



# ION PUMPS USERS MANUAL

PN 900013, Rev E



ISO 9001:2008 Certified

## GENERAL INFORMATION

Gamma Vacuum ion pumps provide clean, contamination free operation and have long operating lives, with no moving parts, no requirement for water cooling or liquid nitrogen for operation and little energy consumption.

They provide high pumping speeds and feature fast starting and stability.

There are 29 standard models of ion pumps in the 0.2 L/S to 1200 L/S range available from Gamma Vacuum. Most pump sizes are available in differential ion or conventional pumping configurations.

All pumps are fully enclosed by pole pieces and stainless steel covers which cover the magnets and pumping pockets where appropriate.

**WARNING:** Do not use unauthorized parts.



Such parts may compromise safety. Contact Gamma Vacuum with any questions.

## APPROVALS

Gamma Vacuum ion pumps are shown to meet CE and TUV/NRTL approvals:

- EN 1012-2
- EN 61010-1
- UL 61010-1
- CAN/CSA C22.2 No 61010-1

**Read this entire manual and follow installation instructions. Failure to do so may cause injury and/or may void warranty.**

## MODELS

Small Pumps	Low Profile Pumps	Tall Profile Pumps
Mini	100L	150T, 150TV
3S	200L	200T
10S, 10ST, 10SW	300L	250T
20S	400L, 400LX	300T, 300TV
25S, 25SVT, 25SVW	600L, 600LX	500T
40S	800LX	600TV
45S	1200LX	
75S		

Individual model specification information is located on our website at: [www.gammavacuum.com](http://www.gammavacuum.com)



## WARNINGS



**WARNING:**  
GAMMA VACUUM CONTROL UNITS DESIGNED FOR ION-PUMP OPERATION ARE CAPABLE OF DELIVERING 7000 VDC UNDER OPEN CIRCUIT OR LOW PRESSURE OPERATING CONDITIONS. FOR SAFE OPERATION, THE CONTROL UNIT AND ION PUMP SHOULD HAVE A COMMON CHASSIS CONNECTOR WHICH IS TIED TO THE POWER SYSTEM GROUND.

**ALERTE:**  
LES UNITES DE CONTROLE DE GAMMA VACUUM POUR L'OPERATION DES POMPES IONIQUES SONT CAPABLES DE FOURNIR 7000 VOLTS CONTINUS DANS UN CIRCUIT OUVERT OU EN TRAVAILLANT SOUS BASSE PRESSION. POUR OPERER EN TOUTE SECURITE, L'UNITE DE CONTROLE ET LA POMPE IONIQUE DOIVENT AVOIR UN CONNECTEUR DE CHASSIS EN COMMUN QUI EST LIE A LA TERRE DU SYSTEME D'ALIMENTATION.

**警告:**

イオンポンプ用ガンマ製真空制御装置は通電、もしくは低圧の状態では運転した場合直流7000V供給可能です。安全運転のため、制御装置とイオンポンプはアースに接続された共通の等級配線を使用する必要があります。

**安全警告:**

伽玛真空(公司)为离子泵运行所设计的控制单元在开路或低压运行条件下可输送7000伏直流电压。为确保安全运行,控制单元与离子泵应有一个共同的底盘连接器,和电源接地相连。

**ADVERTENCIA:**

LAS UNIDADES DE CONTROL DE VACIO GAMMA DISEÑADAS PARA LA OPERACIÓN DE BOMBAS TIPO IONICAS, SON CAPACES DE ALCANZAR 7,000 VDC BAJO OPERACION DE CIRCUITO ABIERTO O EN CONDICIONES DE OPERACIÓN A BAJA PRESIÓN. PARA UNA OPERACIÓN FUERA DE RIESGO Y PELIGRO, LA UNIDAD DE CONTROL Y LA BOMBA IÓNICA, DEBEN TENER UN CONECTOR COMÚN A UN CHASÍS EL CUAL ESTARÁ A SU VEZ, ENLAZADO A LA TIERRA DE LA FUENTE DE PODER.

**ACHTUNG:**

GAMMA VACUUM STEUERGERÄTE FÜR IONENGETTER-PUMPEN KÖNNEN HOCHSPANNUNGEN BIS ZU 7000 VOLT GLEICHSPANNUNG ERZEUGEN BEIM HOCHVAKUUM-BETRIEB ODER OFFEN LIEGENDEN ANSCHLÜSSEN. FÜR DEN SICHEREN BETRIEB MUSS EIN GEMEINSAMER SCHUTZLEITER DIE GEHÄUSE VON PUMPE UND STEUERGERÄT MIT DEM SCHUTZLEITER DES NETZANSCHLUSSES VERBINDEN.



**WARNING:**  
HIGH MAGNETIC FIELD. CAN CAUSE IMPLANTED HEART PACEMAKES AND CARDIOVERTER DEFIBRILLATORS TO CEASE OPERATION. MAINTAIN 12 INCH SAFE DISTANCE FROM ION PUMP.

**ALERTE:**  
CHAMP MAGNETIQUE INTENSE. PEUT CAUSER DES PANNES D'OPERATION SUR DES PACEMAKERS ET DES DEFIBRILLATEURS CARDIAQUES MAINTENIR UNE DISTANCE DE SECURITE DE 30 CM A PARTIR DE LA POMPE.

**警告:**

高磁場の為、心臓脈拍調整器や心臓除細動器が止まる危険性があります。イオンポンプから最低でも30cm離れたところで使用ください。

**安全警告:**

强磁场, 强磁场会导致埋藏式心脏起搏器和复律除颤器停止运行。请务必使之和离子泵保持12英寸的安全距离。

**ADVERTENCIA:**

ALTO CAMPO MAGNÉTICO. EL ALTO CAMPO MAGNÉTICO GENERADO PUEDE CAUSAR EL CESE DE LA OPERACION DE MARCADORES DE PASO Y DESFIBRILADORES CARDÍACOS.

**ACHTUNG:**

STARKE MAGNETISCHE FELDER. ZUR VERMEIDUNG VON MUSKELZERRUNGEN ODER RÜCKENSCHÄDEN BEIM TRANSPORT GEEIGNETE HUBVOR-RICHTUNGEN UND HEBETECHNIKEN VERWENDEN.



**WARNING:**  
HEAVY OBJECT. TO AVOID MUSCLE STRAIN OR BACK INJURY, USE LIFTING AIDS AND PROPER LIFTING TECHNIQUES WHEN REMOVING OR REPLACING.

**ALERTE:**  
OBJET LOURD. POUR EVITER UNE TENSION MUSCULAIRE OU UN MAL DE DOS, UTILISER DES AIDES ET DES TECHNIQUES DE LEVAGE APPROPRIÉES POUR L'ENLEVEMENT OU LE DEPLACEMENT.

**警告:**

大変重い装置です。筋挫傷、背部損傷等を防ぐ為、移動や移送の際は適切な技術や補助機器等を使用してください。

**安全警告:**

重物。为避免肌肉拉伤或背部受伤, 当移动或归位时请使用起重设备以及适当的起重技术。

**ADVERTENCIA:**

OBJETO PESADO. PARA EVITAR UN SOBRE-ESFUERZO MUSCULAR O DAÑO FÍSICO, UTILIZE LA AYUDA DE ELEVADORES Y TÉCNICAS APROPIADAS PARA EL MANEJO DE OBJETOS PESADOS, CUANDO LO TRANSPORTE, DESPLAZE O CONSIDERE REEMPLAZARLO.

**ACHTUNG:**

SCHWERES OBJEKT. ZUR VERMEIDUNG VON MUSKELZERRUNGEN ODER RÜCKENSCHÄDEN BEIM TRANSPORT GEEIGNETE HUBVOR-RICHTUNGEN UND HEBETECHNIKEN VERWENDEN.





**CAUTION:**  
NOT FOR USE WITH  
FLAMMABLE GASES.



**CAUTION:**  
BURN HAZARD. ALL ION  
PUMP SURFACES ARE HOT  
DURING BAKE. DO NOT  
TOUCH PUMP UNLESS BAKE  
IS OFF AND PUMP HAS  
COOLED.



**WARNING:**  
HEATERS ARE CONFIGURED  
FOR EITHER 100-120  
OR 200-240 VOLTS,  
16 AMPS MAX. VERIFY  
APPROPRIATE CONNECTOR  
AND VOLTAGE PRIOR TO  
CONNECTION. VOLTAGE  
OR CURRENT CAN CAUSE  
INJURY OR DEATH.  
DISCONNECT ALL POWER  
CORDS BEFORE SERVICING.  
600°C WIRING REQUIRED  
AT PUMP TERMINALS.



**WARNING:**  
READ AND UNDERSTAND  
OPERATOR'S MANUAL  
BEFORE USING THIS  
MACHINE. FAILURE TO  
FOLLOW OPERATING  
INSTRUCTIONS COULD  
RESULT IN INJURY OR  
DAMAGE TO EQUIPMENT.

**ATTENTION:**  
NE PAS UTILISER AVEC DES  
GAS INFLAMMABLES.

**ATTENTION:**  
RISQUES DE BRULURE .  
TOUTES LES SURFACES  
DE LA POMPE IONIQUE  
SONT CHAUDES PENDANT  
L'ETUVAGE . NE PAS  
TOUCHER LA POMPE SAUF  
SI L'ETUVAGE EST ARRETE ET  
LA POMPE REFROIDIE.

**ALERTE:**  
LES ELEMENTS CHAUFFANTS  
SONT CONFIGURES POUR  
100-120 OU POUR 200-240  
VOLTS, 16 AMPS MAX .  
VERIFIER LES CONNECTEURS  
ET LES VOLTAGES AVANT LA  
CONNECTION. VOLTAGE  
OU COURANT PEUVENT  
CAUSER DES BLESSURES OU  
LA MORT. DECONNECTER  
TOUS LES CORDONS AVANT  
LE SERVICE. CONNECTIONS  
A 600°C NECESSAIRE AU  
NIVEAU DE LA POMPE.

**ALERTE:**  
LIRE ET COMPRENDRE LE  
MANUEL D'OPERATION  
AVANT D'UTILISER CETTE  
MACHINE . NE PAS SUIVRE  
LES INSTRUCTIONS  
D'OPERATION PEUT CAUSER  
DES BLESSURES OU DES  
DEGATS A L'EQUIPEMENT.

**危険:**  
可燃性ガスには使  
用しないでください。

**危険:**  
運転中、イオン  
ポンプの表面は大変  
熱くなります。運  
転が止まり、ポン  
プが冷えるまで触  
れないでください。

**警告:**  
加熱器の電圧値は  
100-120もしくは  
200-240V、最大  
電流値は16Aに設  
定されています。  
接続前に必ず、コ  
ネクタと電圧が適  
切であることを確  
認してからご使用  
ください。不適切  
な電圧値、電流値  
での使用は使用者  
が死亡、または重  
傷を負う原因にな  
ります。修理前は  
全ての電源コード  
を取り外してくだ  
さい。またポンプ  
端子は600度の配  
線が必要です。

**警告:**  
この装置を使用さ  
れる前に必ず取扱  
説明書を熟読し理  
解した上でご使用  
ください。取扱説  
明書の通り操作を  
しなかった場合、  
装置が損傷、破損  
することがありま  
す。

**安全警告:**  
请勿与易燃气体同  
用。

**安全警告:**  
烫伤危险。所有离  
子泵的 surface 在经烘  
烤时均十分灼热。  
请勿在烘烤结束前、  
离子泵冷却之前  
触摸。

**安全警告:**  
发热器有100-120  
伏或200-240伏两  
种电压设置, 电流  
最大值为16安培。  
请于连接之前预先  
检验连接器和电压  
值是否合适。电压  
及电流可致伤或致  
死。请在维修前断  
开所有的电源线。  
泵的终端必须...  
在泵端配线必须  
能承受600度的温度。

**安全警告:**  
在使用这台机器前,  
请务必阅读并理解  
“操作员手册  
(指南)”。如果  
未能遵循操作步骤  
说明, 将可能导致  
设备的损坏。

**PRECAUCION:**  
NO DEBE USARSE CON GASES  
FLAMABLES O INFLAMABLES.

**PRECAUCION:**  
PELIGRO DE QUEMADURA. TODAS  
LAS SUPERFICIES DE LAS BOMBAS  
IÓNICAS ESTÁN CALIENTES  
DURANTE SU FUNCIONAMIENTO.  
NO TOQUE LA BOMBA A  
MENOS QUE ESTA HAYA SIDO  
DESCONECTADA Y SE HAYA  
ENFRIADO.

**ADVERTENCIA:**  
LOS CALEFACTORES ESTAN  
CONFIGURADOS PARA AMBOS  
100- 120 Ó 200-240 VOLTS,  
16 AMP MÁXIMO. VERIFIQUE  
LA APROPIADA CONEXIÓN Y  
VOLTAJE PREVIO AL ENCHUFE  
Y PUESTA EN MARCHA U  
OPERACION. UN INCORRECTO  
VOLTAJE O CORRIENTE, PUEDE  
CAUSAR DAÑO O INCLUSO LA  
MUERTE. DESCONECTE TODA  
ALIMENTACION ELÉCTRICA  
ANTES DE DAR SERVICIO DE  
MANTENIMIENTO, REPARACION O  
REVISIÓN INTERNA. EL CABLEADO  
TIPO 600°C ES REQUERIDO EN LAS  
TERMINACIONES DE LA BOMBA.

**ADVERTENCIA:**  
LEA, ESTUDIE, Y ENTIENDA BIEN EL  
MANUAL DE OPERACION, ANTES  
DE USAR ESTA MAQUINARIA.  
UNA FALLA POR NO SEGUIR LAS  
INSTRUCCIONES OPERATIVAS,  
PUDIERA RESULTAR EN DAÑO O  
PERJUICO DEL EQUIPO.

**VORSICHT:**  
NICHT GEEIGNET FÜR DEN  
EINSATZ MIT BRENNBAREN  
GASEN.

**VORSICHT:**  
VERBRENNUNGSGEFAHR. DIE  
GESAMTE OBERFLÄCHE DER  
IONENGETTERPUMPE WIRD BEIM  
AUSHEIZEN SEHR HEIß. NICHT  
BERÜHREN BEVOR DIE HEIZUNG  
AUSGESCHALTET UND DIE PUMPE  
ABGEKÜHLT IST.

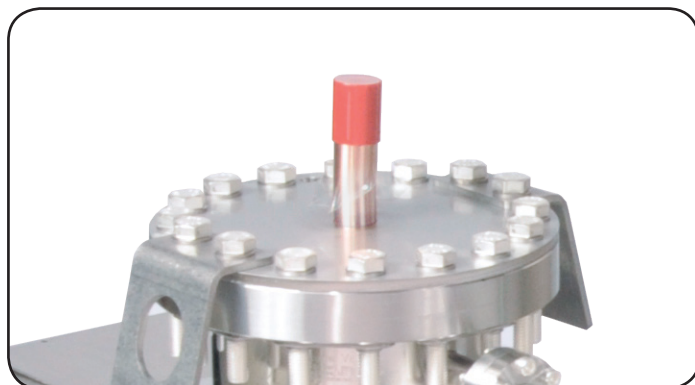
**ACHTUNG:**  
DIE AUSHEIZELEMENTE SIND  
GEEIGNET FÜR DEN BETRIEB  
MIT 100-120 V ODER 200-  
240 V WECHSELSPANNUNG,  
MAX. 16 AMPERE. VOR  
DER INBETRIEBNAHME DIE  
KORREKTE BETRIEBSSTROMUNG  
SICHERSTELLEN. ELEKTRISCHE  
SPANNUNGEN ODER STRÖME  
KÖNNEN VERLETZUNGEN  
ODER DEN TOD VERURSACHEN.  
TRENNEN SIE ALLE ELEKTRISCHEN  
ANSCHLÜSSE VON DER  
SPANNUNGSVERSORGUNG  
BEVOR SIE ARBEITEN AN  
DEM GERÄT AUSFÜHREN.  
DIE KABELVERBINDUNGEN  
AN DER PUMPE MÜSSEN FÜR  
EINE TEMPERATUR VON 600°C  
GEEIGNET SEIN.

**ACHTUNG:**  
LESEN UND VERSTEHEN SIE  
DIE BEDIENUNGSANLEITUNG  
BEVOR SIE DAS GERÄT IN BETRIEB  
NEHMEN. FEHLBEDIENUNGEN  
KÖNNEN ZU VERLETZUNGEN  
FÜHREN ODER DIE AUSRÜSTUNG  
BESCHÄDIGEN.

## UNPACKING THE PUMP

### Unpack the pump carefully

Do not remove or damage the protective plastic cover on the copper punch-off tube, or the pump may be vented to atmospheric pressure. The pump should be kept under vacuum until it is ready to be installed.



### Inspect for any obvious damage

If the pump is damaged in any way, a claim should be filed with the carrier immediately and notification given to Gamma Vacuum.

If equipment must be retuned for inspection or repair, obtain authorization from Gamma Vacuum prior to shipping. Contact Gamma Vacuum for authorization and return instructions.

### Check the equipment received

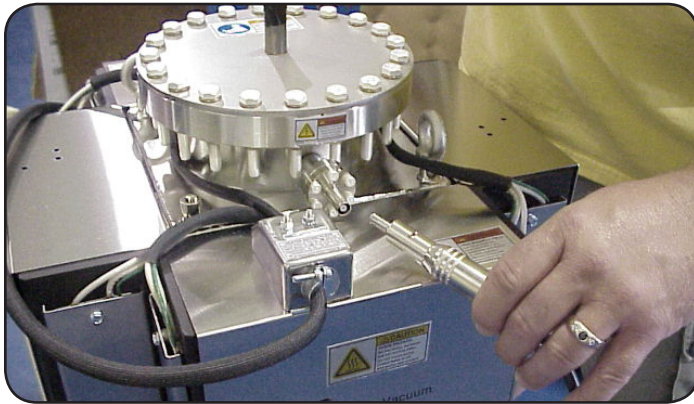
Ensure that all items shipped have been received. If any items are missing, notify the carrier and Gamma Vacuum. Save all packaging material for inspection.

## INITIAL CHECKOUT

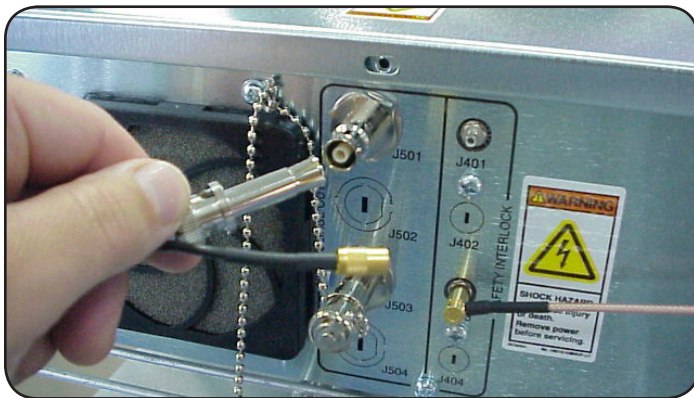
### Pre-Venting Procedure

Ion pumps are shipped under vacuum to ensure ultra high vacuum cleanliness and to demonstrate the vacuum integrity of the ion pump.

1. Connect the high voltage cable to the ion pump. Use the supplied cable or a cable with the appropriate mating connector for your feedthrough.



2. Connect the high voltage cable to an ion pump controller with the correct polarity. Connect the SAFECONN SMB connector, if included.



3. Enable high voltage on the ion pump controller.
4. The ion pump should start immediately and follow the time, pressure, and current specifications recorded on the included certificate of conformance.

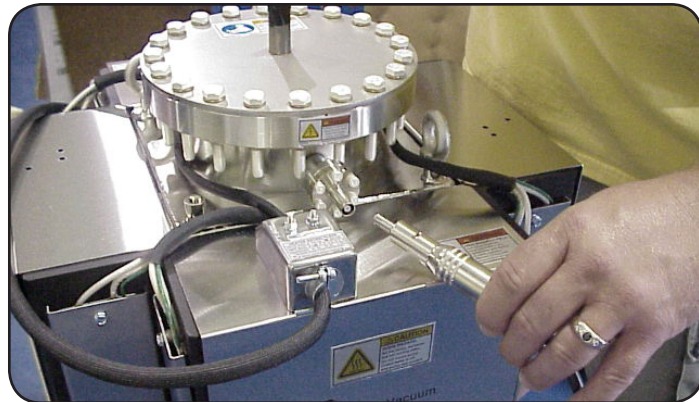
## INSTALLATION

1. Remove the blank-off flange from the pump using dry nitrogen as a venting gas.
2. Bolt the ion pump to the system using the bolt set from the blank-off flange.  
Pumps up to the size of the 40S many be cantilevered during operation. Given proper support, other pumps can be mounted in

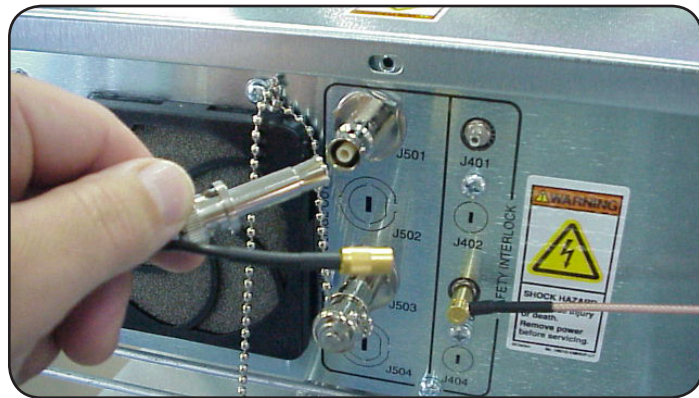
any position with respect to the inlet flange. M8 mounting bosses are supplied on larger pumps for mounting purposes (use ISO 3266 compliant eye-bolts).

**NOTE:** If the vacuum system is to be cycled often, it is recommended that an isolation valve be installed between the ion pump and the vacuum chamber.

3. Several styles of feedthrough connection systems are available, but SAFECONN connectors are standard.
4. To connect the SAFECONN connector, push the cable end connector onto the feedthrough and turn clockwise to lock in place.



5. Attach the other end of the cable to the 10 kV high voltage connector mounted on the rear of the power supply chassis.



**NOTE:** Although the high voltage cable has a grounded shield, we recommend that a separate wire be connected from the pump body to the safety ground on the rear of the control unit chassis. The wire should have a ring lug or other connector that can be inserted with one of the flange bolt washers.

6. The power unit is equipped with a three prong grounding power plug. This plug must be inserted into a similar three-wire receptacle which is a connection to system ground. If such a receptacle is not available, a separate ground must be provided.

## OPERATION

### General Recommendations

Read the following recommendations before operating your ion pump:

- Ensure that the air and environment are free from contaminants.
- Hands should be gloved and free from oils. Use UHV practices when working with ion pumps.
- For better starting and pump down time, flush the system with dry nitrogen to decrease water vapor and noble gas quantities.
- Check to see that the ion pump controller is properly connected and that the system is tightly sealed.
- To increase ion pump life and shorten time to ultimate pressure, use the full extent of the roughing system and start the ion pump at the lowest possible pressure.

### Rough Pumping

Rough pumping removes a high volume of gas load and achieves a pressure at which the ion pump will start. The ion pump will start quicker, achieve ultimate pressure faster, and last longer.

**CAUTION:** Do not contaminate the ion pump with hydrocarbons from oils used to seal mechanical pumps.

Rough pump the system after you install the ion pump on the system. Refer to the roughing pump manufacturer's manual for instructions on roughing procedures, proper operation, and venting. Rough pumping must reduce system pressure to  $1 \times 10^{-4}$  torr or lower.

### Pump Starting (Not Isolated)

This procedure is used when the ion pump is started after exposure to atmospheric pressure or any pressure above  $2.5 \times 10^{-2}$  torr. If the pump is still under vacuum, see "Pump Starting (Isolated)" on page 5.

1. Switch on the roughing pump and open the roughing valve.
2. On the ion pump controller, set the controller readout display to voltage. Set the ion pump controller switch to start, if so equipped.
3. Switch on the ion pump controller when system pressure has reached  $1 \times 10^{-4}$  torr (lower pressure is better).
4. The controller should read 300 to 500 volts and slowly increase to full voltage (normally 5000 to 7000 volts).
5. Close the roughing valve when the controller reads 2000 volts or greater.
6. When the controller reads 3500 volts, set the power unit switch to run, if so equipped. To determine ion pump pressure, set the controller readout display to a current range, and calculate pressure by means of the current to pressure equation.

**NOTE:** Gamma Vacuum ion pump controllers have a selection for pressure readout.

### Pump Starting (Isolated)

This procedure is used if the ion pump is under vacuum and isolated with a high-vacuum isolation valve. In this case, the ion pump is kept in operation while the remainder of the system is opened to atmosphere.

1. Check to see that the ion pump is operating properly.
2. Switch on the roughing pump and open the roughing valve.
3. On the ion pump controller, set the controller readout display to voltage. Set the ion pump controller switch to start, if so equipped.
4. When system pressure has reached  $1 \times 10^{-4}$  torr (lower pressure is better), begin closing the roughing valve and opening the isolation valve. Do not let ion pump voltage drop below 3000 volts.
5. When voltage is greater than 3500 volts, with the isolation valve fully open and the roughing valve fully closed, place the ion pump controller switch to run, if so equipped.

## Ongoing Operation

After the ion pump has started, it continues to reduce pressure in the system without further attention.

**NOTE:** The ion pump can be kept in permanent operation.

The ion pump controller should provide overload protection to turn off the ion pump if system pressure rises above ion pump operating pressure. Other desirable features of an ion pump controller are:

- ion pump over-current protection
- safety interlocks
- voltage, current, and pressure display
- analog outputs that correspond to ion pump voltage and current
- remote control on/off
- setpoints—relays that can interlock equipment and processes, or control bakeout by ion pump current or calculated pressure
- computer interface for remote operation by computer

## Venting Procedure

To enhance system performance:

- Minimize the time the ion pump is exposed to atmosphere.
- Use dry nitrogen gas when venting the ion pump to atmospheric pressure.

**NOTE:** If an isolation valve is included, close it (with ion pump in operation) before opening the system. When venting the system to atmosphere, ion pump current may rise. This is not a problem if pressure remains below  $1 \times 10^{-6}$  torr.

1. Switch off the ion pump controller.
2. Connect a source of clean dry nitrogen to the up-to-air valve.
3. Open the up-to-air valve slowly to prevent dry nitrogen from entering the system too quickly.
4. Open the roughing isolation valve, gradually.

**CAUTION:** When venting, do not pressurize the ion pump or vacuum system above atmospheric pressure.

## Bakeout Procedure

Bakeout reduces high gas loads. Gamma Vacuum bakeout heaters heat ion pumps above  $150^{\circ}\text{C}$  in free air (without covers or blankets). They heat the ion pump to a high enough temperature to adequately degas pump surfaces while preventing loss of magnetic flux

In free air, element heater temperature is self-limiting: the ion pump and magnet temperatures are held to acceptable limits without a thermostat. If ion pumps are covered or insulated during bakeout, then the temperature of the ion pump should be thermostatically controlled.

**NOTE:** When connecting heaters to a power source, ensure that power disconnects are readily available.

## Before You Begin

During bakeout, monitor system pressure so that it does not exceed  $1 \times 10^{-5}$  torr. It might be necessary to switch the heaters off periodically and allow pressure to drop, then switch the heaters back on as the gas load is reduced.

**WARNING:** Heaters are extremely hot to the touch. To avoid severe injury, isolate the pump so that no one is able to touch it.



**CAUTION:** Temperatures above  $350^{\circ}\text{C}$  can cause irreversible loss of magnetic field strength. When operating the system at  $350^{\circ}\text{C}$  or above, remove the ferrite magnets from the ion pump.



**CAUTION:** Heater must be wired to a disconnect and over-current protection device.



## Bakeout Operation Procedure

1. Switch on the heaters.
2. Monitor system pressure until system is heat-soaked and system pressure begins to decline.
3. If bakeout temperatures near  $250^{\circ}\text{C}$ , shut off the ion pump and use an auxiliary pump for bakeout.
4. Do not cut the bakeout period short. In most cases, a minimum of eight hours is recommended. Longer bakeout periods are often advisable.

**NOTE:** In a few cases, the ion pump is so badly contaminated that bakeout is not sufficient and it may be necessary to use chemical cleaning, which is a difficult procedure. If this is the case, contact your local service for details.



## MAINTENANCE

**CAUTION:** This equipment uses a high voltage, detachable power supply cord. Do not replace with inadequately rated supply cords.



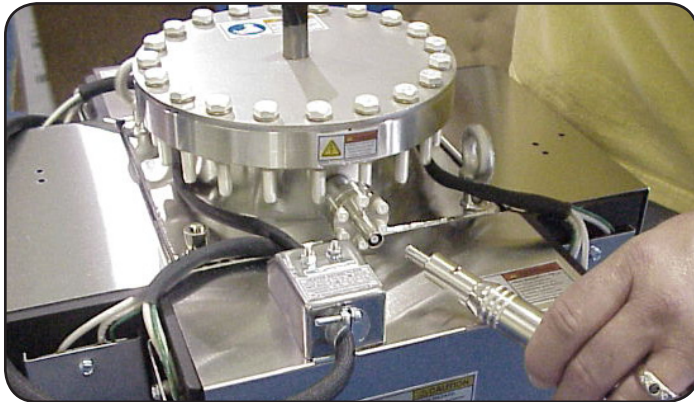
### Performance Checks

The ion pump operates on the cold cathode discharge principle, so it does not include any moving parts. The pump is a sealed trapping device and all gaseous material pumped is retained inside the pump in the form of solid-state compounds. For these reasons the pump requires only minimum maintenance to provide trouble-free operation for extended periods of time.

### Operation Check

With the pump under vacuum, verify as follows:

1. Check that the ion pump control unit is in proper operating condition. (Refer to Control Unit user manual.)
2. Connect the high voltage connector to the ion pump high voltage lead-through (ceramic insulator).



3. Turn on the control unit. Observe the decrease in current as the pump pumps itself down. Voltage should read  $7000 \pm 10\%$  and current of a few microamps after a short period of time.

### Leakage Current Check

Total current in an ion pump is a combination of the following four currents:

- **Discharge current** is the sum of ion flow to/from the cathode plates, which consists of ion collisions with cathode plates and ions liberated from cathode plates. This current is almost proportional to ion pump pressure.
- **Secondary electron current** occurs when electrons are ejected from cathode plates or ion pump walls by colliding ions. This current increases with increasing ion energy (operating voltage).
- **Leakage current** flows across a resistive element such as high voltage cable insulation, high voltage feedthrough, or insulating ceramics. This current increases as the ion pump ages when sputtered deposits coat the ceramic insulators with a conductive film.
- **Field emission current** is caused by a high voltage gradient. This current depends on the voltage, distance to adjacent surfaces, and the geometry of the field emission point. Sharp edges and needle points exhibit higher emission currents because the electric field gradient is greater around them.

To determine whether ion pump current increase is due to an increase in system pressure or leakage current/field emission:

1. Place the system under vacuum sufficient to produce an ion pump current of 1 mA or less. See "Rough Pumping" on page 5.
2. Switch off the ion pump controller.
3. Remove the magnets from the ion pump (see "Magnetic Strength Check" on page 7).
4. Switch on the ion pump controller. Current should be negligible on the ion pump controller at full ion pump controller voltage.
5. If leakage current is present, maintenance may be required.

**NOTE:** Leakage current causes errors in pump pressure reading, however, it does not necessarily affect actual pumping speed.

### Magnetic Strength Check

**NOTE:** To complete this process, you need a gaussmeter.

Magnetic field strength is one factor that determines the pumping speed of the ion pump. The magnets are magnetized prior to assembly at the factory, and there should not be a noticeable reduction in strength unless the magnets are heated above  $350\text{ }^{\circ}\text{C}$  or are badly damaged.

To check field strength:

1. Remove a magnet assembly from one or more pumping elements.
2. Set the gap between the assemblies at  $1\text{-}1/2"$  (38 mm). Use a wooden spacer block where necessary.
3. Check all components of the field in the gap. The field should be approximately 1000–1500 gauss depending on magnetic circuit design.

## Troubleshooting

Symptom	Possible Cause	Recommended Corrective Action
Pump does not pump system down.	<ol style="list-style-type: none"> <li>1. Large leak in system.</li> <li>2. Gauge equipment or power unit malfunction.</li> <li>3. Pump has short circuit.</li> <li>4. Magnetic field strength low.</li> <li>5. Pump hot.</li> </ol>	<ol style="list-style-type: none"> <li>1. Leak check system, repair leak.</li> <li>2. Check gauge and/or power unit operation.</li> <li>3. Burn short out or return to factory for repair.</li> <li>4. Check field strength, remagnetize if necessary.</li> <li>5. Allow to cool to room temperature.</li> </ol>
Pump down is slow and base pressure higher than previously.	<ol style="list-style-type: none"> <li>1. Leak in system.</li> <li>2. Atmospheric contaminants on pump and system walls.</li> <li>3. Gassy material in system.</li> <li>4. Pump hot.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check system for leaks, repair.</li> <li>2. Use low temperature bakeout of system.</li> <li>3. Remove materials with high outgassing rate.</li> <li>4. Allow to cool to room temperature.</li> </ol>
Pump does not start.	<ol style="list-style-type: none"> <li>1. Insufficient roughing vacuum.</li> <li>2. Leak in roughing system.</li> <li>3. Pump contaminated from hydrocarbon source.</li> <li>4. Pump contaminated with inert gases.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check roughing pump for correct operation, check roughing gauge.</li> <li>2. Leak check roughing system, repair leak.</li> <li>3. Use RGA to determine if oil is present. Pump requires chemical cleaning.</li> <li>4. Rerough system with dry N2 backfill.</li> </ol>
Pump becomes hot during starting.	<ol style="list-style-type: none"> <li>1. Insufficient roughing vacuum.</li> <li>2. Leak in rouging system.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check roughing pump operation.</li> <li>2. Leak check roughing system, repair leak.</li> </ol>
Pump becomes hot during operation.	<ol style="list-style-type: none"> <li>1. Pressure too high, has load too heavy for pump to handle.</li> </ol>	<ol style="list-style-type: none"> <li>1. Reduce gas load and/or clean system.</li> </ol>
Pump current rises to higher level than previously.	<ol style="list-style-type: none"> <li>1. System contaminated with atmospheric contaminants.</li> <li>2. Pressure in system is higher.</li> <li>3. Pump has developed high leakage current.</li> </ol>	<ol style="list-style-type: none"> <li>1. Use low temperature bakeout.</li> <li>2. Reduce gas load, outgas system, remove gassy materials.</li> <li>3. a. Burn out leakage paths. b. Replace insulators</li> </ol>
Pump current shows zero but system pressure indicates higher pressure.	<ol style="list-style-type: none"> <li>1. Pump magnets installed incorrectly.</li> <li>2. Pump up to air.</li> </ol>	<ol style="list-style-type: none"> <li>1. Verify magnets are installed correctly.</li> <li>2. Confirm ion pump is not at atmospheric pressure.</li> </ol>



## CORRECTIVE PROCEDURES

### Leak Testing

The most common cause of the slow pumpdown and high base pressure in any vacuum system is a leak. Even an extremely small leak, which would be undetectable in a pressure system, can be very serious in an ultra-high vacuum system.

Using a mass spectrometer or equivalent type leak detector, spray the outside surface of the system at suspected leak points with a probe gas through a fine muzzle. If a leak detector is not available, a less desirable method of leak detection is to monitor the pump current in conjunction with using a probe gas such as helium. Any leak should be fixed permanently.

### Low Temperature Bakeout

This procedure is very effective for improving the pumpdown speed and base pressure of a system which does not appear to be performing as well as it has previously. The principal reason for decreased performance is the contamination of the system or pump with atmospheric water vapor.

This water vapor enters an open system and adheres to the system walls. Although this contamination does not physically harm the pump or "load it up," it is not removed by subsequent roughing cycles and forms a significant additional gas source in the system, particularly in moist climates.

To remove water vapor and restore proper operation:

1. Place the system under vacuum with the system sealed and the ion pump in operation.
2. Bake out temperatures of 200°C to 250°C are sufficient to obtain pressures in the UHV range. Bakeouts at higher temperatures must be done into an auxiliary pump since the pumping speed of an ion pump is very low at these temperatures due to the reduced field strength of the magnets at elevated temperatures. To prevent irreversible loss of magnetic field strength at temperatures above 350°C, remove the magnets from the pump (see "Magnetic Strength Check" on page 7). If there are any non-metallic (for example, Viton) seals in the system, the bakeout should be limited to 150°C. If the ion pump is equipped with a bakeout heater, use it in place of the heat lamps on the pump.
3. Adjust the heat to prevent pressure in the system from rising above approximately  $2 \times 10^{-5}$  torr.
4. Generally, an overnight bakeout of this sort will be sufficient, but longer bakeouts may be required for contaminated systems.

This procedure may be repeated as many times as it provides beneficial results. In the majority of cases, it will greatly improve system performance without additional work being required.

### High Electrical Leakage

High leakage current does not appreciably affect the operation of the pump, but it does render the pump incapable of giving accurate pressure readings. However, pressure can be read by determining the total leakage current after removing the magnets, and subtracting this value from the total current drawn by the pump.

To reduce electrical leakage:

1. Connect the Gamma Vacuum control unit to the ion pump.
2. With the pump pressure in the low micron range ( $10^{-2}$  torr), turn on the control unit.

3. Several applications of this technique may be necessary. Be sure to allow the control unit to discharge completely between each application.
4. If this procedure does not eliminate the leakage current, check the feedthrough for leakage as described in "Performance Checks" on page 7.

**CAUTION:** THESE CONTROL UNITS ARE CAPABLE OF DELIVERING 7000VDC UNDER OPEN CIRCUIT CONDITIONS. OBSERVE SAFETY PRECAUTIONS LISTED IN "WARNINGS" ON PAGE 2.



5. If the feedthrough is not the cause of the leakage current, the pumping element ceramic insulators are the conduction path and should be replaced.

### Pump Short Circuits

On infrequent occasions, the pump may develop a short circuit after extended operation because a flake of deposited material is shorting across the pump element anode-cathode units.

1. Check for shorts by measuring resistance between the feedthrough tip and the pump body. Resistance should be infinite.
2. If a short is indicated, turn on the control unit with the pump in the low micron range ( $10^{-3}$  torr).
3. If several applications of this technique do not remove the short, let the pump up to atmosphere and repeat the procedure. See "Rough Pumping" on page 5 and the "Pump Starting" sections on page 5.
4. If this procedure does not remedy the short, remove the pump from the system and remove and inspect the connector straps and pumping elements. Connect each pumping element individually to the control unit and check for shorts by turning on the control unit.
5. Replace all ceramics.
6. Remove all loosely adhering material from the part, including the pump envelope.
7. Degrease parts and reassemble with new ceramics.
8. Vacuum flakes and loose material out of pump body.
9. Reassemble and turn on power supply at atmosphere to check for shorts or leakage.

**CAUTION:** THESE CONTROL UNITS ARE CAPABLE OF DELIVERING 7000VDC UNDER OPEN CIRCUIT CONDITIONS. OBSERVE SAFETY PRECAUTIONS LISTED IN "WARNINGS" ON PAGE 2.



### Chemical Cleaning

In a few instances, a system and pump may be so badly contaminated by a source other than atmospheric contamination that a moderate bakeout is not sufficient for improving performance.

In these cases, it may be necessary to use chemical cleaning. This procedure is difficult and requires special equipment and chemicals.

Gamma Vacuum provides this service. Contact the factory for details.

## WARRANTY & SERVICE

### Service

#### Cleaning Procedure

Prior to any cleaning of the pump, the mains power should be disconnected. Once powered off, use a 50% distilled water and 50% isopropyl alcohol solution to clean the entire unit. A soft, non abrasive cloth will ensure no damage to the LCD screen and finish of the unit.

#### Service Requests

Upon notification, Gamma Vacuum will identify the level of service required. To assist in this process, please provide the following information in as much detail as possible:

- Part Number
- Serial Number
- Detailed Description of the Vacuum System Hardware
- Detailed Description of the Vacuum System Process (gas species introduced, ultimate pressure, operational pressure)
- Reason for Service Request
- Required Documentation

To expedite this process, please forward this information to [service@gammavacuum.com](mailto:service@gammavacuum.com).

#### Direct Support

Prior to recommending replacement parts or service at our facility, Gamma Vacuum can assist with general vacuum issues via e-mail or by telephone at no charge. It is our goal to have vacuum systems functional with minimal time and financial investment.

To do this, our service technicians require as much information as possible about the vacuum system in need of support. To assist in this process, please provide the following information in as much detail as possible:

- Part Number
- Serial Number
- Detailed Description of the Vacuum System Hardware
- Detailed Description of the Vacuum System Process (gas species introduced, ultimate pressure, operational pressure)
- Reason for Support Inquiry

To expedite this process, please forward this information to [service@gammavacuum.com](mailto:service@gammavacuum.com) or contact our facility directly at the numbers below.

### Warranty

#### General Terms

Gamma Vacuum warrants to the Buyer that the equipment sold is new equipment, unless previously stated, and is, at the time of shipment to Buyer from Gamma Vacuum, free from defects in material and workmanship. As Buyer's sole exclusive remedy under this warranty, Gamma Vacuum agrees to either repair or replace, at Gamma Vacuum's option and free of parts charge to Buyer, and part or parts which, under proper and normal conditions of use, prove to be defective within twelve (12) months from the date of receipt by buyer.

As expendable items may have a life time of less than one year, their warranty is subject to reasonable service and will be replaced as determined by Gamma Vacuum. All warranty claims must be brought to the attention of Gamma Vacuum within thirty (30) days of failure to perform.

This warranty does not cover loss, damage, or defects resulting from transportation to the buyer's facility, improper or inadequate maintenance by buyer, buyer supplied software or interfacing, unauthorized modifications of misuse, operation outside of environmental specifications for the equipment or improper site preparation and maintenance.

In-warranty repaired or replacement parts are warranted only for the remaining unexpired portion the the original warranty period applicable to the parts which have been repaired or replaced. After expiration of the applicable warranty period, the Buyer shall be charged at Gamma Vacuum's then current prices for parts, labor, and transportation.

Reasonable care must be used to avoid hazards. Gamma Vacuum expressly disclaims responsibility for any loss or damage caused by the use of its products other than in accordance with proper operating and safety procedures.

EXCEPT AS STATED HEREIN, GAMMA VACUUM MAKES NO WARRANTY, EXPRESSED OR IMPLIED (EITHER IN FACT OR BY OPERATION OF LAW), STATUTORY OR OTHERWISE: AND, EXCEPT AS STATED HEREIN, GAMMA VACUUM SHALL HAVE NO LIABILITY FOR SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND OR FROM ANY CAUSE ARISING OUT OF THE SALE, INSTALLATION, OR USE OF ANY OF ITS PRODUCTS.

Statements made by any person, including representatives of Gamma Vacuum, which are inconsistent or in conflict with the terms of this warranty shall not be binding upon Gamma Vacuum unless reduced to writing and approved by an officer of Gamma Vacuum.

Gamma Vacuum may at any time discharge its warranty as to any of its products by refunding the purchase price and taking back the products.

## Warranty Claims

Upon notification, Gamma Vacuum will investigate Warranty Claims. To initiate a Warranty Claim, please contact Gamma Vacuum or a representative of Gamma Vacuum directly. To assist in this evaluation, please provide the following information in as much detail as possible:

- Part Number
- Serial Number
- Detailed Description of the Vacuum System Hardware
- Detailed Description of the Vacuum System Process (gas species introduced, ultimate pressure, operational pressure)
- Detailed Reason for the Warranty Claim

To expedite this process, please forward this information to to [service@gammavacuum.com](mailto:service@gammavacuum.com).

## Returning Material

### Return Procedure

In the event a product requires service, exchange, or return, a Return Material Authorization (RMA) number must be obtained from Gamma Vacuum prior to shipment.

RMA numbers can be obtained by calling Gamma Vacuum toll-free. The RMA process will be expedited if any of the following information can be provided:

- Original Purchase Order Number
- Gamma Vacuum Sales Order Number
- Product Order Number and/or Product Description
- Product Serial Number

All products received for repair or replacement shall be prepaid. Items not labeled with an RMA number will be accepted; however substantial delay in processing may result. A standard restocking fee may apply.

**NOTE:** Prior to issuance of an RMA, the required documents must be submitted to Gamma Vacuum.

### Required Documentation

During a lifetime of system operation, it is possible that certain contaminants, some of which could be hazardous, may be introduced into the vacuum system, thus contaminating the components. Please complete the form on the next page to identify any known hazardous substances that have been introduced into the vacuum system.

This will enable us to evaluate your equipment and determine if we have the facilities to make the repair without risk to employee health and safety. Return, repairs, or credit will not be authorized until this form has been signed and returned.

**NOTE:** Prior to returning any materials, Gamma Vacuum must issue an RMA. The RMA number should be clearly labeled on all shipping information and packages.



## RETURN MATERIAL AUTHORIZATION FORM

Thank you for taking the time to complete this form. Please complete this form and return to Gamma Vacuum in electronic format (Adobe PDF format [.pdf] preferred), or via fax. Digital signatures are acceptable.

**Assigned RMA:** \_\_\_\_\_

**Your Reference:** \_\_\_\_\_

### CONTACT INFORMATION

Name: \_\_\_\_\_  
E-mail Address: \_\_\_\_\_  
Phone: \_\_\_\_\_  
Fax: \_\_\_\_\_  
Website: \_\_\_\_\_

### COMPANY INFORMATION

Company Name: \_\_\_\_\_  
Date: \_\_\_\_\_  
Address: \_\_\_\_\_

### RETURN INFORMATION

Type of Product:	Ion Pump Ion Pump Controller Other	Part Number:	_____
		Description:	_____
		Serial Number:	_____
Contaminant Status*:	Has Not Been Exposed Has Been Exposed	Original	_____
		Purchase Order:	_____
Claim Status:	Warranty Claim Service Request Shipping Error Evaluation Other	Your Reference:	_____
Reason for Return:	_____		
Additional Information:	_____		

**Signature of Certifying Official:** \_\_\_\_\_

**Name and Title of Certifying Official:** \_\_\_\_\_

\* Contaminants to vacuum systems are defined as: any substance that, because of its properties, is not compatible with ultra-high vacuum (UHV) operation. Some of these are: silicon (in the form of silicones), sulfur, cadmium, fluorine and chlorine. Contaminants have been determined by vapor pressure curves and/or properties that are detrimental to the operation of UHV products.

\*\* Hazardous substance means a chemical or substance, or mixture of chemicals or substances, which:

- is regulated by the Federal Occupational Safety and Health Administration under Code of Federal Regulations, title 29, part 1910, subpart Z;
- is either toxic or highly toxic, an irritant, corrosive, a strong oxidizer, a strong sensitizer, combustible, either flammable or extremely flammable, dangerously reactive, pyrophoric, a carcinogen, a teratogen, a mutagen, a reproductive toxic agent, or that otherwise, according to generally accepted documented medical or scientific evidence, may cause substantial acute or chronic personal injury or illness during or as a direct result of any customary or reasonably foreseeable accidental or intentional exposure to the chemical or substance. (Common examples: arsenic, cadmium, gallium, cesium, mercury, radiation, etc.)

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**E-mail: [info@gammavacuum.com](mailto:info@gammavacuum.com) Website: [www.gammavacuum.com](http://www.gammavacuum.com)**