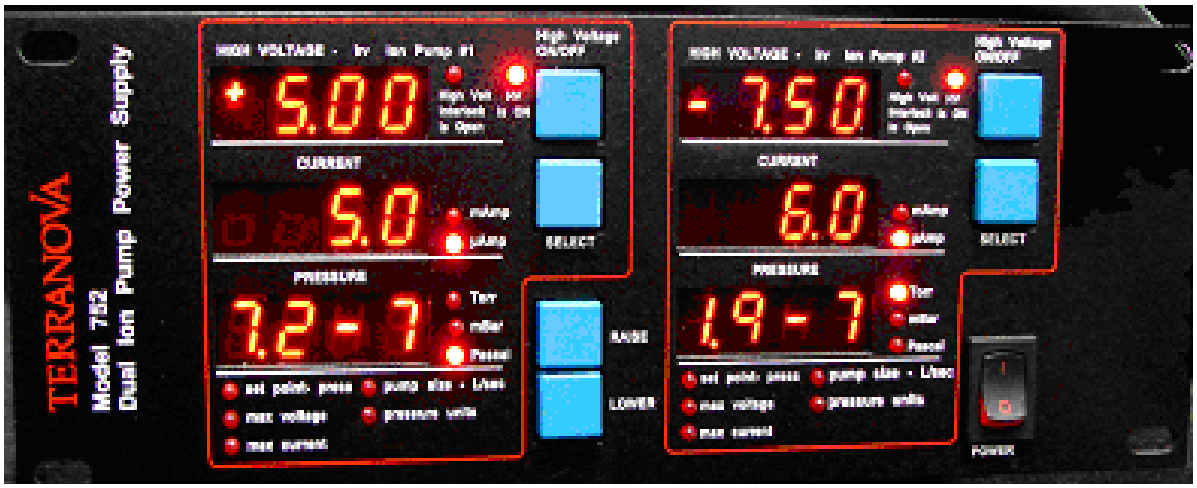
Instruction Manual

Terranova Model 752

Dual Ion Pump Control/Display



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I Technical Specifications

A. Description

The Terranova Model 752 Ion Pump Control Unit is designed to supply operating power to two sputter ion pumps and to display the voltage, current and pressure independently for each. It is designed to start and operate pumps of 60 l/s and smaller and to operate larger pumps of any size at lower pressures.

The Terranova Model 752 is a programmable, microprocessor controlled unit, which gives it great versatility in operation, display, control and data communication. Some major features include:

FOR EACH DUAL INDEPENDENT SUPPLY/CONTROL

- Programmable High Voltage Output

- Independent User Configured High Voltage Polarity

- Programmable Maximum Current

- Programmable Pump Size for Pressure Display

- Programmable Process Control Set Point
- Choice of Pressure Units

- Display for voltage, current and pressure

- RS 232, 422 and 485 Serial I/O for Data Collection and Computer Control

- Analog Outputs for Monitoring Voltage and Current

- Ground Sensing Circuit for Operator Safety

GENERAL FEATURES

- CE, UL and CSA Conformance for EMI, EMC and Safety

- Power Interlock Micro-Switch on Top Cover

- Universal Power Supply: 100-250 Volts; 50/60 Hz

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B. Specifications

1. Electrical Specifications

INPUT PARAMETERS

Voltage	Universal: 100-250 Volts, 50/60 Hz.
Current	1 Amp maximum in START mode (115VAC).

OUTPUT PARAMETERS (Each Module)

Open Circuit Voltage	Operator Set+/-3500 to 7000 VDC (Units shipped with + high voltage polarity unless otherwise specified. Instructions for switching polarity are in Section IV.)
Short Circuit Current	Operator Set 50 milliamps maximum
Overload Protection	Fuse for line power. Power automatically adjusted for pump starting. Automatic Shutdown for Shorted Output.
Display	LED Displays 3 Digits plus Sign (+/-) X.XX - kilovolts 3 Digits Current - milliamp & microamp autoranging 2 Digits plus Exponent for Pressure
Pressure Units	Operator Set: Torr, mbar, Pascal
Set Point Relay	Rated at 240 VAC, 1 Amp

ANALOG OUPUTS

Voltage	Linear: 0 - 10 volts; 1 volt per 1000 volts
Current	Linear: 0 - 10 volts; User Selectable 200 microamps per volt to 2000 microamps 2 milliamps per volt to 20 milliamps (default) Log: $V = 8 + \log_{10}$ (Ion Pump Current)

RS-232 INPUT/OUTPUT - Pressure, Current, Set-up

RS-232 configuration	9600 bps, 8-N-1

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2. Physical Specifications

CONNECTORS/CABLES	
Line Power (1)	6.7 foot (2 meter) length Belden Type 17250 or equivalent NEMA 5-15P grounding plug. PH-290B
High Voltage Output (2)	Kings Connector, Rated at 10KV Ion Pump Cables: -10 Series, See Section IV & Duniway Catalog/ Web
Serial I/O(1)	9-Pin D-sub type Connector, Female Pins
Miscellaneous I/O(1)	15-Pin D-sub type Connector, Female Pins
Auxiliary I/O(1)	25 Pin D-sub type Connector Female Pins
Ground Sense (2)	Isolated 6/32 Threaded Stud
DIMENSIONS	
Panel	9.5 in (24.1 cm) W x 3.5 in (90 cm) H
Cabinet Depth	16 in (406 cm) deep (Allow 4 in (10.2 cm) extra for cable clearance)
WEIGHT	
Installed Weight Shipping Weight	6 lb (2.7 kg) 10 lb (4.5kg)
OPERATING ENVIRONMENT	
Temperature	32oF to 105oF (0oC to 40oC)
Humidity	0 - 80% Relative Humidity, Non-Condensing
Altitude	Sea Level to 10,000 feet (3100 meters)

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C. Connector Pin Configuration

1. Serial RS-232 Multi-Drop RS-422/485Rear Panel, 9-pin D-sub type connector

PIN	RS-232 SIGNAL	RS-422/485 SIGNAL
Pin 1	DCD	---
Pin 2	TxD	-Tx
Pin 3	RxD	-Rx
Pin 4	DTR	---
Pin 5	SIGNAL GROUND	SIGNAL GROUND
Pin 6	DSR	---
Pin 7	CTS	+Rx
Pin 8	RTS	+Tx
Pin 9	RI	---

Figure 1: Serial Interface Connector Pin Connections

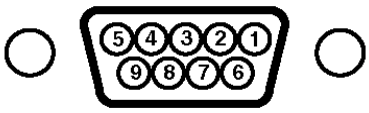

Figure 2: Serial I/O Connector-Rear Panel

(The 9 pin D-sub connector on the control unit has female pins, the cable connector must have male pins. An unterminated 9 pin D-sub connector with male pins is included in the accessory kit shipped with the unit. If you have difficulty finding a connector for use with this unit, please call Duniway Stockroom Corp.)

NOTE: INTERNAL JUMPER AND DIP SWITCH SETTINGS:

Changing from RS-232 (default) configuration to RS-485 configuration requires changes to internal jumpers and internal DIP switches. See Section IV-L for the DIP switch settings.

RS-232 format is 9600 bps, 8-N-1.

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2. Miscellaneous I/O **Rear panel, 15-pin D-sub connector (J-9)**

Pin1	SETPOINT RELAY COMMON See Figure 7 below
Pin 2	SETPOINT #1 RELAY NORMALLY CLOSED (NC) See Figure 7 below
Pin 3	DIGITAL COMMON This is the electronics common, or ground for digital signals
Pin 4	ANALOG COMMON This is electronics common, or ground, and should be used in conjunction with analog output signals
Pin 5	-15 VOLTS, 0.2 A
Pin 6	+15 VOLTS, 0.2 A
Pin 7	+ 5 VOLTS, 0.2 A The voltages on pins 5, 6, 7 and 10 may be used for external applications, such as control of actuators, in conjunction with the Set Point Relay or may be used for signal conditioning; please note the current limit
Pin 8	HV #1 PULSE CONTROL INPUT, TTL LEVEL See Figure 8 below: Remote HV control modes – SW1-3 and SW1-4
Pin 9	SETPOINT #1 RELAY NORMALLY OPEN (NO) See Figure 7 below
Pin 10	+ 12 VOLTS, 0.2 A See pin 5, 6, 7
Pin 11	+ 5 VOLTS WHEN SETPOINT #1 ‘ON’ This pin has +5 volts present when the SETPOOINT relay is active; THE SETPOINT LED on the front panel will also be lit

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Pin 12 CURRENT MONITOR #1 - ANALOG OUT
2 mA per volt or 200 microA per volt or logarithmic; see Section IV-H of this manual for complete description

Pin 13 + 12 VOLTS WHEN HV #1 'ON' NEGATIVE
This pin has +12 volts present when the high voltage is on, and output polarity is negative; use in conjunction with pin 3, Digital Common

Pin 14 VOLTAGE #1 MONITOR - ANALOG OUT
This pin has a voltage present that indicates the magnitude of the high voltage; Voltage monitor 1 volt per 1000 volts; e.g. for 7.5 kv, the output is 7.5 volts; use in conjunction with pin 4, Analog Common

Pin 15 + 12 VOLTS WHEN HV #1 'ON' POSITIVE
This pin has +12 volts present when the high voltage is on, and output polarity is positive, use in conjunction with pin 3, Digital Common

Figure 3: Miscellaneous I/O Connector Pin Connections

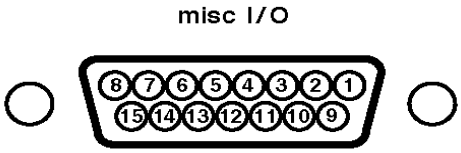

Figure 4: Miscellaneous I/O Connector - Rear Panel J-9

(The 15 pin D-sub connector on the control unit has female pins, the cable connector must have male pins. An unterminated 15 pin D-sub connector with male pins is included in the accessory kit shipped with the unit. If you have difficulty finding a connector for use with this unit, please call Duniway Stockroom Corp.)

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3. Auxiliary I/O **Rear panel, 25-pin D-sub connector**

PIN	SIGNAL
Pin D25-1	SETPOINT #1 COMMON to J9-1
Pin D25-2	SETPOINT #1 N.C. to J9-2
PinD25- 3	SETPOINT #1 + 5 VOLTS - J9-11 **
Pin D25-4	SETPOINT 2 COMMON
Pin D25-5	SETPOINT #2 N.C
Pin D25-6	NOT USED
Pin D25-7	NOT USED
Pin D25-8	CURRENT MOPNITOR FOR HV #2.
Pin D25-9	HV #2 MONITOR 1 VOLT/1000 VOLTS
Pin D25-10	HV #2 PULSE CONTROL - J9-8
Pin D25-11	+12 VOLTS IF HV #1 NEGATIVE & ON **
Pin D25- 12	+ 5 VOLTS - 200mA LIMIT
Pin D25- 13	HV #1 PULSE CONTROL to J9-8
Pin D25-14	SETPOINT #1 N.O. to J9-9
Pin D25-15	COMMON CHASSIS GROUND
Pin D25-16	ELECTRONICS COMMON
Pin D25-17	SETPOINT #2 N.O
Pin D25-18	SETPOINT# 2 + 5 VOLTS - J9-15**
Pin D25-19	NOT USED
Pin D25-20	NOT USED
Pin D25- 21	+12 VOLTS IF HV #2 NEGATIVE & ON **
Pin D25-22	+12 VOLTS IF HV #2 POSITIVE & ON **
Pin D25-23	CURRENT MONITOR FOR HV #1 to J9-12
Pin D25-24	HV #1 MONITOR 1 VOLT/1000 VOLTS*
Pin D25-25	+12 VOLTS IF HV #1 POSITIVE & ON **

** INDICATES OTHER JUMPER OR SWITCH SETINGS REQUIRED

Figure 5: Auxiliary I/O Connector Pin Connections

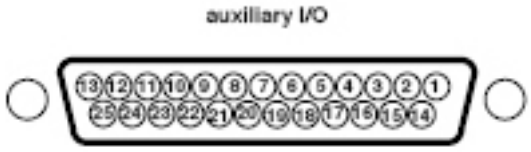

Figure 6: Auxiliary I/O Connector - Rear Panel

(The 25 pin D-sub connector on the control unit has female pins, the cable connector must have male pins. An unterminated 25 pin D-sub connector with male pins is included in the accessory kit shipped with the unit. If you have difficulty finding a connector for use with this unit, please call Duniway Stockroom Corp.)

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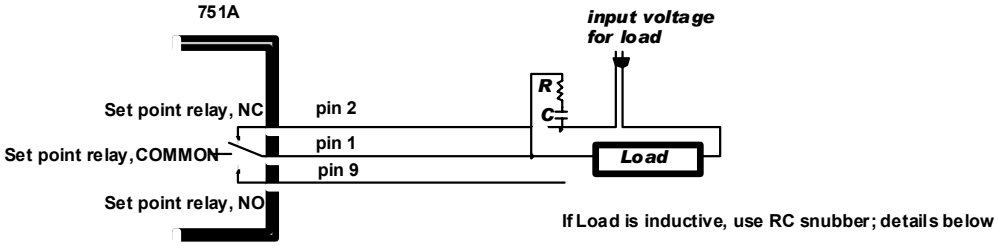
4. Set Point Relay Connections



Snubber calculations

$$C = \frac{I^2}{10} \qquad R = \frac{E}{10*I\left(1+\frac{50}{E}\right)}$$

Where: C = capacitance, in uF
I = load current in amperes prior to contact opening
R = resistance in series with capacitor, in ohms
E = source voltage

For 1 amp load and 110 VAC, C and R calculate to:
C= 0.1 uF
R= 6 ohm (use 10 ohm)

For 0.1 amp and 110 VAC...
C= 0.001 uF
R= 60 ohm (use 100 ohm)

Snubber equations courtesy of CDE

Normal practice is to use 0.01 and 100 ohm for many types of load. These values are intended as guidlines only; your application may require experimentation to determine the best values of R and C or use of other snubber configurations.

Be certain to select C with a voltage rating equal to or greater than the input voltage.
R is typically 1/2 watt rating for most applications.

For additional information visit the paper by Tyco Relays (formerly Potter & Brumfield):
http://www.pandbrelays.com/app_pdfs/13c3311.pdf

Figure 7: Set Point Relay Connections

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4. Remote HV Control Modes

Mode	SW1-4	SW1-3	Function of J9-8	Front Panel HV button active?	Set Point Relay Controls:
0	Off	Off	Ignore	Yes	Pressure set point
1	Off	On	2nd Interlock	Yes	Pressure set point
2	On	Off	HV ON Pulse mode	Yes	Pressure set point
3	On	On	Not defined yet	-	-

Figure 8: Remote HV Control Modes

Mode 0
Standard operation, J9-8 (15-pin I/O connector) is ignored
Set Point relay (J9-1, J9-2, J9-9; 15-pin I/O connector) is on for pressure set point

Mode 1
J9-8 operates as a second interlock, must be low for HV to turn ON through comm (e.g. RS-232) or front panel
Set Point relay (J9-1, J9-2, J9-9; 15-pin I/O connector) is on for pressure set point

Mode 2
J9-8 (15-pin I/O connector) operates as a control line for HV.

HV on: 2-second or longer pulse held low; HV turns ON when pulse goes high.
HV off: >0.2 second; HV turns OFF when pulse goes low.

Front panel HV button control is available for ON or OFF control of HV.
Comm HV control is disabled; if attempted, an error is displayed for one second.

SELECT may be used to scroll thru the parameters, but does not allow changes ("beeep"and 1 second error code if user presses RAISE or LOWER)
Set Point relay (J9-1, J9-2, J9-9; 15-pin I/O connector) is on for pressure set point

Changes in setup parameters are not allowed in Mode 2. Parameters my be changed by holding down RAISE and SELECT at power on. This puts the unit in setup mode, and the display will flash "SU" alternately. When finished, turn power off then on to revert to normal.

Mode 3
Not defined yet; for future use.

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II Installation

A. General Considerations

WARNING!

The primary safety hazard when operating high voltage power supplies such as the Model 752 is electrical shock. Electrical shock can result from contact with the AC line voltage, internal potentials in the control unit or the high voltage output of the unit itself. The high voltage output hazard can exist either from direct contact with the high voltage lead or as a result of loss of proper grounding of the unit or the pump.

Always wait at least 15 seconds after turning OFF high voltage before working on either the Model 752 or the sputter-ion pump.

The Terranova 752 Ion Pump Power Supply is designed for independent operation, display and control of two sputter-ion pumps. Due to the Model 752 output power limitation of watts, it can be used for all functions (starting from the 10-3 torr range and low pressure operation) only for pumps of approximately 30 liters per second rating and smaller. For larger pumps, the Model 752 can be used only for operation at lower pressure ranges, or for systems roughed with a turbo-pump to appropriately low pressures.

See the table below for recommended maximum pressures of operation.

Pump Rating	Maximum Operating Pressure
400/500 l/s	5×10^{-5} Torr
220/270 l/s	1×10^{-4} Torr
110/140 l/s	3×10^{-4} Torr
60 l/s	5×10^{-4} Torr
30 l/s	1×10^{-3} Torr + Start
20 l/s	1×10^{-3} Torr + Start
8 l/s	1×10^{-3} Torr + Start
2 l/s	1×10^{-3} Torr + Start
Mini	1×10^{-3} Torr + Start

Figure 9: Operating Pressure Ranges for Various Ion Pump Sizes

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The Terrnova 752 Ion Pump Control unit is designed to operate either diode or triode sputter ion pumps. These generic pump types differ in two important ways; namely:

Diode pumps require positive high voltage. Typical examples would be the Varian-style 8 l/s, 20 l/s, 30 l/s and 60 l/s models or P-E-style 20 l/s, 25 l/s, 40 l/s and 50 l/s. Diode pumps can also be called "Noble Diode", "Galaxy^{tm} Diode" and "Differential Ion". Factory set-up is for Positive High Voltage unless otherwise specified; for diode style pumps only.

Triode pumps require negative high voltage. Typical examples would be the Varian-style 20 l/s, 30 l/s, 45 l/s and 60 l/s models. Triode pumps can also be called "StarCell ^{R}" and "Galaxy^{tm} Triode".

See Section IV for High Voltage Polarity changeover procedure

Galaxy is a trademark of Duniway Stockroom Corp.; StarCell is a trademark of Varian, Inc.

A typical sputter ion pump is generally very tolerant of a wide range of power supply operating characteristics in the NORMAL mode of operation. This mode exists at pressures less than the critical transition pressure, usually around 10^{-4} torr. This pressure depends upon the design of the pump in relation to such parameters as anode cell geometry and magnetic field. For more information on this topic, please contact your Duniway Stockroom Corporation customer support representative.

In the START mode of operation, sputter ion pumps are generally very intolerant of improper matching of the pump requirements to the electrical characteristics of the power supply.

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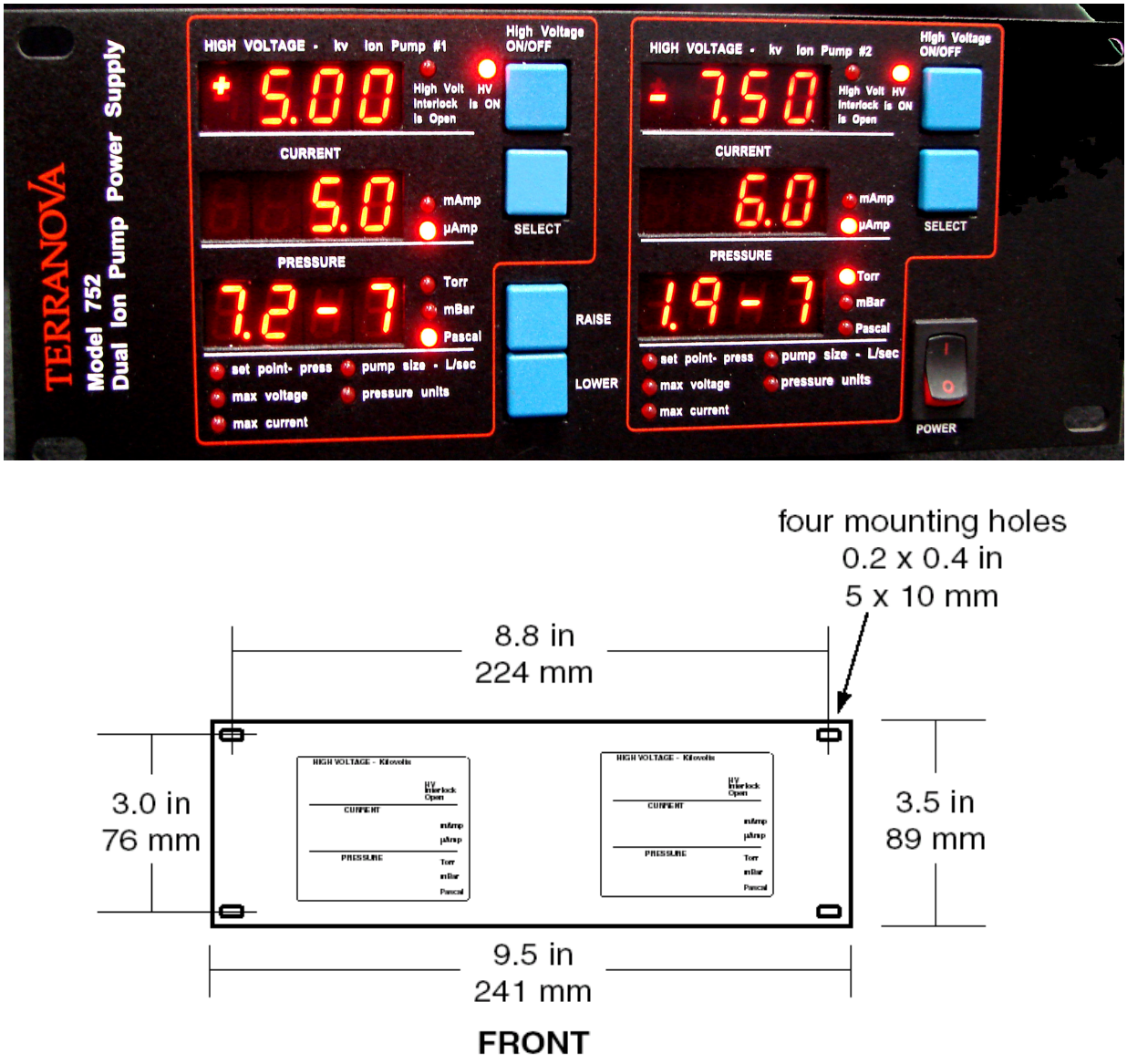

Figure 10: Model 752 Front Panel & Mounting Dimensions

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B. Front Panel Description and Preliminary Set Up

1. Displays:

There are three alphanumeric displays:for each HV supply

High Voltage: Polarity sign (+ or -) and 3 digits with decimal.
Current: 3 digits with decimal
Pressure: 2 digits with decimal plus exponent with sign

There are 12 LED indicators for each HV supply.
HV Interlock
HV On
Current (2): milliamp or microamp range
Pressure Units (3): torr or mbar or Pascal
Set Point Set Up or Activated
Maximum Voltage Set Up
Maximum Current Set Up
Pump Size Set Up
Pressure Units Set Up

2. Set-Up Keys

The following Set Up keys are provided
For each HV supply:
SELECT Places that HV supply into Set Up Mode and activates the other two keys
One common pair:
RAISE /\ increases the value of the selected parameter
LOWER \/ decreases the value of the selected parameter

3. Power Switch

A single rocker-type power switch is provided on the front panel. It is labelled with the international binary 0/1 notation: Binary zero (circle) depressed is OFF and binary 1 (bar) depressed is ON.

4. High Voltage Switch

A push button is provided for each HV supply to turn high voltage on and off. Turning high voltage on requires the operator to depress the button for 2 seconds (for safety reasons), while turning high voltage off is instantaneous.

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C. Initial Set Up

1. Turn on: When the power is initially turned on by depressing the bar side of the rocker type power switch, the Model 752 will cycle through a diagnostic exercise in the following sequence:

"BEEP" a. All display segments will momentarily activate.

"BEEP" b. All LED indicators will momentarily activate.

"BEEP" c. The model number "752" will appear on the CURRENT display of HV #1, and
The Firmware version "N.NN" (e.g. 1.15) will appear on the PRESSURE display of HV #1.

"BEEP" d. The internal DIP switch S-1 and S-3 setup will appear in the PRESSURE display HV #1
The RS485 (e.g. 5) address will appear in the CURRENT display HV #2.
(RS485 address will be displayed even if RS232 or RS422 are enabled)

e Ready: HV displays reads OFF, Units LED ON as set (torr, mbar, pascal)

(Holding down the SELECT button during power-up will retain display of model #, DIP switch settings and Firmware version until the SELECT button is released. This is for ease of interpretation.)

2. Set Up: After the turn on cycle described above, the parameter set up process is accomplished by sequential operation of the "SELECT" switch. located in the display section, for each HV supply and the indicated parameter "RAISE" and "LOWER" switches, located in the lower center of the front panel.

a. The first press of the "SELECT" button will allow the adjustment of the set point pressure which is shown on the "Pressure" display, for the selected HV Supply,. The default set point pressure is OFF and the range is $0.1X\ 10^{-9}$ to $1X10^{-5}$ in the chosen units of pressure. Press the /\ RAISE button to raise the set point pressure and press the \/ LOWER button to lower the set point pressure.

SET POINT OPERATION

In operation, as the pressure falls in the ion pump, the set point relay goes to the 'ON' condition when the pressure is less than or equal to entered setting.

Pressure Falling: (Set Point Relay 'ON' if P = or < Setting).

As the pressure rises, the set point relay goes to the 'OFF' position when the pressure is equal to or greater than 1.20 times the entered setting. This 20% hysteresis range is provided to avoid "chatter" in the set point relay at or very near the entered setting.

Pressure Rising: (Set Point Relay 'OFF' if P = or > 1.2 x Setting)

Both Normally Open (NO) and Normally Closed (NC) terminals are provided on the Auxiliary I/O Connector, see Section C2)

b. The second press of the "SELECT" button will allow the adjustment of the maximum voltage supplied by the Model 752, which is displayed on the "High Voltage" display. The default maximum high voltage is 7500 volts (displayed as +7.50 KV) and the range is 3500 volts to 7000 volts. Press the /\ RAISE button to raise the maximum high voltage and press the \/ LOWER button to lower the maximum high voltage.

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c. The third press of the "SELECT" button will allow the adjustment of the maximum current supplied by the Model 752, which is displayed on the "Current" display. The default maximum current is 10 milliamps, and the range is 1 milliamp to 50 milliamps. Press the /\ RAISE button to raise the maximum current and press the \/ LOWER button to lower the maximum current.

d. The fourth press of the "SELECT" button will allow the choice of the pump size, (used in the calculation of pressure from the pump current), which is displayed on the "Current" display. The default pump size is 20 liters per second and the range is 0.1 liter per second to 999 liters per second. Press the /\ RAISE button to raise the pump size and press the \/ LOWER button to lower the pump size

e. The fifth press of the "SELECT" button will allow the choice of pressure units displayed by the Model 752, which is displayed on the "Pressure" display. The default pressure units are torr (displayed as tor) and the alternate choices are millibar (displayed as bar) and Pascal (displayed as pas). Press the /\ RAISE button or the \/ LOWER button to change the choice of pressure units.

f. The sixth press of the "SELECT" button will return the Model 752 HV supply being adjusted to the "Operate" mode, in the transition, all display segments will momentarily be illuminated.

3. **Re-Setting Parameters to Default Values:** Each HV supply can be separately returned to default settings of parameters by turning the power switch OFF, then simultaneously depressing the SELECT button, RAISE (/\) and LOWER (\/) buttons for that HV supply on the front panel while turning the power switch ON. Hold the SELECT, RAISE & LOWER buttons depressed; the unit will cycle through its normal turn-on diagnostic process (see C.1, above) and then the selected HV Supply display will show "rst" and the unit will emit short 'beeps' until the reset is complete. At this point, operation of both HV supplies can be resumed.

(Note: For the HV supply not selected above, parameters will remain at their previous values, unless it also is put through the Re-Set process. In either case, to restore operation, the HV ON button for each HV supply will need to be operated.)

D. Safety Considerations

The primary safety hazard when operating high voltage power supplies such as the Model 752 is electrical shock. Electrical shock can result from contact with the AC line voltage, internal potentials in the control unit or the high voltage output of the unit itself. The high voltage output hazard can exist either from direct contact with the high voltage lead or as a result of loss of proper grounding of the unit or the pump.

WARNING!

Always wait at least 15 seconds after turning OFF high voltage before working on either the Model 752 or the sputter-ion pump.
NOTE: In a properly operating Model 752, the absence of hazardous potentials on the high voltage output may be verified by reading the high voltage meter on the front panel.

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E. Rear Panel

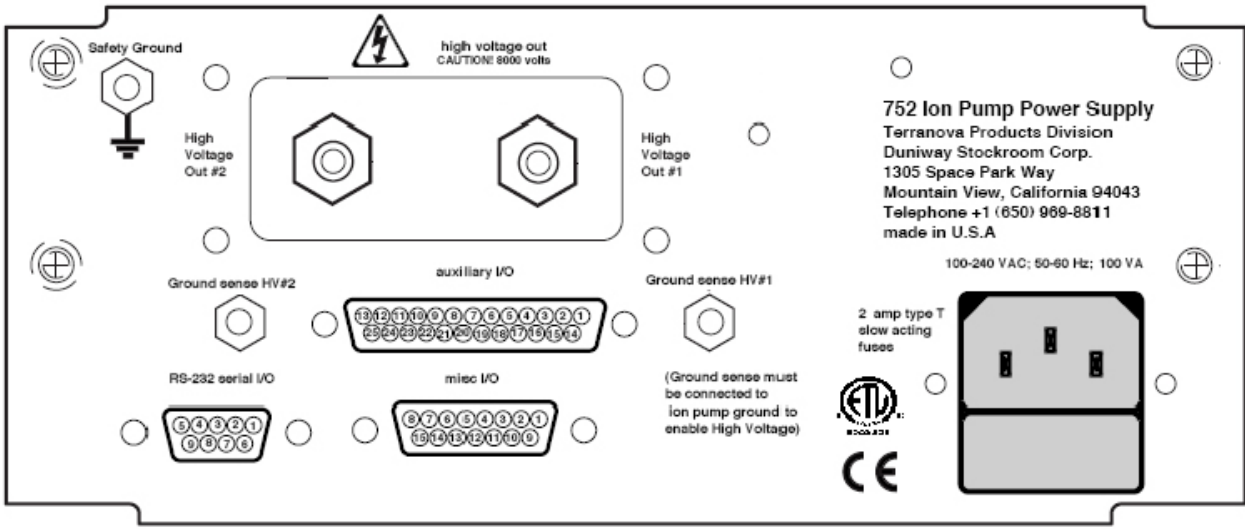

Figure 11: Model 752 Rear Panel

Power Input/Fuse Module

The Power Input socket is a standard IEC 320 instrument power input receptacle. Replacement fuses are 2 amp type S Slow Blow fuses. The Model 752 has a universal power supply which accepts 100 - 240 Volts, 50-60 Hz.

High Voltage Connectors

The standard High Voltage output connectors are two Kings-type 10 KV co-axial connector. (Units are also available with two Fischer -type connectors or one Kings-type and one Fischer-type**.** See Section IV-F, below for high voltage cable descriptions.)

Ground Sense Circuit Terminals

A Ground Sense Circuit Terminal for each High Voltage supply is provided on the rear panel of the Terranova 752. They are isolated 6/32 screw-lug. If the Ground Sense Terminal and High Voltage cable shield are not properly connected to the vacuum system ground, the high voltage can not be turned on. See additional explanation below in Section II-F.

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Ground Lug

A separate Safety Ground (Earth Ground) 6/32 screw-lug is also provided. This lug is permanently attached to the Model 752 chassis. See the explanation above before using this terminal.

Serial RS-232 D-9 Connector

A D-9 connector is provided for the serial I/O signals. See section I-C for the pin-signal configuration.

Miscellaneous I/O DB-15 Connector

A DB-15 connector is provided for the miscellaneous I/O signals. See section I-C for the pin-signal configuration.

Auxiliary I/O DB-25 Connector

A DB-25 connector is provided for the auxiliary I/O signals. See section I-C for the pin-signal configuration.

F. Safety Interlock - Ground Sense Circuit Description and Procedure

A Safety Interlock circuit has been incorporated into the Model 752 for each HV supply to reduce the riskof electrical shock in the case that proper grounding is lost. The required Ground return path is provided through shielding on the high voltage cable. See the discussion below.

PROCEDURE: **GROUND SENSE SAFETY WIRE**

1. Ensure that continuity exists between the high voltage output connector shell and the sputter-ion pump body.

2. Make a connection between the ground sense lug connector for that HV supply on the rear panel of the Model 752 (See Figure 2 - Photo of Rear Panel) and any convenient fastener on the sputter ion pump body.

3. If there is a ground fault (open circuit), The High Voltage for that HV supply will be turned OFF and the Ground Sensing Circuit LED “HV Interlock Open” lamp on the front panel will be illuminated. To restore High Voltage, correct the grounding problem and press the High Voltage ON button on the front panel.

WARNING!

Under no circumstances should the ground sense strap be connected directly to the case of the Model 752. That would defeat the protection provided by this safety feature and may result in serious electrical shock hazard to personnel.

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Discussion of the Ground-Sense Safety Circuit Operation

The Terranova Ground-Sense Circuit is provided to assure that the high voltage will be turned off if either the Ground-Sense connection or the High Voltage connection to the ion pump is broken or lost.

The Ground-Sense safety feature operates to allow the HV to operate when the Ground-Sense wire is connected between the Terranova 752 Ground-Sense terminal on the rear of the unit and the ion pump body; AND the high voltage cable ground shield is properly terminated both through the HV ion pump connector to the ion pump body and through the controller connector to the Terranova 752 chassis.

If either Ground-Sense or Ground Shield connections are interrupted at either end, the HV will automatically be shut off.

NOTE: *A redundant ground connection, either intentional through a separate grounding wire or unintentional, through chassis contact with pump/system ground (as in mounting pump and control on the same conducting rack or cart), will defeat the HV turn-off portion of the Ground Sense safety circuit*. See the table below for state conditions for all these alternatives.

Use of cables other than those approved by Duniway Stockroom Corp. could lead to operation problems of safety hazards.

752 Ground Sense Conditions

Case	Ground Sense Line	HV Cable Ground	Redundant 752-Pump Ground		752 HV
1	N	N	N		OFF
2	Y	Y	N		ON
3	Y	N	N		OFF
4	N	Y	N		OFF
5	N	N	Y		OFF
6	Y	N	Y		ON*
7	N	Y	Y		OFF
8	Y	Y	Y		ON*

Figure 12 - Terranova 752 Ground-Sense Conditions

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G. Connection to Pump

Each HV supply of the Model 752 is connected to a sputter-ion pump by means of a coaxial cable assembly. To see a list of cables, go to Section IV-L, or for more details, photographs, prices or special length cables, please call Duniway Stockroom Corp. or go to our web page at **www.duniway.com**.

PROCEDURE: **CONNECTION TO THE PUMP**

1. Turn OFF the POWER switch on the front panel of the Model 752. (See Figure 6 - Front Panel Photograph)

2. Make or confirm the required ground connections to the Model 752 as described above in Section II-D.

3. Verify that (or set) the pump selection is set to the correct value for the sputter ion pump in use.

4. Verify that the high voltage polarity is correct for the pump in use. Positive (+) polarity is used for diode, noble diode and DI pumps while negative (-) polarity is used for triode and StarCell ^{R} pumps. If you have any questions about the type of pump you are planning to use, contact Duniway Stockroom Corp. immediately.

5. Attach the high voltage connector to the ion pump.

6. Connect the Kings-type, 10KV connector (control unit end of high voltage cable) to the high voltage output connector on the rear of the control unit.

WARNING!

NEVER apply power to the Model 752 until proper grounding has been checked and verified.

Now, rough pump the system to a pressure of 10^{-3} torr or below. Turbo roughing is strongly recommended, however a cryosorption pumps or two stage oil sealed rotary pump or other roughing pump can be used with careful attention to technique and appropriate trapping of pump oils.

CAUTION

At pressures below about 1.5 X 10^{-1} torr for most systems and pumps, the backstreaming of mechanical pump oil is a significant problem. High quality oil traps MUST be used.

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III Operation

A. Start-Mode Operation (applies to each HV supply)

1. Turn the POWER switch on the front panel to ON. No warm-up period is required.

2. When it is suspected or observed that the roughing system has reached its base pressure, the ion pump starting cycle can be started. **Note the maximum recommended operating pressures for various pump sizes listed is section II-A, above.**

3. Push the High Voltage switch and hold for two seconds. The High Voltage ON LED will be activated and the High Voltage display will show the voltage. The voltage will ramp up to the Maximum Voltage designated in the set-up procedure (or to some lower value determined by the load represented by higher pressure in the ion pump.) The Current and Pressure displays will remain off until several seconds have elapsed (to avoid displaying erroneous transient start up values).

4. When the initial voltage (at maximum or rising), current (falling) and pressure (falling) are observed to be improving, close the roughing valve.

If the voltage falls (meaning that current and therefore pressure is rising), reopen the roughing valve.

If the voltage increases or remains constant (pressure is decreasing or "holding"), leave the roughing valve closed.

NOTE

With a sputter ion pump, a modest rise in pressure is normal during the initial START. This is caused by heating of the pump components and is beneficial in outgassing the elements for later operation in the NORMAL mode.

5. Maximum Current (Imax) Operation: During Initial Set Up (Section II-C), the operator chooses a value for the maximum current (Imax) which the ion pump should be exposed to. This function is provided to limit the power input, especially to small pumps. In operation, if the pump current rises to Imax, the Terranova 752 automatically begins limiting power by incrementally reducing the high voltage applied to the ion pump. This incremental voltage reduction continues until the ion pump current stays below the Imax setting. If the ion pump current remains at or near the Imax setting for extended periods, the 752 goes into a cool-down mode (below).

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6. Cool-Down Mode: If the ion pump current remains at or near the maximum current (Imax) setting for a period of 10 minutes, the 752 automatically shuts OFF the high voltage to allow the ion pump to cool down. The high voltage stays off for 5 minutes and then comes back on. This cyclical process continues (10 minutes ON - 5 minutes OFF) for 5 cycles if the ion pump current stays at or near Imax. If the ion pump current goes significantly below Imax at any time during this process, the Imax/Cool-Down Mode will be re-started at the beginning. If the full 5 cycles are completed without significant ion pump current reduction, the 752 automatically goes into shut-down mode (below).
A seriesof 'beeps' is emitted when the cool-down mode or shut-down mode is commenced. The display shows "**CdX**" when the voltage goes off, where X is the cool-down cycle number, between 1 and 5. The unit emits X beeps when entering a cool-down cycle.

7. Shut-Down Mode: If the 752 goes through the full cool-down cycle, it goes into shut-down mode. The high voltage is turned OFF, a 5 second 'beep' is emitted and the display shows "**Sd**".

In addition, if the high voltage output is shorted to ground, due to malfunction of the ion pump, cable or connector, the 752 will enter shut-down mode within 5 seconds. The high voltage turns OFF, a 5 second 'beep' is emitted and "**Sd**" is displayed.

To recover normal operation from shut-down, resolve the situation that led to shut-down and press the HV button on the front panel for 2 seconds.

NOTE: HIGH POWER INTERACTION OF THE TWO HV SUPPLIES: If both HV supplies are operating and the total power load exceeds about 65 watts, the high voltage for both supplies will be temporarily decreased.

B. Normal Mode Operation

Operation in the NORMAL mode is simple and automatic. As the pressure and current fall, the operating voltage approaches the open circuit value for the control unit; and the current is approximately proportional to pressure over a wide range of pressures.

Pressure at the pump inlet flange may be read directly on the "pressure" display of the front panel. (This assumes that the pump size in the selection mode has been made properly during set up.)

Alternately, if the current vs. Pressure relationship is known for the pump in use, current may be read directly and converted into a pressure reading.

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DISCUSSION OF THE TECHNIQUE

The current drawn in a sputter-ion pump is nearly proportional to pressure. For the Terranova 752 unit, the equation used for calculating pressure from current is:

$$\mathbf{P = (K \times I)/ (S \times V)},$$

where P is the pressure in Torr, K is a constant equal to 369.6, I is the current in amps, S is the Pumping Speed as entered during Set-Up in liters per second and V is the Voltage in volts as entered during Set-Up.

While it is true that the current drawn in a sputter-ion pump is nearly proportional to pressure over a wide range, there are limitations to the technique. Specifically:

1. The proportionality is only approximate.
2. At pressures less than 1×10^{-8} Torr, the current to the Penning discharge is multiple valued, displaying significant hysteresis. Thus the current drawn depends on whether the pressure is rising or falling.
3. Sharp points and edges, or flakes which may form with prolonged pump use, particularly in triode pumps, can add significant current, due to field emission, which is independent of the pressure. (These field emission points can be removed by "hi-potting" the pump, that is, by applying AC or DC voltages to the pump of at least twice the operating voltage, preferably with the pump magnets removed.)

For these reasons, the accuracy of the pressure as indicated by the ion pump current is no better than +/-20%, and that accuracy is only achieved in the pressure range between 1×10^{-7} Torr and 1×10^{-5} Torr.

For pressures below 1×10^{-8}Torr, a Bayard-Alpert ionization gauge is strongly recommended for pressure measurement.

Note that for sputter ion pumps, it is possible to extrapolate the current value to extremely low pressures and obtain a "reading" for the pressure. This is subject to the same fundamental limitations indicated above, and is therefore not a reliable indication of pressure.

Note that these effects, while significant to the measurement of pressure, have only minor effects on the pumping efficiency, and for that purpose may be generally neglected.

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C. Communications Functions RS-232, 422 and 485 Commands

General format for Queries

The serial port (see page 7 for pin/signal configuration) allows the user to remotely **Query** (read) the Terranova 752 for the parameter values shown below on this page and to remotely **Set** the parameters shown on the next page.

FORMAT: [start character][two byte address][three byte query mnemonic][?][,][chksum][cr]
(The start character for the 752 is '*', asterisk.)
The address field is used only when the unit is configured for the RS-485 communications mode (DIP switch S1-1 On), and is a two byte value in hexadecimal. The address value is set up by using DIP switch S2. See Section IV-D for more information on DIP switch settings.

The checksum is only used when the unit is configured with dip switch S1-7 ON. Even if the switch is on, sending a value of 00 for the checksum will cause it to be ignored. Regardless of the setting of this switch, the 752 will always calculate and send a checksum.
Examples of query/response in the RS-232/422 mode, checksum disabled:

To get the voltage value for HV supply #1:***VO1?<cr>**
Response for 4300 volts: **OK:4.3e+3,cc<cr>**

Examples of query/response in the RS-485 mode, checksum enabled:

To get the voltage value for HV supply #1:***05VO1?,00<cr>**
Response for 4300 volts: **05,OK:4.3e+3,cc<cr>**

The third character of the three byte query mnomic designates the number (1 or 2) of the HV supply, where applicable.

Query	Function	Response
MOD	**Read** Model Number	752
VER	**Read** Firmware Version	N.NN
CU1 or CU2	**Read** Current	N.NN e +/-X (amps)
PR1 or PR2	**Read** Pressure	N.NN e -X (in selected pressure units)
VO1 or VO2	**Read** Voltage	N.NN e +/-X (Volts)
ST1 or ST2	**Read** Supply Status	XX (Status Code: 00, Off; 10, Running; 02, Cooling; 03, Shutdown; 04, Interlock)
UN1 or UN2	**Read** Selected Units	Torr, mBar, Pascal
PS1 or PS2	**Read** Pump Size	NNN.N (liters per second, 0.1-999)
PO1 or PO2	**Read** HV Polarity	Pos, Neg
HV1 or HV2	**Read** HV ON or OFF	On, Off
MC1 or MC2	**Read** Maximum Current	N.NN e +/-X (amps)
SP1 or SP2	**Read** Set Point	N.N e -X (selected pressure units)
MV1 or MV2	**Read** Max Volts	NN00 (Volts)

Figure 13: Serial Interface Query-Response Format (HV Supply 1 & 2)

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IMPORTANT NOTE

The entire string that is sent from the start character (*) to the end character (<cr>) must be received within 500 milliseconds or less, otherwise the entire transmission will be voided.

If sending commands manually using a window on a PC (e.g., Hyperterminal), store the desired commands into a text file (multiple commands are allowed) and use Hyperterminal to transfer this text file to the instrument.

General format to set a value

[start character][two byte address][three byte command mnemonic][:][value][,][chksum][cr]

Example to set the pump size to 20 liters per second on HV supply #1

In RS-232/422 mode, checksum disabled:
Send: ***PS1:20<cr>**
Response: **OK:20,cc<cr>**

In the RS-485 mode, checksum enabled:
Send: ***05PS1:20,00<cr>**
Response: **05,OK:20,cc<cr>**

Command	Description	Parameter
UN1 or UN2	**Set** Pressure Units	Torr, mBar, Pascal
PS1 or PS2	**Set** Pump Size	NNN.N (liters per second)
HV1 or HV2	Turn HV On or OFF	On, Off
SP1 or SP2	**Set** Set Point	N.N e-X (0.0 is off)
MV1 or MV2	**Set** Max Volts	NN00 (will be rounded to the nearest 500 volts)
MC1 or MC2	Set Max Current	NN (1-25 mA)

Figure 14: Serial Interface Parameter Control Command Format

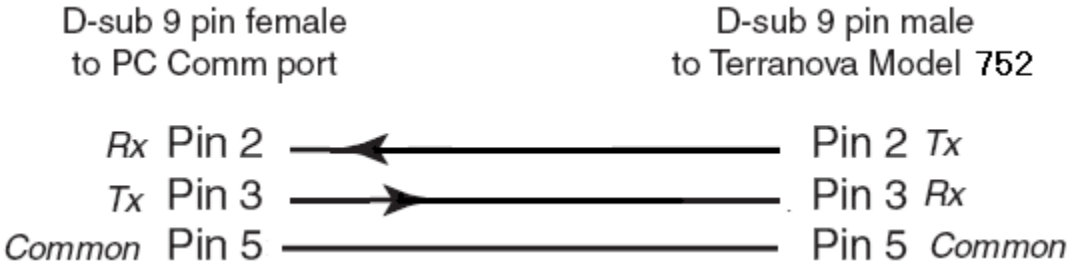

Figure 15: Serial Cable - PC to 752

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D. Power Characteristics

Each of the two high voltage supplies has the following Voltage, Current and Power characteristics.

NOTE: The maximum power output of the two supplies combined will not exceed 65 watts. In most situations, this will not influence the operation of pumps attached to the Terranova 752.

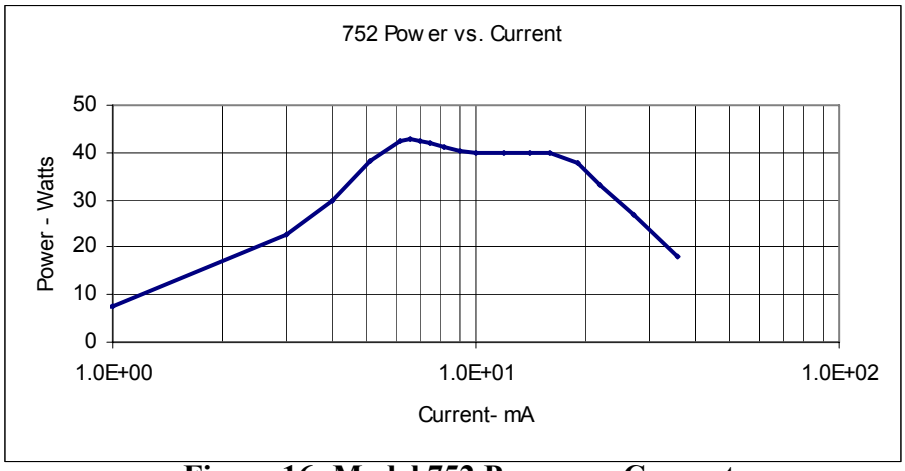

Figure 16: Model 752 Power vs. Current

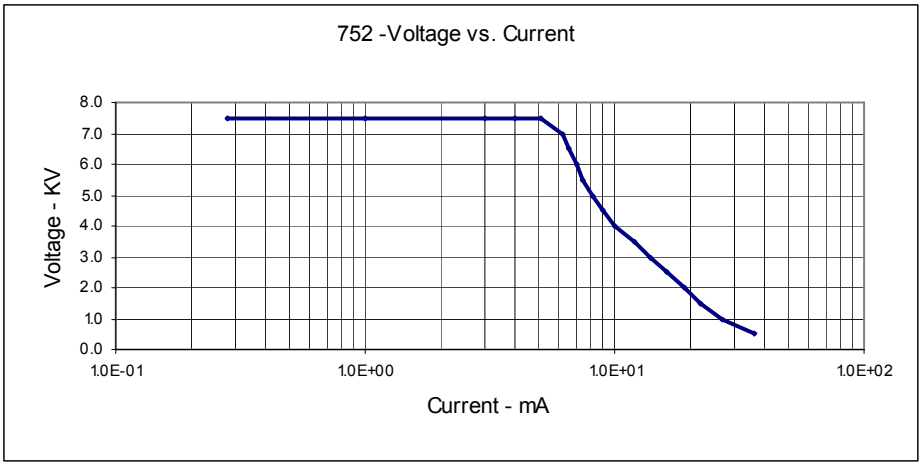

Figure 17 Model 752 Voltage vs. Current

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IV Maintenance

A. 752 Block Diagram

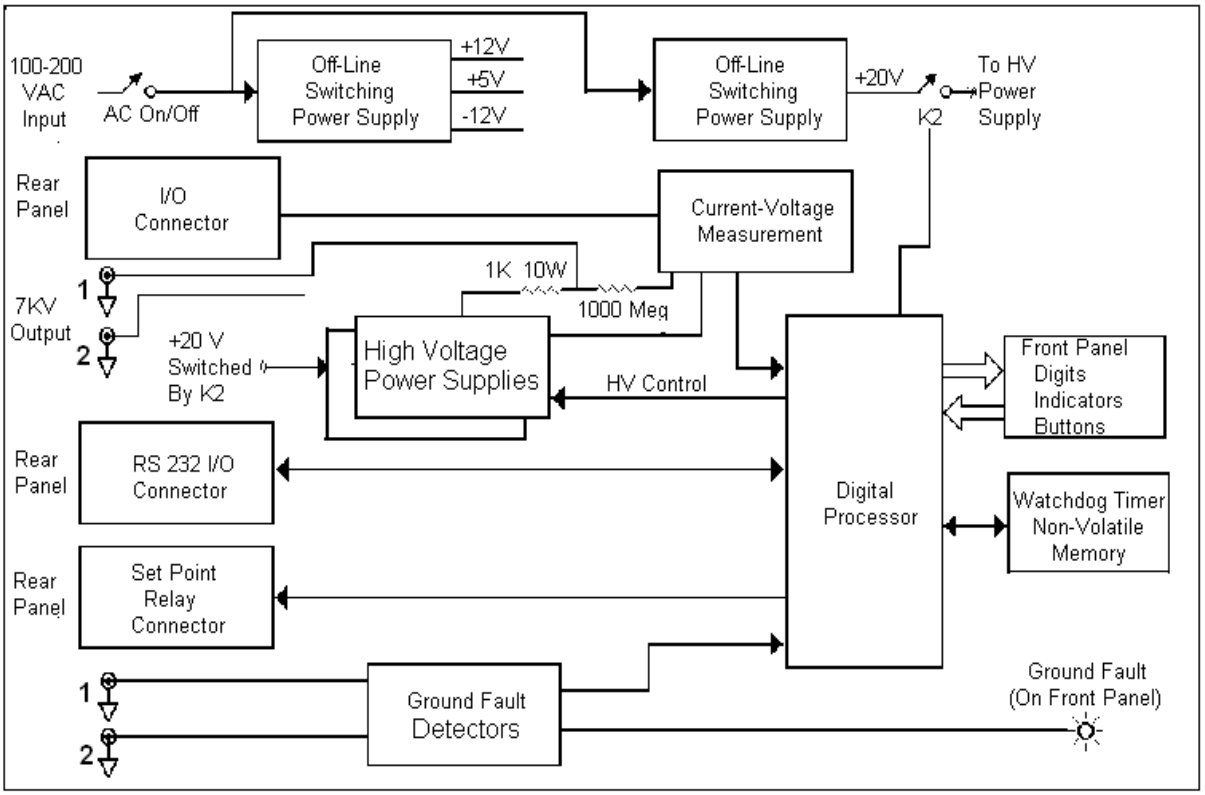

Figure 18: Model 752 Block Diagram

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B. Verification of Operation

Terranova 752 --- Ion Pump Control-Display Units

This set of three procedures can be performed together sequentially or independently.

Power-On Initiation Cycle

When the unit is switched on with power applied, the display will cycle through the following sequence as shown in Section II-C-1:

Parameter Setup/Display

With power applied, parameter setup can be accomplished by following the procedure in Section II-C 2

Current Output Verification/Calibration

Use the "Calibration Plug" part number **10KV-20M** supplied by Duniway Stockroom. With the High Voltage turned OFF, with the unit set up with the parameters listed in item 2 above, attach the calibration plug to the High Voltage output connector on the back of the unit. (If the unit has a "ground sense" terminal on the rear panel, attach it to a ground lug.) Turn on Power and the High Voltage and allow a few seconds for the unit to stabilize.

The displays should read:

a) Top, High Voltage-Kilovolts, **5.00**, +/- 0.00
b) Middle, Current, **250** microamps, +/- 20%*
c) Bottom, Pressure, **9.2-6** (9.2×10^{-6}) torr, +/- 20%*

* +/- 20% accuracy is due to buildup of tolerances in Calibration Plug and unit circuits.

DISCUSSION OF THE TECHNIQUE

CALIBRATION PLUG

The resistor built into the "Calibration Plug" is 20 Meg-ohm ($2 \times 10^{+7}$ ohms). The current drawn through this resistor follows ohm's law,

$$\mathbf{I = V/R}$$

So, for the setup example above,

$$\mathbf{I = 5 \times 10^{+3} \text{ volts} / 2 \times 10^{+7} \text{ ohms} = 2.5 \times 10^{-4} \text{ amps}}$$

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ION PUMP CURRENT/PRESSURE RELATIONSHIP

The current drawn in a sputter-ion pump is nearly proportional to pressure. For the Terranova 752 unit, the equation used for calculating pressure from current is:

$$\mathbf{P = (K \times I)/ (S \times V)},$$

where P is the pressure in Torr, K is a constant equal to 369.6, I is the current in amps, S is the Pumping Speed in liters per second, as entered during Set-Up, and V is the Voltage in volts as entered during Set-Up.

For the example Setup above:

$$\mathbf{P = (369.6 \times I)/ (2.0 \times 5000) = 3.7 \times 10^{-2} (I)}$$

or

$$\mathbf{P=(3.7X10^{-2})X(2.5X10^{-4})=9.25X10^{-6}torr}$$

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C. Diagnosing Ion-Pumped Vacuum Tube/System Condition

Using the Terranova 752 Controller

Condition a: Hard Vacuum

1. This desired condition is indicated by low current/pressure readings. Depending on the size of the ion pump, the current should be a few microamps or less. For example, the I/P in amps per torr is approximately 10 times the pumping speed of the pump. For a 2 liter per second ion pump, I/P should be approximately 20 amps per torr. A pump current of 2 microamps ($2x10^{-6}$ amps) would indicate a pressure of $1x10^{-7}$ torr. For another example, a pressure of $1x10^{-8}$ torr would yield a pump current of 0.2 microamps ($2x10^{-7}$ amps).
2. Small ion pumps sometimes require significant time for the discharge to strike at hard vacuum. This determination should be made only after allowing several minutes to elapse after first applying the ion pump voltage.
    a. If this condition is suspected, and the pump is accessible, lightly tap the metal body of the ion pump with a non-magnetic object, such as a pen or screw-driver handle, to encourage starting of the pump.
    b. Another method of starting the ion pump discharge at hard vacuum conditions, is to temporarily apply a higher voltage, by the procedure described below Condition B-1).
    c. The starting of the discharge will be indicated by a temporary surge of current, which will then gradually decline to the expected value.
    d. When the ion pump discharge starts, return the MAXIMUM VOLTAGE to its operating value of 4KV. This is best done without turning the High Voltage OFF!
3. Low or no current at operating voltage (4KV) can also indicate the Down to Air condition, see Condition B, below.

Condition b: Down to Air

1. Low or no ion pump current at operating voltage (4KV) can occur if the tube/system is down to air, that is, at high or atmospheric pressure due to a significant leak. This condition can be tested for and verified by operating the pump briefly at higher than operating voltage. Follow the steps below:
    a. With the High Voltage OFF, press the ADJUST button twice to enter the High Voltage adjust mode (the red LED marked “Maximum Voltage” will be illuminated.)
    b. Press the RAISE button until the display shows 7.50 (7500 volts).
    c. Press the ADJUST button four more times to return to the OPERATE mode.
    d. Press and hold the High Voltage On/Off button until the display begins to show the voltage and current.
2. As the voltage rises toward 7.5KV (7500 volts), the current pressure display will fluctuate and you should hear a “sizzling” or “tickling” sound from the ion pump due to high voltage breakdown inside the pump.
3. DO NOT leave the High Voltage on in this condition for more than a few seconds at a time, because damage could occur to the internal insulating surfaces of the ion pump.

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Condition c: Poor Vacuum

If the operating current is steady at a higher than expected value, for example, more than 10 micro-amps ($1x10^{-5}$ amps) for a 2 liter per second ion pump, the vacuum in the tube/system is poor. Further tube/system diagnosis, leak checking and repair should be undertaken.

Condition d: Pump Leakage Current

If the ion pump current is a steady or fluctuating around a few microamps, and it is believed that the tube/system is under hard vacuum, there may be leakage current in the ion pump. The following steps can be taken to resolve this condition.

1. Insulator External Surface Contamination: After turning the High Voltage OFF, remove the High Voltage Connector from the ion pump. Using a lint-free cloth or paper wipe and some solvent such as alcohol, gently clean the insulator surface of the High Voltage Feedthrough. When the surface is clean and dry, re-attach the High Voltage Connector and resume operation.
2. Field Emission Leakage Current: Follow the steps outlined in Section III-F above to diagnose and fix this condition.
3. If neither of these steps reduces the current, it is most likely truly due to ion current related to slightly elevated pressure in the tube/system.

D. Loading Code Revisions

On some occasions, it may be advisable to install micro controller firmware code revisions in the field. This is accomplished by utilizing the JTAG port. (see Figure 20) If this process becomes necessary, a complete kit with detailed instructions will be offered.

E. Additional Information

If you need additional information, please call Duniway Stockroom at 1-800-446-8811 or go to our web-site, www.duniway.com. On our web-site, under “DOCUMENTS”, you will find on-line versions of the Terranova 752 Manuals, plus more information on operating ion pumps.

F. Trouble Shooting

Problem	Possible Cause	Remedy/Diagnostic
Unit will not turn on	Input fuses are open	Check fuses at AC input connector; missing, blown?
Unit will not turn on	Internal connector to power switch is not in place	Disconnect AC power cord, remove cover and verify that J10 is connected; J10 is located near rear-left side
Unit will not turn on	AC outlet has no power	Verify AC outlet power; 100 to 240 VAC, 47-63 Hz
Unit will not turn on	AC line cord is defective	Check continuity of AC line cord
Unit 'beeps' at turn-on, but display is dark	Internal connector to front panel is not connected	Disconnect AC power cord, remove cover and check ribbon-cable connector to display
Unit turns on, but display has random LED segments lit and doesn't respond	Microprocessor is not operating	Disconnect AC power cord, remove cover and verify that U1 and U2 are properly seated/socketed
Some LEDs or display segments don't light	LED component is defective	Return unit to Duniway Stockroom Corp. or request replacement display board
No beeps or response when any front panel buttons are pushed	Internal connector to front panel is not connected	Disconnect AC power cord, remove cover and check ribbon-cable connector to display

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Problem	Possible Cause	Remedy/Diagnostic
No beeps or response when one front panel button is pushed, others OK	Defective button/switch	Return unit to Duniway Stockroom Corp. or request replacement display board
High voltage doesn't turn on when HV button is pushed	Ground-Sense Safety interlock is open, or High Voltage Ground Shield is open or unit is in Remote HV Control Mode	Check isolated Ground Sense connector on rear of unit for proper connection to ground. Check HV cable shield connections. Check DIP switch settings for proper configuration.
High voltage LED turns on, but voltage shows zero, pump connected	HV output is shorted	Remove HV connector from ion pump, try again
High voltage LED turns on, but voltage shows zero, pump not connected	Internal HV power supply not connected	Disconnect AC cord, remove cover and verify connection of J4 and J1 on HV board
High voltage LED turns on, but voltage stays near zero, pump connected/not connected	Plus/Minus 15 volt supplies are defective	Disconnect AC cord, remove cover and verify +/- 15 volts on E1 and E2, front-left. If defective, return unit to Duniway Stockroom Corp. for repair
High voltage LED turns on, but current stays near zero, pump connected	Pressure below detectable level.	No action required
High voltage LED turns on, but current stays near zero, pump connected	Cable to ion pump is open or not connected	Turn 752 off, disconnect HV cable, check continuity of both center conductor and shield.

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Problem	Possible Cause	Remedy/Diagnostic
High voltage rises above and stays above set value	HV sense resistor is broken	Disconnect AC cord, remove cover and verify resistor (R16) is connected between HV coaxial connector center conductor and HV power supply
High voltage rises above and stays above set value	Ground connection is missing on HV power supply	Disconnect AC cord, remove cover and verify connection from TB4 on HV supply and chassis
RS232 communications don't respond	Tx and Rx are inverted	Invert connections to Tx and Rx on serial I/O cable connector
HV #1 or HV #2 display reads "OUT"	HV #1 or HV #2 module is missing or otherwise not available. Attempted parameter adjustments for that supply will return E9 Attempted Serial communications with that supply will return E9	Disconnect AC cord, remove cover and verify HV module present, connected

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Problem	Possible Cause	Remedy/Diagnostic
Set point relay contacts don't toggle	Contacts are welded together due to excess current or transients	Disconnect AC cord, remove cover and replace relay; add transient absorber to relay load.
Error Codes	**Err2**	HV Exceeded 8KV; Recover
	Err3	Illegal Operation, attempt to change units in Pascal mode
	Err4	Attempt to change setup parameter while in Mode 2 HV Remote
	Err5	Attempt to turn on HV with Interlock 1 fault (J9-8)
	Err6	Attempt to turn on HV while in Remote Mode
	Err8	Parameter at limit
	Err9	Function not allowed at this time.

Figure 19: Error Codes

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Figure 20: Model 752 Top View, Cover Removed (Front: Right -- Rear:Left)

Note Power Interlock Micro-Switch at Left of Photo - grid A/B-7
JTAG Port - Load Firmware Code Revisions - grid R-8/9
Set Point Configuration JP-14, 15, 16 - grid C-2/3
Internal Re-Set Button - R-7/8
Fan (On Cover) Cable Connector - R-7

G. High Voltage Output Polarity Change Procedure

1. Remove the AC Power Cord

2. Remove the top cover (6 Phillips Head screws)

3: Make the 4 Step Polarity Change (See Figure 20 for reference letters)

A. High Voltage Diode: Locate the High Voltage Diode mounted with screws through lugs on the top of two ceramic stand-offs (For HV Supply #1, Figure 20, H-8/9; For HV Supply #2, Figure 20, H-6). The diode has a stripe around one end. When the diode is mounted with this stripe toward the left side of the 752 (bottom of Figure 20), the unit is configured for negative (-) high voltage output. When the diode is mounted with the stripe toward the right side of the 752 top of figure 20), the unit is configured for positive (+) high voltage output. See the labels on Figure 20 to verify the instructions.

Remove the two screws from the high voltage diode lugs, being sure to retain the screws and/or washers from dropping into the interior of the unit. Flip the High Voltage Diode over to obtain the direction for the desired high voltage polarity Replace and tighten the screws through the lug and into the top of the stand-off.

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B. Polarity Jumpers: Locate the High Voltage Polarity Jumpers (For High Voltage Supply #1 Figure 20, I-9; For High Voltage Supply #2 Figure 20, I-6).on the High Voltage Supply (#1 or #2) being configured. Note the label "Select Output Polarity" on the printed circuit board beneath the two jumpers. There are two jumper positions: J-2 NEG for negative (-) HV polarity and J-2 POS for positive (+) HV polarity. Place/verify that the 4 pin jumper is in the correct position to correspond to the placement of the HV diode in Step A, above. NOTE: Failure to make the High Voltage Diode & Jumpers (J-2 & J-3) the same polarity will result in damage to the HV transformer.

C. DIP Switch Settings:

For HV supply #1, locate the DIP switch S1 (Figure 20, grid Q-7) Switch S1 is the switch toward the left side of the unit (when facing the front panel) labelled "S1". The individual switches on Switch S1 are labelled 1 through 8. Locate switch S1-1. For Positive (+) High Voltage Output, switch S1-1 should be in the OFF position. For Negative (-) High Voltage Output, switch S1-1 should be in the ON position. Switch S1-1 controls the + and - sign on the high voltage supply #1 display.

For HV supply #2, locate the DIP switch S3 (Figure 20, grid Q-5/6) Switch S3 is the switch toward the right side of the unit (when facing the front panel) labelled "S3". The individual switches on Switch S3 are labelled 1 through 8. Locate switch S3-8. For Positive (+) High Voltage Output, switch S3-8 should be in the OFF position. For Negative (-) High Voltage Output, switch S3-8 should be in the ON position. Switch S3-8 controls the + and - sign on the high voltage supply #2 display.

D. Miscellaneous I/O Jumpers:

For HV supply #1, locate jumper JP-8 inside the rear panel near the Miscellaneous I/O plug (Figure 20, grid B-5) For Positive High Voltage Polarity, connect pins 1 and 2 of JP-8. For Negative High Voltage Polarity, connect pins 2 and 3 of JP-8.Place/verify that the jumper is in the correct position to correspond with the placement of the High Voltage diode in step A, above.

For HV supply #2, locate jumper JP-13 inside the rear panel near the Miscellaneous I/O plug (Figure 20, grid B-5).; For Positive High Voltage Polarity, connect pins 1 and 2 of JP-13. For Negative High Voltage Polarity, connect pins 2 and 3 of JP-13. Place/verify that the jumper is in the correct position to correspond with the placement of the High Voltage diode in step A, above.

See Section IV-G below for other DIP switch settings.

Finally, verify that all four components (High Voltage Diode, Polarity Jumper, Dip Switch and Misc. I/O jumper) are set consistently to the voltage polarity required for ion pump operation. See Section II-A for ion pump voltage polarity requirements.

H. Current: Analog Output Range Settings

The Analog Output Range setting is controlled by DIP Switches S1 & S3 (see Figure 20 Q 5/6/7). The Analog Output signal is available on pin 12 of the Miscellaneous I/O Connector on the rear panel. There are three User Selectable ranges available:

1. Linear Analog Out, 0 - 10 volts,200 microamps per volt to 2000 microamps*
2. Linear Analog Out 0 - 10 volts,2 milliamps per volt to 20 milliamps* (default)

*NOTE: recommended lower limit for accurate readings is 1% of full scale. For example, on the 200 microamps/volt scale, this would be equivalent to a current reading of 20 microamp.

3. Log, Analog Out: Vout = log 10 (current in amps) +8

Example: Current = 800 microamps (8×10^{-4} amps), Vout = 4.90 volts

See next page for Table of Additional Examples

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To change the range: (after turning off the unit and removing the power cord)

1. Locate DIP Switches S1 and S3 (Figure 20 - Q-5/6/7). The DIP Switches has 8 individual ON-OFF switches, S1-1 through S1-8 and S3-1 through S3-8.
2. Locate Switches S1-7 and S3-7
3. For Output Range Setting Linear **200 microamps per volt,** put Switch S1-7 in the OFF position and Switch S3-7 in the OFF position.
4. For Output Range Setting Linear **2 milliamps per volt,** put Switch S1-7 in the ON position. and Switch S3-7 in the OFF position.
5. For Output Range Setting **Log,** put Switch S3-7 in the ON position, S1-7 doesn't matter.

Vout by Current Decade

V-out	Ion Pump Current
0.0 v	0.02 microamp or less
1.0 v	0.1 microamp (10^{-7} amp)
2.0 v	1.0 microamp (10^{-6} amp)
3.0 v	10 microamp (10^{-5} amp)
4.0 v	100 microamp (10^{-4} amp) >>>>
5.0 v	1 milliamp (10^{-3} amp)
6.0 v	10 milliamp (10^{-2} amp)
7.0 v	100 milliamp (10^{-1} amp)
8.0 v	1 amp (10^{0} amp)

Example: Vout 200 to 900 microamp

V-out	Ion Pump Current
4.30 v	200 microamp (2 x 10^{-4} amp)
4.47 v	300 microamp (3 x 10^{-4} amp)
4.60 v	400 microamp (4 x 10^{-4} amp)
4.7 v	500 microamp (5 x 10^{-4} amp)
4.79 v	600 microamp (6 x 10^{-4} amp)
4.84 v	700 microamp (7 x 10^{-4} amp)
4.90 v	800 microamp (8 x 10^{-4} amp)
4.95 v	900 microamp (9 x 10^{-4} amp

Figure 21: Logarithmic V-out vs. Ion Pump Current

For a convenient reference on logarithm tables:
http://www.sosmath.com/tables/logtable/logtable.html

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I. Internal DIP Switch Settings

There are three internal DIP switches located near the front of the main printed circuit board inside the unit. (See Figure 20, Q-5/6/7)
NOTE: Remove the power cord before opening the unit.

DIP Switch S1 (Figure 18, grid Q-5/6)

The following shows the functions and default values for DIP Switch S-1. The factory default settings for this switch are shown below. The settings of this switch are displayed in hexadecimal format on the right two digits of the CURRENT display during start-up.

S1-1 Display HV #1 Polarity Default OFF=Positive (+); ON=Negative (-). (S3-8 for HV #2)
S1-2 Power Loss Restart; Default OFF=Disabled; ON=Enabled.
S1-3 * Remote HV Control Mode Set-Up; Default OFF=Disabled; ON=Enabled.
S1-4 * Remote HV Control Mode Set-Up, Default OFF=Disabled; ON=Enabled.
S1-5 Factory Diagnostic, Pascal Units Only; Default OFF=Disabled; ON=Enabled.
S1-6 Test Mode; Default OFF=Disabled; ON=Enabled
S1-7 Current Monitor #1, OFF=200 microamp/V; ON=2 mA/V Default
S1-8 Current Monitor #2, OFF=200 microamp/V; ON=2 mA/V Default
Note: Settings for S1-7 and S1-8 have no effect when S3-7 is set to ON, LOG output.

Figure 22: DIP Switch - S1 - Settings

DIP Switch S2 (Figure 18, grid Q-6)

The switches on DIP switch S2 are used to set up **only** the RS 485 address, binary, 1-255, S2-1=LSB, S2-8=MSB. Default is S2-1 and S2-3 ON, all others OFF. (RS 485 address = 5).

DIP Switch S3 (Figure 18, grid Q-7)

S3-1 and S3-2 Serial Port 1 Configuration -- External Port
- 232 S3-1=ON, S3-2=ON (Default)
- 422 S3-1=OFF, S3-2=ON
- 485 S3-1=OFF. S3-2=OFF

S3-3 and S3-4 Serial Port 2 Configuration -- Internal Port; Factory Use Only
- 232 S3-3=ON, S3-4=ON (Default)
- 422 S3-3=OFF, S3-4=ON
- 485 S3-3=OFF. S3-4=OFF

S3-5, Serial Port 1, checksum enabled=ON, Default=OFF
S3-6, Serial Port 2, checksum enabled=ON, Default=OFF
S3-7, Current Monitors 1 & 2, Output Format, ON=Log, OFF=Linear (Default)
S3-8, Display HV #1 Polarity Default OFF=Positive (+); ON=Negative (-) (S1-1 for HV #1)

Figure 23: DIP Switch S3 Settings

J. Internal Jumper Settings

Jumper	Location	Function
JP8	B-5	HV #1 POLARITY: 1-2 POS, 12 VDC J9-13 (DEFALUT), 2-3 NEG; 12 VDC J9-13
JP9	R-8	BEEPER ENABLE, ON-ENABLE BEEPER (DEFAULT) OFF-DISABLE BEEPER
JP13	B-5	HV #2 POLARITY: 1-2 POS, 12 VDC J31-18 (DEFALUT), 2-3 NEG; 12 VDC J31-16

Figure 24-Internal Jumper Settings

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K. Fuses:

The fuses are located in the power input module on the back panel.
There are two fuses: 2 amp, type S, Slow Blow.

Replacement types are:
Bussman GDC-2A or
Littlefuse 218 002

L. High Voltage Cables --

From: Model 752 - Kings Type - 10KV to: Ion Pump

Bakeable, Radiation Resistant Tefzel(tm) Coaxial Cable with Ground Return

Pump End Connector	Cable Part Number	
Standard Varian	Standard	V-410-10
Varian StarCell R	Standard	S-410-10
Varian Mini	Standard	M-410-10
Varian Interlock	Bakeable	FS-410-10
P-E/Ultek	Standard	P-410-10

Duniway Stockroom Corp. has the parts and knowledge to build a large variety of cables:
Hybrid Vendor Cables, Virtually Any Length,Bakeable - Non- Bakeable
Custom Coax Wire, Custom Shielding
Duniway Stockroom Corp. also supplies High Voltage Feedthroughs for all the common ion pumps; as well as rebuilding services and parts. For more details, prices or special cables, please call Duniway Stockroom Corp. or go to our web page at **www.duniway.com**.

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V Warranty & CE Declaration

Terranova products of Duniway Stockroom Corp. are warranted 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 items. Shipping damage is excluded from the scope of this warranty. Gauge tubes 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 Duniway Stockroom receives notice of such defects during the warranty period. Duniway Stockroom will repair or replace firmware that does not execute its programming instruction due to such defects. Duniway Stockroom does not warrant that the operation of the firmware or hardware will be uninterrupted or error-free.

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

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

1. *Improper or inadequate maintenance by 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. DUNIWAY STOCKROOM DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

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

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DECLARATION OF CONFORMITY

We, Duniway Stockroom Corp., declare under our sole responsibility, that the following products, displaying the CE mark on the rear panel:

Model 751A Ion Pump Control Unit
Model 752 Ion Pump Control Unit

to which this declaration relates, are in conformity with the following standards or normal documents

EMC Directive (89/336/EEC//93/68/EEC)
Electromagnetic Compatibility Standards:
EN 50081-1: 1992, EN 50082-1: 1993
EN 61326: 1997/A1: 1998/A2: 2002

Low Voltage Directive (73/23/EEC//93/68/EEC)
Electrical/Technical Safety Standard:
EN 61010-1: 1993/A2: 1995: 2001

following the provisions of the EMC directive (89/336/EEC)

UL and CSA Listing

Safety of Electrical Equipment for Laboratory Use
UL61010A-1, Issued 2002/01/30
CAN/CSA C22.2 No. 1010.1-92, 97

2003309

April 2007

by: Sherman Rutherford
Compliance Manager

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