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vacuum
environments
on Earth.

Titanium Sublimation Pump & TSP Controller Users Manual

PN 900027, Rev B

Specification information is located on our website at:

www.gammavacuum.com

ISO 9001:2008 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 (LN₂) Cryoshroud

A cryo shroud provides capture and hold of H₂O & CO₂ pumping when cooled with LN₂. 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 LN₂ (liquid nitrogen). When used with LN₂, 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.

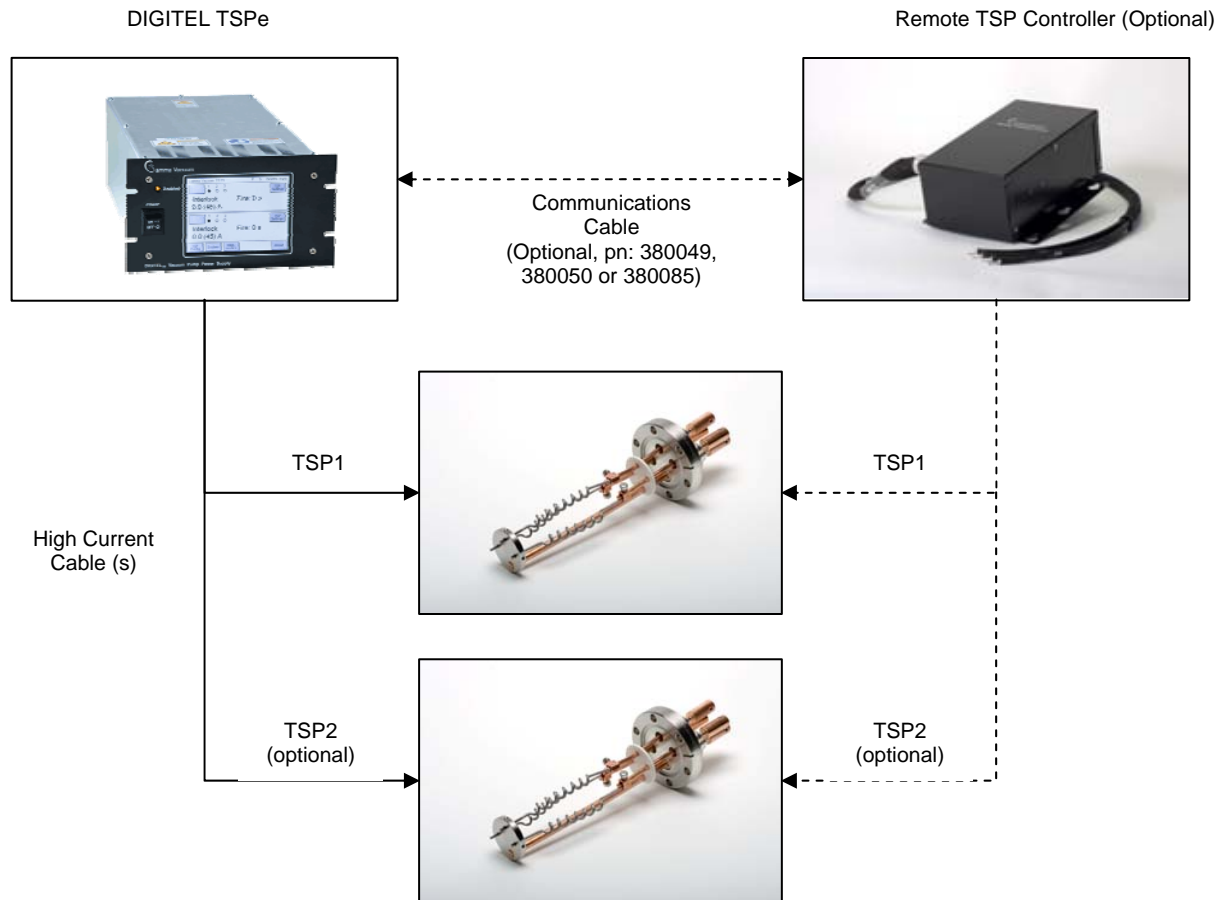


DIGITEL TSPe Controller

The DIGITEL TSPe controller allows control of a TSP (titanium sublimation pump) or NEG (non-evaporable getter). It has the capability of operating up to 8 filaments total in any TSP configuration (independently, 3 or 4 filaments per TSP).

The TSPe controller system consists of:

- TSPe Control unit
- Optional remote TSP controller and communications cable
- High-current cable from the Remote TSP/NEG Control to the TSP/NEG



TSP Specifications

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

DIGITEL TSPe Controller Specifications

Parameter	Specification
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)	55 Amps (1000 watts)
Voltage Output (max)	14 VAC
Power Ramp Rate (amps/sec)	5
Dimensions	WxHxD: 3U x ½ rack x 438 mm (17.2")
Input Power	120 +/- 10% or 240 +/- 10%, configurable
Line frequency	47 to 63 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

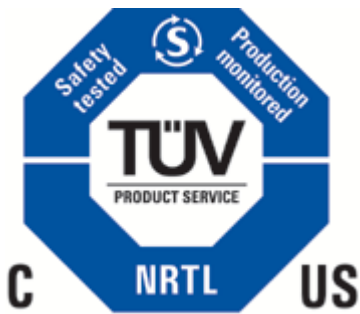
- EN 55011 Class A radiated and Conducted Emissions

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.

遠园! !

瓊汗Ⓞ几腕ワ釣キ!
所ホ樹ヨワ統ヲ(名)!
ニ吊(体)バメブヅゐ!
兮罾若ネ損統へム!
(体)わ滝儼わ(ム)キ!
霖(名)郷デ嗽嚙ネ!
ッ(体)へゐ!

楮榭遠园! !

! 躲电危险。躲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.

遠园! !

寓高霖ヅ越茹ヨベ!
み眾昆(名)筋(名)藜(名)阨(名)!
劬(名)罕(名)髻(名)瓊(名)わ(名)!
哲(名)纒(名)載(名)ワ(名)釣(名)キ(名)!
吊(名)ル(名)敏(名)疎(名)ヲ(名)種(名)唱(名)溜(名)!
壯(名)罕(名)兮(名)罾(名)へ(名)ヨ(名)バ!
メ(名)ブ(名)ヅ(名)ゐ!

楮榭遠园! !

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

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.

遠园! !

ピワ越茹(名)兮罾(名)!
金(名)閑(名)具(名)レ(名)所(名)ホ(名)喚(名)敏(名)!
辺(名)梵(名)膝(名)猷(名)献(名)辻(名)へ(名)腕(名)!
軀(名)へ(名)倉(名)ヨ(名)フ(名)兮(名)罾(名)!
バ(名)メ(名)ブ(名)ヅ(名)ゐ(名)喚(名)敏(名)辺(名)!
梵(名)膝(名)ワ(名)鐙(名)栴(名)柿(名)克(名)!
へ(名)ル(名)ヌ(名)ヤ(名)ム(名)嬌(名)嚙(名)わ(名)!
越(名)茹(名)ネ(名)瞳(名)劬(名)わ(名)宛(名)瞳(名)!
ベ(名)体(名)ビ(名)ラ(名)ネ(名)ッ(名)体(名)へ(名)!
べ(名)ゐ!

楮榭遠园! !

! 在使用这台机器前，请务必阅读并理解“操作员手册（指南）”。如果不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

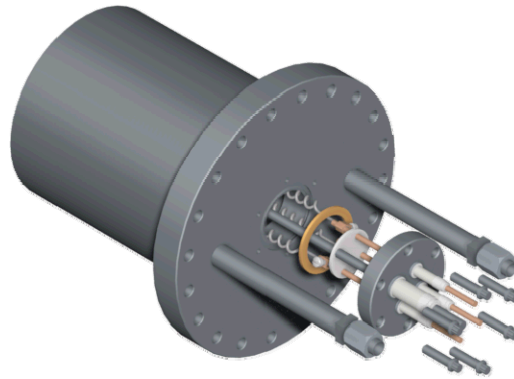
You need the following items to install the TSP:

- 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.



TSPe Controller Installation Procedure

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

Required Items

You need the following items to install the controller:

- 3-wire, detachable universal input power cable (included with controller)
- High current (H-C) cable for each TSP (ordered separately)

Perform the following procedure to install the TSPe controller:

1. Place the TSPe Controller in the desired location.
2. Connect the MS Style connector to the back of the TSPe controller.
3. Route the high current cable to the TSP.

NOTE: There are two types of connection systems available on the TSP. The older lug style connection system was used from the 1970's until 2010. Beginning in 2011, the TSP feedthrough was changed to an MS Style connector. If there is not an MS Style connector, continue to step 5.

4. If an MS style connector is on the TSP feedthrough, connect the H-C current cable to the TSP. Do not continue to step 5.
5. If installed, remove the strain relief shroud from the TSP connection using a Philips screw driver.
6. Place the shroud over the high current wires and around the cable. Loosen the wire clamp if necessary.

7. Connect the common high current wire to the longest copper connection and secure with the M3 set screw.
8. 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.
9. Reinstall the protective shroud.
10. Turn on power to the TSPe.

Dual TSP Installation Procedure

Follow the above procedure with these exceptions:

1. Route the TSP1 and TSP2 high current cables to the respective TSP locations.

Remote TSP Controller Installation Procedure

Please reference PN 900016, Titanium Sublimation Pump & Remote TSP Pump Controller Users Manual.

TSPe Controller Operation

Description



Power On/Off Switch

The main switch controls the input power to the controller. Off and on positions are indicated on the switch. Turning off the controller will immediately disable all power from the outputs on the back panel.

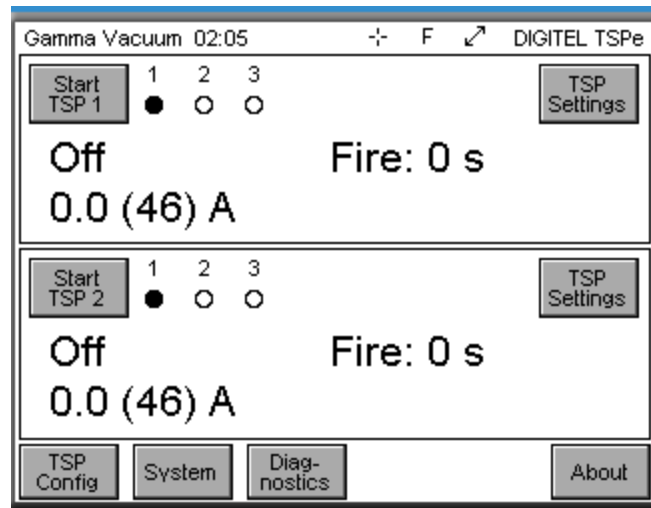
High Current Indicator Lights

A high current indicator light indicates power is being applied to a single filament of a TSP or NEG element.

LCD Touch Screen

This interface consists of a ¼ VGA LCD touch screen. This screen is used for all front panel operations excluding the main power on/off switch.

Main Display

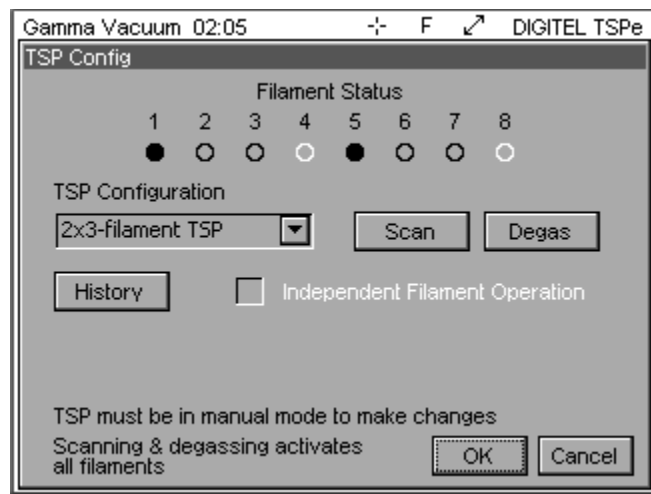


The main display of the TSPe is shown upon start-up of the controller. This display is comprised of four areas:

1. TSP identification and status information
2. TSP 1 and TSP 2 settings parameters
3. Overall TSP configuration parameters
4. System and Diagnostics tools and parameters

TSP Configuration (Config) Menu

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



Scan

The 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

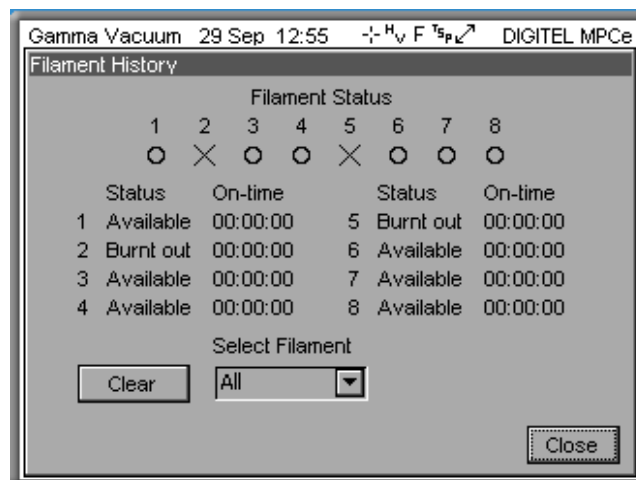
This area of the screen represents the current filament status through a graphical representation using the following symbols:

- 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

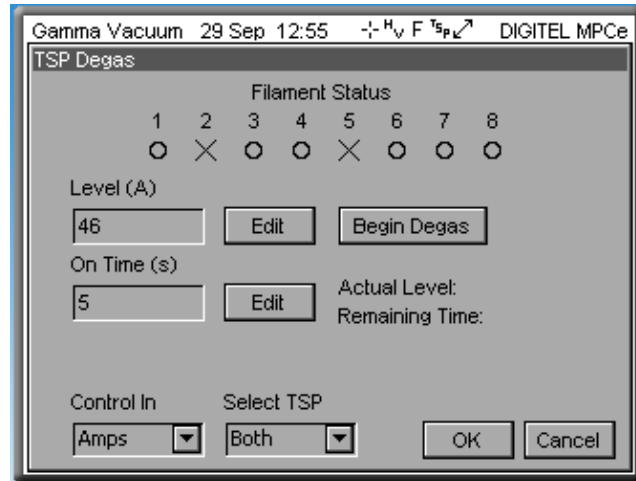
Selecting this box overrides the TSP configuration and forces each filament to be treated as an independent TSP (a one to one relationship). This option disables any programmed TSP parameters and can only be operated in manual TSP mode.

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



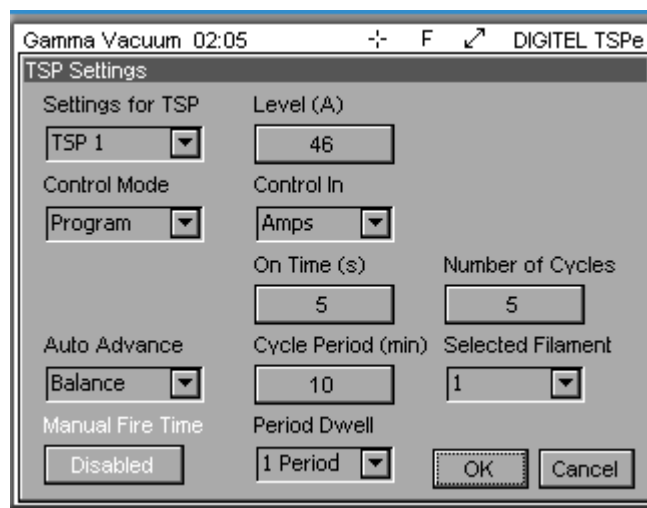
The TSP degass feature can be customized to specific amperage and on time values. While degassing, the actual levels are displayed. The degass routine ramps voltage up slowly for each active filament independently and maintains the set amperage for the set on-time.

Note: Degassing will activate all installed filaments.

TSPe 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.

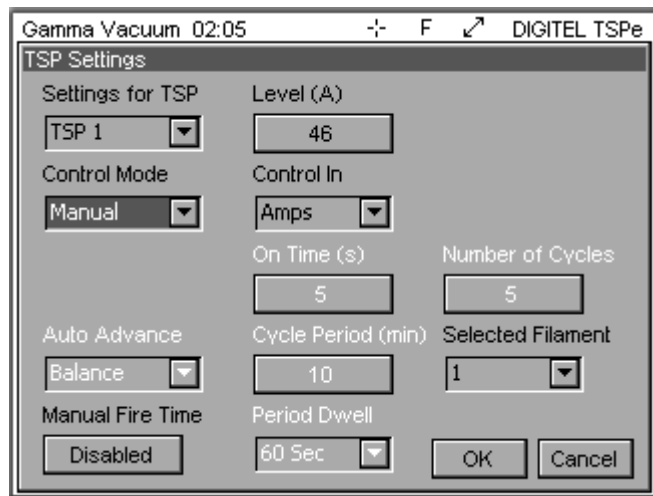
Programmed Mode Parameters



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 Mode enables programmed or manual modes of operation.
- 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) Manual Fire Time, sets an automatic shut-off of manual firing when programmed. If this value is not set the TSP firing must be manually stopped (Maximum time 999 Seconds).
- 5) 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.
- 6) On Time, sets the number of seconds the TSP fires at the programmed level (Maximum time 999 Seconds).
- 7) Cycle Period, the time in minutes between each TSP firing.
- 8) Active Filament, determines the next filament to fire.
- 9) Number of Cycles, how many times the TSP fire. This can be set to infinite in the edit menu.
- 10) Selected Filament, chooses which filament to fire or start the auto advance feature from.
- 11) Period Dwell, determines the time to wait to fire after programmed mode has been enabled.

Manual Mode Parameters

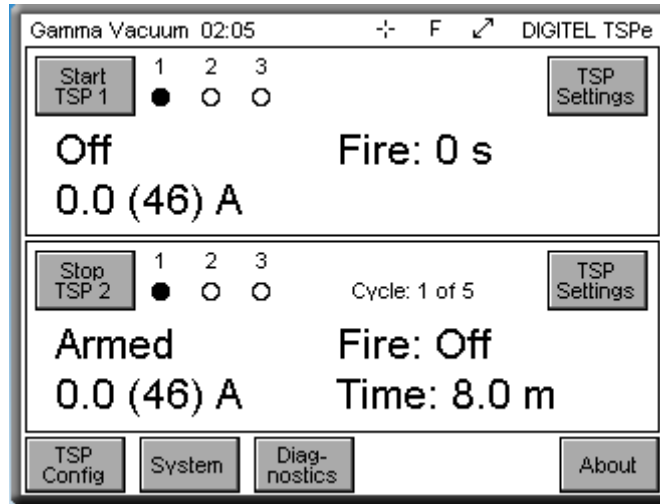


The available parameters in manual control mode are (unavailable options are grayed out):

- 1) Settings for TSP
- 2) Level (A)
- 3) Auto Advance
- 4) Selected Filament
- 5) Manual Fire Time

See above section for detailed descriptions

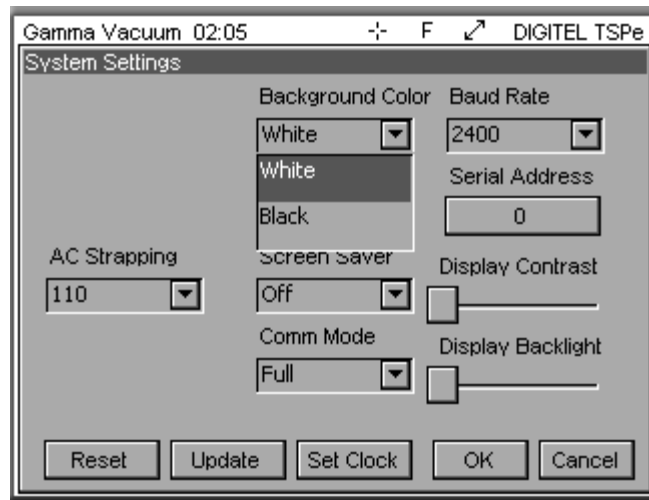
TSP Sublimation Screens



Manual and Programmed Mode

Once the TSP has been properly configured and the settings entered, the TSPe will show the appropriate parameters in the TSP firing screen.

System Menu



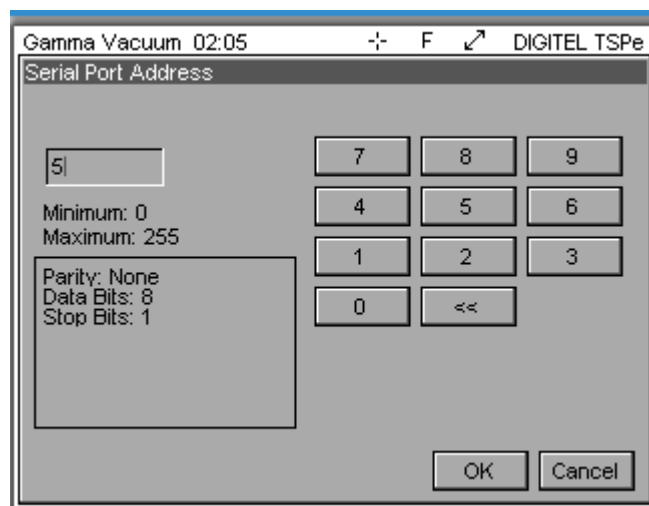
System settings are entire controller parameters that are not specific to supply one or supply two. Values are selectable via pull-down menus or edit buttons. When parameters are entered press the OK button.

Comm Mode

The communications mode determines local, full, or remote control of the controller. In local mode, the controller only accepts front panel commands and serial communication is ignored. In full mode, the controller accepts both front panel and serial commands. In remote mode, the controller accepts only serial commands and the front panel becomes locked. To unlock the front panel, press and hold the 'Supply 1' area of the screen for several seconds.

Serial Address

The controller supports RS 232/422/485 serial standards. These protocols require the controller to have a unique address. For controllers set in the same 485 string, this address must be unique for each controller in the string. The default value set is five (5). The address can be between 0 and 255. The << button is equal to a backspace.



Reset

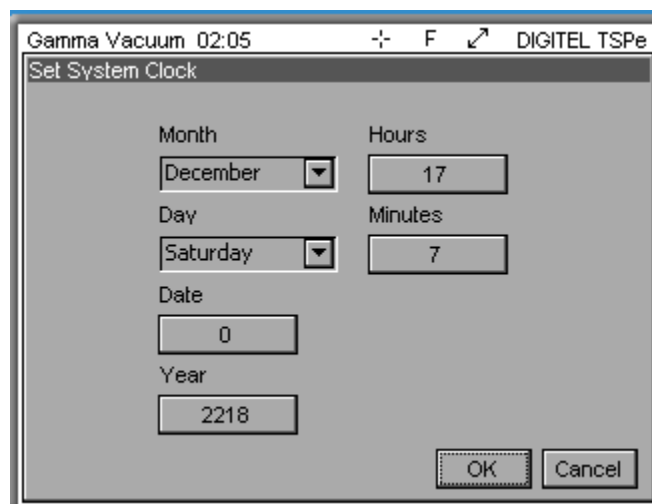
Selecting this option resets all TSPe system parameters to their default values. A confirmation is required.

Update

This option initiates an on screen message to confirm that a new firmware version is to be loaded. For further information, contact Gamma Vacuum and reference Service Bulletin 00.004.343.

Set Clock

Settable parameters include hours, minutes, day, date, month, and year. Hours are in 24 hour format. AM and PM are not selectable. When parameters are entered, press the OK button.



The screenshot shows a dialog box titled "Set System Clock" with the following fields and values:

Field	Value
Month	December
Day	Saturday
Date	0
Year	2218
Hours	17
Minutes	7

Buttons: OK, Cancel

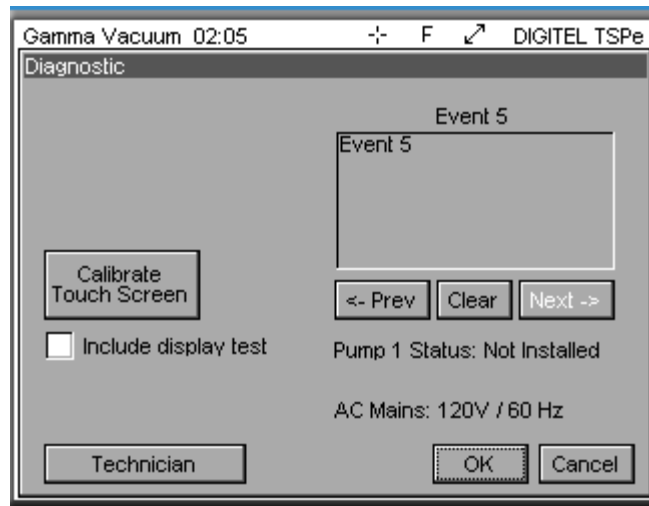
Background Color and Display Contrast

These parameters change the appearance of the LCD touch screen. Depending on lighting and individual preference, one value may appear better to a particular individual. The background can be changed between white, black, and gray. The contrast is scalable through seven settings. Contact Gamma Vacuum if the contrast needs altering beyond the 7 scalable software units.

Screen Saver

The compact florescent bulb in LCD touch screen is automatically dimmed to 50% brightness after 30 minutes of inactivity to conserve bulb lifetime. The time interval of this screen saver can be set to 30 minutes, 4 hours or 8 hours. It can also be disabled.

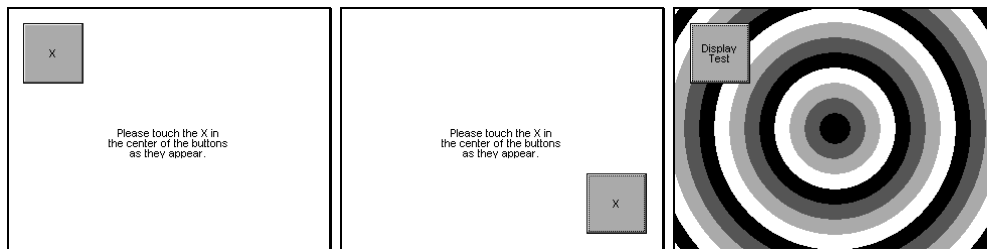
Diagnostic Menu



The diagnostic menu provides screens for calibrating and determining historical events recorded in the event log. Memory information is also provided for service/support diagnostic information.

Calibrate Touchscreen

To accurately represent button presses with corresponding information on the screen, the touchscreen may require calibration. When started, the controller goes through the calibration steps on the screen for reference. It is important that when pressing the target X calibration buttons that the user press the X firmly and hold for at least ½ second. An additional display test can be added to verify contrast settings show distinction between all gray scales.

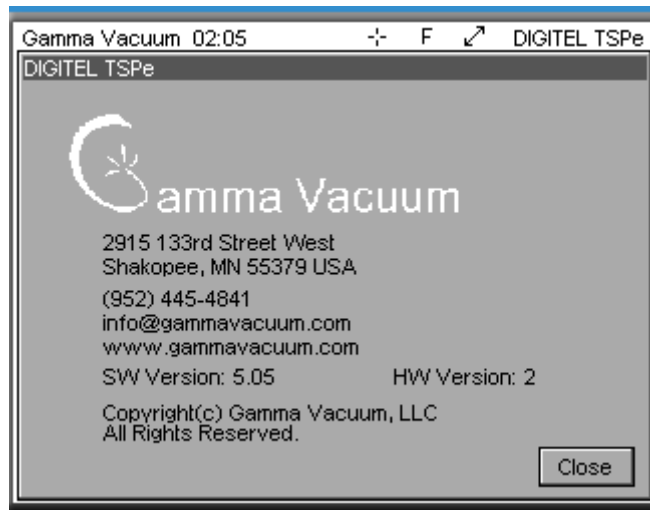


Event Log

The Event Log stores information whenever a significant “event” occurs. The log contains up to 50 events. When the buffer is full, the earliest event is erased to store a new event. The <- and -> buttons navigate from one event to another. An event contains the following information:

1. The supply the event occurred on.
2. The type of event that occurred.
3. The date and time when the event occurred.
4. Supply voltage and current at the time of the event.

About Menu



The about menu shows Gamma Vacuum contact information and installed software revision. Revision information may be required for service or support from Gamma Vacuum.

The Required Loader indicates the version of the bootloader that the software expects to be present. Contact Gamma if a different version is loaded than is shown on this screen. The first number of the Altera version is the version of Altera PLDs loaded on the processor board, and the second number (in parentheses) is the version expected. Again, contact Gamma if a different version is loaded than is shown on this screen.

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 TSPe Controller connections.



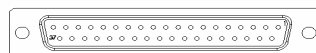
TSPe Controller (2 connections shown)

Power Input, J507

The J507 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 connection.

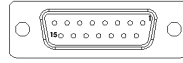
Contact Gamma Vacuum if a change in input power is required.

Set Point/Analog Output, J104



J104 is a 37-pin, female Sub-D connector that is not used in the TSPe controller.

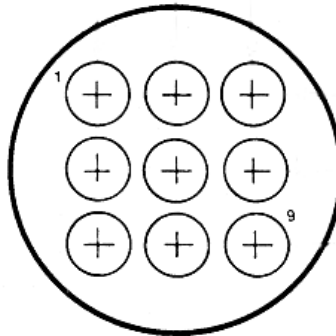
Remote TSP/NEG Control, J505 (Optional)



The Remote TSP/NEG Controller requires a 15-pin Sub-D connector to facilitate communications between the TSPe and Remote TSP/NEG Controller. This connection is made using a 15-pin Sub-D cable available from Gamma Vacuum.

NOTE: Details of the TSP/NEG option are available in the Remote TSP Controller Manual.

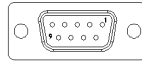
High Voltage/TSP Interlock, J506 (Optional)



The remote interlock allows disabling of the high voltage outputs or TSP filament firing.

To enable the TSP (if installed), short pins 2 to 4 and 6 to 8 for TSP 1 and TSP 2 (if available) respectively.

TSPe Serial Interface, J112



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

TSP/NEG Serial Commands

Hex Command	Description	Data Field	Response	Data/Response Interpretation
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. Pressure values are ignored for TSPe application.	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 in seconds W, is set to 1 to ignore pressure (automatic cycle period)
28	TSP OFF, Disables TSP firing in all modes (manual, programmed, and degass)	-	-	
29	FILAMENT ACTIVE, Sets which filament is active during TSP Timed	N	-	N = Filament number (1-8)
65	TSPX STATUS, Reports how many cycles left and minutes each filament has been used.	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	-	-	-
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	-	-	-
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	-	-	-
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)

Hex Command	Description	Data Field	Response	Data/Response Interpretation
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"	-
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.
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.
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.	-	-	-
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.

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 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.

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.)

2915 133rd Street West, Shakopee, MN 55379

Phone: 952-445-4841 Fax: 952-445-7615

e-mail: <mailto:info@gammavacuum.com> web site: www.gammavacuum.com