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# Titanium Sublimation Pump & Remote TSP Pump Controller Users Manual

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PN 900016, Rev C

Specification information is located on our website at:

[www.gammavacuum.com](http://www.gammavacuum.com)

ISO 9001:2000 Certified

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## General Information

### Titanium Sublimation Pump (TSP)

The Titanium Sublimation Pump (TSP) is designed to be used in high to extreme vacuum environments although it can be operated over a wide range of pressures. TSPs effectively remove chemically active gases and are excellent in combination with an ion pump. The amount of gettering material evolving from an ion pump is directly proportional to the pressure and atomic weight of the gas molecules. Therefore, at low pressures there is not sufficient gettering material to remove light gases (e.g. hydrogen). TSP operation is relatively insensitive to system pressure and has no difficulty emitting gettering material at low pressure. In most ultra-high and extreme-high vacuum systems, hydrogen is the primary load contributor. Hydrogen removal is greatly aided with the use of a TSP.

The TSP is a getter type pump and sublimates titanium from its filaments. The sublimated titanium coats the line-of-sight surfaces surrounding the filaments. The titanium serves to capture chemically-reactive (non-noble) gases. Sublimation requires heating of the elements which raises the vacuum system temperature temporarily raising system pressure. Therefore, the TSP should be operated intermittently. The film deposited will capture gases permanently for a long period after firing.

The TSP does not effectively remove all gases (mainly noble) from the system and therefore should be used in conjunction with other vacuum pumps (e.g. ion pump).

Due to the conductive nature of the titanium film, it is a good practice to eliminate line of sight from the TSP to the rest of the vacuum system. If the film coats electrical insulators (e.g. the ceramic insulators of the sputter-ion pump) it will create an electrical path which can lead to electrical leakage or shorts.



### Liquid Nitrogen (LN<sub>2</sub>) Cryoshroud

A cryo shroud provides capture and hold of H<sub>2</sub>O & CO<sub>2</sub> pumping when cooled with LN<sub>2</sub>. It provides a surface for sublimated titanium while preventing line of sight migration of Ti. Cryo shrouds can be used with and without coolants. Recommended coolants include: water, and LN<sub>2</sub> (liquid nitrogen). When used with LN<sub>2</sub>, hydrogen pumping speed is increased by a factor of 6.5.



### Ambient Shield

An ambient sublimation shield provides a surface for sublimated titanium while preventing line of sight migration of Ti. It is low cost and is smaller than the cryo shield.

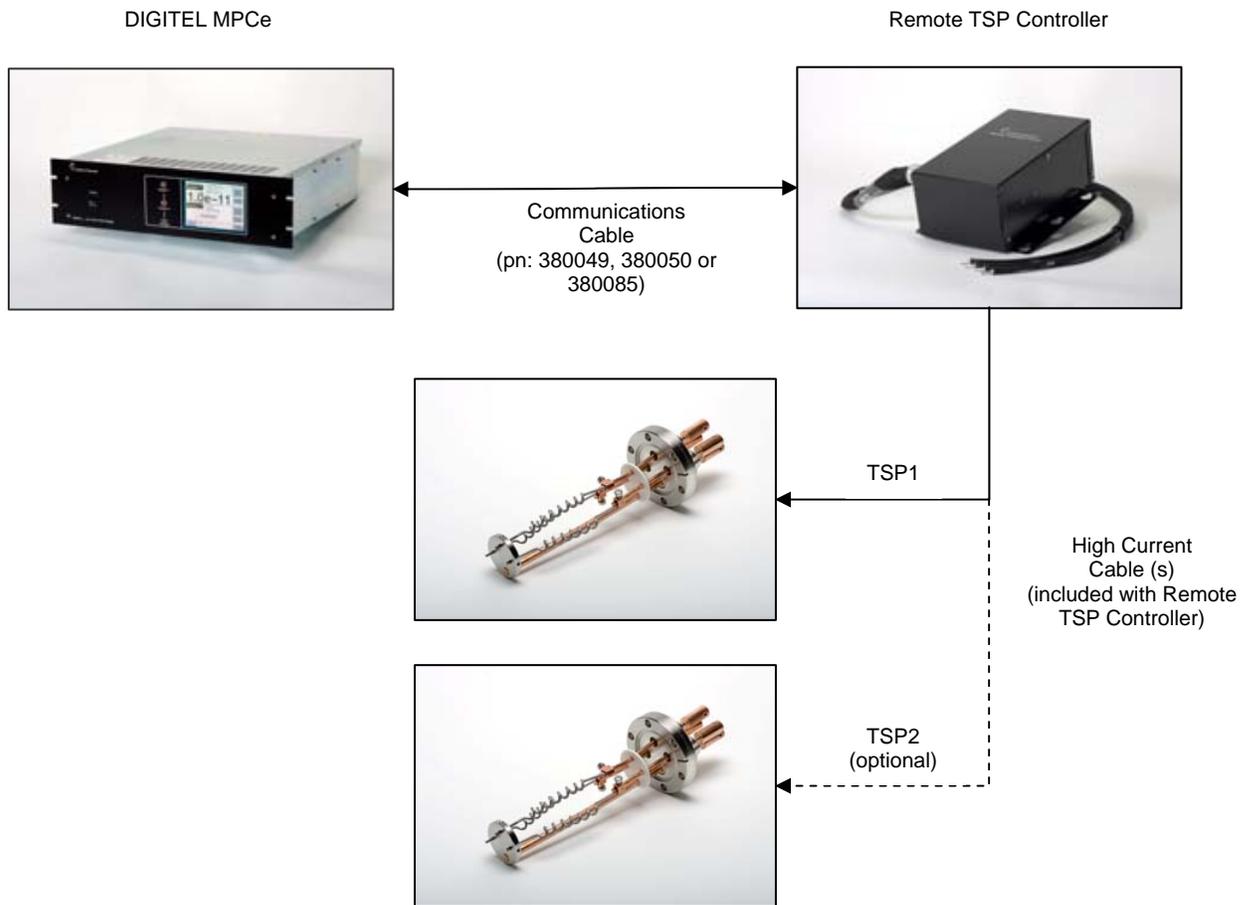


### Remote TSP/NEG Controller

The remote TSP/NEG option allows control of a TSP (titanium sublimation pump) or NEG (non-evaporable getter). The remote controller operates in conjunction with the DIGITEL Ion Pump Power Supply Line. It has the capability of operating up to 8 filaments total in any TSP configuration (independently, 3 or 4 filaments per TSP).

The remote TSP/NEG controller system consists of:

- Remote TSP/NEG Control unit
- control cable from the DIGITEL MPC to the Remote TSP/NEG Control
- high-current cable from the Remote TSP/NEG Control to the TSP/NEG



## ***TSP Specifications***

<b>Temperature (max):</b>	Bakeable to 250°. Includes adapter cables for mating with the TSP controller.
<b>Number of Filaments</b>	3 Spiral design
<b>Filament Material: mm (in.)</b>	85% titanium, 15% molybdenum alloy wire
<b>Total length of each wire: mm (in.)</b>	219 (8.6)
<b>Coiled length of wire: mm (in.)</b>	117 (4.6)
<b>Weight per filament</b>	3.1 to 3.5g
<b>Filament life</b>	up to 20 hours depending on operating conditions (pressure, current)
<b>Maximum current</b>	50A at 8 VAC

## **Remote TSP/NEG Controller Specifications**

The Remote TSP Controller specifications match the Digital MPCe specifications with the following additions:

<b>Parameter</b>	<b>Specification</b>
Number of Independent TSPs	1 or 2 (up to 4 filaments per TSP)
Control Modes	Manual, Programmed
Auto Filament Advance	Disabled, Next, Rotate
Power Control	Watts or Amps
Power Output (max)	75 Amps (1000 watts)
Voltage Output (max)	14 volts
Power Ramp Rate (amps/sec)	5
Dimensions	Single, WxHxD: 138 mm (5.4") x 292 mm (11.5") x 219 mm (8.6") Double, WxHxD: 175 mm (5.4") x 292 mm (11.5") x 219 mm (8.6")
Input Power	120 +/- 10% or 240 +/- 10%, configurable
Line frequency	48 to 62 Hz. No adjustment necessary
Maximum Humidity	50%
Maximum Operating Temperature	40 C

## ***Approvals***

TSP Products are shown to meet the intent of Directive 89/336/EEC for Electromagnetic Compatibility and Low-Voltage Directive 73/23/EEC for product Safety. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

### EN 50081-1 Emissions

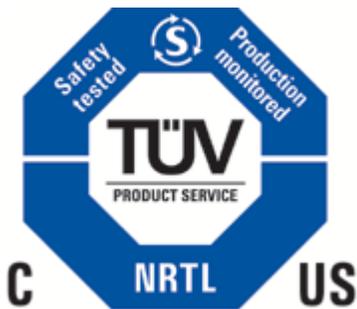
- EN 55011 Class A radiated and Conducted Emissions

### EN 50082-1 Immunity

- IEC 801-2 Electrostatic Discharge Immunity
- IEC 801-3 RF Electromagnetic Field Immunity
- IEC 801-4 Electrical Fast Transient/Burst Immunity

### Low Voltage Directive 73/23/EEC

- EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use



# Installation

## *Receiving and Unpacking*

Check the equipment received against the packing list enclosed to insure that all items shipped have been received. If there are any shortages, notify the carrier and Gamma Vacuum. Save all packaging material for inspection.

Inspect for any obvious damage. If the equipment is damaged in any way, a claim should be filed with the carrier (one copy to Gamma Vacuum). If equipment is to be returned for inspection or repair, authorization must be obtained from Gamma Vacuum Prior to reshipping. Instructions for return will be provided at that time.

## *Safety Notices*



**WARNING:** GAMMA VACUUM CONTROL UNITS DESIGNED FOR ION-PUMP OPERATION ARE CAPABLE OF DELIVERING 7000 VDC UNDER OPEN CIRCUIT OR LOW PRESSURE OPERATING CONDITIONS. GAMMA VACUUM PRODUCTS ARE DESIGNED AND MANUFACTURED TO PROVIDE PROTECTION AGAINST ELECTRICAL AND MECHANICAL HAZARDS FOR THE OPERATOR AND THE AREA SURROUNDING THE PRODUCT. OBSERVE ALL INFORMATION IN THIS SECTION.

Installation procedures are for use by qualified and authorized personnel who have experience working with voltages greater than 50 volts. To avoid personal injury, do not perform any installation or service procedures unless qualified to do so.

There are no serviceable parts inside the Remote TSP Controller.

Do not operate the control without a proper electrical ground or near water. The control may be damaged and its safety reduced, if it is operated outside of its specifications.

## Product Safety Labeling


**WARNING:**

SHOCK HAZARD. CAN CAUSE INJURY OR DEATH. REMOVE POWER BEFORE SERVICING.

**ALERTE:**

RISQUE DE CHOC. PEUT CAUSER DES BLESSURES OU LA MORT. RETIRER LA SOURCE D'ALIMENTATION AVANT LE SERVICE.

**警告：**

点検・修理の際は必ず全ての電源をお切りください。使用者が感電したり、死亡、または重傷を負う危険があります。

**安全警告：**

触电危険。触电可能导致受伤或死亡。请于维修前去掉电源。

**ADVERTENCIA:**

PELIGRO POR DESCARGA. PUEDE CAUSAR LESIÓN O INCLUSO LA MUERTE. RETIRE Y DESCONECTE LA FUENTE DE ALIMENTACION ELECTRICA, ANTES DE PROCEDER AL SERVICIO DE REPARACIÓN, MANTENIMIENTO O REVISION INTERNA.

**ACHTUNG:**

GEFAHR ELEKTRISCHER SCHLÄGE. VERLETZUNGS- ODER LEBENSGEFAHR. TRENNEN SIE ALLE ELEKTRISCHEN ANSCHLÜSSE VON DER SPANNUNGSVERSORGUNG BEVOR SIE ARBEITEN AN DEM GERÄT AUSFÜHREN


**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、移動や移設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 HUBVORRICHTUNGEN UND HEBETECHNIKEN VERWENDEN.


**WARNING:**

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

**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.

**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：**

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。

**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 PERJUICIO DEL EQUIPO.

**ACHTUNG:**

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

## TSP Installation Procedure

If purchased as part of an ion pump, the TSP and corresponding shield come pre-installed. Refer to this section if the TSP and shield are purchased separately.

### Required Items

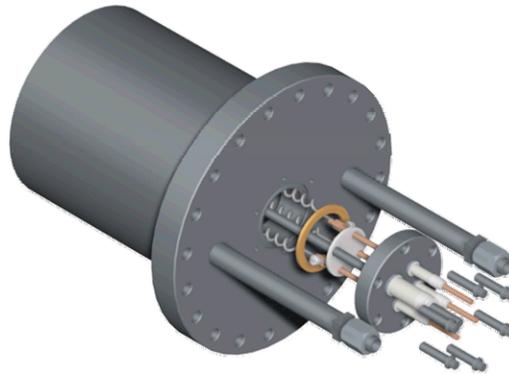
You need the following items to install the TSP:

- Cyroshroud, ambient sputter shield or suitable 2 3/4" CFF vacuum system port.
- 2 3/4", 3 3/8" and/or 8" CFF gaskets, washers, bolts and nut plates (provided with new equipment purchase).
- Corresponding wrenches for CFF bolts.

## Installation Procedure

Perform the following procedure to install the TSP and shield:

1. Place the 2 3/4" or 3 3/8" gasket on the corresponding shield port.
2. Insert the TSP in the corresponding shields (cryo shown) 2 3/4" or 3 3/8" port through the gasket.
3. Insert bolts through TSP flange into shield and tighten according to standard CFF procedures.
4. Place 8" CFF gasket on the proper inlet port to the vacuum system.
5. Insert the TSP/Shield assembly into the port through the gasket.
6. Insert 8" CFF bolts with washers through shield and into the mating port connections,
7. Secure with nut plates if required.
8. Tighten according to standard CFF procedures.



## ***Remote TSP Controller Installation Procedure***

The Remote TSP Controller requires a communication cable with the DIGITEL MPCe for proper operation.

### Required Items

You need the following items to install the TSP:

- DIGITEL MPC
- Communications cable (Gamma part numbers: 380049, 380050 or 380085)
- M4 hex wrench
- Phillips screw driver
- 5/16" hex driver, slotted screw-driver, or adjustable wrench
- Assembled TSP/Cryoshroud or TSP/Ambient Sputter Shield assembly

### Single TSP Procedure

Perform the following procedure to install the TSP and shield:

1. Place the Remote TSP Controller in the desired location. The Remote TSP Controller can be mounted using the installed bracket.
2. Connect the communications cable to the J505 connection on the back panel of the MPCe.
3. Route the communications cable from the MPC to the Remote TSP Controller.
4. Connect the communications cable to the J2/TSP1 connection on the Remote TSP Controller.

5. Route the high current cable to the TSP.
6. If installed, remove the strain relief shroud from the TSP connection using a Philips screw driver.
7. Place the shroud over the high current wires and around the cable. Loosen the wire clamp if necessary.
8. Connect the common high current wire to the longest copper connection and secure with the M3 set screw.
9. Connect remaining high current wires in the preferred order using the M3 set screw. The orientation of the wires to the connectors is not relevant for proper TSP operation and is governed by technician preference.
10. Reinstall the protective shroud.
11. Insert IEC power plug in to J1 connection on Remote TSP Controller.
12. Turn on power to the MPC.

### ***Dual TSP Installation Procedure***

Follow the above procedure with these exceptions:

1. Branch the communications cable at the controller end using a splitter cable (Gamma part number 390718) to the J2 (TSP-1 Control) and J3 (TSP-2 Control) connections.
2. Route the TSP1 and TSP2 high current cables to the respective TSP locations.

# Remote TSP Controller Operation

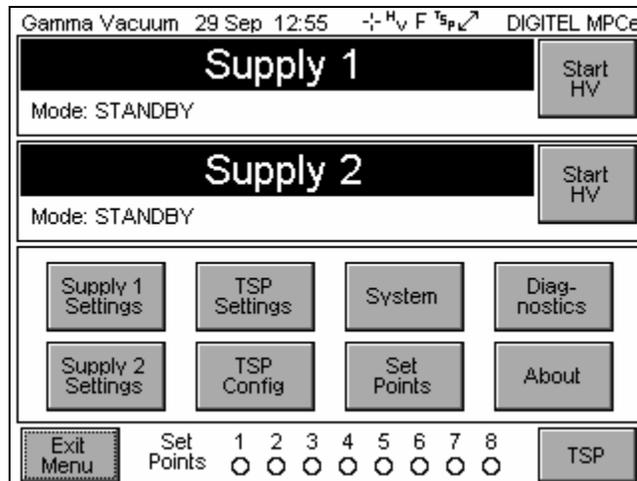
## Description

The Remote TSP Controller user interface is conducted through the MPCe front panel. For more information on how to use the MPCe, refer to the MPCe/LPCe Users Manual (pn 900015).



## Menu Display

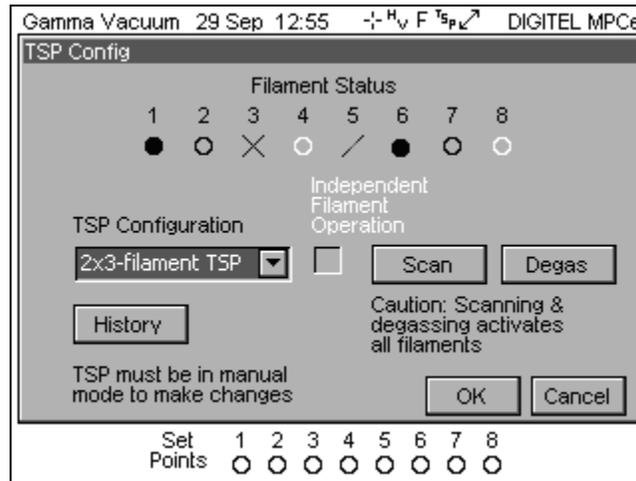
The TSP parameters are controlled through the MPCe Menu screen. The TSP functions are separated into 2 areas.



1. TSP Config (configuration): This section displays and controls possible hardware configurations. For example, how many TSPs and how many filaments each TSP has.
2. TSP Settings: This section displays and controls possible operation modes of the TSP and their parameters. For example, which TSP is configured with which pump and do they operate in manual or programmed mode.

## TSP Configuration (Config) Menu

The configuration menu applies to the hardware settings of the TSP(s) attached to the Remote TSP Controller. Upon entering this screen, the Remote TSP controller can automatically scan the available hardware and determine the configuration automatically by pressing the Re-Scan button. The configuration detected can be manually overwritten.



### Re-Scan

The Re-Scan button initiates a scan of the TSP hardware and automatically sets the TSP Configuration selected based on the hardware detected. In the event that a scan does not select the appropriate TSP Configuration, manually enter the desired configuration using the TSP Configuration pull down menu.

**Note:** Re-Scanning will activate all installed filaments.

### TSP Configuration

The TSP configuration pull down menu allows the current number of TSPs (1 or 2) and the current number of filaments (3 or 4) to be viewed and selected when automatically scanned or manually overwritten.

## Filament Status

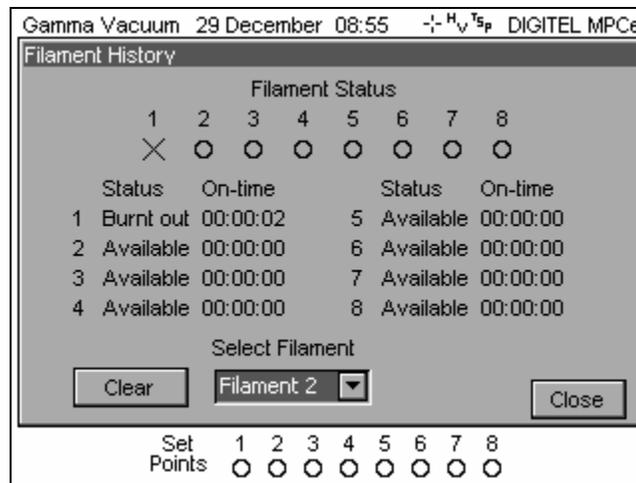
This area of the screen represents the current filament status through a graphical representation using the following symbols:

- A black filled-circle represents the selected filament (filament 1 in the above example).
- A black open circle represents a detected filament (filament 2 in the above example).
- An 'X' represents a filament that was previously detected. The controller assumes the filament to be burned out or not installed (filament 3 in the above example).
- A white open circle indicates that a filament has not been detected on that high current wire (filament 4 in the above example).
- A forward slash '/' indicates that the filament is installed, but is not achieving the desired level of current. This often occurs during the end of the filament life prior to it burning out (filament 5 in the above example).

## Independent Filament Operation

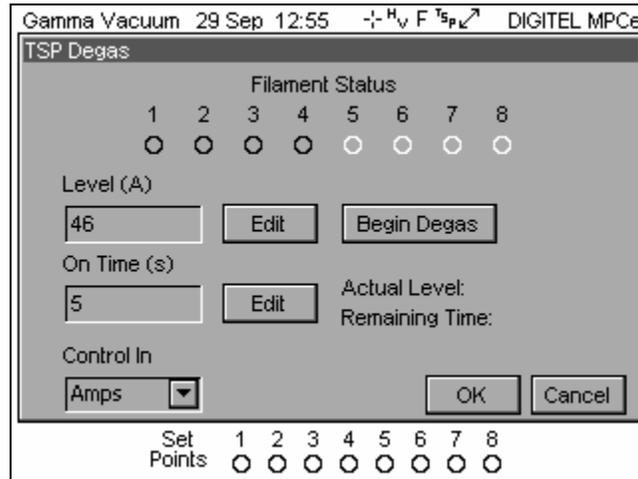
Selecting this box overrides the TSP configuration and forces each filament to be treated as an independent TSP (a one to one relationship). This option disables any programmed TSP parameters and can only be operated in manual TSP mode.

## History



This view shows the filament on-time and current status of each filament. These parameters can be cleared for each filament by selecting the filament in the Select Filament pull-down menu and pressing the Clear button.

## Degas



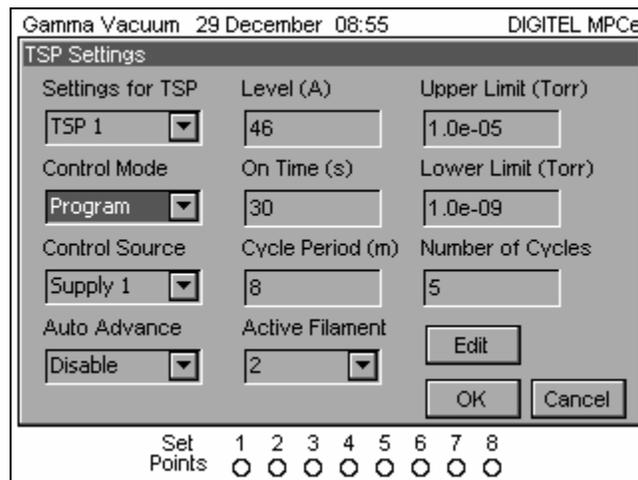
The TSP degass feature can be customized to specific amperage and on time values. While degassing, the actual levels are displayed. The degass routine ramps voltage up slowly for each active filament independently and maintains the set amperage for the set on-time.

**Note:** Degassing will activate all installed filaments.

## ***TSP Settings Menu***

The TSP settings menu allows control over software parameters for firing the TSP through the Remote TSP controller. Control mode can be set to either programmed or manual. Available options depend on the control mode selected.

## Programmed Mode Parameters



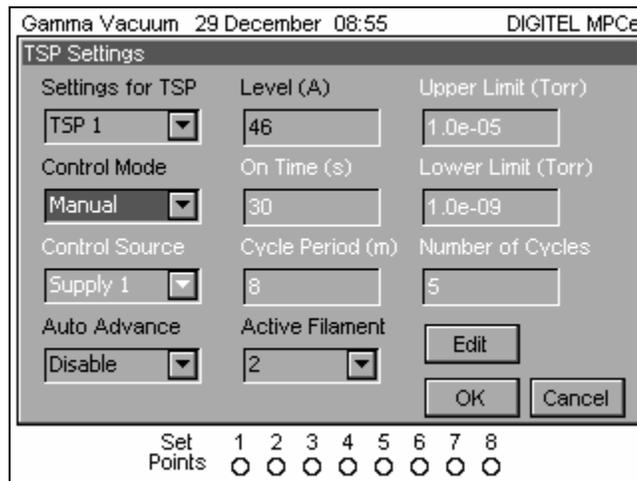
The available parameters in programmed control mode are:

- 1) Settings for TSP, selects if the shown parameters are for TSP1 or TSP2 (each TSP can be set for either manual or programmed).
- 2) Control Source, determines which supply (1 or 2) the current TSP responds to for pressure limits. If "None" is selected, the TSP program will activate regardless of any pump pressure.
- 3) Auto Advance, this feature determines if and what type of auto advance is used between filament firings. The available auto-advance options are:
  - a) Disabled, fires consistently on one TSP until it is burned out and does not activate another filament.
  - b) Balance, fires the active filament, then sets the active filament to the next sequential filament. When the last filament is reached, the rotation starts again at the first filament.
  - c) Next, fires the active filament until it can no longer fire, assumed it to be burned out, and then advances to the next sequential filament.
- 4) Level (A), when in edit mode, this value determines the maximum amperage or wattage applied to the filament. Amps or watts can be selected in the edit screen.
- 5) On Time, sets the number of seconds the TSP fires at the programmed level.
- 6) Cycle Period, the time in minutes between each TSP firing while within pressure limits. This can be set to an automated scale in the edit mode that changes the period based on pressure according to the following table:

Pressure (mbar)	Cycle Period (minutes)
$1 \times 10^{-6}$	10
$1 \times 10^{-7}$	20
$5 \times 10^{-8}$	30
$1 \times 10^{-8}$	60
$5 \times 10^{-9}$	200
$1 \times 10^{-9}$	400
$5 \times 10^{-10}$	600
$1 \times 10^{-10}$	800

- 7) Active Filament, determines the next filament to fire.
- 8) Upper Limit, if the pump pressure is higher than this pressure limit the TSP will not fire.
- 9) Lower Limit, If the pump pressure is lower than this pressure limit the TSP will not fire.
- 10) Number of Cycles, how many times the TSP fire. This can be set to infinite in the edit menu.

### Manual Mode Parameters

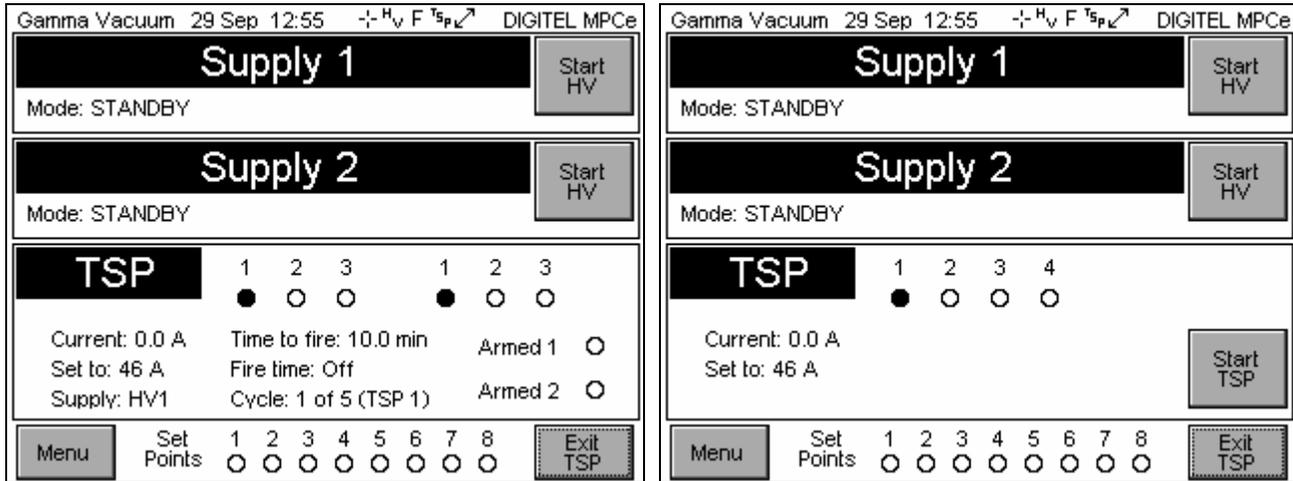


The available parameters in manual control mode are (unavailable options are grayed out):

- 1) Settings for TSP
- 2) Level (A)
- 3) Auto Advance
- 4) Active Filament

See above section for detailed descriptions

### **TSP Sublimation Screen**



Programmed and Manual Mode

Once the TSP has been properly configured and the settings entered, the TSP will show the appropriate parameters in the TSP firing screen. This screen is entered by pressing the TSP button in the lower right hand corner of MPCe units equipped with the TSP option.

In manual mode, a button allows for the direct control of firing TSP1 or TSP2 if configured.

# Procedures and Additional Information

## ***Cold Start Procedure***

This procedure is used when the pump is started after exposure to any pressure above 3.3 Pa (including atmospheric pressure).

1. Check to see that the ion pump power supply and TSP Control are properly connected and that the system is tightly sealed.
2. Begin the roughing procedure for the system.
3. Perform the Degassing Filament Procedure.
4. Start the ion pump (if available).
5. The roughing valve can normally be closed when the ion pump has started. This is indicated by an ion pump voltage of 2000V or greater.

**NOTE:** The titanium film that evaporates during Step 3 provides very high pumping speeds for certain gases. This results in faster starting for the ion pump and faster pump down at higher pressures (down to 1E-6 Pa), where ion pump speeds are slower.

## ***Degassing Filament Procedure***

New filaments or ones that have been up to air must be outgassed into the roughing system. The following procedure forces the major gas load from the filaments out of the system. A slight release of gas occurs each time a filament is cycled ON, which is quickly pumped away by the ion pump.

1. Rough the system to a pressure of 0.25 Pa or lower.
2. Initiate the degas procedure from the TSP Configuration Menu.

## ***Normal Operation***

The amount of sublimated titanium that is required during normal operation is a function of the gas load in the system. In some applications, such as thin film deposition, considerable titanium is required. In others, such as space simulation where the outgassing load is small, only an occasional layer of fresh titanium is required. The requirements of each application are best learned by experience. Use the information in this subsection as a guide.

**NOTE:** During operation the filament current should be set at 48 Amps for a 30-second cycle time. Current levels lower than 47 Amps sublimate less titanium and current levels above 50 Amps tend to shorten filament life.

## ***Titanium Consumption***

The consumption of titanium is a function of pressure experienced. At higher pressures, the titanium combines with a relatively large quantity of gas. The rate of arrival of gas molecules at the surface is greater than the rate of arrival of titanium. Under these conditions, all the molecules of titanium combine with a gas molecule before the next monolayer of metal is deposited. At low pressures used titanium can be covered before it combines with a gas molecule. Therefore it is desirable at lower pressures to deposit a thin film of titanium and allow it to pump before covering up that layer. After a period of time, the residual pumping effect of the titanium decays and a fresh layer of material should be deposited.

## ***Filament Replacement Procedure***

Gamma Vacuum offers a replacement filament kit (pn 360028). This kit is required to perform filament maintenance of the TSP. The kit consists of:

- 12 spiral titanium/molybdenum alloy filaments
- 24 stainless steel screws (newer TSPs only require 12 of these)
- 24 copper lugs (newer TSPs only require 12 of these)
- Four 2 3/4" and three 3 3/8" silver plated gaskets (for use with either a 3 or 4 filament TSP respectively)
- Wrench (a special wrench designed to prevent bending of posts during filament installation)

To replace the filaments:

1. Turn off the power to the TSP.
2. Vent the system. Use dry nitrogen if possible.
3. Remove the TSP from the vacuum system.
4. Remove the existing filaments by unscrewing the attached screws and/or set screws.
5. Clean electrical contacts of the filament holder using a wire brush suitable for vacuum use (e.g. clean stainless steel). If the wire brush does not clean them, sand blasting may be necessary.

**Caution:** Premature filament failure may result if the contacts are not sufficiently cleaned.

6. Rotate the filament so that it is as far as possible from the center (current return) post.

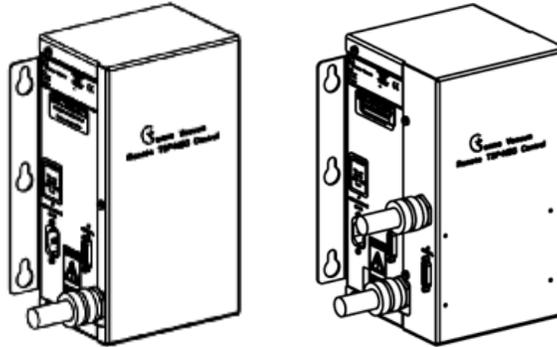
**Caution:** Bending the filaments away from the center post after they have been tightened (step 6) may cause early failure.

7. Secure the filaments with the new copper lug. Use the special wrench provided (or use a pliers) to hold the lug while it is being tightened to prevent the filament holder from bending and putting a pre-stress on the cold filament.
8. Reinstall the TSP per the Installation Procedure section of this manual.
9. Follow the Degassing Filament Procedure in this manual. Then, the filaments are ready for normal operation.

# TSP Controller Connections

## Description

The figure below shows the Remote TSP Controller connections.



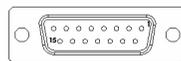
Single and Dual Remote TSP Controller

## Power Input, J1

The J1 location is dedicated to input power. It is a standard IEC interface. Prior to attaching input power, verify the proper voltage of the unit is 120 or 240 volts by observing product labeling. This information is available on the serial number block of the unit and near the J1 connection.

Contact Gamma Vacuum if a change in input power is required.

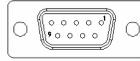
## MPC/MPCe Controller, J2 (J2/J3 for Dual only)



The Remote TSP/NEG Controller is supplied with a 15-pin Sub-D connector to facilitate communications between the MPC and Remote TSP/NEG Controller. The mating connection on the MPC/MPCe is J505.

**NOTE:** A Y cable is required for Dual TSP Remote TSP Controller operation. Connections are made according to labels on Y cable.

## MPCe Serial Interface, J112 (MPCe Backpanel)



Detailed Command/Response packet information is available in the MPCe manual (PN 900015).

### Remote TSP/NEG Serial Commands

Hex Command	Description	Data Field	Response	Data/Response Interpretation
27	TSP1 TIMED, Sets TSP1 mode of operation to programmed. Cycles TSP once every X minutes, for Y number of cycles, but only if pressure is above specified amount. Applicable to MPCe and legacy product.	XXX,YYY, Z.ZE-ZZ,DDD	-	XXX is the cycle period in minutes YYY is the number of cycles Z.ZE-ZZ is the pressure DDD is the duration of each firing is seconds
79	TSPX TIMED, Sets TSP (1 or 2) mode of operation to programmed. Cycles TSP once every X minutes, for Y number of cycles, but only if pressure is above specified amount. MPCe only.	N, XXX,YYY, Z.ZE-ZZ, A.AE-AA,DDD, W	-	N is the corresponding TSP (1 or 2) XXX is the cycle period in minutes YYY is the number of cycles Z.ZE-ZZ is the upper pressure A.AE-AA is the lower pressure DDD is the duration of each firing is seconds W, is set to 1 to ignore pressure (automatic cycle period)
28	TSP OFF, Disables TSP firing is all modes (manual, programmed, and degass)	-	-	
29	FILAMENT ACTIVE, Sets which filament is active during TSP Timed	N	-	N = Filament number (1-8)
2A	TSP1 STATUS, Reports how many cycles left and minutes each filament has been used. Applicable to MPCe and legacy product.	-	CCC, N- MMMM, N- MMMM, N- MMMM, and N- MMMM	CCC = number of remaining cycles N = filament number (1-4) MMMM = total minutes of filament use, 0 if degassing, 9999 if open
65	TSPX STATUS, Reports how many cycles left and minutes each filament has been used. MPCe only	R	CCC, N- MMMM, N- MMMM, N- MMMM, and N- MMMM	R = the corresponding TSP (1 or 2) CCC = number of remaining cycles N = filament number (1-4) MMMM = total minutes of filament use, 0 if degassing, 9999 if open
2B	FILAMENT CLEAR, Executed after degassing Resets logged time of all filaments to zero	-	-	-
2C	FILAMENT AUTO1, Automatically advances to the next filament if the one being used is open. Applicable to MPCe and legacy product.	"YES" or "NO"	-	-

Hex Command	Description	Data Field	Response	Data/Response Interpretation
77	FILAMENT AUTOX, Automatically advances to the next filament if the one being used is open. MPCe only.	R, I	-	R = the corresponding TSP (1 or 2) I = rotation mode 0 = disabled 1 = balanced 2 = next
2D	TSP CONTINUOUS, Sets the TSP mode of operation to manual	-	-	-
2E	SUBLIMATION LEVEL 1, For programmed mode of operation, sets the TSP controlling parameter (watts or amps) and its corresponding value. Applicable to MPCe and legacy product.	XXX,P, N	-	XXX = parameter value P = W (watts), A (amps) N = on time in seconds (0-255)
78	SUBLIMATION LEVEL X, For programmed mode of operation, sets the corresponding TSP controlling parameter (watts or amps) and its corresponding value. MPCe only.	R, XXX,P	-	R = the corresponding TSP (1 or 2) XXX = parameter value P = W (watts), A (amps)
2F	DEGAS Runs the degas feature	-	-	-
30	GET SUB LEVEL 1 Reads the TSP sublimation level and the controlling parameter either Amps or Watts. Applicable to MPCe and legacy product.	-	XXX, P	XXX = watts or amps P = W (watts) or A (amps)
81	GET SUB LEVEL X Reads the corresponding TSP sublimation level and the controlling parameter either Amps or Watts. MPCe only.	R	XXX, P	R = the corresponding TSP (1 or 2) XXX = watts or amps P = W (watts) or A (amps)
31	GET QUAL PRESSURE 1 Reads the programmed TSP qualifying pressure	-	Z.ZE-ZZ	Z.ZE-ZZ is the pressure
82	GET QUAL PRESSURE X Reads the programmed TSP qualifying pressure	R	Z.ZE-ZZ, X.XE-XX	R = the corresponding TSP (1 or 2) Z.ZE-ZZ is the upper pressure X.XE-XX is the lower pressure
70	INSTALLED CONDITION Returns the state of the remote TSP box connectivity.	-	"YES" or "NO"	-
71	FIRING CONDITION Returns the firing state of the remote TSP. Filament or TSP number is not identified.	-	"YES" or "NO"	-
72	GET TIME 1 (DURATION) Returns the TSP on-time in seconds for TSP 1. Applicable to MPCe and legacy product.	-	DDD	DDD = duration value set in the TSP1 TIMED command in seconds.
83	GET TIME X Returns the TSP on-time in seconds for the corresponding TSP/ MPCe only.	R	DDD	R = the corresponding TSP (1 or 2) DDD = duration value set in the TSPX TIMED command in seconds.
73	GET PERIOD 1 Returns the TSP period in seconds for TSP 1. Applicable to MPCe and legacy product.	-	DDD	DDD = period value set in the TSP1 TIMED command in seconds.
84	GET PERIOD X Returns the TSP period in seconds for the corresponding TSP. MPCe only.	R	DDD	R = the corresponding TSP (1 or 2) DDD = period value set in the TSPX TIMED command in seconds.

Hex Command	Description	Data Field	Response	Data/Response Interpretation
74	GET CURRENT Returns the instantaneous TSP current of the firing filament.	-	XXX, P	XXX = parameter value P = W (watts), A (amps)
86	SET CONFIGURATION Sets the TSP filament configuration.	N	-	N = configuration mode 0 = invalid 1 = not installed 2 = NEG 3 = Single TSP, 3 filament 4 = Single TSP, 4 filament 5 = Single TSP, 6 filament 6 = Single TSP, 8 filament 7 = Dual TSP, 3 filaments 8 = Dual TSP, 4 filaments
87	GET CONFIGURATION Returns the TSP filament configuration.	-	N	N = configuration mode 0 = invalid 1 = not installed 2 = NEG 3 = Single TSP, 3 filament 4 = Single TSP, 4 filament 5 = Single TSP, 6 filament 6 = Single TSP, 8 filament 7 = Dual TSP, 3 filaments 8 = Dual TSP, 4 filaments
88	SET IND MODE Enables and disables the TSP independent mode.	"YES" or "NO"	-	-
89	GET IND MODE Returns the TSP independent mode status.	-	"YES" or "NO"	-
8A	AUTO SCAN Rescans the filaments to determine filament configuration. CAUTION: Activates all filaments.	-	-	-
8B	SET CONTROL SOURCE Sets the HV control source for programmed mode of corresponding TSP.	R, N	-	R = the corresponding TSP (1 or 2) N = High Voltage Section (1 or 2)
8C	GET CONTROL SOURCE Returns the HV control source for programmed mode of corresponding TSP.	R	"HV 1" or "HV 2"	R = the corresponding TSP (1 or 2)
93	GET VOLTAGE Returns the instantaneous TSP voltage of the firing filament.	-	"XXXX"	XXXX = TSP voltage
D2	SET DEGASS Sets TSP DEGASS parameters	XX, NNN	-	XXX = number of watts or amps NNN = the number seconds (0 - 255)
D5	GET ACTIVE TSP Returns the current active TSP	-	"N"	N = 1 or 2

# Warranty & Service

## ***Service***

### 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 Buyers sole exclusive remedy under this warranty, Gamma Vacuum agrees to either repair or replace, at Gamma Vacuums 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 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 of 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 directly or a representative of Gamma Vacuum. 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 [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 the Gamma Vacuum toll-free number. 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 process 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 in word and return to Gamma Vacuum in word, Adobe Acrobat format (.pdf), or via fax. The "tab" key moves between fields. Digital signatures are acceptable.

### Assigned RMA:

### Your Reference:

### Company Information

Company Name:

Date:

Address:

### Contact Information

Name:

Phone:

Primary E-mail:

Fax:

Web Site 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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