.

23

START the power supply.

24, W{0…5}

Select an anode voltage secondary tapping, 1…5, 0=off.

25

Transmit full status. DataBytes[] returned as follows:

W{0…12000}	Ion current, µA
W{0…250}	Anode1 current, Amps*10, RMS
W{0}	Anode2 current = 0, not used in single head systems.
W{0…300}	Anode volts, Peak
W{0…1500}	Anode1 power, Watts, RMS
W{0}	Anode2 power = 0, not used in single head systems.
W{0…250}	Filament1 current, Amps*10, RMS
W{0}	Filament2 current = 0, not used in single head systems.
W{0…500}	Filament1 Volts*10, RMS
W{0}	Filament2 volts = 0, not used in single head systems.
W{0…255}	Waterflow1 Litre/minute*10
W{0}	Waterflow2 = 0, not used in single head systems.
W{0…5000}	Gasflow1 sccm*100
W{0…5000}	Gasflow2 sccm*100
B{0…255}	Power controller1 flags
B{0}	Power controller2 flags = 0, not used in single head systems.
B{0…255}	Control controller flags3
B{0…255}	**Dummy byte is transmitted if Front Panel Revision software is from 1.6(26/NOV/2008) to 2.0(7/SEP/2009) inclusive.**

B{0…255} Control controller alarm flags

B{0…255} Control controller status flags

26

Transmit short status. DataBytes[] returned as follows:

B{0…255} Power controller1 flags

B{0} Power controller2 flags = 0, not used in single head systems.

B{0…255} Control controller flags3

B{0…255} Control controller alarm flags

B{0…255} Control controller status flags

Flag/Status Bit Definitions for Commands 25 and 26 above

Power controller1/2 flag bit definitions:

Bit7 0=ok, 1=filament primary circuit breaker tripped

Bit6 0=ok, 1=filament current imbalance, leg shorted to earth/ground

Bit5 0=ok, 1=filament open circuit

Bit4 0=ok, 1=water flow < threshold

Bit3 0=ok, 1=second filament active AND open circuit

Bit2 0=ok, 1=filament current > maximum

Bit1 0=default, 1=2nd filament selected

Bit0 0=stopped, 1=closed loop running

Power controller flag3 bit definitions:

Bit7 0=ok, 1=anode primary circuit breaker tripped

Bit6 0=ok, 1=anode power limiter active

Bit5 0=ok, 1=inside ambient temp > threshold

Bit4 0=ok, 1=EEPROM registers check sum error

Bit3 0=ok, 1=interlock open

Bit2 0=ok, 1=fan failure

Bit1 0=ok, 1=EEPROM calibration check sum error

Bit0 reserved

Control controller alarm flag bit definitions:

Bit7 0=ok, 1=Power controller Registers not received.

Bit6 0=ok, 1=Power controller receive timeout

Bit5 0=ok, 1=Ion current monitor receive timeout

Bit4 0=ok, 1=Touch screen receive timeout

Bit3 0=ok, 1=Remote lockout receive timeout

Bit2 0=ok, 1=Ion Current Monitor alarm, see ICM display or ALARM window

Bit1 0=ok, 1=OR of alarm bits that STOP but can restart

Bit0 0=ok, 1=OR of alarm bits that FORCE STOP condition

Control controller status flag bit definitions:

Bit7 0=Auto mode off, 1=Auto mode on

Bit6 reserved

Bit5 1=Mass Flow Controller 2 timeout.

Bit4 1=Mass Flow Controller 1 timeout.

Bit3 1=Program Load or Save in progress, remote program upload in progress.

Bit2 1=Controller transferring data to touch screen, updating set points.

Bit1 0=STOPPED, 1=STARTED

Bit0 0=Manual, 1=Remote locked

27

Transmit revision status. DataBytes[] returned as follows:

B{66}	ASCII “B”
B{80}	ASCII “P”
B{65…90}	ASCII “AN” or “RS”,
B{65…90}	Analogue or RS485 gas control.
B{0…255}	Power controller PCB Unumber location
B{65…90}	Power controller PCB revision ASCII character
B{0…255}	Power controller major software revision
B{0…255}	Power controller minor software revision
B{70}	ASCII “F”
B{80}	ASCII “P”
B{65…90}	ASCII “SS”, “SD” or “MS”= Multiple Power controllers.
B{65…90}	Single Power Controller, Single or Dual Head
B{0…255}	Control controller PCB Unumber location
B{65…90}	Control controller PCB revision ASCII character
B{0…255}	Control controller major software revision
B{0…255}	Control controller minor software revision

Commands 28…30 will return an acknowledge command of 194 if the Power controller Registers have not been received.

28

Transmit the anode voltage select index, 0…5

DataBytes[] returned as follows:

B{0…5} Anode voltage select index, 0=off

29

Transmit the five anode volt TAP selections. If a selection is not available, 0 is returned. DataBytes[] returned as follows:

W{0…300} First anode volt selection, lowest voltage.

W{0…300}

W{0…300}

W{0…300}

W{0…300} Fifth anode volt selection, largest voltage.

30

Transmit the 22 character BACK PANEL model descriptor.

DataBytes[] returned as follows:

B[22] An array of 22 ASCII bytes including trailing spaces.

31

Transmit the BACK PANEL register values.

DataBytes[] returned as follows:

B[90] An array of 90 bytes.

Commands 32…39 acknowledge with full status. See command 25 for data details.

Commands 32…34 are grouped for single gas systems.

Commands 35…39 are grouped for dual gas systems.

A filament set point of 1000 corresponds to full power if feedback mode is constant power or maximum current if feedback mode is constant current. If OPEN loop mode is selected a set point of 0 corresponds to a duty cycle of 12.5%, a set point of 1000 corresponds to a duty cycle of 87.5%. The feed back mode defaults to CLOSED when the power supply is first turned on, this parameter is not saved with programs.

A gas set point of 1000 corresponds nominally to Logical full-scale flow. A +/-2.3% adjustment is allowed for outgoing reference and gain tolerances with Analogue units.

32, W{0…1000}, W{0…1023}

Set the filament and gas1 set points.

33, W{0…1000}

Set the filament set point.

34, W{0…1023}

Set the gas1 set point.

35, W{0…1000}, W{0…1023}, W{0…1023}

Set the filament, gas1 and gas2 set points.

36, W{0…1000}

Set the filament set point.

37, W{0…1023}, W{0…1023}

Set the gas1 and gas2 set points.

38, W{0…1023}

Set the gas1 set point.

39, W{0…1023}

Set the gas2 set point.

40

Turn pulse mode on.

41

Turn pulse mode off.

42, W{10…255}

Set the pulse period seconds*10, 1.0 to 25.5 seconds

43, W{1…255}

Set the pulse on time seconds*10, 0.1 to 25.5 seconds

Commands 44…47 are for test and diagnostic purposes ONLY, and are not for general use. Misuse can result in damage to the ion source filament and anode head.

44, W{0…4095}, W{1…32}=N

Transmit the Power controller N-byte RAM block, starting at address W{0…4095}. The addresses wrap around 12 bits.

DataBytes[] returned as follows:

B[N] An array of N bytes.

45, W{0…4095}, W{1…32}=N

Transmit the Control controller N-byte RAM block, starting at address W{0…4095}. The addresses wrap around 12 bits.

DataBytes[] returned as follows:

B[N] An array of N bytes.

46, B{0…255}, B{0…255}

Set the Filament power controller ‘deltaK’ and ‘damping’ coefficients.

Acknowledges with full status, see command 25 for data details.

47, B{0…255}, B{0…255}

Set the Anode beam power limiter ‘N’ and ‘D’ ratio gain coefficients.

Acknowledges with full status, see command 25 for data details.

48

Disable remote one-second timeout. Lock command (20) must be issued first.

Command 48 must be issued within the one-second-timeout period. Once disabled, timeout cannot be re-enabled.

49

Enable remote alarms. When enabled, any alarm condition will be transmitted to remote; if alarms persist they will be retransmitted every second. Once enabled, alarms cannot be disabled.

50

Enable sending full status to remote every 100mS when received by Power controller. Once enabled, a full status record with a command code of 160 will be transmitted every 100mS, see command 25 for data details.

51

Disable sending full status to remote every 100mS.

52, B{0…15}

Set configuration bit RB0…15.

53, B{0…15}

Clear configuration bit RB0…15.

54, W{0…65535}

Load configuration bits RB0…15.

Configuration Bit Definitions for Commands 52 to 54 above

Bit15	not used	
Bit14	not used	
Bit13	not used	
Bit12	not used	
Bit11	not used	
Bit10	not used	
Bit9	0=Oxygen, 1=Argon	Single gas mode: Gas1 = Oxygen, Gas2 = Argon
Bit8	0=OFF, 1=ON	Auto anode beam control
Bit7	0=SINGLE, 1=DUAL	Gas control
Bit6	not used	
Bit5	0=NO, 1=YES	Clean mode is permanent
Bit4	0=OFF, 1=ON	Dual gas purge – Gas2 enabled
Bit3	0=OFF, 1=ON	Dual gas purge – Gas1 enabled
Bit2	0=NO, 1=YES	Ion current monitor connected
Bit1	0=OFF, 1=ON	Pulse mode
Bit0	0=Power, 1=Current	Filament control feedback

Note: If single gas control is selected (Bit7=0) then Bit9 defines which gas is to be used. If Oxygen (Bit9=0) is required the cable must be connected to Gas1, likewise if Argon (Bit9=1) is required the cable must be connected to Gas2.

Alarm Codes

Alarms are divided into four groups, each group having a maximum of 16 codes.

Alarm codes always have bit7 set = 1

Alarm group 0x80+0x00

128

General alarm. DataBytes[] returned as per command 26, short status. If alarms persist the alarm is resent every second if enabled, see command 49.

Alarm group 0x80+0x10

144

Internal error, code fall through when decoding BootLoad source bits.

Group 0x80+0x20

160

Not technically an alarm. DataBytes[] returned = full status, see command 25 for data details. Sent when command 50 has been issued and will repeat every 100mS until disabled by command 51.

Alarm group 0x80+0x40

192

Invalid command. First DataByte[] returned = received command code.

193

Invalid data. One or more of the command parameters are out of range. First DataByte[] returned = received command code.

194

Invalid ready. A previous command has not completed its operation. This can occur if a program load/save is in progress, or if NOT remote locked and new set-point(s) have not been transmitted to the touch screen. First DataByte[] returned = received command code.

10

TROUBLESHOOTING

Problem	Possible Cause	Remedy
No Beam Current	▪ No gas flow ▪ No electron emission ▪ Filament broken ▪ No anode voltage ▪ Magnet de-magnetised	▪ Check regulator pressure,. Also check chamber pressure increases with MFC ▪ Check filament current ▪ Check anode connections ▪ Check anode fuse & circuit breaker ▪ Check for magnetic field strength
Ion beam unstable, fluctuating (It may be noticed that more gas flow is required to achieve the same beam current)	▪ Anode surface coated ▪ Gas delivery volume too high ▪ Chamber pressure fluctuating	▪ Clean anode ▪ Shorten line between MFC & chamber, reduce volume of delivery line ▪ Fluctuations can result from evaporation methods
Power does not come on when START button pressed	▪ Water flow too low	Check water flow on screen. Minimum of 2.5 l/min required
Anode circuit breaker trips when START button pressed	Rectifiers or power control devices faulty	Check & replace as necessary

Variable film properties, poor adhesion of metal films	▪ Beam not neutralised ▪ Gases contaminated	▪ Check neutralisation procedures ▪ Check for contamination
Plasma glow discharge in chamber, beam cannot be established	▪ Magnet may be de-magnetised. If ion source has been overheated, the magnet may be reduced in strength. This may occur if the magnet has been raised to above 120 °C ▪ Chamber pressure too high	Check magnet field strength and replace magnet or re-magnetise as appropriate. • Check source of high chamber pressure • Check pumping speed of high vacuum pump • Ensure that ion source electrical leads are not unnecessarily long
Filament life too short	Filament power set too high	Check proper operating parameters

If the above tips do not sufficiently answer your problem please contact Telemark for advice.