



# DIGITEL MPCq CONTROLLER USERS MANUAL

Document 900034, Rev B



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### 1. GENERAL INFORMATION

The DIGITEL™ MPCq is an ion pump power supply controller. It is designed to operate up to two independent ion pumps along with a titanium sublimation pump (TSP). It can accommodate any ion pump size up to 1200 l/s. The front panel display provides direct readout of the ion pump voltage, current, or pressure. Individual model specification information is located on our website at: [www.gammavacuum.com](http://www.gammavacuum.com).

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



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

### 3. WARNINGS



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

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

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

**安全警告:**  
触电危险。触电可导致受伤或死亡。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 REVISIÓN INTERNA.

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



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

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

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

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

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

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



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

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

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

**安全警告:**  
在使用这台机器前，请务必阅读并理解“操作员手册（指南）”。如果未能遵循操作・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 AUSTRÜSTUNG BESCHÄDIGEN.

### 2. APPROVALS

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

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



## 4. UNPACKING THE CONTROLLER

### 4.1 Inspect For Any Obvious Damage

If the controller is damaged in any way, a claim should be filed with the carrier immediately and notification given to customer center where the order originated, and/or Gamma Vacuum.

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

### 4.2 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.

## 5. SAFETY NOTICES

1. Gamma vacuum controllers designed for ion pump operation are capable of delivering 7kV 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.
2. Installation procedures are for use by qualified, authorized personnel who have experience working with 50 volts or greater. To avoid personal injury, do not perform any installation or service unless qualified to do so.
3. There are no serviceable parts inside the controller power-supply, and voltages as high as 7kV may be present. Do not open the supply case under any circumstances. In the event of the power-supply requiring attention, return it to Gamma Vacuum.
4. Do not disconnect the high-voltage cable with the power on. After turning the power off, allow at least one minute before disconnecting electrical equipment.
5. Do not operate the controller without a proper electrical ground or near water. The controller may be damaged and its safety reduced if it is operated outside of its specifications.

## 6. INSTALLATION

The DIGITEL MPCq is a full 19 inch rack controller. No additional hardware needed to install in a standard 19 inch wide device rack.

Maintain a 2.52 in. (64 mm) clearance behind controllers for cable bend radius and proper airflow.

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



### 6.1 Required Items

You will need the following items to install the controller:

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

### 6.2 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 DIGITEL rear panel.
3. Connect the high voltage cable to the ion pump and the high voltage connector on the DIGITEL rear panel (J501–J504).
4. If high voltage cable has an optional safeconn feature (HV interlock), an additional connector is part of the high voltage cable. Connect it to the safeconn connector (J401–J404), otherwise, use safeconn shorting jumper cable to connect to safeconn connector (J401–J404). Safeconn interlock must be satisfied, otherwise HV cannot be turned on.
5. Verify correct input voltage requirements. Connect mains AC power cable to input power receptacle on the controller rear panel.

## 7. CONTROLLER CONFIGURATION

Following configuration options are specified at order time:

### 7.1 Input Mains AC Voltage (110Vac vs. 220Vac)

Controller does not have universal power input, thus input mains AC voltage is part of the controller configuration.

Care must be taken when connecting controller to mains AC voltage to avoid connecting controller to wrong input voltage.

### 7.2 Supply configuration

Following controller configurations are valid:

- One HV supply/channel
- Two HV supplies/channels
- One HV supply/channel and one internal TSP or NEG supply

### 7.3 Output voltage polarity for each HV channel (positive vs. negative)

In case of positive polarity, output voltage is set to 7kV by default.

In case of negative polarity, output voltage is set to -5.6kV by default.

Output voltage is fixed (linear power supply, transformer tap).

### 7.4 Type of the HV output connectors

Following are standard HV connector types for J501 - J504:

- SHV-10kV (matching safeconn connector type is SMB style)
- Fisher (matching safeconn connector type is mini banana style)

Other HV connector types are available per request.

### 7.5 Number of HV output connectors per HV supply

There can be more than one HV output connector tied to the same HV supply. In such case, connectors are tied in parallel.

Controller can have maximum of 4 HV output connectors in any configuration. For example, 2 HV output connectors per 1 HV supply.

### 7.6 Communication interface

Controller comes standard with Serial and Ethernet interface.

Profibus interface is optional.

### 7.7 Remote TSP control

Controller comes standard with connector J505 CTRL installed.

Connector can be used to connect and control Remote TSP/NEG Controller.

See rear panel section for connector location.

If internal TSP/NEG supply is installed, connector J505 is not available.

## 8. HV CONTROL / ION PUMP OPERATION

### 8.1 Prior to using an ion pump

Confirm following:

- Rough pump down to  $1 \times 10^{-4}$  Torr or less (the lower the better).  $1 \times 10^{-6}$  Torr is recommended. See Rough Pump user manual for details.

**NOTE:** Use the full extent of available rough pumping before starting an ion pump to extend pump's lifetime, improve system ultimate pressure, and get accurate current readings.

- Evacuate the Vacuum System
- Ensure contaminants do not exist in the system.
- If necessary (i.e. ion pump exposed to atmospheric pressure) bake the ion pump and system into roughing pump to achieve lowest pressure. See Ion Pump user manual for details.

### 8.2 Prior to turning on HV and starting an ion pump

Confirm following:

- Verify high voltage cable is installed and connecting controller's high voltage (HV) output connector (rear panel, J501-J504) to the ion pump.
- Verify controller and connected ion pumps are grounded using redundant ground wire.
- Verify controller's high voltage output has correct polarity for the connected ion pump (positive for diode pump, negative for triode pump).
- Verify safeconn interlock is satisfied.

If high voltage cable has optional safeconn interlock feature, an additional connector is part of the high voltage cable. Connect it to controller's safeconn connector (J401-J404). If high voltage cable does not have safeconn interlock feature, use safeconn shorting jumper cable to connect to controller's safeconn connector (J401-J404).

Safeconn interlock must be satisfied, otherwise HV cannot be turned on.

If safeconn interlock is not satisfied, controller will display error 20 (safeconn interlock not satisfied) for that HV channel.

- Verify proper pump size is configured. HV cannot be turned on if pump size is set to 0. By default pump size is set to 0.

If pump size is set to zero, controller will display error 22 (Pump size not configured) for that HV channel.

### 8.3 Turn HV on/off

Turning HV on/off can be achieved:

- Using front panel touchscreen.
- Using remote communication (Serial, Ethernet or Profibus).
- Using rear panel connector J104, Misc. I/O. (Digital Inputs)

## 9. PRESSURE MEASUREMENT

Pressure value is determined using following equation 
$$P = \frac{(0.066 * I * (\frac{5600}{V}) * U * F)}{S}$$

Where:

I - Current in amps.

V - Voltage in volts.

U - Pressure units conversion factor (1 for Torr, 1.33 for mBar and 133 for Pascal).

F - Configured pump pressure factor. Typically set to 1. See "11.4 Supply Setup" on page 8.

S - Configured pump size in l/s. See "11.4 Supply Setup" on page 8.

## 10. FRONT PANEL

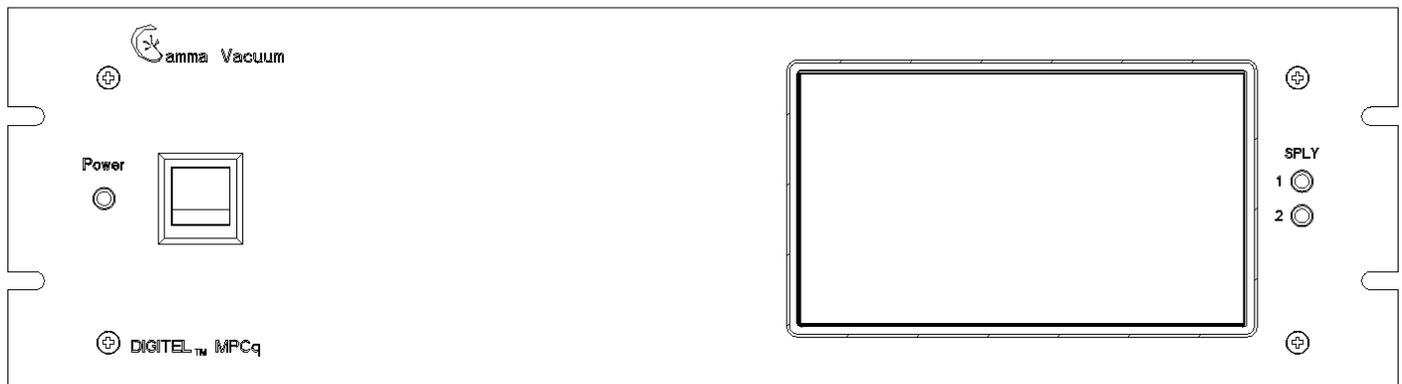


Figure 1. MPCq Front Panel

### 10.1 Description

Front panel contains:

- Main power on/off rocker type switch (hard switch, when in off position main power is completely cut off from the unit)
- Main power indicator lamp (color green)
- 7" TFT WVGA (800x480) Color LCD, 16:9 aspect ratio, touchscreen capable (primary user interface)
- Two supply HV on/off indicator lamps (color red). Note, both lamps are installed even in single supply configuration.

## 11. TOUCHSCREEN USER INTERFACE

### 11.1 Home Screen

Touch anywhere on the screen to invoke button controls.



Figure 2. Home Screen (two HV supplies installed)

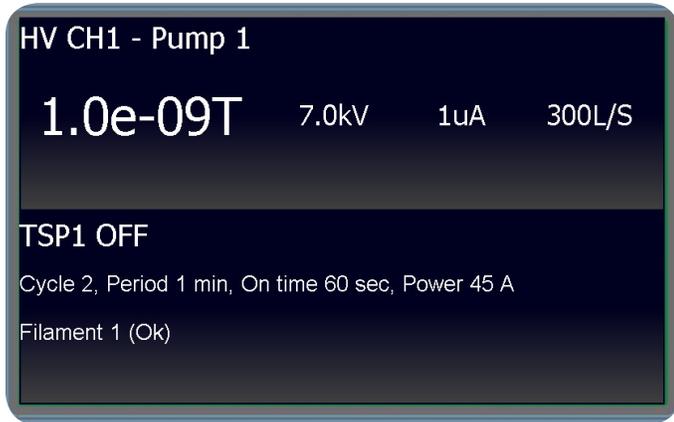


Figure 3. Home Screen (with internal TSP supply installed)

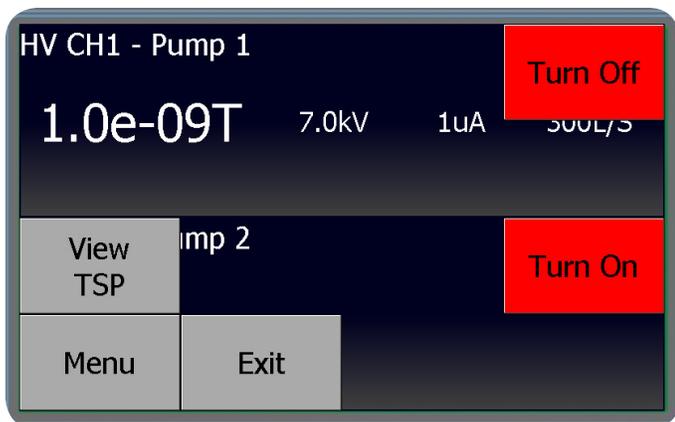


Figure 4. Home Screen With Control Buttons Invoked

Available options:

View TSP - Switches home screen to TSP view. Button is available only if Remote TSP Controller is connected to the MPCq Controller.

Menu - Invokes main menu.

Exit - Clears screen/hides control buttons.

Turn On/Off - Turns HV on/off for respective HV channel.

### 11.2 Main Menu (Page 1)

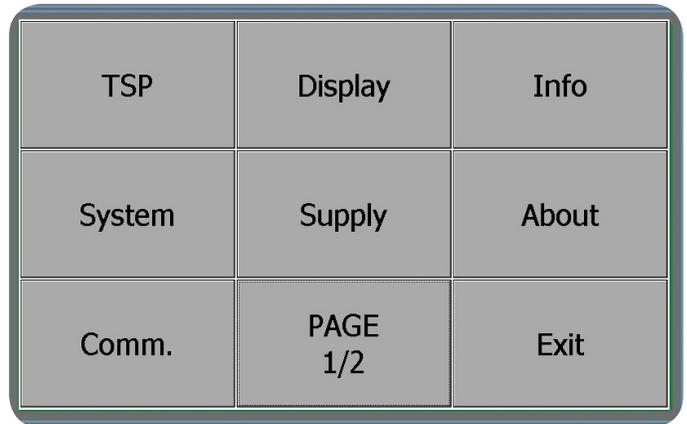


Figure 5. Main Menu (Page 1)

Page 1 of main menu is accessed by pressing the "PAGE 1/2" button. Exit button will exit main menu and show home screen.

### 11.3 Main Menu (Page 2)

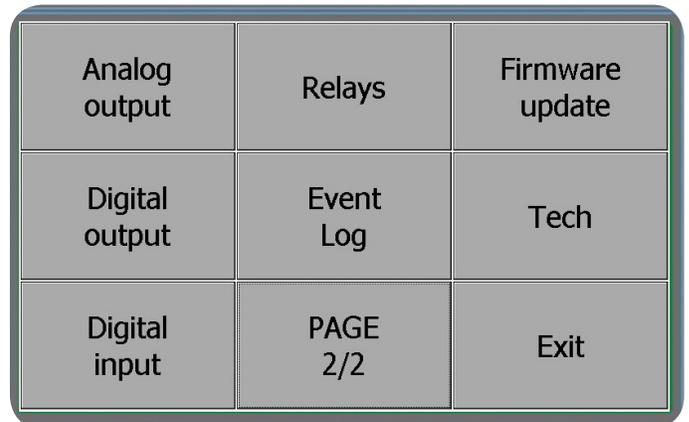


Figure 6. Main Menu (Page 2)

Page 2 of Setup Screen is accessed by pressing the "PAGE 1/2" button.

Exit button will exit main menu and show home screen.

## 11.4 Supply Setup

Supply 1 (Connector: J501)		
Pump name Pump 1	Main display value Pressure	
Pump size (l/s) 300	Pressure factor 1.00	
Auto restart OFF	Supply calibration	
Home	Supply 1	Back

Figure 7. Supply Setup Screen

Available setup:

Pump name - Configures pump name. Max of 15 characters.

Pump size - Configures pump size (0-1200).

Auto restart - Configures supply auto restart option (on/off).

Main display value - Configures main display value (voltage, current pressure).

Pressure factor - Configures pump pressure factor. See "9. Pressure Measurement" on page 6 for details.

Supply calibration - Invokes supply calibration (zeroing) process.

## 11.5 Display Setup

Display Setup	
Brightness Level 10	Touchscreen calibration
Screensaver ON	
Home	Back

Figure 8. Display Setup Screen

Available setup:

Brightness Level - Configures screen brightness level (1-10).

Screensaver - Configures screen-saver on/off state. Turning screen-saver off is not recommended as this will shorten screen backlight lifetime.

Touchscreen calibration - Invokes touchscreen calibration process.

## 11.6 System Setup

System	
Language ENGLISH	Restore Default Settings
Pressure units TORR	Setpoint view OFF
Fan Control ON	
Home	Back

Figure 9. System Setup Screen

Available setup:

Language - Configures user interface language.

Pressure Units - Configures system pressure units (Torr, mBar, Pascal).

Fan Control - Configures fan control (On, Auto).

Restore Default Settings - Resets all settings to system defaults.

Setpoint view - Turns on/off setpoint view button on the home screen.

## 11.7 Analog Output

Analog output 1 Setup J104 pin 30		
Function (AO1) Pressure, logarithmic	Offset 0	
Supply source Supply 1	Output state Normal	
Response time N/A		
Home	Analog output 1	Back

Figure 10. Analog Output Screen

Total of four analog outputs on connector J104:

Analog Output 1 (J104, pin 30)

Analog Output 2 (J104, pin 32)

Analog Output 3 (J104, pin 34)

Analog Output 4 (J104, pin 36)

By default, all analog outputs are turned off (function set to off).

Analog output signal range 0-10V.

### Available Functions:

OFF	Current, 1V / 10uA
Pressure, logarithmic	Current, 1V / 100uA
Current, logarithmic	Current, 1V / 1mA
Current, 1V / 1nA	Current, 1V / 10mA
Current, 1V / 10nA	Current, 1V / 50mA
Current, 1V / 100nA	Voltage, 1V / 1kV
Current, 1V / 1uA	

Supply Source - Selects supply driving analog output.

### Options applicable to 'Pressure, logarithmic' and 'Current, Logarithmic' functions:

Offset: Valid range from -15 to +15

Output State: Normal vs. Inverted (see examples below for details)

### Logarithmic Current Example:

Current =  $2 \times 10^{-8}$  (20nA), Offset = 8, Output state = Normal

Step 1: Calculate the log of the current ( $\text{Log}(2 \times 10^{-8}) = -7.7$ ).

Step 2: If 'Output state = Inverted' multiply current log value in step 1 by (-1).

Step 3: Add the offset value ( $-7.7 + 8 = 0.3$  Volts).

The analog output pin will read 0.3V.

### Logarithmic Pressure Example:

Pressure =  $1 \times 10^{-9}$  Torr, Offset = 11, Output state = Normal

Step 1: Calculate log of pressure ( $\text{Log}(1 \times 10^{-9}) = -9$ )

Step 2: If 'Output state = Inverted' multiply current log value in step 1 by (-1).

Step 3: Add offset value ( $-9 + 11 = 2$ V)

The analog output pin will read 2V.

## 11.8 Digital Input Setup

Digital input 1 Setup J104 pin 22		
Function (DI1) HV Interlock		
Supply source Supply 1		
Home	Digital input 1	Back

Figure 11. Digital Input Setup Screen

Total of four digital inputs on connector J104.

Digital Input 1 (J104, pin 22)

Digital Input 2 (J104, pin 23)

Digital Input 3 (J104, pin 24)

Digital Input 4 (J104, pin 25)

By default all digital inputs are turned off (function set to off).

### Available Functions:

OFF

HV Interlock

HV Switch

TSP 1 Interlock

TSP 2 Interlock

### HV Interlock Function

Ground pin to satisfy interlock. If interlock is not satisfied, HV cannot run.

### HV Switch Function

Ground pin to turn on HV, otherwise HV is off.

### TSP 1 Interlock Function

Ground pin to satisfy TSP 1 interlock. If interlock is satisfied, TSP 1 cannot run.

### TSP 2 Interlock Function

Ground pin to satisfy TSP 2 interlock. if interlock is not satisfied, TSP 2 cannot run.

Supply Source - Selects supply that will be controlled by this setup.

## 11.9 Digital Output

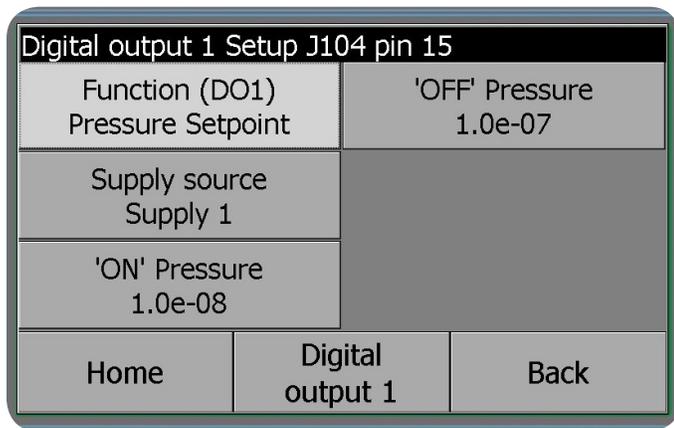


Figure 12. Digital Output Setup Screen

Total of four digital outputs on connector J104:

Digital Output 1 (J104, pin 15)

Digital Output 2 (J104, pin 17)

Digital Output 3 (J104, pin 19)

Digital Output 4 (J104, pin 37)

By default, all digital outputs are turned off (function set to off).

Digital output signal 0-5V.

### Available Functions:

OFF

Pressure setpoint

HV Error

HV Output state

### Pressure Setpoint Function

ON Pressure - When pressure value gets below this point, digital output is asserted.

OFF Pressure - When pressure value gets above this point, digital output is deasserted.

### HV Error Function

Digital output is asserted when supply error is detected.

### HV Output State Function

Digital output is asserted when supply is on (HV on), or de-asserted when supply is off (HV off).

Supply source - Selects supply driving digital output.

## 11.10 Relay Setup

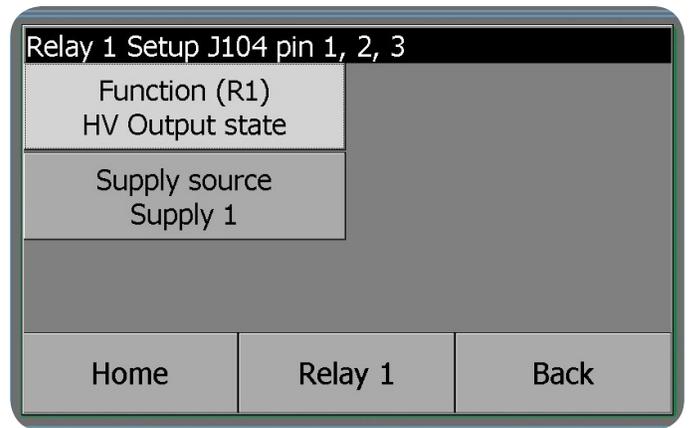


Figure 13. Relay Setup Screen

Total of four relays on connector J104:

Relay 1 (J104, pins 1, 2, 3)

Relay 2 (J104, pins 4, 5, 6)

Relay 3 (J104, pins 7, 8, 9)

Relay 4 (J104, pins 10, 11, 12)

By default, all relays are turned off (function set to off).

Setup is identical to digital output setup. See digital output setup.

For relay pinout details see "Table 2. J104 Connector Pinout" on page 16.

### 11.11 Serial Port Setup

Serial Settings	
Node Address 5	Data bits 8 Stop bits 1
Serial Standard RS-232	Serial Protocol Gamma
Baud rate 115200 bps	
Home	Back

Figure 14. Serial Port Setup Screen

Available setup:

Node Address - Configures unit node address (1-255). Gamma protocol command packet structure requires node address.

Serial Standard - Selects serial standard: RS-232, RS-485HD (two wire mode), and RS-485FD(four wire mode)).

Baud Rate - Selects baud rate (9600, 19200, 38400, 57600, 115200).

Data bits/Stop bits - Information only.

Serial Protocol - Selects serial protocol running on the serial port.

Supported protocols are Gamma, Modbus

ASCII, and Modbus RTU.

**NOTE:** Modbus register map is available on Gamma Vacuum website under download section.

### 11.12 Profibus Setup

Profibus Settings	
Profibus OFF	Parameters Process
Node Address 5	
Interface Status Disabled	
Home	Back

Figure 15. Profibus Setup Screen

For Profibus information reference Profibus user manual, document 900033 available on Gamma Vacuum website under download section.

### 11.13 Ethernet Interface Setup

Ethernet Setup	
MAC address AA:AA:AA:AA:AA:AA	Subnet mask 255.255.255.0
DHCP ON	Gateway address 1.1.1.1
IP address 1.1.1.2	Link state Connected
Home	Back

Figure 16. Ethernet Setup Screen

Available setup:

MAC address - Information only. Ethernet MAC address. Cannot be changed.

DHCP - Selects DHCP client on/off.

IP address - Configures Ethernet IP address.

Subnet Mask - Configures Ethernet subnet mask address.

Gateway address - Configures Ethernet gateway address.

Link state - Information only.

Supported Protocols:

Gamma Protocol (Running on TCP port 23)

Modbus TCP Protocol (Running on TCP port 502)

**NOTE:** Modbus register map is available on Gamma Vacuum website under download section.

### 11.14 TSP Sublimation View



Figure 17. TSP Sublimation View Screen (no control buttons)

First text line indicates current TSP status. Here 'TSP 1 OFF'.

Second text line indicates current TSP configuration as defined in the TSP Setup window.

Third text line indicates currently active TSP filament. This is the filament that will be sublimated.

#### Available TSP status:

'TSP Initializing' - TSP is initializing.

'TSP OFF' - TSP is off.

'TSP ON' - TSP is currently sublimating.

'TSP Armed' - TSP is running programmed mode, but not currently sublimating TSP filament.

'TSP Armed, Supply is off' - TSP cannot continue because Pressure Window is set, but supply is off.

'TSP Armed, Outside the pressure window' - TSP cannot continue because Pressure Window is set, but pump pressure is outside the pressure window.

'TSP Armed, Interlock - Active' - TSP cannot continue because TSP interlock is set, but not satisfied.

'TSP Armed, Waiting – In use' - TSP cannot continue because other TSP is currently running the sublimation cycle.

### 11.15 TSP Sublimation View With Controls

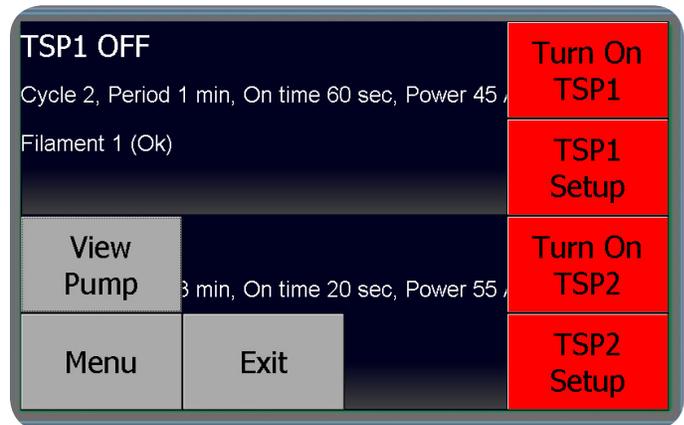


Figure 18. TSP Sublimation View Screen With Controls

View Pump - Switches home screen to pump view.

Menu - Invokes main menu.

Exit - Clears screen / hides control buttons.

Turn On TSP (Turn Off TSP) - Starts TSP programmed mode according to the parameters defined in TSP Setup window. If TSP programmed mode is running this button will turn off TSP operation.

TSP Setup - Invokes TSP Setup screen.

## 11.16 TSP Setup

TSP 1 Setup		
Filament 1 (OK)	Advance options Configure	
Current target (A) 45	Number of cycles 2	
On time (s) 60	Cycle period (min) 1	
Home	TSP 1	Back

Figure 19. TSP Setup Screen

Available setup :

Filament - Selects active filament (1-4).

Filament status reads (OK) if at the end of the firing cycle, filament current reached 80% of current target value. A question mark (?) is displayed if filament current did not reach 80% of the current target value.

Current Target (A) - Configure sublimation current target level.

On Time (s) - Configures sublimation time in seconds.

Number of Cycles - Configures number of sublimation cycles to run.

Cycle period - Configures time in minutes between each sublimation cycle.

Advance Options Configure - Invokes TSP advance options window.

TSP1/TSP2 - Selects TSP for which above parameters are configured.

## 11.17 TSP Pressure Window Setup

TSP 1 / Advance options / Pressure window		
Pressure window OFF	Supply source Supply 1	
Pressure high limit 1.0e-06		
Pressure low limit 1.0e-11		
Home	TSP 1	Back

Figure 20. TSP Pressure Window Screen

Available setup :

Pressure Window - Turns on/off pressure window option.

When pressure window is enabled sublimation process will run only if pump pressure is within the defined pressure window. If pump pressure is outside the defined pressure window, the TSP status will read 'TSP Armed, Outside the pressure window' and sublimation process is not allowed.

Pressure High Limit - Specifies upper pressure limit.

Pressure Low Limit - Specifies lower pressure limit.

Supply Source - Specifies which supply/pump pressure reading will be taken into consideration for pressure window.

## 12. ERROR / STATUS CODES

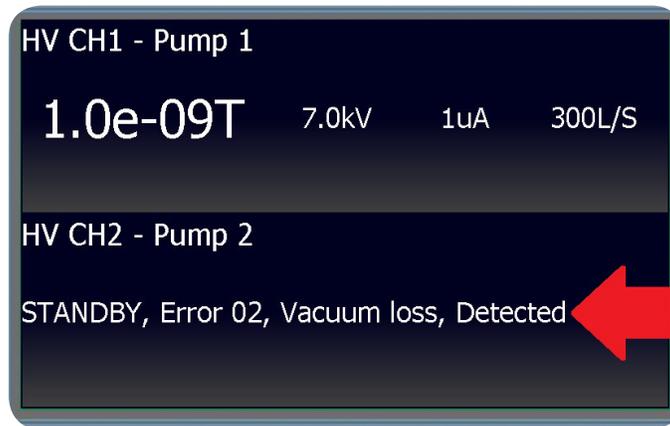


Figure 21. Display Error/Status Codes Screen

### 12.1 Error Example 'STANDBY, Error 02, Vacuum loss, Detected'

'STANDBY' - Indicates supply HV can be turned on. In comparison, 'DISABLED' indicates supply HV cannot be turned on.

Turning on supply HV will clear all outstanding errors not requiring user intervention.

For example, error 02 indicates vacuum loss detected while pump was running. User can turn on HV and start pump again, no other action is required.

In comparison, error 20 indicates safeconn (HV interlock) is not satisfied. The state will read 'DISABLED'. User cannot turn on HV until safeconn is satisfied.

'Error 02' - See "Table 1. Error / Status Codes" for description of the errors.

'Vacuum Loss' - Short description of the error.

'Detected' - Indicates error status. Detected means error was detected at some time in the past, but not active anymore.

In comparison, 'Active' indicates error was detected and still active at this time. Addition user intervention is required to clear the error.

Table 1. Error / Status Codes

1.1 Error/ Status Code	1.2 Description
01	Too many cooldown cycles occurred during pump starting.
02	Vacuum loss detected. Output voltage dropped to less than 1.2kV while pump was running.
03	Short circuit detected during pump starting.
05	Excess power detected. Excess amount of power delivered to the pump for the configured pump size.
07	Excess pump start time. The output voltage did not reach 2kV within maximum pump starting time of 5 minutes.
12	Pump thermal runaway detected. Significant drop in voltage detected during pump starting.
20	Safeconn (HV Interlock) not satisfied. HV cannot run.
21	HV interlock not satisfied or HV switch is off. HV cannot run. See section on digital inputs for details.
22	Pump size set to OL/s. HV cannot run.
23	Supply not calibrated. Current metering might not be accurate.
26	Supply over-temperature detected. HV cannot run.

#### NOTE:

If error code is not listed in the table please contact Gamma Vacuum for more information.

## 13. REAR PANEL

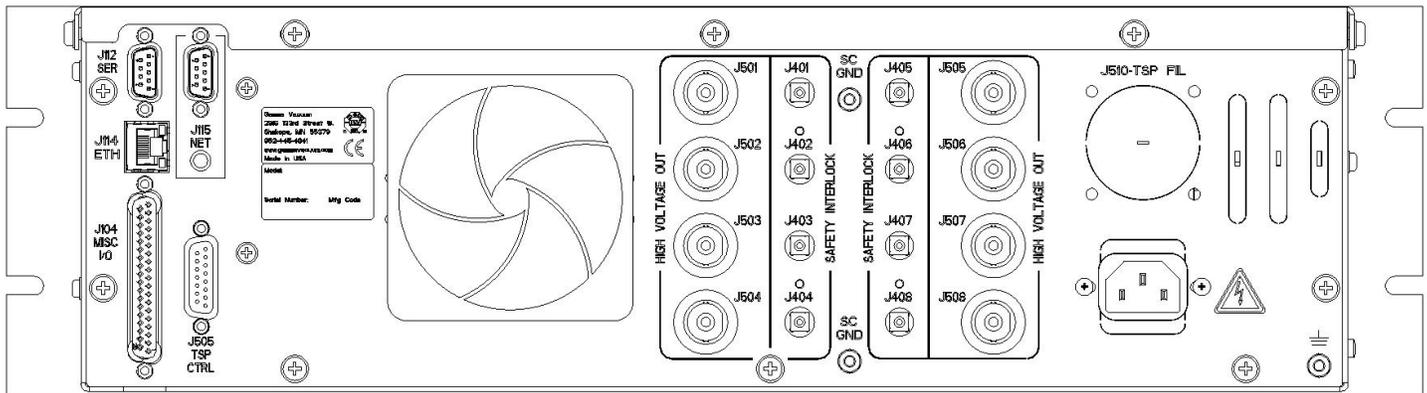


Figure 22. MPCq Rear Panel

### 13.1 Description

Power input is a standard IEC interface.

### 13.2 Connector pair J501-504/J401-404, HV Output connectors and safeconn (HV interlock) connectors

The SHV 10kV (Fisher) type connector and corresponding SMB (mini banana) connector is supplied for each high voltage output connection.

The SHV 10kV (Fisher) type connectors are used to relay high voltage to the ion pump.

The SMB (mini banana) connections are used to relay safeconn (HV interlock) logic signal from controller to the ion pump high voltage feedthrough.

When connection HV cable to the controller, insert mating connector into desired J50X connection and lock the connector.

SMB (mini banana) connectors are push-on connectors. Press firmly until the connector snaps into place.

NOTE: Other connector types available per request.

### 13.3 Connector J115, NET (Profibus, optional)

Standard Sub-D 9-pin female connector. Connection to Profibus interface.

For Profibus information reference Profibus user manual, document 900033, available on Gamma Vacuum website under download section.

### 13.4 Connector J505, CTRL

Standard Sub-D 15-pin female connector.

Used in combination with Remote TSP/NEG Controller to facilitate communications between controllers. Connection is made using straight-through Sub-D 15-pin cable available from Gamma Vacuum (PN 380049 - length 3m, PN 380050 - length 6m, PN 380085 - length 15m, PN 380895 - length 30m).

**NOTE:** Connector is not installed if controller is configured with internal TSP or NEG supply.

### 13.5 Connector J114, ETH

Standard RJ-45 connector. Connection to Ethernet interface.

Connector has two LED indicators:

- Green LED - Indication of link state.
- Orange LED - Indication of data activity.

### 13.6 Connector J510, TSP FIL (TSP, optional)

Installed in case when MPCq is configured with internal TSP supply.

Three filament, keyed TSP Pump connector.

Use high current cable to connect to Titanium Sublimation Pump (TSP).

### 13.7 Connector J104, Misc I/O

Standard Sub-D 37-pin female connector.

Table 2. J104 Connector Pinout

2.1 Pin	2.2 Description
1	Relay 1 Common *
2	Relay 1 NC
3	Relay 1 NO
4	Relay 2 Common *
5	Relay 2 NC
6	Relay 2 NO
7	Relay 3 Common *
8	Relay 3 NC
9	Relay 3 NO
10	Relay 4 Common *
11	Relay 4 NC
12	Relay 4 NO
13	Reserved - do not use, ground
14	Reserved - do not use, ground
15	DIGITAL OUT 1 - output, digital, 0/+5VDC, 7mA max
16	Reserved - do not use, ground
17	DIGITAL OUT 2 - output, digital, 0/+5VDC, 7mA max
18	Reserved - do not use, ground
19	DIGITAL OUT 3 - output, digital, 0/+5VDC, 7mA max
20	Reserved – do not use, output, digital, 0/+5VDC, 7mA max
21	Reserved – do not use, output, digital, 0/+5VDC, 7mA max
22	DIGITAL IN 1 - input, pulled-up internally to +3.3V, ground to activate assigned function
23	DIGITAL IN 2 - input, pulled-up internally to +3.3V, ground to activate assigned function
24	DIGITAL IN 3 - input, pulled-up internally to +3.3V, ground to activate assigned function
25	DIGITAL IN 4 - input, pulled-up internally to +3.3V, ground to activate assigned function
26	+12Vdc - supply, regulated, 80mA max
27	Not connected
28	Not connected
29	Reserved - do not use, ground
30	ANALOG OUT 1 - output, analog, range 0 to +10VDC
31	Ground
32	ANALOG OUT 2 - output, analog, range 0 to +10VDC
33	Ground
34	ANALOG OUT 3 - output, analog, range 0 to +10VDC
35	Ground
36	ANALOG OUT 4 - output, analog, range 0 to +10VDC
37	DIGITAL OUT 4 - output, digital, 0/+5VDC, 7mA max

\* Maximum relay current 500mA, maximum voltage 28V. Common and NC pins are connected in default or de-energized state.

### 13.8 Connector J112, SER

Standard Sub-D 9-pin female connector. Connection to serial interface. Supported serial standards are RS-232, RS-485 full duplex (four wire setup), and RS-485 half duplex (two wire setup).

Table 3. J112 Connector Pinout

3.1 RS-232		3.2 RS-485 Full Duplex (4 wire)		3.3 RS-485 Half Duplex (2 wire)	
RXD	2	+TX	2	+TX/+RX	2
TXD	3	-TX	8	-TX/-RX	8
GND	5	GND	5	GND	5
		+RX	3		
		-RX	7		

#### Cabling for RS-232 Serial Protocol

The MPCq functions as data terminal equipment (DTE) devices.

When the controller is connected to another DTE device (such as a personal computer), a null modem serial cable or a simple 3 wire serial crossover cable is required to connect the devices. The null modem cable swaps the signal lines so the receive and transmit signals are properly connected.

**NOTE:** For-RS 232, the serial cable between the PC and the MPCq only needs to cross Rx and Tx pins. No other signals are needed, except ground pin 5.

## 14. SERIAL COMMUNICATION

Following serial protocols are supported:

Gamma Protocol

Modbus ASCII Protocol

Modbus RTU Protocol

**NOTE:** Modbus register map is available on Gamma Vacuum website under download section.

### 14.1 Gamma Protocol Over Serial Connection

#### Gamma Protocol Command Packet Structure Over Serial Connection

The command packet is made up of at least five fields. The minimum command packet (single command with no data) is 11 bytes long. No new commands should be sent to the controller before the response from the previously sent command has been received.

Table 4. Command Packet Structure Over Serial Connection

START	space	ADDRESS	space	COMMAND	space	DATA	space	CHECKSUM	TERMINATOR
1 byte	1 byte	2 bytes	1 byte	2 bytes	1 byte	(variable)	1 byte	2 bytes	1 byte

See table below for more detail on packet structure.

4.1 Field	4.2 Size	4.3 Comment
1. START	1 ASCII character	ASCII character is '~' (TILDA)
Start is the first byte in the command packet and tells remote controllers to start decoding a message.		
2. ADDRESS	2 ASCII 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.		
<b>NOTE:</b> Must be supplied, even when running RS 232.		
3. COMMAND CODE	2 ASCII hex characters	Range 00 through FF
See "Table 9. Gamma Protocol Commands" on page 20 for list of available command codes. The command code must be two hex digits, even if the first is a zero.		
4. DATA field(s)	As needed	ASCII printable characters only
Data field(s) are for any commands that have a data value. Not all commands require data field. If command has more than one data value associated with it, such as setting an X and a Y value, the command field could be followed by two data fields (X and Y) separated by a comma and space between them. All data must be sent in ASCII printable format (no binary or "control" characters).		
5. CHECKSUM	2 ASCII 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.		
<b>NOTE:</b> Checksum field can be bypassed by specifying "00".		
6. TERMINATOR	1 ASCII hex character	ASCII carriage return
ASCII value of carriage return character placed at the end of a command packet. There is not a space between the checksum and terminator field.		

## 14.2 Gamma Protocol Response Packet Structure Over Serial Connection

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 5. Response Packet Structure Over Serial Connection

ADDRESS	space	STATUS	space	RESPONSE CODE	space	RESPONSE DATA	space	CHECKSUM	TERMINATOR
2 bytes	1 byte	2 bytes	1 byte	2 bytes	1 byte	(variable)	1 byte	2 bytes	1 byte

5.1 Field	5.2 Size	5.3 Comment
1. ADDRESS	2 ASCII 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.		
2. STATUS	2 ASCII hex 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 followed by an error code. (See "Table 6. Response Code Error Codes" on page 18.)		
3. RESPONSE CODE	2 ASCII 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. (See "Table 6. Response Code Error Codes" on page 18)		
<b>NOTE:</b> If there is not an applicable error code, a "00" will be transmitted.		
4. RESPONSE DATA	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.		
<b>NOTE:</b> Optional, only required if the command code requires it.		
5. CHECKSUM	2 ASCII 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.		
6. TERMINATOR	1 ASCII hex characters	ASCII carriage return
ASCII value of carriage return character placed at the end of a packet. There is not a space between the checksum and terminator field.		

Table 6. Response Code Error Codes

6.1 Code	6.2 Description
00	Command executed successfully.
01	Bad command format. Returned if command syntax is not valid.
02	Bad command code. Returned if command code is not valid.
03	Bad checksum. Returned if checksum is not valid.
04	Timeout. Returned if complete command packet was not received within 2 seconds from receiving the tilde start character.
06	Unknown error. Used for internal purpose.
07	Communication error. Returned if null character 0x00 is received or if buffer overflow occurred.
08	Bad parameter. Returned if command parameters are not valid.

### 14.3 CRC Checksum Example

**NOTE:** A checksum of "00" will bypass checksum field verification by the controller.

The command to be sent to the unit is  
0x01 – SYS GET 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.

- 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.

Table 7. Command CRC Checksum

7.1 Characters	7.2 Value (Decimal)	7.3 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

- 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.

- The command to be sent to the unit is,

'~ 01 01 22' + carriage return.

- The unit will respond with, '01 OK 00 DIGITEL MPCQ 0E'.

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

### 14.4 Examples - Gamma Protocol Over Serial Connection

For example, 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 examples assume unit address is set to 1 and supply 1.

**NOTE:** Command checksum can be set to "00" to bypass checksum field verification by the controller.

#### Example 1

Command - SYS GET MODEL, 0x01

Tx – "~ 01 01 22" + carriage return.

Rx – "01 OK 00 DIGITEL MPCQ 2E" + carriage return

Table 8. Response CRC Checksum

8.1 Characters	8.2 Value (Decimal)	8.3 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
M	77	0x4D
P	80	0x50
C	67	0x43
Q	81	0x51
space	32	0x20
	Total = 1326	Total = 0x52E

- Example in decimal, take 1326 mod 256 and result is 46, which converted to hex is 0x2E. This is the response checksum. Example in hex, take 0x52E mod 0x100 and result is 0x2E. This is the response checksum.

#### Example 2

Command - HV GET CURRENT, 0x0A

Tx – "~ 01 0A 01 B3" + carriage return

Rx – "01 OK 00 1.33E-11 AMPS C5" + carriage return

#### Example 3

Command - HV GET PRESSURE, 0x0B

Tx – "~ 01 0B 01 B4" + carriage return

Rx – "01 OK 00 1.0E-11 TORR A5" + carriage return

## 14.5 Gamma Protocol Commands

Table 9. Gamma Protocol Commands

9.1 Hex Command	9.2 Description	9.3 Data Field	9.4 Response	9.5 Data/Response Description
01	SYS GET MODEL Get controller model string.		DIGITEL MPCQ	
02	SYS GET FIRMWARE VERSION Get firmware version.		SW Version X.XX	Where: X.X is firmware version number
0E	SYS SET PRESSURE UNITS Set pressure units.	U		Where: U is pressure units (T - Torr, M - mBar, P - Pascal)
4F	SYS TFTP SERVER ADDRESS Configures the IP address of the TFTP server used in the firmware upgrade process. If no parameter is specified, the current address is returned.	X.X.X.X	X.X.X.X	Where: X.X.X.X is the IP address of the TFTP server
8F	SYS SET FIRMWARE UPDATE Tells system firmware update is wanted. Send the command and cycle power. Upon power up, bootloader shall be running.			No parameters.
ED	SYS GET/SET PUMP NAME Sets/gets pump name. If only S parameter is specified, the current name is returned.	S, TEXT	TEXT	Where: S is supply (1-2) TEXT is string up to 15 characters
FF	SYS RESET Restarts the system.	N		Where: N is the reboot mode 0 = Reboot 1 = Reboot and start boot loader 3 = Reset non-vol parameters to defaults
0A	HV GET CURRENT Reads supply current	S	X.XE-X AMPS	Where: S is supply (1-2)
0B	HV GET PRESSURE Reads supply pressure	S	X.XE-XX UUU	Where: S is supply (1-2) UUU is pressure units (TORR, MBar, or PASCAL)
0C	HV GET VOLTAGE Reads supply voltage	S	XXXX	Where: S is supply (1-2)
0D	HV GET STATUS Reads pump status.	S, XX	YY	Where: S is supply (1-2) XX is option. Currently only option 00 is available. YY can be "00" for pump standby "01" for pump starting "02" for pump running "03" for pump cooldown "04" for pump error
11	HV GET PUMP SIZE Reads pump size.	S	N L/S	Where: S is supply (1-2) N is pump size
12	HV SET PUMP SIZE Sets pump size.	S, N		Where: S is supply (1-2) N is pump size
1D	HV GET PUMP PRESSURE FACTOR Reads the pump pressure factor.	S	N.NN	Where: S is supply (1-2) N.NN is pump pressure factor (0.01 - 9.99)
1E	HV SET PUMP PRESSURE FACTOR Sets the pump pressure factor.	S, N.NN		Where: S is supply (1-2) N.NN is pump pressure factor (0.01 - 9.99)

9.1 Hex Command	9.2 Description	9.3 Data Field	9.4 Response	9.5 Data/Response Description
33	HV SET SUPPLY AUTO RESTART Sets supply auto restart option.	S, X		Where: S is supply (1-2) X is Y for on and N for off
34	HV GET SUPPLY AUTO RESTART Reads supply auto restart option.	S	YES or NO	Where: S is supply (1-2)
37	HV TURN ON Turns on supply HV.	S		Where: S is supply (1-2)
38	HV TURN OFF Turns off supply HV.	S		Where: S is supply (1-2)
3B	HV GET/SET SET-POINT Configures setpoints. Set-points (N parameter) 1-4 are relays. Set-points (N parameter) 5-8 are digital outputs. If only N parameter is specified, the current set-point configuration and state is returned.	N, F, S, X.XE-XX, Y.YE-YY	N, F, S, X.XE-XX, Y.YE-YY, A	Where: N is the set-point number (1-8) F is the function 0=Off, 1=Pressure Setpoint, 2=HV Error, 3=HV On/Off Indicator S is the configured supply (1, ,2 ,3 or 4) X.XE-XX is the On Pressure Y.YE-YY is the Off Pressure* A indicates: 1 = Relay/TTL output energized, 0 = Relay/TTL output de-energized) *Off Pressure must be at least 20% greater than On Pressure. If not, controller will automatically set Off Pressure to 20% greater than On Pressure.
58	HV GET/SET DIGITAL INPUT Configures digital inputs. If only N parameter is specified, the current digital input configuration is returned.	N, S, F	S, F	Where: N is the digital input (1-4) S is the pump (1-2) F is function: "00" - Off "01" - HV Interlock "02" - HV Switch On/Off "03" - TSP 1 Interlock "04" - TSP 2 Interlock
5A	HV GET/SET ANALOG OUTPUT Configures analog outputs. If only N parameter is specified, the current analog output configuration is returned.	N, S, F, O, I, R	S, F, O, I, R	Where: N is analog channel (1-4) S is pump (1-4) F is function(see below) O is log offset (-15 to +15) I is inverted mode (0-normal, 1-inverted) R is response mode (0-normal, 1-fast) Function: "00" - Off "01" - Logarithmic pressure "02" - Logarithmic current "03" - Volts per 1uA "04" - Volts per 10uA "05" - Volts per 100uA "06" - Volts per 1mA "07" - Volts per 10mA "08" - Volts per 50mA "09" - Volts per 1nA "10" - Volts per 10nA "11" - Volts per 100nA "12" - Volts per 1kV
28	TSP TURN OFF Turns off TSP sublimation.	R		Where: R is TSP (1-2)
29	TSP SET ACTIVE FILAMENT Sets TSP active filament.	R, N		Where: R is the TSP (1-2) N is the filament number (1-4)

9.1 Hex Command	9.2 Description	9.3 Data Field	9.4 Response	9.5 Data/Response Description
2D	TSP TURN ON Turns on TSP programmed mode.	R		Where: R is TSP (1-2)
DF	TSP GET ACTIVE FILAMENT Reads active TSP filament.	R	N	Where: R is TSP (1-2) N is the active filament.
30	TSP GET SUBLIMATION TARGET LEVEL Reads sublimation target power level.	R	X, P	Where: R is TSP (1-2) X is number of amps/watts P is 'A' for Amps or 'W' for Watts
31	TSP GET LOWER PRESSURE Reads lower TSP pressure. See pressure window option.	R	Z.Ze-ZZ	Where: R is TSP (1-2) Z.Ze-ZZ is lower pressure
EB	TSP SET LOWER PRESSURE Sets upper TSP pressure. See pressure window option.	R, Z.ZE-ZZ		Where: R is TSP (1-2) Z.Ze-ZZ is lower pressure
EA	TSP SET UPPER PRESSURE Sets upper TSP pressure. See pressure window option.	R, Z.ZE-ZZ		Where: R is TSP (1-2) Z.Ze-ZZ is the upper pressure
82	TSP GET UPPER PRESSURE Reads upper TSP pressure. See pressure window option.	R	Z.Ze-ZZ	Where: R is TSP (1-2) Z.Ze-ZZ is the upper pressure
72	TSP GET ONTIME Reads TSP sublimation on time.	R	D	Where: R is TSP (1-2) D is the on-time (duration) value in seconds.
73	TSP GET PERIOD Reads TSP cycle period.	R	D	Where: R is TSP (1-2) D is the cycle period value in minutes.
74	TSP GET RUNTIME POWER LEVEL Reads current power level.		X,P	Where: X is number of watts/amps. P is 'W' for Watts or 'A' for Amps
78	TSP SET SUBLIMATION TARGET LEVEL Sets sublimation target power level.	R, X, M		Where: R is TSP (1-2) X is number of amps/watts M is 'A' for Amps or 'W' for Watts
79	TSP SET PARAMETERS Configures TSP parameters.	R, M, N, X.XE-XX, Y.YE-YY, D, P		Where: R is TSP (1 or 2) M is cycle period in minutes (time between fires) N is number of cycles X.XE-XX is high pressure limit Y.YE-YY is low pressure limit D is sublimation duration in seconds P is pressure window (0 = on, 1 = off/ignore)
8B	TSP SET SUPPLY Configures TSP supply.	R, S		Where: R is TSP (1-2) S is supply (0-2), 0 indicates no supply, pressure window is off
8C	TSP GET SUPPLY Reads TSP supply.	R	S	Where: R is TSP (1-2) S is supply (1-2)

9.1 Hex Command	9.2 Description	9.3 Data Field	9.4 Response	9.5 Data/Response Description
DE	TSP GET TSP STATUS Reads TSP status.	R, X	YY	Where: R is TSP (1-2) X is option. Currently option 0 is only supported. YY is a two digit status code "00" - for TSP Initializing "01" - for TSP Off "02" - for TSP Armed (Running) "03" - for TSP Armed (Waiting, pressure window, supply is off) "04" - for TSP Armed (Waiting, pressure window, pump pressure outside the defined pressure window) "05" - for TSP Armed (Waiting, Interlock not satisfied) "06" - for TSP Armed (Waiting, Other TSP is firing) "07" - for TSP Firing

## 15. ETHERNET COMMUNICATION

Following protocol are support over Ethernet connection:

Gamma Protocol (Running on TCP port 23)

Modbus TCP Protocol (Running on TCP port 502)

**NOTE:** Modbus register map is available on Gamma Vacuum website under download section.

### 15.1 Gamma Protocol Over Ethernet Connection

#### Gamma Protocol Command Packet Structure Over Ethernet Connection

A raw TCP session may be established to port TCP 23, allowing remote control. Once the TCP session is established, commands may be issued.

**NOTE:** In comparison to communication over serial connection, no address field and no checksum fields are required.

Table 10. Command Packet Structure Over Ethernet Connection

START	space	COMMAND CODE	space	DATA(optional)	TERMINATOR
3 bytes	1 byte	2 bytes	1 byte	(variable)	1 byte

10.1 Field	10.2 Size	10.3 Comment
1. START	3 ASCII hex characters	ASCII characters are 'cmd'
Start is the first 3 digits in the command packet and tells controller to start decoding a message.		
3. COMMAND CODE	2 ASCII hex characters	Range 00 through FF
See "Table 9. Gamma Protocol Commands" on page 20 for list of available command codes. The command code must be two hex digits, even if the first digit is a zero.		
4. DATA	As needed	ASCII printable characters only
Data field(s) are for any commands that have a data value. Not all commands require data field. If command has more than one data value associated with it, such as setting an X and a Y value, the command field could be followed by two data fields (X and Y) separated by a comma and space between them. All data must be sent in ASCII printable format (no binary or "control" characters).		
5. TERMINATOR	1 ASCII hex characters	ASCII carriage return
ASCII value of carriage return character placed at the end of a command packet. There is no space before the terminator field.		

#### Gamma Protocol Response Packet Structure Over Ethernet Connection

In comparison to response structure over serial communication, no address and no checksum fields are supplied in response.

See response packet structure over serial connection for more information.

### 15.2 Examples - Gamma Protocol Over Ethernet Connection

#### Example 1

Command - SYS GET MODEL, 0x01

Tx - "cmd 01" + carriage return.

Rx - "OK 00 DIGITEL MPCQ" + carriage return

#### Example 2

Command - HV GET CURRENT, 0x0A

Tx - "cmd 0A 01" + carriage return

Rx - "OK 00 1.33E-11 AMPS" + carriage return

#### Example 3

Command - HV GET PRESSURE, 0x0B

Tx - "cmd 0B 01" + carriage return

Rx - "OK 00 1.0E-11 TORR" + carriage return

## 16. PROFIBUS COMMUNICATION

For Profibus information reference Profibus user manual, document 900033, available on Gamma Vacuum website under download section.

## 17. TECHNICAL SPECIFICATIONS

<b>Dimensions (max)</b> .....	472 x 432 x 131mm, length x width x height (fits standard 19 inch wide device rack)
<b>Shipping Weight (max)</b> .....	32 (66) kg lbs (fully configured with two supplies)
<b>Operating Temperature</b> .....	0 to 40C Free airflow around the unit is required.
<b>Altitude</b> .....	Sea level to (2000m) 6560 ft.
<b>Humidity</b> .....	0 to 80% RH (non-condensing)
<b>Storage Temperature</b> .....	10 to 70C
<b>Input voltage</b> .....	110Vac or 220Vac, +/- 10%. (input mains voltage configuration specified at order time)
<b>Input current</b> .....	10A fused
<b>Line Frequency</b> .....	50/60Hz

### High Voltage Supply

Power supply type.....	Linear (HV transformer)
Number of channels (max).....	2
Voltage(fixed output).....	Default configuration +7kV(CV/DI) or -5.6kV (TR)
Voltage resolution .....	100V
Current per channel (max).....	500mA (short circuit)
Current resolution (max).....	0.1uA
Power per channel (max) .....	500W
Output connector type.....	SHV-10 or Fischer Type (other connector types are available per request)
SAFECONN Connector .....	(HV Interlock) SMB (with SHV-10 output connector) or Mini Banana (with Fisher output connector)
<b>Display/Controls</b> .....	7" TFT WVGA (800x480) Color LCD, 16:9 aspect ratio, Touchscreen
<b>Communications</b> .....	Ethernet, Serial (RS-232, RS-485HD 2 wire mode, RS-485FD 4 wire mode), Profibus (optional)

### Available analog and digital I/O connections

Setpoint Relays.....	4 relays, 500mA max, 28V max, user configurable
Setpoint Logic Outputs.....	4 TTL Outputs, 6mA max, 5V, user configurable
Logic Inputs.....	4 TTL inputs, internally pulled up to 3.3V, user configurable
Analog Outputs .....	4 analog outputs 0-10V, user configurable (voltage, current or pressure)
Remote TSP/NEG Control .....	A connector for remote TSP or NEG operation supplied

### TSP Supply (In combination with Remote TSP Control or if internal TSP supply is installed)

Power supply type.....	Linear (transformer)
Number of filaments .....	4 for internal TSP supply, 8 in combination with Remote TSP Controller
Power output (max).....	800W
Current output (max).....	55A (maximum programmable TSP filament sublimation current value)
Current resolution .....	0.1A
Control.....	Fully user programmable via front panel touchscreen or using remote communication

## 18. WARRANTY & SERVICE

### 18.1 Service

#### Cleaning Procedure

Prior to any cleaning of the controller, 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

Service requests should go through customer center or local sales representative originally purchased through.

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

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

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

#### Direct Support

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

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

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

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

### 18.2 Warranty

#### General Terms

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

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

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

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

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

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

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

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

**Warranty Claims**

Upon notification, Gamma Vacuum will investigate Warranty Claims. To initiate a Warranty Claim, please contact Gamma Vacuum 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](mailto:service@gammavacuum.com).

**18.3 Returning Material****Return Procedure**

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

The RMA process will be expedited if any of the following information can be provided:

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

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

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

**Required Documentation**

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

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

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

**19. RETURN MATERIAL AUTHORIZATION FORM**

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

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

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

**CONTACT INFORMATION**

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

**COMPANY INFORMATION**

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

**RETURN INFORMATION**

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

\_\_\_\_\_

\_\_\_\_\_

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

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

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

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

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

**Gamma Vacuum**

**Part of the Atlas Copco Group**

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