Small Pump Controller (SPCe)
Instruction manual

www.gammavacuum.com

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We accept no liability for loss of profit, loss of market or any other indirect or consequential loss whatsoever.

Product warranty and limit of liability are dealt with in our standard terms and conditions of sale or negotiated contract under which this document is supplied.

You must use this product as described in this manual. Read the manual before you install, operate, or maintain the product.

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1. Safety and compliance

1.1. Definition of Warnings and Cautions

NOTICE:

For safe operation from the start, read these instructions carefully before you install or commission the equipment and keep them safe for future use.

Read all the safety instructions in this section and the rest of this manual carefully and make sure that you obey these instructions. The equipment must only be operated and maintained by trained personnel in the proper condition and as described in this instruction manual.

Obey local and state requirements and regulations. If you have any questions about safety, operation or maintenance of the device, please contact our nearest subsidiary.

Important safety information is highlighted as warning and caution instructions. Obey these instructions.

WARNING:

If you do not obey a warning, there is a risk of injury or death. Different symbols are used according to the type of hazard.

CAUTION:

If you do not obey a caution, there is a risk of minor injury, damage to equipment, related equipment or process.

NOTICE:

Information about properties or instructions for an action which, if ignored, will cause damage to the equipment.

We reserve the right to change the design and the stated data. The illustrations are not binding.

Keep the instructions for future use.

1.2. Safety symbols

The safety symbols on the products show the areas where care and attention is necessary.

The safety symbols that follow are used on the product or in the product documentation.

	Warning/Caution An appropriate safety instruction must be followed or caution to a potential hazard exists.
	Warning - Dangerous voltage Identifies possible hazards from dangerous voltages.
	Warning - Heavy object Identifies a possible hazard from a heavy object.
	Warning - Read the manual

1.3. Warnings

	WARNING: Shock hazard. Can cause injury or death. Remove power before servicing.	AVERTISSEMENT : Risque de choc électrique. Peut entraîner des blessures, voire la mort. Coupez l'alimentation électrique avant l'entretien.	警告: 感電事故。怪我や死亡事故の原因になります。保守を行う前に、電源を切ってください。
	ADVERTENCIA: Peligro de descarga. Pueden producirse lesiones o incluso la muerte. Desconecte la alimentación antes de realizar cualquier tarea de mantenimiento.	WARNUNG: Stromschlaggefahr. Es besteht Verletzungs- und Todesgefahr. Vor Wartungsarbeiten vom Strom trennen.	警告： 触**电**危**险**。可能**导**致人**员**伤亡。**维护**之前先断**电**。

	WARNING: Heavy object. To avoid muscle strain or back injury, use lifting aids and proper lifting techniques when removing or replacing.	AVERTISSEMENT : Objet lourd. Pour éviter les blessures musculaires ou dorsales, utilisez des engins de levage et des techniques de levage appropriées lors du retrait ou du remplacement d'un objet lourd.	警告: 重量のある装置、部品。筋挫傷、背中や腰の怪我を避けるために、取り外しや交換はリフトを使用した適切な吊り上げ方法で行ってください。
	ADVERTENCIA: Objeto pesado. Para evitar distensiones musculares o lesiones en la espalda, utilice ayudas para la elevación y técnicas de elevación adecuadas durante la retirada o sustitución del equipo.	WARNUNG: Schwerer Gegenstand. Um Muskelverspannungen oder Rückenverletzungen zu vermeiden, verwenden Sie beim Entfernen oder Ersetzen Hebehilfen und geeignete Hebetechniken.	警告： 重物。为了避免肌肉劳损或背部损伤，执行卸除或更换操作时，应使用起重工具，并采用适当的起重技巧。

	WARNING: Read and understand operator's manual before using this machine. Failure to follow operating instructions could result in injury or damage to equipment.	AVERTISSEMENT : Lisez et comprenez le mode d'emploi avant d'utiliser cette machine. Le non-respect des instructions d'utilisation peut entraîner des blessures ou endommager l'équipement.	警告: 本機械を使用する前に、取扱説明書をよく読み、十分に理解してください。操作手順に従わない場合、怪我や機器が損傷する原因となることがあります。
	ADVERTENCIA: Lea y comprenda el manual del operador antes de utilizar este equipo. Si no se siguen las instrucciones de funcionamiento, podrían producirse lesiones o daños en el equipo.	WARNUNG: Sie müssen diese Bedienungsanleitung lesen und verstehen, bevor Sie diese Maschine benutzen. Die Nichtbeachtung der Gebrauchsanleitung kann zu Verletzungen oder Schäden an der Anlage führen.	警告： 使用本设备之前，请阅读并理解操作员手册。不遵守操作手册说明可能导致人员受伤和设备损坏。

1.4. Safety notices

1. To avoid personal injury, do not perform any installation or service unless qualified to do so. Installation should be performed by qualified,

authorized personnel who have experience working with voltages greater than 50 volts.

2. Do not open the SPCe case under any circumstances. There are no serviceable parts inside the SPCe, and voltages over 5000V are present. In the event that the SPCe requires attention, return it to Gamma Vacuum.
3. Do not disconnect the high-voltage cable with the power on. After turning off the SPCe, allow at least one minute before disconnecting electrical equipment.
4. 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 specifications.
5. 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 subjected to change and not specified by the manufacturer.

2. General information

The DIGITEL SPCe is an intelligent, programmable ion pump power supply, which features a LCD display and soft-keys for navigation. It requires an external 24 V d.c. power supply (depends on the ordered part number) supplied with the SPCe. It is equipped with an universal power input too permit operation from 85 to 260V a.c., 50 or 60 Hz. It is 1/4 rack and 2u high with an optional half rack or full rack mount kit.

The SPCe can be controlled two ways: directly from the front panel or remotely through serial or Ethernet ports. The serial port supports RS-232/422/485 protocols.

Individual model specification information is located on our website at: www.gammavacuum.com

WARNING:

Do not use unauthorized parts. Such parts may compromise safety. Contact Gamma Vacuum with any questions.

CAUTION:

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

2.1. Approvals

Gamma Vacuum Small Pump Controllers (SPCe) are shown to meet the EEC Low-Voltage Directive and Electromagnetic Compatibility

approvals:

- EN 61326-1
- EN 616326-2-1
- Low Voltage Directive 73/23/EEC

CE

Safety tested Production monitored TÜV SÜD NRTL C US

3. Unpacking the controller

3.1. Inspect for any obvious damage

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

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

3.2. Check the equipment received

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

4. Installation

- The SPCe can be mounted in a standard 19 in. (48.3 cm) rack or used as a free-standing unit. Optional 19-in. Rack Adapter Kit (part 310057) and Half-Rack Adapter Kit (part 360242) are available.
- When installing, make sure the rear power cord is accessible.
- Maintain a 2.52 in. (64 mm) clearance behind controllers for cable bend radius and proper airflow.
- Maintain a .125 in. (3 mm) gap between vertically mounted controllers. This gap is designed in the rack mount kit, and they can be mounted directly above or below each other.
- Position the control so that the power plug can be reached to disconnect power.

CAUTION:

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

CAUTION:

Remove all metal jewellery prior to working with any potential electrical hazards.

4.1. Required items

You will need the following items to install the controller:

1. A 3-wire, detachable, universal input power cable that connects to the 24 V power supply (both included for most part numbers).
2. A high voltage (HV) cable for each pump (ordered separately).
3. A safety ground cable for each pump (ordered separately).

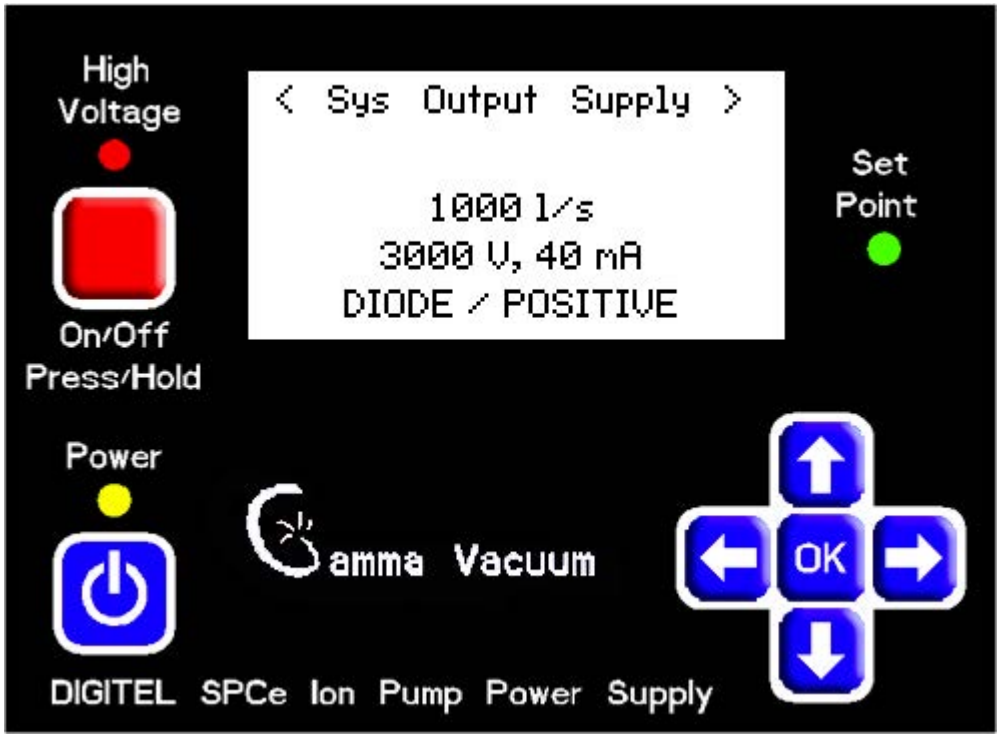
4.2. Installation procedure

1. Place the controller in its location and secure as necessary.
2. Connect the safety ground cable to the pump and the safety ground stud at the SPCe rear panel.
3. Connect the high voltage cable to the ion pump and the high voltage connector on the SPCe rear panel (J501).
4. If you have the optional SAFECONN feature, an additional connector is part of the HV cable. Connect it to the SAFECONN connector (J401).
5. Verify input voltage requirements, and then connect the detachable universal input power adapter cable to the input power receptacle on the 24 V power supply. Connect the 24 V d.c. supply to the SPCe.
6. Connect the power adapter mains cable to A/C power source.

5. Operation

5.1. Front panel

Figure 1. *Front panel*



LED indicators and LCD display

LEDs indicate the status of the main power, high voltage, and the set point. The LCD displays operation parameters, messages, and menu options.

During ion pump operation, the screen displays voltage, current, and pressure. One of these three values is displayed larger than the other two; this can be changed by pressing the left and right arrow keys.

Soft keys

- Main Power: Turns on and off the controller.
- High Voltage: Enables high voltage when pressed and held for 1-2 seconds.
- OK and arrow keys: Open and navigate the configuration menus, and commit changes.

Note:

Some keys may be disabled by a serial command when the controller is connected to a computer or terminal.

5.2. High voltage operation (quick start)

Prior to starting the ion pump, confirm the following:

- The controller and connected ion pumps are grounded with a redundant grounding wire.

- The high voltage cable is attached to the controller and the ion pump.
- The controller's high voltage output has the correct output polarity for the ion pump (positive voltage for diode pump and negative voltage for triode pump).

Evacuate the vacuum system

1. Rough pump down to 1x10-4 Torr or less (the lower the better). See Rough Pump manual for details.
2. Ensure 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 Operation section in the Pump manual for details.

Starting the ion pump

1. If the ion pump size has not been entered into the System Menu, enter the ion pump size. The SPCe will not start until the ion pump size has been entered.
2. Press and hold High Voltage on the front panel for 1-2 seconds.

Stopping the ion pump

Press High Voltage on the front panel to disable high voltage.

6. Display menu

Operation parameters, messages, and menu options are shown on the LCD display.

6.1. Display during ion pump operation

When the ion pump is in operation, the SPCe displays voltage, current, and pressure.

Figure 2. *Display during ion pump operation*

Accessing Main Menu Settings

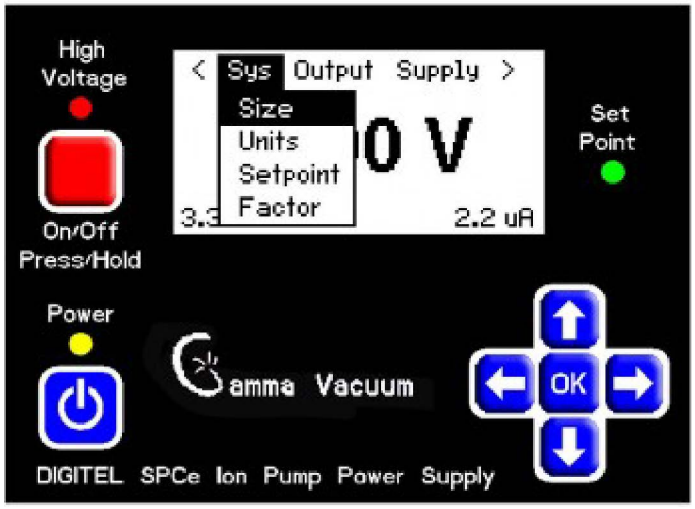
The main menu categories are:

- System
- Output
- Supply
- Communications
- Serial
- Ethernet
- Configuration
- Diagnostics
- SPC.

To access and navigate the main menu: (Refer to Figure: Front panel)

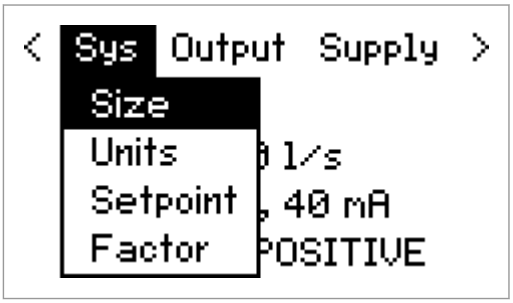
- Press OK to access the main menu.
- Press the left and right arrow keys to navigate through the main menu.
- Press the up and down arrow keys to navigate through the drop down menus.
- Press OK to select the highlighted menu item.

Figure 3. *Accessing Main Menu settings*



6.2. System information menu (Sys)

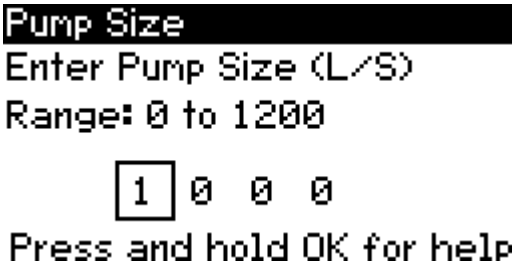
Figure 4. *System information menu (Sys)*



Size

The Size parameter must be set prior to high voltage operation. Setting the correct pump size allows the controller to properly monitor power delivered to the ion pump and calculate pressure.

Figure 5. *Pump size*



Pressure is calculated using the following current-to-pressure calculation:

$$P = \frac{(0.066 * I * (\frac{5600}{V}) * U * F)}{S}$$

Where:

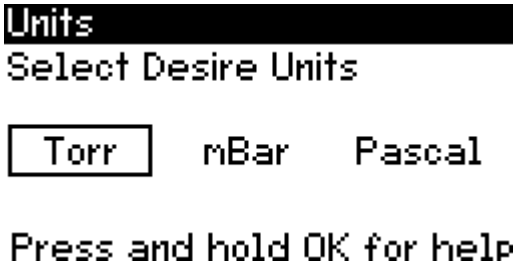
- I - Current in amps.
- V - Voltage in volts. (SPCe is variable)
- U - Pressure units conversion factor (1 for Torr, 1.33 for mbar and 133 for Pascal).

- F - MPCe/LPCe programmed calibration factor (typically set to 1)
- S - Configured pump size in l/s.

Units

The Units parameter changes the displayed unit of measurement for pressure. It can be changed to display in Torr, m Bar, or Pascal. (Torr is the default.)

Figure 6. *Units*



Setpoint

- On Point: The setpoint will deactivate when the pressure is equal to or below this pressure.
- Off Point: The setpoint relay will activate when the pressure is equal to or above this pressure.
- The off point pressure must be equal to or greater 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 setpoint is active, the setpoint will remain active independent of the pressure thereafter.
- Error: The setpoint will turn on when the SPCe has an error condition.

Figure 7. *Setpoint function config*

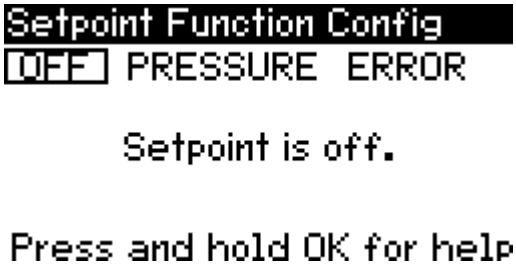
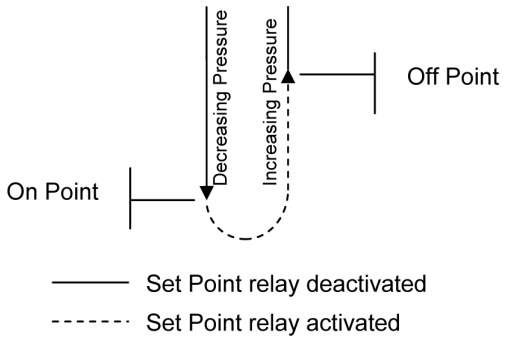


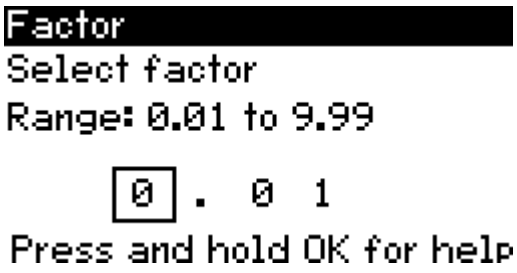
Figure 8. *Setpoint*



Factor

The calibration factor is a variable used in the current-to-pressure calculation. The default value is one. 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.

Figure 9. *Factor*



Pressure is calculated using the following current-to-pressure calculation:

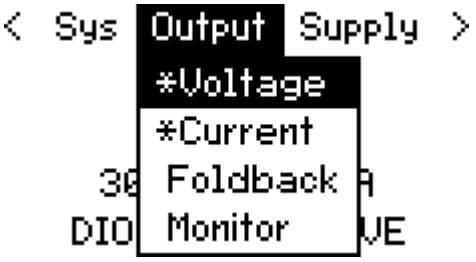
$$P = \frac{(0.066 * I * (\frac{5600}{V}) * U * F)}{S}$$

Where:

- I - Current in amps.
- V - Voltage in volts. (SPCe is variable)
- U - Pressure units conversion factor (1 for Torr, 1.33 for mbar and 133 for Pascal).
- F - MPCe/LPCe programmed calibration factor (typically set to 1)
- S - Configured pump size in l/s.

6.3. High voltage output menu (output)

Figure 10. *Output*



Note:

If an asterisk (*) is present, a pump size has not been entered into the controller.

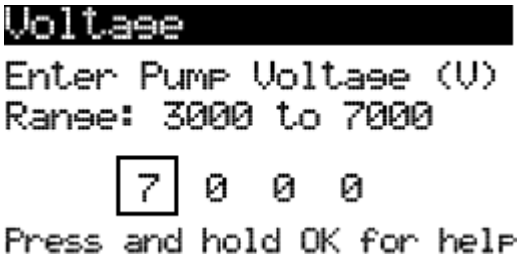
Voltage

The Voltage parameter sets the output voltage. It can be set in the range of 3000 to 7000 V d.c. For ion pumps at 5 l/s or less, the default voltage is 5000 V d.c. For ion pumps larger than 5 l/s, the default voltage is 7000 V d.c.

Note:

The default voltage for ion pumps at 5 l/s or less but with 5 KV feedthrough is 7000 V d.c.

Figure 11. *Voltage*



Current

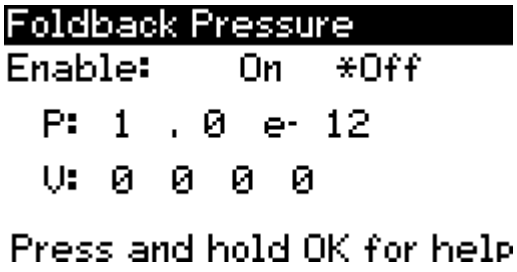
The Current parameter sets the output current. The maximum current output is limited based on the size of the ion pump programmed into the controller. The default is 2 mA per l/s.

Figure 12. *Current*

Foldback Voltage Feature

With the Foldback feature enabled, the SPCe will reduce the voltage once a specified pressure is reached. The specified pressure can be set in the range of $1x10^{-5}$ to $1x10^{-12}$ Torr. The default is $9x10^{-9}$ Torr. The Foldback voltage can be programmed in the range of 3000 V to 6900 V, done in 100 V increments. The default voltage is 3500 V.

Figure 13. *Foldback pressure*



Pressure or Current Output Setting (Monitor)

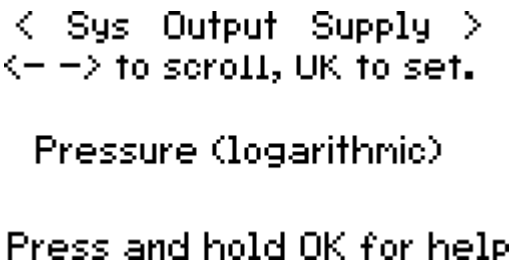
The SPCe can be monitored via the miscellaneous I/O port (J1). This parameter determines the pressure or current output. Selectable values are:

- Pressure: Logarithmic
- Current: Logarithmic
- Current: 1VDC per 1nA
- Current: 1VDC per 10nA
- Current: 1VDC per 100nA
- Current: 1VDC per 1uA

- Current: 1VDC per 10uA
- Current: 1VDC per 100uA
- Current: 1VDC per 1mA
- Current: 1VDC per 10mA
- MidiVac Emulation

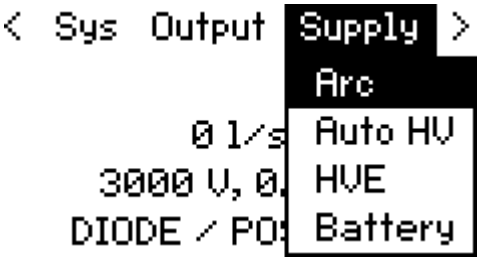
The logarithmic output calculates the log base 10 of the selected measurement (current or pressure) and adds an offset in order to make the voltage output positive. (The Log base 10 of a number less than 1 is negative.) When logarithmic output is selected, an offset must also be specified. The higher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

Figure 14. *System output supply*



6.4. Supply menu (supply)

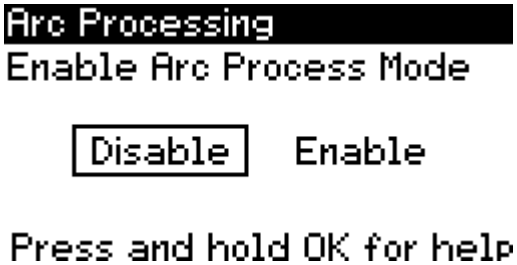
Figure 15. *Supply menu*



Arc Detection (Arc)

Arc detection provides protection for the ion pump by lowering high voltage during arcing. The default setting is off.

Figure 16. *Arc processing*



Power Loss Recovery (Auto HV)

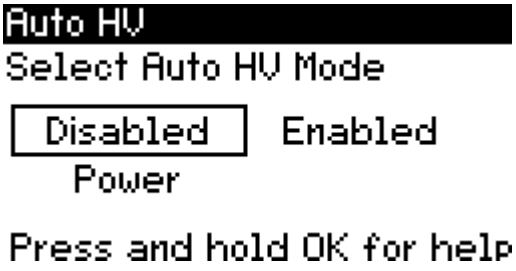
The software contains a power loss recovery feature to restart the system if the system was turned off due to a power failure.

- Disabled (default option): If input power is disrupted, the controller will not power up when input power is restored.

- Enabled: If HV is on and input power is disrupted, the controller will power up and will turn on HV when input power is restored. If HV is off and input power is disrupted, the controller will power up, but it will not turn on HV when input power is restored.
- Power: If the input power is disrupted, the controller will power up, but will not turn on the HV when input power is restored. This is independent on the HV on/off state.

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.

Figure 17. *Auto HV*

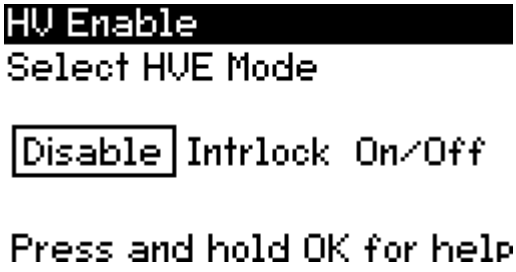


High Voltage Enable (HVE)

This parameter controls the high voltage on/off via the HVE interlock signal. When enabled, the SPCe is controlled by a signal on the miscellaneous I/O port (J1) connector. If the signal is High, high voltage will enable.

- Disabled (default option): Pin 8 on the J1 misc. I/O connector on the rear panel does not have a function.
- Intrlock: Pin 8 serves as the interlock function. Logic high (+3.3 V d.c. to +12 V d.c.) on this pin enables HV to be turned on by the user, but does not turn on HV automatically. Logic low disables HV operation—user cannot turn on HV.
- On/Off: Pin 8 serves as the on/off switch function. Logic high turns on HV. Logic low turns off HV.

Figure 18. *HV enable*

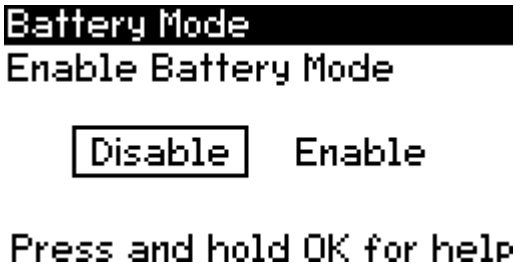


Battery Mode (Battery)

Disables or enables battery mode.

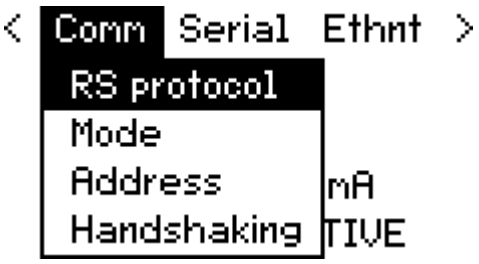
- Disabled (default option): The input power voltage must be in the +22 to +26VDC range in order to run HV.
- Enabled: The input power voltage can be outside this range.

Figure 19. *Battery mode*



6.5. Communications mode (Comm)

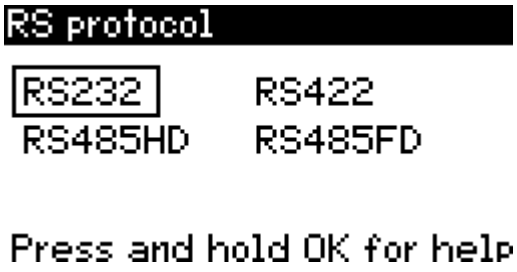
Figure 20. *Communication mode*



RS protocol

This parameter allows protocol selection for remote communications. The available options are listed below.

Figure 21. *RS protocol*

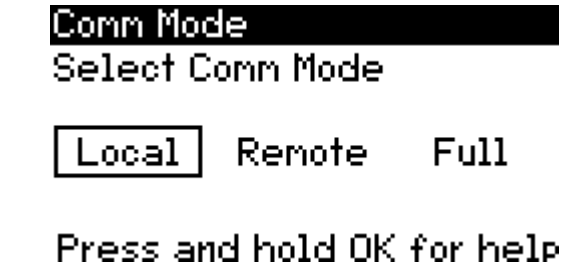


Mode

There are three user input modes to the SPCe. They are changed by selecting Mode on the Comm menu. Select the type of communication for the controller.

- Local: The controller only accepts change commands made via the keypad. The controller will accept read only commands via serial/ Ethernet. It will not, however, accept write/change commands via serial/ Ethernet.
- Remote: The controller will accept all serial and Ethernet commands. When remote mode is activated, the keypad is locked. To unlock the keypad, press and hold down arrow key. Note, when keypad is unlocked, the communication mode is set to full. To lock the keypad, press and hold down arrow key or set communication mode to remote. Message “Keypad locked” is shown on the screen.
- Full: The controller will accept all commands from the keypad and serial/ Ethernet.

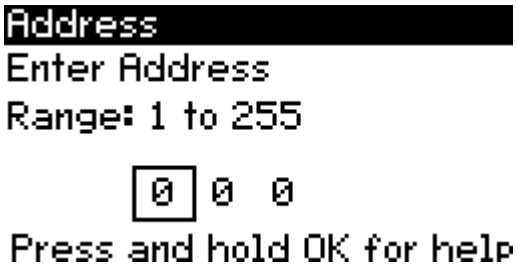
Figure 22. *Mode*



Address

This parameter is used to set the SPCe serial address. The default value is 5.

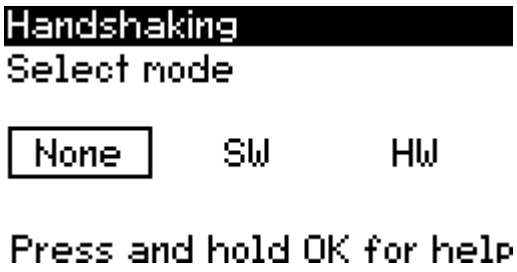
Figure 23. *Address*



Handshaking

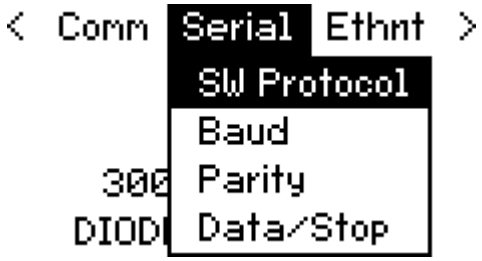
This parameter is used to set serial handshaking. The default value is set to disabled.

Figure 24. *Handshaking*



6.6. Serial parameters menu (Serial)

Figure 25. *Serial menu*



SW protocol

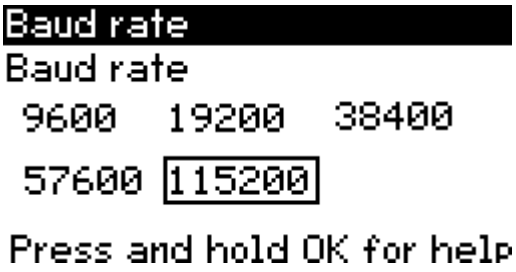
This parameter chooses the command set used for remote commands.

Figure 26. *SW protocol*

Baud rate (Baud)

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

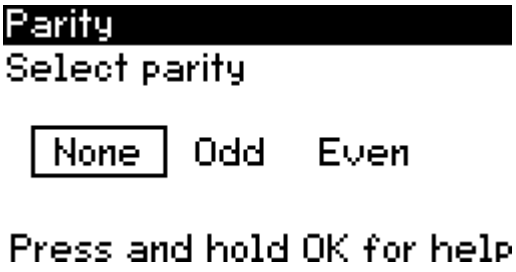
Figure 27. *Baud rate*



Parity

This parameter is used to set the parity party check of the SPCe. The default value is None.

Figure 28. *Parity*



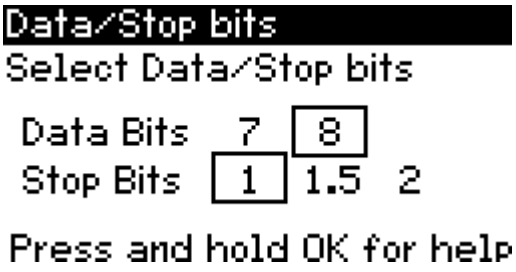
Data bits

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

Data and stop bits

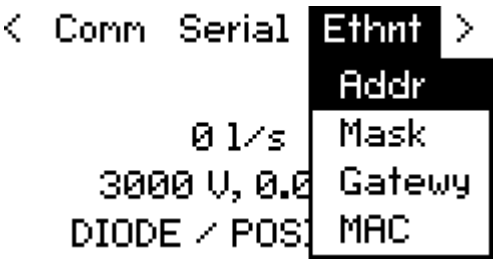
This parameter is used to set the stop bits of the SPCe. The default value is 1.

Figure 29. *Data and stop bits*



6.7. Ethernet parameters menu (Ethnt)

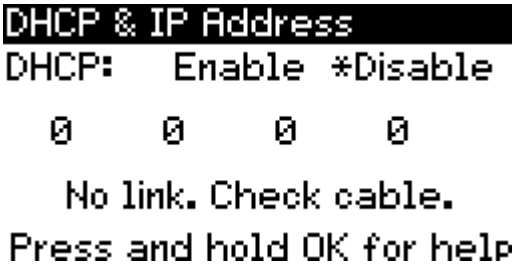
Figure 30. *Ethernet parameter menu*



DHCP & IP address (Addr)

The SPCe is capable of acting as a DHCP (Dynamic Host Configuration Protocol) client. When enabled as a DHCP client, the SPCe will obtain needed network information from a DHCP server. When DHCP is disabled, the user may change the SPCe Ethernet address. Currently IPv4 is the only supported format.

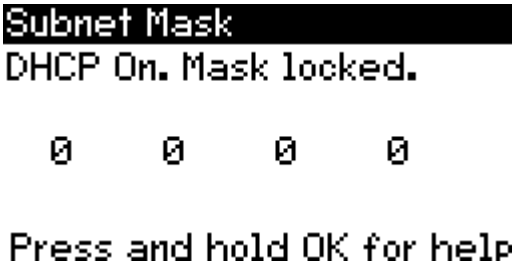
Figure 31. *DHCP and IP address*



Subnet mask(Mask)

When DHCP is disabled, the user may change the Ethernet subnet mask.

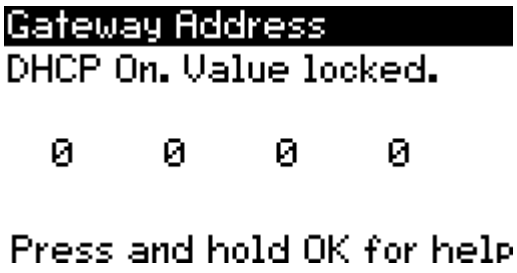
Figure 32. *Subnet mask*



Gateway

When DHCP is disabled, the user may change the SPCe Ethernet gateway address.

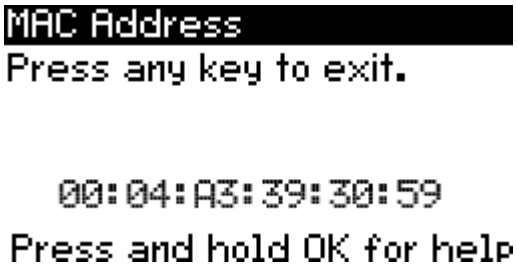
Figure 33. *Gateway address*



MAC address (MAC)

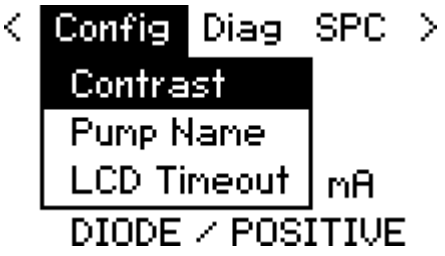
This screen shows the controller's MAC address.

Figure 34. *MAC address*



6.8. Configuration menu (Config)

Figure 35. *Configuration menu*



Contrast

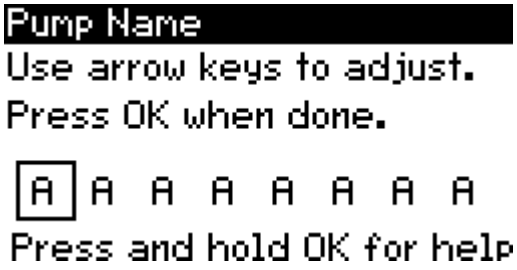
This function is used to adjust the contrast of the display. Use the arrow keys to adjust the screen contrast.

Figure 36. *Adjust display*

Pump name

This parameter allows the pump name to be changed. Use the up and down arrows to cycle through letters, numbers, and symbols. Use the left and right arrow keys to move the selector.

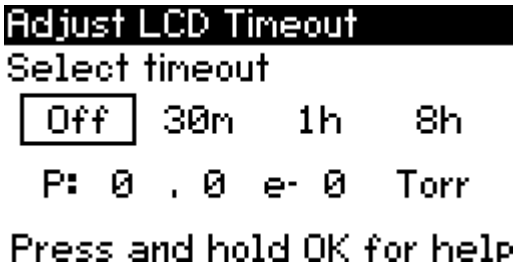
Figure 37. *Pump name*



LCD timeout

The SPCe's LCD back light can be dimmed to extend the life of the display. By enabling this parameter, the back light is dimmed after a specified amount of time has passed since the last key press. This feature is off by default.

Figure 38. *Adjust LCD timeout*



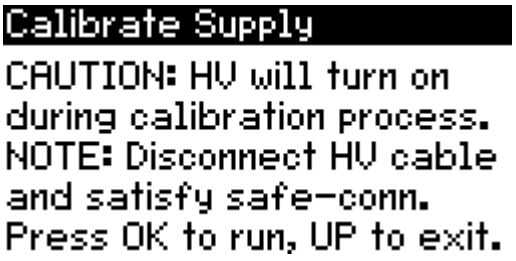
6.9. Diagnostics menu (Diag)

Figure 39. *Diagnostic menu*

Zero offset calibrate supply

Prior to operating an ion pump, the controller should be calibrated to account for 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.

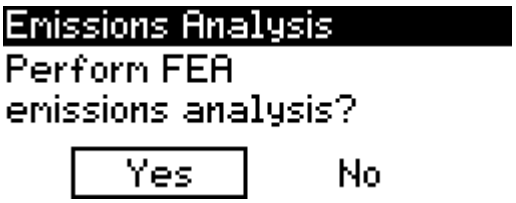
Figure 40. *Calibrate supply*



Fowler-nordheim field emission analysis (FEA)

Analyzing the emission current of an ion pump allows for more accurate pressure readings. 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.

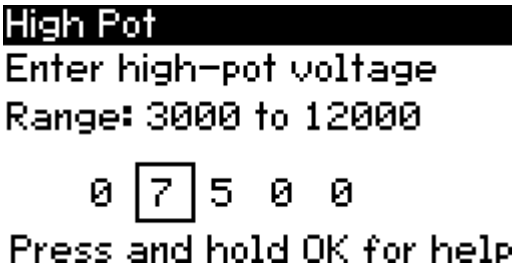
Figure 41. *Emission analysis*



High pot

This feature operates the ion pump in a high-pot mode where the pump voltage can perform in the range of 10.5 kV for hi-pot cleaning of an ion pump. The ion pump will attempt to reach a preset voltage up to 10.5 kV.

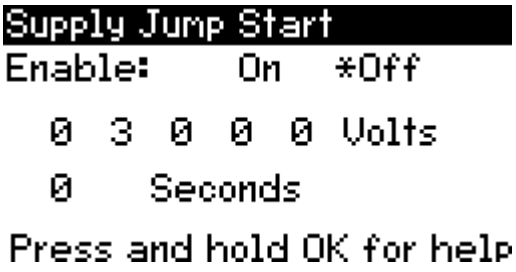
Figure 42. *High pot*



Supply Jump Start (Jump Mode)

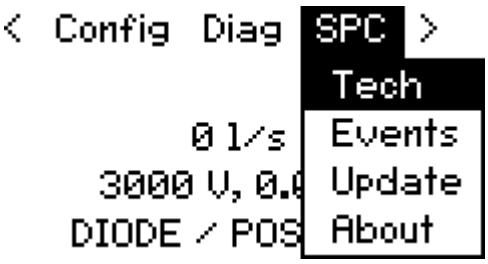
Enabling Jump Start causes the SPCe to increase the voltage to the set value when initially starting the ion pump. This causes the ion pump to potentially arc from cathode to anode, which creates electrons within the ion pump. These electrons start the initial electron charge within the pump. This feature is useful when starting smaller pumps that are very low in pressure when the pump is turned on (for example after a long turbo bake).

Figure 43. *Supply jump start*



6.10. SPC

Figure 44. *SPC*

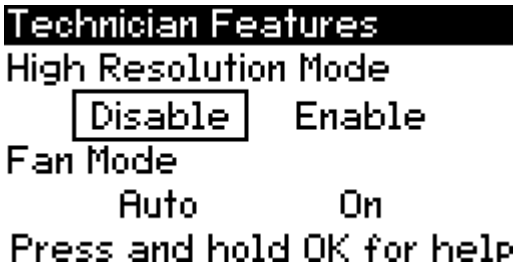


Technician features

This is the technician screen for the SPCe.

- High Resolution Mode: This mode can be enabled or disabled. Disabled is the default. When enabled, the pressure value coefficient, also called significant, has additional digit, i.e. $1.57e^{-10}$ vs. $1.5e^{-10}$.
- Fan Mode: This mode can be set to on or auto. When set to on, the fan is always on when HV is on. When set to auto, the fan is on when in pump starting mode and not in pump running mode.

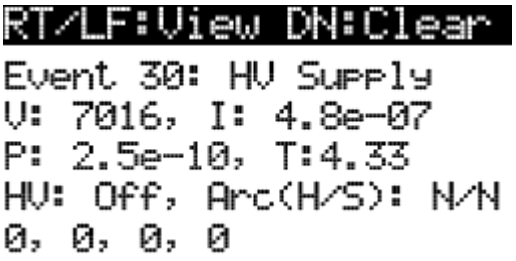
Figure 45. *Technician features*



Events

During operation, the SPCe records various vacuum events that occur (short circuit, excessive arcing, etc). These event are recorded and viewable. The event description, time, voltage, current, and pressure are recorded.

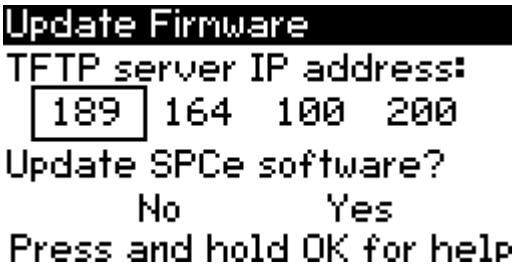
Figure 46. *Events*



Update firmware

The SPCe firmware can be updated via serial cable or ethernet. The latest version of SPCe software can be download from www.gammavacuum.com. Reference Service Bulletin 00.056.092 in that download for full details.

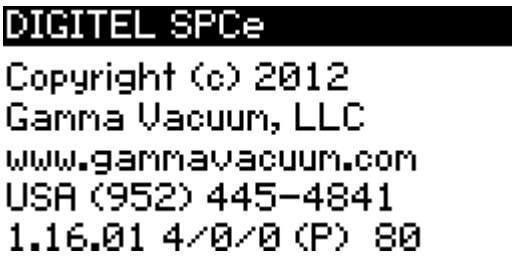
Figure 47. *Update firmware*



About

This screen displays manufacturer, contact, and revision information

Figure 48. *DIGITEL SPCe*



7. Display messages

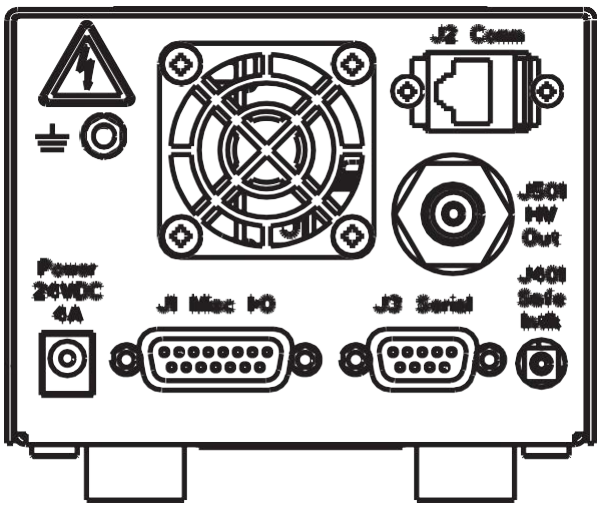
During operation, the SPCe may detect and report a number of possible operating conditions. For example, the SAFECONN connector may become disconnected, the vacuum may fail, or the ion-pump may have a problem. These conditions are reported by the following messages on the display:

Display Message	Display Meaning
01: Cool down Cycles > 3	Too many cool down cycles occurred during pump starting.
02: Vacuum Loss	The voltage dropped below 1200 V while pump was running.
03: Short Circuit	Short circuit condition has been detected during pump starting.
04: Excess Pressure	Excessive pressure condition detected. Pressure greater than $1.0e^{-04}$ Torr detected. (Obsolete starting with version 1.15.03)
05: Pump Overload	Too much power delivered to the pump for the given pump size.
06: Supply Power > 50W	Supply output power detected greater than 50 W.
07: Start Under Voltage	The voltage did not reach 2000 V within the maximum pump starting time of 5 minutes.
10: Pump is Arcing	Arcing detected.
12: Thermal Runaway	Significant drop in voltage detected during pump starting.
19: Unknown Error	(Used internally for troubleshooting.)
20: SAFE_CONN Intrlock	Safety interlock connection is not detected. Check safe-conn connection.
21: HVE Interlock	HVE interlock function is active on pin 8 on J1 misc i/o connector. To turn on HV, user must satisfy interlock (3.3 V d.c. to 12 V d.c. on pin 8 on J1 misc i/o connector).
or 21: HVE Signal Off	HVE on/off function is active on pin 8 on J1 misc i/o connector. Logic high (3.3 V d.c. to 12 V d.c. on pin 8 on J1 misc i/o connector) turns on HV. Logic low turns of HV.
22: Set Pump Size	Pump size is not set.
23: Calibration Needed	Supply calibration has not been performed. Required for accurate current/pressure readings.
24: Reset Required	Supply calibration parameters are outside normal ranges. System reset will clear all parameters to factory defaults.
25: Temperature Warning	Supply internal temperature is past the threshold.
26: Supply Over Heat	Supply internal temperature too high. HV operation is disabled.
27: Current Limited	Supply current is limited. The limit is set by programming the pump size or manually by the user.
30: Internal Bus Error	Internal data bus error detected.

Display Message	Display Meaning
31: HV Control Error	Supply HV control mechanism malfunctioning. On/Off state is malfunctioning.
32: Current Control Err	Supply current control mechanism malfunctioning.
33: Current Measure Err	Supply current measuring mechanism malfunctioning.
34: Voltage Control Err	Supply HV control mechanism malfunctioning. Voltage output level is malfunctioning.
35: Voltage Measure Err	Supply voltage measuring mechanism malfunctioning.
37: HV Not Installed	Internal boards polarity mismatch.
37: Input Voltage Error	HV module missing.
38: Input Voltage Error	Input power voltage outside 22-26 V d.c. range. HV operation disabled. When running in battery mode, this restriction is off.

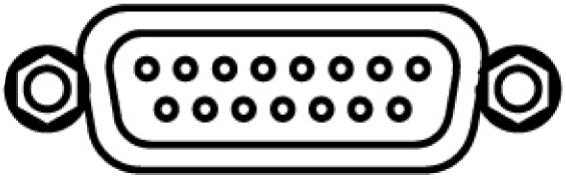
8. Back panel operation

Figure 49. *Back panel view*



8.1. Remote hardware option (J1)

Figure 50. *Remote hardware*



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

Pin number	Function
1	Setpoint relay common
2	Setpoint relay NC
3	GND
4	GND
5	-14 V
6	+14 V
7	+5 V
8	Remote HV Enable (3.3–12 V)
9	Setpoint relay NO
10	+14 V
11	Setpoint logic output
12	Output current monitor
13	HV enable monitor
14	Output voltage monitor
15	+14 V

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

The setpoint relay is driven while either of the following two sets of conditions are 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 2 kV.
4. The calculated pressure is lower than the user-selected setpoint pressure.

OR

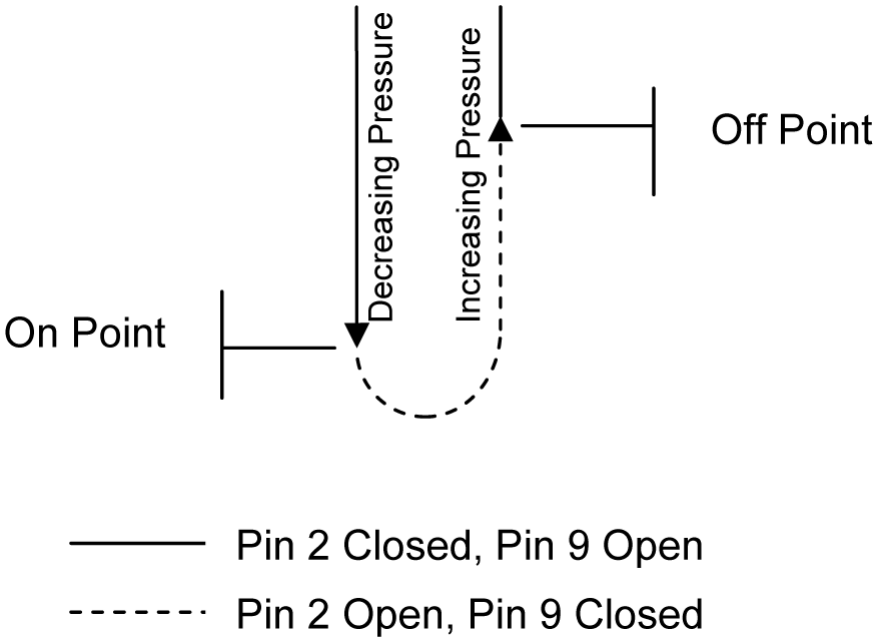
1. The SPCe unit is powered up.
2. The SPCe unit is in error mode.

Note:

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

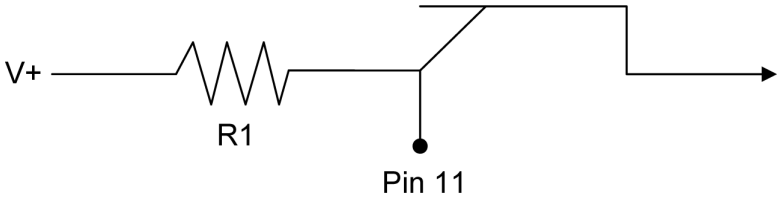
Pin 1 is the relay common, pin 2 is the normally closed, and pin 9 is the normally open contact.

Figure 51. *Pressure output*



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

Figure 52. *Current output*



Output current or pressure (Pin 12)

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

Logarithmic Current (i) Examples:

Example 1

Offset = 8

Current = 2 x 10^{-8} (20 nA)

Step 1: Calculate the log of the current (Log (2 x 10^{-8}) = -7.7)

Step 2: Add the offset value (-7.7 + 8 = 0.3 Volts = V_{pin12})

Example 2

Offset = 8

Current = 5 x 10^{-6} (5 uA)

Step 1: Calculate the log of the current (Log (5 x 10^{-6}) = -5.3)

Step 2: Add the offset value (-5.3 + 8 = 2.7 Volts = V_{pin12})

Example 3

Offset = 7

Current = 2 x 10^{-8} (20 nA)

Step 1: Calculate the log of the current (Log (2 x 10^{-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 = 1 x 10^{-9} Torr/mbar/pascal

Step 1: Calculate the log of the pressure (Log (1 x 10^{-9}) = -9)

Step 2: Add the offset value (-9 + 10 = 1 Volt = V_{pin12})

Example 2

Offset = 11

Pressure = 6 x 10^{-8} Torr/mbar/pascal

Step 1: Calculate the log of the pressure (Log (6 x 10^{-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 0 V and can sink 100 mA. 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 that is proportional to the HV output voltage and can be used to monitor the HV. The scaling factor is 1 V per 1 KV out.

8.2. Power supplies

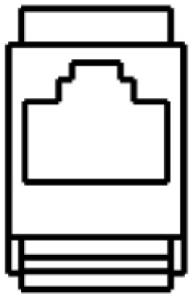
The following power supply pins are available on the misc. I/O connector. These power supplies are not protected and should be used with care. Do not attempt to power the SPCe by connecting external power supplies to these pins.

- Pin 5 is connected to (approximately) –12 V.
- Pin 10, pin 6, and pin 15 are connected to (approximately) +12 V.
- Pin 7 is connected to (approximately) +5 V.
- Pin 3 and pin 4 are grounded.
- The +14 V and –14 V supplies are regulated but not calibrated - in practice they may vary over the range 12 V to 15 V or so. Do not draw more than 50 mA from any of these supplies, and do not inject significant levels of noise onto them.
- The +5 V supply may range from +4.9 V to +5.1 V. Do not draw more than 100 mA from this supply.

9. Serial (J3) and ethernet (J2) operation

9.1. Ethernet connector

Figure 53. *Ethernet connector*



A Telnet session may be established to port TCP 23, 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>

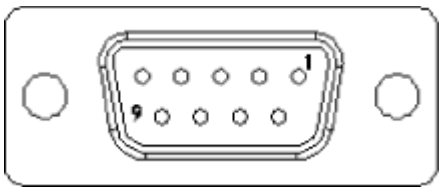
For example, to set the pump size to 1200 using the command CMD_HV_SET_PUMPSIZE, issue the following command in the Telnet session:

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 issued as 01.

9.2. Serial connector

Figure 54. *Serial connector*



J3 is a 9-pin, female DE-9 connector used to route 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	
RXD	2
TXD	3
GND	5

RS - 422	
+RX	3
-RX	7

RS - 422	
GND	5

RS - 485 full duplex operation	
+TX	2
-TX	8
GND	5
+RX	3
-RX	7

RS - 485 half duplex operation	
+TX/+RX	2
-TX/-RX	8
GND	5

Note:

RS 422 is not bi-directional.

9.3. Standard

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 acknowledgment 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.

9.4. 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.

9.5. 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:.

Table 1. *Command packet structure*

Start Char	Space	Address	Space	Command	Space	Checksum	Terminator
1 byte	1 byte	2 bytes	1 byte	2 bytes	1 byte	2 bytes	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 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 fields (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.		

Field	Size	Comment
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.		

Command packet example

Command to be sent is “0x01” - GET CONTROLLER MODEL

Serial address of the controller is 5.

Command packet

“~ 05 01 00<CR>” where “<CR>” is return carriage character.

Command packet in ASCII hexadecimal

“7e 20 30 35 20 30 31 20 30 30 0D”

Response to “0x01” - GET CONTROLLER MODEL

“05 OK 00 DIGITEL SPCe 46<CR>” Where “<CR>” is the return carriage character.

Note:

Command checksum is set to “00” to bypass the checksum field verification by the controller.

9.6. Decoding the command packet

An SPCe operates in one of three modes: monitor, receive, and respond. Receipt of data is interrupt driven or otherwise multiplexed, so 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 SPCe 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:
   - a valid start character followed by a space,
   - a 2-byte hex value matching the controller’s address followed by a space,
   - at least one 2-character hex value command followed by a space,

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

9.7. Response packet

The response packet is made up of at least five fields and contains information to let the controlling computer know 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.

Table 2. *Response packet*

Address	space	Status	space	Response code	space	Checksum	Terminator
2 bytes	1 byte	2 bytes	1 byte	2 bytes	1 byte	2 bytes	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 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>		

Field	Size	Comment
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	ACSII 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.		

9.8. RS 232/422/485 general commands

Table 3. *General commands*

Hex command	Description	Data field	Response	Data/Response description
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

Hex command	Description	Data field	Response	Data/Response description
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	n.nn		n.nn range is 0.00 – 9.99

Hex command	Description	Data field	Response	Data/Response description
	Sets the calibration factor that modifies pressure.			
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.			

Hex command	Description	Data field	Response	Data/Response description
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 is 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

Hex command	Description	Data field	Response	Data/Response description
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)	

Hex command	Description	Data field	Response	Data/Response description
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

Hex command	Description	Data field	Response	Data/Response description
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.	"XXXX" (set mode)	"XXXX" (get mode)	X.XE-XX = Target pressure (set mode)

9.9. CRC checksum example

The command to be sent to the unit is

0x01 – CMD_SYS_MODEL.

Full command is:

'~ 01 01 XX' + carriage return,

where XX is an 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.
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 sent 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,
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.

Table 4. *Command CRC checksum*

Characters	Value (Decimal)	Value (Hex)
space	32	0 X 20

Characters	Value (Decimal)	Value (Hex)
0	48	0 X 30
1	49	0 X 31
space	32	0 X 20
0	48	0 X 30
1	49	0 X 31
space	32	0 X 20
	Total = 290	Total = 0 X 122

Table 5. *Response CRC checksum*

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
	32	0x20
	Total = 1352	Total = 0x548

9.10. 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

10. Warranty and service

10.1. Service

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 the pump's lifetime, improve system ultimate pressure, and give the most accurate current readings.

10.1.1. Cleaning procedure

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

10.1.2. 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.

10.1.3. 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 numbers.

10.2. Warranty

10.2.1. General terms

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

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

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

In-warranty repaired or replacement parts are warranted only for the remaining unexpired portion the 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, labour, 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.

10.2.2. Warranty claims

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

- Part number
- Serial number
- Detailed description of the vacuum system hardware
- Detailed description of the vacuum system process (gas species introduced, ultimate pressure, operational pressure)
- Detailed reason for the warranty claim

To expedite this process, please forward this information to service@gammavacuum.com.

10.3. Returning material

10.3.1. Return procedure

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

RMA numbers can be obtained by calling Gamma Vacuum tollfree. 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 product description
- Product serial number

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

NOTE:

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

10.3.2. 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 labelled on all shipping information and packages.

11. Disposal

Dispose of the pump and any components and accessories safely and in accordance with all local and national safety and environmental requirements.

Particular care must be taken with any components that have been contaminated with dangerous process substances.

Take appropriate action to avoid inhalation of any particles that may be present in the pump.

P20010442A

EU Declaration of Conformity

Gamma Vacuum
Part of the Atlas Copco Group
2700 4th Ave E, Suite 100
Shakopee, MN 55379
USA

Documentation Officer
Jana Sigmunda 300
Lutín , 78349
Czech Republic
T: +42(0) 580 582 728
documentation@vt.atlascopco.com

The product specified and listed below

SPC Controller:
TUV: SUD Certificate U8 17 08 60983 023
Model=Product Type: SPC-A-BB-C-D-EEEEE-FF-G-HHHHH
Where:
A = Number of High Voltage Sections
BB=Polarity of High Voltage
C=High Voltage Connector Type
D= High Voltage Outputs per High Voltage Section
EEEEE= Input Voltage
FF= Communication Port Options
G= High Voltage Enable option
HHHHH=TSP

Is in conformity with the relevant requirements of European CE legislation:

2014/35/EU	Low voltage directive (LVD)
2014/30/EU	Electromagnetic compatibility (EMC) directive Class A Emissions, Industrial Immunity
2011/65/EU	Restriction of certain hazardous substances (RoHS) directive as amended by Delegated Directive (EU) 2015/863

Based on the relevant requirements of harmonised standards:

EN 61010-1:2010/A1:2019	Safety requirements for electrical equipment for measurement, control and laboratory use. General requirements
EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements

This declaration, based on the requirements of the listed Directives and EN ISO/IEC 17050-1, covers all product serial numbers from this date on: *2021-04-21*

You must retain the signed legal declaration for future reference
This declaration becomes invalid if modifications are made to the product without prior agreement.

Ian Keech, VP Engineering
Scientific Vacuum Division
Burgess Hill, UK

Marcus Thierley
General Manager
Shakopee, USA

This product has been manufactured under a quality management system certified to ISO 9001:2015

P20010442A

Declaration of Conformity

Gamma Vacuum
Part of the Atlas Copco Group
2700 4th Ave E, Suite 100
Shakopee, MN 55379
USA

Documentation Officer
Innovation Drive
Burgess Hill
West Sussex
RH15 9TW
documentation@vt.atlascopco.com

This declaration of conformity is issued under the sole responsibility of the manufacturer.

SPC Controller:
TUV: SUD Certificate U8 17 08 60983 023
Model=Product Type: SPC-A-BB-C-D-EEEEE-FF-G-HHHHH
Where:
A = Number of High Voltage Sections
BB=Polarity of High Voltage
C=High Voltage Connector Type
D= High Voltage Outputs per High Voltage Section
EEEEE= Input Voltage
FF= Communication Port Options
G= High Voltage Enable option
HHHHH=TSP

The object of the declaration described above is in conformity with relevant statutory requirements:

Electrical Equipment (Safety) Regulations 2016

Electromagnetic Compatibility Regulations 2016
Class A Emissions, Industrial Immunity

Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

Relevant designated standards or technical specifications are as follows:

EN 61010-1:2010/A1:2019	Safety requirements for electrical equipment for measurement, control and laboratory use. General requirements
EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements

This declaration, based on the requirements of the listed Statutory Instruments and EN ISO/IEC 17050-1, covers all product serial numbers from this date on: *2021-04-21*

You must retain the signed legal declaration for future reference
This declaration becomes invalid if modifications are made to the product without prior agreement.

Signed for and on behalf of Gamma Vacuum

Ian Keech, VP Engineering
Scientific Vacuum Division
Burgess Hill, UK

Marcus Thierley
General Manager
Shakopee, USA

This product has been manufactured under a quality management system certified to ISO 9001:2015

ADDITIONAL LEGISLATION AND COMPLIANCE INFORMATION

EMC (EU, UK): Class A/B Industrial equipment

Caution: This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

RoHS (EU, UK): Material Exemption Information

This product is compliant with no Exemptions

REACH (EU, UK)

This product is a complex article which is not designed for intentional substance release. To the best of our knowledge the materials used comply with the requirements of REACH. The product manual provides information and instruction to ensure the safe storage, use, maintenance and disposal of the product including any substance-based requirements.

Article 33.1 Declaration (EU, UK)

This product does not knowingly or intentionally contain Candidate List Substances of Very High Concern above 0.1%ww by article as clarified under the 2015 European Court of Justice ruling in case C-106/14.

Additional Applicable Requirements

The product is in scope for and complies with the requirements of the following:

2012/19/EU	Directive on waste electrical and electronic equipment (WEEE)
Product is certified to CAN/CSA-C22.2 No.61010-1-12:2012/A1:2018-11	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements
Product is certified to UL61010-1 3rd Edition	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements

材料成分声明

China Material Content Declaration

表示该有害物质在该部件的所有均质材料中的含量低于 GB/T 26572 标准规定的限量要求。

Indicates that the hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in GB/T 26572.

2700 4th Avenue E, Suite 100, Shakopee, MN 55379, USA. 1 800 237 3603, 952 445 4841
1 952 445 7615 info@gammavacuum.com www.gammavacuum.com