Terranova® 762 Series
Ion Pump Power Supply
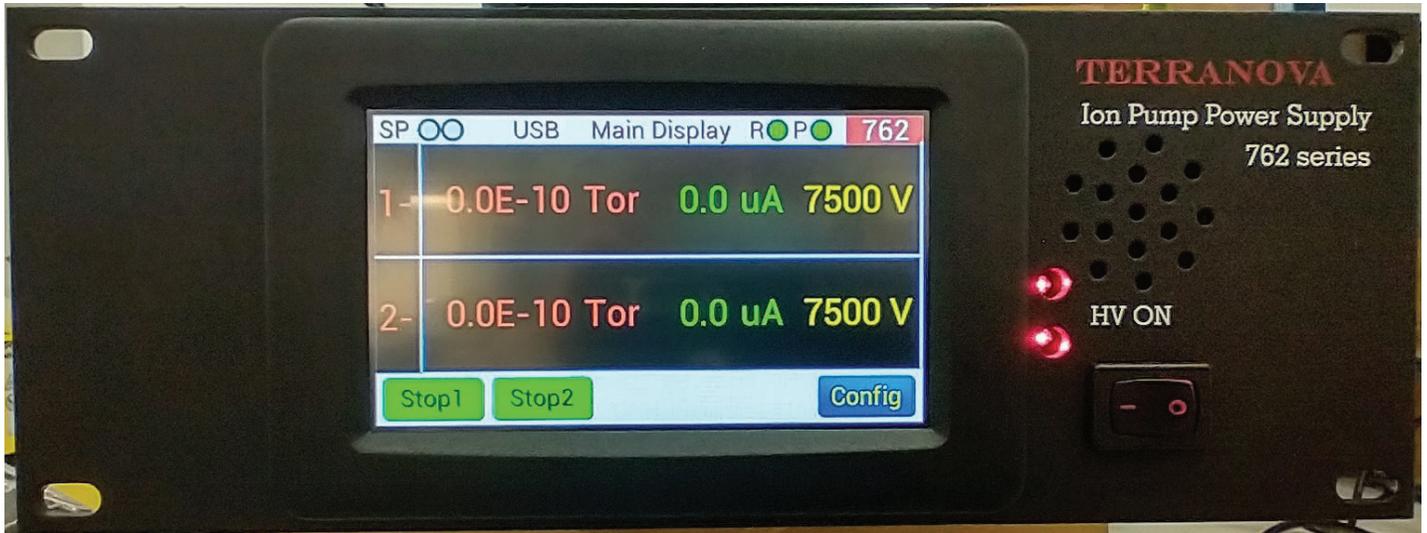
For use with the following:

Part No.	Description
T–762–K110	Two 10kV Kings HV connectors (110 VAC)
T–762–K220	Two 10kV Kings HV connectors (220 VAC)
T–762–F110	Two Fischer-style HV connectors (110 VAC)
T–762–F220	Two Fischer-style HV connectors (220 VAC)

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General Manual Information

This manual contains important information regarding the safe operation of the Terranova® 760 series models listed on the cover page. We advice the customer read the manual in its entirety and to contact Duniway Stockroom with any questions before use.

The Terranova 760 series of ion pump controller is intended for use with standard high vacuum ion pumps (positive or negative polarity). It is not intended for any other use. Using it with other products or cables not intended for use with the Terranova 760 series ion pump controller may result in:

1.   Injury to personnel

2.   Damage to the equipment

3.   Voidance of the Warranty

Manual Symbol Key

The following symbols are used in this manual when customer should take particular consideration

WARNING!

The orange warning symbol is used to indicate a hazard that may cause serious injury or death to personnel if proper safety protocols are not followed.

CAUTION

The yellow caution symbol is used to alert personnel against practices that may potential damage equipment.

The electricity hazard symbol is used to warn personnel of a voltage hazard

The earth terminal symbol is used to indicate where proper grounding practices should be followed to protect personnel against electrical shock and protect equipment against possible damage.
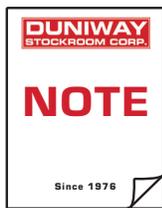
The note symbol is used to emphasize helpful information from the manual.

Specifications

Operating Voltage	Universal	100 V to 240 V AC @ 50 Hz to 60 Hz; 200VA for 762
Open Circuit Voltage	Operator Set	± 2000 to ± 7500 V DC
	Polarity	Positive
		Negative
Short Circuit Current	Operator Set	50 mA maximum (total) per channel
High Voltage Output	Options	Two 10 kV Kings connector
		Two Fischer-style connector

Overload Protection

Fuse for input power
Automatic power adjustment during starting phase
Automatic shutdown for shorted output
Overvoltage Category II

Display

3.5" Color LCD touchscreen display w/ LED back-light

Relay Rating	Power	60 W / 120 VA (maximum)
	Current	2 A (maximum)
	Voltage	150 V DC or 300 V AC (maximum)

See **Appendix** for details

Dimensions	Height	3.5 in. (89 mm)
	Width	9.5 in. (241 mm)
	Length	16.0 in. (406 mm)

Weight 6 lb. (2.7 kg)

Operating Environment	Location	Indoor Use Only- Rack or Desktop
	Altitude	Up to 3100m
	Humidity	0 - 80 % (non-condensing)
	Temperature	0 °C to 40 °C
	Pollution	Pollution Degree 2

Accessories

Included	Instruction manual (Online)
	One AC power cord with NEMA 5-15P plug and C13 connector (110 V AC)
	One unterminated AC power cord with C13 connector (220 V AC)
	Replacement fuse
	One unterminated male 9-pin D-sub connector
	One unterminated male 25-pin D-sub connector

Required (Sold separately)		
	Ion pump(s)	Visit our website under the Ion Pumps Overview page at www.duniway.com/catalog/ion-pumps
	Ion pump cable(s)	Visit our website under the Ion Pump Cables & Connectors section at www.duniway.com/catalog/ion-pumps

Optional (Sold separately)		
	RS232-TN76X	RS-232 serial communication cable (10 ft)*
	8000-0934-00	Half-rack adapter kit for one Terranova® unit
	8000-0934-01	Full-rack adapter kit for two Terranova® units
	10KV-100M	Test plug

*Custom cable lengths are available upon request

Maintenance

The Terranova® 760 series Ion Pump Power Supply should not be serviced by the user. Any maintenance must be performed by Duniway Stockroom personnel. If any service is required, please contact your Duniway Stockroom customer service representative for a Return Merchandise Authorization (RMA) number to return the Terranova® 762.

Introduction

The Terranova® 760 series Ion Pump Power Supply is designed to start and operate a wide range of ion pump models from a number of manufacturers. The Terranova® 762 is factory-configured to operate two ion pumps. The factory changeable polarity provides the ability to operate pumps that require either positive or negative high voltage. With programmable parameters and a number of ways to exchange information, the Terranova® 760 series' versatility allows its use in a number of applications.

Legacy Terranova® 741/751/752/751A/752A

The legacy Terranova® 741, 751/752, and 751A/752A models have been (or will be soon in the case of the 751A/752A) discontinued and replaced by the Terranova® 760 series. Although the Terranova® 741, 751/752, and 751A/752A have been discontinued, the units may still be sent to Duniway Stockroom for service. Please contact your Duniway Stockroom customer service representative for further details.

WARNING!   **CAUTION**

Bodily harm or equipment damage can result due to electric shock originating from the input AC voltage, internal unit potentials, or high voltage output. The high voltage output hazard can exist either from direct contact with the high voltage lead or due to loss or lack of proper grounding from either the Terranova® 761 or ion pump.

Figure 1. Terranova® 762 Controller front view and dimensions

Front Panel Description

1. Power: Main switch to turn controller ON or OFF. Do not block as this is the main on/off switch for unit.

2. 3.5" Color LCD touchscreen display: Screen to input and output all values, parameters, and functions of the control unit

3. Channel #1 LED: Disabled when safety interlock circuit is open; (high) voltage output will be illuminated when "ON"

4. Channel #2 LED: Disabled when safety interlock circuit is open; (high) voltage output will be illuminated when "ON"

Figure 2. Terranova® 762 Controller back and connector view

Rear Panel Description

Ion Pump Connections

1. High Voltage 1: (High) voltage output connection for Pump # 1

2. Ion Pump Ground Sense 1: Safety interlock connection for Pump #1

3. High Voltage 2: (High) voltage output connection for Pump #2

4. Ion Pump Ground Sense 2: Safety interlock connection for Pump #2

Other Connections

5. Serial I/O: 9-pin D-sub connector used for RS-232, RS-422, and RS-485 serial communication

6. USB: Used for external communication

7. Ethernet: Used for external communication

8. I/O: 25-pin D-sub connector used for analog output monitors, set point relay output, and other voltage signals

9. AC Power Module: Consists of both the power cord socket and fuse holder. There should be adequate clearance behind the unit to allow the user to disconnect the power plug from the unit.

Installation

Installing the Terranova® 762 Controller

The Terranova® 762 Controller is housed in a standard EIA half-rack box. See **Figure 1** for dimensions. The control unit may be used as a table-top device or can be installed in most equipment racks and cabinets. User should leave enough clearance at time of installation to both access rear cable connections and for ventilation purposes.

Connecting the Ion Pump(s)

The Terranova® 762 controller is equipped with either two 10 kV Kings or two Fischer-style high voltage connectors. The connectors are located on the back of the unit labeled VOLTAGE OUTPUT (see **Figure 2**). To connect and operate the ion pumps with the Terranova® 762 controller the user will require a Duniway or equivalent ion pump cable.

To properly connect the Terranova® 762 controller to the ion pump(s):

1. Secure the ion pump cable to the respective ion pump high voltage feedthrough

2. Secure the ion pump cable to the respective VOLTAGE OUTPUT connector

3. Secure the required secondary ground sense lead to the ion pump body and respective GROUND SENSE #6-32 stud and Keps nut assembly (see **Safety Interlock**)

The user should always ensure the ion pump and high voltage cable are both properly connected and secured before use.

WARNING!   **CAUTION**

Use of ion pump cables other than those approved by Duniway Stockroom may lead to operational problems or safety hazards.

NEVER apply power to the Terranova® 762 until proper grounding has been established.

Safety Interlock

A safety interlock or secondary ground sense circuit is incorporated into the Terranova® 762 controller to disable high voltage operation when open. The safety interlock circuit is completed via external leads available on most Duniway ion pump cables. The external leads must properly connect the ion pump body to the respective GROUND SENSE stud (see **Figure 2**) to complete the safety interlock circuit and enable high voltage operation. High voltage output will be disabled if an open circuit or ground fault is detected. To restart high voltage operation, user must correct the grounding issue. **Table 1** lists various ground sense connection conditions and respective effects on high voltage operation.

A redundant ground connection, either intentional or unintentional, between the control unit and ion pump may circumvent the safety interlock feature. User should correct any grounding issues to ensure safe operation. A potential (unintentional) redundant ground may occur through chassis contact with the ion pump or vacuum system ground when both the ion pump and Terranova® 762 are mounted on the same conducting rack or cart.

Pump Cable Ground Sense Wire Connection

Case	Coax Cable Connected at 762	Coax Cable Connected to Ion Pump	Coax Ground Shield Continuous	762 Ground Sense Lug	Ion Pump Ground	Ion Pump Independently Grounded*	HV Enable
1	Y	Y	Y	Y	Y		ON
2		X	X	Y	Y		OFF
3	X		X	Y	Y		OFF
4	X	X		y	y		OFF
5	X	X	X		X	X	OFF
6	X	X	X	X		X	OFF
7	X	X	X	Y	Y	Y	ON

Table 1. Terranova® 762 controller ground sense conditions

WARNING!

Y means strictly "condition met"
<blank> means strictly "condition not met"
X means "condition may or may not be met", i.e., it does not matter

* Ion pump body and 762 chassis electrically connected by means other than the HV pump cable. Safety interlock is defeated when ground sense wire is still connected at both ends.

Display Information

Power-up Display

The Terranova® 760 series will output the Power-up screen as shown in Figure 3 when turned ON via the POWER button and both self-adjusting cooling fans will automatically start. If the power-loss restart function is disabled, the control unit will output the Main display as shown in Figure 4 and the channel will enter standby mode.

Figure 3. Power-up screen

CAUTION

Touch screen responds best to a light finger tap or a capacitive stylus. Using excessive force or a metallic object when pressing on the touch screen may damage the surface and void the warranty.

Main Display

The Main Display is the starting point for using the Terranova® 760 series. The Main Display screen provides access to all configuration menus as well as ion pump operation. The Main Display outputs a number of configuration settings via the Status Bar located atop the screen (See Figure 4).

The middle section of the screen is reserved for channel-specific information. As seen in Figure 4, the channel number and polarity appear on the left-hand side of the screen. The right-hand side of the screen is reserved for channel output. "Ready" will appear when a channel is in standby and "ready" for use. Otherwise, the pressure, current, and (high) voltage values will be output (see Figure 5) during normal ion pump operation or immediately after a power-loss restart. Buttons are located at the bottom of the screen to either operate the ion pump or configure the Terranova® 760 series. The HV ON/OFF buttons will toggle in function depending on the state of the high voltage.

Figure 4. Main Display with Standby message

Figure 5. Main Display with HV operation enabled

Status Bar

The Status Bar displays information about the status and setting of a number of parameters such as the selected communication protocol. As shown in Figure 5, the Status Bar is located atop the screen and will appear on all displays except the About screen. Below is a list of all icons:
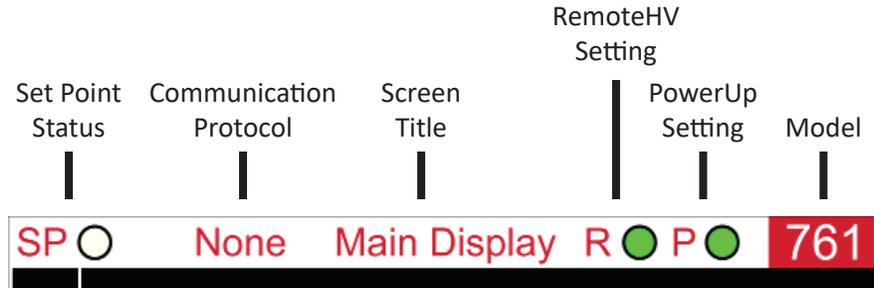
Figure 6. Status Bar

- **Communication protocol setting**

  RS232   Serial protocol

  RS422   Serial protocol

  RS485   Serial protocol

  Ether   Ethernet protocol

  USB   USB protocol

  None   Function disabled

- **Screen title**

  Main   Home

  Config   Main configuration menu

  About   Terranova®760 series information

  System   Terranova® 762 settings

HVPS #1/2   Channel settings

- **PowerUp (P) setting**

  Normal start-up operation

  Terranova® reset enabled

  Power-loss function enabled

- **RemoteHV (R) setting**

  Local Only operation

  Local and Remote operation

- **Set point (SP) status**

  Function disabled

  Function enabled; relay OFF

  Setpoint tripped; relay ON

Configuration Display

The Configuration display provides access to both the controller-specific and channel-specific menu settings. Figure 7 shows all the various options available through the Configuration screen. The Status Bar will reflect the title of the selected screen. The Terranova® 760 series will return to the Main Display if left unattended for more than 5 minutes.

Button functions are as follows:

Tap **System** to enter the System Configuration display.

Tap HVPS green area to enter the channel configuration menu.

Tap **About** to view the model number and firmware version (see Figure 8).

Tap **GoMain** to return to the Main Display.

Tap **Quit** to exit the About screen and return to the Configuration display.
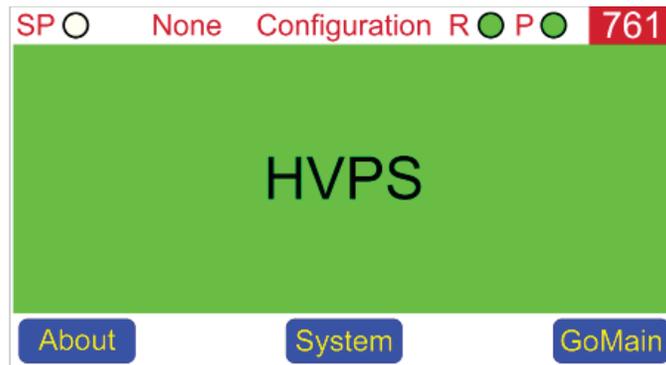
Figure 7. Configuration display

Figure 8. About screen

System Configuration Display

The System Configuration display provides access to the controller-specific settings. As shown in Figure 9, all parameters which can be modified are enclosed (for illustrative purposes) in a red rectangle. These values represent "buttons" that switch and display the next available option when tapped. The Terranova® 760 series will return to the Main Display if left unattended for more than 5 minutes; any unsaved changes will be deleted. Any unsaved changes before a power loss will also be deleted.

Button functions are as follows:

Tap **Sound** to enter the Sound display.

Tap **Quit** to return to the Configuration display.

Tap **Save** to store change and return to the Configuration display.

See "Sound Configuration" to view or change the Terranova® 760 series sound profile.

See "Controller Configuration" to view or change controller-specific parameters.
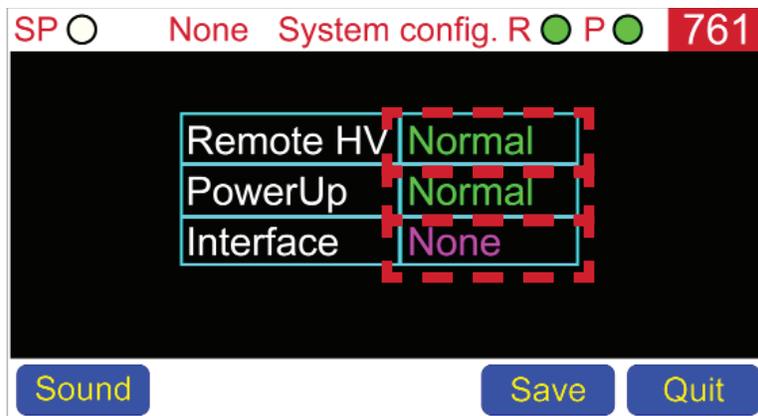
Figure 9. System Configuration display

NOTE
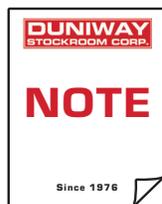
"Save" button will only appear after a change is attempted or made by the user.

Parameters accessed through the "System config." display cannot be viewed or modified remotely.

Channel Configuration Display

The Channel Configuration display provides access to the channel-specific parameters that affect Terranova® 760 series output and ion pump operation. As shown in Figure 10, all parameters which can be modified are enclosed (for illustrative purposes) in either an orange or red rectangle. Tapping on a numerical value (i.e. orange rectangle) opens a Parameter Entry screen (see Figure 11
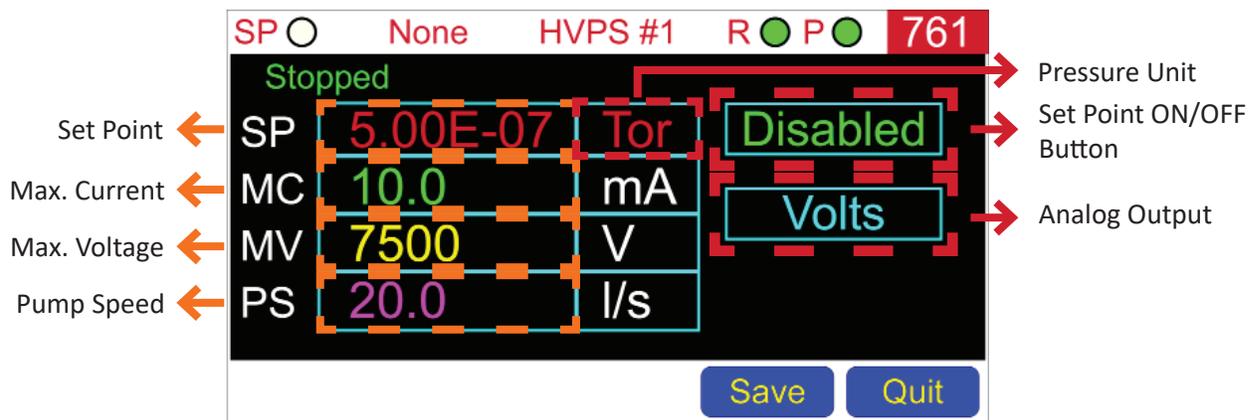
Figure 10. Channel configuration screen

NOTE
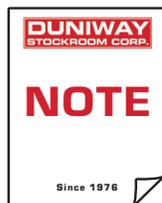
"Save" button will only appear after a change is attempted or made by the user.

Parameter Entry Screen

The parameter entry screen allows the user to enter a new parameter value via the front panel. To open the respective parameter entry screen, the user must tap the numerical value of the parameter to be modified. Only parameters that are enclosed by an orange rectangle (see Figure 10) will open a parameter entry screen. The Terranova® 760 series will return to the Main Display if left unattended for more than 5 minutes; any unsaved changes will be deleted. Any unsaved changes before a power loss will also be deleted.

Figure 11 illustrates an example of a parameter entry screen — all parameter entry screens will have a similar layout. A number pad with mathematical symbols will become available so the user can input the new parameter value. The currently-stored value is visible in the top, left corner of the screen. The Low and High Limit values define the range of the parameter. The new value will appear on the yellow rectangle and may be input in a number of formats so long as it possesses the correct syntax and is within the parameter range. An incorrect format or out-of-range value will output the error code "Value out of bounds" below the yellow rectangle (see "Parameter Entry Screen Example").

Button functions are as follows:

Tap **Enter** to temporarily store value and return to the Channel Configuration display.

Tap **Clear** to clear all input characters.

Tap **BSpace** to backspace one character at a time.

Tap **Quit** to return to the Channel Configuration display without saving any changes.
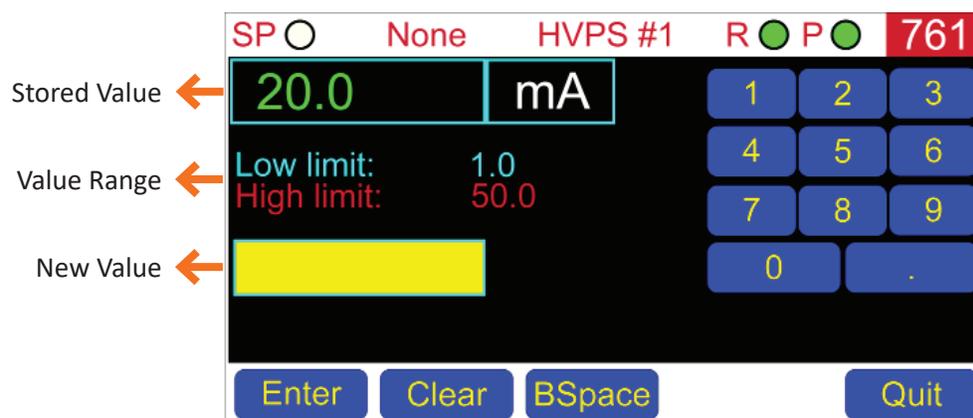
Figure 11. Example of a parameter entry screen

Parameter Entry Screen Example

To enter a new set point (SP) pressure value, the SP parameter value shown in Figure 12 must be tapped. Once the parameter is tapped, the parameter entry screen shown below will appear. The currently-saved SP value (i.e. 5.00×10^{-7} Torr) is visible in the top, left corner of the screen. To introduce a new SP value, the selected pressure value must be within the listed High and Low Limit values. In this case, the new SP value must be less than or equal to 1.00×10^{-6} Torr and greater than or equal to 5×10^{-10} Torr.

To enter 1.00×10^{-8} Torr as the new SP value, both 0.00000001 and 1E-8 are accepted formats and will be interpreted as 1.00E-08. However, if the user selects and enters 1.00×10^{-5} Torr as the new SP value, the Terranova® 762 will output the error code "Value out of bounds". To clear the error code, the user can either tap `BSpace` to backspace one character at a time or tap `Clear` to clear all input characters. To store the new parameter value and return to the Channel Configuration display, tap `Enter` .
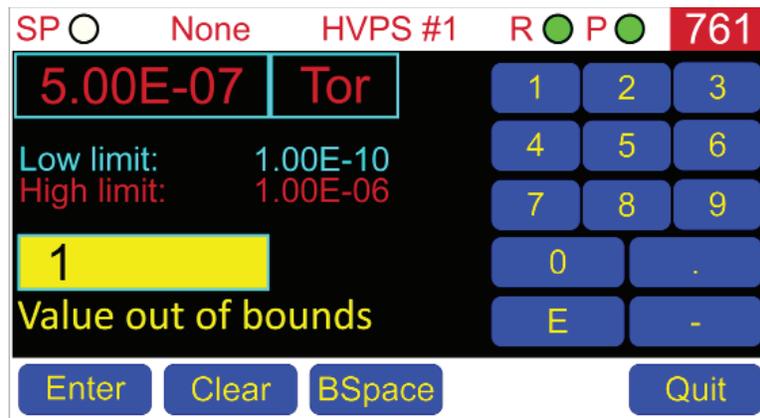
Figure 12. Example of "Value out of bounds" message
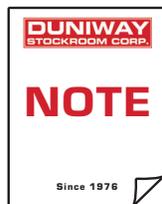
NOTE The parameter entry screen only temporarily stores a value. To permanently save a value, the user must tap "Save" on the Channel configuration screen.

Controller Configuration

Remote HV

The Terranova® 760 series has two different modes of operation available via the RemoteHV setting: Local and Remote. In both modes, parameter input may be modified either via the front panel or through the selected communication protocol. Default mode of operation is Local.

Local Operation

High voltage operation and parameter input is conducted via the front panel. Remote HV only 'enables' remote HV operation of the TTL signal or the user-installed switch. Serial communication and front panel button control of HV turn-on/off are always active. A user-installed switch can also be used to control high voltage operation. High voltage output is dependent on the safety interlock circuit (see **Safety Interlock**). High voltage operation will be interrupted if the safety interlock circuit is open or a ground fault is detected. User is only able to send query characters via the selected communication protocol. Default mode of operation.

Remote Operation

Parameter input is conducted via the front panel or through serial communication. A user-installed switch can also be used to control high voltage operation. High voltage output is dependent on the safety interlock circuit (see **Safety Interlock**). High voltage operation will be interrupted if the safety interlock circuit is open or a ground fault is detected.

When using a TTL circuit (or switch closure to GND), a LOW-True pulse of 2 seconds minimum duration is required. When HV is off, HV turn-on will occur on the rising (trailing) edge of the pulse. When HV is on, turn-off occurs immediately on the falling (leading) edge of the applied pulse. In both cases, the pulse width of 2 seconds minimum must be maintained. The TTL (or switch) input for channel 1 is PIN 6 and for channel 2 is PIN 19. Both are referenced to digital ground. See Table 6 for pin configuration.

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NOTE

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The front panel buttons used to operate voltage output will become hidden.

Changing the Mode of Operation

To change the mode of operation, the user must enter the System Configuration screen. To enter the System Configuration screen:

1. Tap Config to enter the Configuration display (see Figure 7)

2. Tap System to enter the System Configuration display (see Figure 9)

3. As shown in Figure 9, all controller-specific settings are available on screen

     A.   To return to the Configuration screen without making any changes, tap Quit

4. Tap the RemoteHV toggle button (red rectangle) to change the mode

     NORMAL: Front panel voltage operation

     REMOTE: Voltage operation via communication protocol

5. Tap Save to store change and return to the Configuration display

6. Tap GoMain to return to the Main Display

As shown in Figure 13, the RemoteHV indicator in the Status Bar will change to the corresponding color associated with the selected mode after tapping Save .
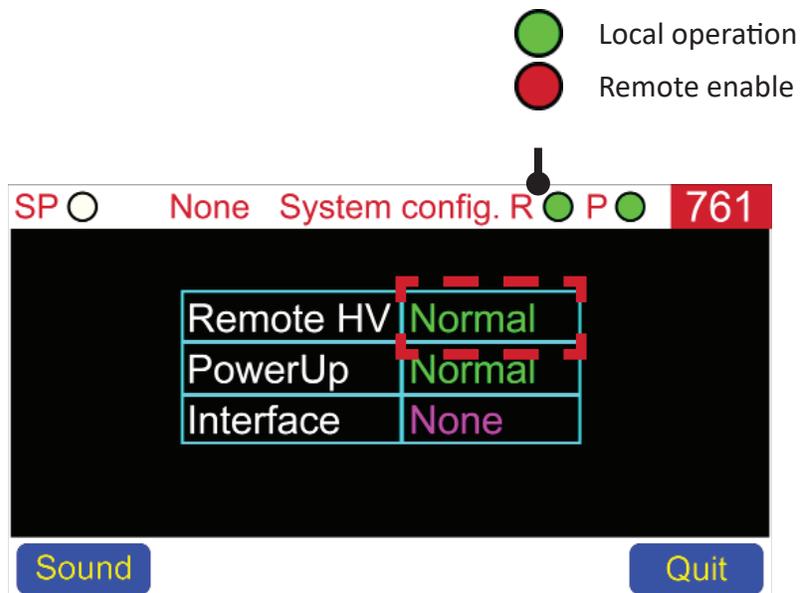
Figure 13. RemoteHV toggle button

PowerUp

The PowerUp setting selects the state in which the Terranova® 760 series starts up at power ON. There are three different options available: Normal, Recover, and Default. Default state is Normal.

Power-loss Restart

The Terranova® 760 series may be set to automatically restart high voltage operation after a power interruption. If HV on a given channel was 'ON' before the power interruption, HV operation on that channel will commence again when AC power to the controller is restored. The safety interlock circuit must remain closed throughout the entire process for a successful power loss restart. The automatic restart function is by default disabled.

Default Parameters

Restoring default parameters provides a starting point for control unit settings in the event of system reconfiguration. Default parameters will not occur until the next controller power cycle. To restart the controller, user should turn the Terranova® 760 series OFF via the power button. Once power is restored, default parameters will be established and the "P" indicator will turn green to indicate normal operation.

Parameter	Value
RemoteHV	Normal
PowerUp	Normal
Interface	RS-232
Sound	Chack

Table 2. Controller default values

Parameter	Value
SP: Set point value	5.00×10^{-7} Torr
Pressure unit	Torr
MC: Max. current	10 mA
MV: Max voltage	7500 V
PS: Pump size	20.0 l/s
Set point function	Disabled
Analog output	Volts

Table 3. Channel default values

Changing the Mode of Operation

To change the Terranova® 760 series start-up function, the user must enter the System Configuration screen. To enter the System Configuration screen:

1. Tap Config to enter the Configuration display (see Figure 7)

2. Tap System to enter the System Configuration display (see Figure 9)

3. As shown in Figure 16, all controller-specific settings are available on screen

   A. To return to the Configuration screen without any changes, tap Quit

4. Tap the PowerUp toggle button (red rectangle) to change the start-up function:

   NORMAL: Normal start-up operation

   RECOVER: Power-loss function enabled

   DEFAULT: Terranova 761® reset enabled

5. Tap Save to store change and return to the Configuration display

6. Tap GoMain to return to the Main Display

As shown in Figure14, the PowerUp indicator in the Status Bar will change to the corresponding color associated with the selected mode after tapping Save .
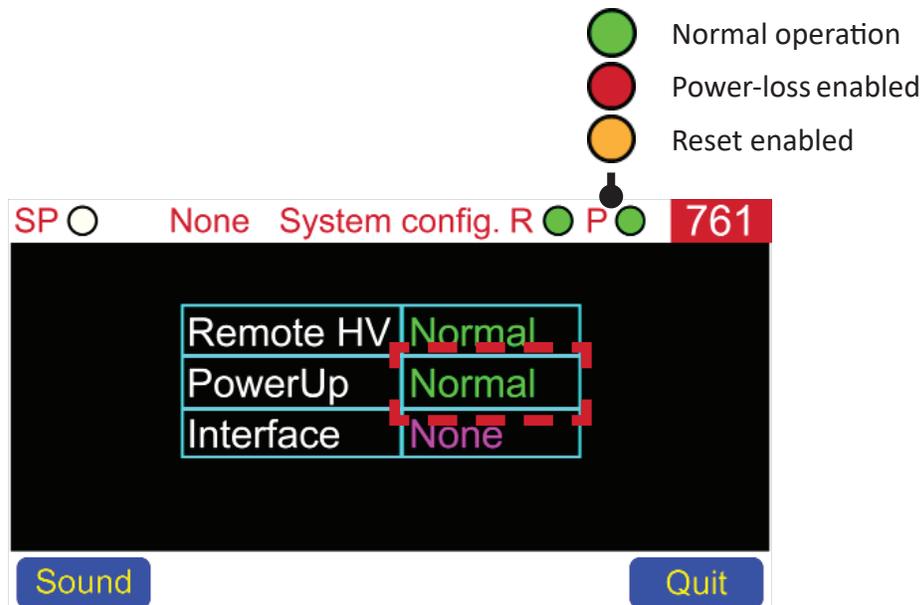

Figure 14. PowerUp toggle button

Sound Configuration

The Terranova® 760 series has a speaker that emits a sound profile with every function. To view or change the emitted sound file, the user must enter the Sound Configuration screen.

To enter the Sound Configuration screen:

1. Tap Config to enter the Configuration display

2. Tap System to enter the System Configuration display

3. Tap Sound to enter the Sound Configuration display

4. As shown in Figure 15, the current sound file is highlighted by a white square

    A. To return to the System Configuration display without making any changes, tap Quit

5. To select a new sound file, tap on the green area of the new sound file. As shown in Figure 15, a turquoise square will highlight the selected sound file.

6. Tap Save to store change and return to the System Configuration screen

7. Tap Quit to return to the Configuration display

8. Tap GoMain to return to the Main display

Figure 15. Sound configuration screen

Ion Pump Operation

The Terranova® 760 series is able to operate ion pumps from a number of manufacturers and at various pressure ranges due to the user-adjustable current and voltage parameters. While small ion pumps can be started at relative high vacuum pressures, larger ion pumps with higher current requirements must be started at lower vacuum pressures. However, once an ion pump is started, the Terranova® 760 series is able to maintain normal operation for all compatible units.

Ion Pump Parameters

The current limit and voltage output are set (respectively) via the maximum current (MC) and maximum voltage (MV) parameter. Along with the MC and MV parameters, the Terranova® 760 series uses the pump speed (PS) parameter and pressure unit to approximate the pressure inside the ion pump. See "Pressure Measurement" for details on how pressure is calculated. The selected pressure unit is also used to define the pressure units for all pressure parameters and output.

Modifying Ion Pump Parameters

To view or change the ion pump parameters, the user must enter the Channel Configuration menu. As shown in Figure 16, the ion parameters are enclosed (for illustrative purposes) in either an orange or red rectangle. Table 4 lists the range for the ion pump parameters. To operate the ion pump or view and modify ion pump parameters remotely, see "Communication Protocols".
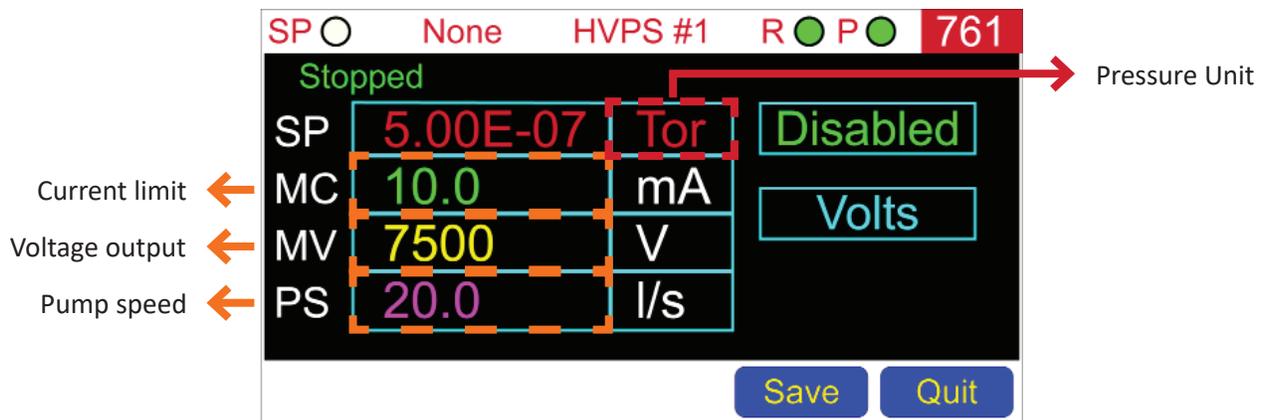
Figure 16. Ion pump parameters

Parameter	Range
MC	1.0 - 50.0 mA
MV	±2000 - ±7500 V
PS	0.1 - 999.0 l/s
Pressure Unit	torr, mbar, Pascal

Table 4. Ion pump parameter ranges

To view or change the ion pump parameters:

1. Tap **Config** to enter the Configuration display (see Figure 7)

2. Tap the HVPS green area on the Configuration screen to enter the channel configuration display (see Figure 10)

3. As shown in Figure 10, all channel-specific parameters are available on screen.

    A. To return to the Configuration display without making any changes, tap **Quit**

4. To change a parameter value enclosed by an orange rectangle, tap a numerical value to open the respective Parameter Entry screen (see Figure 11 for a screen description).

    A. Use the number pad to input the new parameter value

    B. Tap **Enter** to temporarily store the new value and exit the screen

5. Repeat Steps 4 - 6 to enter a new value for the remaining numerical parameters

6. To change the pressure unit for all pressure values, tap inside the red rectangle to toggle between the available units. The pressure units will appear one by one with every tap of the area.

7. Tap **Save** to permanently save changes and exit to the Configuration display
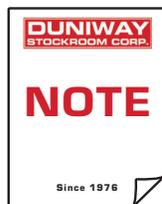
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NOTE

Since 1976

"Save" button will only appear after a change is attempted or made by the user.

User must tap "Save" on the Channel Configuration display to permanently store all changes.

Starting the Ion Pump

To operate an ion pump with the Terranova® 760 series, system pressure must be less than the recommended values in **Table 5**. Before commencing ion pump operation, the user should verify the Terranova® 760 series is set to the proper output polarity. As shown in Figure 4, the Main Display indicates polarity next to the channel number: green "+" for positive polarity and red "-" for negative polarity. Diode ion pump elements such as standard diode, Galaxy™ diode, or differential diode require positive polarity. Triode ion pump elements such as StarCell® and Galaxy™ triode require negative polarity. To operate the ion pump remotely, see "Communication Protocols".

To commence ion pump operation, the user should touch and hold   `Run1`   for at least TWO seconds. If successful, the Terranova® 760 series will emit a click and the Channel#1 LED will become illuminated. Thereafter, the PRESSURE, CURRENT, and HIGH VOLTAGE values will be output onto the Main Display (see Figure 5). Otherwise, the control unit will remain in Standby

Pumping Speed [L/s]	Pressure [Torr]
400 - 500	5×10^{-5}
220 - 270	1×10^{-4}
110 - 140	3×10^{-4}
60	5×10^{-4}
≤ 30	1×10^{-3}

Table 5. Recommended MAXIMUM Ion Pump Starting Pressures

NOTE
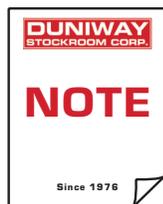
To avoid erroneous transient values, the VOLTAGE and CURRENT output will slowly increase after ion pump operation is commenced.

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Start Phase

Once high voltage operation is commenced, user should observe the HIGH VOLTAGE and CURRENT values. Decreasing current and increasing high voltage values are an indication of a successfully started ion pump. However, if high voltage output does not appear to increase, the ion pump or vacuum system is still at too high of a pressure. User should terminate high voltage operation and increase the current limit of the Terranova® 760 series if too low of a value was selected. Otherwise, the user should further evacuate the ion pump and vacuum system. Once a lower vacuum pressure is achieved, high voltage operation should be restarted. As shown in Figure 17, current and thus, power, is highest during the starting phase of an ion pump.

If high voltage output increases or remains constant as current decreases, user should isolate the ion pump and chamber from the roughing system to help start the ion pump. If this isolation leads to an increase in current, user should terminate high voltage operation and continue pumping on the ion pump and vacuum system. Once a lower vacuum pressure is achieved, high voltage operation should be restarted. Otherwise, the ion pump and chamber should remain isolated; user should observe current and high voltage values for normal operation.

An increase in vacuum pressure may be observed during the starting phase of an ion pump. The increase in pressure is due to outgassing of previously-absorbed atoms and molecules caused by internal pump heating. Outgassing is beneficial as it helps lessen the overall gas load.

Normal Operation

Once an ion pump is successfully started, Terranova® 760 series operation is almost automatic. As shown in **Figure 19**, high voltage output will approach the open circuit value (i.e. MV value) as current output approaches 0 µA. Units for the current value will auto range during use as the ion pump current increases or decreases. To terminate ion pump operation, tap   Stop1 .
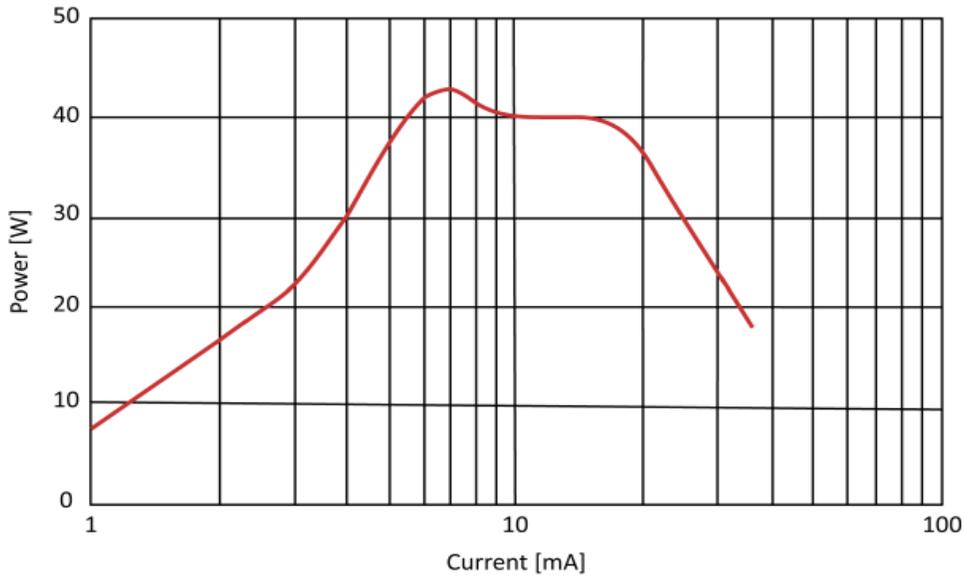
Figure 17. Terranova® 760 Series power vs. current graph
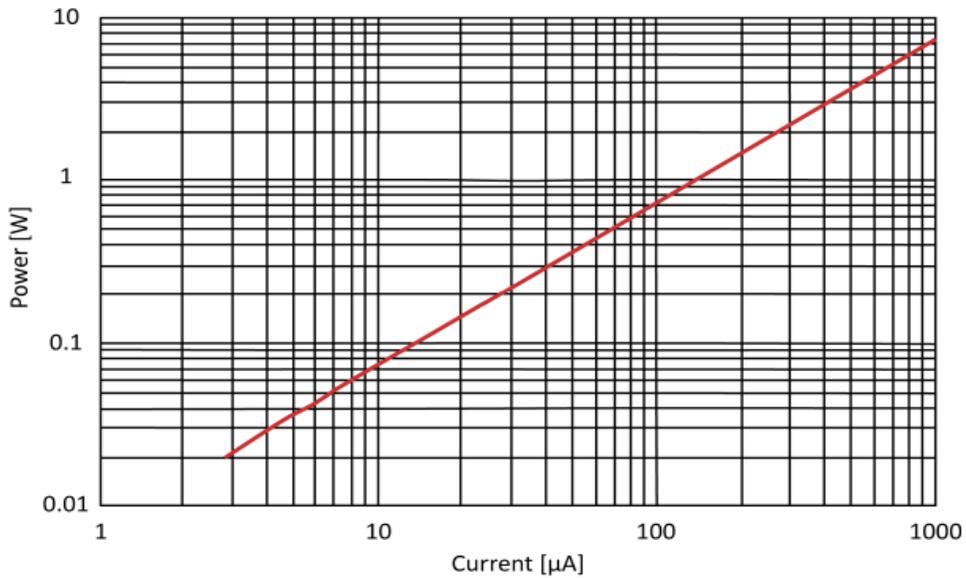
Figure 18. Terranova® 760 Series voltage vs. (low) current graph
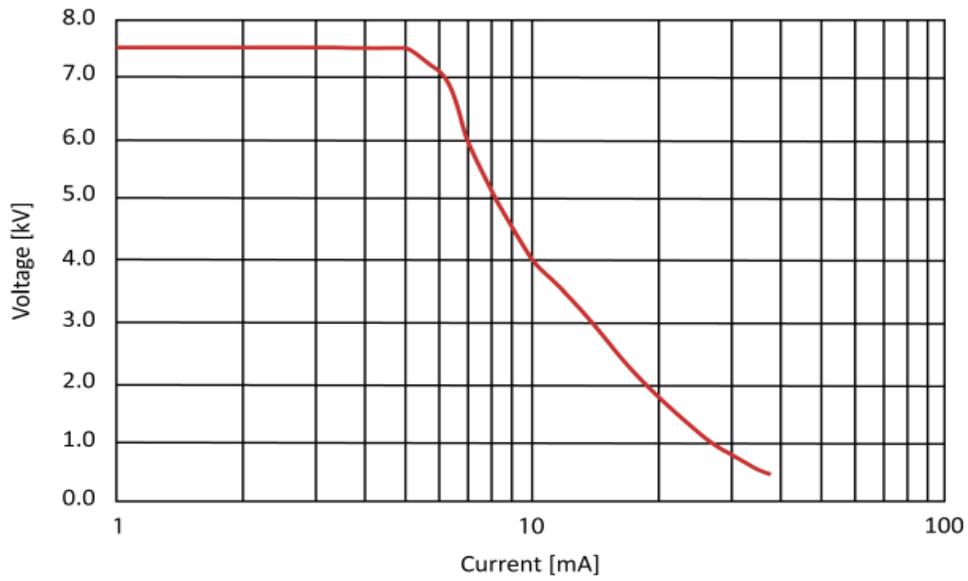
Figure 19. Terranova® 760 series voltage vs. current

Pressure Measurement

The Terranova® 760 series outputs pressure measurements based on the ion pump current shown on the Main display. Once an ion pump reaches normal operation, current becomes nearly proportional to vacuum pressure over a wide range of pressure values. If the proper pump size (i.e. pumping speed) has been selected, pressure at the ion pump inlet may be read from the front display. The following equation is used to approximate the pressure P in torr:

$$P = \frac{K \cdot I}{S \cdot V}$$

where K is an experimentally-determined constant equal to 370, I is current in amperes, S is the pumping speed of the ion pump (i.e. PS value) in liters per second, and V is the voltage output in volts. For example, if voltage output is 6000 V and PS is set to 100 L/s, V = 6000 V and S = 100 L/s. Therefore, if the current reading on the Main display is 1.0 mA (or 1.0×10^{-3} A), P is approximately 6.2×10^{-7} Torr.

Current measurements can also be used to determine pressure if the ion pump current-pressure relationship is known. However, ion pump pressure readings should only be taken as an approximation and not a reliable indication of system pressure. A separate pressure gauge such as an ionization gauge is strongly recommended for more accurate pressure measurements.

NOTE The PUMP SPEED and CURRENT display value are used to calculate the PRESSURE value on the display
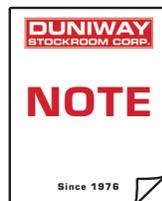
NOTE User cannot recuperate from a shutdown state via remote operation

PIN	Function	Output	Description
1	Channel #1 SET POINT relay	Common	See **Set Point Operation**
2	Channel #1 SET POINT relay	Normally closed (NC)	See **Set Point Operation**
3	Channel #1 SET POINT relay	Normally open (NO)	See **Set Point Operation**
4	Chassis ground		
5	User Voltage output	+5 V DC	See **NOTE 1**
6	Channel #1 TTL digital input		See **Mode of Operation**
7	Digital ground		
8	Isolated ground		See **NOTE 2**
9	Ch #1 HV digital output		See **NOTE 3**
10	Ch #1 set point digital output		See **NOTE 4**
11	Reserved		
12	Analog ground		
13	Channel #1 Analog output		See **Analog Output**
14	Channel #2 SET POINT relay	Common	See Set Point Operation
15	Channel #2 SET POINT relay	Normally closed (NC)	See Set Point Operation
16	Channel #2 SET POINT relay	Normally open (NO)	See Set Point Operation
17	Chassis ground		
18	User Voltage output	+12 V DC	See **NOTE 5**
19	Channel #2 TTL digital input		See Mode of Operation
20	Digital ground		
21	Ch #2 HV digital output		See NOTE 3
22	Ch #2 setpoint digital output		See NOTE 4
23	Reserved		
24	Analog ground		
25	Channel #2 Analog Output		See Analog Output

Table 6. I/O port pin configuration
NOTES

1. **PIN 5**: +5VDC output available for external use; current limit: 80 mA
2. **PIN 8**: Isolated ground...for use with digital outputs. See below.
3. **PIN 9, PIN 21**: Digital output available when high voltage (HV) operation is ON
4. **PIN 10, PIN22**: Digital output available when set point operation is ON
5. **PIN 18**: +12VDC output available for external use; current limit: 150 mA

Isolated Ground The four digital outputs at pins 9,10,21,22 are referenced to ISO_GND which is not internally connected to the controller's digital or analog grounds. These outputs are opto-isolated, open-drain transistors which must have external pull-up resistors to an external supply referenced to ISO_GND. If the isolation is not needed, ISO_GND can be connected to Digital GND at pin 7 and the user power supplies at pin 5 or pin 18 can be used to supply the pull-up resistors to provide the desired digital signal levels.

Set Point Operation

The Terranova® 760 series can be utilized for process control functions via the use of a programmable set point and its corresponding relay. The set point function must be enabled to utilize this feature and can be enabled, disabled, and changed via the serial comm link using the SEx and SPx commands or be enabled through the front panel. The set point (SP) pressure value is set via the SP parameter which can be adjusted via either the front panel or through the selected communication protocol. See page 35 to adjust the set point value via the front panel; see page 42 to adjust the set point value via the communication protocol. Relay output is accessible via the I/O port. See **Table 6** for relay pin configuration. See Appendix for relay use with inductive or capacitive load switching.
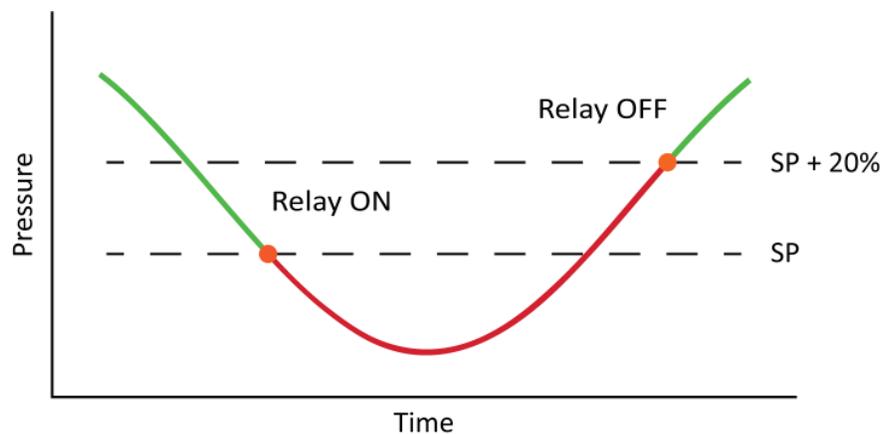
Figure 20. Relay operation graph

As shown in **Figure 20**, the relay activates once the Terranova® 760 series pressure output is less than or equal to the user-defined SP value. The relay will stay active until the pressure output is greater than or equal to 20% of the SP value. The SP indicator in the Status Bar is ● when the relay is inactive and ● when the relay is active. For example, if the SP value is set to 1.0×10^{-8} Torr, the relay will stay inactive until the Terranova® 760 series pressure output is less than or equal to 1.0×10^{-8} Torr. Conversely, the relay will stay active until the pressure reading is greater than or equal to 1.2×10^{-8} Torr.

Set Point Function

The set point function (and relay) is by default disabled — the SP indicator in the Status Bar will display ◯ . As shown in Figure 21, the set point parameters are enclosed (for illustrative purposes) in an orange and red rectangle. To view and modify the set point parameters remotely, see "Communication Protocols".

To toggle the set point feature or change the SP parameter value via the front panel:

1. Tap Config to enter the Configuration display (See Figure 21)

2. Tap the HVPS green area on the Configuration screen to enter the channel configuration display (see Figure 21)

3. As shown in Figure 21, all the channel-specific parameters are available on screen

    A. To return to the Configuration screen without making any changes, tap Quit

◯ Set point function disabled

🟢 Set point function enabled; relay OFF

🔴 Set point function enabled; relay ON
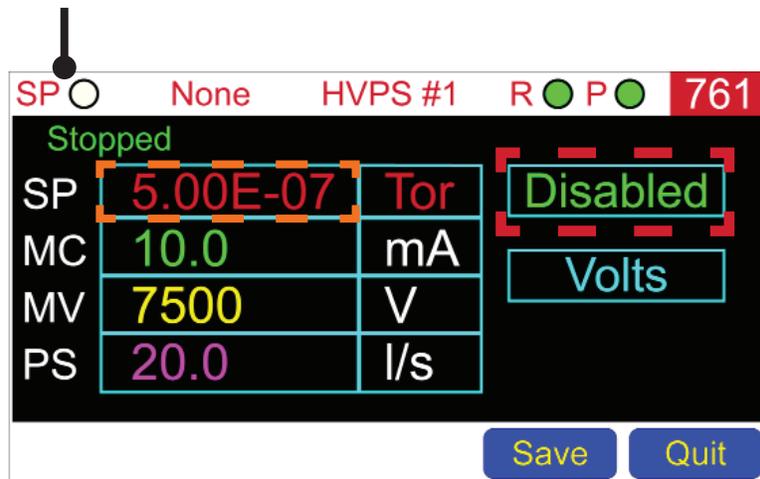
Figure 21. Set point parameter and toggle button

4. Tap the SP function toggle button (red rectangle) to select the desired state

    DISABLED: Set point function disabled

    ENABLED: Set point function enabled

5. Tap the SP numerical value (orange rectangle) to open the Parameter Entry screen (see "Parameter Entry Screen" for a screen description).

    A.   Use the number pad to input the new pressure value. **Table 8** lists the SP value range for the respective pressure unit.

    B.   Tap Enter to temporarily store the new value and exit the screen.

6. Tap Save to permanently save changes and exit to the Configuration display

7. Tap GoMain to return to the Main Display

As shown in Figure 21, the set point indicator in the Status Bar will change to ◯ when the set point function is disabled and 🟢 when the set point function is enabled after tapping Save .

Range	
Torr	1.00×10^{-5} to 1.00×10^{-10}
mBar	1.33×10^{-5} to 1.33×10^{-10}
Pascal	1.33×10^{-3} to 1.33×10^{-8}

Table 7. SP parameter range

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"Save" button will only appear after a change is attempted or made by the user.

User must tap "Save" on the Channel Configuration display to permanently store all changes.

Analog Output

The Terranova® 760 series has analog output available for use as a secondary method to read the high voltage or current values shown on the Main display. The unit outputs a voltage signal for each type of analog output. There are 5 (five) signals for each channel, as described below. They are multiplexed to a single Analog Out pin for each channel. The particular signal present on the channel Analog Out pin at any given time is selected by the user via the front panel or serial communication link. Analog output is accessible via the I/O port. Default monitor is the high voltage monitor (i.e. VOLTS). See **Table 6** for pin configuration.

High Voltage Monitor

The high voltage monitor is based on the value shown on the Main display. The analog output function provides a normalized value (i.e. divided by 1000) of 1 V per 1 kV for the high voltage output. For example, an output of 7.5 V corresponds to 7.5 kV.

Current Monitor

Four different user-selectable analog output voltage scales – three linear, one logarithmic – are available to monitor the current value shown on the Main display. See **Setting the Current Monitor** to change current monitor scale.

Linear Output

Linear output is available in the following three scales: 20 μA, 200 μA, and 2 mA per 1 V. The lowest recommended value for accurate readings when linear output is selected is 1% of full scale. See **Table 4** for analog output to current relationship.

Voltage [V]	Current [mA]	Current [μA]	Current [μA]
0.1	0.2	20	2
0.5	1	100	10
1.0	2	200	20
2.0	4	400	40
3.0	6	600	60
4.0	8	800	80
5.0	10	1000	100
10.0	20	2000	200

Table 8. Linear current monitor voltage output

Logarithmic Output

The logarithmic output scale requires the user to convert the voltage output into a current measurement. Current, I, as a function of the analog output, V, is calculated by

$$I = 10^{(V-8)}$$

where V is in volts and I is in amperes. For example, if V is equal to 4.903 V, I is 8.0×10^{-4} A or 800 µA. The lowest recommended voltage value for accurate readings is 1 V. **Table 9** lists sample output and corresponding current values.

Voltage [V]	Current
1.0	0.1 µA
2.0	1 µA
3.0	10 µA
4.0	100 µA
5.0	1 mA
6.0	10 mA
7.0	100 mA
8.0	1 A

Table 9. Logarithmic output and calculated current values
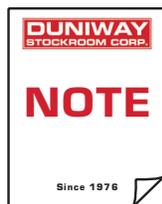
NOTE   Only one output monitor may be selected per channel at any given time

Setting the Output Monitor

To change or view the selected output monitor, the user must enter the Channel Configuration screen. To enter the Channel Configuration screen:

1. Tap Config to enter Configuration display (See Figure 22)

2. Tap the HVPS green area on the Configuration screen to enter the channel configuration display (see Figure 22)

3. As shown in Figure 22, all the channel-specific parameters are available on screen

   A. To return to the System Configuration menu without saving any changes, tap Quit

4. Tap the analog output toggle button (red rectangle) to select the new monitor:

   VOLTS: Linear, high voltage monitor [kV]

   200 µA: Linear, current monitor [200 µA/V]

   2 mA: Linear, current monitor [2 mA/V]

   20 µA: Linear, current monitor [20 µA/V]

   LOG I: Logarithmic, current monitor

5. Tap Save to store change and return to the Configuration display

6. Tap GoMain to return to Main Display
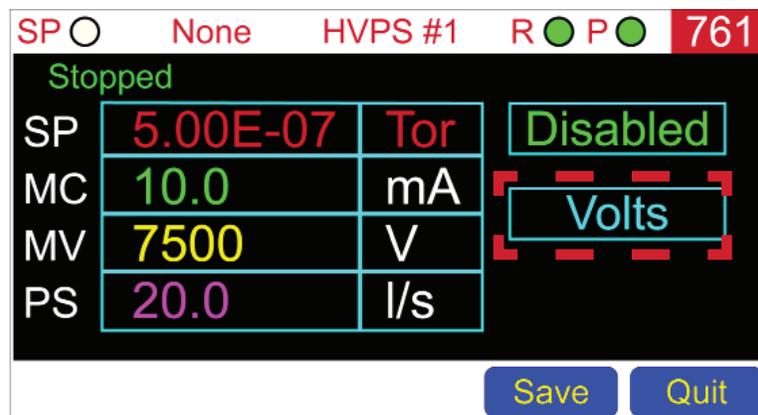
Figure 22. Analog output toggle button

Communication Protocols

The SERIAL I/O 9-pin D-sub, ethernet, and USB ports are available to remotely query the Terranova® 760 series to both read or set parameter values and operate the high voltage function. Five different user-selectable communication protocols are available via the Interface setting for data transmission: RS-232, RS-422, RS-485, ethernet, and USB. The Terranova® 760 series' serial communication standard may only be selected via the front panel display.

Selecting the Communication Protocol

To change the Terranova® 760 series communication protocol, the user must enter the System Configuration screen. To enter the System Configuration screen:

1. Tap [Config] to enter Configuration display

2. Tap [System] to enter System Configuration display

3. As shown in Figure 23, all the system-specific parameters are available on screen

    A. To return to the System Configuration menu without saving any changes, tap [Quit]
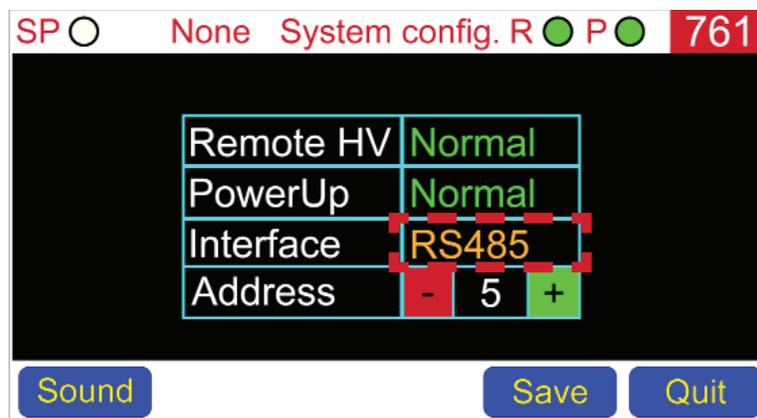
Figure 23. Interface toggle button with RS-485 address input
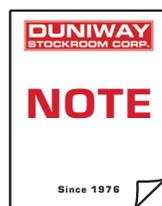
NOTE Address parameter only appears when RS-485 is temporarily or permanently selected.

4. Tap the Interface toggle button (red rectangle) to select the new protocol:

       RS232:   RS-232 serial

       RS422:   RS-422 serial

       RS485:   RS-485 serial (see "RS-485 Address" for more details)

       ETHER: Ethernet

       USB: USB

       NONE: Function is disabled

5. Tap **Save** to save change and return to the Configuration display

6. Tap **GoMain** to return to Main Display

As shown in Figure 23, the Status Bar will display the selected protocol after tapping **Save** .

RS-485 Address

Selecting the RS-485 communication protocol allows the Terranova® 760 series to be installed in a multi-drop network with as many as 32 terminals. In this type of network topology, the master computer must be assigned the address 0 and the Terranova® 760 series a unique address from 1 to 31. All frames must have an address on the network for the master computer to communicate. To satisfy the addressing scheme, the network address must be placed at the head of the frame in two bytes ASCII from 00 to 31 where 00 is reserved for an external network master computer.

To change the Terranova® 760 series address from default 5, the communication protocol must be set to RS-485. See "Selecting the Communication Protocol" to change the communication protocol. Thereafter, the Address parameter will appear below the Interface setting (see Figure 23). To change the address, the user should tap the "+" and "-" buttons to increase or decrease

RS-232/422/485 Protocol

A separate cable and program, such as PuTTY, are required to remotely communicate with the Terranova® 760 series. The control unit accepts single and multiple input queries or commands via a text file. Duniway Stockroom cable **RS232-TN751A** is available for RS-232 serial communication. See **Table 10** for pin configuration. See **Table 11** for serial communication settings.

All commands are of the type *stop and wait*. User sends a command and receives a response before sending a new command. All commands and responses are made using printable ASCII code. All commands are ended by a *carriage return* (i.e. ASCII Code 13); responses are ended by a *carriage return* (i.e. ASCII Code 13) and/or a *new line* (i.e. ASCII Code 10).

PIN	RS-232	RS-422/485
1	--	--
2	TxD	TxD+
3	RxD	RxD+
4	--	--
5	Common	Common
6	--	--
7	--	RxD-
8	--	TxD-
9	--	--

Table 10. Serial I/O port pin configuration

Parameter	Value
Speed (baud)	9600
Data bits	8
Stop bits	1
Parity	None
Communication mode	Half Duplex

Table 11. Terranova® 760 series' serial communication settings

Ethernet and USB

The Terranova® 760 series comes with Ethernet and USB ports which can be used to communicate with the 760 series similar to RS232/485 using Telnet.

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Query Characters

The Terranova® 760 series utilizes a three-digit query character to select the parameter to output. See **Table 12** for query characters. A two-digit unique address from 00 to 31 must precede the query character to identify the device when configured for RS-485 serial communication. See Changing the **RS-485 Address (page 41)**.

Command Characters

The following input format is used by the Terranova® 760 series to modify parameters or operate the high voltage function

[Address][Command character]**:**[Value]

where the colon symbol (**:**) tags the transmission as a command string. The command character is a three-digit alphanumeric character used to select the parameter or function to modify or operate, respectively. The command value must follow the character after the colon symbol. See **Table 12** for command characters and corresponding input format. The address is a two-digit numerical value from 00 to 31 used to identify the device when configured for RS-485 serial communication. See **Changing the RS-485 Address**.

Description	Input	Output
Serial communication: RS-232/422 CHANNEL 1 CURRENT display reading: 15 mA	CU1	OK:1.5E-2
Serial communication: RS-485 CHANNEL 2 PRESSURE display reading: 1.5×10^{-9}	PR2	OK:1.5E-9
Serial communication: RS-232/422 CHANNEL 3 CURRENT display reading: N/A	CU3	ER:06

Table 12. Query communication examples

NOTE Since 1976
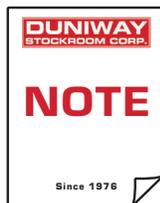
Communication is disabled whenever the Terranova® 761 outputs an error message to the front panel. Changes may also be made from the front panel.

Character	Description	Output Format	
MOD	Model number	761	
VER	Firmware version	LXX.XX.XX.XX.XX	
STx	Terranova® 761 state	**R**: Run, **S**: Stop, **G**: Ground	
HVx	High voltage state	**0**: OFF, **1**: ON	
POx	High voltage polarity	**P**: Positive, **N**: Negative	
VOx	HIGH VOLTAGE output	XXXX [V]	
CUx	CURRENT output	X.XX e±X [A]	
PRx	PRESSURE output	X.XX e±X [in selected pressure unit]	
SPx	SET POINT value	X.XX e±X [in selected pressure unit]	
MVx	MAXIMUM VOLTAGE value	XXXX [V]	
MCx	MAXIMUM CURRENT value	X.XX e±X [A]	
PSx	PUMP SIZE value	XX.X [L/s]	
UNx	PRESSURE UNIT value	**T**: Torr, **B**: mBar, **P**: Pascal	
SSx	Set point state	**0**: OFF, **1**: ON	
AOx	Analog output setting	**VOLT**:	High voltage [1kV/V]
		IHI:	Current - linear[2 mA/V]
		IMID:	Current - linear [200 µA/V]
		ILO:	Current - linear [20 µA/V]
		ILOG:	Current - logarithmic

Table 13. Query characters
In tables above, x=channel#: PO1 returns N if ch 1 polarity is negative; HV2 returns 0 if ch2 HV is OFF

NOTES

1. L in firmware version is an alphabetical letter
2. X in output format is a non-negative integer
3. Bold values are output...
4. ST1: **G** indicates the safety interlock circuit is open
5. MV1 and VO1 will always output positive values regardless of polarity

Command Query Examples: mv1 returns 7500 if channel 1 is set to highest HV setting; AO2 returns IHI if current range on channel 2 is set to the 2mA/V linear range

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NOTE

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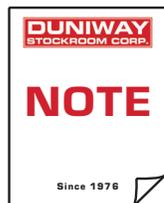
Query characters are not case-sensitive

Character	Description	Input Format	
HVx	High voltage operation	**0**: OFF, **1**: ON	
SPx	SET POINT value	X.XX e±X [in selected pressure unit]	
MVx	MAXIMUM VOLTAGE value	XXXX [V]	
MCx	MAXIMUM CURRENT value	X.XX e±X [A]	
PSx	PUMP SIZE value	XX.X [L/s]	
UNx	PRESSURE UNIT value	**T**: Torr, **B**: mBar, **P**: Pascal	
SEx	Set point enable	**0**: OFF, **1**: ON	
AOx	Analog output setting	**:VOLT**	High voltage [1kV/V]
		:IHI	Current - linear[2 mA/V]
		:IMID	Current - linear [200 µA/V]
		:ILO	Current - linear [20 µA/V]
		:ILOG	Current - logarithmic

Table 14. Command characters

Command Set Examples:

MV1:5000 -- sets max. HV voltage for channel 1 to 5 kV

ps2:50 -- sets pump size to 50 litres on channel 2

SE1:1 -- enables setpoint function on channel 1

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NOTE

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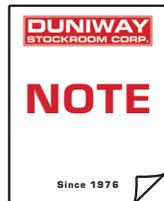
Command characters are not case-sensitive

Description	Input	Output
Serial communication: RS-232/422 CHANNEL 1 SET POINT value: 1.2×10^{-8}	SP1:1.2E-8	OK
Serial communication: RS-485 CHANNEL 1 PRESSURE UNIT value: Pascal	UN1:P	OK
Serial communication: RS-232/422 CHANNEL 2 PRESSURE UNIT value: ATM	UN2:A	ER:07

Table 15. Command communication examples
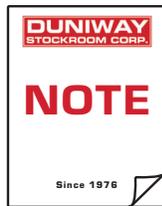
NOTE

If set command does not have semicolon... Set command will only output OK if successfully transmitted, unless error code.

Code	Mnemonic	Explanation
01	UNK_CODE	Query or set command does not exist
02	QUERY_NOT_EXEC	Query command sent to disconnected channel (?)
03	IS_NOT_SET	Command is not a set command
04	CHAN_EXEC	Parameter change is currently not allowed (?)
05	NOT_IN_REMOTE	Set command must be in remote control mode (?)
06	BAD_HVPS_NO	Channel is not installed
07	BAD_ARG	Set command has incorrect value
08	BAD_LIMITS	Set command has out-of-range value
09	OUT_BOUNDS	Query output is out of range

Table 16. Communication error codes

Troubleshooting

Problem	Possible Cause	Diagnostic
Unit does not power ON	Input fuse is open AC outlet has no output Power cord is defective	See **Changing the Fuse** Check AC outlet Check power cord for continuity
Unit powers ON, but screen does not illuminate	Screen has failed	Return unit to Duniway Stockroom
Screen is not responsive	Screen has failed	Return unit to Duniway Stockroom
No sound is emitted when screen buttons are tapped	Speaker is disabled	See **Sound Configuration**
Unit powers ON, but only outputs long, continuous BEEP sound	Microprocessor is not working properly	Reset control unit (see **Restoring the Terranova 761**); if problem persists, return unit to Duniway Stockroom
No high voltage output when **RUNX** button is depressed	Safety interlock circuit is open Ion pump cable ground sense conductor is open	See **Safety Interlock** Check ion pump cable for continuity
High voltage operation is ON, but high voltage output is 0 kV when ion pump is either connected or disconnected	High voltage output is shorted Internal high voltage power supply has failed	Remove high voltage connector from ion pump and restart control unit Return unit to Duniway Stockroom
High voltage operation is ON, ion pump is connected, but current is 0 μA	Ion pump is at pressure less than 1×10^{-9} Torr Ion pump cable is defective	No action required Check ion pump cable for continuity
High voltage output is above MAXIMUM VOLTAGE value	High voltage sense resistor is broken No ground connection present to internal power supply	Return unit to Duniway Stockroom
Serial communication does not respond	Tx and Rx are inverted	Invert Tx and Rx connection on serial I/O cable connector
Set point relay contacts do not toggle	Contacts are welded together due to excess current or transients	Return unit to Duniway Stockroom

Leakage Current

If a vacuum system is known to be in the ultra-high vacuum range but current reading is steady or fluctuating between a few microamperes, the non-zero current reading may be due to leakage current. Leakage current can originate from either the ion pump and/or control unit.

An old and/or dirty Terranova® 760 series with faulty and/or failing electronic components can be a source of leakage current. A functional Terranova® 760 series without an ion pump connected should output the voltage limit (i.e. MV) value and 0 µA on the display. Any current output is leakage current originating from the control unit. To remove leakage current, the control unit should be cleaned and/or sent in for service to replace faulty components.

Although leakage current affects the pressure output of the Terranova® 760 series, it does not affect pump efficiency or performance. Nevertheless, ion pump pressure readings should only be taken as an approximation and not a reliable indication of system pressure. A separate pressure gauge such as an ionization gauge is strongly recommended for more accurate pressure readings.

Display Error Codes

The Terranova® 760 series will enter a shutdown state to protect the equipment from possible damage or indicate equipment failure. When the control unit enters a shutdown state, high voltage operation is disabled and the respective failure code is output onto the display. User should correct the issue that caused the shutdown before restarting high voltage operation. As shown in Figure 17, the HV ON/OFF button will become hidden until the event that caused the error code is resolved. To recover from a shutdown and restart high voltage operation, power the controller on/off.

Error Message	Description
Ground Fault	Safety interlock not connected
CPU Overtemperature	Internal Controller Overtemperature
HVPS Overtemperature	High Voltage Assembly Overtemperature
HVPS Internal Power Fail	Power Supply Failure on HVPS Assembly
HV Fault	Internal High Voltage Failure
HV Overload	Pump Pressure Too High or Shorted HV Cable
Cooldown	HV Shutdown after > 10min. Current Limiting

Table 17. Display error codes

Over Current Protection

"HV Shutdown" is displayed when high voltage output is shorted to ground or power output remains relatively high. Over current can be due to a malfunction of either the ion pump or ion pump cable. "HV Shutdown" is also displayed when current output is not successfully reduced after 10 minutes of operation with current-limiting active.

Transformer Failure

"HV Fault" is displayed when the Terranova® 760 series high voltage transformer has failed. The control unit may output relatively low or zero voltage on the HIGH VOLTAGE display.

Overtemperature Protection

"HVPS Overtemperature" is displayed whenever the HV generator assembly overheats during operation. "CPU Overtemperature" is displayed when the internal temperature of the unit goes above allowable limits. The 760 Series will overheat if the internal fan(s) have failed. The control unit may also overheat if it is not properly ventilated. User should ensure ventilation ports are not blocked and check for possible external heat sources near the control unit.
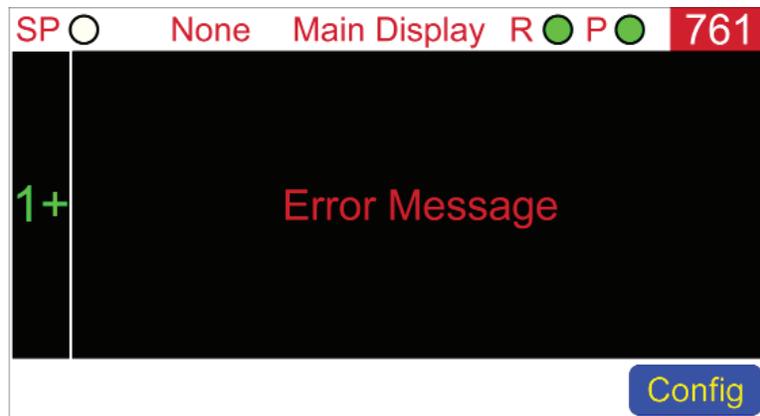
Figure 24. Error message display

Changing the Input Fuse

The Terranova® 760 series contains one slow-blow Type T, 2 A fuse used to interrupt AC power in the event of overcurrent from the electrical outlet. The fuse is held in the fuse block located within the AC power module, below the power cord socket. Recommended replacement fuses are Bussman GDC-2A and Littelfuse 218 002.
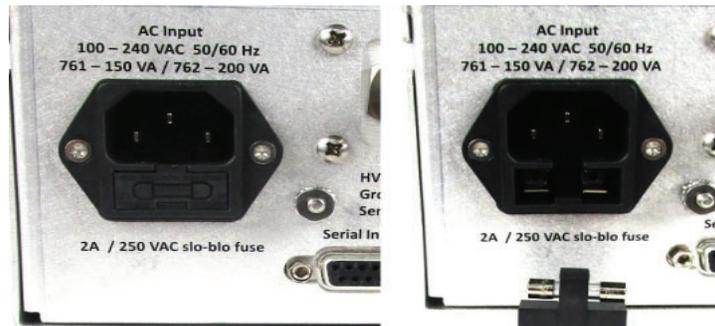

Figure 25. Terranova® 762 AC power module

WARNING!

User should wait at least 15 seconds after turning OFF the Terranova® 762 before removing the power cord

To change fuses:

1. Turn unit OFF via the **POWER** switch
2. Remove power cord and ion pump cable(s)
3. Locate the fuse block immediately below the power cord socket (see **##)**
4. Press the tab of the fuse block and withdraw the assembly
5. Inspect and replace faulty fuse
6. Reinsert fuse assembly into power module
7. Push fuse assembly into place until assembly tab "clicks"

When ready for use, user should re-connect the ion pump cable(s) and power cord. Once the Terranova® 761 is powered ON, operation may be resumed.

Declaration of Conformity

C €

Manufacturer:	Duniway Stockroom Corp.
	48501 Milmont Drive
	Fremont, CA 94538
Product Name:	Terranova® 762 Ion Pump Control Unit

We declare, under our sole responsibility, that the named products which display the CE mark are in conformity with the following harmonized standards and/or normal documents or technical specifications:

EMC:	EN 61326-1:2013
LVD:	EN 61010-1:2010/A1:2019

The named products are in conformity with the following requirements of the EU directives:

2014/30/EU	Electromagnetic Compatibility Directive
2014/35/EU	Low Voltage Directive
2011/65/EU	RoHS directive as amended by Delegated Directive2015/863

ETL Certified and Listed

The named products conform or are certified to the following standards relating to the safety of electrical equipment for measurement, control, and laboratory use:

UL:	61010-1:2012 Ed.3+R:29APR2016
CSA:	C22.2#61010-1-12:2012 Ed.3+U1;U2;A1

Fremont, CA on 02 December 2022

Place and Date

x _Michael Ricks_

Name: Michael Ricks
Title: General Manager

Declaration of Conformity

UKCA

Manufacturer:	Duniway Stockroom Corp.
	48501 Milmont Drive
	Fremont, CA 94538
Product Name:	Terranova® 762 Ion Pump Control Unit

We declare, under our sole responsibility, that the named products which display the UKCA mark are in conformity with the following harmonized standards and/or normal documents or technical specifications:

EMC:	EN 61326-1:2013
LVD:	EN 61010-1:2010/A1:2019

The named products are in conformity with the following relevant statutory requirements:

Electrical Equipment (Safety) Regulations 2016

Electromagnetic Compatibility Regulations 2016
Class A Emissions, Industrial Immunity

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

Fremont, CA on 02 December 2022

Place and Date

x _Michael Ricks_

Name: Michael Ricks
Title: General Manager

# Appendix: Note on Set Point Relays
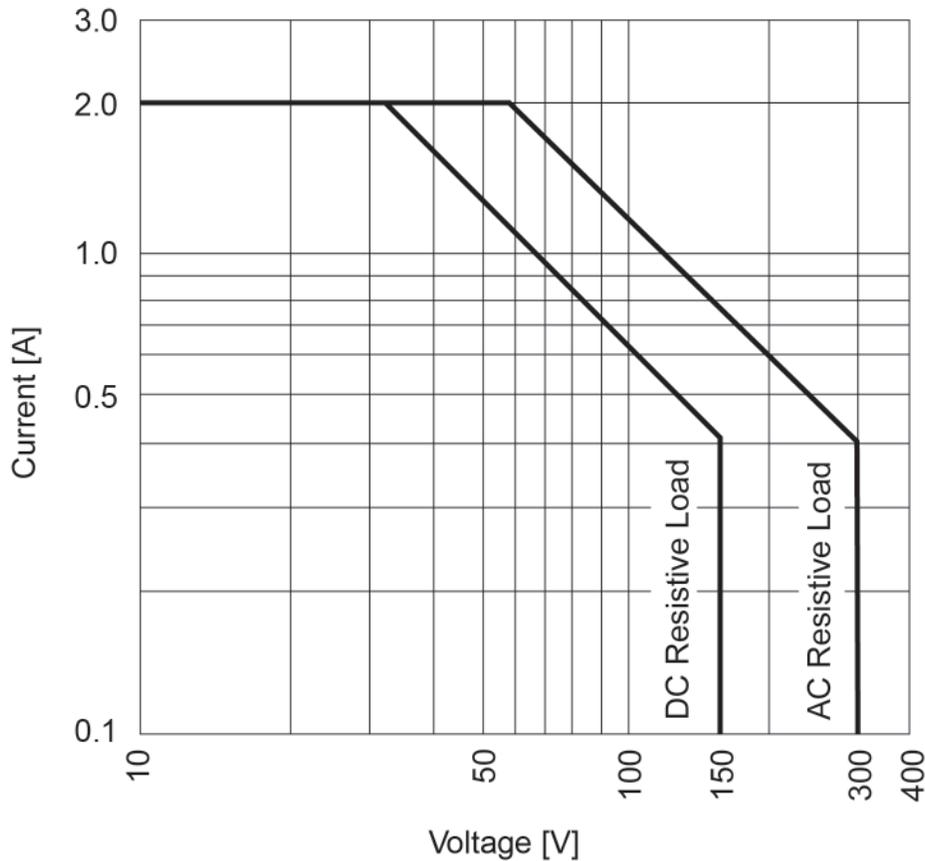
Figure I. AZ5 relay maximum switching capacity

The Heavy Duty Type AZ5 relay is used in the Terranova® 761 to control external functions. As shown in **Figure I**, maximum switching capacity for resistive loads varies from 2 A at 30 V DC (or 60 V AC) to 0.4 A at 150 V DC (or 300 V AC).

Protective Circuits for Inductive Loads

A protective circuit or component is recommended when switching inductive loads to suppress sudden voltage spikes. One method to suppress high voltage spikes in an AC circuit is by using a "snubber" circuit. A "snubber" circuit consists of a capacitor and resistor across an inductive load. As shown in **Figure II**, the "snubber" circuit is parallel to the LOAD which is connected in series with the Terranova® 761 relay.
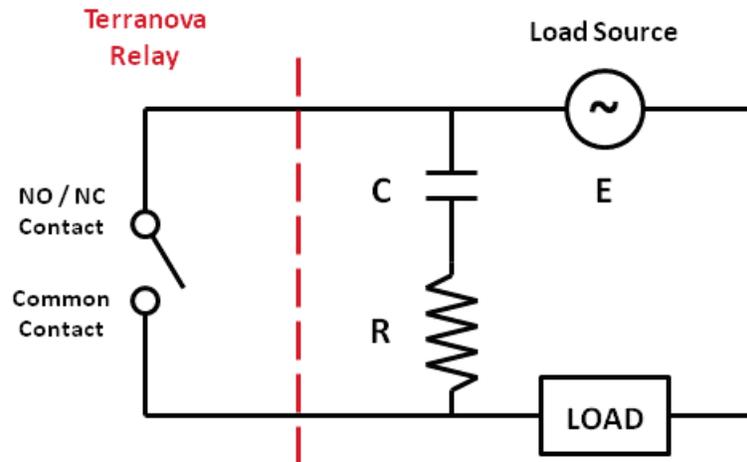
Figure II. Example of "snubber" circuit

To calculate the appropriate capacitor C in microfarads [μF] and resistor R in ohms [Ω] to use in the "snubber" circuit, Paktron Capacitors' Quencharc® technical note[1] suggests the following empirical equations

$$C = \frac{I^2}{10} \quad \text{(1), and}$$

$$R = \frac{E}{10I\left(1 + \frac{50}{E}\right)} \quad \text{(2),}$$

where I is the load current prior to contact opening in amperes [A] and E is the source voltage in volts [V]. For example, if **Figure 2** shows a 0.1 A LOAD with a 110 V AC source connected in series with the Terranova® relay, I = 0.1 A and E = 110 V AC. Therefore, **Equation 1** provides a capacitance value of 0.001 μF; **Equation 2** provides a resistance value of approximately 76 Ω. Thus, a 0.001 μF capacitor and a 100 Ω resistor should be used for the "snubber" circuit. However, user must take into consideration the voltage and power rating of the capacitor and resistor, respectively, to meet the requirements of the circuit. Similar protective circuits or components should be considered to suppress current spikes in capacitive loads.

1.　Pancon Corporation. '2012 Catalog'. 2012. 18-19. Web. http://www.panconcorp.com/PDFs/Catalogs/ Paktron_2012catalog.pdf