# Terranova® 752A

## Dual Ion Pump Power Supply

## Instructions Manual


### For use with the following:

| Part No. | Description |
|---|---|
| T–752A–K110 | Two 10kV Kings HV connectors (110 VAC) |
| T–752A–K220 | Two 10kV Kings HV connectors (220 VAC) |
| T–752A–F110 | Two Fischer-style HV connectors (110 VAC) |
| T–752A–F220 | Two Fischer-style HV connectors (220 VAC) |



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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® 752A Dual 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® 752A.

## 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®752A Dual 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 the user 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.

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# Specifications

| | | |
|---|---|---|
| **Operating Voltage** | Universal | 100 V to 240 V AC @ 50 Hz to 60 Hz; 250 VA |
| **Open Circuit Voltage*** | Operator Set | 3500 to 7500 V DC |
| | Polarity | Positive (default) |
| | | Negative |
| **Short Circuit Current*** | Operator Set | 50 mA maximum |
| **High Voltage Output** | Options | Two 10 kV Kings connectors |
| | | Two Fischer-style connectors |
| **Overload Protection** | Fuse for input power | |
| | Automatic power adjustment during Start 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 |

*Applies to each channel

# 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

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-TN751A** | RS-232 serial communication cable (10 ft)* |
| **8000-0934-00** | Half-rack adapter kit for one supply |
| **8000-0934-01** | Full-rack adapter kit for two supplies |
| **10KV-100M** | Test plug |

*Custom cable length is available upon request

# Front Panel Display

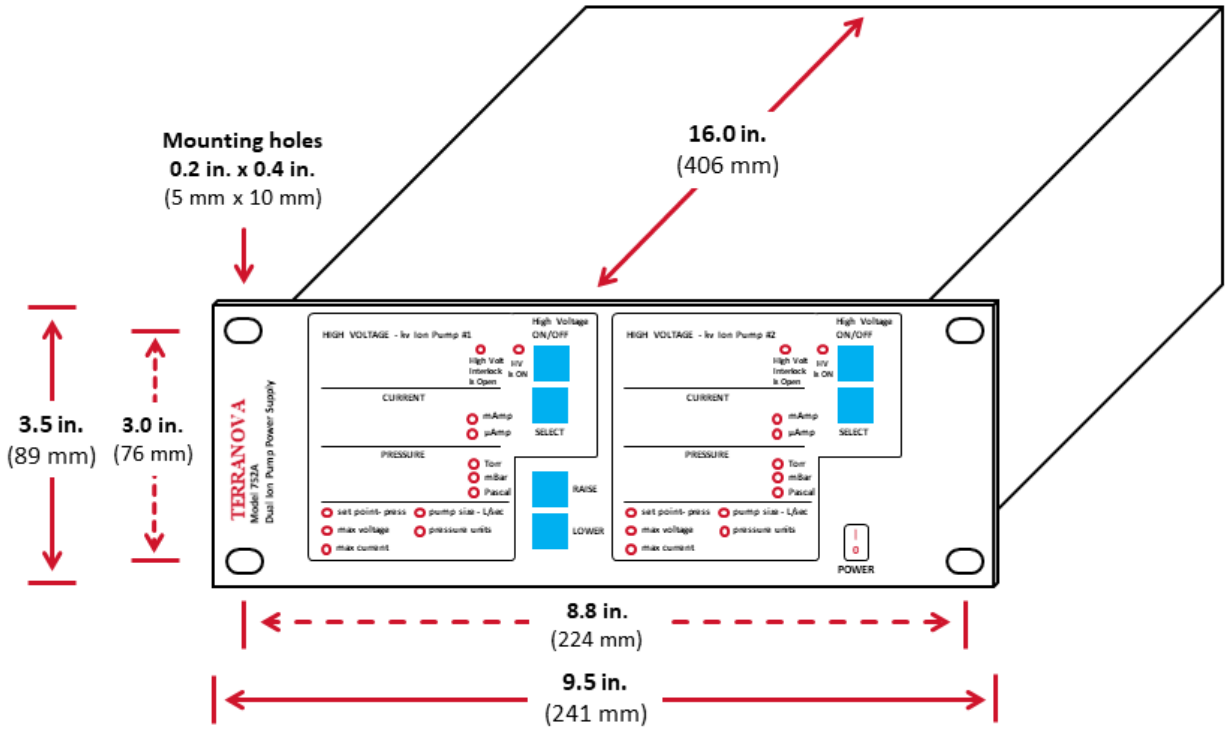


**Figure 1.** Terranova® 752A front view and dimensions

## Switch and Buttons

1. POWER: Main ON/OFF switch for the Terranova® 752A
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 - PRESS) will become illuminated
4. RAISE: Button to increase or change a parameter value
5. LOWER: Button to decrease or change a parameter value

DUNIWAY STOCKROOM CORP.

**NOTE**

Since 1976

RAISE and LOWER buttons are shared by both channels.

HIGH VOLTAGE ON/OFF and SELECT button descriptions apply to both channels.

# Displays and LEDs

## Display

1. HIGH VOLTAGE: Outputs pump voltage and MAX VOLTAGE parameter
2. CURRENT: Outputs pump current, MAX CURRENT and PUMP SIZE parameters, and Terranova® 752A status and information
3. PRESSURE: Outputs pump pressure, SET POINT parameter, and Terranova® 752A status and information

## LED

1. HV IS ON: Illuminates when voltage operation is enabled
2. HIGH VOLT INTERLOCK IS 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 - PRESS: Parameter to modify the set point pressure value
9. MAX VOLTAGE: Parameter to modify the Terranova® 752A voltage limit
10. MAX CURRENT: Parameter to modify the Terranova® 752A current limit
11. PUMP SIZE - L/SEC: Parameter to modify the ion pump speed
12. PRESSURE UNITS: Parameter to select the pressure units for all pressure values


Display and LED descriptions apply to both channels

# Rear Panel Connections

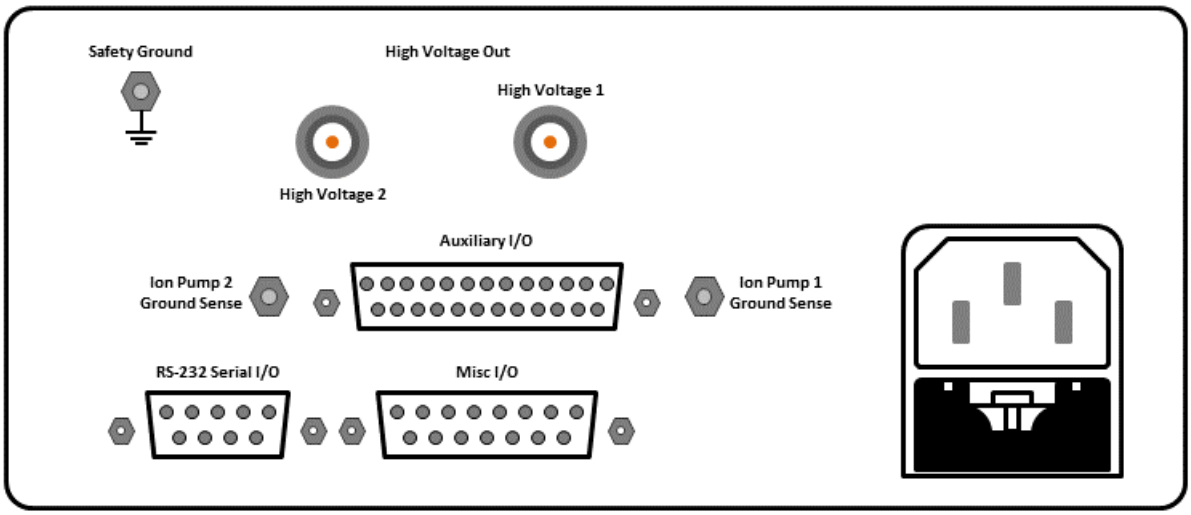


**Figure 2.** Terranova® 752A rear panel view

## Ion Pump Connections

1. HIGH VOLTAGE 1: Channel #1 ion pump connection
2. ION PUMP GROUND SENSE 1: Channel #1 safety interlock connection
3. HIGH VOLTAGE 2: Channel #2 ion pump connection
4. ION PUMP GROUND SENSE 2: Channel #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 10** on page 35 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. AUXILIARY I/O: 25-pin D-sub connector used for analog output, set point relay output, and other voltage signals. See **Table 2** for pin assignment.
5. AC Power Module: Power cord socket and fuse holder

| 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 | 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 2** |
| 8 | CHANNEL 1 TTL input | | See **"Mode of Operation"** |
| 9 | CHANNEL 1 SET POINT relay | Normally open (NO) | See **"Set Point Operation"** |
| 10 | Voltage output | +12 V | See **NOTE 1** |
| 11 | CHANNEL 1 SET POINT status | +5 V | See **NOTE 3** |
| 12 | CHANNEL 1 current monitor | | See **"Analog Output"** |
| 13 | CHANNEL 1 (-) HV status | +12 V | See **NOTE 4** |
| 14 | CHANNEL 1 HV monitor | | See **"Analog Output"** |
| 15 | CHANNEL 1 (+) HV status | +12 V | See **NOTE 5** |

**Table 1.** MISC I/O pin assignment

## NOTES

1. **PIN 5-6, 10**: Nominal output available for external use; current limit: 0.2 A
2. **PIN 7**: Nominal output available for external use; current limit: 0.2 A (Same as PIN 12 on the AUXILIARY I/O port)
3. **PIN 11**: Nominal output available when CHANNEL 1 relay is active
4. **PIN 13**: Nominal output available when CHANNEL 1 high voltage (HV) operation is ON and output polarity is negative
5. **PIN 15**: Nominal output available when CHANNEL 1 high voltage (HV) operation is ON and output polarity is positive


All MISC I/O functions are identical and not additional to those found in the AUXILIARY I/O connector.

| 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 status | +5 V | See **NOTE 1** |
| 4 | CHANNEL 2 SET POINT relay | Common | See **"Set Point Operation"** |
| 5 | CHANNEL 2 SET POINT relay | Normally closed (NC) | See **"Set Point Operation"** |
| 8 | CHANNEL 2 current monitor | | See **"Analog Output"** |
| 9 | CHANNEL 2 HV monitor | | See **"Analog Output"** |
| 10 | CHANNEL 2 TTL input | | See **"Mode of Operation"** |
| 11 | CHANNEL 1 (-) HV status | +12 V | See **NOTE 2** |
| 12 | Voltage output | +5 V | See **NOTE 3** |
| 13 | CHANNEL 1 TTL input | | See **"Mode of Operation"** |
| 14 | CHANNEL 1 SET POINT relay | Normally open (NO) | See **"Set Point Operation"** |
| 15 | Earth ground | | |
| 16 | Digital ground | | |
| 17 | CHANNEL 2 SET POINT relay | Normally open (NO) | See **"Set Point Operation"** |
| 18 | CHANNEL 2 SET POINT status | +5 V | See **NOTE 4** |
| 21 | CHANNEL 2 (-) HV status | +12 V | See **NOTE 5** |
| 22 | CHANNEL 2 (+) HV status | +12 V | See **NOTE 6** |
| 23 | CHANNEL 1 current monitor | | See **"Analog Output"** |
| 24 | CHANNEL 1 HV monitor | | See **"Analog Output"** |
| 25 | CHANNEL 1 (+) HV status | +12 V | See **NOTE 7** |

**Table 2.** AUXILIARY I/O pin assignment

## NOTES

1. **PIN 3**: Nominal output available when CHANNEL 1 relay is active
2. **PIN 11**: Nominal output available when CHANNEL 1 voltage operation is enabled and output polarity is negative
3. **PIN 12**: Same as PIN 7 on the MISC I/O port
4. **PIN 18**: Same as PIN 3, but for CHANNEL 2
5. **PIN 21**: Same as PIN 11, but for CHANNEL 2
6. **PIN 22**: Same as PIN 25, but for CHANNEL 2
7. **PIN 25**: Nominal output available when CHANNEL 1 voltage operation is enabled and output polarity is positive
8. **PIN 6-7, 19-20**: Not available

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# Introduction

The Terranova® 752A Dual Ion Pump Power Supply is designed to start and operate a wide range of ion pump models from a number of manufacturers. The Terranova® 752A is configured to 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® 752A's versatility allows its use in a number of applications.

## Legacy Terranova® 752

The legacy Terranova® 752 model has been discontinued and replaced by the Terranova® 752A. Although the Terranova® 752 has been discontinued, the unit 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 ion pump or Terranova® 752A.

# Pre-installation Settings

## Mode of Operation

The Terranova® 752A has three different modes of operation available: Mode 0, Mode 1, and Mode 2. The selected mode of operation applies to both channels. In all three modes, high voltage operation may be manually controlled via the **HIGH VOLTAGE ON/OFF** button or through serial communication.

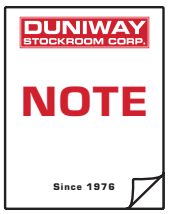
### Mode 0: Standard Operation

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 20) of the channel. High voltage operation will be interrupted if the respective 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 20) of the channel. 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 respective 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 respective safety interlock circuit is open, a ground fault is detected, or when a HIGH-level TTL signal is applied (or the installed switch is opened) to the respective channel. The TTL signal is input (or switch is installed) between PIN 8 / PIN 3 of the MISCELLANEOUS port (PIN 13 / PIN 15 on the AUXILIARY port) for CHANNEL 1 and PIN 10 / PIN 15 of the AUXILIARY port for CHANNEL 2. See **Table 1** on page 6 and **Table 2** on page 7 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 respective CURRENT display.

## Mode 2: Remote Operation

High voltage operation may be 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 respective safety interlock circuit (see **"Safety Interlock"** on page 20). High voltage operation will be interrupted if the respective 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 (or PIN 13 / PIN 15 on the AUXILIARY port) for CHANNEL 1 and PIN 10 / PIN 15 of the AUXILIARY port for CHANNEL 2. See **Table 1** on page 6 and **Table 2** on page 7 for pin configuration.

### Mode 2 Special Setup

In Mode 2, user may only scroll through unit parameters via the respective **SELECT** button. To set or change parameters via the front panel, the Terranova® 752A must enter a special setup mode. If user attempts to change parameters via the front panel, error code ER4 will be output on the respective CURRENT display.

To access the special setup mode:

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

If successful, CHANNEL 1 HIGH VOLTAGE display will flash the code SU. Thereafter, user may release the CHANNEL 1 **SELECT** button and modify parameters via the front panel buttons. To return the Terranova® 752A 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 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® 752A 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® 752A operation may be resumed.

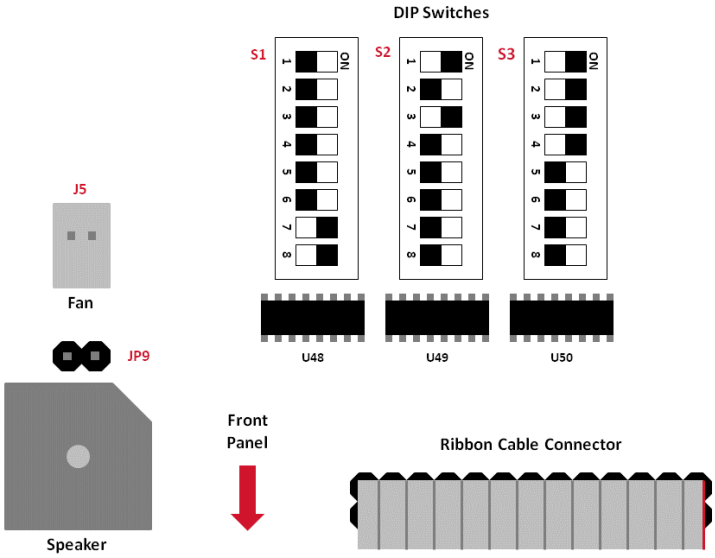



**Figure 3.** DIP switch and JP9 jumper location

## Changing the Output Polarity

Each channel on the Terranova® 752A can be independently set to output either positive or negative high voltage.

**WARNING!**

User should wait at least 15 seconds after turning OFF the Terranova® 752A before removing the power cord

To change the 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 and identify the proper HV board for CHANNEL 1 or CHANNEL 2
7. Locate the HV diode. As shown in **Figure 4**, the HV diode is the electrical component identified by the arrow.
8. Remove the two #6-32 screws to uninstall the HV diode

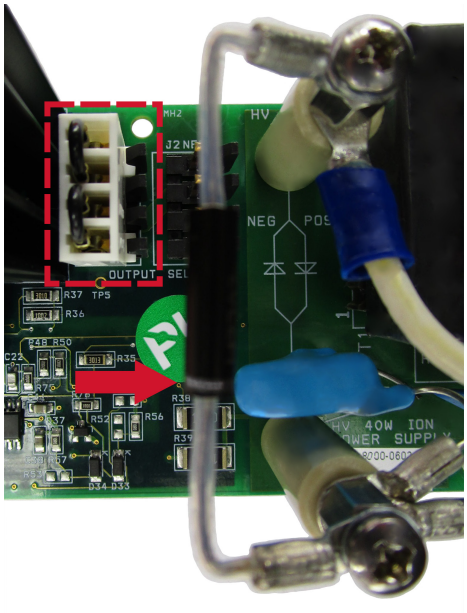



**Figure 4.** Component position for positive voltage output

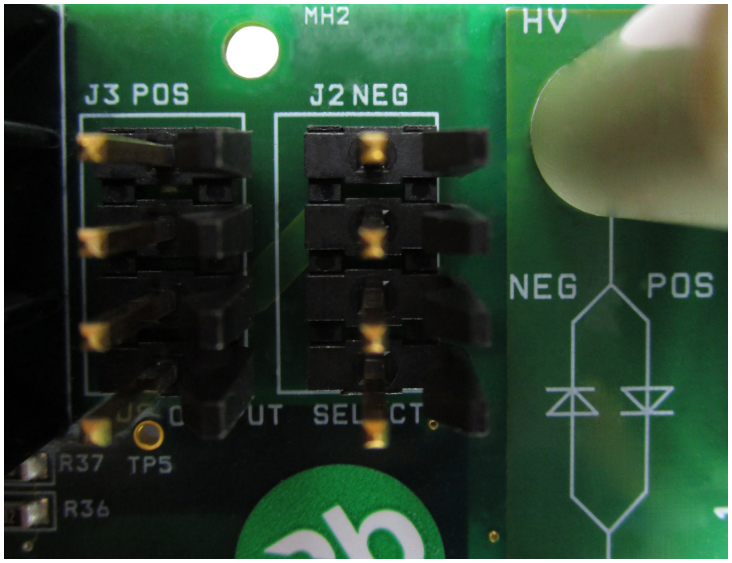



**Figure 5.** 4-pin header and HV diode diagram

9. Locate the J2 and J3 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)

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

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

    Negative polarity: **J2 NEG**

12. 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.

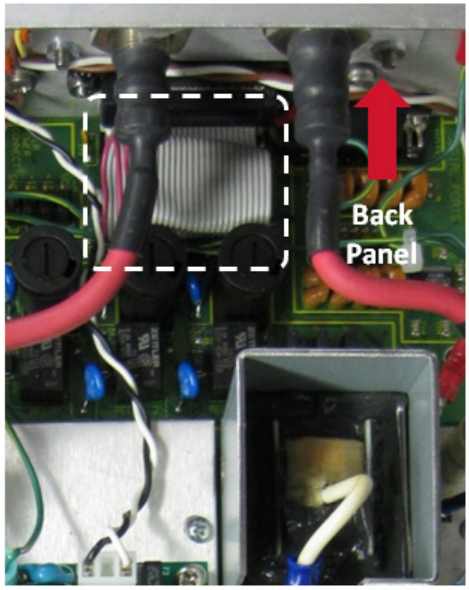



**Figure 6.** Ribbon cable above pin headers

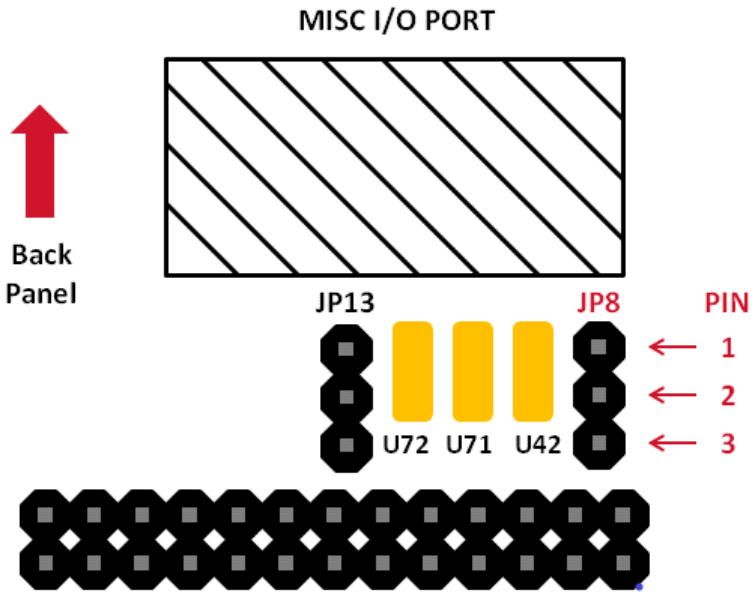



**Figure 7.** JP8 and JP13 pin header location

13. Locate DIP Switch S1-1 for CHANNEL 1 (see **Figure 3** on page 12)

    Locate DIP Switch S3-8 for CHANNEL 2

14. Set respective DIP switch to proper state

    Positive polarity: OFF

    Negative polarity: ON

15. Locate and remove the ribbon cable in **Figure 6** to access the JP8 and JP13 pin headers in **Figure 7**. As shown in **Figure 6**, the ribbon cable is the electrical component inside the dashed box.

16. Locate the JP8 pin header for CHANNEL 1 (See **Figure 7**)

    Locate the JP13 pin header for CHANNEL 2

17. Remove the 2-pin shunt jumper from respective jumper block

18. Re-install 2-pin shunt jumper to the proper position

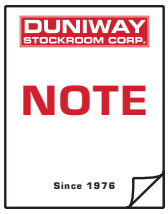
    Positive polarity: Connect **PIN 1** / **PIN 2**

    Negative polarity: Connect **PIN 2** / **PIN 3**

19. Verify all four electrical components are installed to the same polarity setting

20. 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® 752A operation may be resumed.




DIP Switch S1-1 and S3-8 control the ± symbol of the HIGH VOLTAGE display on CHANNEL 1 and CHANNEL 2, respectively.

JP8 activates the proper CHANNEL 1 HV status pin on the MISC I/O and AUXILIARY I/O port. JP13 activates the proper CHANNEL 2 HV status pin on the AUXILIARY I/O port.

## Power-loss Restart

The Terranova® 752A 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® 752A 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 12)
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® 752A operation may be resumed.

## Disabling the Speaker

The Terranova® 752A has a speaker that BEEPs with every function.

**WARNING!**

User should wait at least 15 seconds after turning OFF the Terranova® 752A 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 12)
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® 752A operation may be resumed.

# Installation

## Installing the Terranova® 752A

The Terranova® 752A 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 a single control unit and a full-rack adapter kit for two control units are available to mount the Terranova® 752A 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® 752A is equipped with either 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® 752A, the user will require a Duniway or equivalent ion pump cable.

To properly connect the Terranova® 752A 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® 752A until proper grounding has been established.

## Safety Interlock

A safety interlock or secondary ground sense circuit is incorporated into the Terranova® 752A 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 for the channel. 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 of the channel will illuminate if the corresponding safety interlock circuit is open. To restart high voltage operation, user must correct the grounding issue. **Table 3** 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® 752A 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 3.** Terranova® 752A ground sense conditions

**WARNING!**

Under no circumstance should the secondary ground lead be connected directly to the Terranova® 752A case. This would defeat the protection provided by this safety feature and may cause serious injury or death

# Power-up

The Terranova® 752A 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 CHANNEL 1 display segments become illuminated
2. All CHANNEL 1 LED indicators (except HV ON/OFF and HIGH VOLT INTERLOCK IS OPEN) become illuminated
3. Steps 1 and 2 repeat for CHANNEL 2
4. CHANNEL 1 CURRENT display reads DIP switch hexadecimal code (e.g. 0FC0)

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

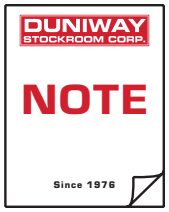
   CHANNEL 1 PRESSURE display reads the firmware version (e.g. 1.82)

   CHANNEL 2 CURRENT display reads RS-485 address (e.g. 5)

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

   CHANNEL 2 PRESSURE display reads the model number (e.g. 752A)

If self-test is successful, each channel will enter the standby mode. While on standby, the respective 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

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# Channel Settings

The Terranova® 752A 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 29 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 31 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 of the respective channel to enter its setup mode. **Table 4** lists the default channel parameters; **Table 5** 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 4.** Channel default values

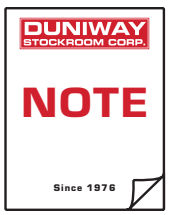
| Parameter | Range |
|---|---|
| MC | 1.0 - 50.0 mA |
| MV | 3500 - 7500 V |
| PS | 0.1 - 999.0 l/s |
| Pressure Unit | torr; mbar; Pascal |

**Table 5.** 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 $1.0 \times 10^{-5}$ to $0.1 \times 10^{-9}$ 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 31 for more details.
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 MAX VOLTAGE value by 0.5 kV that is shown on the HIGH VOLTAGE display. HIGH VOLTAGE display and MAX VOLTAGE LED will flash during adjustment.
3. Press the **SELECT** button a third time to adjust the current output limit. Use the **RAISE** and **LOWER** button to increase or decrease the MAX CURRENT value shown on the CURRENT display. CURRENT display, mAMP LED, and MAX 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 during the setup process for approximately 60 s. Any parameter changes will be saved. If the 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

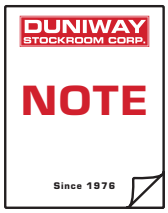
The Terranova® 752A is capable of operating most, if not all, ion pumps through a wide range of vacuum pressures. While small ion pumps can be started at relative high vacuum pressures, larger ion pumps with higher current requirements must be started at lower vacuum pressures. However, once the ion pump is started, the control unit is able to maintain normal operation for all compatible units. See **Table 6** for recommended starting pressures.

Before commencing ion pump operation, the user should verify the respective channel 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"** to modify the high voltage output polarity.

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

**Table 6.** Recommended ion pump starting pressures

To commence high voltage operation, the user should depress the corresponding **HIGH VOLTAGE ON/OFF** button for more than 2 seconds. Otherwise, the Terranova® 752A will emit a BEEP and the channel will remain on standby. 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, the user should press the corresponding **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® 752A, system pressure must be less than the recommended values in **Table 6**. Once high voltage operation is commenced, user should observe the corresponding 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 8**, current and thus, power, are 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® 752A operation is almost automatic. As shown in **Figure 10**, 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.

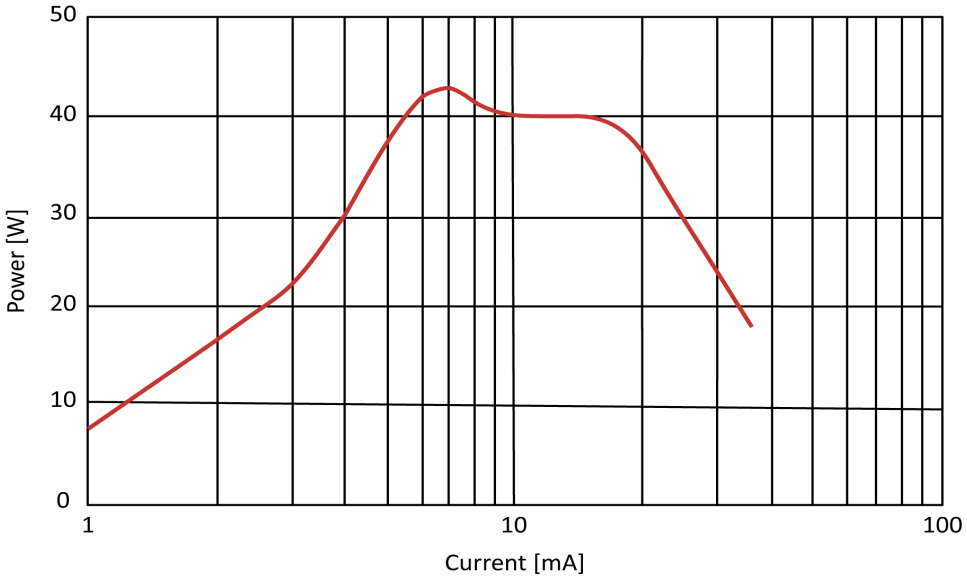



**Figure 8.** Terranova® 752A power vs. current graph

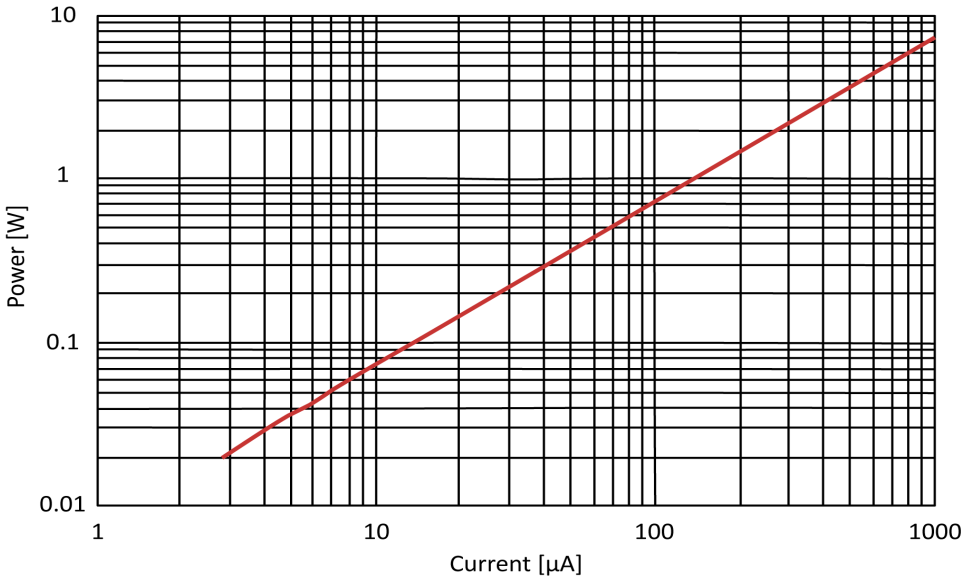



**Figure 9.** Terranova® 752A power vs. (low) current graph

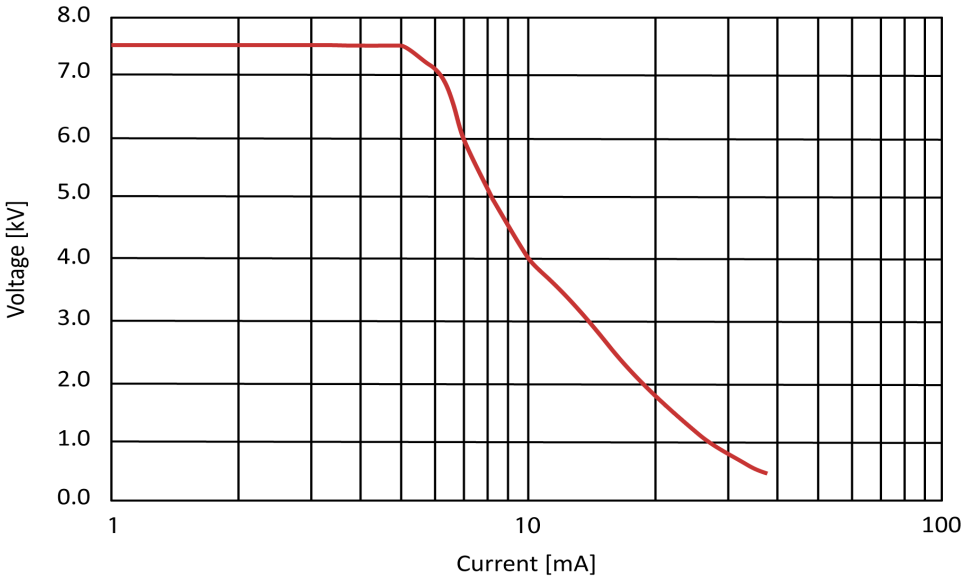



**Figure 10.** Terranova® 752A voltage vs. current graph

## Pressure Measurement

The Terranova® 752A outputs pressure measurements based on the ion pump current shown on the respective 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 $1.0\times10^{-3}$ A), $P$ is approximately $6.2\times10^{-7}$ 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® 752A will reduce the high voltage applied to the ion pump of the respective channel. 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 corresponding channel will enter the Cool-down Mode.

If a channel enters the Cool-down Mode, a BEEP will be emitted – if speaker is not disabled – followed by the code CD1 on the respective CURRENT display. The control unit will emit X BEEPs and output the code CDX onto the respective CURRENT display, where X is the cycle number, to indicate the start of the corresponding OFF/ON cycle. During each cycle, high voltage output 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 channel 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 channel will automatically enter the Shutdown Mode.

## Shutdown Mode

The Terranova® 752A will enter a shutdown state to protect the equipment from possible damage or indicate equipment failure. When a channel enters a shutdown state, the respective 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 corresponding 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 respective **HIGH VOLTAGE ON/OFF** button.

### Over Current Protection

Code SD (or 01 in serial communication) is displayed when high voltage output is shorted to ground or power output remains relatively high for the respective channel. Over current can be due to a malfunction of either the ion pump or ion pump cable. Code SD is also displayed on the respective channel when current output is not successfully reduced during the Cool-down Mode.

### Transformer failure

Code HF (or 06 in serial communication) is output when the high voltage transformer has failed on the respective channel. The channel may output relatively low or zero voltage on the corresponding HIGH VOLTAGE display.

### Over Temperature Protection

Code CF (or 07 in serial communication) is output whenever the Terranova® 752A 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® 752A can be utilized for process control functions through the use of two programmable set points and corresponding relays. Each channel is able to independently-operate one set point (i.e. CHANNEL 1 SET POINT and CHANNEL 2 SET POINT). Set point pressure values may be adjusted via the front panel or through serial communication. Relay output is accessible via the MISC I/O or AUXILIARY I/O connector for CHANNEL 1 and the AUXILIARY I/O connector for CHANNEL 2. See **Table 1** on page 6 and **Table 2** on page 7 for relay pin configuration.

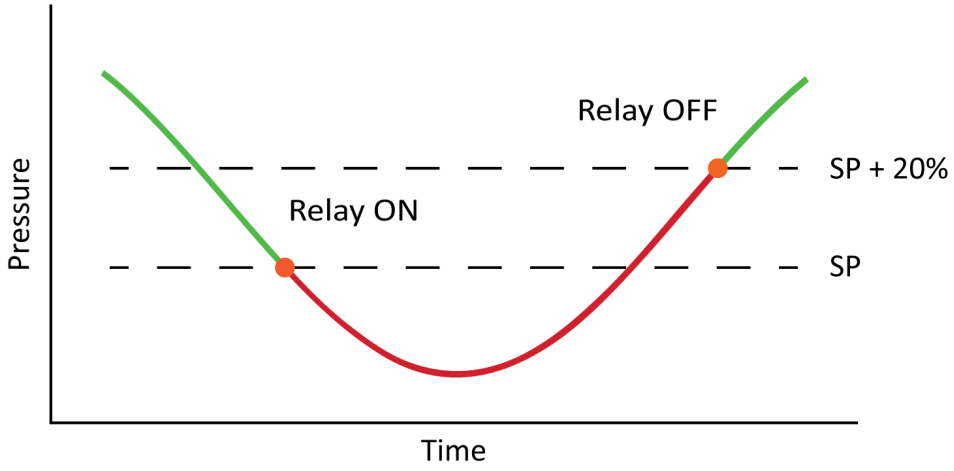



**Figure 11.** Relay operation graph

The corresponding relay will activate once the pressure reading is less than or equal to the respective SET POINT value. The corresponding 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 respective SET POINT value. For example, if the SET POINT is $1.0 \times 10^{-8}$ Torr, the relay will activate once the pressure reading is less than or equal to $1.0 \times 10^{-8}$ Torr and deactivate once the pressure reading is greater than or equal to $1.2 \times 10^{-8}$ 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® 752A 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 MISC I/O or AUXILIARY I/O connector for CHANNEL 1 and the AUXILIARY I/O connector for CHANNEL 2. See **Table 1** on page 6 and **Table 2** on page 7 for relay pin configuration.

## High Voltage Monitor

The high voltage monitor is based on the value shown on the respective 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 respective CURRENT display. Default current monitor scale is linear at 2 mA per 1 V. Although the linear scales can be independently set for each channel, the logarithmic scale applies to both channels. See **"Setting the Current Monitor"** on page 34 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 7** 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 7.** 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 $8.0 \times 10^{-4}$ A or 800 µA. The lowest recommended voltage value for accurate readings is 1 V. **Table 8** 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 8.** 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 for the channel. Although DIP Switch S1 and S3 have eight individual ON / OFF switches labeled 1 through 8, only switches S1-7, S1-8, and S3-7 are utilized.

**WARNING!**

User should wait at least 15 seconds after turning OFF the Terranova® 752A before removing the power cord

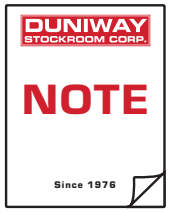
To change the respective monitor scale:

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 12)
7. Set switches to desired scale for each channel:

| | |
|---|---|
| CHANNEL 1 linear [µA]: | S1-7, **OFF** / S3-7, **OFF** |
| CHANNEL 1 linear [mA]: | S1-7, **ON** / S3-7, **OFF** (default) |
| CHANNEL 2 linear [µA]: | S1-8, **OFF** / S3-7, **OFF** |
| CHANNEL 2 linear [mA]: | S1-8, **ON** / S3-7, **OFF** (default) |
| 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® 752A operation may be resumed.




Logarithmic scale applies to both channels. S1-7 and S1-8 have 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® 752A 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 9** for pin configuration.

A separate cable and program, such as PuTTY, are required to remotely communicate with the Terranova® 752A. 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 10** 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 9.** Serial I/O port pin configuration

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

**Table 10.** Terranova® 752A RS-232 settings

## Setting the Communication Standard

The Terranova® 752A 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® 752A before removing the power cord

To change the Terranova® 752A 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 12)
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® 752A operation may be resumed.

## Setting the RS-485 Address

The Terranova® 752A 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 12**, default RS-485 address is 00000101 in binary notation or 5 in decimal notation.

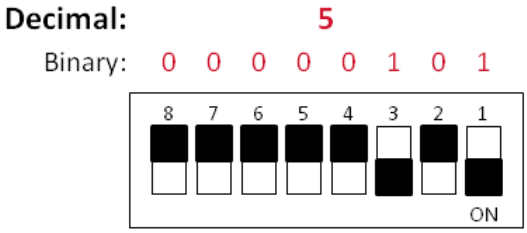



**Figure 12.** DIP Switch S2 diagram


User should wait at least 15 seconds after turning OFF the Terranova® 752A before removing the power cord

To change the Terranova® 752A 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 12)
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 CHANNEL 2 CURRENT display during the self-test. Thereafter, the control unit may resume normal operation.

| Character | | Description | Output Format |
|---|---|---|---|
| Channel 1 | Channel 2 | | |
| MOD | | Model number | 752A |
| VER | | Firmware version | X.XX |
| ST1 | ST2 | Terranova® 752A status | 00: OFF<br>01: Running<br>02: Cooling X<br>03: Shutdown X<br>04: Interlock |
| HV1 | HV1 | High voltage status | On, Off |
| PO1 | PO2 | High voltage polarity | Pos, Neg |
| VO1 | VO2 | HIGH VOLTAGE display | XXXX [V] |
| CU1 | CU2 | CURRENT display | X.XX e-XX [A] |
| PR1 | PR2 | PRESSURE display | X.XX e-XX<br>[in selected pressure unit] |
| SP1 | SP2 | SET POINT value | X.XX e-XX<br>[in selected pressure unit] |
| MV1 | MV2 | MAX VOLTAGE value | XX00 [V] |
| MC1 | MC2 | MAX CURRENT value | X.XX e-XX [A] |
| PS1 | PS2 | PUMP SIZE value | XXX.X [L/s] |
| UN1 | UN2 | PRESSURE UNITS value | TORR, mBAR, PASCAL |

**Table 11.** Serial communication query characters

## NOTES

1. X is a non-negative integer
2. "02: Cooling X" is output when the respective channel is in a cool-down cycle. See **"Cool-down Mode"** on page 29.
3. "03: Shutdown X" is output when the respective channel is in a shutdown state. See **"Shutdown Mode"** on page 30.
4. "04: Interlock" is output when the respective safety interlock circuit is open. See **"Safety Interlock"** on page 20.
5. VOX and MVX will always output positive values regardless of polarity
6. "ER:02, Unknown Command" error message is output when proper query format is not sent

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**NOTE**
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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)]

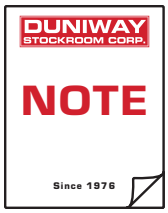
where the asterisk symbol (*****) indicates the start of transmission and the question mark symbol (**?**) tags the transmission as a query string. The query character is a channel-specific, three-digit character used to select the parameter to output. See **Table 11** for query characters.

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 37.

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 42. However, the Terranova® 752A will always output a checksum value regardless of checksum function state.

| Description | Input | Output |
|---|---|---|
| Serial communication: RS-232/422<br>Checksum value: Disabled<br>CHANNEL 1 HIGH VOLTAGE display: 4.30 kV | *VO1? | OK:4300,NN |
| Serial communication: RS-485<br>Hexadecimal address: 05<br>Checksum value: 00<br>CHANNEL 2 HIGH VOLTAGE display: 4.30 kV | *05VO2?,00 | 05,OK:4300,NN |

**Table 12.** Query communication examples




NN is the two-digit checksum value that is automatically calculated and output by the Terranova® 752A

## Command Characters

The following input format is used by the Terranova® 752A to modify parameters or operate the high voltage function

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

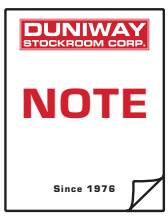
where the asterisk symbol (*) indicates the start of transmission and the colon symbol (:) tags the transmission as a command string. The command character is a channel-specific, three-digit character used to select the parameter or function to modify or operate, respectively. The command value must follow the character after the colon symbol. See **Table 13** for command characters and corresponding input format.

| Character | | Description | Input Format |
|---|---|---|---|
| Channel 1 | Channel 2 | | |
| SP1 | SP2 | SET POINT value | X.X e-XX<br>(0: Off) |
| MV1 | MV2 | MAX VOLTAGE value | XX00 [V]<br>(3500 - 7500, 500 V increments) |
| MC1 | MC2 | MAX CURRENT value | XX [mA]<br>(1 - 50) |
| PS1 | PS2 | PUMP SIZE value | XXX.X [L/s]<br>(0.1 - 999) |
| UN1 | UN2 | PRESSURE UNITS value | TORR, MBAR, PASCAL |
| HV1 | HV2 | High voltage operation | ON, OFF |

**Table 13.** 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 37.

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 42. However, the Terranova® 752A will always output a checksum value regardless of checksum function state.

Command strings to modify parameters may be sent while the Terranova® 752A is on standby 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® 752A.

| Description | Input | Output |
|---|---|---|
| Serial communication: RS-232/422<br>Checksum value: Disabled<br>CHANNEL 1 PUMP SIZE value: 20 L/s | *PS1:20.0 | OK:20.0,NN |
| Serial communication: RS-485<br>Hexadecimal address: 05<br>Checksum value: 00<br>CHANNEL 2 PUMP SIZE value: 20 L/s | *05PS2:20.0,00 | 05,OK:20.0,NN |

**Table 14.** Command communication examples


NN is the two-digit checksum value that is automatically calculated and output by the Terranova® 752A.

## 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® 752A 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 12)
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 12); 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 12); 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<br>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 $1 \times 10^{-9}$ Torr | No action required |
| | Ion pump cable is defective | Check ion pump cable for continuity |
| High voltage output is above MAX VOLTAGE value | High voltage sense resistor is broken<br>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 |

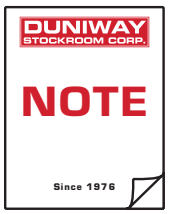
## Restoring Default Parameters

Restoring default parameters provides a starting point for control unit readjustment in the event measurements become unreliable. Each channel may be independently-restored to default parameters. However, resetting the Terranova® 752A does not affect any changes done via the internal DIP switches.

To restore default parameters:

1. Turn the unit OFF via the **POWER** switch
2. Simultaneously depress the **SELECT** button of the channel to be restored along with 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 corresponding 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 of CHANNEL 1 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 15.** Terranova® 752A 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® 752A with faulty and/or failing electronic components can be a source of leakage current. A functional Terranova® 752A without an ion pump connected should output the corresponding MAX VOLTAGE value on the HIGH VOLTAGE display and $0.0 \times 10^{-9}$ µA on the CURRENT display of the respective channel. 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® 752A, 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® 752A 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 13**, $\mathbf{N_1}$ 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® 752A 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 13** which describes the corresponding Terranova® 752A setup as described in **Table 16**.

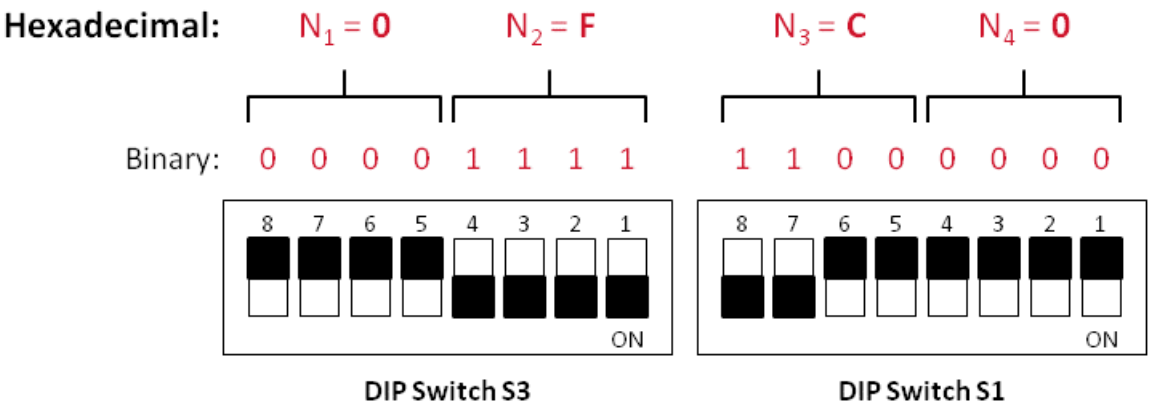



**Figure 13.** Hexadecimal code 0FC0 DIP switch setup

| DIP Switch | State | Description |
|---|---|---|
| S1-1 | OFF | CHANNEL 1 HV polarity symbol: **Positive** (see **"Changing the Output Polarity"**) |
| S1-2 | OFF | Power loss restart: **Disabled** (see **"Power-loss Restart"**) |
| S1-3<br>S1-4 | OFF<br>OFF | Mode of operation: **Mode 0** (see **"Setting the Mode of Operation"**) |
| S1-7 | ON | CHANNEL 1 Current monitor scale: **2 mA / V** (see **"Setting the Current Monitor"**) |
| S1-8 | ON | CHANNEL 2 Current monitor scale: **2 mA / V** (see **"Setting the Current Monitor"**) |
| S3-1<br>S3-2 | ON<br>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"**) |
| S3-8 | OFF | CHANNEL 2 HV polarity symbol: **Positive** (see **"Changing the Output Polarity"**) |

**Table 16.** Hexadecimal code 0FC0 output

## Changing the Input Fuse

The Terranova® 752A 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.

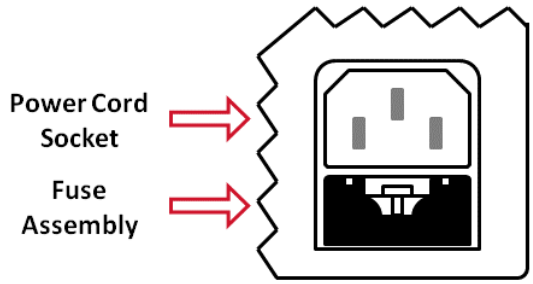



**Figure 14.** Terranova® 752A AC power module


User should wait at least 15 seconds after turning OFF the Terranova® 752A 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 immediately below the power cord socket (see **Figure 14**)
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® 752A operation may be resumed.

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# Appendix: Note on set point relays

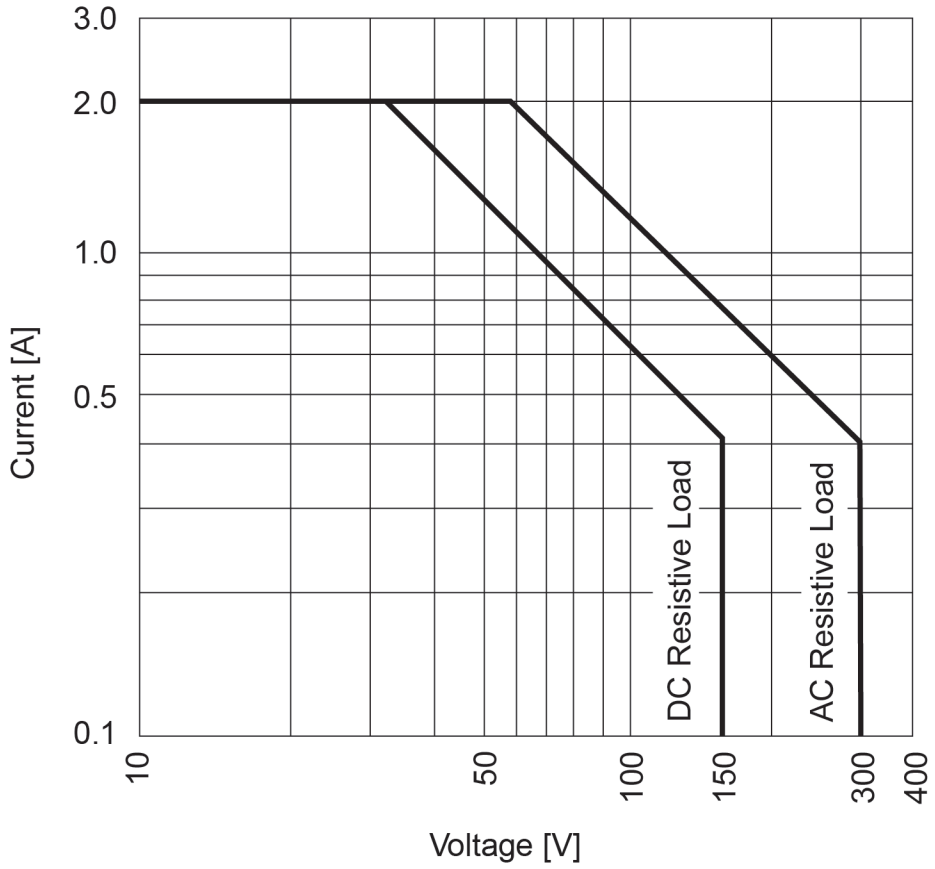


**Figure I.** AZ5 relay maximum switching capacity

The Heavy Duty Type AZ5 relay is used in the Terranova® 752A 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® 752A relay.

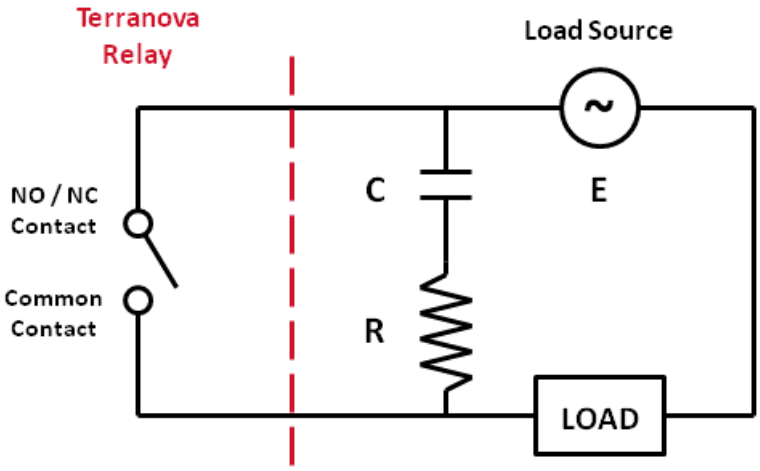


**Figure II.** Example of "snubber" circuit

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