High-powered solutions for RF and microwave applications

OWNERS MANUAL

DELTA GLOW *INTEGRATED*™ *MODEL DGi*

HIGH ENERGY RF PLASMA SOURCE

Manitou Systems, Inc.
12 South Street
Danbury, CT 06810
Tel: 203-792-8797 • Fax: 203-792-7097
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WARNING Lethal RF and DC voltages are present in this system.

Only qualified personnel should install and service this equipment.

Prior to installation and operation of this system, this instruction manual should be consulted to ensure that the installation and operation are in accordance with **Manitou Systems'** recommendations.

Failure to properly install or operate this unit will result in voiding the equipment warranty.

This owner's manual is provided to enable the user to safely install, operate and service the equipment described.

Manitou Systems, Inc. reserves the right to make product changes and enhancements without notification or obligation.

For more information, please contact us at:

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Our web site address is www.manitousys.com

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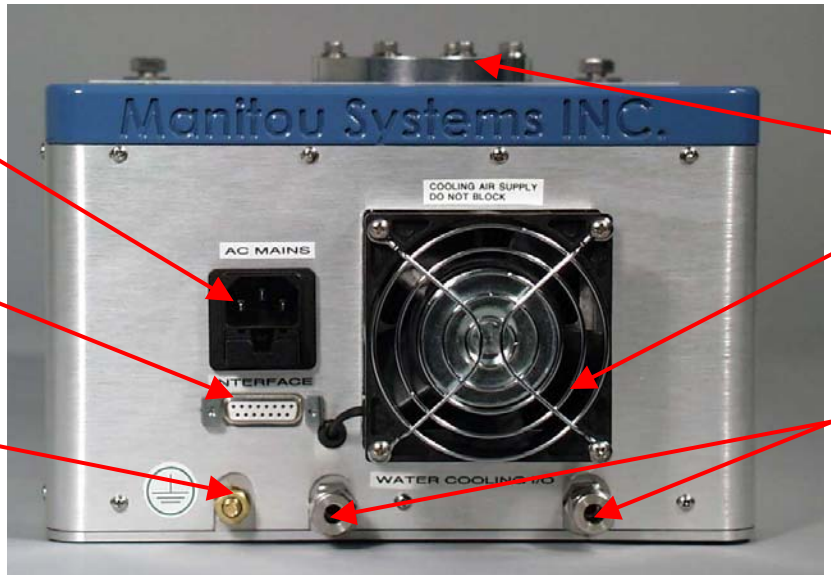
TABLE OF CONTENTS

Delta Glow *Integrated* ™ Quick Start Guide

The following short form information is designed to enable the advanced user of Manitou Systems, Inc. RF plasma source products to install and interface the hardware. Additional and detailed information will be found throughout this manual.

Delta Glow *Integrated* ™ Model DGi High Energy Plasma Source



AC Mains Input Connection 208VAC 50/60Hz

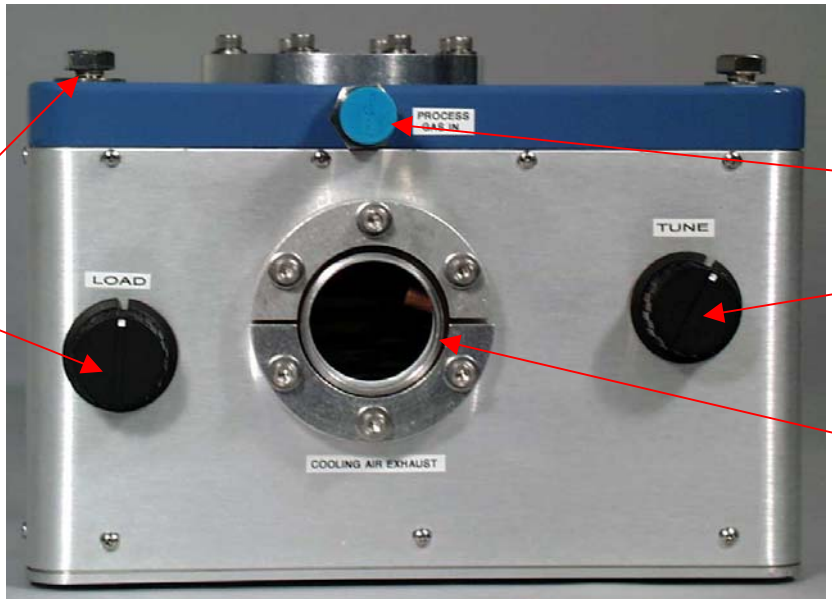
Control Interface Connection DB 15 Male

Chassis Ground Connection ¼-20 Threaded Stud

Upstream Process Tube Port / Blankoff KF-50

Cooling Fan (Supply Side)

Water Cooling Connection Points Swagelok



Upper Mounting Points (4 Places)

Plasma Matching "LOAD" Control

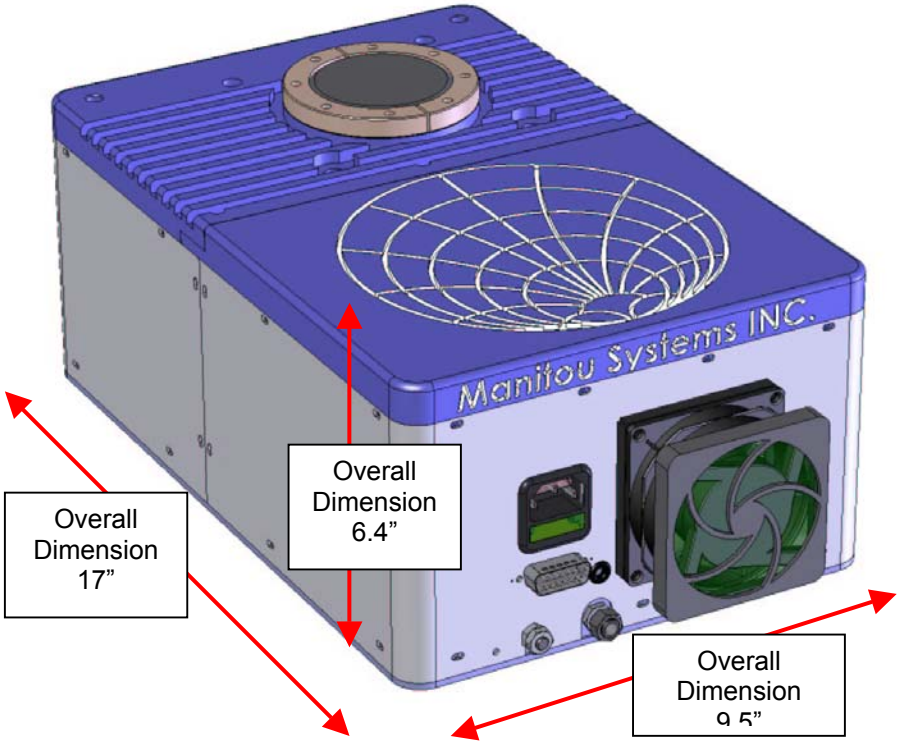
¼" VCR process gas input connection

Plasma Matching "TUNE" Control

KF40 Cooling Air Exhaust Port

Delta Glow *Integrated* ™ Model DGi High Energy Plasma Source

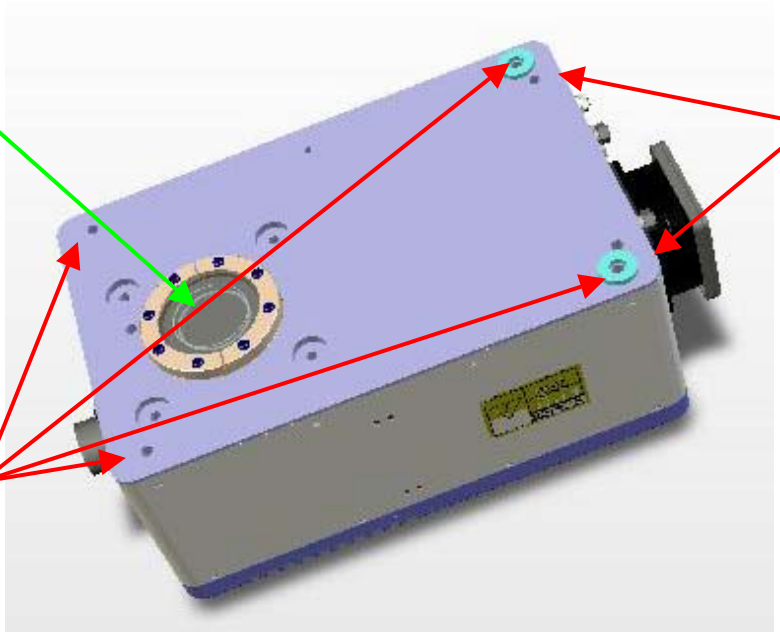
Dgi Overall Dimensions



Connection To Vacuum Process Chamber - KF50 Plasma Output Shown with KF50 bulkhead clamps

Use a KF50 nipple or direct connection using just a KF50 centering ring and spacer plate

Threaded Mounting Holes 3/8-16 X 0.75” Deep 4 Places



These two mounting holes illustrated with flat spacer washers – For use with KF-50 Spacer Plate

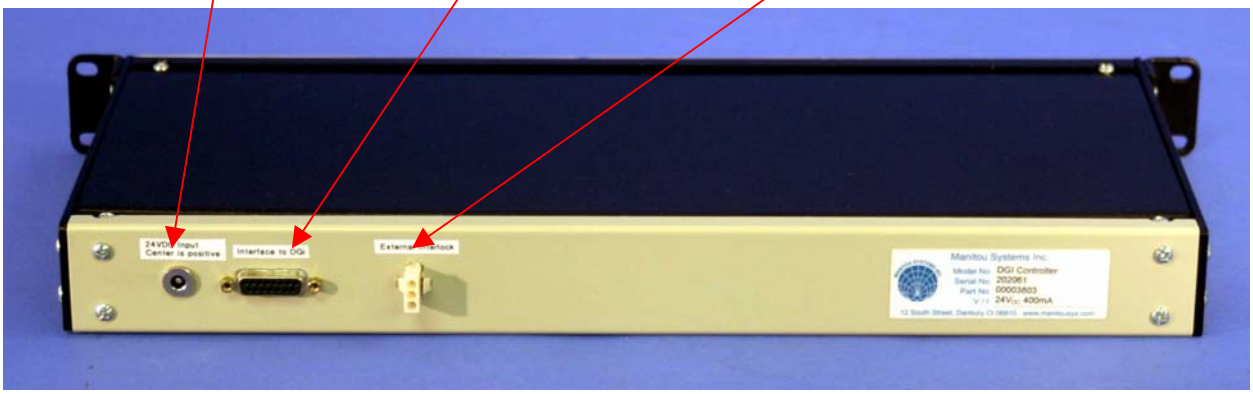
Delta Glow *Integrated* ™ Control Panel

Front side view

LED Indicators | Controls | LCD Meters

Rear side view

24VDC Power Input | DB15 Control Interface | External Interlock Connector



QUICK START GUIDE

Delta Glow *Integrated* ™ Mounting and Facilities Connection

1. Please un-pack all items and check all packages and their internal packing material upon receipt of shipment from Manitou Systems Inc. A complete list of included items is located in section 2.2 of this manual.

2. Physically mount the plasma source to the vacuum system port using the bottom KF50 downstream port and KF50 centering ring. Use the 3/8-16 threaded holes on the bottom plate and/or top plate to secure the source against a bracket.

3. Connect the ¼" diameter water cooling fittings to plastic hoses and then to an appropriate water source and return.

4. Connect the Cooling Air Exhaust to the user's house exhaust with a high temperature plastic, flexible hose. Use a KF40 half nipple and centering ring.

5. Connect the process gas input (¼" VCR fitting) to a regulated gas supply. Select the proper grade of gas for the application. The process gas can be controlled during plasma on time by using a solenoid-operated valve.

6. Connect a proper ground strap from the threaded brass stud to the process chamber / system ground point.

7. Connect the AC Mains input to a 208VAC, 8amp, 50/60Hz power source.

8. Mount the Control Panel in a 19" electronics rack.

9. Connect the DB15 control cable between the DGi and the Control Panel.

10. Connect the Interlock Shorting plug to the rear of the Control Panel. This plug comes from the factory with its wires shorted together (interlock satisfied). It is preferred that you connect the two wires to the plasma system interlock string so that these wires are "open" if there is a system fault – no vacuum in chamber, no cooling water flow, etc.

11. Connect the DC power input on the controller to the included 24 VDC wall power pack (or to a separate 400mA/24VDC power source).

12. Familiarize yourself with the use of the **Delta Glow *Integrated* ™** plasma source – additional information will be found in various sections of this manual.

13. Operate the Dgi.

1.1 GENERAL DESCRIPTION

The **Delta Glow *Integrated*** ™ plasma source is designed to generate a continuous dense gas plasma for use in thin film deposition, etching and material surface modification applications. A combination of proprietary plasma excitation circuitry and simple construction techniques enable the DGi to provide an economical and reliable high-energy, down stream plasma process engine.

The ***Delta Glow*** **Integrated** ™ system is furnished complete with it's own integrated RF power delivery system. Continuous wave (CW) operation is standard and pulse power operation is available upon request at time of order placement. The RF generator section utilizes proven push-pull RF amplifier topology that enables stable output into a dynamic plasma load and high reflected power conditions. A high current switch mode power supply module is employed to convert the AC mains power into the low voltage required by the RF amplifier while ensuring compliance with international standards.

The ***Delta Glow Integrated*** ™ control system is built around typical analog circuits and devices. This allows for accurate process control and active hardware management. Many internal operating parameters and all faults may be monitored and used for process control via the analog user interface port. All subsystems are designed to withstand the rigors of 100% duty cycle industrial environments with all electrical components selected to operate well within their typical ratings. Active thermal management coupled with tight control leads to an unparalleled MTBF rating.

This device is housed in a single compact enclosure designed to be mounted directly onto the vacuum process chamber. Rugged construction enables use in all industrial environments. All mechanical components are constructed from chemically treated aluminum and stainless steel. RF components are 100% silver-plated for enhanced conductivity. Dielectric parts are manufactured from virgin grade PTFE, ceramics or Ultem plastic.

1.1 GENERAL DESCRIPTION cont.

Vacuum chamber interfacing is accomplished through an industry standard NW-50 (KF50) vacuum flange treatment. Process gas enters the reactor tube via a ¼" VCR fitting. A secondary process gas inlet is available by replacing the KF50 blanking plate located on the top lid with one that has a fitting.

Standard reactor tubes are manufactured from quartz. Optional tubes are manufactured from alumina (ceramic) material. All vacuum seals are typically made from Viton – optional compounds include Calrez®. The process tube and sealing o-rings are the only consumables and are field replaceable. Some applications require the use of pass through process tube. This is possible by replacing the existing tube with a smaller diameter tube (<50mm) or by machining away the inner lip on the top plate.

Typical applications include vacuum chamber conditioning/cleaning, plasma enhanced chemical vapor deposition (PECVD), polymer material surface treatments, gas plasma studies, and in-situ enhancements of the thin film deposition process.

1.2 ICON EXPLANATIONS

WARNING is used only where an immediate hazard exists. When this word is used, immediate danger exists and special precautions are necessary to prevent possible injury, death or significant property damages.

CAUTION is used when unsafe operating or service practices could result in damage to the equipment.

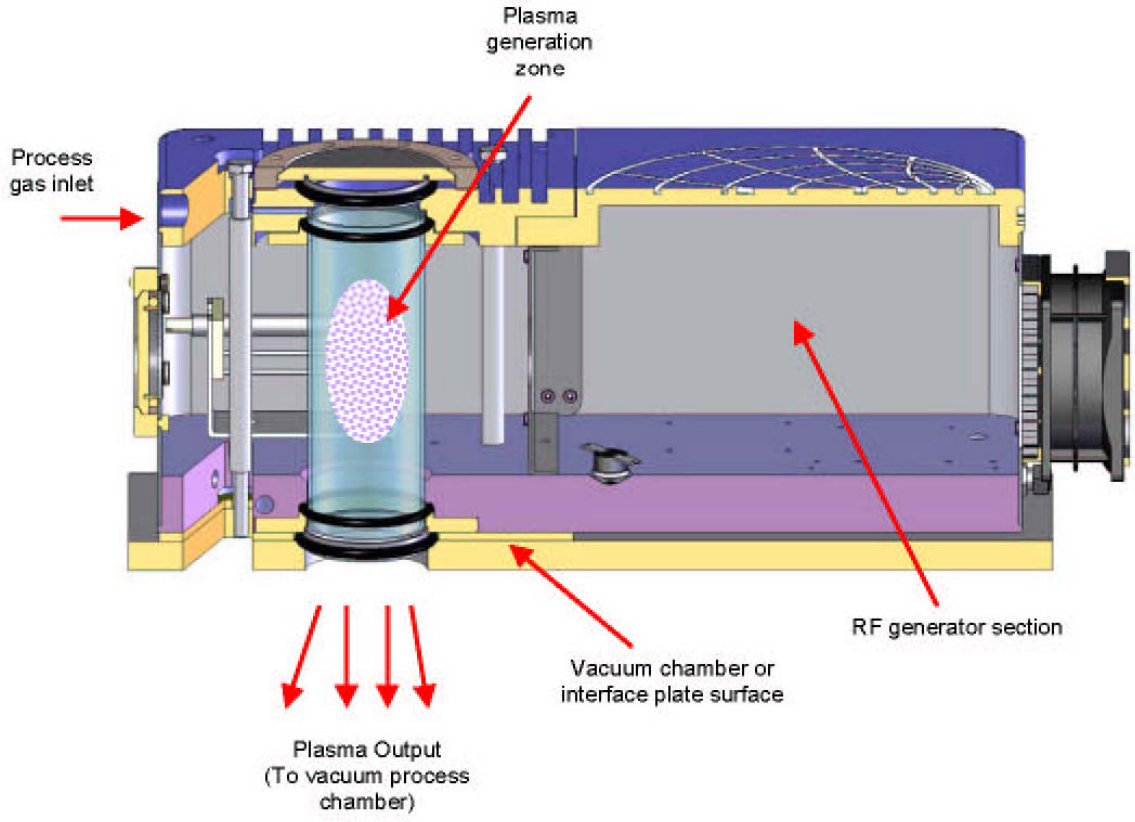
 This icon means "NOTE" or the information following should be mentally highlighted.

 The finger-pointing icon is used to indicate a procedure or step required before powering on the system.

1.3 MECHANICAL DESCRIPTION

The DGi plasma source module measures 17" L x 9.5" W x 6.4" H (overall dimensions). The source's base plate, top plates and compression rings are constructed from chemically treated (iridite process) aluminum. The plasma section front sheet metal cover is removable to provide access to the impedance matching network components for the initial matching set up.

The plasma section top lid is removable to enable servicing and replacement of the process tube. Two process tube compression rings and o-rings are employed to provide the vacuum seal. A 50mm diameter process tube is sealed (retained) into the top plate with one compression ring. The tube then passes through the bottom plate and is sealed with the 2nd compression ring. This captured tube provides containment for the plasma reaction.



1.3 MECHANICAL DESCRIPTION cont.

Ambient cooling air is drawn into the enclosure by the rear panel mounted fan. The cooling air is then forced into the plasma section and provides a turbulent flow around the process tube's diameter, through the antenna coil and then out of the enclosure through a hole in the plasma section sheet metal. The air passing through the enclosure transfers the radiated heat from the plasma process tube and the RF antenna coil out of the enclosure. The heated exhaust air exits through a KF40 fitting treatment on the sheet metal. The user's house exhaust will provide some suction to assist the flow through action.

Flow controlled process gas enters the plasma source upstream of the process tube through a ¼" VCR fitting located on the lip of the top lid perpendicular to the process tube. The process gas flows toward the outlet of the plasma source via the pressure differential created by the vacuum system pumps. Energized gas radicals are therefore carried out of the source and into the vacuum chamber.

RF power is delivered from the 600 watt on board RF power generator to the plasma source through the internal manually adjusted impedance matching network. A silver plated RF antenna coil is located inside the source body and used to transfer the electric field RF energy into the dielectric process tube. The antenna is self supported and centered using two standoffs.

The bottom plate is considered the plasma source output or exhaust. The dense plasma exits through the KF50 fitting treatment. The user may select a variety of methods, fittings and transitions to accommodate an installation on the vacuum chamber.

1.4 TECHNICAL SPECIFICATIONS

Delta Glow *Integrated* Plasma Source

Operating Frequency	13.56 MHz +/- .005%
RF Generator Output Power	600 watts (maximum) into a 50-ohm or tuned plasma load.
Reflected Power Tolerance	~14% of forward power or 75 watts (maximum)
Input Power	187-220 VAC, 50/60 Hz, 1 Phase, 8A, with ground. AC mains connector = IEC/EN 60320-1/C14.

1.4 TECHNICAL SPECIFICATIONS cont.

Output Impedance (of RF Generator)	50 ohms resistive
Output Connector (of RF Generator)	Type "BNC" female
RF Output Regulation Stability	+/- 1% of set point
External Interface Connector	D-Sub 15 male
Fuses (Mains)	2 each - 5 X 20 mm 8.0A located on power inlet
Fuses (DC)	2 each - PC type 5.0A located on the SMPS PCB inside the unit. Buss type FF PC-Tron
Plasma Duty Cycle	100%
RF output blanking capability	The RF generator section is capable of operating in pulse mode using an external function generator. This option must be specified at time of order placement. The maximum frequency range is 15Hz > 40KHz.
Process Gas Interface	¼" VCR male connector. Use ¼" diameter stainless steel tubing to connect the source to a flow meter/controller. Typical installations may include the use of bellows flex lines and/or welded 90-degree fittings to ease routing. A secondary gas input is available by replacing the existing KF50 blank off flange with one that has a VCR or Swagelok fitting.
Operating Environment	Maximum 90% relative humidity (non-condensing) & 5-40 degrees C ambient temperature.

1.4 TECHNICAL SPECIFICATIONS cont.

Forced Air Cooling	Forced air is utilized to cool the RF generator, process tube and antenna. The user's house exhaust pressure should be typically 5.08cm/2" of H^2O @ ~3 SCFM.
Water Cooling	Water cooling of the base plate. The nominal flow rate is 2 gal (7.6L)/ minute. The nominal temperature is 20 deg. C/68 deg. F $\pm$5 deg. The nominal pressure is 60-80 psig.
Vacuum Interface	The source's bottom plate is manufactured with a KF50 fitting treatment and bolt pattern to fit a mating flange using a centering ring and a pair of half clamps. The user is required to furnish these parts as well as the complementary transition fittings.
Matching Network Circuit Topology	Typical "L" configuration using variable shunt and series capacitors. Both variable capacitors include additional fixed ceramic capacitors placed in parallel to effectively increase the tuning range. The delivered impedance matching network may need adjustment (swapping of fixed capacitor values) to enable it to properly tune the plasma load impedance. The actual component values may change based on plasma process parameters.
Process Tube Type	50mm OD, 46mm ID, x 137.2mm long tube and Viton composition o-rings. An optional alumina tube and/or Calrez inert o-rings are available as replacement parts or as original equipment. (Please note that the maximum diameter of this tube at any point is 50mm.)
Process operating pressure	1 Micron to 10 Torr based on flow rates and process gas types.

1.4 TECHNICAL SPECIFICATIONS cont.

Physical mounting	Via the 3/8-16 threaded bolt holes – 2 on the top and 4 on the bottom plates.
DGi Actual Weight	31 lbs.
DGi Shipping Weight	34 lbs
Source Footprint	17" L x 9.5" W x 6.4" H

DGi Control Panel

Control Panel Actual Weight	3 lbs
Control Panel Shipping Weight (With DC supply & DB15 Cable)	8 lbs
Size	1RU (1.75" tall) X 19" W x 8" D
Metering	Two - 3.5 digit LCD displays for monitoring Forward & Reflected RF power.
LED Indicators	Five – For monitoring system activity & faults. Plasma ON, RF ON, Power ON, Temperature Fault, Interlock Fault
Input Power	24VDC @ 300mA via a 5.5/2.5mm DC power Jack
Controls	Mini toggle switch to turn RF Output ON & OFF, 10 Turn Pot to set RF Output level
Interface Connection	Type DB Female connector

1.5 SAFETY PRECAUTIONS

SAFE OPERATION IS THE RESPONSIBILITY OF THE USING ORGANIZATION AND IT'S PERSONNEL. READ THIS OWNERS MANUAL AND UNDERSTAND HOW TO AVOID HAZARDS PRIOR TO OPERATING THIS UNIT.

Your compliance with the following safety practices is expected:

1. Never work alone on live electrical circuits. You must be within sight or calling distance of another employee who has the following qualifications:

   A. Knows how to remove power from the equipment.
   B. Knows how to apply artificial respiration.
   C. Is acquainted with emergency procedures, first aid locations and the use of fire extinguishers.

2. Do not wear rings, wristwatches or other jewelry on your person while working on live electrical circuits.

3. Wear eye protection while working on live electrical circuitry where a flash might occur. **DO NOT WEAR CONTACT LENSES**.

   Because currents of 40 ma or greater across the chest can be fatal, read this manual to find out, before working on the equipment, how much current is present in each circuit. **BE EXTRA CAREFUL!**

4. Replace all safety shields after completing system setup, trouble shooting and maintenance procedures.

5. Immediately report to your supervisor any unsafe conditions that exist.

1.5 SAFETY PRECAUTIONS cont.

WARNING Proper use and safe operating practices with respect to this system are the responsibility of the user of this system. Manitou Systems, Inc. provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation and safety practices; take appropriate action to protect personnel and property from hardware failure. All personnel who work with or are exposed to this system must take precautions to protect themselves against possible serious and/or fatal bodily injury. **DO NOT** be careless around this system.

1.6 THEORY OF OPERATION

The Model DGi is a type ICP (induction coupled plasma) source designed to operate at a fixed frequency and efficiently couple RF energy into the plasma process tube. The **Delta Glow *integrated*** **TM** device is also known as a "down stream" reactor as the raw process gas that enters one end of the process tube is pumped through it's process tube to the main vacuum chamber as it is converted to active gas radicals. The reactive gas species is then used to perform various thin film process functions in the main vacuum chamber.

The internal manual impedance matching network enables the delivered RF energy (from the RF generator @ 50 ohms impedance) to be matched to the highly inductive characteristics of the plasma source. The manual matching network is sufficient as the plasma source is very well behaved operating into typically fixed process parameters.

These sources may be scaled up or down in physical size to accommodate different types of process applications. Manitou Systems offers additional models that can be used for both development and production applications.

1.7 APPLICATIONS

History of the Delta Glow™ product

The Model DG-300 (the original product) was originally developed for the purpose of enhancing an industrial low temperature CVD process. Delta Glow™ provided O_2 radicals necessary to react an HMDSO pre-cursor liquid and deposit a glass like barrier film (SIO_x) onto plastic substrates This thin film performance coating enhanced the substrate's surface by providing an oxygen barrier. The substrate material is used today in medical devices and food packaging. Since it's introduction in 1993, Delta Glow™ products have been used to enhance many different thin film processes.

1.7 APPLICATIONS cont.

Below, please find a list of applications for this product family:

- Deposition - Delta Glow can be used as the main plasma source reacting the process gas. Coupled with the proper diffusion plate, this apparatus comprises the source technology required to perform many CVD processes.
    - CVD – semiconductor
    - CVD – industrial low temperature CVD–deposition of $Si0^2$ films

- Reactive Sputter Deposition – These processes can be enhanced by the use of the Delta Glow to provide a source of energetic reactive process gas molecules onto the substrate's surface. These gas molecules easily combine with the material being sputtered to form dense reactive films.

- Etching - Delta Glow is employed to react a gas mixture for the purpose of etching a thin film structure on a semiconducting substrate.

- Cleaning Source – Using reactive gas chemistries the Delta Glow is typically used to clean vacuum process chambers in between process cycles and during process start up.
    - Industrial laser cavities
    - Semiconductor & Flat panel display CVD chambers – Using process chemistries Such As NF^3 & O^2

- Cleaning Source
    - Accessory To Vacuum Systems
        - Chamber Cleaning & Conditioning - Delta Glow provides an energetic plasma discharge to bombard the internal surfaces of a vacuum chamber with ions and electrons. The plasma stimulates and mobilizes water vapor while the vacuum pumping system provides the method for removal. The source can be used as a production tool to reduce initial pump-down times or installed as an OEM component to be used during every process cycle.
        - In Between Process Runs – load lock chambers - Faster Pump-down on New Chambers - Chamber Cleansing Between Process Cycles
        - Substrate Pre-clean & Condition
        - During pump down – Desorption of Water Vapor on Surfaces - Via Electron & Ion Bombardment
        - UV Activation

- Enhancement to Processes
    - O^2 Radical Generator

1.7 APPLICATIONS cont.

- Manufacturing tool
  - Newly Manufactured Chambers
  - Tool to ignite light bulbs – low sodium – consumer lamp testing

- Polymer Materials surface enhancements or modifications - Chemical Activation
  - Powder substrate surface treatments – The surfaces of powdered material can be treated to provide hydrophilic or hydrophobic properties by passing it through the plasma source's dense plasma region. The typical apparatus consists of a long, vertically mounted dielectric tube which is vacuum pumped at the bottom and has the substrate material introduced at the top end. Differential pumping techniques may be employed to ensure acceptable vacuum levels.
  - Polymer based medical devices such as catheter tubes can be treated to provide enhanced properties such as increased lubricity and cell growth adhesion. The material is processed by passing it through the center of the Delta Glow source. Vacuum chambers located on either side of plasma source contain the pay out and take up reels, pumping ports and process gas inlet.

- Polymer Materials surface enhancements or modifications - Chemical Activation
  - Plastic substrates such as automotive parts, medical devices, etc. can be plasma processed to provide better paint adhesion, gas barriers, and other properties that enable their use in specialized applications. The Delta Glow is used as the main plasma source (to provide energetic gas radicals) in conjunction with a secondary plasma source (to provide the substrate surface reaction and process uniformity across the substrate).

- Novel applications
  - Excitation of gaseous lamps – Delta Glow is used to excite electrodeless and conventional lamps during testing and as an industrial light source. These include mercury vapor and other specialized industrial lamps.
  - Exhaust Gas Abatement – Exhaust gas from many plasma processes can be post processed through the Delta Glow plasma source. The DG-300 is placed in-between the high vacuum pump and the process chamber. The rich plasma discharge is used as a secondary reaction to neutralize and abate the main process effluents.

- Benefits of ownership
  - Reduced Contamination In Deposited Films -The innovative new plasma sources improve the quality of thin films by reducing contaminants and deposited film inclusions.
  - Better Film Quality Control

1.8 WARRANTY DESCRIPTION

The Model DGi is covered under a limited warranty. Please note that the process tube and all o-ring seals are not covered as they are considered consumable items. Failure to follow proper installation and operational procedures will void this warranty. Additional details can be found in the Manitou Systems Inc. Standard Terms and Conditions form located on the Manitou Systems web site.

Manitou Systems Inc. warrants that all equipment manufactured by it shall be free from defects in materials and workmanship under normal use and service for a period of twelve (12) months from date of shipment. This warranty is subject to MSI's equipment being installed, maintained, and operated in accordance with this operating and maintenance instruction booklet. Warranty shall be void if MSI's equipment is modified by the CUSTOMER or used in other than recommended manner or applications. Purchased equipment incorporated into any item supplied by MSI will be covered by manufacturer's warranty.

The liability of MSI for any claims of CUSTOMER arising out of damages alleged to result from the use or failure of equipment provided by MSI shall be limited to the original invoice cost. MSI shall not be liable for latent defects or consequential damages.

This warranty is in lieu of all other warranties, express or implied including any implied warranty of fitness for a particular purpose to the extent that any implied warranty of merchantability is disclaimed.

The CUSTOMER may bring no action regardless of the form, arising out of the actions hereunder more than one (1) year after the cause of the action has occurred.

Repairs to equipment under warranty will be performed at MSI after determination that equipment is under warranty. CUSTOMER is responsible for all applicable shipping charges to and from MSI. CUSTOMER will obtain an RMA # prior to shipment of any equipment back to MSI. MSI has the right to invoice the CUSTOMER for all parts and services not covered under the warranty.

2.1 UNPACKING YOUR DGi SYSTEM

Remove the units from their packing and shipping materials. Inspect for any damage and contact **Manitou Systems** and the shipping company if any is found. Remember to take photos of the damage for use in communicating with the shipping company and for your documentation.

The DGi is shipped in it's own carton with its accessories. The Remote Control Panel is shipped in it's own carton with its accessories.

These products are shipped with plastic caps and plugs to protect the various RF and tube fittings. Remove these before installation and use.

2.2 SYSTEM COMPONENTS LIST

The following list details the included components in the **Delta Glow *integrated*** ™ package. Please check all packing material upon receipt of shipment from Manitou Systems Inc. Your Delta Glow package may include items which vary slightly from the list below so always verify the deliverable to the included packing list.

A. Standard DGi package includes:

- Model DGi plasma source.
- Mounting bolts & washers.
- Spare fuses.
- AC Mains cable with stripped ends (user to furnish plug).
- KF40 bulkhead clamp, hardware & centering ring for use on cooling air exhaust port (user to furnish a KF40 half nipple and hose).

B. Standard DGi Control Panel includes:

- DGi Control 19" Panel
- DB15 Shielded Cable
- Interlock Shorting plug
- DB15 Connector & Hood (for User interface)
- 24VDC Wall Mount Power Supply

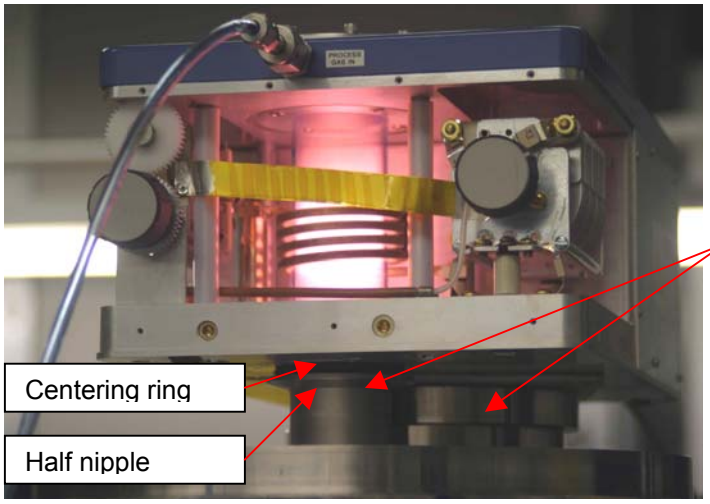
2.3 MECHANICAL INSTALLATION OF THE DGI

The Delta Glow Integrated can be mounted onto a vacuum process chamber using various methods.

A. Connection to a KF50 half nipple (on a vacuum chamber wall or flange)
B. Direct mounting onto a top plate or surface with a machined in KF50 seal treatment
C. Use of a pass through type process tube (all vacuum sealing done outside the DGi module

Please select your desired mounting method and then review the following images and drawings.

A. Connection to a KF50 half nipple (on a vacuum chamber wall or flange)



The image to the left shows a typical DGi under operation on a test stand at Manitou Systems. Its plasma section cover is removed and the tuning knobs re-installed to enable adjustment of the impedance matching network.

For this test, it is just sitting on the KF50 nipple while being supported horizontal on the rear using metal blocks.

In a typical user installation, the KF50 fitting will be secured with a bulkhead clamp and the metal blocks replaced by a bracket.

This mounting method will enable the user to connect the plasma output port to the vacuum chamber with a short (customer supplied) nipple. One side of the nipple will be a type KF50 and will connect to the DGi using a bulkhead clamp. The opposite end of the nipple will mate with the customer's vacuum chamber port – i.e., KF50, 2-3/4" CF or other fitting. This end of the nipple can also be directly welded to a flange or specific interface plate.

Please remember to allow enough space between the ends of the nipple to insert the 10-32 cap head screws into the bulkhead clamp. If the installation requires a tight clearance, the cap head screws can be replaced by hex head bolts. Use flat washers under each bolt head.

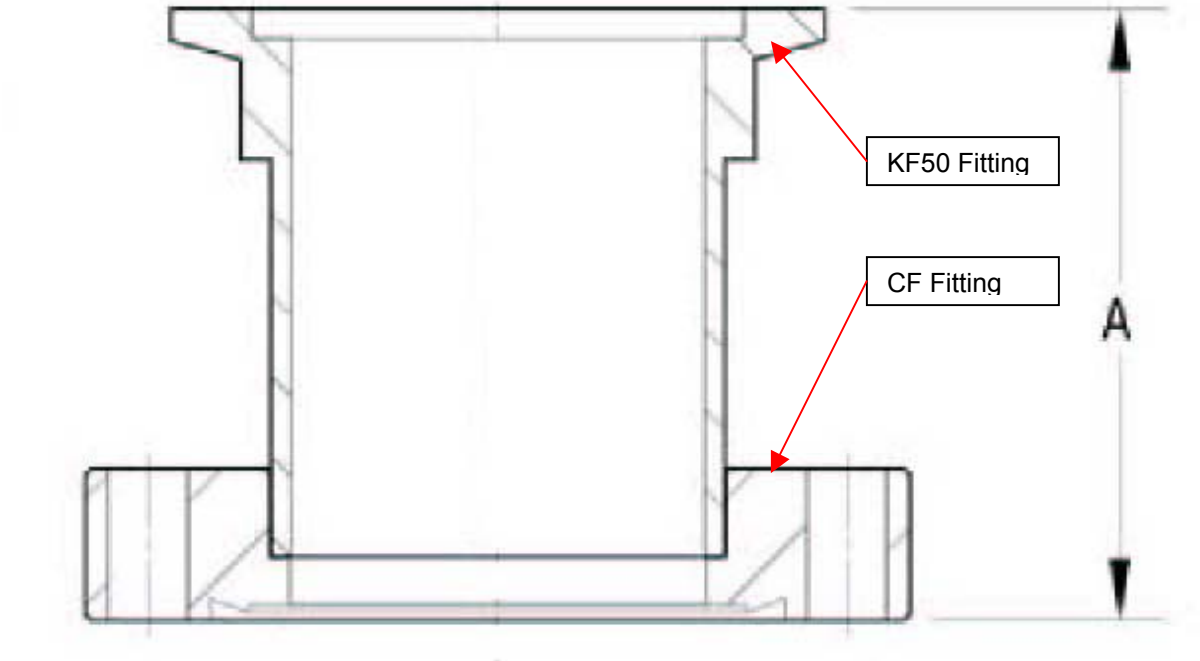
2.3 MECHANICAL INSTALLATION OF THE DGI cont.

A. Connection to a KF50 half nipple (on a vacuum chamber wall or flange)

Additional (customer supplied) brackets are required to support the DGi body. You may use one or more of the 3/8-16 X 0.75" deep, threaded holes located on the upper or lower body plates. There are two holes located on the corners of the top cover adjacent to the process tube blank off plate. Four additional holes are provided on the bottom plate at each corner. Four stainless steel flat washers are provided for use under the bolts.

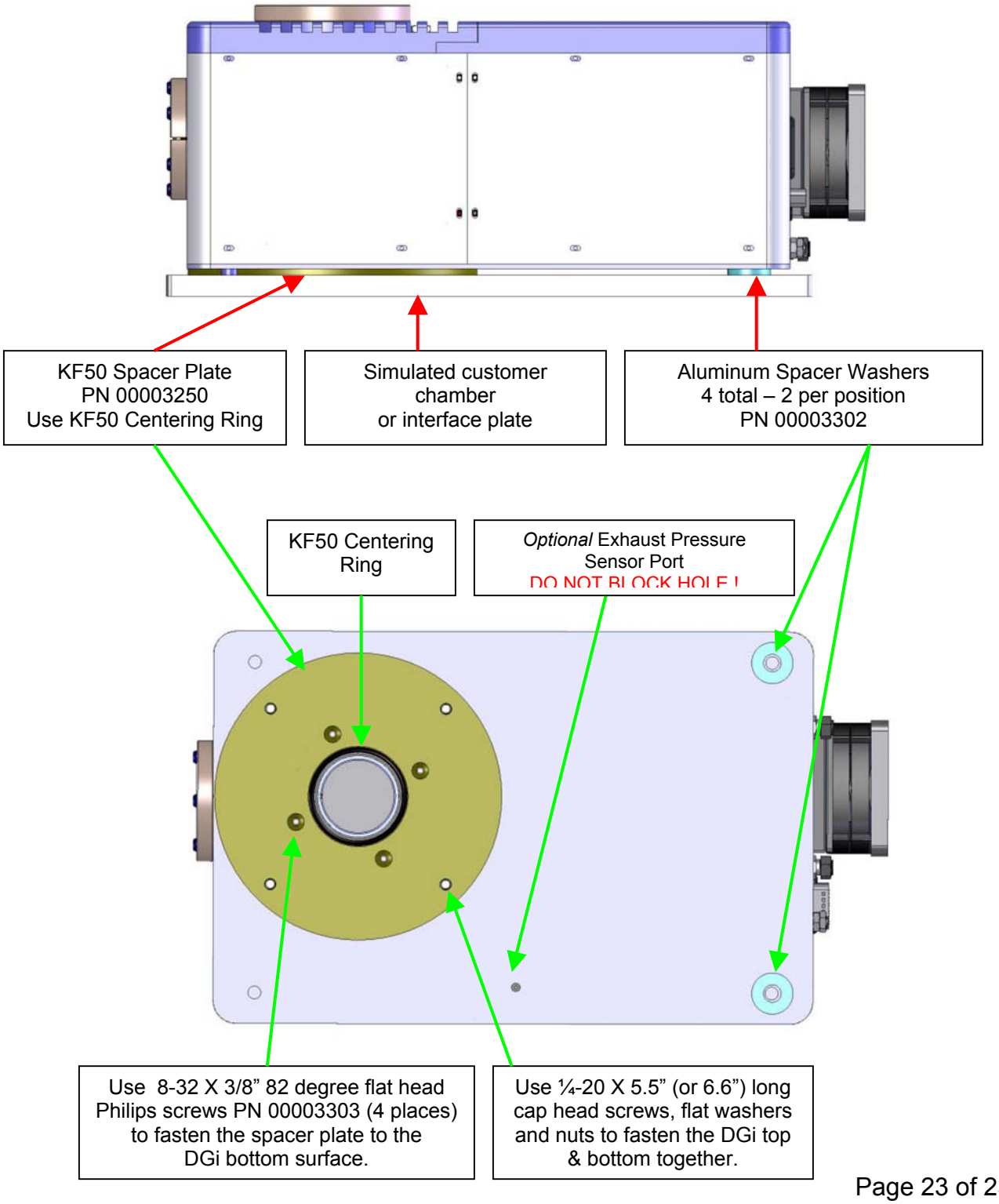
The image below represents a KF50 fitting welded to a Conflat type flange. The DGi would mount to the KF50 fitting while the Conflat flange can mate with another flange or be considered the vacuum chamber plate.

If the plasma process is to be performed in side a connecting vacuum chamber, it is recommended to mount the DGi as close as possible to that chamber.



2.3 MECHANICAL INSTALLATION OF THE DGI cont.

B. Direct mounting onto a top plate or surface with a machined in KF50 seal treatment



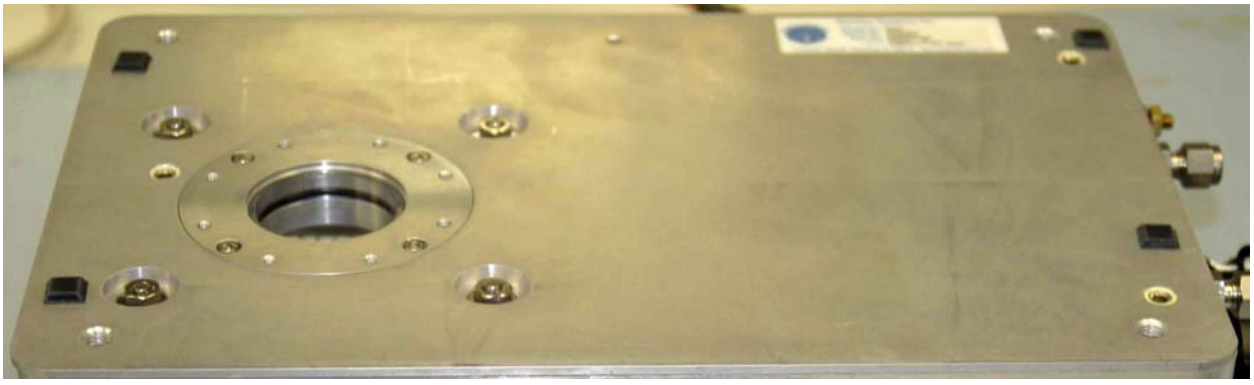
2.3 MECHANICAL INSTALLATION OF THE DGI cont.

B. Direct mounting onto a top plate or surface with a machined in KF50 seal treatment

This mounting method will enable the user to connect the plasma output port directly to the vacuum chamber with an *optional* aluminum spacer plate kit. With this mounting method, the user will prepare the vacuum chamber flange or interface surface with a machined treatment identical to a KF50 flange. A pattern of four ¼-20 blind threaded holes will also need to be placed around the KF50 sealing treatment. The DGi will then mate with the KF50 centering ring and be held in place by the compression of the long through bolts. The 6.5" X ¼-20 hex long through bolts will pass through the DGi body clamping the upper and lower surfaces together as well as clamping its body to the user's vacuum chamber interface plate.

Additional fastening and support of the DGi is always advised and can be accomplished through the use of specific brackets as described above. Please note that four 3/8" aluminum washers are used on the rear surface of the DGi to ensure parallel spacing to the vacuum interface plate. Note: the four 3/8-16 mounting holes on the bottom surface of the DGi can also be used with smooth locating studs (placed onto the vacuum interface plate) to aid in assembly.

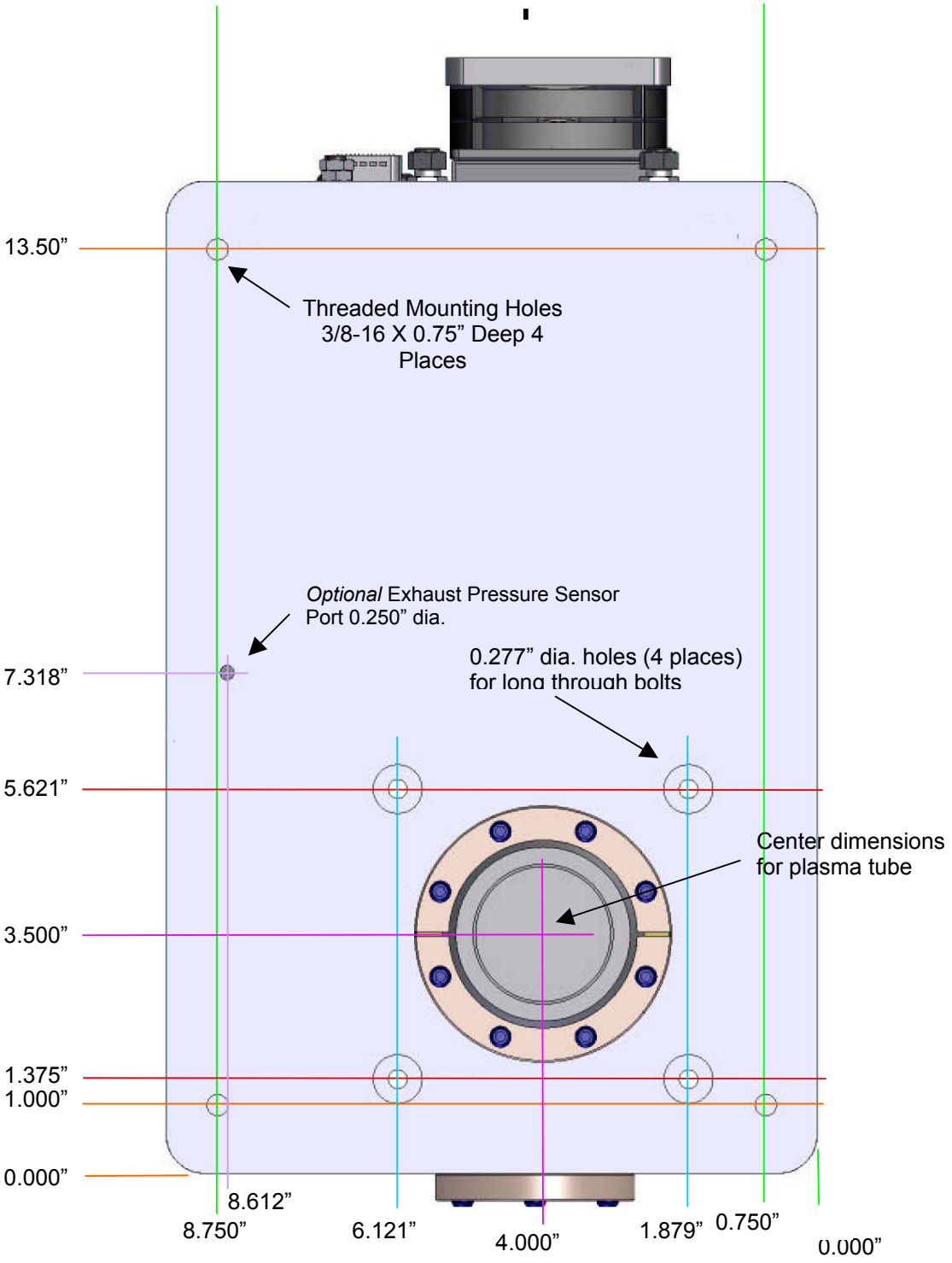
See images on following pages for specific dimensional mounting information.



The image above shows the actual DGi bottom plate as delivered from the factory

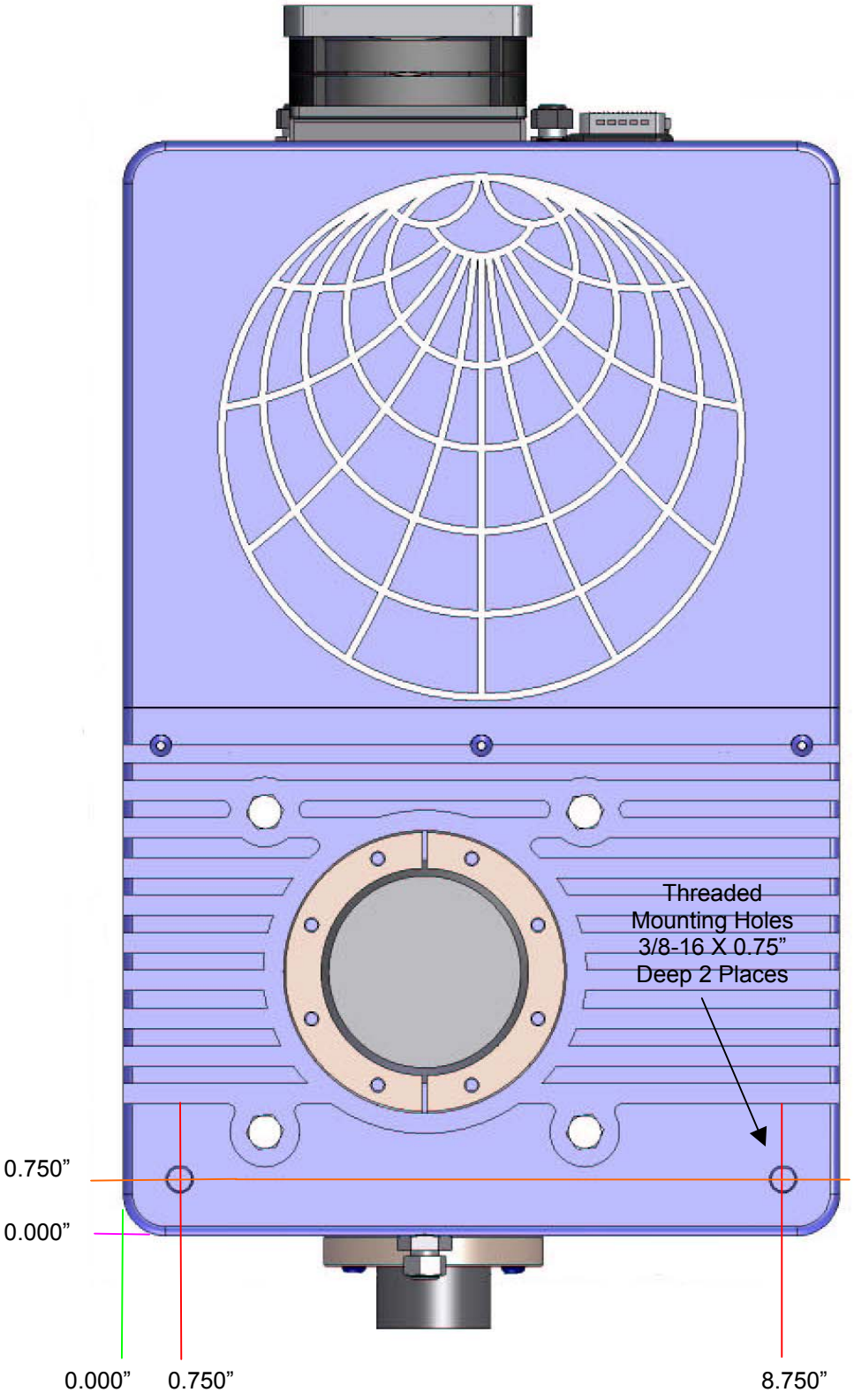
2.3 MECHANICAL INSTALLATION OF THE DGI cont.

Dgi Mounting Dimensions – Bottom Surface View



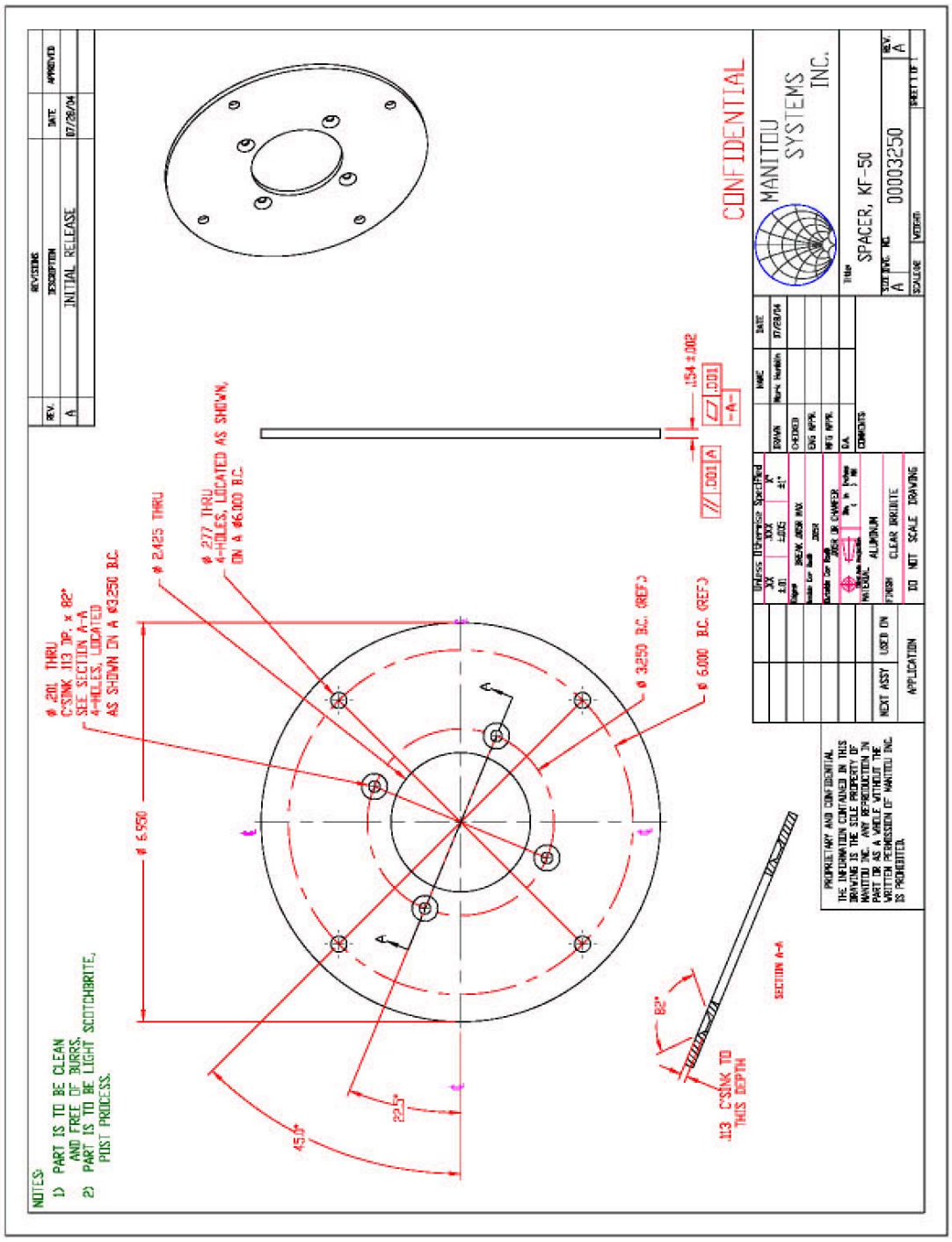
2.3 MECHANICAL INSTALLATION OF THE DGI cont.

Dgi Mounting Dimensions – Top Surface View



2.3 MECHANICAL INSTALLATION OF THE DGI cont.

Optional KF50 Spacer Plate



2.3 MECHANICAL INSTALLATION OF THE DGI

C. Use of a pass through type process tube (all vacuum sealing done outside the DGi module

This application of the DGi will enable the plasma discharge to be maintained in a user's process tube that is dimensionally longer than the length of the original tube (and longer than the DGi is high). The upstream connection to the process gas and the downstream connection to the vacuum pump (and process chamber if used) are done outside of the DGi enclosure. An easy way to approach this configuration is to use a process tube smaller than 50mm diameter and use o-ring sealed compression fittings at each end. Another method is to use a quartz tube of the original diameter dimensions (46mm ID x 50mm OD) and make it longer than the original 137.2mm length. This will enable it to protrude into the vacuum process chamber or connect with another type of vacuum interface.

If the DGi is to be employed in an R&D application where additional vacuum penetrations (up & down stream ends) are required, we suggest the use of KF50 type metallic or glass TEE or 4-way cross fittings. These are easily attached to the existing KF50 vacuum seals on the DGi and will enable instrumentation to be attached.

In any application, it is important that the DGi body is fastened using proper brackets and/or fabricated supports.

Please consult the factory before modifying the DGi body structure.

Please note that the use of non-standard process tube diameters may effect the ability to properly tune the plasma discharge. It may be required to modify the impedance matching component value(s) and/or the dimensions of the antenna coil.

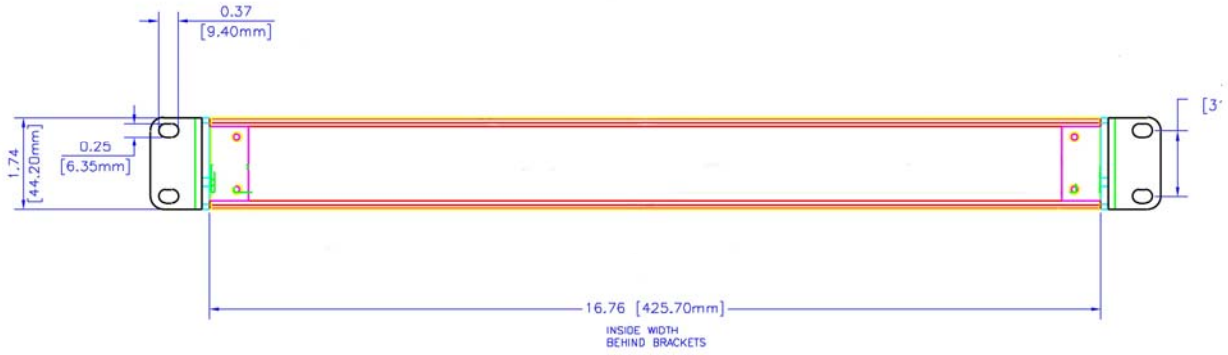
2.4 MECHANICAL INSTALLATION OF THE CONTROL PANEL

DGi Control Panel

1. The DGi Control Panel is built in a 1RU (1.75” tall) electronics rack mount enclosure. It is 8” deep.

2. Physically mount the unit is an electronics rack accessible to the operator. It is desirable to locate it near the plasma source as tuning the plasma requires viewing the reflected power meter.

Below is a drawing of the unit’s front panel mounting holes.



3. Connect the Control Panel to the DGi using the shielded DB15 cable. This cable may be extended or replaced by a longer one (up to 50’).

4. Connect the interlock shorting plug to the rear of the unit.

5. Connect the DC power supply to the unit.

2.5 ELECTRICAL AND FACILITIES INSTALLATION

The following installation steps will help understand how to connect the Model DGi to a plasma processing system. Please keep in mind that most RF System problems are directly related to the installation and grounding techniques that are employed.

- General information

WARNING Please review the following initial checkout procedure. Follow these steps prior to normal system operation.

1. The high voltage in this process system can cause instant electrocution upon contact or, under some circumstances, even close proximity to contact. Except as specified in this manual, never open the system covers or panels without disconnecting the AC input power at it's wall source and also attaching a grounding rod to the high voltage circuit.

2. The system's radio frequency power is transferred to the plasma source through a shielded components & cables. Harmonic RF energy generated in the plasma discharge and will radiate if the vacuum chamber is not well grounded. Install a low impedance ground strap between the chamber and matching network module & chamber and earth ground. This strap should be constructed from silver plated copper sheet. The width should be 1" to 2" wide X .020" thick. Keep these connections as short as possible.

3. Before operating the system for the first time, it is essential to insure that ground connections have been installed as specified that all interlocks are verified to be working properly, that all high voltage and RF carrying conductors are shielded from human contact. Every precaution must be taken to install and operate the system in accordance with this manual.

4. In a faulty circuit, operational voltages can be retained internally even after the source of the power is shut off. Always insure that all filter capacitors are discharged after disconnecting source power and before examination. Don't assume the power is off until it is checked.

5. If you must examine the system or it's AC source with the power on, have another person present, use the schematics, lock out any power that is not needed, and attach test meter leads **before** turning the power on. NEVER, UNDER ANY CIRCUMSTANCES, REACH INSIDE THE UNIT WITH THE POWER ON.

2.5 ELECTRICAL AND FACILITIES INSTALLATION cont.

6. Module Grounding

There are high RF circulating currents flowing through any given conductor connecting the matching network output to the plasma chamber even at low power operation. Current values of 5 to 30 amps are common as the real component of the plasma impedance is measured at 1 to 10 ohms.

At typical operating frequencies of 13.56 MHz, skin effects cause the RF current to flow on the conductor surface (~ 10-20 micrometers in depth). Improperly designed conductors will exhibit resistive power losses in addition to unwanted developed voltages across the conductor surface. Therefore, all RF carrying conductors should have a large surface area (i.e. wide strap – not a round dimensioned wire).

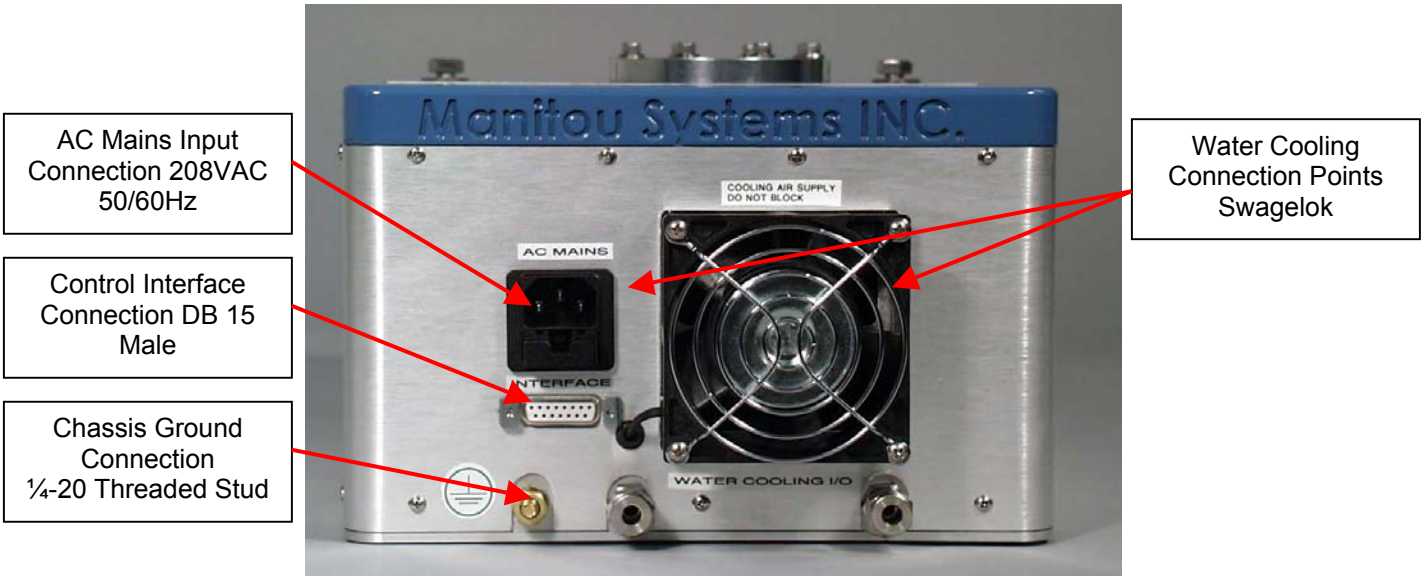
7. Cable Positioning

Dress all RF carrying cables away from all other control and sensor cables to eliminate the possibility of conducted electrical interference.

2.5 ELECTRICAL AND FACILITIES INSTALLATION cont.

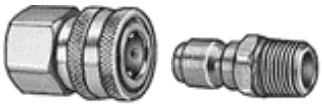
DGi Electrical and Facilities Installation

Once the DGi is mechanically installed, all electric and water connection can be connected.



1. Connect the DGi to a proper cooling water source and return. The water system should be free from particulates and biological materials. See the specification section for the water specification.

   Use ¼" diameter poly flow plastic tubing for this purpose. To make servicing easier, you may want to install (positive shutoff) quick disconnect connections and shutoff valves.



Typical quick connect fittings – please contact your supplier of tube fittings for available types.
We recommend the use of high flow/positive shutoff types.

2. Connect the DGi to a proper source of single-phase power rated at 208V 8A nominal. Use the included power cord.

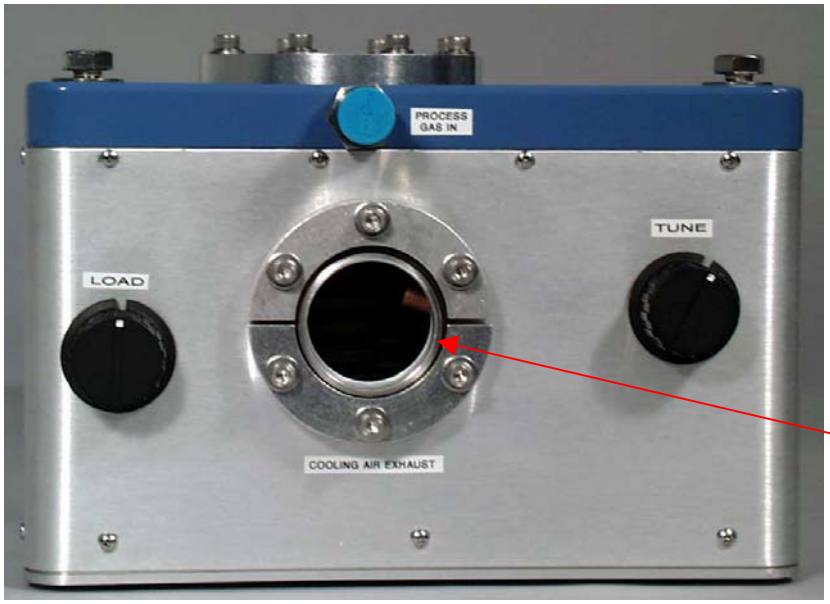
3. Connect a proper ground strap from the threaded brass stud to the vacuum chamber / system ground point.

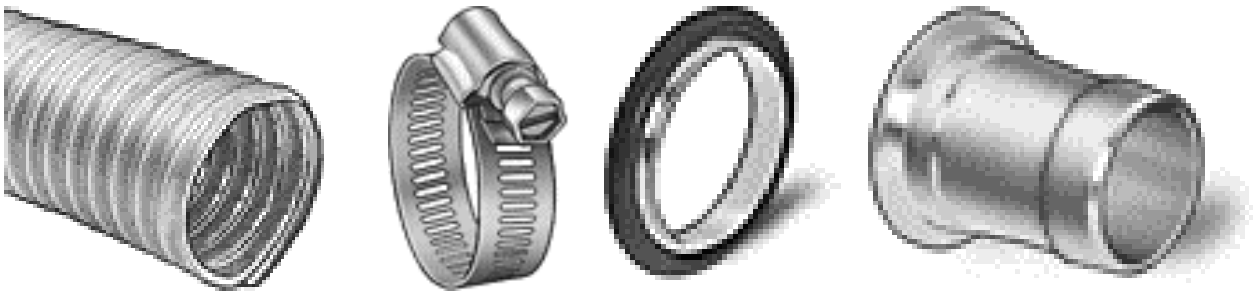
2.5 ELECTRICAL AND FACILITIES INSTALLATION cont.

4. Connect the unit's cooling air exhaust to a properly rated house exhaust system. Use a high temperature flexible plastic hose and a KF40 half nipple. See the specifications section for the details of the exhaust. The purpose of this exhaust is to remove the warm air and any generated ozone.

   A typical flexible hose has a rating of -20° to +150° F. It can be obtained from McMaster-Carr Supply Company. Their web address is: www.mcmaster.com. The hose part number is: 5500K32 and has a 1.5" inner diameter which is suitable to fit over a KF40 half nipple with a hose clamp to secure it.

   Please note that some installations may require the use of metal exhaust tubing based on the exhaust temperature and clean room installation location.

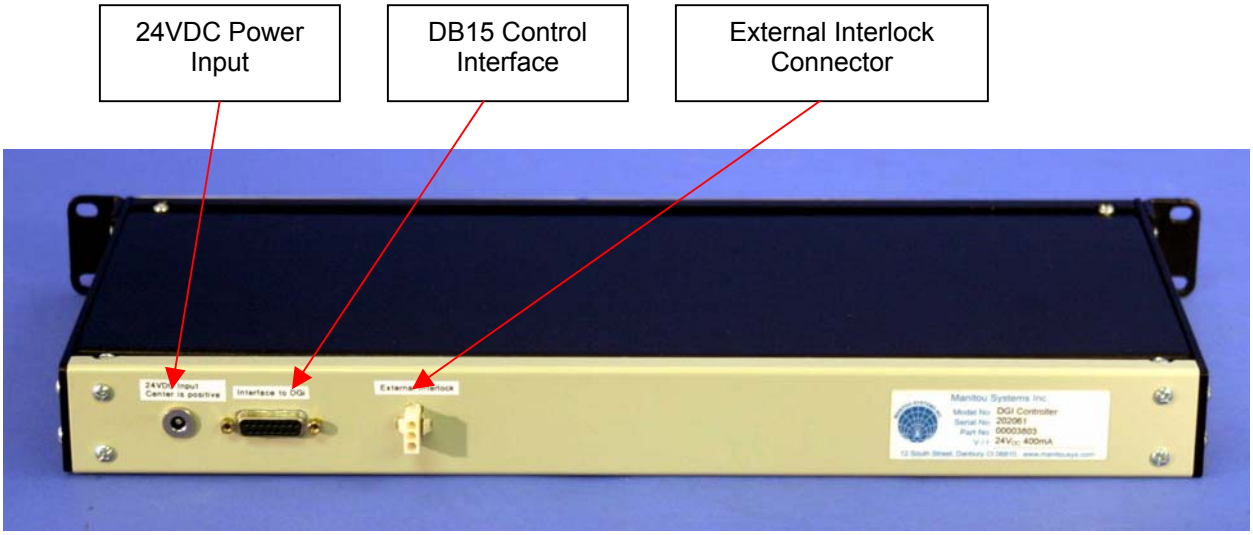




Typical exhaust hose treatment
Hose ----- Clamp ----- KF40 Centering Ring ----- KF40 Fitting

2.5 ELECTRICAL AND FACILITIES INSTALLATION cont.

DGi Control Panel Electrical Installation



1. Connect the DB15 control cable to the Interface position.

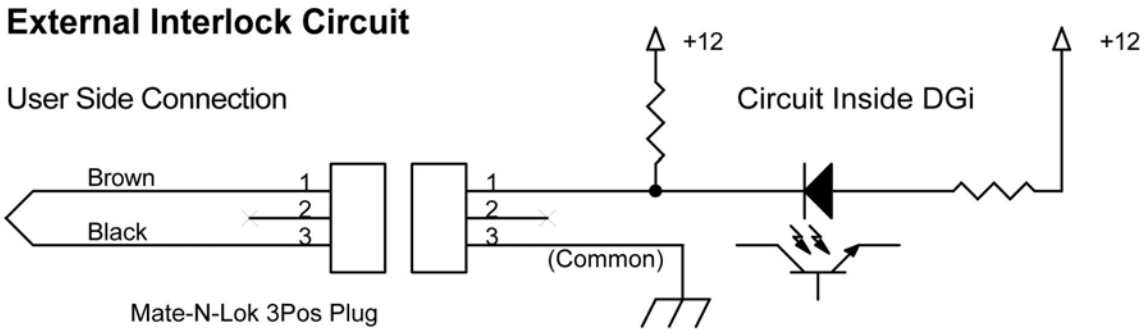
2. Connect the Interlock shorting plug to the proper position. The cable comes shorted together from the factory. It should be connected to a proper interlock system for safe operation of the equipment. This two wire interlock connector requires a contact closure from an outside source to satisfy the DGi circuit.

   If you wish to fabricate an application specific cable and connector, you should obtain the following parts:

   - 1 each AMP Mate-N-Lok plug P/N 172166-1
   - 2 each AMP Sockets P/N 770986-1 (for 22 – 26AWG wire)
   - Pin #1 on the plug connects to the DGi Interlock Input. This line is internally pulled high when the interlock circuit is NOT satisfied. When pulled low (to common), the interlock is satisfied.
   - Pin #2 is un-used
   - Pin #3 on the plug connects to the system common or chassis ground

2.5 ELECTRICAL AND FACILITIES INSTALLATION cont.

DGi Control Panel Electrical Installation



3. Connect the 24VDC wall power supply to the DC Power Jack. If you wish to wire this directly to a system level 24VDC control power supply, use a coaxial DC Power Plug 5.5mm OD X 2.5mm OD of center pin. This part can be obtained at Mouser Electronics P/N 1710-2521. The current draw for the Control Panel is ~300mA (maximum).

2.5 ELECTRICAL AND FACILITIES INSTALLATION cont.

Connecting Directly to the DGi Analog Interface

The User may elect to connect the DGi plasma source directly to a host computer or PLC type controller. If so, the rack mount controller will not be necessary. Always use a shielded, high quality cable for this connection.

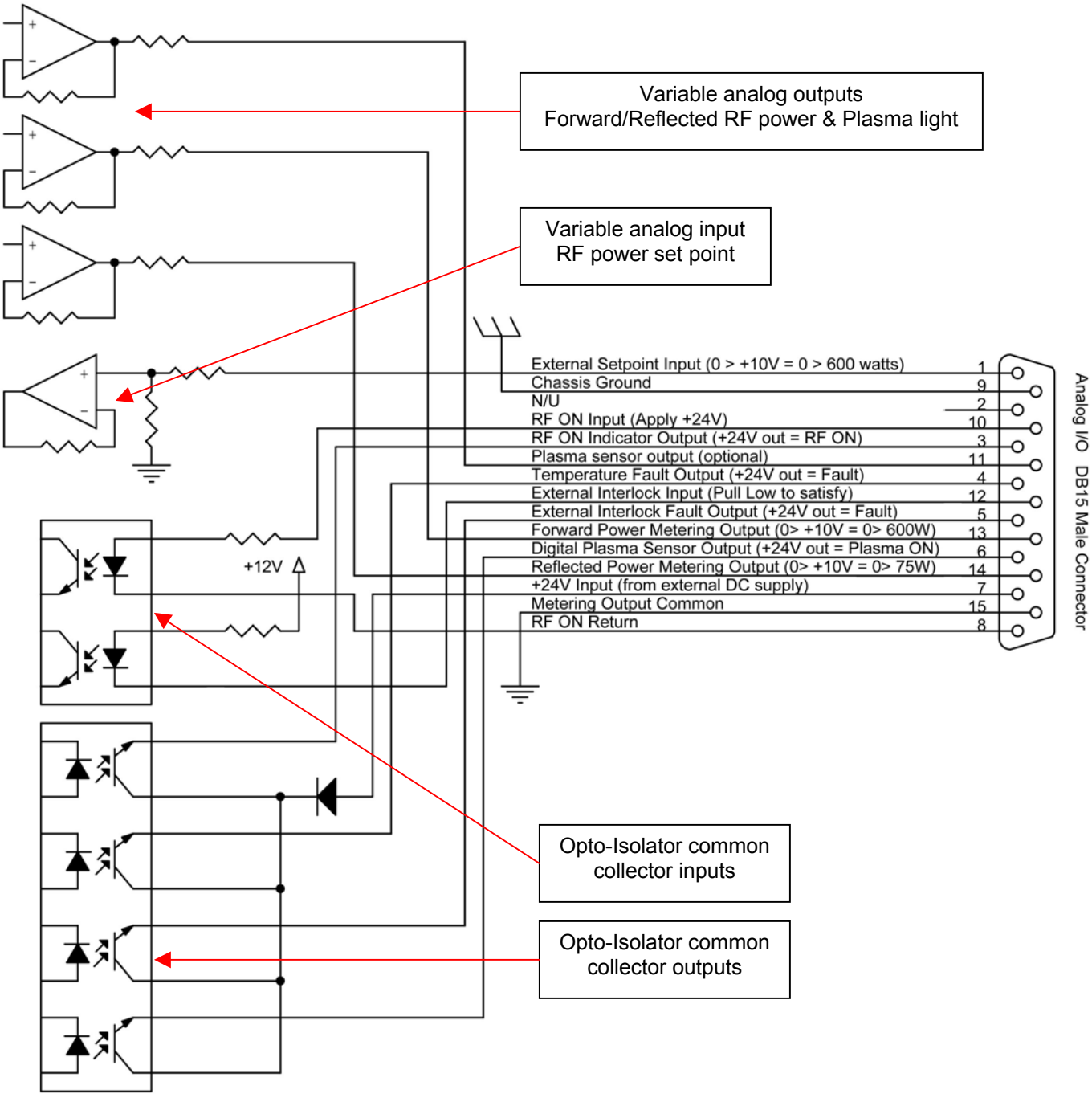
The DB15 male connector pin outs are as follows:

DGi Interface	DB15 Male Connector		
Pin #	Description	Type	Signal
1	External RF Output power set point	Input – analog	0 > +10 VDC
2	Not used		
3	RF ON indicator output (Note: this signal is on when RF output is ON + above 25 watts)	Output – digital	+24V out = RF is ON
4	Temperature Fault output	Output – digital	+24V out = Fault
5	External Interlock Fault output	Output – digital	+24V out = Fault
6	Plasma Sensor digital output (Note: this is part of an optional circuit)	Output – analog	+24V out = Plasma is ON
7	+24V control power supply input. Apply +24V from an external power supply to operate opto-isolators)	Power supply input	+24V
8	RF ON Return	Common	Return to RF ON driver
9	Chassis ground	Ground	Return for opto isolators
10	RF ON input	Input – digital	Apply +24V to turn RF output ON
11	Plasma Sensor analog output (Note: this is part of an optional circuit)	Output – analog	0 > +10 VDC = relative plasma intensity
12	External Interlock input	Input – digital	Pull low to satisfy
13	Forward Power metering output	Output – analog	0 > +10 VDC = 0 > 600 watts
14	Reflected Power metering output	Output – analog	0 > +10 VDC = 0 > 75 watts
15	Metering output common	Common	Meter return

2.5 ELECTRICAL AND FACILITIES INSTALLATION cont.

Connecting Directly to the DGi Analog Interface

Below, please find a schematic of the typical Analog I/O connector and internal circuitry used in the DGi.

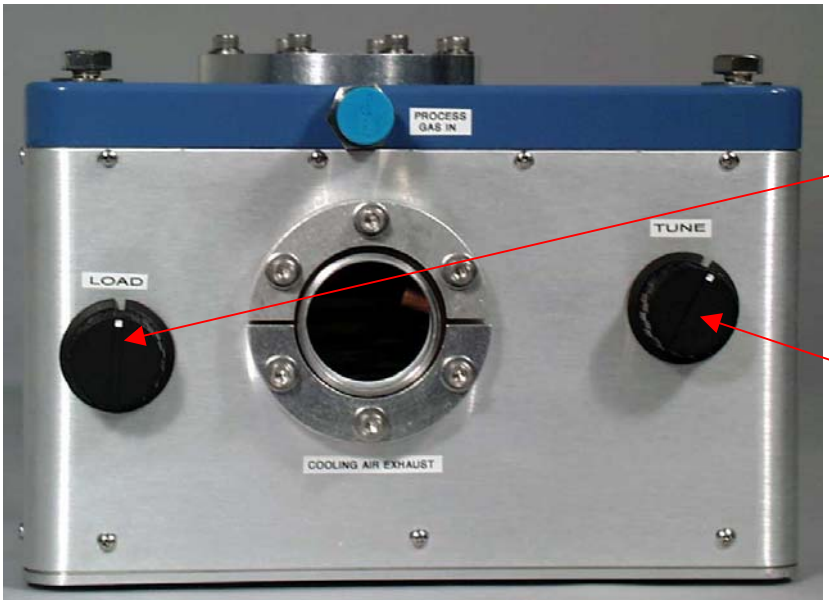


3.1 DELTA GLOW *INTEGRATED* OPERATION

This section describes the Delta Glow Integrated user controls and their function.

AC Mains Input
2 Fuses under this cover

Analog Control Interface to control panel or user's controller
DB 15 Male Connector



Plasma Matching "LOAD" Control
0 > 180 degrees of rotation =
0> 100% of range
6 O'clock = 0% 12 O'clock = 100%

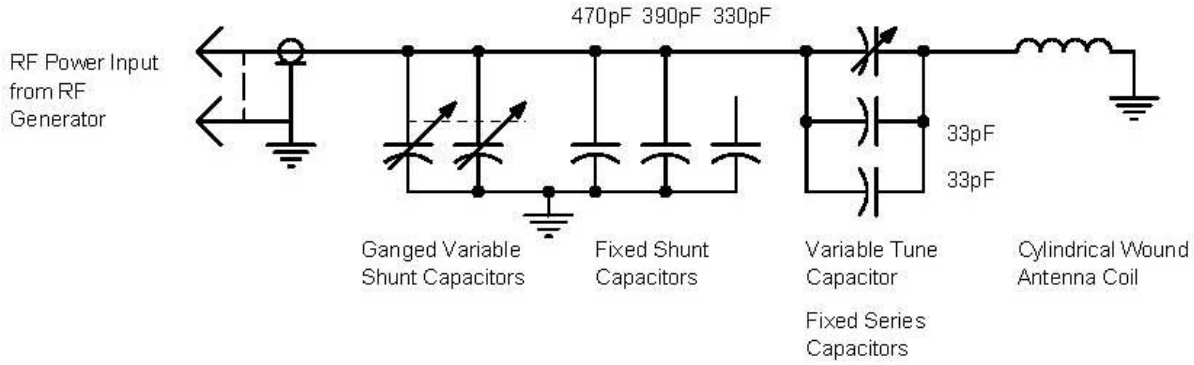
Plasma Matching "TUNE" Control
0 > 180 degrees of rotation =
0> 100% of range
6 O'clock = 0% 12 O'clock = 100%

3.1 DELTA GLOW *INTEGRATED* OPERATION cont.

The plasma **Load** and **Tune** controls are part of the integrated, manually adjusted impedance matching network. Its function is to provide a 50 ohm resistive impedance to the RF power generator module resulting in maximum RF power transfer to the antenna coil and plasma discharge.

The Load knob operates the load (or shunt) capacitor and the Tune knob operates the tune (or series) capacitor.

Plasma Matching Circuit

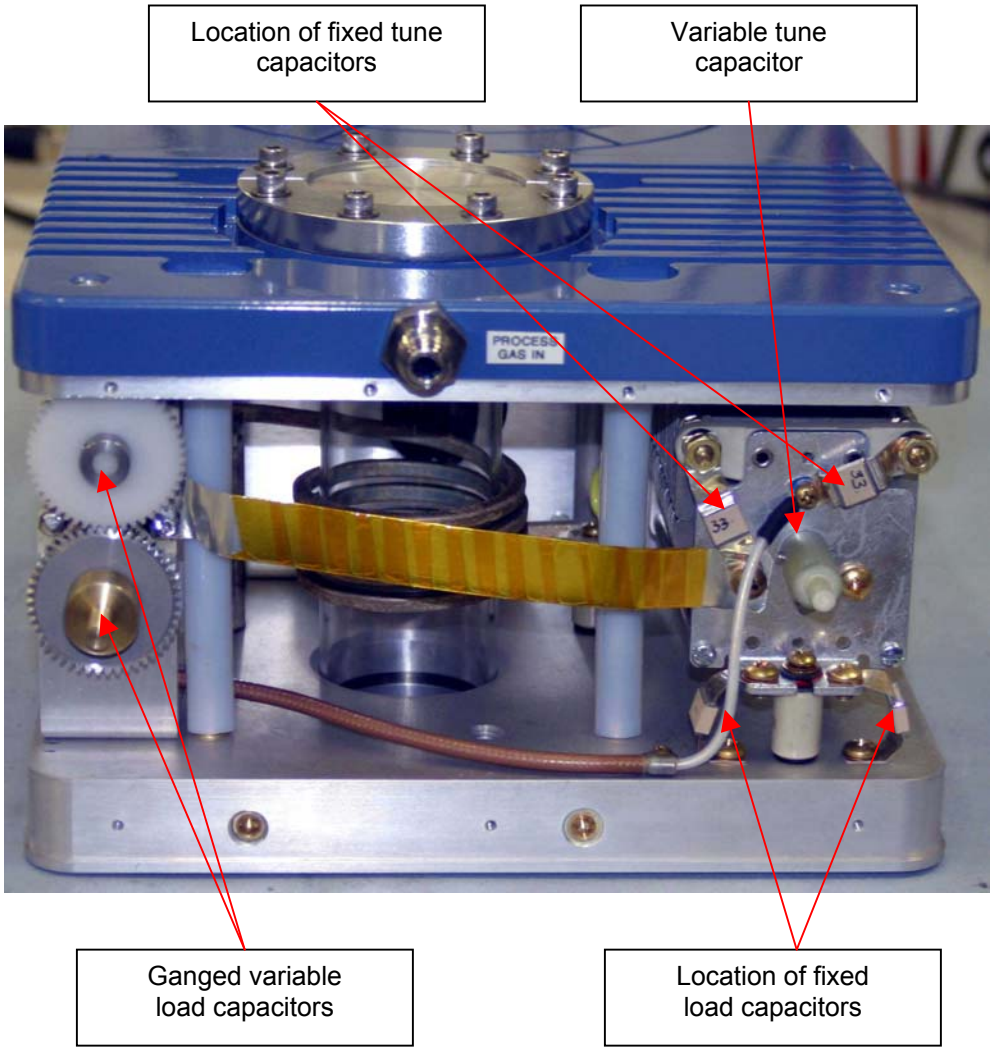


The DGI is delivered from the factory with various fixed capacitors installed as well as an additional fixed capacitor located in the accessories bag.

- Shunt capacitor location
  - 390pF and 470pF fixed shunt capacitors are installed and connected from the Tune capacitor to the base plate (ground). These are in effect in parallel with the ganged Shunt capacitors.
  - There is a 330pF capacitor connected at the ground (base plate) point but left disconnected at the “hot” end. It may be connected later to enable tuning of certain types of plasma loads.
- Series capacitor location
  - Two 33pF fixed capacitors are installed and connected across (in parallel with) the Tune capacitor.
- Note: The 100pF fixed capacitor in the accessory bag may be used to replace or combine with any of the shunt or series capacitors now connected.

3.1 DELTA GLOW *INTEGRATED* OPERATION cont.

Below, please find an image of the DGi Impedance Matching Section

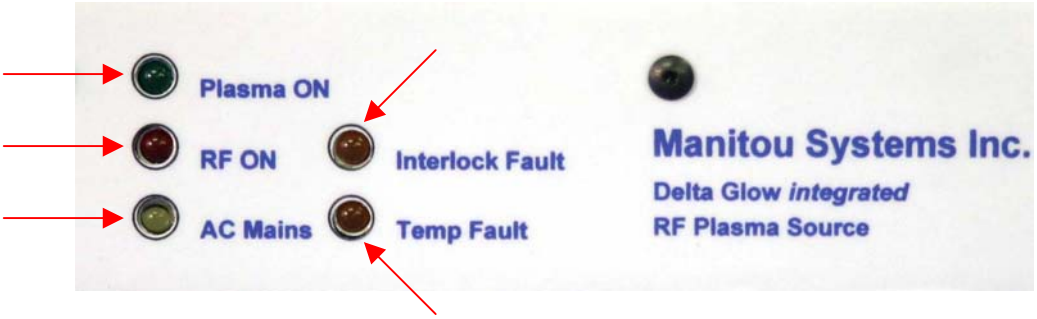


3.2 CONTROL PANEL OPERATION

Below, please find an image of the DGi Control Panel

The DGi Control Panel has various operator controls, displays and indicators. There are explanations below of each one.

- LED status indicators



- **Plasma ON** – Green - This *optional* indicator is driven by a photocell detector looking at the plasma discharge. It will light indicating the presence of the plasma discharge light.
- **RF ON** – Red – This indicator will light when the RF power is turned ON and is above a 25 watt threshold.
- **Power ON** – White – This indicator will light when an external source of 24VDC power is applied to the controller.
- **Temperature Fault** – Yellow – This indicator will light when the unit is in an over temperature condition.
- **Interlock Fault** – Yellow – This indicator will light when the External interlock is not satisfied.

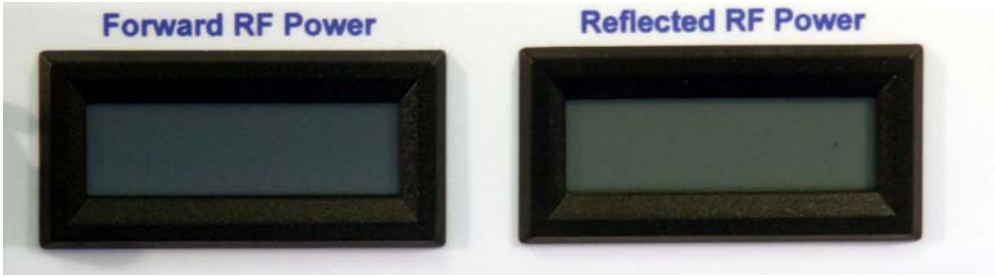
3.2 CONTROL PANEL OPERATION cont.

- Operator Controls

- **RF ON/OFF switch** – Mini toggle switch – This switch will turn the RF power to ON in the up position and to OFF in the down position.

- **Set point Potentiometer –** 10 turn control – This control will linearly set the RF power output from 0 > 600 watts.

- Metering



- **Forward RF Power** – 3.5 Digits – This meter will display the actual Forward RF power being delivered to the plasma.

- **Reflected RF Power** - 3.5 Digits – This meter will display the actual Reflected RF power being returned to the plasma. It is an indication of the impedance matching quality. A lower value = a better plasma match.

3.3 PRELIMINARY SETTINGS

Prior to turning on the AC Main Power and RF Output Power we recommend presetting the controls to the following:

A. RF Power set point to 0.00 watts
B. RF ON/OFF to OFF
C. Impedance matching network controls (Load & Tune) pre-set to 50% or mid range positions.

☞ Ensure that the electrical cables, exhaust hose and cooling water lines are properly connected (and leak free).

3.4 PRELIMINARY CHECKS BEFORE STARTING THE PLASMA

✎ Prior to turning the RF Power ON, preset and stabilize all process parameters such as vacuum chamber pressure and process gas flow.

☞ Ensure that all electrical connections and system grounds are tight. Plug in AC Mains power cord.

☞ Turn on the AC mains power to the DGi and Control Panel.

3.5 STARTING THE PLASMA

Turn ON the RF Power (on the control panel). Raise the RF Power Output control (turn C.W.) so that ~50 watts of FORWARD RF power is being delivered to the plasma source.

Adjust the matching network's Tune capacitor (right hand control) either way off of the 50% setting until the glow discharge starts. You can visually see the plasma discharge by looking into the vacuum chamber view port or by looking through the cooling fan on the rear of the DGi cabinet. (A mirror may assist in the initial set up of the unit or simply remove the front sheet metal cover for access to the plasma section.)

Once the plasma ignites, the reflected power reading will reduce to a stable level. During this initial setup, the reflected power value may actually be equal to the forward value (50wF = 50wR). If this is the case, then the Load and Tune controls will need to be independently adjusted to lower the reflected power value. This is an iterative process with the Tune control being most sensitive and the Load control exhibiting a broader response to adjustment.

3.5 STARTING THE PLASMA cont.

The user will be able to adjust the Load and Tune controls to obtain an operational reflected power below 1% of the indicated forward power.

Please note that sometimes the best match is not optimal for re-ignition of the plasma discharge. If the RF is turned OFF and then turned back ON for the next cycle and does not ignite (Reflected power is at the 75 watt maximum point and the Forward power is limited to ~ 75>100 watts), you will need to adjust the Tune control CCW slightly to re-ignite. The optimal Tune control setting will be located somewhere in between the lowest Reflected power position and the re-ignition position. It is OK to operate the unit with a reflected power value of up to 10% (of the forward value). If the reflected vale reaches the limit, the Forward value will fold back to protect the RF power circuits.

Remember to log the Tune and Load positions into a notebook for future reference. It is a good idea to also include all process parameters as well as other related information.

Now, the power can be raised to the desired process power. A small amount of adjustment will be necessary to reduce the reflected power value at the actual (higher) process power set point. Note these positions.

The DGI has a well-behaved plasma load and will not require constant adjustments if the process is well defined and controlled during each cycle. Re-adjustment will be required if the process parameters change either during the cycle or from cycle to cycle.

The following section is provided to assist with basic troubleshooting of the DGi plasma source.

4.1 Frequently Asked Questions

The FAQs described below are based on real problems encountered during the commissioning and use of the DGi and its related OEM versions. Please feel free to submit your experiences with this product so that this manual and the web page can continue to grow as a technical resource for user base.

1. Why won't my DGi power up?
    - Is the unit connected to the correct (187>240VAC) AC mains voltage? If other voltages are applied, the internal circuits will not operate correctly.
    - Is this circuit actually live?
    - Are the fuses OK? The DGi uses an IEC (HP) type AC mains input module. This module includes a filter and fuses.
2. Why doesn't the Forward power reach 100% or set point? Or, why does the Forward value drop over time?
    - This condition suggests that the reflected power has risen to the maximum safe operating value where it then reduces the forward power back to a safe operating level.
    - Creeping reflected power may be caused by a change in the impedance matching set point resulting from a change in the process parameters - i.e. chamber pressure, gas flow or gas composition. Verify that these remain stable.
    - A few questions to ask yourself while troubleshooting:
        - How long does it take for the forward power to drop below its set point? Please note the value of both the Forward & Reflected power values.
        - Is the reflected power rising at the same time?
        - At what value is the reflected power upon the start of the process?
        - The fix may be to re-adjust the Tune and Load controls to a minimum value after the run has started so the drift will remain in the safe RF power operating window.
        - Has the reflected power properly minimized upon installation and commissioning?

4.1 Frequently Asked Questions cont.

3. Why is there an interlock fault ?

    - The external interlock switch contacts (located on the control panel) may be open. This circuit is closed when satisfied. The opto-isolated output is then pulled high in an un-satisfied condition. (Pin #5 on the DB15 I/O connector) causing the fault condition.

4. Why can't the Reflected power be tuned to zero watts?

    - Have you tried adjusting the "Plasma Tuning" control?
    - Have any process parameters changed since the last time the unit was operated? These include chamber pressure, process gas type, DGi gas injection type and gas flow rates. Also verify the pumping speed is the same as before.
    - If this is a new installation, have all process parameters and sensors been calibrated and tested?
    - If the unit was disassembled for any reason, has the antenna coil mounting and spacing been disturbed?
    - If all attempts are made to reduce the Reflected power to zero (or close to zero) watts, then the impedance matching circuit element values may require tweaking. See the following section.

5. Why won't the plasma ignite?

    - This condition can be caused by many sub-systems in the process system. We suggest that you verify that the AC mains and control cables are properly connected. Is there a Forward and Reflected RF power reading being displayed on the control panel displays? If so, the problem may be located somewhere in the matching network section or plasma source and include failed matching network components (typically capacitors), disconnected (internal) RF cable or, open circuit condition on the antenna coil.
    - Likely problems located after the DGi are typically the preset process conditions in the vacuum system - pressure, process gas flow & and gas composition.

6. How do I change this process tube and O-ring set?

    - Refer to the next section (Maintenance).

4.1 Frequently Asked Questions cont.

7. What is the Reflected power fold back point?

    - The reflected power fold back setting is 75 watts. This means that the RF generator section will produce its maximum Forward power until 75 watts reflected is reached and then the forward power will start to fold back protecting the RF power section.

4.2 Plasma Source

WARNING Most operational problems result from vacuum or process gas system failures. Be sure to inspect the vacuum process system first! Never turn ON the RF power above 50 watts upon commissioning or if a problem is suspected!

1. Plasma discharge will not ignite

    Is the control panel properly connected and powered up?
    Is the AC mains power connected and turned ON?
    Is the RF ON & indicating forward power?
    Is the vacuum level correct?
    Is the process gas supply turned ON and flowing?

2. Plasma discharge ignites but the reflected power is not reduced to a level of below 1% (of the forward power)

    Is the matching network properly adjusted?
    Is it possible to reduce the reflected power to a level lower than the forward power but not below 1% (and the capacitor positions are at their maximum or minimum)? The *fixed* component values in the matching network section may need to be adjusted. See the next section.

3. The DGI body heats up excessively

    Is the cooling fan operating properly?
    Is the cooling air inlet plugged up?
    Is the exhaust hose connected and operational with the proper vacuum level?

4.2 Plasma Source

4. The DGi may operate normally at a very low power input but operation at higher power results in little or no plasma discharge and high reflected power

    - The antenna assembly may have become damaged and is arcing internally. This will be evident by removing the plasma section sheet metal cover and inspecting. A telltale black carbon residue will be noticeable between the antenna coil and the body or the process tube. Factory service is required.
    - The antenna coil may also arc in the event that debris or excessive moisture has entered the source body.

5. Why is there is a smell of ozone in the room?

    - The DGi (when using a quartz process tube) will oxidize the air in the plasma section around the process tube. If the exhaust air flow (vacuum) is not present or the flow is too low, this will cause the buildup of ozone.

6. The DGi looses vacuum integrity

    - Perform a helium leak check on the source. The problem is usually limited to a cracked process tube or defective o-ring seals.
    - Ensure that the proper tube and seal material is specified for the current process chemistry. Note: Fluorine based chemistries will consume Viton seals & quartz process tubes. We suggest the use of Kalrez seals and an Alumina process tube.

4.3 IMPEDANCE MATCHING NETWORK SECTION

The impedance matching network section enables the complex plasma impedance to be matched to the output of the RF generator section. We ship the DGi with specific fixed capacitor values installed in the unit.

As the DGi may be used with many different plasma process gas types, flow rates and pressures we suggest that the unit is first tried with a non reactive gas such as argon and then commissioned with the desired process gas. It is important to obtain a data benchmark for the DGi operating on *your* process system. The information below will guide the user through the commissioning process.

Please note that different plasma operating pressures and gas compositions will cause different tuning positions on the network. Keep a log of these parameters so when they change, corrective action can be taken based on known previous information.

If the DGi ***will*** ignite the plasma discharge and only partially match the plasma load and the variable Load & Tune capacitors have been adjusted between their end stops with no possible match point please record the typical process parameters and capacitor positions (and fixed installed values) for use in discussions with the factory if necessary and follow the next steps.

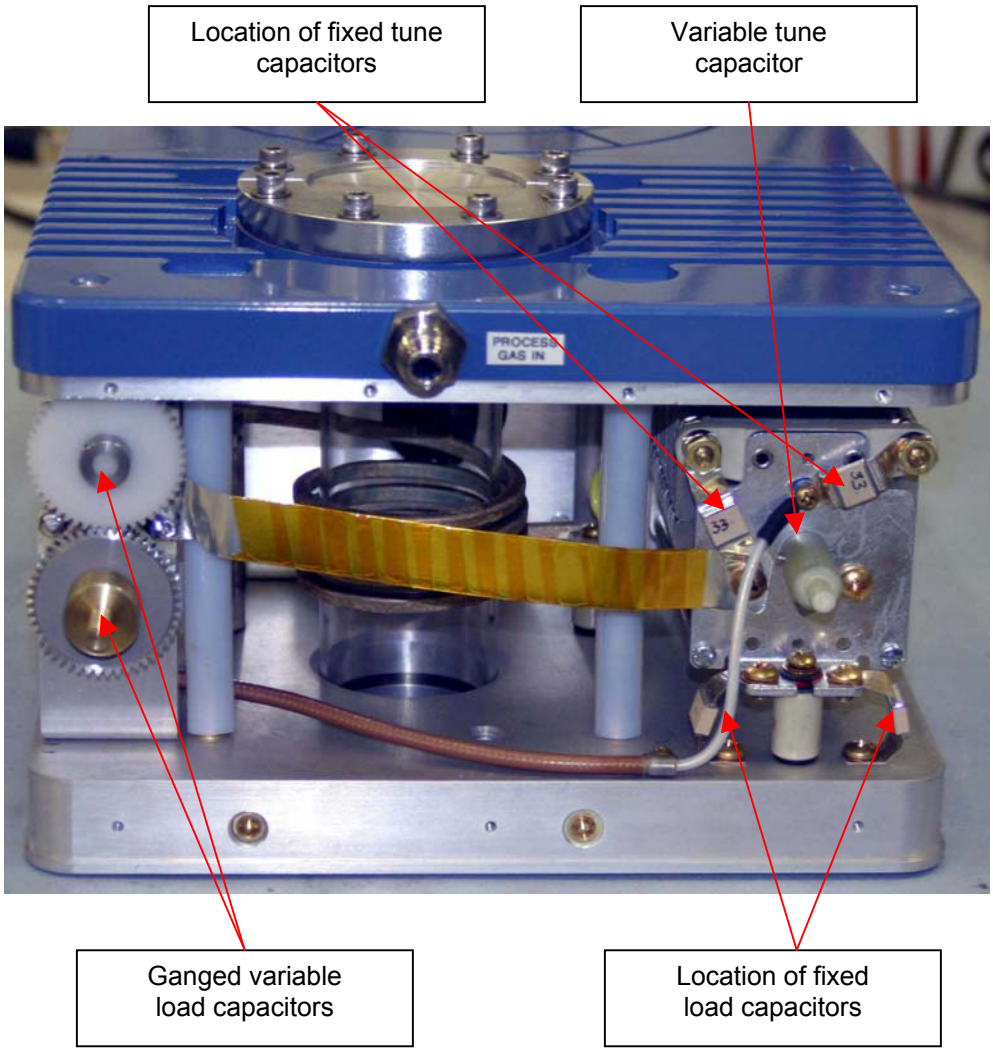
- If the Load capacitor is at the maximum (100%) capacity position, it is likely that an additional (or larger value) fixed shunt capacitor may be required.

- If the Load capacitor is at the minimum capacity position (0%), it is likely that a smaller value fixed shunt capacitor (or no ***fixed*** shunt capacitor) may be required.

- If the Tune capacitor acts as the Load capacitor (described above) then the fixed tune capacitor values may need to be adjusted.

4.3 IMPEDANCE MATCHING NETWORK SECTION cont.

The image below shows the location of the Load and Tune fixed capacitors.



4.4 Contacting Manitou Systems for help troubleshooting a problem

Please have the answers to these questions handy:

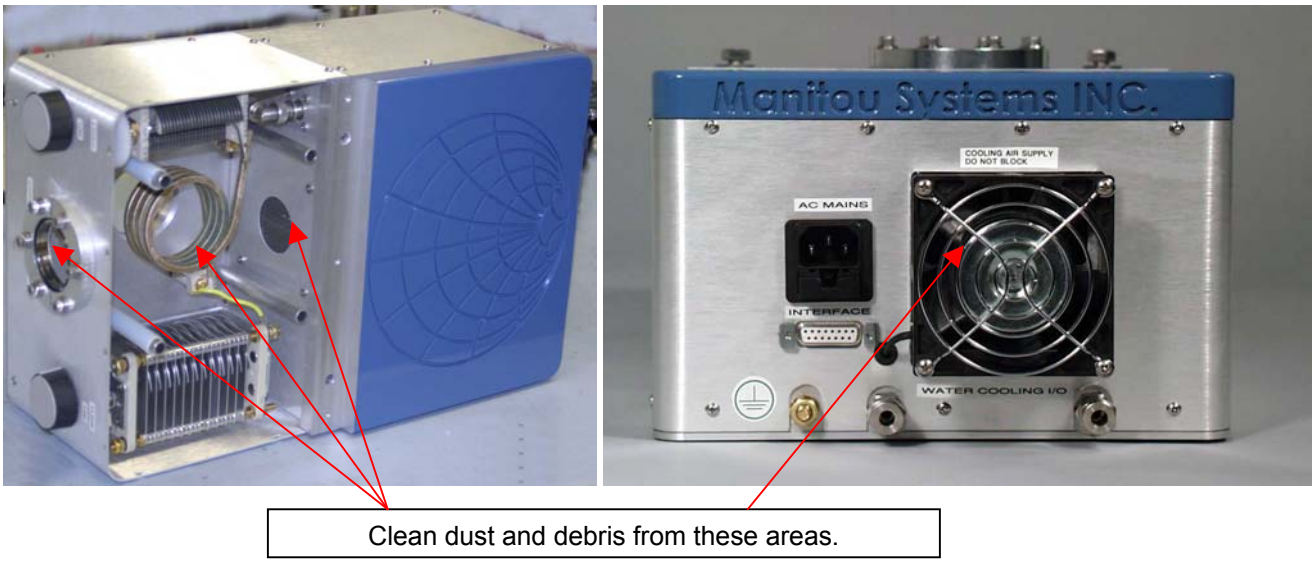
- Product serial number
- Has the system worked in the current configuration and with the current operational parameters before? (Ie, is this a problem that has suddenly cropped up in a previously working system, or a new system or process?) If the system was previously functioning, has anything changed? (The replacement of a process gas bottle or a sputter target, for example.)
- What about the process? Has something changed ?
- What is the nature of the problem? (Lack of plasma ignition, inability to tune out reflected power, etc..) If tuning is an issue and plasma can be established, note and record the position of the tuning capacitor when the load is tuned to minimum reflected power.
- Are input fuses on the device blown?
- Is the external user interlock satisfied?

5.1 CLEANING OF DEBRIS

After continued use, the DGi will build up dust and debris around the cooling air supply, internal divider through hole locations and the exhaust fan.

NOTE: Collected dust and debris around the capacitors and inductor will likely cause arcing (especially in humid environments).

To clean these areas, the user will need to remove the plasma section sheet metal and the RF generator section top lid.



Use a vacuum cleaner with a soft brush attachment to gently remove the dust build up from these areas.

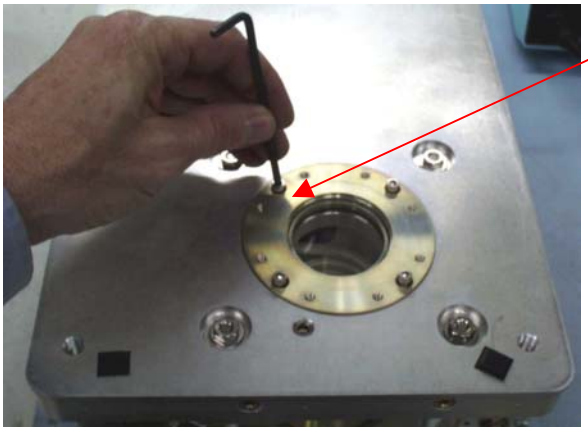
If the system is used in a very dusty location, the top cover may be removed to facilitate the cleaning of the interior components (tuning capacitors). Use dry compressed air (less than 20 psi) to loosen and blow out the dust.

5.2 REPLACEMENT OF PROCESS TUBE AND O-RINGS

During normal operation of the DGI, the process tube and sealing o-rings may need replacement. The period between service will vary based on operating parameters including power level, process gas type, pressure level, tube and o-ring types, etc. The following section will explain how to properly dissemble the source, replace the process tube and o-rings and re-assemble to unit.

CAUTION – Exercise extreme caution if the process chemistry and resultant contamination is considered hazardous to human health!

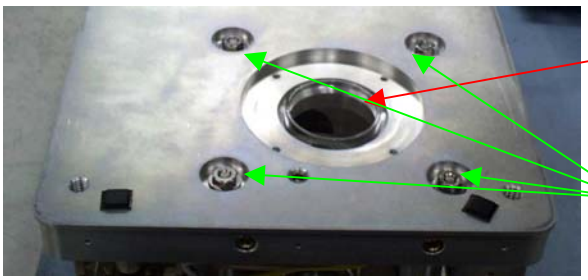
It is assumed that the DGI is removed from the vacuum process chamber and is on a workbench. Use the images below as guides for the disassembly and re-assembly process.



Use an Allen driver to remove the four cap head Allen screws from the lower sealing disk.

Remove the compression ring using one of the KF50 clamp screws inserted into ring as a “handle”.

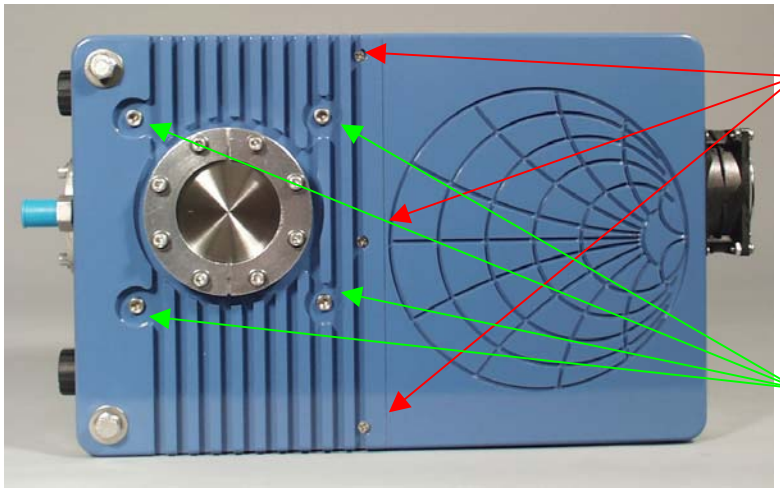
Now remove the o-ring using a non-metallic pick to separate the o-ring from the process tube. The o-ring may be melted against the tube so perform this task carefully as to not break the tube.



Bottom surface of DGi without o-ring and compression ring.

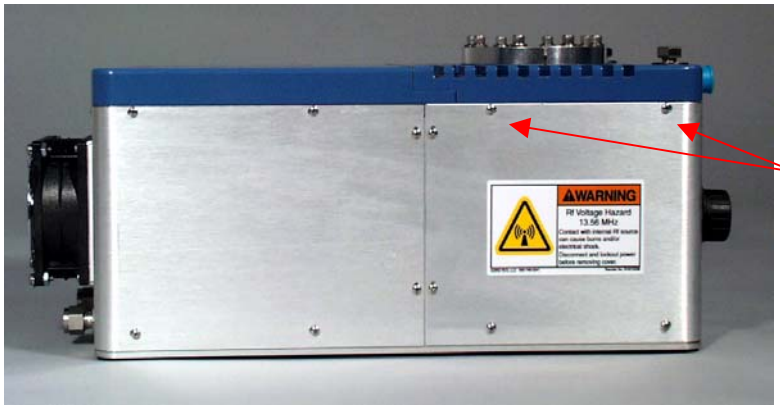
Remove these four ¼-20 nuts. See next image and use a hex wrench on the top side and a 7/16” socket wrench on the bottom side.

5.2 REPLACEMENT OF PROCESS TUBE AND O-RINGS



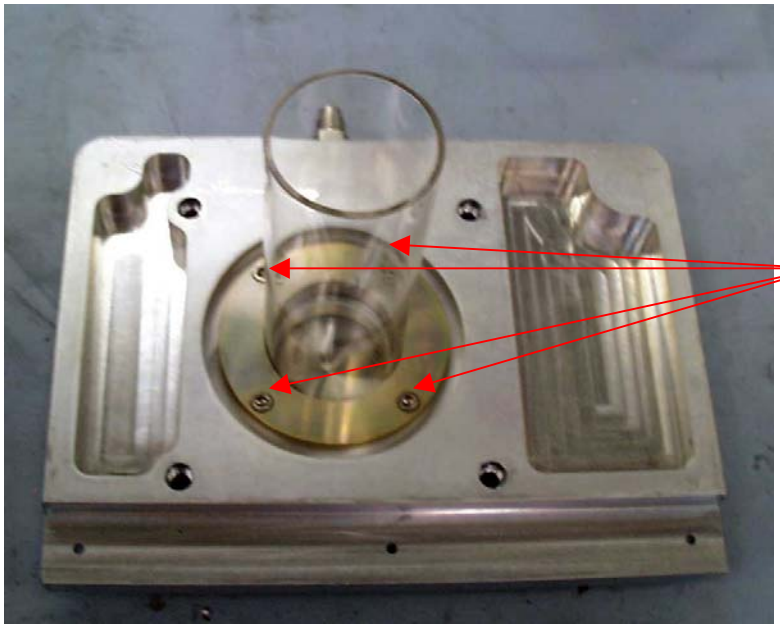
Remove these three Philips screws.

Remove these four ¼-20 long cap head Allen screws. See previous image and use a hex wrench on the top side and a 7/16” socket wrench on the bottom side.



Remove the 4-40 screws on the entire upper lip of the top plate.

The entire top plate with process tube can now be removed from the DGi by lifting straight up.



The top plate assembly will look like this when positioned up side down.

Remove the four cap head Allen screws, lift off the inner compression ring and the process tube/o-ring.

5.2 REPLACEMENT OF PROCESS TUBE AND O-RINGS

Once the top plate has been dissembled, all parts should be properly cleaned to remove any process residue. Properly dispose of all consumables.

To re-assemble, reverse the order of the disassembly process. Remember to lubricate the o-rings prior to installation.

Performa a helium leak check before re-installing the DGi on the process system.

5.3 SPARE PARTS AND CONSUMABLES

Consult the factory for all spare parts requirements. Below, you will find typical spares that will be required for periodic process tube maintenance.

- Fastener kit including vented cap head screws
- O-ring kit
  - ♦ Calrez® o-rings
- VCR gasket
- Service tool kit
- Quartz process tube and Calrez® o-rings
- Alumina process tube replacement kit
  - ♦ Calrez® o-rings
  - ♦ Process tube