DIGITEL TSPq controller
Instruction manual

www.gammavacuum.com

Original instructions

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Disclaimer

The content of this manual may change from time to time without notice. We accept no liability for any errors that may appear in this manual nor do we make any expressed or implied warranties regarding the content. As far as practical we have ensured that the products have been designed and constructed to be safe and without risks when properly installed and used in accordance with their operating instructions.

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 pump or the system.

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。

2.   General information

2.1.   Approvals

TSP products are shown to meet the intent of Directive 89/336/EEC for Electromagnetic Compatibility and Low-Voltage Directive 73/23/EEC for product Safety.

Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

- EN 50081-1 Emissions
    - EN 55011 Class A radiated and Conducted Emissions
- EN 50082-1 Immunity
    - IEC 801-2 Electrostatic Discharge Immunity
    - IEC 801-3 RF Electromagnetic Field Immunity
    - IEC 801-4 Electrical Fast Transient/Burst Immunity
- Low Voltage Directive 73/23/EEC
    - EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use.

3. Introduction

3.1. Titanium Sublimation Pump (TSP)

WARNING:

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

The TSP is designed to be used in high to extreme vacuum environments, but it can be operated over a wide range of pressures. TSPs effectively remove chemically active gases and are excellent in combination with an ion pump.

The amount of gettering material evolving from an ion pump is directly proportional to the pressure and atomic weight of the gas molecules. Therefore, at low pressures there is not sufficient gettering material to remove light gases (e.g. hydrogen). TSP operation is relatively insensitive to system pressure and has no difficulty emitting gettering material at low pressure. In most ultra-high and extreme high vacuum systems, hydrogen is the primary load contributor. Hydrogen removal is greatly aided with the use of a TSP.

The TSP is a getter type pump and sublimates titanium from its filaments. The sublimated titanium coats the line-of-sight surfaces surrounding the filaments. The titanium serves to capture chemically reactive (non-noble) gases.

Sublimation requires heating the filaments, which raises the vacuum system temperature and, temporarily, system pressure. Therefore, the TSP should be operated intermittently. The film deposited will capture gases permanently for a long period after firing.

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

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

Figure 1. *Titanium Sublimation Pump (TSP)*

3.2. Liquid Nitrogen (LN2) cryoshroud

A cryoshroud provides capture and hold of water (H_2O) and carbon dioxide (CO_2) pumping when cooled with liquid nitrogen (LN_2).
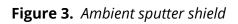
It provides a surface for sublimated titanium while preventing line of sight migration of titanium (Ti). Cryoshrouds can be used with and without coolants. Recommended coolants include: water and LN_2. When used with LN_2, hydrogen pumping speed is increased by a factor of 6.5.

Figure 2. *Liquid nitrogen cryoshroud*

3.3. Ambient sputter shield

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

Figure 3. *Ambient sputter shield*

4. Installation

Note the following when you install the SPC-NEG

- The SPC-NEG can be mounted in a standard 19 in. (48.3 cm) rack or used as a free-standing unit. A 19 in. Rack adapter kit (Part 310057) and Half-rack adapter kit (Part 360242) are available as an option.
- Make sure that the rear power cord is accessible.
- Maintain a 2.52 in. (64 cm) clearance behind controllers for cable bend radius and proper airflow.
- Maintain a 0.125 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 controller so that the power plug can be reached to disconnect power.

4.1. Pre-installation checks

- Make sure that all items on the enclosed packing list have been received. If any items are missing, notify us and the carrier.
- Store all packaging material for inspection.
- If the equipment is damaged in any way, inform us and request a claim with the carrier immediately.
- If the equipment must be returned for inspection or repair, obtain authorization from us prior to shipping. Contact us for authorization and return instructions.

4.2. Inspect for any obvious damage

If the equipment 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.

4.3. Safety notices

4.4. Required Items

- DIGITEL TSPq Controller
- Remote TSP Controller (optional)
- Titanium Sublimation Pump (TSP) (sold separately)
- TSP high current cable (sold separately)
- Liquid nitrogen cryoshroud (optional)
- Ambient sputter shield (optional)

5. Controller configuration

Following configuration options are specified at order time:

- Input mains a.c. voltage
  The controller uses a universal input of 90-240 V a.c., 48-62 Hz.
- NEG pump connectors
  Single output connector J510 Output 1 on the rear panel.

5.1. Input mains a.c. voltage

Controller does not have universal power input. Input mains AC voltage is part of the controller configuration. Following options are available:

- 100-120 V a.c., 57-63 Hz
- 200-240 V a.c., 57-63 Hz

Care must be taken when connecting controller to mains a.c. voltage to avoid connecting controller to wrong input voltage.
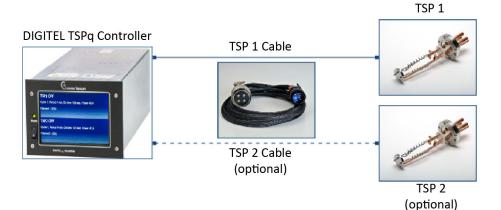
5.2. Number of TSP pump connectors

Following options are available:

- Single output connector J510 Output 1 (TSP 1) on the rear panel. See DIGITEL TSPq standalone configuration on page 14 for details.
- Two output connectors J510 Output 1 (TSP 1) and J511 Output 2 (TSP 2) on the rear panel. See DIGITEL TSPq standalone configuration on page 14 for details.
- No connectors. Remote connection J113 connector installed. Used in combination with Remote TSP Controller. See DIGITEL TSPq + Remote TSP controller configuration on page 15 for details.
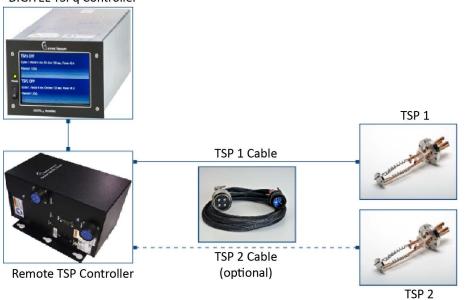
5.3. DIGITEL TSPq standalone configuration

Figure 4. *DIGITEL TSPq standalone configuration*

DIGITEL TSPq Controller

TSP 1

TSP 1 Cable

TSP 2 Cable
(optional)

TSP 2
(optional)

5.4. DIGITEL TSPq + Remote TSP controller configuration
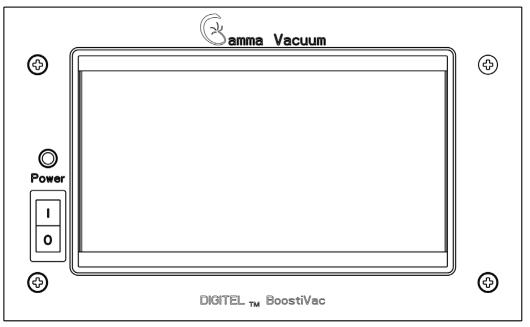
Figure 5. *DIGITEL TSPq + Remote TSP controller configuration*

6.   Front panel

Figure 6. *Front panel*

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.
- 7" TFT WVGA (800x480) Color LCD, 16:9 aspect ratio, touchscreen - Primary user interface.
- 'Power' indicator lamp - Color green. When light up, indicates primary input power present.

7. Touchscreen user interface

7.1. Home screen

Tap the screen to show "Turn ON" and "MENU."

"MENU" takes you to NEG recipe selection, custom recipe setup, and display setup.

Figure 7. *Home screen*

Line one indicates TSP status. Following are possible statuses:

- Initializing
- OFF
- Armed, X/Y min
- Armed, Interlock - Active
- Armed, Waiting - In use
- ON X/Y A

The 'OFF' status indicates TSP programmed mode is not running.

Armed status indicates TSP programmed mode is running, but actual TSP filament sublimation is not in progress at this time.

For example, 'Armed, 2/15 min' status indicates two minutes has passed from last sublimation cycle where period between sublimation cycles is set to 15 minutes.

The 'Armed, Interlock -Active' status indicates TSP programmed mode is running, but sublimation is not possible because TSP interlock is not satisfied.

The 'TSP 1 Armed, Waiting -In use' status indicates TSP 1 programmed mode is running, but sublimation is waiting for TSP 2 sublimation to complete.

The 'ON 40/45A' status indicates filament sublimation is in progress. The filament current is ramping up and currently at 40 Amps, where target sublimation current level is set to 45 Amps.

Line two indicates current TSP setup. See TSP setup on page 18 for details.

Line three indicates status of the currently selected TSP filament. See TSP setup on page 18 for details.

Figure 8. *Home screen (control buttons visible)*

Available setup:

Menu - Invokes main menu.

Exit - Clears screen/hides control buttons.

TSP Setup - Invokes respective TSP setup screen.

Turn On/Off TSP- Starts/stops sublimation programmed mode for respective TSP (1-2).

Turning on TSP will start TSP programmed mode according to parameters specified in the TSP Setup window.

TSP 1 and TSP 2 programmed modes can run simultaneously, but only one filament can be sublimated at a time.

7.2. TSP setup

Figure 9. *TSP setup screen*

Available setup:

Filament - Selects active filament (1-4). This filament is used in the sublimation process.

The filament status is displayed in brackets next to filament number.

Filament status reads (ok) if at the end of the last sublimation cycle, filament current reached at least 80% of the target current value.

The status will read (open?) if filament current did not reach 80% of the target current value.

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

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

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

Cycle period - Configures time in minutes between each sublimation cycle. Cycle period is not applicable (N/A) when number of cycles is set to 1.

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

7.3.   Display setup

Figure 10. *Display setup screen*

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

Screensaver - Configures screen-saver on/off state. Turning screensaver off is not recommended as this will shorten screen backlight lifetime. When screen-saver is enabled/active, display brightness level is reduced to level 1.

Touchscreen calibration - Invokes touchscreen calibration process.

7.4.   Digital input setup

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
- TSP 1 Interlock
- TSP 2 Interlock

TSP 1 interlock function

Ground pin to satisfy TSP 1 interlock.

If interlock is not satisfied, TSP 1 sublimation is not possible.

TSP 2 interlock function

Ground pin to satisfy TSP 2 interlock. If interlock is not satisfied, TSP 2 sublimation is not possible.

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

7.5. Serial port setup

Figure 12. *Serial port setup screen*

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

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 protocol is Gamma protocol.

7.6. Ethernet interface setup

Figure 13. *Ethernet setup screen*

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

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.
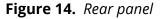
Gateway address - Configures Ethernet gateway address.
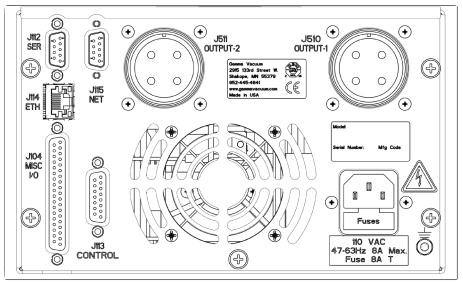
Link state - Information only.

Supported Protocols: Gamma Protocol (Running on TCP port 23)

8.   Rear panel

Figure 14. *Rear panel*

Description

Power input is a standard IEC interface.

Connector J113 (optional)

Standard Sub-D 15-pin female connector. Used to connect to remote TSP controller.

Connector J114

Standard RJ-45 connector. Connection to Ethernet interface.

Connector has two LED indicators:

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

Connector J115 NET (Profibus, optional)

Standard Sub-D 15-pin female connector. Connection to Profibus interface.

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

Connector J510 OUTPUT-1

Connector type Amphenol MIL-DTL-5015, P/N 97-3102A-24-22S(946)'.

Connection to TSP 1.

Connector J511 OUTPUT-2 (optional)

Connector type Amphenol MIL-DTL-5015, P/N 97-3102A-24-22S(946)'.

Connection to TSP 2.

Connector J104, Misc I/O

Standard Sub-D 37-pin female connector.

Connector J112, SER

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

Table 1. *J104 Connector pinout*

Pin	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/+5 V d.c., 7 mA maximum
16	Reserved - do not use, ground
17	DIGITAL OUT 2 - output, digital, 0/+5 V d.c., 7 mA maximum
18	Reserved - do not use, ground
19	DIGITAL OUT 3 - output, digital, 0/+5 V d.c., 7 mA maximum
20	Reserved – do not use, output, digital, 0/+5 V d.c., 7 mA maximum
21	Reserved – do not use, output, digital, 0/+5 V d.c., 7 mA maximum
22	DIGITAL IN 1 - input, pulled-up internally to +3.3 V, ground to activate assigned function
23	DIGITAL IN 2 - input, pulled-up internally to +3.3 V, ground to activate assigned function
24	DIGITAL IN 3 - input, pulled-up internally to +3.3 V, ground to activate assigned function
25	DIGITAL IN 4 - input, pulled-up internally to +3.3 V, ground to activate assigned function
26	+12 V d.c. - supply, regulated, 80 mA maximum

Pin	Description
27	Not connected
28	Not connected
29	Reserved - do not use, ground
30	ANALOG OUT 1 - output, analog, range 0 to +10 V d.c.
31	Ground
32	ANALOG OUT 2 - output, analog, range 0 to +10 V d.c.
33	Ground
34	ANALOG OUT 3 - output, analog, range 0 to +10 V d.c.
35	Ground
36	ANALOG OUT 4 - output, analog, range 0 to +10 V d.c.
37	DIGITAL OUT 4 - output, digital, 0/+5 V d.c., 7 mA maximum

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

Table 2. *J112 Connector pinout*

RS-232		RS-485 Full Duplex (four wire)		RS-485 Half Duplex (two 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 controller 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 three 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 controller only needs to cross Rx and Tx pins. No other signals are needed, except ground pin 5.

9.   Serial communication

Following serial protocols are supported:

Gamma Protocol

9.1.   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 3. *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.

	Field	Size	Comment
1	START	1 ASCII character	ASCII character is '~' (TILDA)
	ASCII representation of the tilde '~' character. 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. Note: Must be supplied, even when running RS 232.		
3	COMMAND CODE	2 ASCII hex characters	Range 00 through FF
	The command code must be two hex digits, even if the first is a zero. See Table: Gamma protocol commands for list of available command codes.		
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. 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.		

	Field	Size	Comment
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.		

📄 **Note:**

Checksum field can be bypassed by specifying "00".

9.2. 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 4. *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

	Field	Size	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: Response codes).		
3	RESPONSE CODE	2 ASCII hex characters	Range 00 through FF
	See Table: Response codes for description of possible response codes.		
4	RESPONSE DATA	As needed	ASCII printable characters only
	Data field(s) are used to respond to commands requesting data. 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.		
5	CHECKSUM	2 ASCII hex characters	Computed checksum of packet
	Checksum contains a simple computed checksum of the response packet. See CRC checksum example on page 28 for details.		
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 5. *Response codes*

Code	Description
0	Command executed successfully.
1	Bad command format. Returned if command syntax is not valid.
2	Bad command code. Returned if command code is not valid/does not exist.
3	Bad checksum. Returned if checksum is not valid/does not match calculated checksum.
4	Timeout. Returned if complete command packet was not received within 2 seconds from receiving the tilde start character.
6	Unknown error. Used for internal purpose.
7	Communication error. Returned if null character 0x00 is received or if internal buffer overflow occurred.
8	Bad parameter. Returned if any of the command parameters is not valid.

9.3. 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' + cr,

Where XX is an unknown command checksum at this time and 'cr' is ASCII carriage return character.

📄 **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 6. *Command CRC checksum*

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

1. 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.
2. The command to be sent to the unit is, '~ 01 01 22' + cr
3. The unit response is, '01 OK 00 DIGITEL TSPq 65'.
4. To verify checksum for the response, perform similar calculations.

> 📖 **Note:**

'cr' is ASCII carriage return character.

Table 7. *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
T	84	0x54
S	83	0x53
P	80	0x50
q	113	0x71
space	32	0x20
	Total = 1381	Total = 0x565

Example in decimal, take 1381 mod 256 and result is 101, which converted to hex is 0x65. This is the response checksum. Example in hex, take 0x565 mod 0x100 and result is 0x65. This is the response checksum.

9.4. Gamma protocol commands

Table 8. *Gamma protocol commands*

Hex Command	Description	Data Field	Response	Data/Response Description
1	SYS GET MODEL Get controller model string.		DIGITEL TSPq	
2	SYS GET FIRMWARE VERSION Get firmware version.		SW Version X.XX	Where: X.X is firmware version number
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.
FF	SYS RESET Restarts the system.	N		Where: N is the reboot mode 0 = Reboot 1 = Reboot and start bootloader app
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 must be set to 0 F is function: "00" - Off "03" – TSP 1 Interlock "04" - TSP 2 Interlock
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)
2D	TSP TURN ON	R		Where:

Hex Command	Description	Data Field	Response	Data/Response Description
	Turns on TSP programmed mode.			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
72	TSP GET ON TIME 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

Hex Command	Description	Data Field	Response	Data/Response Description
79	TSP SET PARAMETERS Configures TSP parameters.	R, M, N, E-XX, E-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, must be set to 1.0E-11. X.YE-YY is low pressure limit, must be set to 1.0E-05. D is sublimation duration in seconds P is pressure window, must be set to 1
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) "05" - for TSP Armed (Waiting, Interlock not satisfied) "06" - for TSP Armed (Waiting, Other TSP is firing) "07" - for TSP On (Sublimating)

10. Ethernet communication

Following protocol are support over Ethernet connection:

Gamma Protocol (Running on TCP port 23)

10.1. 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.

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 Gamma protocol response packet structure over serial connection on page 27 for more information.

Examples - Gamma protocol over Ethernet connection

Example 1

Command - SYS GET MODEL, 0x01

Tx – "cmd 01" + cr

Rx – "OK 00 DIGITEL TSPq"+ cr + cr +lf + ">" characters.

📄 **Note:**

'cr' stands for carriage return ASCII character, 'lf' stands for line feed ASCII character.

Command packet structure over Ethernet connection

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

	Field	Size	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: Gamma protocol commands for list of available command codes. The command code must be two hex digits, even if the first digit is a zero.		

	Field	Size	Comment
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. All data must be sent in ASCII printable format (no binary or "control" characters).		
5	TERMINATOR	1 ASCII hex characters	ASCII character for 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.		

11.   Technical specifications

Table 9. *Technical specifications*

Dimensions (maximum)	460x208x130 mm, length x width x height (3U high, 1/2 rack wide)
Shipping Weight (maximum)	16 kg (36 lbs)
Operating Temperature	0 to 40 °C (free airflow around the unit is required)
Altitude	Sea level to (2000 m) 6560 ft
Humidity	0 to 80% RH (non-condensing)
Storage temperature	10-70 °C
Input voltage	100-120 V a.c. or 200-240 V a.c. (input mains voltage configuration specified at order time)
Input current	8 A fused for 110 V a.c., 4 A fused for 220 V a.c.
Line frequency	47-63 Hz
Display/Controls	7" TFT WVGA (800x480) Color LCD, 16:9 aspect ratio, touchscreen
Communications	Ethernet, Serial (RS-232, RS-485HD 2 wire mode, RS-485FD 4 wire mode), Profibus (optional)
Power supply (TSP pump)	
Power supply type	Linear (transformer)
Number of supplies (maximum)	1
Number of connectors (maximum)	2
Number of filaments	3 per connector
Output connector type	Amphenol MIL-DTL-5015 p/n 97-3102A-24-22S(946)
Power per supply (maximum)	800 W
Current output (maximum)	55 A (maximum programmable TSP filament sublimation current value)
current resolution	0.1 uA
Control	Fully user programmable via front panel touchscreen or using remote communication

12. Warranty and service

12.1. 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.

12.2.   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.

Direct support

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

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

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

- Reason for support inquiry

To expedite this process, please forward this information to service@gammavacuum.com or contact our facility directly at the numbers below.

12.3.   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

13. 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.

GAMMA
V A C U U M

EU Declaration of Conformity

CE

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

MPCQ, TSPQ, NEGQ Controller:
TUV: SUD Certificate U8 17 11 60983 025
Model= T-U-V-W-X-Y-Z
Where:
T= Number of High Voltage Sections
U=High Voltage Polarity
V=Connector Type
W=Number of Connectors per High Voltage Section
X=Input Voltage
Y= Communication Port Options
Z=TSP or NEG Options

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

Declaration of Conformity

UK CA

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.

MPCQ, TSPQ, NEGQ Controller:
TUV: SUD Certificate U8 17 11 60983 025
Model= T-U-V-W-X-Y-Z
Where:
T= Number of High Voltage Sections
U=High Voltage Polarity
V=Connector Type
W=Number of Connectors per High Voltage Section
X=Input Voltage
Y= Communication Port Options
Z=TSP or NEG Options

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

Electrical Equipment (Safety) Regulations 2016

Electromagnetic Compatibility Regulations 2016

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 Class A Emissions, Industrial Immunity

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.