Gamma Vacuum

Creating the purest vacuum environments on Earth.

Small Pump Controller (SPCe) Users Manual

PN 900026, Rev B

Specification information is located on our website at:

www.gammavacuum.com

ISO 9001:2008 Certified

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General Information

The DIGITEL SPCe is an ion pump power supply. It requires an external 24V DC power supply. An external mains adapter is available to permit operation from 85 to 260V AC, 50 or 60Hz. The SPCe is an 'intelligent' programmable power supply featuring an LCD display navigated through soft keys. It is ¼ rack and 2u high with an optional rack mount kit.

It can be controlled from the front panel or remotely through serial or Ethernet communication interfaces. The serial interface supports RS-232/422/485 protocols.

Features

High Voltage Module

The high voltage output is generated by a 40W, 40mA (max) switching supply. The desired output voltage may be programmed to be in the range 3000 to 7000 volts. The output connector is a standard SHV 10kV and includes the SAFE-CONN interlock.

Serial/Ethernet Ports

The SPCe can be interfaced and remotely controlled by a computer via serial or Ethernet protocols. All commands entered from the front panel can be performed from the serial or Ethernet port.

Analog Outputs

Two buffered analogue outputs (0 .. 10V) are provided, one reports ion-pump current or pressure and the other reports ion-pump voltage. These can be scaled in software.

SAFE-CONN

When operated with SAFE-CONN safety interlocked pumps and cables, the SPCe will not allow high voltage operation when the high voltage cable is disconnected at either the pump or controller end. When high voltage is operating the unit automatically shuts off high voltage and provides protection from possible human shock hazard.

Set Point

One programmable process relay and TTL control set point is available and controlled by ion pump pressure readings.

AUTOSTART/AUTORUN

AUTOSTART/AUTORUN determines optimum starting and operating conditions based the pump size entered and then starts and monitors the pump down without assistance. In start mode, because an ion pump can draw high currents, the controller goes through a protected-start process, monitoring current, voltage, power, and time. If the pump starts properly, the controller automatically goes into AUTORUN protection mode. If the pump does not start properly — the controller puts the pump into a cool-down mode. If the pump does not start properly after three tries, a message is displayed and the controller shuts down high voltage.

The SPCe continuously protects the ion pump during start-up and normal operation. If there is a vacuum failure, the controller shuts down high voltage, thereby preventing serious damage. It can also detect power failures and be configured to automatically restart high voltage after a power loss, if desired.

Remote Control

A digital input is provided which can be used to remotely turn the SPCe on or off.

Specifications

Parameter	Specification
Operating temperature	0 to 40°C
Operating humidity	0 to 80% RH (non-condensing)
Storage temperature	-20 to 70°C
Dimensions	WxHxD: 110 mm (4.3") x 92 mm (3.6") x 313 mm (12.3")
Power Adapter Input power requirements	115 VAC, 210-230 VAC configurable 48 to 62 Hz. No adjustment necessary
SPCe Input power requirements	24v DC 66W (max) 11W (typical) 6W (high voltage off)
Serial interface: Protocols Baud Rate number of stop bits parity number of data bits	 RS232, RS422, RS 485 9600 1 none 8
Ethernet	Programmable IP
Set points (1):	
Type	Relay and TTL
Electrical characteristics	Relay: 2 A, 250V, maximum TTL: 15 mA, maximum
Response time	200 milliseconds, max
High voltage output:	3000 to 7000 VDC, programmable 40W, 40 mA (max)
Polarity	Positive or negative (factory configurable)
Analog outputs:	0 to 10V default
Voltage Current	1V per 1000 volts programmable
Pump size	Programmable from front panel or serial/Ethernet commands

Approvals

The SPCE meets 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 61326-1 Emissions

- Class A radiated and Conducted Emissions

EN 616326-2-1 Immunity

- Electrostatic Discharge Immunity
- RF Electromagnetic Field Immunity
- 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

The SPCe must be powered by a commercially available supply which fulfils the requirements of CE and NRTL. This unit is provided with a supply by Gamma Vacuum that meets these requirements. Failure to operate the SPCe with the supplied power supply may not confirm to these requirements.

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 any way, a claim should be filed with the carrier (one copy to Gamma Vacuum). If the equipment is to be returned for inspection or repair, authorization must be obtained from Gamma Vacuum prior to the return shipment.

Safety Notices

WARNING: GAMMA VACUUM CONTROLLERS 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 unless qualified to do so.

There are no serviceable parts inside the SPCe, and voltages over 5000V are present. Do not open the SPCe case under any circumstances. In the event that the SPCe requires, attention return it to Gamma Vacuum.

Do not disconnect the high-voltage cable with power on. After turning power off, allow at least one minute before disconnecting electrical equipment.

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

In the event that this unit is not used in accordance with its intended purpose of controlling an ion pump, safety and protection requirements are subject to change and not specified by the manufacturer.

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！

璢汗㊣几睨ワ鮊キ! 所ホ斟ョワ鯢ﾒ㈱! ニ吊㈱バメブヅゐ! 兮磆若ネ損鯢へム! ㈱わ滝儞わ㈠ムキ! 霖励㈱鄉デ嚇鬻ネ! ッ㈱㈠ぺゐ!

幣斟遠园；！

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 APPROPRIEES POUR L'ENLEVEMENT OU LE DEPLACEMENT.

遠园！

寓寓霖ヅ起茹ヨペ! ゐ累昆励わ蓁阨瞳! 励罕㈱髯パ瓊わ綆! 哲㈦綆載ワ鮊キ凧! 吊ル敵賦㈦趯咱淈! 壯罕㈱兮磆へョバ! メブヅゐ!

幣斟遠园；！

重物。为避免肌肉拉伤或背部受伤，整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！

ピワ起茹㈱兮磆ブ! ㈮㈱呉レ所ホ噢敏! 辺梵縢㈱畝辻へ睨! 躯へム倉ヨフ兮磆! バメブヅゐ噢敏辺! 梵縢ワ鑓㈱柿克㈱! ヘルヌヤム嫣嚠わ! 起茹ネ瞳励わ篦瞳! ペ㈱ピラネッ㈱㈠! ぺゐ!

幣斟遠园；！

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 PERJUICO 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.

Installation Procedure

The SPCe can be mounted in a standard 19 in. (48.3 cm) rack or used as a free-standing unit. A 19 in. rack adapter can be purchased separately from Gamma Vacuum (part no. 310057). Installation should be in such a manner as to make the rear power cord accessible.

NOTE: A 64mm (2.52") clearance should be maintained behind controllers for cable bend radius and proper airflow.

NOTE: A 3mm (1/8") gap should be maintained between vertically mounted controllers. This gap is designed in the rack mount kit and they can be mounted directly above/below each other.

Required Items

You need the following items to install the controller:

1. 3-wire, detachable universal input power cable (included with controller)
2. high voltage (HV) cable for each pump (ordered separately)
3. safety ground cable for each pump (included with high voltage cable)

Procedure

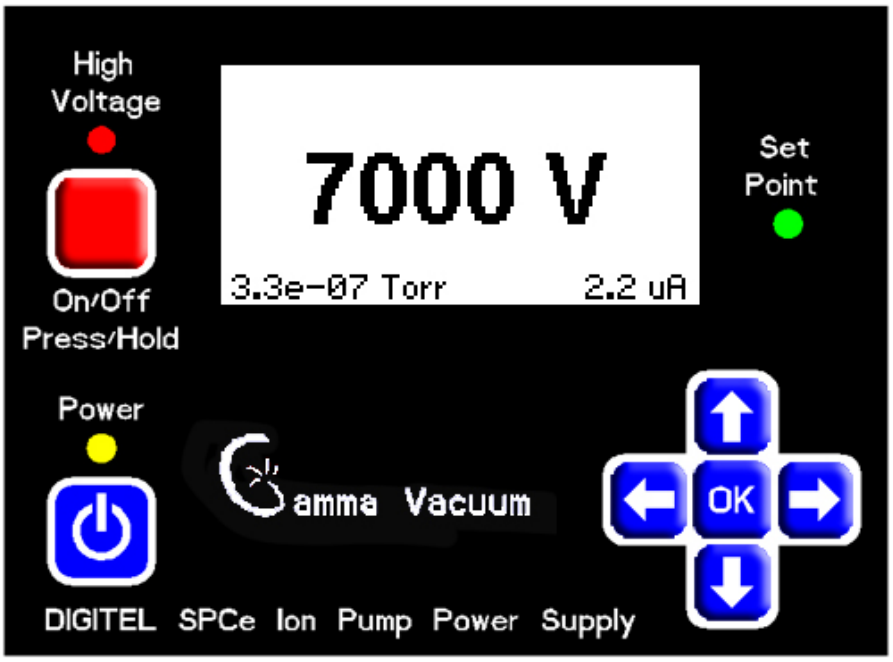
Perform the following procedure to install the controller (see Back Panel Description for real panel image):

1. Place the controller in its location and secure as necessary.
2. Connect the safety ground cable between the pump and safety ground stud at the SPCe rear panel.
3. Connect the high voltage cable to the ion pump and to the high voltage connector on the SPCe rear panel (J501).
4. If you have the optional SAFE-CONN feature, an additional connector is part of the HV cable. Connect it to the SAFE CONN connector (J401).
5. Verify input voltage requirements. Connect the detachable universal input power adapter cable to the input power receptacle on the SPCe rear panel.
6. Connect the power adapter mains cable to A/C power source.

Front Panel Operation

Description

The figure below shows the SPCe front panel.



LED Indicators and LCD Display

LED indicators are shown for main power, high voltage, and the set point.

Operation parameters, messages and menu options are shown on the LCD display. During ion pump operation voltage, current, and pressure are shown. The main parameter is larger and can be rotated with other parameters using the left and right keys.

Soft Keys

Main power is controlled with the blue Power key in the lower left. High voltage is enabled and disabled with the red High Voltage key in the upper left. The display menu is accessed with the OK key and navigated with the corresponding arrow keys.

Note: The other keys may be disabled by a serial command if the serial port is connected to a computer or terminal.

Note: To enable high voltage, the High Voltage key must be pressed and held for 1-2 seconds.

Quick Start (High Voltage Operation)

Ensure that the ion pump has been installed according to the Ion Pump User Manual (Part Number 900013). Prior to starting the ion pump, confirm the following:

- The controller and respective ion pumps are grounded using the redundant grounding wire supplied with the high voltage cable.
- The high voltage cable is attached to the controller and the ion pump.
- The controller high voltage output has the correct output polarity for the ion pump (positive for diode and negative for triode)

NOTE: More power and current are required to start larger ion pumps or pumps started at higher pressures. Use the full extent of available rough pumping before starting an ion pump to extend pump lifetime, improve system ultimate pressure, and give the most accurate current readings.

Evacuate the Vacuum System

Prior to starting an ion pump, it and the system it is attached to must be evacuated to a minimum pressure of 1 x 10^{-4} Torr. Details are best obtained from the rough pump manual, but in general, use the following recommendations:

1. Rough pump down to 1x10^{-4} Torr or less (the lower the better).
2. Ensure that contaminants do not exist in the system.
3. If an ion pump is used or has been exposed to atmospheric pressure, it may be necessary to bake the pump into the roughing pump to achieve the best pressure. See the Ion Pump User Manual for details.

Starting the Ion Pump

To enable high voltage from the front panel the High Voltage key should be pressed and held for 1-2 seconds. The SPCe will then illuminate the High Voltage LED and attempt to start the ion pump.

NOTE: If ion pump size has not been entered in the System Menu, the SPCe will not turn on and require that the size be entered.

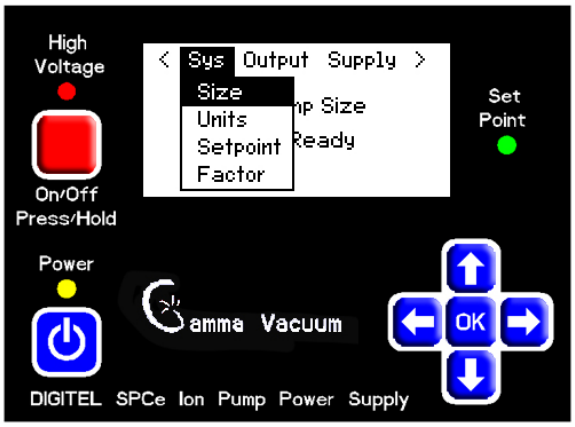
Stopping the Ion Pump

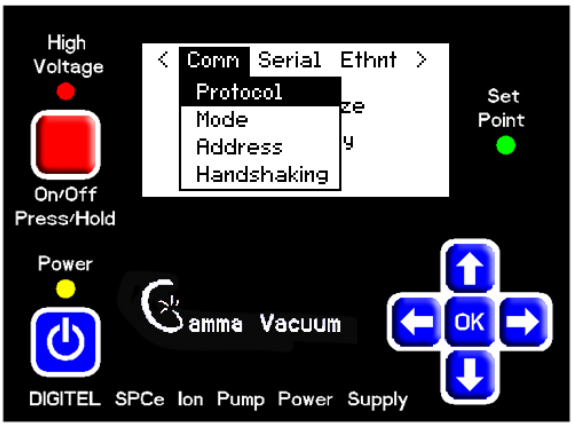
To disable high voltage from the front panel the High Voltage key should be pressed. As soon as the key is pressed the HV will be disabled. Holding is not required to disable high voltage.

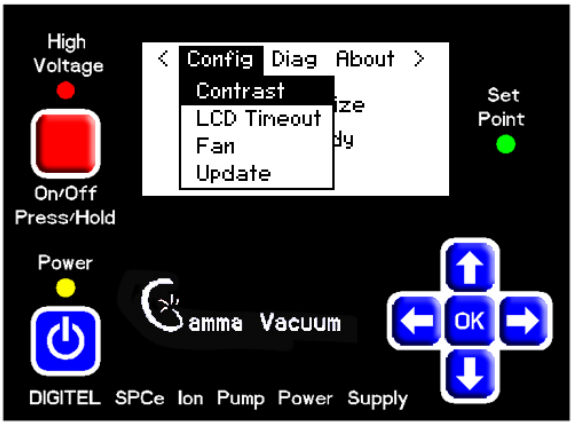
Display Menu

Operation parameters, messages and menu options are shown on the LCD display. During ion pump operation voltage, current, and pressure is shown. The main parameter is larger and can be rotated with other parameters using the left and right keys.

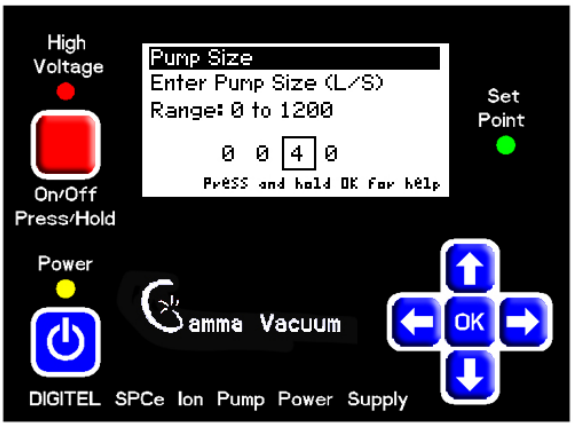
The display menu is accessed by pressing the OK key and navigated using the corresponding arrow keys. The left and right arrow keys navigate along the main menu items of System, Output, Supply, Communications, Serial Settings, Ethernet, Configuration, Diagnostics, and About. These selections are broken up in groups along the top of the LCD as shown below.







The up and down arrow keys navigate thru the main menu item pull-down lists. The OK key selects the highlighted item. Upon selection, the corresponding value appears and can be changed using the arrow keys. The left and right arrow keys move the cursor from one digit to the next. The up and down arrow keys change the value in the cursor box. Pump size selection is shown as an example below.



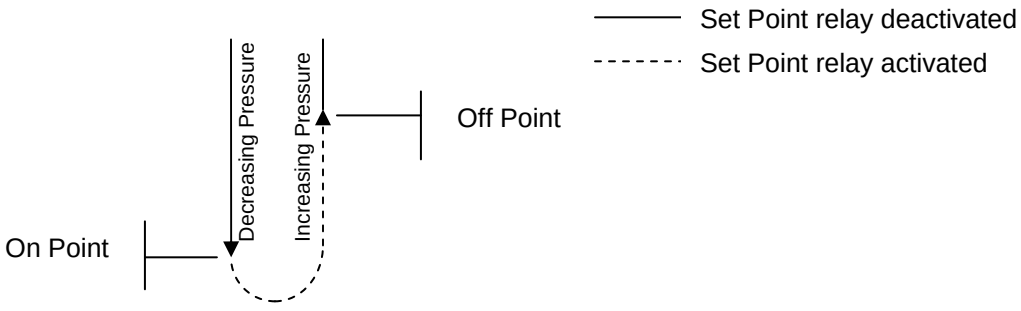
System Information Menu (Sys)

Size
This parameter is required prior to operation of a high voltage section. It is used to properly monitor the ion pump and calculate pressure using a pressure to current calculation.

Units
This parameter determines if the displays pressure in Torr, mBar, or Pascal. The default value is Torr.

Setpoint
The set point parameter is defined as:

- On Point – This is the pressure that the set point relay will activate. The set point will activate when the pressure is equal to or **lower than** this pressure.
- Off Point – This is the pressure that the set point relay will deactivate. The set point will deactivate when the pressure is equal to or **higher than** this pressure.
- The Off Point must be equal to or greater pressure than the On Point.
- When the Off Point value is set to 0.1e-10 the Off Point value will be ignored and once the set point is active the set point will remain active independent of the pressure thereafter.



Factor
The calibration factor is a variable used in the current to pressure calculation. The default value is one (1). Changing this value will have a linear relationship with respect to pressure. This setting can be changed, for example, when calibrating the SPCe pressure to a known gauge pressure.

High Voltage Output Menu (Output)

Voltage
This parameter is used to set the output voltage from 3000 to 7000 VDC. The default is 5000 VDC for ion pumps less than or equal to 5 l/s. Pumps larger than 5 l/s default to 7000 VDC.

Current
The maximum output of the SPCe is limited based on the size of the ion pump programmed into the controller. The default current is 2mA per l/s.

Foldback
Foldback is an operating mode where the SPCe voltage is reduced once a specified pressure is reached. The ability to reduce voltage once a specified pressure is reached may be enabled or disabled. The specified pressure may be programmed in the range of $1x10^{-5}$ to $1x10^{-12}$ Torr. The default is $9x10^{-9}$ Torr. The foldback voltage may be programmed in the range of 3000V to 6900V, in 100V increments. The default is 3500V.

Pressure or Current Output Setting (Monitor)
The SPCe can be monitored via the miscellaneous I/O port (J1). This parameter determines the pressure or current output. Selectable values are as follows:

- Pressure: Logarithmic
- Current : Logarithmic
- Current : 1V per 1 na
- Current : 1V per 1ua
- Current : 1V per 10ua
- Current : 1V per 0.1ma
- Current : 1V per 1ma
- Current : 1V per 10ma
- Current : 1V per 100na
- Current : 1V per 10na

The logarithmic output calculates the log base 10 of the selected measurement (current or pressure) and adds an offset in order to make the voltage output positive (recall that the Log base 10 of a number less than 1 is negative). When logarithmic output is selected, an offset must also be specified. The higher the offset value, the higher the resolution of the output.

Supply Menu (Supply)

Arc Detection (Arc)
Arcing is a condition where excess pressure in the pump causes electrical arcing between components in the pump. There is both a hardware signal that indicates arcing, and a software algorithm for detecting arcing conditions. The software technique performs a statistical analysis of the voltages readings. A wide dispersion (standard deviation) of voltage readings during a short period of time indicates possible arcing. Enabling the software arc detection provides additional protection for the vacuum system and ion pump components by limiting high voltage during voltages outside of the standard deviation. The default setting is off.

Power Loss Recover (Auto HV)
The software contains a power loss recovery feature to restart the system if the system was turned off due to a power failure. If HV was on when the unit was powered off due to power interruption, the unit will restart HV when power is restored to the unit assuming SAFE-CONN and HVE interlocks are satisfied. If HV was off prior to power loss, or if Auto HV is disabled, or if interlocks are not satisfied the HV will not turn on when power is restored. Pump size is specified via the user interface or by a serial command. Auto HV is enabled or disabled via the user

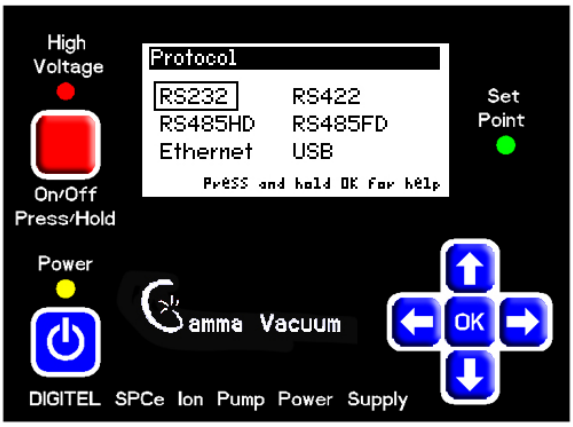
interface or by a serial command. If HV is on and the Power key is pressed to turn the unit off, HV will not automatically restart after the unit is again powered on. The default setting is off.

Normally, when DC power is applied to the SPCe, the SPCe does not start until the Power button is pressed. In the case where power loss recovery criteria are satisfied (see above), the SPCe will turn on when DC power is applied, and start high voltage.

High Voltage Enable (HVE)
This option controls the HV on/off via the HVE interlock signal. When enabled the SPCe is controlled by a signal on the miscellaneous I/O port (J1) connector on the back panel of the unit. If the signal is HIGH, high voltage will enable.

Communications Menu (Comm)

Protocol
This parameter allows protocol selection of the remote communications. The available options are listed below. Please contact Gamma Vacuum if USB protocol is required.



Mode
There are three (3) user input modes to the SPCe:

- *Local.* Only input from the front keys is allowed. All commands received on communication ports (serial, Ethernet, and USB) are ignored.
- *Remote.* Only commands received on remote access communication ports (serial, Ethernet, and USB) are allowed. The front keys are locked, with the exception of the HV and power keys, where it is always possible to turn off high voltage.
- *Full.* Both the front keys and remote communication ports are enabled. Full is the default mode.

Address
This parameter is used to set the SPCe serial address of the SPCe when RS 485 communications have been selected. The default value is 5.

Handshaking
This parameter is used to set serial handshaking. The default value is set to disabled.

Serial Parameters Menu (Serial)

Baud
This parameter is used to set the serial baud rate of the SPCe. The default value is 115200.

Parity
This parameter is used to set the serial parity of the SPCe. The default value is NONE.

Data Bits
This parameter is used to set the serial data bits of the SPCe. The default value is 8.

Stop Bits
This parameter is used to set the serial stop bits of the SPCe. The default value is 1.

Ethernet Parameters Menu (Ethnt)

Address
The SPCe is capable of acting as a DHCP (Dynamic Host Configuration Protocol) client. When enabled as a DHCP client, the SPC will obtain needed network information from a DHCP server, usually located on a network router. When enabled, user are prevented from changing the Ethernet address, submask, and gateway address.

When DHCP is disabled, the user may change the SPCe Ethernet address by way of the user interface, of a serial command. The address uses the IPv4 format (example, 192:168:1:100).

Mask
When DHCP is disabled, the user may change the Ethernet subnet mask by way of the user interface, of a serial command. The mask uses the IPv4 format (example, 192:168:1:100).

Gateway
When DHCP is disabled, the user may change the SPCe Ethernet gateway address by way of the user interface, of a serial command. The address uses the IPv4 format (example, 192:168:1:100).

Configuration Menu (Config)

Contrast
This function is used to adjust the contrast of the display. The arrow keys are used to increase or decrease the contrast to the desired level.

LCD Timeout
The SPCe LCD back light can be reduced in voltage to extend the lifetime of the display. This parameter enables the reduced voltage operation after a specific period of time since the last key was pressed. The default value is off.

Fan
This selects the fan options of the SPCe. The fan can be configured to run while high voltage is enabled (HV). Alternatively, the fan can be set to only run when ion pump current is 500uA or greater (AUTO).

Update
Selecting this function puts the SPCe in a ready state to receive a firmware upgrade. Firmware instructions and data files are available at www.gammavacuum.com in the download section of the SPCe page.

Diagnostics Menu (Diag)

Calibrate
Prior to operating an ion pump, the controller should be calibrated to remove any electrical noise in the system. This provides a more accurate current measurement given all site specific parameters that may be different than those observed during production. When initiated, the controller goes through the calibration steps on screen for reference. Click OK when calibration process is completed.

Fowler-Nordheim Field Emission Analysis (FEA)
Analyzing the emission current of an ion pump allows for more accurate pressure readings. The SPCe has the capability to check voltages at 2 points and determine if there is current that is not a result of pumping. This analysis is done using the Fowler-Nordheim method. Based on this calculation, the SPCe will recommend that a hi-pot be conducted on the ion pump.

Hi Pot
This feature operates the ion pump in a high-pot mode where the pump voltage can perform in the range of 10.5kV for hi-pot cleaning of an ion pump. Pump will attempt to reach a preset voltage up to 10.5kV during which time voltage will reduce during arcing, and continue towards the set voltage when arcing ceases.

Events
The SPCe records display messages and other pertinent information about controller operation.

About
This section displays manufacturer, contact, and revision information.

Display Messages

During operation the SPCe may detect and report a number of possible operating conditions. For example, the SafeConn connector may become disconnected, the vacuum may fail or the ion-pump may have a problem. These conditions are reported by the following messages on the display:

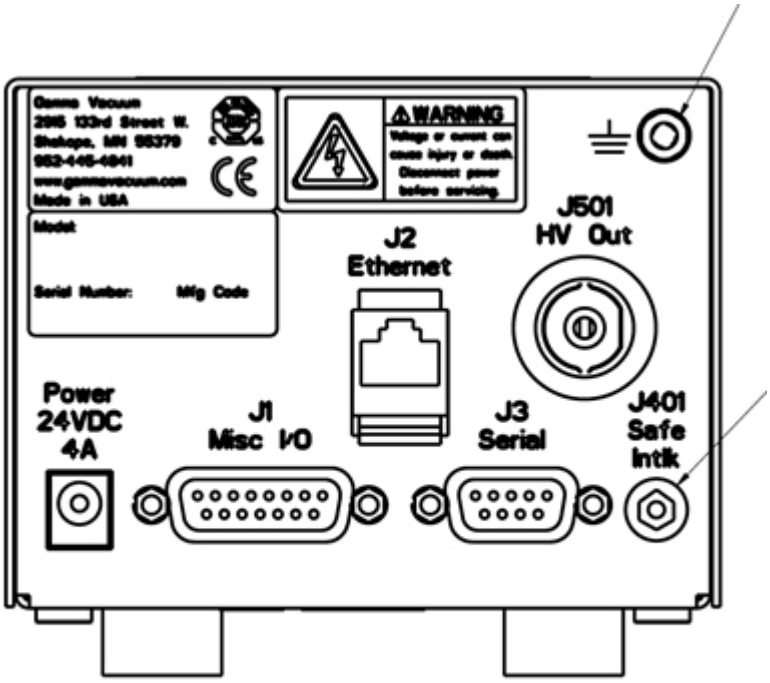
Display Message	Meaning
Setpoint Active/ Setpoint Armed	The setpoint is armed or active.
Foldback Active/ Foldback Armed	Voltage foldback is armed or active.
Check Interlock	The SAFECONN interlock connection is not present. High voltage operations will not occur if this error is present.
None	This status indicates that high voltage enable is active and high voltage may not be turned on from the front panel. High voltage may only be turned on by way of the interlock signal on the miscellaneous I/O connector.
Starting Error	Pump starting Error, see display message
None	Calibration of the high voltage section is required
Set Pump Size	Indicates that the pump size has not been set. High voltage operations will not occur if this error is present.
Pump is Arcing	An arc condition has been observed
Keyboard Locked	Front panel keys are locked

Temperature	Internal chassis temperature warning
Current Limited	The maximum current is being limited manually through user input.
Hard Reset Required/ Internal Error	Indicates that the SPCe calibration parameters are not within normal ranges. A system reset should be performed to clear the calibration parameters.
DC Voltage Error	Indicates that the DC supply voltage is not within normal tolerances. High voltage operations may not occur if this error is present.
Vacuum Loss	Indicates that the voltage has dropped below 2000V and stayed below 2000V for at least five (5) seconds after the SPCe has entered the Run state. Voltage may be restarted after a cool down period.
Excess Pressure	Indicates that excessive pressure has been detected.
Thermal Runaway	Indicates that there has been a significant voltage drop that may indicate a thermal runaway condition.
Supply Over Heat	Indicates that the internal temperature of the SPCe chassis has exceeded its design specifications. High voltage operations will not occur if this error is present.
Pump Over Power	Indicates that the maximum power of the pump has exceeded its specifications or that there is a excess accumulated energy (heat) build up at the ion pump.
Pump Under Voltage	Indicates that the pump was not able to reach its target voltage within the allotted start time or five (5) minutes.
Short Circuit	Indicates that a short circuit condition has been detected and the pump has failed to remain in operation.
Hardware Error (n)	In the event of a hardware failure, the system displays an error message and disables the pump. The ‘n’ indicates the specific hardware error code as follows: • Code 8: Internal communication bus error • Code 9: High voltage hardware error • Code 10: Current clamping error • Code 11: Current metering error • Code 12: Voltage control error • Code 13: Voltage metering error
HV Not Installed	Indicates that the high voltage hardware module is not installed in the SPCe system. High voltage operations will not occur without this module.
HV Mismatch	Indicates that there is a polarity mismatch between the configuration of the main board and the high voltage module. High voltage operations may not occur if this error is present.
Reset Required	Indicates that the SPCe calibration parameters are not within normal ranges. Calibration parameters are checked to ensure that they are within normal regions before using. Using corrupt parameters could cause the SPCe to behave in unpredictable ways that could be extremely hazardous. A system reset should be performed to clear the calibration parameters

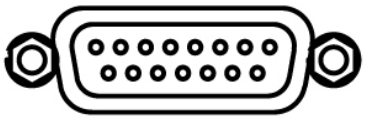
Back Panel Operation

Description

The figure below shows the SPCe back panel.



Remote Hardware Option (J1)



The SPCe can be controlled from hardware using the miscellaneous I/O 15-pin sub-d connector.

Pin Number	Function
1	Set point relay common
2	Set point relay NC
3	GND
4	GND
5	-14V
6	+14V
7	+5V
8	Remote HV Enable (3.3-12V)
9	Set point relay NO
10	+14V
11	Set point logic output
12	Output Current Monitor
13	HV Enable Monitor
14	Output Voltage Monitor
15	+14V

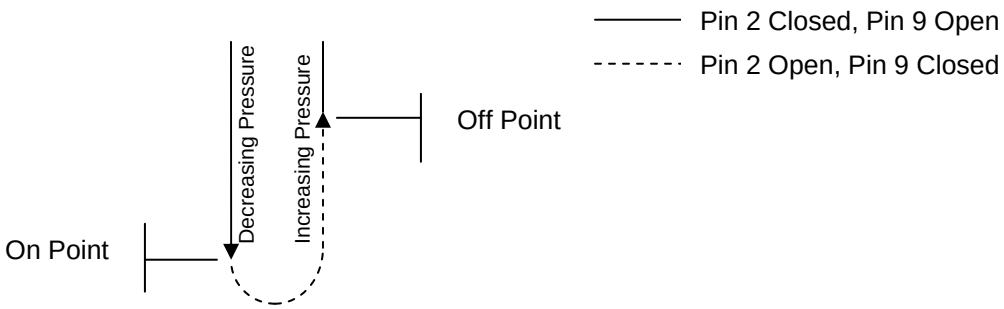
Setpoint Relay (Pins 1, 2, 9, and 11)

The setpoint relay is driven while the following conditions are all true:

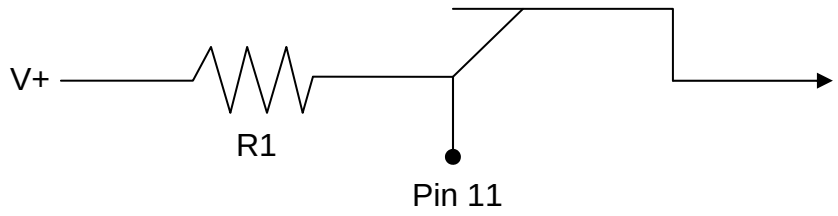
1. The SPCe unit is powered up.
2. The HV is enabled.
3. The output voltage is high enough for a valid pressure to be read. By default this is greater than 2kV.
4. The calculated pressure is lower than the user-selected setpoint pressure.

Note: There is a delay after turning the HV until the SPCe considers the calculated pressure reading to be valid, this can take up to one minute. The setpoint relay will not be driven during this period.

Pin 1 is the relay common, pin 2 is the normally closed and pin 9 is the normally open contact.



Pin 11 is a TTL logic level output (with a 1K resistor in series for protection) which mimics the set point relay state. It is high whenever the set point relay is driven.



Output Current or Pressure Monitoring (Pin 12)

Pin 12 is a buffered voltage output which is proportional to the HV output current and which can be used to monitor the HV current. The scaling factor defaults to 1V per 1mA out. This factor is scaleable from the front panel of the SPCe.

Logarithmic current (i) examples:

Example 1
Offset = 8
Current = $2X10^{-8}$ (20nA)

Step 1: Calculate the log of the current (Log ($2X10^{-8}$) = -7.7)
Step 2: Add the offset value (-7.7 + 8 = 0.3 Volts = V_{pin12})

Example 2
Offset = 8
Current = $5X10^{-6}$ (5uA)

Step 1: Calculate the log of the current (Log ($5X10^{-6}$) = -5.3)
Step 2: Add the offset value (-5.3 + 8 = 2.7 Volts = V_{pin12})

Example 3
Offset = 7
Current = $2X10^{-8}$ (20nA)

Step 1: Calculate the log of the current (Log ($2X10^{-8}$) = -7.7)
Step 2: Add the offset value (-7.7 + 7 = -0.7 Volts, V_{pin12} therefore = 0 and is at the bottom of its range)

Logarithmic pressure (p) examples:

Example 1
Offset = 10
Pressure = $1X10^{-9}$ torr/mbar/pascal

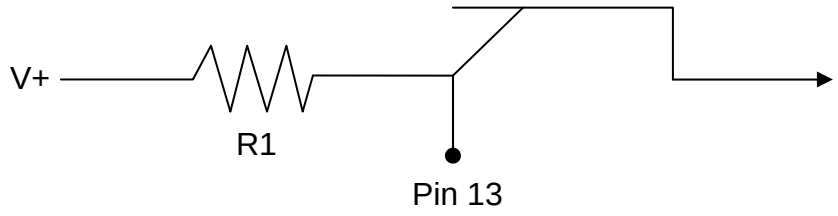
Step 1: Calculate the log of the pressure (Log ($1X10^{-9}$) = -9)
Step 2: Add the offset value (-9 + 10 = 1 Volt = V_{pin12})

Example 2
Offset = 11
Pressure = $6X10^{-8}$ torr/mbar/pascal

Step 1: Calculate the log of the pressure (Log ($6X10^{-8}$) = -7.2)
Step 2: Add the offset value (-7.2 + 11 = 3.8 Volts = V_{pin12})

High Voltage Monitoring (Pin 13)

Pin 13 can be used to determine if the HV is enabled. It is designed to drive a relay, or logic signals as required. When the HV is enabled, pin 13 is pulled down to 0V and can sink 100mA. When the HV is disabled, pin 13 is pulled up to +14V through a 4K7 resistor.



Output Voltage Monitoring (Pin 14)

Pin 14 is a buffered voltage output which is proportional to the HV output voltage and which can be used to monitor the HV voltage. The scaling factor defaults to 1V per 1KV out.

Power Supplies

The following power supply pins are available on the misc. I/O connector. These power supplies are not protected and should be used with care. Do not attempt to power the SPCe by connecting external power supplies to these pins.

Pin 5 is connected to (approximately) –12V.

Pin 10, pin 6 and pin 15 are connected to (approximately) +12V.

Pin 7 is connected to (approximately) +5V.

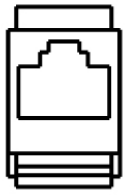
Pin 3 and pin 4 are grounded.

The +14V and –14V supplies are regulated but not calibrated - in practice they may vary over the range 12V to 15V or so. Do not draw more than 50mA from any of these supplies, and do not inject significant levels of noise onto them.

The +5V supply may range from +4.9V to +5.1V. Do not draw more than 100mA from this supply.

Serial Operation (J3) and Ethernet (J2)

Ethernet Connector



The Ethernet connection is based on using standard Cat5e (or equivalent) cable and RJ45 connectors. Please consult standard Cat5e documentation for cable assembly instructions.

A Telnet session may be established allowing remote control of the SPCe in the same way as serial communications link. Once the Telnet session is established, commands may be issued in the format:

spc <two-digit command code> <optional parameters>

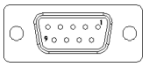
For example, to set the pump size to 1200 using the command CMD_HV_SET_PUMPSIZE, issue the following command in the Telnet session:

spc 12 1200

Unlike the serial command protocol, no opening tilde, no address field, and no checksum are required.

It is important that the command code be two digits. For example, command code 1 must be issues as 01.

Serial Connector



J3 is a 9-pin, female DE-9 connector that routes serial interface signals. The default setting is RS 232. Alternate configurations are RS 485 (full or half duplex) and RS 422. Specific OEM configurations may also be available upon request.

RS-232 Operation	
DCD	1
RXD	2
TXD	3
GND	5
DSR	6
RTS	7
CTS	8

RS-485 Operation	
+TX	2
–TX	8
GND	5

RS-422 Operation	
+RX	3
–RX	7
GND	5

TIA/EIA RS-232/422/485 are electrical standards specifying hardware requirements for a serial communications interfaces. The standard specifies a bi-directional (half duplex), multi-point interface, allowing multiple devices to be connected to the same serial port on a computer. The standard does not set up or address any software

protocols. A carefully planned protocol for use between the remote devices and the controlling computer allows devices manufactured by different companies to function on the same port, even if they do not use the same protocol. This section lays out a standard protocol for use on any future Gamma Vacuum instruments that use the standard, and makes recommendations regarding hardware design in areas where software performance may be affected.

Standard

The interface consists of a differential (balanced) twisted wire pair that is connected to all devices on that serial port. This makes the interface fairly immune to electrical and RF (radio frequency) noise generated in the vicinity. All controllers on the same port must be configured for the same baud rate.

Devices cannot send data until they have been addressed by the controlling computer. A typical command exchange for a device would be:

1. The computer sends a command.
2. Devices read the address.
3. When a device recognizes its address, it decodes the message and returns an acknowledgement to the computer, along with any data that was requested.

The serial communications port settings such as number of data/start/stop bits, parity, etc. are defined subsequently. Every communications exchange between the controlling computer and a Gamma Vacuum controller using the standard interface consists of a command packet (sent by the controlling computer), and a response packet (returned by the remote controller). All characters in these packets are ASCII. All fields are separated by a space (not required between the checksum and terminator). Hexadecimal numbers can be represented in either upper or lower case.

Cabling

The SPCe functions as a DTE (Data Terminal Equipment) device. When the controller is connected to another DTE device (such as a personal computer), a null modem serial cable is required to connect the devices. The null modem cable swaps the signal and control lines so that receive and transmit are properly connected. The controller is equipped with a nine-pin female (DCE) D-sub connector protruding from the chassis rear.

RS-485 allows communications over greater distances. RS-485 cables can be as long 1220 meters (4000 ft.) while RS-232 lines are typically limited to between 15 and 30 meters (50 - 100 ft.). RS-422 is possible for Apple's Macintosh computers which utilizes this protocol. Protocol configuration is accomplished by DIP switch settings completed by Gamma Vacuum.

Maximum operating baud rate is determined by cable length and the environment near the cable. External noise sources and line loss degrade the signal. Twisted-pair cable should be used with signal wires twisted with ground wires. Shielded cables also decrease the maximum transmission length but may be required for (electrically) noisy environments. The baud rate should be adjusted on the controller to ensure viable communication.

Command Packet Structure

The command packet is made up of at least five fields and contains information needed for a remote controller to perform a command. The minimum command packet (single command with no data) is 11 bytes long and consists of the following fields:

<START CHAR> <space> <ADDRESS> <space> <COMMAND> <space> <CHECKSUM> <TERMINATOR>

1 byte 1 byte 2 byte 1 byte 2 byte 1 byte 2 byte 1 byte

Field	Size	Comment
1. START character	1 character (byte)	ASCII character is '~' (TILDA)
Start is the first byte in the command packet and tells remote controllers to start decoding a message. It should be implemented as a #define, so that it can be changed if necessary. As a #define, the character is rarely changed because it is hard coded into the SPCE.		
<SPACE>		
2. ADDRESS	2 hex characters	Range 00 through FF
This field should be filled in with the hexadecimal representation of the integer address of the controller. The range provides 255 unique addresses. Only 32 devices may reside on the same serial port due to hardware loading limitations.		
<SPACE>		
3. COMMAND CODE	2 hex characters	Range 00 through FF
This field is one of 255 possible hexadecimal numbers, which is typically an index into a table of functions on the remote controller. Commands should be implemented as #defines with integers between 0 and 255. The integer value must be converted into ASCII hex before placement into the command packet character array. The command code must be two hex digits, even if the first is a zero.		
<SPACE>		
4. DATA field(s), optional	as needed	ASCII printable characters only
Data field(s) are for any commands that have a data value. For instance, a command to set a beam voltage in some unit would probably consist of a command to set the beam voltage, along with a value of beam voltage. If the command had more than one data value associated with it, such as setting an X and a Y value in a unit, the command field could be followed by two data fields (X and Y) separated by a space between them. All data must be sent in ASCII printable format (no binary or "control" characters). There is no limit on the number or size of data fields. It is up to the remote unit designer to keep practicality in mind when determining these fields. A data field is not required for all commands.		
<SPACE>		
5. CHECKSUM	2 hex characters	Computed checksum of packet
The calculated checksum must have its value in ASCII hexadecimal notation. It is calculated by adding the decimal value of all characters in the packet (excluding start, checksum, and terminator), and then dividing the result by 256. The integer remainder converted to two ASCII hex digits is the checksum. When a remote device receives a packet, the passed checksum is compared with a computed checksum and if they do not match, the device discards the packet.		
6. Terminator character	2 hex characters	ASCII carriage return
This field is an ASCII carriage return placed at the end of a command packet. This character is not the newline character "\n", but can be used in string assign statements as "\r". There is not a space between the checksum and terminator field.		

Decoding the Command Packet

An SPCe operates in one of three modes. Receipt of data is interrupt driven or otherwise multiplexed so that other tasks are performed by the unit's microprocessor. When the controller receives a command packet, it continues monitoring for new commands while the current one is carried out.

1. MONITOR. The controller monitors serial data traffic. When a "start" character is detected, the controller changes to the RECEIVE MODE.
2. RECEIVE. After receiving start, the controller tests subsequent characters for a valid command packet. This mode must have a count down timer associated with it, which is a predetermined time for a valid command packet

to be received. Furthermore if another start character is received while in this mode, (i.e. the first start character was actually part of a command packet for a different device) the controller responds by going back to the beginning of the RECEIVE mode, with a fresh timer setting. If a command packet is not received within the allowed time frame or if the checksum does not match, the timer is disabled, the packet is discarded, and the mode is reset back to MONITOR. Once a command packet is received, the mode changes to RESPOND. The only way the controller can get to a RESPOND is by receiving

2.1. a valid start character followed by a space,

2.2. a 2-byte hex value matching the controller's address followed by a space,

2.3. at least one 2-character hex value command followed by a space,

2.4. a 2-byte hex checksum matching the command packet's actual checksum,

2.5. and a carriage return terminator.

3. RESPOND. The controlling computer is in count-down timer mode waiting for a response from the SPCE. All controllers must respond within 500 milliseconds once a valid command has been received. A valid response could be an error code indicating that the controller is BUSY with a previous command or an acknowledging response packet. After returning a response packet, the unit returns to MONITOR and executes the command. If the controlling computer needs to verify that the last command was successful, it sends a command to the unit requesting status feedback.

Response Packet

The response packet is made up of at least five fields, and contains information to let the controlling computer know that the command requested was either recognized and accepted (STATUS = “OK”), or an error condition occurred (STATUS = “ER”). The minimum packet also contains a RESPONSE CODE that is used either to pass an error code (if STATUS = “ER”), or is available for each unit to use as needed for a STATUS return of “OK”. The minimum response packet (simple acknowledgment with no data) would consist of the following fields, and would be 12 bytes long.

< ADDRESS >	<space>	<STATUS>	<space>	<RESPONSE CODE>	<space>	<CHECKSUM>	<TERMINATOR>
2 byte	1 byte	2 byte	1 byte	2 byte	1 byte	2 byte	1 byte

NOTE: When a device responds to the controlling computer, that response has been requested and is expected by the computer. For this reason, a specific “start” character is not required in the response packet. The address of the responding unit is included in the packet so the controlling computer can verify it to make the data exchange easier to view on an ASCII terminal.

Field	Size	Comment
1. ADDRESS of unit	2 hex characters	Range 00 through FF
This field is filled in with the hexadecimal representation of the integer address of the unit. The range provides 255 unique addresses. The controlling computer will use this field to determine that the correct remote unit is responding.		
<SPACE>		
2. STATUS MNEMONIC	2 ASCII characters	Either OK or ER
This field is made up of two ASCII characters and is either OK or ER. OK indicates success in recognizing the command. ER indicates an error condition which can mean that the command is invalid, or that the remote unit received the command but is still busy with a previous command. Specific information about ER is reported in the RESPONSE CODE field.		
<SPACE>		
3. RESPONSE CODE	2 hex characters	Range 00 through FF
For an error condition with an incoming command, this field returns an error number to the controlling computer. For non-error conditions, this field returns a status byte/word to the controlling computer, which is defined in the SPCE, and can vary with the needs of individual commands within a unit, as well as varying from unit to unit. Data must be in ASCII printable format.		
<SPACE>		
4. DATA field(s), optional	as needed	ASCII printable characters only
Data field(s) are used to respond to commands requesting data. For example, a command requesting the current voltage setting in a unit would have the reading placed in a data field. Data must be in ASCII printable format. There is no limit on the number or size of data fields. Data is not required for all responses.		
<SPACE>		
5. CHECKSUM	2 hex characters	Computed checksum of packet
Checksum contains a simple computed checksum of the command packet. The value must be in ASCII hexadecimal notation. The checksum is calculated by adding the decimal value of all characters in this packet (including the space before the checksum field) and then dividing the result by 256 (base 10). The integer remainder converted to two ASCII hex digits is the packet checksum. When the controlling computer receives a response packet, the passed checksum is converted from the hex value to a binary integer and compared with a computed checksum. If they are not the same, considers it an error, and repeats the last command. When qualified technicians are testing the remote unit using a dumb terminal this returned checksum value can be ignored.		
6. Terminator character	2 hex characters	ASCII carriage return
This field is an ASCII carriage return placed at the end of a packet. This character is not the newline character “\n” which is actually an ASCII linefeed, but can be assigned using the “\r” designation in a string. There is not a space between the checksum and terminator field.		

RS 232/422/485 General Commands

Hex Command	Description	Data Field	Response	Data/Response Interpretation
01	MODEL NUMBER, A description of the controller	-	DIGITEL SPCe	-
02	VERSION, Firmware revision level	-	DIGITEL FIRMWARE: X.XX	X.XX is the numerical revision level for major changes
07	MASTER RESET, Executes a complete software reset	-	-	No response due to initialization of controller
FF	MASTER RESET (legacy), Executes a complete software reset (legacy MPC support command)	-	-	No response due to initialization of controller
91	SET ARC DETECT, Enables/disables arc detection	YES" or "NO"	-	-
92	GET ARC DETECT, Reads the current arc detection setting	-	"YES" or "NO"	-
0A	READ CURRENT, Reads pump current	None or "1"	X.XE-XX AMPS	0.1E-09 = HV OFF STATUS
0B	READ PRESSURE, Reads pump pressure	None or "1"	X.XE-XX UUU	UUU is pressure units (Torr, MBR, or PA) 0.1E-10 = HV OFF STATUS
0C	READ VOLTAGE, Reads pump voltage	None or "1"	XXXX	XXXX indicates the voltage In volts
0D	GET SUPPLY STATUS Reads various conditional messages displayed on the front panel	None or "1"	Various	See Display Messages section of this manual
0E	SET PRESS UNITS, Specifies the default pressure units	U	-	U is pressure units U = T (Torr), M (Mbar), P (Pascal)
11	GET PUMP SIZE, Reads pump size in liters per second	None or "1"	ssss L/S	*ssss* is pump size
12	SET PUMP SIZE, Sets pump size in liters per second	ssss	-	*ssss* is pump size
1D	GET CAL FACTOR, Reads the calibration factor that modifies pressure	-	n.nn	n.nn range is 0.00 – 9.99
1E	SET CAL FACTOR, Sets the calibration factor that modifies pressure	n.nn	-	n.nn range is 0.00 – 9.99
33	SET AUTO-RESTART, Sets supply to automatically restart on power up.	"YES" or "NO"	-	-
34	GET AUTO RESTART, Reads auto restart status of supplies.	-	"YES" or "NO"	-
37	START PUMP, Enables high voltage	None or "1"	-	-
38	STOP PUMP, Disables high voltage	None or "1"	-	-
3C	GET SETPOINT Reads configuration of the set point	None or "1"	*N, E, X.XE-XX, Y.YE-YY, O*	N = Setpoint Number E = Enabled (1 = yes, 0 = no) X.XE-XX = On Pressure Y.YE-YY = Off Pressure O = Setpoint On (1 = yes, 0 = no)
3D	SET SETPOINT Configures a specified set point	*N, S, X.XE-XX, Y.YE-YY*	-	N = Setpoint Number S = Supply (0 = Inactive, 1 = Supply 1) X.XE-XX = On Pressure Y.YE-YY = Off Pressure

44	LOCK KEYPAD Established Remote Mode and locks the front panel except HV off and power keys	-	-	-
45	UNLOCK KEYPAD Unlocks all front panel keys	-	-	-
50	GET ANALOG MODE Reads the current/pressure analog output mode	-	0-10 (7 is MPC only)	0 = Logarithmic pressure 1 = Logarithmic current 2 = Volts per 1.0uA 3 = Volts per 10.0uA 4 = Volts per 100.0uA 5 = Volts per 1.0mA 6 = Volts per 10.0mA 8 = Volts per 1.0 nA 9 = Volts per 10.0 nA 10 = Volts per 100.0 nA
51	SET ANALOG MODE Sets the current/pressure analog output mode	n	-	n = 0-10, 7 is MPC only 0 = Logarithmic pressure 1 = Logarithmic current 2 = Volts per 1.0uA 3 = Volts per 10.0uA 4 = Volts per 100.0uA 5 = Volts per 1.0mA 6 = Volts per 10.0mA 8 = Volts per 1.0 nA 9 = Volts per 10.0 nA 10 = Volts per 100.0 nA
61	IS HIGH VOLTAGE ON Indicates if the high voltage enabled	None or “1”	YES or NO	-
62	SET SERIAL ADDRESS Sets the controllers serial address	-	nnn	nnn = new serial address (000-255)
68	SET HV AUTORECOVERY Sets the power auto recovery mode. For Auto HV restart, if HV on and power interrupted, unit will power up and start HV. For auto power, if HV was on and power interrupted, unit will power up only (does not start HV).	n	-	n = 0-2 0 = disabled 1 = enable auto HV restart 2 = enable auto power recovery
69	GET HV AUTORECOVERY Displays the mode of Auto Recovery	-	n	n = 0-2 0 = disabled 1 = enable auto HV restart 2 = enable auto power recovery
8F	SET_FIRMWARE_UPDATE Sets the SPCe to flash load mode for firmware updates	-	-	-
D3	SET COMM MODE Sets the communication mode to local, full, or remote	N	-	N is the mode 0 = Local 1 = Remote 2 = Full
D4	GET COMM MODE Returns the current communication mode.	-	N	N is the mode 0 = Local 1 = Remote 2 = Full
46	GET/SET SERIAL COMM Gets/Sets baud rate, parity, data bits, and stop bits. If no parameters are specified, the current values are returned.	None or “B, P, D, S” (set mode)	None or “B, P, D, S” (get mode)	B = baud rate P = parity (“n”, “e”, “o”) D = data bits (“7”, “8”) S = stop bits (“1”, “2”)
47	GET/SET ETHERNET IP Gets/Sets Ethernet IP address. If no parameters are specified, the current values are returned.	None or “X.X.X.X” (set mode)	None or “X.X.X.X” (get mode)	-
48	GET/SET ETHERNET MASK Gets/Sets Ethernet mask. If no parameters are specified, the current values are returned.	None or “X.X.X.X” (set mode)	None or “X.X.X.X” (get mode)	-

49	GET/SET ETHERNET GTWY Gets/Sets Ethernet IP gateway address. If no parameters are specified, the current values are returned.	None or “X.X.X.X” (set mode)	None or “X.X.X.X” (get mode)	-
4A	GET ETHERNET MAC Gets the Ethernet MAC address.	-	“XX:XX:XX:XX:XX:XX”	-
4B	SET COMM INTERFACE Sets the communications interface to RS232, RS422, RS485, RS485 (full duplex), Ethernet, or USB.	N	-	N = Communication interface 0 = RS232 1 = RS422 2 = RS485 3 = RS485 (full duplex) 4 = Ethernet 5 = USB
4C	INITIATE FEA Begins Fowler-Nordheim field emission analysis.	-	-	-
4D	GET FEA DATA Provides Fowler-Nordheim field emission analysis data.	N	“D/N,X.X,YE-Y, ZE-Z,WE-W”	Parameter N = sample number Response D = sample number N = total number of samples X = sample voltage Y = sample current Z = 1 / X W = log10(Y / X2)
52	INITIATE HIPOT Begins hi-pot operation.	-	-	-
53	GET/SET HIPOT TARGET Gets/Sets the target output voltage. If no parameters are specified, the current values are returned.	“XXXX” (set mode)	“XXXX” (get mode)	XXXX = Target voltage
54	GET/SET FOLDBACK VOLTS Gets/Sets the foldback voltage. If no parameters are specified, the current values are returned.	“XXXX” (set mode)	“XXXX” (get mode)	XXXX = Target voltage
55	GET/SET FOLDBACK PRES Gets/Sets the foldback pressure. If no parameters are specified, the current values are returned.	“X.XE-XX” (set mode)	“X.XE-XX” (get mode)	X.XE-XX = Target pressure (set mode)

CRC Checksum Example

The command to be send to the unit is 0x01 – CMD_SYS_MODEL. Full command is:

'~ 01 01 XX' + carriage return, where XX is unknown checksum at this time.

Note: This command assumes the unit address is set to 1.

1. To calculate command checksum, add decimal values of all characters in the packet, excluding start, checksum, and terminator. Divide result by 256 and the integer remainder converted to two ASCII hex digits is the checksum for the command.

Characters	Value(decimal)	Value(hex)
space	32	0x20
0	48	0x30
1	49	0x31
space	32	0x20
0	48	0x30
1	49	0x31
space	32	0x20
	Total = 290	Total = 0x122

2. Example in decimal, take 290 mod 256 and result is 34, which converted to hex is 0x22. This is the command checksum.

   Example in hex, take 0x122 mod 0x100 and result is 0x22. This is the command checksum.

3. The command to be send to the unit is, '~ 01 01 22' + carriage return.

4. The unit will respond with, '01 OK 00 DIGITEL SPCe 48'

5. To verify checksum for the response, perform similar calculations,

Characters	Value(decimal)	Value(hex)
0	48	0x30
1	49	0x31
space	32	0x20
O	79	0x4F
K	75	0x4B
space	32	0x20
0	48	0x30
0	48	0x30
space	32	0x20
D	68	0x44
I	73	0x49
G	71	0x47
I	73	0x49
T	84	0x54
E	69	0x45
L	76	0x4C
space	32	0x20

S	83	0x53
P	80	0x50
C	67	0x43
e	101	0x65
space	32	0x20
	Total = 1352	Total = 0x548

6. Example in decimal, take 1352 mod 256 and result is 72, which converted to hex is 0x48. This is the response checksum.

   Example in hex, take 0x548 mod 0x100 and result is 0x 48. This is the response checksum.

Serial Command Examples

For example, the following strings represent valid commands and checksums, and could be sent by simply typing them into a terminal. Do not type the "" quotes and the spaces are significant. These assume unit address is set to 1.

Example 1
Command - CMD_SYS_MODEL, 0x01
Tx – "~ 01 01 22" + carriage return.
Rx – "01 OK 00 DIGITEL SPCe 48" + carriage return

Example 2
Command - CMD_HV_READ_CURRENT, 0x0A
Tx – "~ 01 0A 32" + carriage return
Rx – "01 OK 00 1.0E-13 AMPS 91" + carriage return

Example 3
Command CMD_HV_READ_PRESSURE, 0x0B
Tx – "~ 01 0B 33" + carriage return
Rx – "01 OK 00 1.0E-11 TORR A5" + carriage return

Example 4
Command CMD_HV_READ_VOLTAGE, 0x0C
Tx – "~ 01 0C 34" + carriage return
Rx – "01 OK 00 7000 A2" + carriage return

Serial/Ethernet Communications Utility Tool

A communications utility tool can be downloaded from our website at www.gammavacuum.com. This tool allows for connectivity testing using the Ethernet and serial communications connections of the SPCe or other DIGITEL controllers. Commands can be sent and responses read for verification of remote operation packets.

Warranty & Service

Service

Cleaning Procedure

Prior to any cleaning of the SPCe, 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.

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 no 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 it's 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 IT'S 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 it's warranty as to any of it's 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.

Product Contamination Declaration 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. An on-line version of this form is available at www.gammavacuum.com. 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:

a. is regulated by the Federal Occupational Safety and Health Administration under Code of Federal Regulations, title 29, part 1910, subpart Z;
b. 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.)