DUNIWAY STOCKROOM CORP. 48501 Milmont Drive • Fremont, CA 94538

Terranova® 751A

Medium Ion Pump Power Supply

Instructions Manual

For use with the following:

Part No.	Description
T–751A–1K110	One 10kV Kings HV connector (110 VAC)
T–751A–1K220	One 10kV Kings HV connector (220 VAC)
T–751A–2K110	Two 10kV Kings HV connectors (110 VAC)
T–751A–2K220	Two 10kV Kings HV connectors (220 VAC)
T–751A–1F110	One Fischer-style HV connector (110 VAC)
T–751A–1F220	One Fischer-style HV connector (220 VAC)
T–751A–2F110	Two Fischer-style HV connectors (110 VAC)
T–751A–2F220	Two Fischer-style HV connectors (220 VAC)

TELEPHONE: (650) 969 • 8811 **TOLL-FREE [US/CA]:** (800) 446 • 8811 **FAX:** (650) 965 • 0764 **EMAIL:** info@duniway.com

REV:0720NC

Warranty

Duniway Stockroom Corporation ("DSC") warrants all Terranova® products to be free of defects in material and workmanship for a period of one year from the date of shipment. At our option, we will repair or replace products which prove to be defective during the warranty period. Liability under this warranty is limited to repair or replacement of the defective item(s). Shipping damage is excluded from the scope of this warranty. Pressure gauges of all types are excluded from this warranty.

Terranova® products are warranted not to fail to execute programming instructions due to defects in materials and workmanship. If DSC receives notice of such defects during the warranty period, DSC will repair or replace firmware that does not execute its programming instruction due to such defects. DSC does not warrant that the operation of the firmware or hardware will be uninterrupted or error-free.

If this product is returned to DSC for warranty service, the Buyer will prepay shipping charges and pay all duties and taxes for products returned to DSC. DSC will pay for the return of products to the Buyer, except for products returned to the Buyer from a country other than the United States.

Please contact your Duniway Stockroom customer service representative for a Return Merchandise Authorization (RMA) number if you need to return a Terranova® product.

Limitation of Warranty

The foregoing warranty does not apply to the defects resulting from:

1. Improper or inadequate maintenance by the Buyer,
2. Buyer-supplied interfacing,
3. Unauthorized modification or misuse,
4. Operation outside of the environmental specifications of the product, or
5. Improper site preparation and maintenance.

The warranty set forth above is exclusive and no other warranty, whether written or oral, is expressed or implied. DSC disclaims any implied warranties of merchantability and fitness for a particular purpose.

Exclusive Remedies

The remedies provided herein are the Buyer's sole and exclusive remedies. In no event will DSC be liable for direct, indirect, special, incidental, or consequential damages, including loss of profits, whether based on contract, tort, or any other legal theory.

DUNIWAY STOCKROOM CORP.

Declaration of Conformity

Manufacturer: Duniway Stockroom Corp.
48501 Milmont Drive
Fremont, CA 94538

Product Name: Terranova® 751A Medium Ion Pump Power Supply
Terranova® 752A Dual Ion Pump Power Supply

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 61000-6-1:2019
EN 61000-6-3:2007+A1:2011
EN 61326-1:2012RLV

LVD: EN 61010-1:2010+A1:2019

CE

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

Electromagnetic Compatibility Directive (2014/30/EU)

Low Voltage Directive (2014/35/EU)

ETL Certified and Listed

ETL C US LISTED 2003309

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

Remark: This Declaration of Conformity replaces all previous ones for the above products.

Fremont, CA on 02 July 2020

Place and Date

x Michael Ricks

Name: Michael Ricks
Title: General Manager

Maintenance

The Terranova® 751A Medium 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® 751A.

Contacting Duniway Stockroom

Duniway Stockroom customer and technical service representatives are available via both telephone and on-line for assistance in service requests, ordering, or any other questions and inquiries:

- For US and Canadian customers: (800) 446-8811
- For customers worldwide: (650) 969-8811
- General email inbox: info@duniway.com
- Website, catalog, and on-line store: www.duniway.com

Our Will Call is also available during normal business hours for in-person assistance or order placement and pick-up:

48501 Milmont Drive
Fremont, CA 94538

General Manual Information

This manual contains important information regarding the safe operation of the Terranova®751A Medium Ion Pump Power Supply models listed on the cover page. We advise the customer read and thoroughly understand the manual in its entirety before use. Any questions should be addressed to your Duniway Stockroom customer service representative.

Manual Symbol Key

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

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.

The yellow caution symbol is used to alert personnel against practices that may potentially 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.

Contents

Figures

Tables

Page Left Intentionally Blank

Specifications

Operating Voltage	Universal	100 V to 240 V AC @ 50 Hz to 60 Hz; 125 VA
Open Circuit Voltage	Operator Set	3500 to 7500 V DC
	Polarity	Positive (default)
		Negative
Short Circuit Current	Operator Set	50 mA maximum (total)
High Voltage Output	Options	One or two 10 kV Kings connectors
		One or two Fischer-style connectors
Overload Protection	Fuse for input power	
	Automatic power adjustment during starting phase	
	Automatic shutdown for shorted output	
Display	Voltage	4 Red LEDs - 3 digits & polarity symbol (±X.XX)
	Current	4 Red LEDs - 3 digits (XXX) with unit auto-range
	Pressure	4 Red LEDs - 2 digits with exponent (X.X -X)
Pressure Units	Torr (default)	
	mbar	
	Pascal	
Relay Rating	Power	60 W / 120 VA (maximum)
	Current	2 A (maximum)
	Voltage	150 V DC or 300 V AC (maximum)
	See **"Appendix: Note on set point relays"** 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	Humidity	0 - 80 % (relative, non-condensing)
	Temperature	0 °C to + 40 °C

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)

Two slow-blow Type T, 2 A replacement fuses

One unterminated male 9-pin D-sub connector

One unterminated male 15-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-TN751A	RS-232 serial communication cable (10 ft)*
8000-0934-00	Half-rack adapter kit for one control unit
8000-0934-01	Full-rack adapter kit for two control units
10KV-100M	Test plug

*Custom cable length is available upon request

Front Panel Display

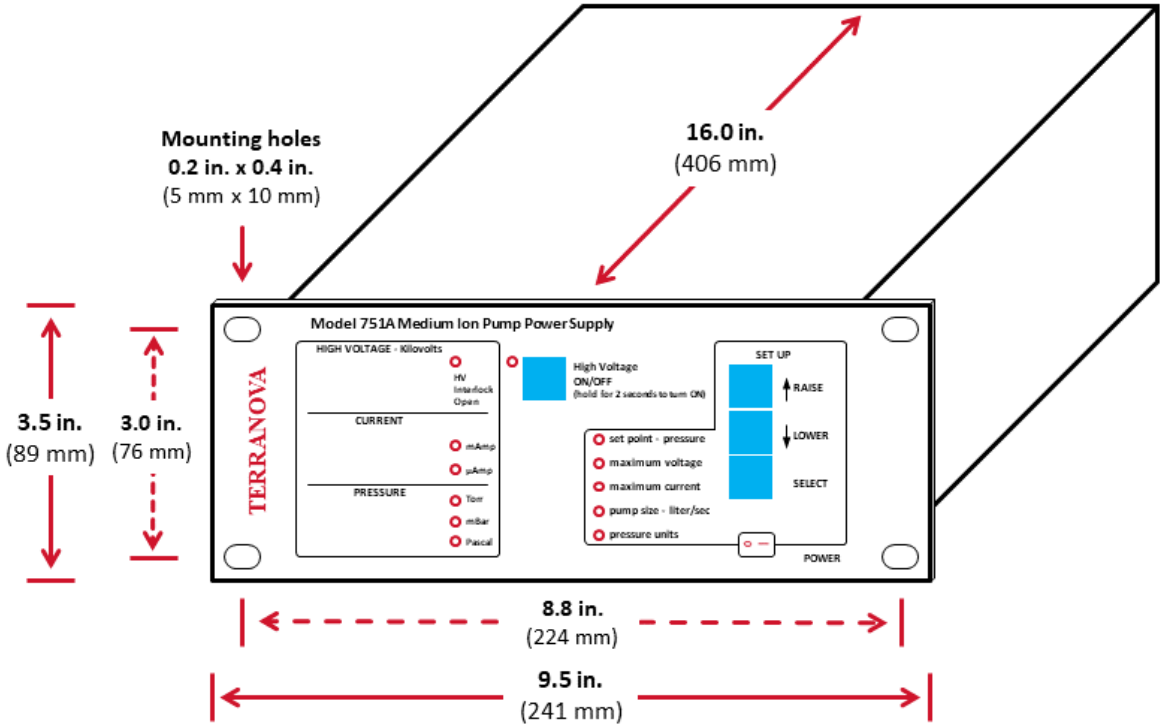


Figure 1. Terranova® 751A front view and dimensions

Switch and Buttons

1. POWER: Main ON/OFF switch for the Terranova® 751A
2. HIGH VOLTAGE ON/OFF: Button to enable or disable voltage operation; button must be depressed for more than 2 seconds to enable voltage output
3. SELECT: Button to cycle through or select a parameter to modify; LED for the selected parameter (e.g. SET POINT - PRESSURE) will become illuminated
4. RAISE: Button to increase or change a parameter value
5. LOWER: Button to decrease or change a parameter value

Displays and LEDs

Display

1. HIGH VOLTAGE: Outputs pump voltage and MAXIMUM VOLTAGE parameter
2. CURRENT: Outputs pump current, MAXIMUM CURRENT and PUMP SIZE parameters, and Terranova® 751A status and information
3. PRESSURE: Outputs pump pressure, SET POINT parameter, and Terranova® 751A status and information

LED

1. HIGH VOLTAGE ON/OFF: Illuminates when voltage operation is enabled
2. HV INTERLOCK OPEN: Illuminates when safety interlock circuit is open; voltage operation is disabled or interrupted when LED is illuminated
3. mAMP: Illuminates when CURRENT is in the milliampere (mA) range
4. µAMP: Illuminates when CURRENT is in the microampere (µA) range
5. TORR: Illuminates when torr is selected as the pressure unit
6. mBAR: Illuminates when mbar is selected as the pressure unit
7. PASCAL: Illuminates when Pascal is selected as the pressure unit
8. SET POINT - PRESSURE: Parameter to modify the set point pressure value
9. MAXIMUM VOLTAGE: Parameter to modify the Terranova® 751A voltage limit
10. MAXIMUM CURRENT: Parameter to modify the Terranova® 751A current limit
11. PUMP SIZE - LITER/SEC: Parameter to modify the ion pump speed
12. PRESSURE UNITS: Parameter to select the pressure units for all pressure values

Back Panel Connections

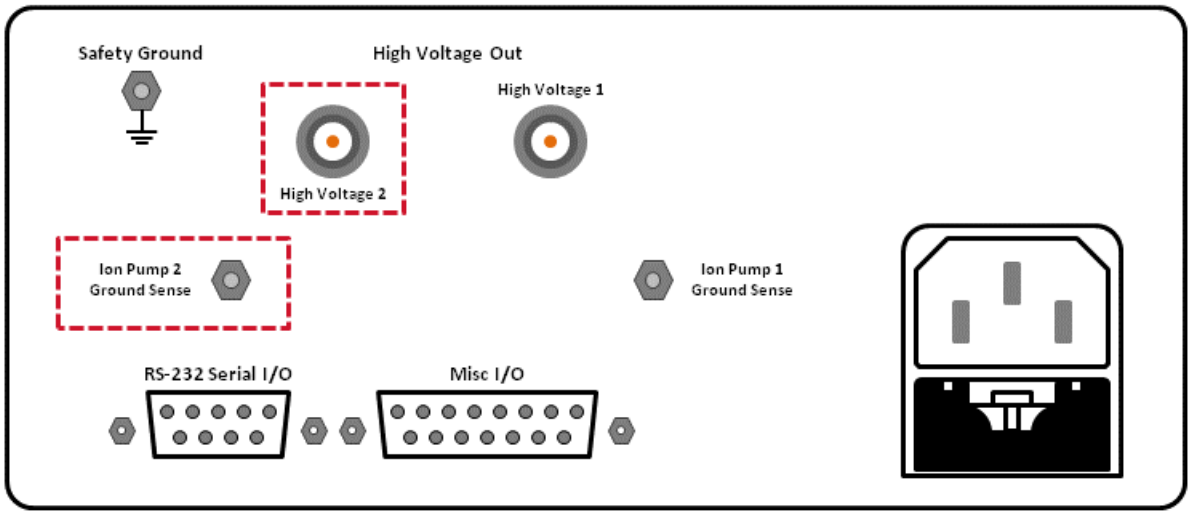


Figure 2. Terranova® 751A rear panel view

Ion Pump Connections

1. HIGH VOLTAGE 1: Pump #1 connection
2. ION PUMP GROUND SENSE 1: Pump #1 safety interlock connection
3. HIGH VOLTAGE 2: Pump #2 connection
4. ION PUMP GROUND SENSE 2: Pump #2 safety interlock connection

Other Connections

1. SAFETY GROUND: Earth ground connection
2. RS-232 SERIAL I/O: 9-pin D-sub connector used for RS-232, RS-422, and RS-485 serial communication. See **Table 9** on page 33 for pin assignment.
3. MISC I/O: 15-pin D-sub connector used for analog output, set point relay output, and other voltage signals. See **Table 1** for pin assignment.
4. AC Power Module: Power cord socket and fuse holder

DUNIWAY STOCKROOM CORP.
NOTE
Since 1976

Dashed components are only available in dual output models

PIN	Function	Output	Description
1	SET POINT relay	Common	See **"Set Point Operation"**
2	SET POINT relay	Normally closed (NC)	See **"Set Point Operation"**
3	Earth ground		
4	Digital ground		
5	Voltage output	-15 V	See **NOTE 1**
6	Voltage output	+15 V	See **NOTE 1**
7	Voltage output	+5 V	See **NOTE 1**
8	TTL input		See **"Mode of Operation"**
9	SET POINT relay	Normally open (NO)	See **"Set Point Operation"**
10	Voltage output	+12 V	See **NOTE 1**
11	SET POINT indicator	+5 V	See **NOTE 2**
12	Current monitor		See **"Analog Output"**
13	(-) HV indicator	+12 V	See **NOTE 3**
14	High voltage monitor		See **"Analog Output"**
15	(+) HV indicator	+12 V	See **NOTE 4**

Table 1. MISC I/O pin configuration

NOTES

1. **PIN 5-7**, **10**: Nominal output available for external use; current limit: 0.2 A
2. **PIN 11**: Nominal output available when relay is active
3. **PIN 13**: Nominal output available when high voltage (HV) operation is ON and output polarity is negative
4. **PIN 15**: Nominal output available when high voltage (HV) operation is ON and output polarity is positive

Introduction

The Terranova® 751A Medium Ion Pump Power Supply is designed to start and operate a wide range of ion pump models from a number of manufacturers. The Terranova® 751A may be factory-configured to operate one or simultaneously-operate two ion pumps. Moreover, the user-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® 751A's versatility allows its use in a number of applications.

Legacy Terranova® 741/751

The legacy Terranova® 741 and Terranova® 751 models have been discontinued and replaced by the Terranova® 751A. Although the Terranova® 741 and Terranova® 751 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.

Note on Dual Output Models

The Terranova® 751A single-channel, dual-output models (Part No. **T-751A-2XXX0**) are available to concurrently operate two ion pumps. However, the ion pumps are not independently operated; all parameters and control unit functions simultaneously apply to both ion pumps. High voltage operation is dependent on the safety interlock circuit (see **"Safety Interlock"** on page 18) of both outputs. The maximum current limit applies to the combined current of both ion pumps. The CURRENT and PRESSURE value is a combined output of both ion pumps. All serial communication queries apply to both ion pumps.

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® 751A or ion pump.

Page Left Intentionally Blank

Pre-installation Settings

Mode of Operation

The Terranova® 751A has three different modes of operation available: Mode 0, Mode 1, and Mode 2. In all three modes, high voltage operation may be manually controlled via the **HIGH VOLTAGE ON/OFF** button located on the front panel or through serial communication.

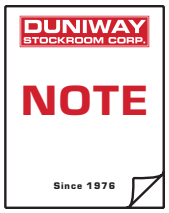
Mode 0: Standard Operation

High voltage operation and parameter input is conducted via the front panel or through serial communication. High voltage output is dependent on the safety interlock circuit (see **"Safety Interlock"** on page 18). High voltage operation will be interrupted if the safety interlock circuit is open or a ground fault is detected. Default mode of operation.

Mode 1: Secondary Interlock

High voltage operation and parameter input is conducted via the front panel or through serial communication. However, high voltage output is dependent on a secondary interlock in addition to the safety interlock circuit (see **"Safety Interlock"** on page 18). The secondary interlock is based on the voltage level of a +5 V TTL circuit. A user-installed switch can also be used to operate the secondary interlock.

To commence and maintain high voltage output, the safety interlock circuit must remain closed and a LOW-level TTL signal must be continuously applied (or the installed switch must remain closed). High voltage operation will be interrupted if the safety interlock circuit is open, a ground fault is detected, or when a HIGH-level TTL signal is applied (or installed switch is opened). The TTL signal is input (or switch is installed) between PIN 8 / PIN 3 of the MISCELLANEOUS port. See **Table 1** on page 6 for pin configuration.



If user attempts to start high voltage operation with the second interlock circuit open, error code ER6 will be output onto the CURRENT display.

Mode 2: Remote Operation

High voltage operation is controlled directly via the front panel or remotely through either serial communication or the voltage level of a +5 V TTL circuit. 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"** on page 18). High voltage operation will be interrupted if the safety interlock circuit is open or a ground fault is detected. All unit parameters must be set or changed via serial communication (see **"Mode 2 Special Setup"**).

If using a TTL circuit (or switch), high voltage output will commence at a rising edge after a LOW-level TTL signal (or switch closure) is applied for more than 2 seconds. High voltage output will be interrupted at a falling edge immediately after a LOW-level TTL signal (or switch closure) is applied. The TTL signal (or switch) is input between PIN 8 / PIN 3 of the MISCELLANEOUS port. See **Table 1** on page 6 for pin configuration.

Mode 2 Special Setup

In Mode 2, user may only scroll through unit parameters via the **SELECT** button. To set or change parameters via the front panel, the Terranova® 751A must enter a special setup mode. If user attempts to change parameters via the front panel, error code ER4 will be output on the CURRENT display.

To access the special setup mode:

1. Turn control unit OFF via the **POWER** button
2. Depress the **SELECT** button, and
3. Restart the control unit via the **POWER** switch

If successful, HIGH VOLTAGE display will flash the code SU. Thereafter, user may release the **SELECT** button and modify parameters via the front panel buttons. To return the Terranova® 751A to normal Mode 2 operation, user must restart the control unit via the **POWER** button.

Setting the Mode of Operation

The mode of operation is changed via the internal DIP Switch S1. Although DIP Switch S1 has eight individual ON/OFF switches labeled 1 through 8, only switches S1-3 and S1-4 are utilized.

WARNING!

User should wait at least 15 seconds after turning OFF the Terranova® 751A before removing the power cord

To change the mode of operation:

1. Turn unit OFF via the **POWER** switch
2. Remove power cord and ion pump cable(s)
3. Remove the six #6-32 screws along the edge of the top cover
4. Carefully lift top cover and disconnect the fan plug
5. Remove top cover
6. Locate DIP Switch S1 (see **Figure 3**)
7. Set switches to desired mode of operation:
   Mode 0: S1-3, **OFF** / S1-4, **OFF** (default)
   Mode 1: S1-3, **ON** / S1-4, **OFF**
   Mode 2: S1-3, **OFF** / S1-4, **ON**
8. Connect the fan plug and replace top cover

When ready for use, user should re-connect the ion pump cable(s) and power cord. Thereafter, Terranova® 751A operation may be resumed.

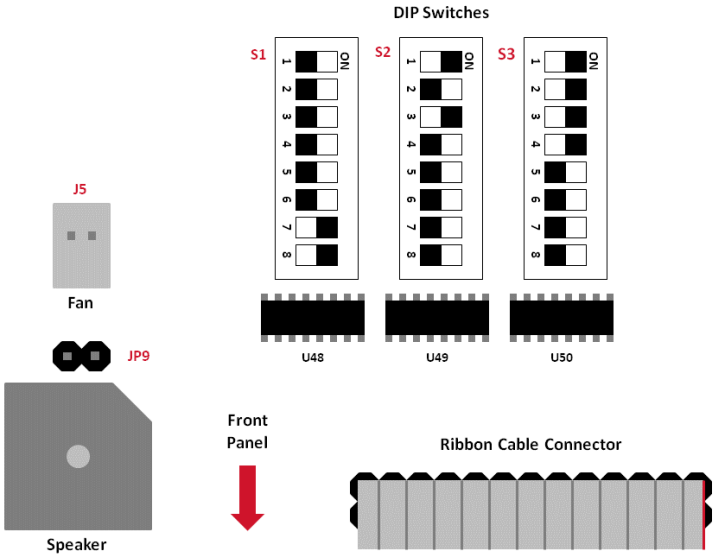


Figure 3. DIP switch and JP9 jumper location

Changing the Output Polarity

The Terranova® 751A can be set to output either positive or negative high voltage. The polarity change applies to both ion pumps on the single-channel, dual-output model.

WARNING!

User should wait at least 15 seconds after turning OFF the Terranova® 751A before removing the power cord

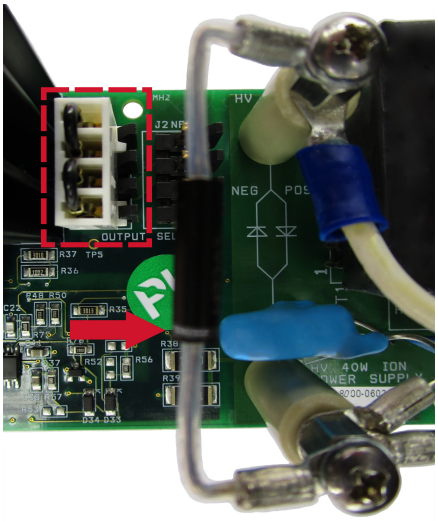


Figure 4. Component position for positive voltage output

To change output polarity:

1. Turn unit OFF via the **POWER** switch
2. Remove power cord and ion pump cable(s)
3. Remove the six #6-32 screws along the edge of the top cover
4. Carefully lift the top cover and disconnect the fan plug
5. Remove top cover
6. Locate the HV diode. As shown in **Figure 4**, the HV diode is the electrical component identified by the arrow.
7. Remove the two #6-32 screws to uninstall the HV diode
8. Locate the J2 NEG and J3 POS 4-pin header. As shown in **Figure 5**, both headers are the electrical components next to the heat sink.

   (Previous models had the 4-pin headers labeled as J2 NEG and J2 POS)

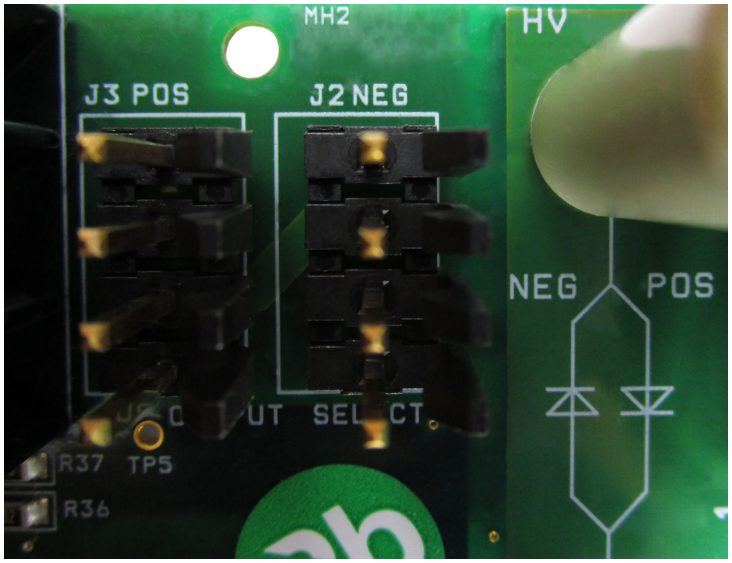


Figure 5. 4-pin header and HV diode diagram

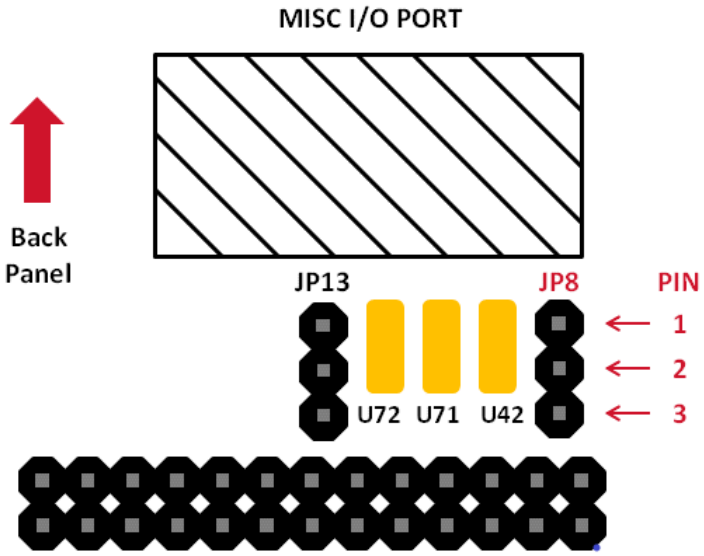


Figure 6. JP8 pin header location

NOTE

JP8 activates the proper HV status pin on the MISC I/O port.

9. Remove the header connector
10. Re-install header connector onto proper 4-pin header

    Positive polarity: **J3 POS** (**J2 POS** on previous models)

    Negative polarity: **J2 NEG**
11. Re-install the HV diode in the proper direction according to the diagram printed on the board directly below the HV diode (see **Figure 5**)

CAUTION

Failure to install HV diode and header connector to the same polarity will result in damage to the high voltage transformer.

12. Locate DIP Switch S1-1 (see **Figure 3** on page 11)
13. Set DIP Switch S1-1 to proper state

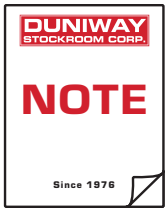
    Positive polarity: OFF

    Negative polarity: ON
14. Locate the JP8 pin header (see **Figure 6**)
15. Remove the 2-pin shunt jumper from JP8 pin header
16. Re-install 2-pin shunt jumper to the proper position

    Positive polarity: Connect **PIN 1** / **PIN 2**

    Negative polarity: Connect **PIN 2** / **PIN 3**
17. Verify all four electrical components are installed to the same polarity setting
18. Re-connect the fan plug and replace top cover

When ready for use, user should re-connect the ion pump cable(s) and power cord. Thereafter, Terranova® 751A operation may be resumed.



DIP Switch S1-1 controls the ± symbol on the HIGH VOLTAGE display

Power-loss Restart

The Terranova® 751A may be set to automatically restart high voltage operation after a power interruption. If high voltage output was enabled before the interruption, high voltage operation will commence once power to the control unit is restored. The safety interlock circuit must remain closed throughout the entire process for a successful power loss restart.

The power loss restart function is changed via the internal DIP Switch S1. Although DIP Switch S1 has eight individual ON/OFF switches labeled 1 through 8, only switch S1-2 is utilized. The automatic restart function is by default disabled.

WARNING!

User should wait at least 15 seconds after turning OFF the Terranova® 751A before removing the power cord

To change the power-loss restart function:

1. Turn unit OFF via the **POWER** switch
2. Remove power cord and ion pump cable(s)
3. Remove the six #6-32 screws along the edge of the top cover
4. Carefully lift the top cover and disconnect the fan plug
5. Remove top cover
6. Locate DIP Switch S1-2 (see **Figure 3** on page 11)
7. Set DIP Switch S1-2 to desired function:

   ON: Restart enabled

   OFF: Restart disabled (default)
8. Connect the fan plug and replace top cover

When ready for use, user should re-connect the ion pump cable(s) and power cord. Thereafter, Terranova® 751A operation may be resumed.

Disabling the Speaker

The Terranova® 751A has a speaker that BEEPs with every function.

WARNING!

User should wait at least 15 seconds after turning OFF the Terranova® 751A before removing the power cord

To disable the speaker:

1. Turn unit OFF via the **POWER** switch
2. Remove power cord and ion pump cable(s)
3. Remove the six #6-32 screws along the edge of the top cover
4. Carefully lift the top cover and disconnect the fan plug
5. Remove top cover
6. Locate JP9 jumper (see **Figure 3** on page 11)
7. Remove the 2-pin shunt jumper from JP9 jumper
8. Connect the fan plug and replace top cover

When ready for use, user should re-connect the ion pump cable(s) and power cord. Thereafter, Terranova® 751A operation may be resumed.

Installation

Installing the Terranova® 751A

The Terranova® 751A is housed in a standard EIA half-rack box. See **Figure 1** on page 3 for dimensions. The control unit may be used as a table-top device or can be installed in most equipment racks and cabinets. A half-rack adapter kit for one control unit and a full-rack adapter kit for two control units are available to mount the Terranova® 751A onto 19" equipment racks — see **"Accessories"** on page 2 for part numbers. 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® 751A is equipped with either one or two 10 kV Kings or Fischer-style high voltage connectors. The connectors are located on the back of the unit labeled HIGH VOLTAGE OUT (see **Figure 2** on page 5). To connect and operate the ion pump(s) with the Terranova® 751A, the user will require a Duniway or equivalent ion pump cable.

To properly connect the Terranova® 751A 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 HIGH VOLTAGE OUT 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"** for further details)

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® 751A until proper grounding has been established.

Safety Interlock

A safety interlock or secondary ground sense circuit is incorporated into the Terranova® 751A 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** on page 5) 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. Both the HV INTERLOCK OPEN and selected pressure unit LED will illuminate if the safety interlock circuit is open. To restart high voltage operation, user must correct the grounding issue. **Table 2** 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® 751A are mounted on the same conducting rack or cart.

Case	Primary (Cable shielding)	Safety Interlock	Redundant	High voltage operation
1	N	N	N	OFF
2	Y	N	N	OFF
3	N	Y	N	OFF
4	N	N	Y	OFF
5	Y	Y	N	ON
6	Y	N	Y	OFF
7	N	Y	Y	ON
8	Y	Y	Y	ON

Table 2. Terranova® 751A ground sense conditions

WARNING!

Under no circumstance should the secondary ground lead be connected directly to the Terranova® 751A case. This would defeat the protection provided by this safety feature and may cause serious injury or death

Power-up

The Terranova® 751A will perform a self-test and the fan will automatically start at power ON. Each self-test step is initiated by a BEEP – if speaker is not disabled – in the following sequence:

1. All display segments become illuminated
2. All LED indicators (except HV ON/OFF and HV INTERLOCK OPEN) become illuminated
3. CURRENT display reads the model number (e.g. 751A)

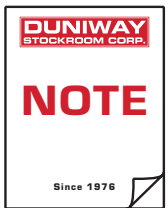
   PRESSURE display reads the firmware version (e.g. 2.88)
4. CURRENT display reads RS-485 address (e.g. 5)

   See **"Setting the RS-485 Address"** on page 37

   PRESSURE display reads DIP switch hexadecimal code (e.g. 0FC0)

   See **"Internal DIP Switch Setup"** on page 45

If self-test is successful, the control unit will enter the standby mode. While on standby, the HIGH VOLTAGE display will read OFF and the corresponding pressure unit LED will become illuminated.



A RS-485 address will be output regardless of selected communication standard

Page Left Intentionally Blank

Channel Settings

The Terranova® 751A is able to operate ion pumps from various manufacturers due to the user-adjustable current and voltage output. The current and voltage output limits are respectively set via the MAX CURRENT and MAX VOLTAGE parameter. Moreover, the control unit is also able to output the approximate ion pump pressure via the use of the PUMP SIZE parameter and selected pressure unit. See **"Pressure Measurement"** on page 27 for details on how pressure is calculated. A set point (and corresponding relay) is available per channel to control external devices. The set point function is by default disabled (i.e. OFF) and is enabled and its value set via the respective SET POINT parameter. See **"Set Point Operation"** on page 29 for details regarding the set point function.

Channel Parameters

To view or change the channel parameters via the front panel, the user must press the SELECT button to enter the setup mode. **Table 3** lists the default channel parameters; **Table 4** lists the value range for all channel parameters except the set point parameter. To view or modify ion pump parameters remotely, see **"Serial Communication"** on page 35.

Parameter	Value
Set point value / function	Disabled (OFF)
Max. voltage	7.5 kV
Max. current	10 mA
Pump size	20 l/s
Pressure unit	Torr

Table 3. Channel default values

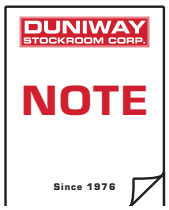
Parameter	Range
MC	1.0 - 50.0 mA
MV	3500 - 7500 V
PS	0.1 - 999.0 l/s
Pressure Unit	torr; mbar; Pascal

Table 4. Channel parameter ranges

To set or modify channel parameters:

1. Press the **SELECT** button to set or adjust the SET POINT pressure value. Use the **RAISE** and **LOWER** button to increase or decrease the value shown on the **PRESSURE** display. Pressure range is 1.0×10^{-5} to 0.1×10^{-9} in the selected pressure unit. PRESSURE display, respective pressure unit LED, and SET POINT LED will flash during adjustment. See **"Set Point Operation"** on page 29.
2. Press the **SELECT** button a second time to adjust the (high) voltage output limit. Use the **RAISE** and **LOWER** button to increase or decrease the MAXIMUM VOLTAGE value by 0.5 kV that is shown on the HIGH VOLTAGE display. HIGH VOLTAGE display and MAXIMUM VOLTAGE LED will flash during adjustment.
3. Press the **SELECT** button a third time to adjust the current limit of the control unit. Use the **RAISE** and **LOWER** button to increase or decrease the MAXIMUM CURRENT value shown on the CURRENT display. CURRENT display, mAMP LED, and MAXIMUM CURRENT LED will flash during adjustment.
4. Press the **SELECT** button a fourth time to set or adjust the pump speed. Use the **RAISE** and **LOWER** button to increase or decrease the PUMP SIZE value by 0.1 L/s from 0.1 L/s to 9.9 L/s and 1 L/s from 10 L/s to 999 L/s that is shown on the CURRENT display. CURRENT display and PUMP SIZE LED will flash during adjustment.
5. Press the **SELECT** button a fifth time to set the pressure unit. Use the **RAISE** and **LOWER** button to select the proper PRESSURE UNITS value shown on the PRESSURE display. PRESSURE display, respective pressure LED, and PRESSURE UNITS LED will flash during adjustment.
6. Press the **SELECT** button a sixth time to return the unit to standby mode.

All display segments will momentarily illuminate during the setup to standby mode transition. The unit will return to standby if left unattended while in the setup process for approximately 60 seconds. Any parameter changes will be saved. If unit is turned OFF while in setup mode, all modified parameters will revert to previous values.



A BEEP will be emitted – if the speaker is not disabled – with each **SELECT** button depression.

The selected pressure unit applies to all parameters and outputs.

Ion Pump Operation

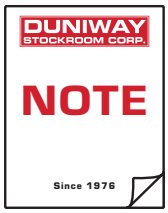
The Terranova® 751A is capable of operating most, if not all, ion pumps through a wide range of vacuum pressures. While small ion pumps can be started at relative high vacuum pressures, larger ion pumps with higher current requirements must be started at lower vacuum pressures. However, once the ion pump is started, the control unit is able to maintain normal operation for all compatible units. See **Table 5** for recommended starting pressures.

Before commencing ion pump operation, the user should verify the Terranova® 751A is set to the proper output polarity. Diode ion pumps such as standard diode, Galaxy™ diode, and differential (or noble) diode require positive polarity; triode ion pumps such as StarCell® and Galaxy™ triode require negative polarity. See **"Changing the Output Polarity"** on page 12 to modify the high voltage output polarity.

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 ion pump starting pressures

To commence high voltage operation, the **HIGH VOLTAGE ON/OFF** button must be depressed for more than 2 seconds. Otherwise, the Terranova® 751A will emit a BEEP and remain in Standby Mode. The HIGH VOLTAGE ON/OFF LED will become illuminated once high voltage operation commences. The HIGH VOLTAGE display will populate first, followed by the CURRENT and PRESSURE displays. To terminate high voltage operation, user should depress the **HIGH VOLTAGE ON/OFF** button.



To avoid erroneous transient values, CURRENT and PRESSURE displays will not immediately output readings after high voltage operation is commenced.

Start Phase

To operate an ion pump with the Terranova® 751A, system pressure must be less than the recommended values on **Table 5**. Once high voltage operation is commenced, user should observe the HIGH VOLTAGE and CURRENT display 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 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 7**, 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® 751A operation is almost automatic. As shown in **Figure 9**, high voltage output will approach the open circuit value (i.e. MAXIMUM VOLTAGE 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.

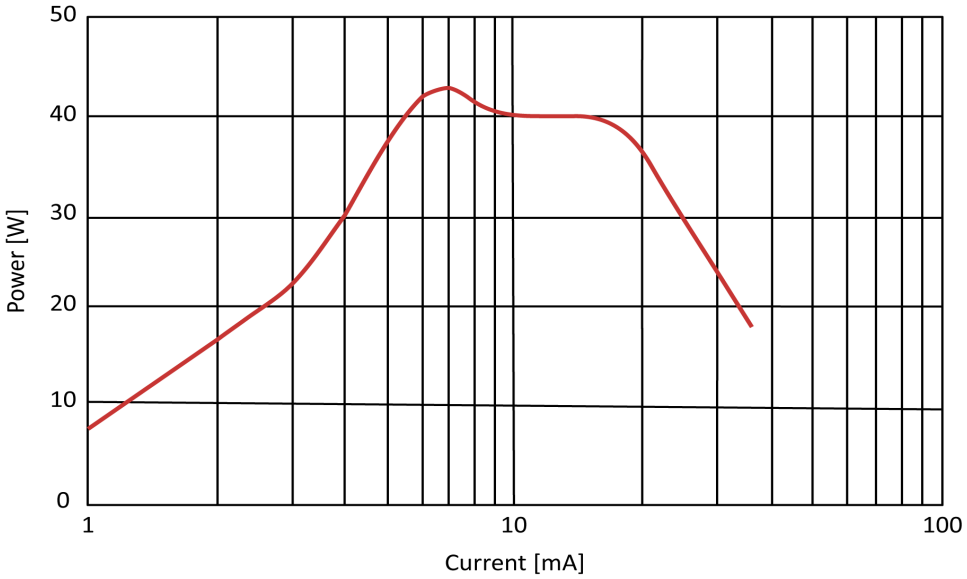


Figure 7. Terranova® 751A power vs. current graph

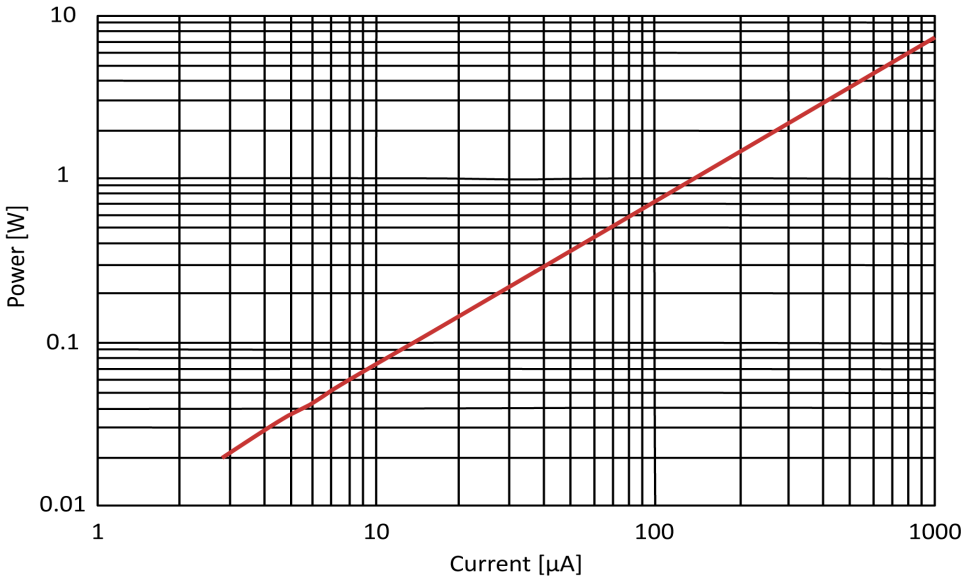


Figure 8. Terranova® 751A voltage vs. (low) current graph

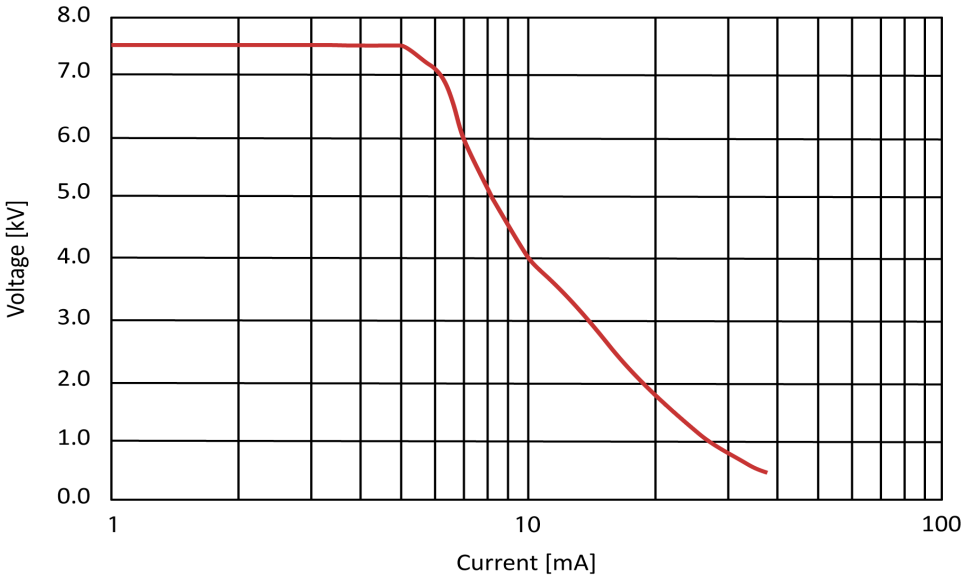


Figure 9. Terranova® 751A voltage vs. current graph

Pressure Measurement

The Terranova® 751A outputs pressure measurements based on the ion pump current shown on the CURRENT 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 PRESSURE 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. PUMP SIZE value) in liters per second, and V is the high voltage (MAXIMUM VOLTAGE value) in volts. For example, if the MAXIMUM VOLTAGE value is set to 6.00 kV and the PUMP SIZE value is set to 100 L/s, V = 6000 V and S = 100 L/s. Therefore, if the current reading on the CURRENT 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.

Cool-down Mode

If the ion pump current is at or near the MAXIMUM CURRENT value, the Terranova® 751A will reduce the high voltage applied to the ion pump. This can occur if user selects too low of a MAX CURRENT value for the selected ion pump. The decrease in voltage output will continue until current output is significantly less than the MAXIMUM CURRENT value. The control unit decreases power output to protect the ion pump – especially small pumps – from possible damage. If current output or power is not significantly reduced within a 10-minute period, the Terranova® 751A will enter a cool-down cycle.

If the control unit enters the Cool-down Mode, a BEEP will be emitted followed by the code CD1 on the CURRENT display. The control unit will emit X BEEPs – if speaker is not disabled – and output the code CDX onto the CURRENT display, where X is the cycle number, to indicate the start of the corresponding OFF/ON cycle. During each cycle, high voltage operation is automatically disabled for 5 minutes (i.e. OFF period) and enabled for 10 minutes (i.e. ON period). If ion pump current is not reduced during the ON period, the unit will commence the next OFF/ON cycle. If current is significantly reduced at any time during an ON period, the control unit will exit the Cool-down Mode and resume normal operation. However, if current is not reduced by the OFF period of the fifth cycle, the Terranova® 751A will automatically enter the Shutdown Mode.

Shutdown Mode

The Terranova® 751A 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, a 5-second BEEP is emitted – if speaker is not disabled – and the respective failure code is output onto the CURRENT display. User should correct the issue that caused the shutdown before restarting high voltage operation. To recover from a shutdown state, high voltage operation may only be restarted via the **HIGH VOLTAGE ON/OFF** button.

Over Current Protection

Code SD (or "03: Shutdown 01" in serial communication) 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. Code SD is also displayed when current output is not successfully reduced during the Cool-down Mode.

Transformer Failure

Code HF (or "03: Shutdown 06" in serial communication) is output when the Terranova® 751A high voltage transformer has failed. The control unit may output relatively low or zero voltage on the HIGH VOLTAGE display.

Over Temperature Protection

Code CF (or "03: Shutdown 07" in serial communication) is output whenever the Terranova® 751A overheats during operation. The control unit will overheat if the internal fan has 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.

User cannot recuperate from a shutdown state via remote operation

Set Point Operation

The Terranova® 751A can be utilized for process control functions through the use of a programmable set point and corresponding relay. The SET POINT pressure value may be adjusted via the front panel or through serial communication. Relay output is accessible via the MISCELLANEOUS I/O port. See **Table 1** for relay pin configuration.

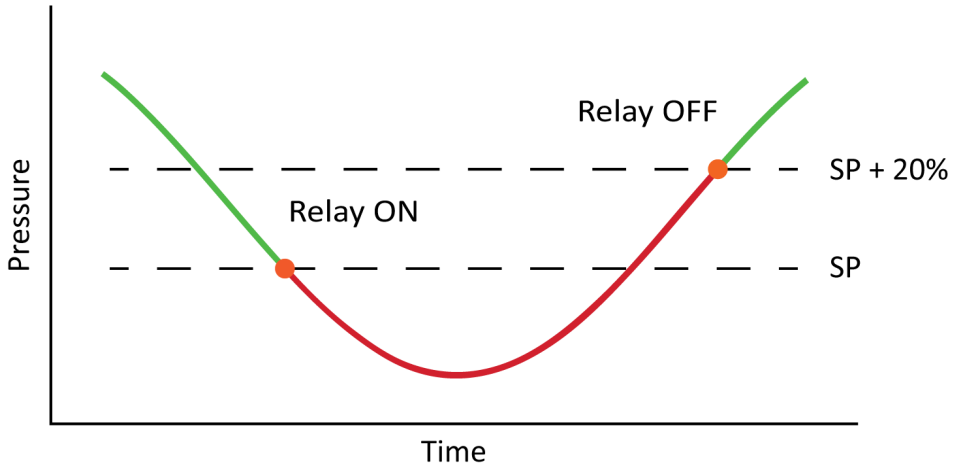


Figure 10. Relay operation graph

The relay will activate once the pressure reading is less than or equal to the SET POINT value. The SET POINT LED will become illuminated once the relay is active. The relay will deactivate once the pressure reading is greater than or equal to 20% of the SET POINT value. For example, if the SET POINT is 1.0×10^{-8} Torr, the relay will activate once the pressure reading is less than or equal to 1.0×10^{-8} Torr and deactivate once the pressure reading is greater than or equal to 1.2×10^{-8} Torr. If the set point value is OFF, the relay will be disabled. The set point pressure display resolution is in 0.1 increments per pressure decade (or order of magnitude) in torr units. Display resolution is converted from torr to millibar or Pascal units. See the **"Appendix: Note on set point relays"** for relay use with inductive or capacitive load switching.

Analog Output

The Terranova® 751A has analog output available for use as a secondary method to read the high voltage and current values shown on the HIGH VOLTAGE and CURRENT display, respectively. The unit outputs a 0 V to 10 V signal for each type of analog output. Analog output is accessible via the MISCELLANEOUS I/O port. See **Table 1** for pin configuration.

High Voltage Monitor

The high voltage monitor is based on the value shown on the HIGH VOLTAGE 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

Three different user-selectable analog output voltage scales – two linear, one logarithmic – are available to monitor the current value shown on the CURRENT display. Default current monitor scale is linear at 2 mA per 1 V. See **"Setting the Current Monitor"** on page 32 to change current monitor scale.

Linear Output

Linear output is available in the following two scales: 200 µA per 1 V or 2 mA per 1 V. The lowest recommended value for accurate readings when linear output is selected is 1% of full scale. See **Table 6** for analog output to current relationship.

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

Table 6. 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, can be approximated 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 (rounded to the nearest one) is approximately 8.0×10^{-4} A or 800 µA. The lowest recommended voltage value for accurate readings is 1 V. **Table 7** lists sample output and 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 7. Logarithmic output and calculated current values

Setting the Current Monitor

A combination of two internal DIP switches, S1 and S3, are used to set the current monitor scale. Although DIP Switch S1 and S3 have eight individual ON / OFF switches labeled 1 through 8, only switches S1-7 and S3-7 are utilized.

WARNING!

User should wait at least 15 seconds after turning OFF the Terranova® 751A before removing the power cord

To change the monitor scale:

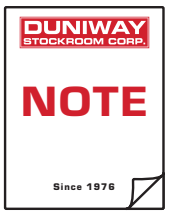
1. Turn unit OFF via the **POWER** switch
2. Remove power cord and ion pump cable(s)
3. Remove the six #6-32 screws along the edge of the top cover
4. Carefully lift the top cover and disconnect the fan plug
5. Remove top cover
6. Locate DIP Switch S1 and DIP Switch S3 (see **Figure 3** on page 11)
7. Set switches to desired scale:

   Linear [µA]: S1-7, **OFF** / S3-7, **OFF**

   Linear [mA]: S1-7, **ON** / S3-7, **OFF**

   Logarithmic: S3-7, **ON**
8. Connect the fan plug and replace top cover

When ready for use, user should re-connect the ion pump cable(s) and power cord. Thereafter, Terranova® 751A operation may be resumed.



S1-7 has no effect when S3-7 is ON (i.e. logarithmic scale)

Serial Communication

The SERIAL I/O 9-pin D-sub port is available to remotely query the Terranova® 751A to both read or set parameter values and operate the high voltage function. Three different user-selectable serial communication standards are available for data transmission: RS-232 (default), RS-422, and RS-485. See **Table 8** for pin configuration.

A separate cable and program, such as PuTTY, are required to remotely communicate with the Terranova® 751A. The control unit accepts single and multiple input queries or commands via a text file. Input must be received in less than or equal to 500 ms; otherwise, transmission will be voided. Duniway Stockroom cable **RS232-TN751A** is available for RS-232 serial communication. See **Table 9** for RS-232 communication settings.

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

Table 8. Serial I/O port pin configuration

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

Table 9. Terranova® 751A RS-232 settings

Setting the Communication Standard

The Terranova® 751A serial communication standard is changed via the internal DIP Switch S3. Although DIP Switch S3 has eight individual ON / OFF switches labeled 1 through 8, only switches S3-1 and S3-2 are utilized.

WARNING!

User should wait at least 15 seconds after turning OFF the Terranova® 751A before removing the power cord

To change the Terranova® 751A communication standard:

1. Turn unit OFF via the **POWER** switch
2. Remove power cord and ion pump cable(s)
3. Remove the six #6-32 screws along the edge of the top cover
4. Carefully lift the top cover and disconnect the fan plug
5. Remove top cover
6. Locate DIP Switch S3 (see **Figure 3** on page 11)
7. Set switches to desired communication standard:

   RS-232: S3-1, **ON** / S3-2, **ON** (default)

   RS-422: S3-1, **OFF** / S3-2, **ON**

   RS-485: S3-1, **OFF** / S3-2, **OFF**
8. Connect the fan plug and replace top cover

When ready for use, user should re-connect the ion pump cable(s) and power cord. Thereafter, Terranova® 751A operation may be resumed.

Setting the RS-485 Address

The Terranova® 751A outputs the RS-485 address during the Self-test as a decimal value from 0 to 255. However, the decimal address is input into the control unit as an 8-bit binary value from 00000000 to 1111111 via DIP Switch S2. The binary bits are determined via the eight individual ON (i.e. 1) / OFF (i.e. 0) switches on DIP Switch S2. DIP Switch S2-1 is the least significant bit; DIP Switch S2-8 is the most significant bit. As shown in **Figure 11**, default RS-485 address is 00000101 in binary notation or 5 in decimal notation.

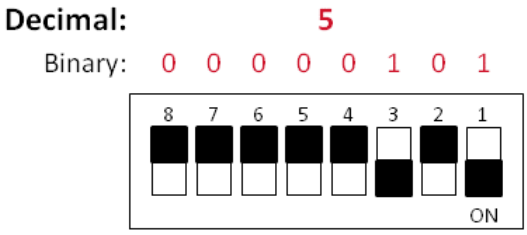


Figure 11. DIP Switch S2 diagram

WARNING!

User should wait at least 15 seconds after turning OFF the Terranova® 751A before removing the power cord

To change the Terranova® 751A RS-485 address:

1. Turn unit OFF via the **POWER** switch
2. Remove power cord and ion pump cable(s)
3. Remove the six #6-32 screws along the edge of the top cover
4. Carefully lift the top cover and disconnect the fan plug
5. Remove top cover
6. Locate DIP Switch S2 (see **Figure 3** on page 11)
7. Set switches to desired address
8. Connect the fan plug and replace top cover

When ready for use, user should re-connect the ion pump cable(s) and power cord. If address change is successful, the corresponding address will appear on the CURRENT display during the self-test. Thereafter, the control unit may resume normal operation.

Character	Description	Output Format
MO	Model number	751A
VE	Firmware version	X.XX
ST	Terranova® 751A status	00: OFF 01: Running 02: Cooling X 03: Shutdown X 04: Interlock
HV	High voltage status	On, Off
PO	High voltage polarity	Pos, Neg
VO	HIGH VOLTAGE display	XXXX [V]
CU	CURRENT display	X.XX e-XX [A]
PR	PRESSURE display	X.XX e-XX [in selected pressure unit]
SP	SET POINT value	X.XX e-XX [in selected pressure unit]
MV	MAXIMUM VOLTAGE value	XX00 [V]
MC	MAXIMUM CURRENT value	X.XX e-XX [A]
PS	PUMP SIZE value	XXX.X [L/s]
UN	PRESSURE UNITS value	TORR, mBAR, PASCAL

Table 10. Serial communication query characters

NOTES

1. X is a non-negative integer
2. "02: Cooling X" is output when the Terranova® 751A is in a cool-down cycle. See **"Cool-down Mode"** on page 27.
3. "03: Shutdown X" is output when the Terranova® 751A is in a shutdown state. See **"Shutdown Mode"** on page 28.
4. "04: Interlock" is output when the safety interlock circuit is open. See **"Safety Interlock"** on page 18.
5. VO and MV will always output positive values regardless of polarity
6. "ER:02, Unknown Command" error message is output when proper query format is not sent

Query characters are not case-sensitive

Query Characters

The following input format is used by the Terranova® 752A to output parameters

*****[Hexadecimal address][Query character]**?**[**,**(Checksum value)]

where the asterisk symbol (*****) indicates the start of transmission and the question mark symbol (**?**) tags the transmission as a query string. The query character is a two-letter character used to select the parameter to output. See **Table 10** for query characters.

The hexadecimal address is a two-digit hexadecimal value from 00 to FF (or 0 to 255 in decimal notation) used to differentiate between multiple devices. The hexadecimal address is only necessary when the unit is configured for RS-485 serial communication. See **"Setting the RS-485 Address"** on page 35.

The checksum value is a two-digit value used to conduct checksums with external devices. The comma mark (**,**) must be included in the query string if sending a checksum value. A checksum value is not required in a query string if checksum function is disabled — see **"Checksum Function"** on page 40. However, the Terranova® 751A will always output a checksum value regardless of checksum function state.

Description	Input	Output
Serial communication: RS-232/422 Checksum value: Disabled HIGH VOLTAGE display reading: 4.30 kV	*VO?	OK:4300,NN
Serial communication: RS-485 Hexadecimal address: 05 Checksum value: 00 HIGH VOLTAGE display reading: 4.30 kV	*05VO?,00	05:OK:4300,NN

Table 11. Query communication examples

NN is the two-digit checksum value that is automatically calculated and output by the Terranova® 751A.

Command Characters

The following input format is used by the Terranova® 751A to modify parameters or operate the high voltage function

*[Hexadecimal address][Command character]:[Value][,(Checksum value)]

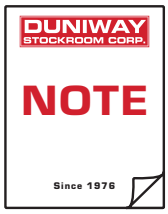
where the asterisk symbol (*) indicates the start of transmission and the colon symbol (:) tags the transmission as a command string. The command character is a two-letter character used to select the parameter or function to modify or operate, respectively. The command value must follow the character after the colon symbol. See **Table 12** for command characters and corresponding input format.

Character	Description	Input Format
SP	SET POINT value	X.X e-XX (0: Off)
MV	MAXIMUM VOLTAGE value	XX00 [V] (3500 - 7500, 500 V increments)
MC	MAXIMUM CURRENT value	XX [mA] (1 - 50)
PS	PUMP SIZE value	XXX.X [L/s] (0.1 - 999)
UN	PRESSURE UNITS value	TORR, MBAR, PASCAL
HV	High voltage operation	ON, OFF

Table 12. Serial communication command characters

NOTES

1. X is a non-negative integer
2. "ER:04 Parameter out of Range" error message is output when proper command format is not sent



Command characters are not case-sensitive

The hexadecimal address is a two-digit hexadecimal value from 00 to FF (or 0 to 255 in decimal notation) used to differentiate between multiple devices. The hexadecimal address is only necessary when the unit is configured for RS-485 serial communication. See **"Setting the RS-485 Address"** on page 35.

The checksum value is a two-digit value used to conduct checksums with external devices. The comma mark (,) must be included in the command string if sending a checksum value. A checksum value is not required in a command string if checksum function is disabled — see **"Checksum Function"** on page 40. However, the Terranova® 751A will always output a checksum value regardless of checksum function state.

Command strings to modify parameters may be sent while the Terranova® 751A is in Standby Mode or if high voltage operation is disabled. All saved changes will appear once the control unit resumes normal operation. User may also modify parameters via the front panel while concurrently communicating with the Terranova® 751A.

Description	Input	Output
Serial communication: RS-232/422 Checksum value: Disabled PUMP SIZE value: 20 L/s	*PS:20.0	OK:20.0,NN
Serial communication: RS-485 Hexadecimal address: 05 Checksum value: 00 PUMP SIZE value: 20 L/s	*05PS:20.0,00	05,OK:20.0,NN

Table 13. Command communication examples

NN is the two-digit checksum value that is automatically calculated and output by the Terranova® 751A.

Checksum Function

The checksum function is changed via the internal DIP Switch S3. Although DIP Switch S3 has eight individual ON/OFF switches labeled 1 through 8, only switch S3-5 is utilized. Checksum function is by default disabled. Checksum function can also be bypassed by sending a **00** checksum value when enabled.

WARNING!

User should wait at least 15 seconds after turning OFF the Terranova® 751A before removing the power cord

To change the checksum function:

1. Turn unit OFF via the **POWER** switch
2. Remove power cord and ion pump cable(s)
3. Remove the six #6-32 screws along the edge of the top cover
4. Carefully lift the top cover and disconnect the fan plug
5. Remove top cover
6. Locate DIP Switch S3 (see **Figure 3** on page 11)
7. Set DIP Switch S3-5 to desired function:

   ON: Checksum enabled

   OFF: Checksum disabled (default)
8. Connect the fan plug and replace top cover

When ready for use, user should re-connect the ion pump cable(s) and power cord. Thereafter, the control unit may resume normal operation.

A checksum value is not required for communication when checksum function is disabled.

Troubleshooting

Problem	Possible Cause	Diagnostic
Unit does not power ON	Input fuses are open	See **"Changing the Input Fuse"**
	AC outlet has no output	Check AC outlet
	Power cord is defective	Check power cord for continuity
	Micro switch is open	Ensure control unit top cover is properly closed
Unit BEEPs at power ON, but LEDs or display segments do not illuminate	Internal front panel connection is not properly installed	Check ribbon cable connector is properly installed (see **Figure 3** on page 11); if problem persists, return unit to Duniway Stockroom
After power ON, no response when front panel buttons are depressed	Front panel buttons(s) are defective	Check ribbon cable connector is properly installed (see **Figure 3** on page 11); if problem persists, return unit to Duniway Stockroom
No BEEPs from unit when front panel buttons are depressed	Speaker is disabled	See **"Disabling the Speaker"**
Unit powers ON, but there is no response and display has randomly lit LEDs or display segments Unit powers ON, but only outputs long, continuous BEEP sound	Microprocessor is not working properly	Reset control unit (see **"Restoring Default Parameters"**); if problem persists, return unit to Duniway Stockroom
No high voltage output when **HIGH VOLTAGE ON/OFF** button is depressed	Safety interlock circuit is open	See **"Safety Interlock"**
	Ion pump cable ground sense conductor is open	Check ion pump cable for continuity
	Control unit is in **Mode 1**	See **"Mode of Operation"**
HIGH VOLTAGE LED is ON, but high voltage output is 0 kV when ion pump is either connected or disconnected	High voltage output is shorted	Remove high voltage connector from ion pump and restart control unit
	Internal high voltage power supply has failed	Return unit to Duniway Stockroom
HIGH VOLTAGE LED is ON, ion pump is connected, but current is 0 µA	Ion pump is at pressure less than 1×10^{-9} Torr	No action required
	Ion pump cable is defective	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

Restoring Default Parameters

Restoring default parameters can provide a starting point for control unit readjustment in the event measurements become unreliable. However, resetting the Terranova® 751A does not affect any changes done via the internal DIP switches.

To restore Terranova® 751A default parameters:

1. Turn the unit OFF via the **POWER** switch
2. Simultaneously depress the **RAISE** and **LOWER** buttons, and
3. Restart the unit via the **POWER** switch

Once power is restored, the unit will commence the self-test. If reset is successful, the code RST will appear on the CURRENT display followed by short BEEPs. User should release the buttons after the code RST has been output to resume normal operation. Error code ER9 will be output after an unsuccessful reset. If code RST is not output, user should repeat the reset sequence.

Error code ER9 will be output onto the CURRENT display if buttons are depressed for too long even after a successful reset (i.e. code RST is output); this is normal.

Error Code	Description
ER2	High voltage exceeded 8.00 kV
ER3	Operation not allowed
ER4	Attempted to change unit parameters via front panel while in Mode 2
ER5	Attempted high voltage operation with safety interlock open
ER6	Attempted to turn high voltage ON via **HIGH VOLTAGE ON/OFF** button while in Mode 1 with secondary interlock fault
ER8	Parameter at limit
ER9	Operation not allowed

Table 14. Terranova® 751A display error codes

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® 751A with faulty and/or failing electronic components can be a source of leakage current. A functional Terranova® 751A without an ion pump connected should output the MAXIMUM VOLTAGE value on the HIGH VOLTAGE DISPLAY and 0 µA on the CURRENT 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 display of the Terranova® 751A, 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.

Internal DIP Switch Setup

The Terranova® 751A outputs a four-digit hexadecimal code during the Self-Test which can be used to determine the individual switch states of both DIP Switch S1 and S3. Each hexadecimal digit, $\mathbf{N_1}$ to $\mathbf{N_4}$, corresponds to a four-switch section of the DIP switches. As shown in **Figure 12 on page 44**, $\mathbf{N_1}$ and $\mathbf{N_2}$ correspond to DIP Switch S3; $\mathbf{N_3}$ and $\mathbf{N_4}$ correspond to DIP Switch S1. The hexadecimal digit is converted from a 4-bit binary value determined by the individual ON (i.e. 1) / OFF (i.e. 0) switch positions per section. The hexadecimal digits have a range from 0 to F (or 0000 to 1111 in binary notation). The right-most switch in each corresponding block is the least significant bit; the left-most switch in each corresponding block is the most significant bit.

For example, if the Terranova® 751A outputs the hexadecimal code 0FC0, this corresponds to 0000, 1111, 1100, and 0000 in binary notation, respectively. The binary notation, in turn, provides the individual switch positions as illustrated in **Figure 12** which describes the corresponding Terranova® 751A setup as described in **Table 15**.

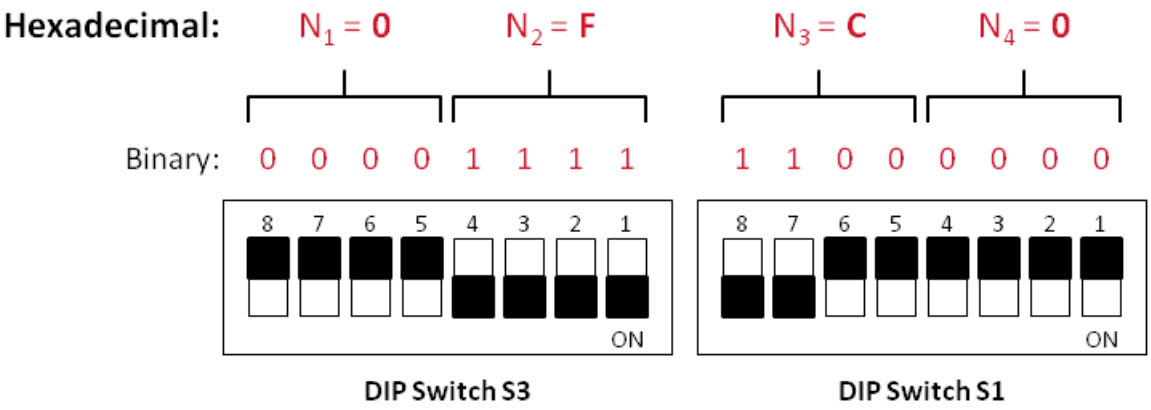


Figure 12. Hexadecimal code 0FC0 DIP switch setup

DIP Switch	State	Description
S1-1	OFF	HV polarity symbol: **Positive** (see **"Changing the Output Polarity"**)
S1-2	OFF	Power loss restart: **Disabled** (see "Power-loss Restart")
S1-3 S1-4	OFF OFF	Mode of operation: **Mode 0** (see **"Changing the Output Polarity"**)
S1-7	ON	Current monitor scale: **2 mA / V** (see **"Setting the Current Monitor"**)
S3-1 S3-2	ON ON	Serial communication standard: **RS-232** (see **"Setting the Communication Standard"**)
S3-5	OFF	Checksum function: **Disabled** (see**"Checksum Function"**)
S3-7	OFF	Current monitor output: **Linear** (see **"Setting the Current Monitor"**)

Table 15. Hexadecimal code 0FC0 output

Changing the Input Fuse

The Terranova® 751A 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.

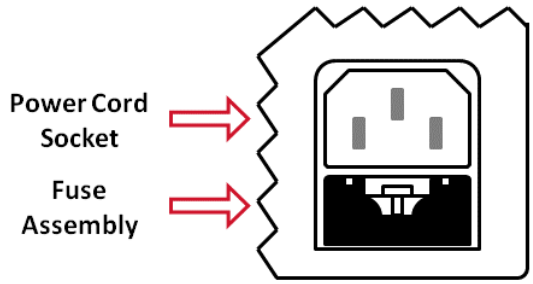


Figure 13. Terranova® 751A AC power module

User should wait at least 15 seconds after turning OFF the Terranova® 751A before removing the power cord

To change the fuse:

1. Turn unit OFF via the **POWER** switch
2. Remove power cord and ion pump cable(s)
3. Locate the fuse block below the power cord socket (see **Figure 13**)
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. Thereafter, Terranova® 751A operation may be resumed.

Page Left Intentionally Blank

Appendix: Note on Set Point Relays

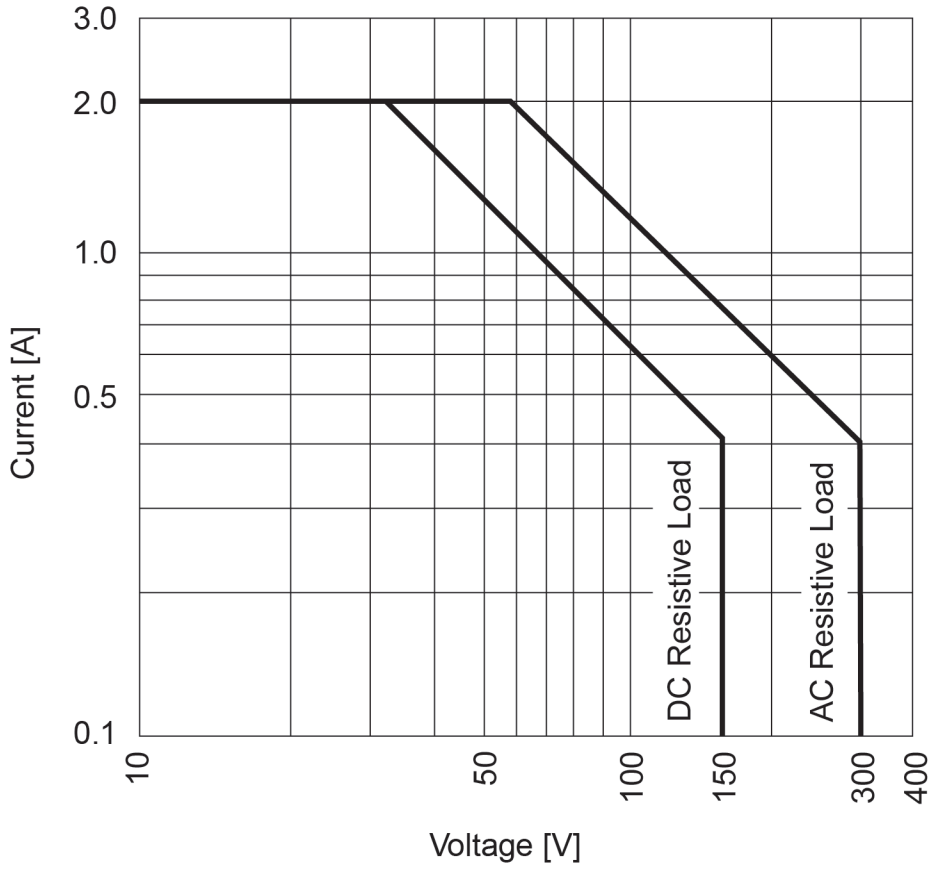


Figure I. AZ5 relay maximum switching capacity

The Heavy Duty Type AZ5 relay is used in the Terranova® 751A 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® 751A relay.

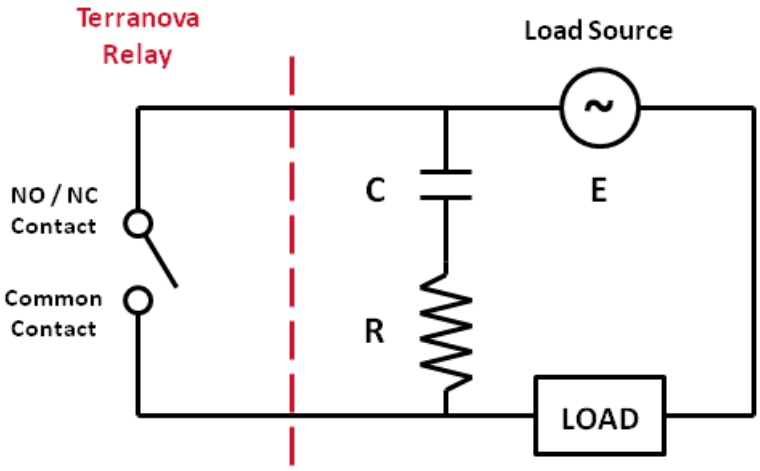


Figure II. Example of "snubber" circuit

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

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

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

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 II** 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