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VARIAN

senTorr™ Gauge Controller

Instruction Manual

Manual No. 6999-08-165
Revision G
February 1999

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November, 1995

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The following format is used in this manual to call attention to hazards.

WARNING

Warnings are used when failure to observe instructions or precautions could result in injury or death to humans.

CAUTION

Cautions are used when failure to observe instructions could result in significant damage to equipment and/or facilities.

NOTE

Notes contain information to aid the operator in obtaining the best performance from the equipment.

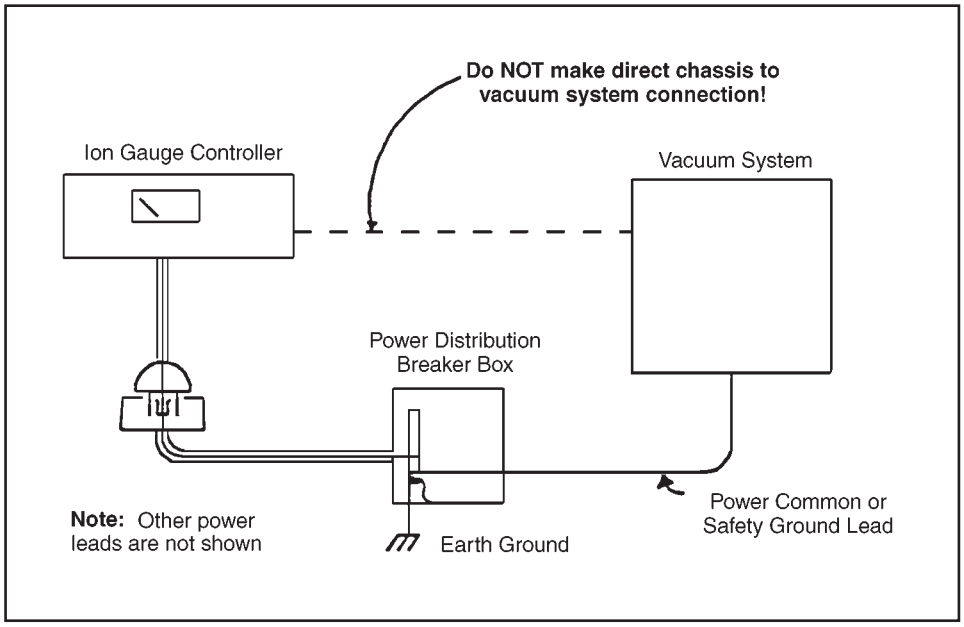
⚠ WARNING

Check that your Ion Gauge Controller and vacuum system are separately grounded to a common ground.

Placement of a ground wire between the vacuum chamber and the controller chassis is not safe; large continuous currents could flow through it.

Personnel could be killed by high voltages (160 to 900 volts may be present in an improperly grounded system).

Make absolutely sure that your vacuum system is grounded as shown in the following schematic diagram; test the system ground be sure that it is complete and capable of supporting at least 10 amperes.



An independent agency has determined that **all** vacuum chambers regardless of manufacture, can possibly become charged to lethal voltage levels, under certain conditions, if they are not grounded with a quality, common ground with the controller of their ionization tube.

After each maintenance/service procedure and before operating the controller and vacuum system, verify the integrity of the ground of both units; **failure to do so could cost you your life!**

WARNING

This equipment contains high voltages (up to 3000 volts), high enough to produce electric shock and cause death or serious injury.

Equipment utilizing these controls should be designed to prevent personal contact with high voltages.

Always break the primary circuit when direct access to the control unit is required.

EMC Warnings

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

FCC

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE

The equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generated, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment ina residential area is also likely to cause harmful radio communications interference in which case the user will be required to correct the interference at his own expense.

Installation Requirements

To maintain compliance with both the FCC Part 15 rules and the European Union's EMI directives the user must use a shielded cable constructed of a braided shield for the analog outputs and setpoint wiring. Metal or metallized plastic backshells directly connected to the cable shield at the 9 pos D-Sub connector if using serial communications. The shields of all I/O cables must be connected to ground at the users equipment. Failure to install the equipment. Failure to install the equipment in this way may result in the unit no longer meeting the requirements for radiated emissions and susceptibility.

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Section 1

INTRODUCTION AND DESCRIPTION

1-1 GENERAL

Varian's senTorr Gauge Controller is a complete, half-rack vacuum gauge controller that offers continuous, reliable pressure measurement from rough to high vacuum. The controller comes completely configured from the factory to operate one of six gauge tube configurations.

UHV2c	Two convectorrs and one UHV type HFIG
BA2	Two Thermocouples and one Bayard-Alpert gauge tube
BA2c	Two ConvecTorrs and one Bayard-Alpert gauge tube
CC2	Two Thermocouples and one Cold Cathode gauge tube
CC2c	Two ConvecTorrs and one cold cathode gauge tube
BA	One Bayard-Alpert gauge tube
CC	One Cold Cathode gauge tube

The senTorr Gauge Controller features one digital display per gauge tube. The displays are LED-driven providing clear and sharp pressure readings. The front panel keypad has practical lockout features that protect against unauthorized parameter inputs. Analog outputs and remote capabilities are located on the back panel. The external remote input controls turnon or turnoff of high-vacuum gauge emission.

Options include set points and RS232 or RS485/422 communication ability. Resistive (I^2R) degas is an option on Bayard-Alpert models, E-beam degas on the UHV models. The set point option includes four set points, one for each gauge tube plus an additional set point that can be assigned to any one of the three gauge tubes.

The senTorr offers an extraordinary amount of gauging and programming capability while still remaining easy to use. The operator can access all of the instrument's functions and parameters through the front panel keypad or the optional serial link.

1-2 SPECIFICATIONS

Power Requirements — 90 to 127 VAC, 50/60 HZ
208 to 250 VAC, 50/60 HZ

The senTorr is fitted with an internal switch to accommodate the desired power input.

Operating Temperature — 0 to 50°C

The senTorr meets all performance specifications (unless otherwise noted) at 25°C (+5°C) at 90 percent relative humidity, non-condensing.

Data Retention — The senTorr will retain its parameter values, upon power down or a power failure, for a period of four years accumulated off-time.

Size — Half-rack mount, 3.5" high by 8.0" wide by 15" deep

Optional rack-mounting kits are available for mounting one or two units in a standard 19-inch rack.

Cabling — The senTorr basic unit includes a 6-foot power cord and fuse set. Gauge cabling is available separately. Standard gauge cable lengths are 10, 25, 50, 75, and 100 feet. Longer cables (up to 500 feet) are available by special order. All cable connections are made at the rear of the unit.

Varian cannot guarantee compliance with FCC regulations for radiated emissions unless all external wiring is shielded. (See page iii)

HFIG Gauge (BA2, BA2c, BA, UHV, UHV2c models)

Minimum pressure capability	1.3×10^{-7} Pa/1×10^{-9} Torr (BA) 5.3×10^{-9} Pa/4×10^{-11} Torr (UHV)
Maximum pressure capability	1.3×10^{-1} Pa/1×10^{-3} Torr (standard BA and UHV) 1.3×10^{1} Pa/1×10^{-1} Torr (broad-range BA)
Degas (optional)	Resistive, 1 hour timeout E-beam (UHV), 15 minute timeout
Sensitivity – Adjustable from 1.33/Pa to 1.31 x 10^{4}/Pa (1/Torr to 99/Torr)	1330/Pa (10/Torr) standard BA default value 1064/Pa (8/Torr) broad range BA default value 3325/Pa (25/Torr) UHV default value
Emission current (Adjustable from 0.1 mA to 9.9 mA)	4 mA (standard BA and UHV) 0.1 mA (broad range BA)
Analog output	1 V/decade 0 V for “OFF”, “- -”, and “xxE” conditions Optional Linear Recorder Out available
Auto-on (standard)	available on BA2, BA2c, and UHV2c configurations only, set to TC1 only

Cold Cathode Gauge (CC2 CC2c, IMG, IMG2c models)

Minimum pressure capability	1.3×10^{-6} Pa/1×10^{-8} Torr (CC models) 5.3×10^{-9} Pa/4×10^{-11} Torr (IMG models)
Maximum pressure capability	1.3 Pa/1×10^{-2} Torr
Operating voltage	–2 kV (CC models) +3 kV (IMG models)
Sensitivity – Adjustable from 133A/Pa to 1.31 x 10^{4} A/Pa (1 A/Torr to 99 A/Torr)	(5 A/Torr) CC default value (2 A/Torr) IMG default value
Analog output	1 V/decade Optional Linear Recorder Out available
Auto-on (standard)	available on CC2, CC2c, IMG2c configurations only, set to TC1 only

Thermocouple and Convectorr Gauge (BA2, CC2, BA2c, CC2c, UHV2c, IMG2c models)

Minimum pressure capability	1.3×10^{-1} Pa/1×10^{-3} Torr
Maximum rated pressure capability	266 Pa/2 Torr (TC models) 1.3×10^{5} Pa/1000 Torr (ConvecTorr models)

Heater current	165 mA ± 10% (TC models)
Calibration (two points)	1.3×10^{-1} Pa/1×10^{-3} Torr (vacuum) 1.0×10^{5} Pa/7.6×10^{2} Torr (atmosphere)
Auto-on threshold (available on TC1 only)	1.3×10^{-1} Pa to 6.6 Pa (1×10^{-3} Torr to 5×10^{-2} Torr)
Analog output	1 V/decade 1 V at 1.3×10^{-1} Pa/1×10^{-3} Torr 7 V at 1.3×10^{5} Pa/1000 Torr 10 V for “03E” condition Optional Linear Recorder Out available

Set Points (all models with Set Point option)

Set Points	floating SPDT relays with NO, NC, and C terminals
Contact rating	3 A at 24 VDC/250 VAC, gold-flashed

Remote Input (all models)

Input	3 to 32 VDC, 500 ohms minimum to activate high-vacuum gauge (optically-isolated and floating level-sensitive)

Options Available

Bayard-Alpert Configurations

Up to three optional plug-in printed circuit boards can be user-installed in the UHV, UHV2c, BA2, BA2c, and BA configurations, with the following restrictions: one set point board, one degas board, and one communications board, either RS232 or RS485/422.

Cold Cathode Configurations

Up to two optional plug-in printed circuit boards can be user-installed in the CC2, CC2c, and CC configurations, with the following restrictions: one set point board and one communications board, either RS232 or RS485/422

1-3 FRONT PANEL

The front panel display of the senTorr 7-segment, LED digits and LED annunciators. These provide continuous, crisp readings, with no directional bias. The display uses three LED colors to group information.

Green	pressure data and parameter values
Yellow	set point and parameter annunciators
Red	operational status legends

A single pressure display features four digits, two for the mantissa and two for the exponent. There is a pressure readout for each gauge, with the Bayard-Alpert or Cold Cathode display labeled “IG” and the two thermocouple or ConvecTorr displays labeled “TC1” and “TC2”, as applicable to the senTorr model.

Label	pressure displayed
IG	Bayard-Alpert or Cold Cathode (depending on the model)
TC1	Thermocouple one or ConvecTorr one
TC2	Thermocouple two or ConvecTorr two

The column of red LED legends indicates the following operational states.

Degas	hot filament ion gauge is degassing
Emis On	ion gauge is on
Auto-On	auto-on feature is programmed
mBar	pressure measurements units are mBar
Torr	pressure measurement units are Torr
Cal	calibrating thermocouples or ConvecTorrs
Hyst	programming set point hysteresis

The keypad is a sealed membrane-type, with tactile feedback. There are eleven keys, some of which are dual function.

To determine the ordering number, select the desired configuration as follows:

Basic Configurations

One Ion Gauge												
BA – Bayard-Alpert (563, 564, 571, 572, 580)	**L**	**9**	**1**	**2**	**0**	**3**	**0**	**1**	**X**	**X**	**0**	**X**
CC – Standard Cold Cathode (524, 525)	**L**	**9**	**1**	**2**	**1**	**3**	**0**	**1**	**X**	**X**	**0**	**X**
UHV – Ultra-High-Vacuum Nude Gauge (UHV-24)	**L**	**9**	**1**	**1**	**0**	**3**	**0**	**1**	**X**	**X**	**0**	**X**
IMG – Ultra-High-Vacuum Inverted Magnetron	**L**	**9**	**1**	**1**	**1**	**3**	**0**	**1**	**X**	**X**	**0**	**X**
One Ion Gauge, Two Thermocouple Gauges												
BA2	**L**	**9**	**1**	**2**	**0**	**3**	**0**	**2**	**X**	**X**	**0**	**X**
CC2	**L**	**9**	**1**	**2**	**1**	**3**	**0**	**2**	**X**	**X**	**0**	**X**
One Ion Gauge, Two ConvecTorr Gauges												
BA2c	**L**	**9**	**1**	**2**	**0**	**3**	**0**	**3**	**X**	**X**	**0**	**X**
CC2c	**L**	**9**	**1**	**2**	**1**	**3**	**0**	**3**	**X**	**X**	**0**	**X**
UHV2c	**L**	**9**	**1**	**1**	**0**	**3**	**0**	**3**	**X**	**X**	**0**	**X**
IMG2c	**L**	**9**	**1**	**1**	**1**	**3**	**0**	**3**	**X**	**X**	**0**	**X**

Setpoint Options

No Setpoints	0
Setpoints	1

Degas Options

No Degas	0
Degas (BA resistive, UHV E-Beam)	1

Communications Options

No Communications	0
RS-232	1
RS-232 Fiber Optic	2
RS-422	3
RS-485	4

1-4 PART NUMBERS AND DESCRIPTIONS

1-5 SERIAL COMMUNICATION

The senTorr offers computer interface options allowing complete operation of the unit remotely via serial link. The RS232 option consists of a plug-in printed circuit board (Varian part no. L9141301) available with either a 9-pin, D-subminiature connector or fiber optic connectors (fiber-optic board, Varian part no. L9141302). It allows complete operation of the Multi-Gauge via a computer using serial communication. All of the keypad functions (except for the baud rate settings and the display output) are accessible through the RS232 bi-directional computer link.

The RS485/422 computer interface option is available as a plug-in printed circuit board (Varian part no. L9143301). This senTorr option provides serial communications capability as specified in EIA (Electronic Industry Association) standard 422 and 485. Both employ differential line drivers and receivers, and are capable of communicating to distances of 4000 feet at 19,200 baud in a multidrop scheme, with up to 32 senTorr units.

Refer to Varian manual 6999-08-170 provided with the serial communication option for further information.

Section II

PREPARATION FOR USE

2-1 UNPACKING

Each senTorr unit is inspected and carefully packed prior to shipment. If the unit arrives damaged, save the packing material and immediately notify the carrier. Because the packing materials are designed specifically for this instrument, they should always be used when transporting the unit. The shipping container is packed with the following contents.

1 senTorr Basic Unit
1 A-C line cord
1 Instruction Manual
4 rubber adhesive feet for bench top use of the senTorr

2-2 INSTALLATION

NOTE

The unit is shipped with switch S1 (internal) set to 230 VAC.

Before operating the unit, it is necessary to set it for the proper line voltage level.

1. Open the unit by removing the two screws at the top rear of the unit then pivot the cover up

WARNING

Before servicing the unit, check that the line cord is not plugged into a power source. Observe all warnings and cautions printed on the cover.

and back to disengage the front lip. Lift off the cover.

2. Set the line voltage by moving line voltage selector switch S1 (Figure 2-1) to either the 115 VAC (for 110 VAC or 115 VAC, 50/60 Hz) or 230 VAC position (for 220 VAC or 240 VAC, 50/60 Hz).
3. Before replacing the top cover, check that switch S1 is correctly positioned, that all cables are properly plugged in, and there is no loose hardware or metal parts inside the senTorr unit. Replace the cover and secure it with the two screws.
4. Mount the unit using the desired rack-mounting kit, then attach the appropriate external gauge and system cables. Refer to Figure 2-2 for rear panel connections and Figure 2-3 for mounting dimensions.

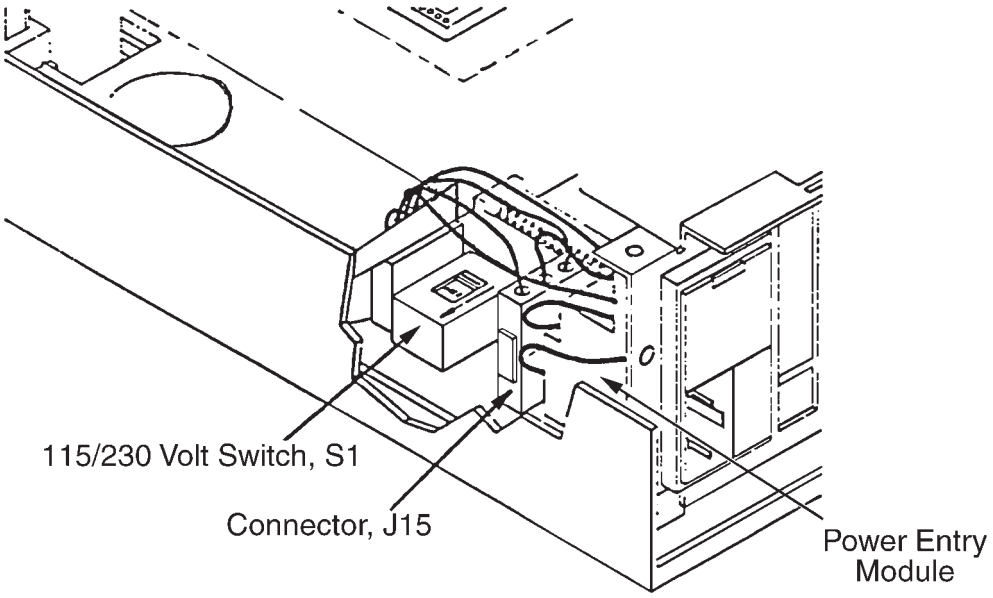


Figure 2-1. Setting Line Voltage

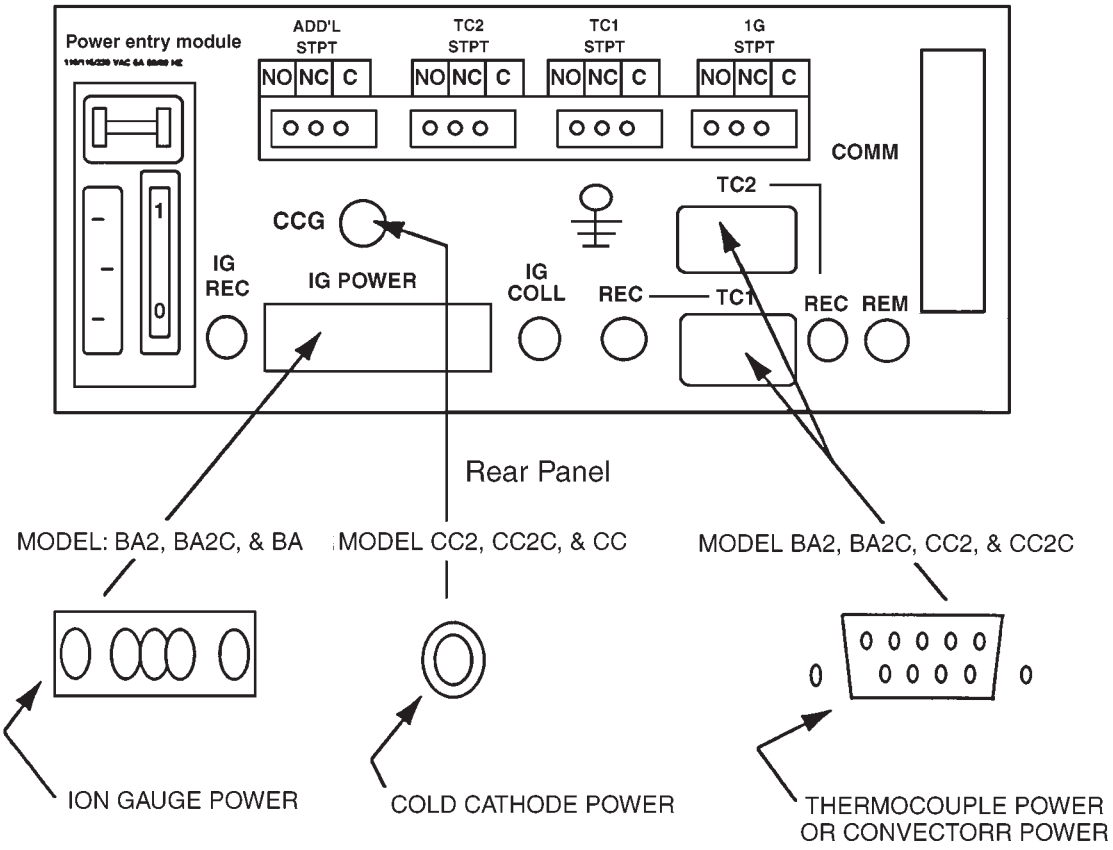


Figure 2-2. Rear Panel Connections

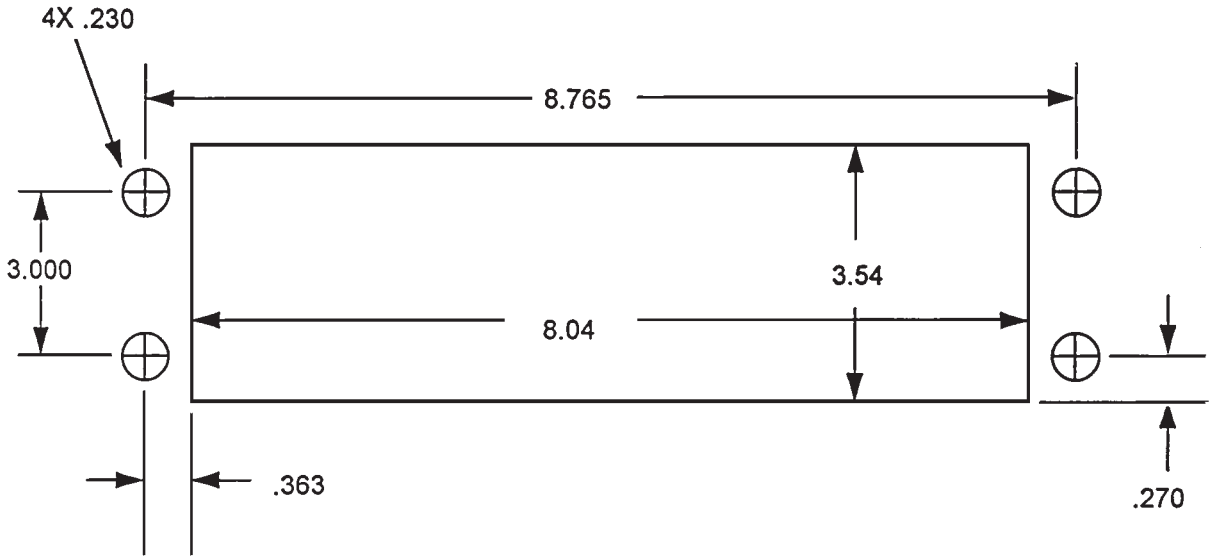


Figure 2-3. Panel Cutout Dimensions

Note: Bezel Trim Kit R0130301 can be used to hide gaps between senTorr case and panel)

Section III

OPERATION

3-1 KEYPAD FUNCTIONS

Refer to Figure 3-1 for the locations of the keys and display features described in following paragraphs. Following each key name are the senTorr models and the option (if any) to which the function applies. Note that some of the keys may not work unless a particular option has been installed.

1. Option Select Key (All Models)

Pressing the “Option Select” key puts the senTorr into the Program mode, as indicated by the flashing yellow annunciator. Repeated “Option Select” key presses single-steps the annunciator through the column of set points and parameters, returning the senTorr to the Run mode after the last key press. “Option Select” also acts as an “escape” key when pressed before the “Enter” key has been used to store a new digit setting.

Read Section 3-2, Parameter Programming, for further information.

2. Enter Key (All Models)

Pressing the “Enter” key advances the flashing cursor through a selected Program mode, and saves the setting when pressing “Enter” after the last digit.

3. UP and DOWN Arrows (All Models)

These keys are used to increment and decrement, respectively, digit values when entering data.

4. Stdby Key (All Models)

Pressing the “Stdby” key will power off all of the display, the fan, and the ion gauge tube. This is a low power shutdown; the unit will continue to provide power to the processor.

5. Units Key (All Models)

Pressing the “Units” key toggles the pressure measurement units between Torr, mBar and Pascal for all pressure readings. The front panel legends will reflect the pressure units, with both the Torr and mbar lamps extinguished for Pascal.

6. Cal Key (BA2, BA2c, UHV2c, CC2, CC2c, IMG2c Models)

This key is used to calibrate the vacuum and atmosphere readings for the thermocouple gauges. The red “Cal” legend will light when calibrating the TC's or ConvecTorrs.

7. Stpt Hyst Key (All Models, with set point option)

Used in conjunction with the “Option Select” program mode to display or program the set point hysteresis values. The red “Hyst” legend will light to indicate that the set point pressure being displayed is the hysteresis level (see para. 3-3).

8. Emis Key (All Models)

Pressing “Emis” turns the high vacuum gauge on or off. The hidden “Emis On” legend will light to reflect the on state of the ion emissions. The high vacuum gauge emissions will come on only if the appropriate vacuum has been achieved.

Emis Key (BA/UHV dual filament models)

Pressing the “Enter” key before pressing “Emis” uses the second filament.

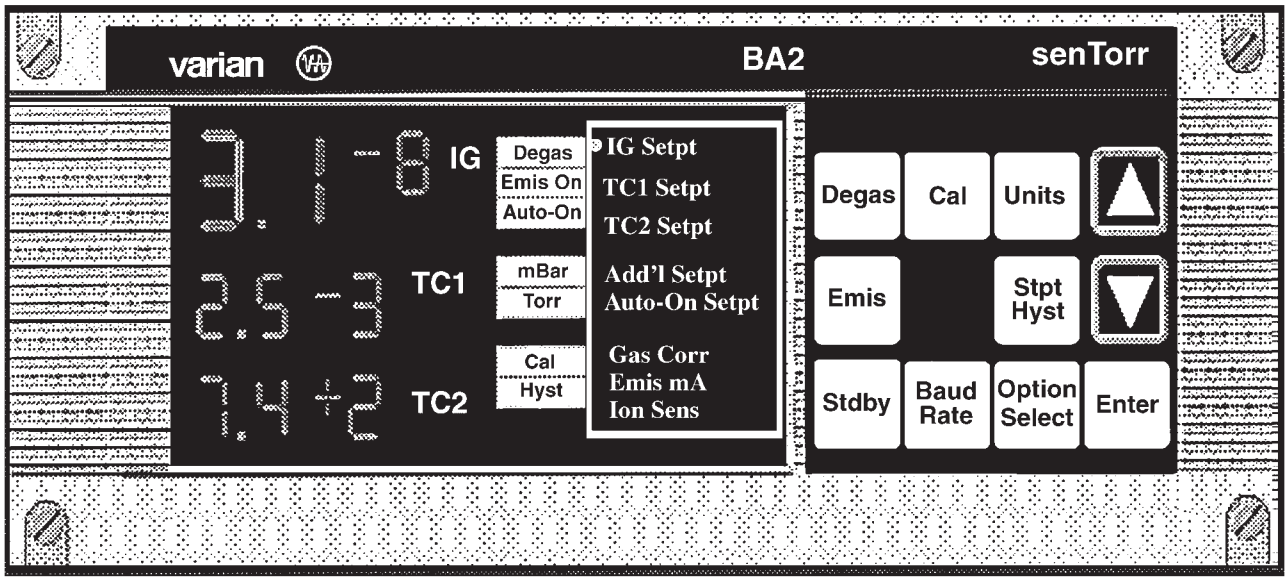


Figure 3-1. Front Panel, senTorr Gauge Controller

9. Baud Rate Key (All Models)

This key is used to display and set the serial communications baud rate, parity, and the controller address (for use in a multi-drop communication link.

After pressing “Baud Rate”, the baud rate will flash in the IG display mantissa. Use the arrow keys to select a baud rate of 1.2 (1200), 2.4 (2400), 4.8 (4800), 9.6 (9600), or 19 (19,200).

Press “Enter” to save the current flashing value as the baud rate and to advance to the parity setting, displayed in the IG display exponent. Use the arrow keys to select parity of O (Odd), E (Even), or “n” (none).

Press “Enter” to save the parity setting and to advance to the controller address setting, displayed in the IG mantissa. Use the arrow keys to select an address from 00 to 99. Once again, press “Enter” to save the address and exit the baud rate settings. This paragraph applicable to the RS 485/422 ONLY.

The default settings are 9600 baud with no parity and an address of 00.

10. Degas Key (BA, UHV Models, with degas option)

Can only activate if the pressure at the Bayard-Alpert ion gauge is less than 10^{-3} Pa/10^{-5} Torr. Pressing the “Degas” key will illuminate the hidden degas legend to reflect the state of the degas. Pressing the Degas key again will turn the degas function off. After engagement, the degas will automatically turn off after approximately 1 hour, for I^2R degas, 15 min for E-beam.The degas option must be installed to operate this function; if the user does not purchase the degas option, then this key has no effect.

3-2 PARAMETER PROGRAMMING

The set point and ion gauge parameters listed in a column on the front panel display (see Figure 3-1) can be viewed or programmed by putting the senTorr into the Program mode. To the left of each parameter is a single yellow LED.

If the yellow LED is flashing, that parameter is selected to the Program mode and its value is displayed in the corresponding gauge readout.

If the yellow LED is lit solidly, that menu item is active, meaning that the set point is energized or the ion gauge parameter has been changed from its default setting.

Enter the Program mode by pressing the “Option Select” key. The first available parameter, beginning from the top of the column and depending on the senTorr models and options installed, will flash in the appropriate gauge display. Repeated “Option Select” key presses will advance through the parameters, returning the unit to the Run mode after the last key press.

When the desired parameter has been selected, the up and down arrow keys can be used to set a new value to the flashing digit. The “Enter” key will advance the flashing through the digits, saving the new value after the last digit has been set.

NOTE

If the yellow LED is left flashing in the Program mode unattended for more than 5 seconds, the default will automatically return the annunciator to the Run mode.

A changed value will not be saved unless it has been “Entered” through all of its digits. The “Option Select” key can be used to “escape” from saving a changed value prior to “Enter”ing the last digit.

After the value has been saved, the whole setting will flash. Press “Enter” to re-program the value, or “Option Select” to advance to the next parameter. The senTorr will exit the Program mode if no keys are pressed for about 8 seconds.

To disable a set point, set its mantissa to “0.0”.

IG Setpt (All Models with Set Point option)

The ion gauge set point can be set to energize when the ion gauge pressure drops below the IG Setpt threshold setting. It will de-energize when the ion gauge pressure goes above the IG Setpt hysteresis setting (refer to Para. 3-3, Set Point Hysteresis). The IG Setpt pressure will flash in the IG display. Use the up and down arrow keys and the “Enter” key to set the digit values and advance through the digits.

TC1 Setpt (All models with Set Point option)

The TC1 set point can be set to energize when TC1 reads less than the TC1 Setpt threshold setting. It will de-energize when the TC1 pressure goes above the TC1 Setpt hysteresis setting (refer to Para. 3-3, Set Point Hysteresis). The TC1 Setpt pressure wll be displayed in the TC1 readout.

TC2 Setpt (All models with TC or Convectorrs with Set Point option)

The TC2 set point can be set to energize when TC2 reads less than the TC2 Setpt threshold setting. It will de-energize when the TC2 pressure goes above the TC2 Setpt hysteresis setting (refer to Para. 3-3, Set Point Hysteresis). The TC2 Setpt pressure wll be displayed in the TC2 readout.

Add'l Setpt (All Models with Set Point option)

The additional set point can be assigned to any of the gauges. When this parameter is selected, all three pressure displays will flash. Press the "Enter" key to assign the Add'l Setpt to the ion gauge, using the standard parameter programming method. If no value is set in the ion gauge display (mantissa = 0.0), the "Enter" key can be pressed again to assign the Add'l Setpt to TC1, or likewise to TC2.

Auto-On (BA2, BA2c, CC2, and CC2c Models)

The Auto-On function assigns TC1 as the turn-on source for the ion gauge. Press "Option Select" until the Auto-On Setpt annunciator is flashing. The Auto-On setting will be displayed in the TC1 readout.

The turn-on pressure can be set from 1.3×10^{-2} Pa to 6.6×10^{-1} Pa (1.0×10^{-3} Torr to 5.0×10^{-3} Torr) and additionally between 1.3 Pa to 6.6 Pa (1.0×10^{-2} Torr to 5.0×10^{-2} Torr), using the standard parameter programming method.

The ion gauge will turn on when TC1 reaches the programmed pressure. When the TC1 pressure rises 10 percent above the programmed Auto-On pressure, the ion gauge will turn off.

The Auto-On feature can be temporarily overridden by pressing the "Emis" key to turn the ion gauge off. It will go back into effect after the TC1 pressure rises above the programmed Auto-On pressure.

GasCorr (All Models)

The gas correction factor adjusts the ion gauge pressure calculation depending on the system gas. The gas correction value will be displayed in the IG readout. The default setting is 1.0, for N_2 (air). The setting can range from 0.1 to 9.9.

Refer to Appendix A for the Table of Gas Correction Factors.

Emis mA (All Models)

The emission current setting controls the hot filament gauge emission current. The programmed value will flash in the IG display. Use the standard parameter programming method to select a value from 0.1 mA to 9.9 mA. The default setting is 4 mA for standard gauges and 0.1 mA for broad-range Bayard-Alpert gauges (Varian models 564 and 580).

If the emission current is set less than or equal to 1.0 mA, it remains constant over all pressures. If the emission current setting is greater than 1.0 mA, it will be automatically reduced to one-tenth of the setting at pressures greater than 6.6×10^{-2} Pa (5×10^{-5} Torr). This feature extends filament life.

Ion Sens (All Models)

The ion gauge sensitivity compensates for the different gauge geometries. The current setting will flash in the IG display. Refer to Page 1-2 for the default sensitivity settings.

3-3 SET POINT HYSTERESIS

A set point will energize when the pressure of its pre-assigned gauge drops below the set point's programmed threshold pressure. The set point will de-energize when the gauge pressure rises above the set point hysteresis pressure. The set point hysteresis automatically defaults to 10 percent above the threshold value. This value can be changed by pressing the “Stpt Hyst” key. The red Hyst legend will light to indicate that the set point pressure being displayed is the hysteresis level.

The “Stpt Hyst” key will not function if the set point has not been programmed.

3-4 SET POINT RELAYS

CAUTION

The relay contacts are gold-flashed, making them suitable for logic-level switching. However, the application of AC or DC voltages greater than 20 V or 20 VA will cause erosion of the gold, even in just one switching cycle.

Refer to Figure 3-2 for set point option.

Find	Part #	Description	Qty on This Sheet
1	L9132002	Set Point Assy	1
2	641309621	Bracket	2
3	614412132	Screw	4
4	L6419301	Cable	1
5	5140687800	Connector Mate	4

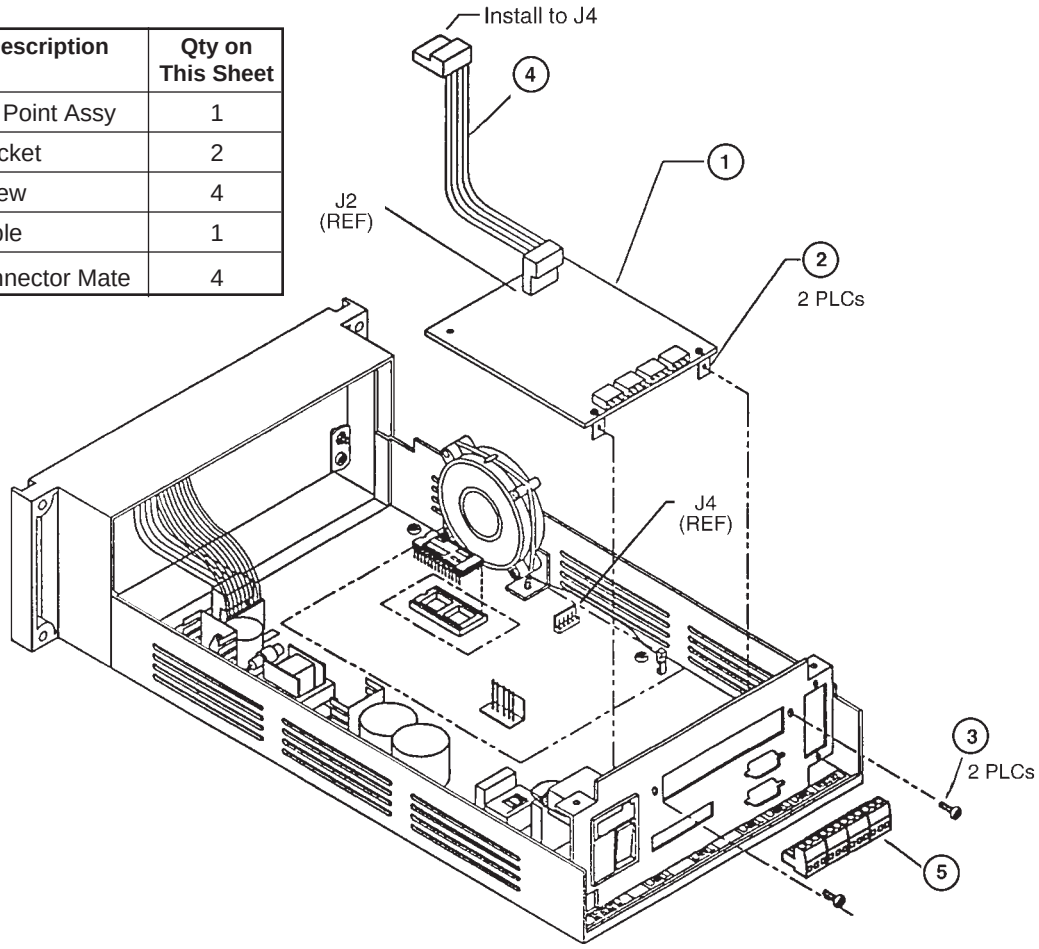


Figure 3-2. Set Point Option

3-5 RECORDER OUTPUT

Recorder output for each gauge is provided at the back of the unit. A two-conductor Micro Jax connector is plugged into each output. Varian strongly recommends the use of shielded wiring (coaxial cable) to maintain compliance with FCC regulations for radiated emissions. Refer to Figure 3-3 to assemble the cable. Any recorder with an imput impedance greater than 2,000 ohms and a full-scale input range of +10 V can be used.

The output reflects the displayed pressure of the gauges. Refer to Figures 3-4a and 3-4b for standard and linear output characteristics of the recorders.

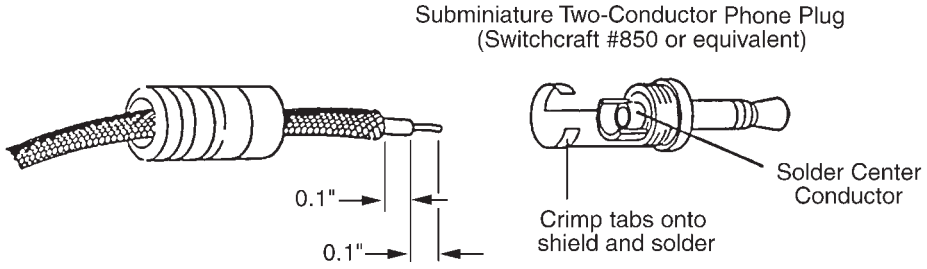


Figure 3-3. Assembling the Cable

Ion Gauge Algorithm: Converting recorder output voltage to pressure

To calculate the pressure from the voltage output

Example recorder output = 4.28 volts DC

To get the exponent, take the integer part of voltage output which is 4 and subtract 11:

4 – 11 = –7 (E-7)

To find the mantissa, take the fractional portion and add .1 to it and divide by .11

(.28 + .1)/.11 = 3.45

therefore:

4.28 VDC = 3.45E-7 Torr

TC ConvecTorr Algorithm: Converting recorder output voltage to pressure

To calculate the pressure from the voltage output

Example recorder output = 3.28 volts DC

To get the exponent, take the integer part of voltage output which is 3 and subtract 4:

3 – 4 = –1 (E-1)

Now to find the mantissa, take the fractional portion and add .1 to it and divide by .11:

(.28 + .1)/.11 = 3.45

therefore:

3.28 VDC = 3.45E-1 Torr

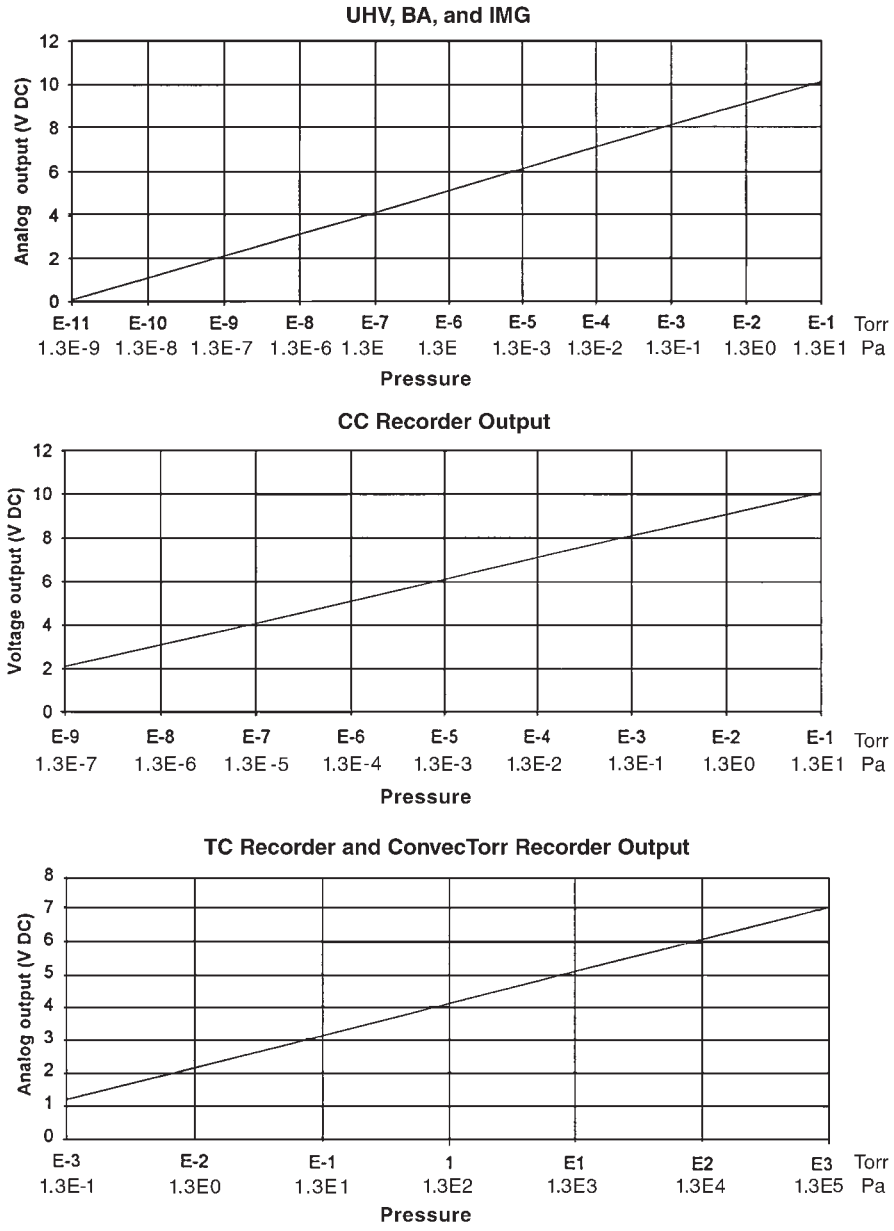


Figure 3-4a. Standard Recorder Output Characteristics

Optional Linear recorder output for TC configuration (requires optionally puchased firmware)

Pressure	Pressure	Voltage
≥133 Pa	≥1E +0 Torr	10
1.3 E1 Pa	1E-1Torr	1
6.6 Pa	5E-2Torr	0.5
1.3 Pa	1E-2Torr	0.1
≤1.3E-1 Pa	≤ 1E-3Torr	0.01
Error E03	Error E03	10.156 (over scale)

Linear recorder output option for BA and CC configurations

Full Scale Setting	Full-Scale Setting	Access Code
1.3E-1 Pa	1E-3 Torr	93 (Default)
1.3E-2 Pa	1E-4 Torr	94
1.3E-3 Pa	1E-5 Torr	95
1.3E-4 Pa	1E-6 Torr	96

Using a full-scale setting of 1E-3 Torr as an example:

Pressure	Pressure	Voltage
≥1.3E-1 Pa	≥ 1E -3 Torr	10
1.3E-2 Pa	1E-4 Torr	1
6.6E-3 Pa	5E-5 Torr	0.5
1.3E-3 Pa	1E-5 Torr	0.1
≤1.3E-4 Pa	≤ 1E-6 Torr	0.01
Exx/Off	Exx/Off	0

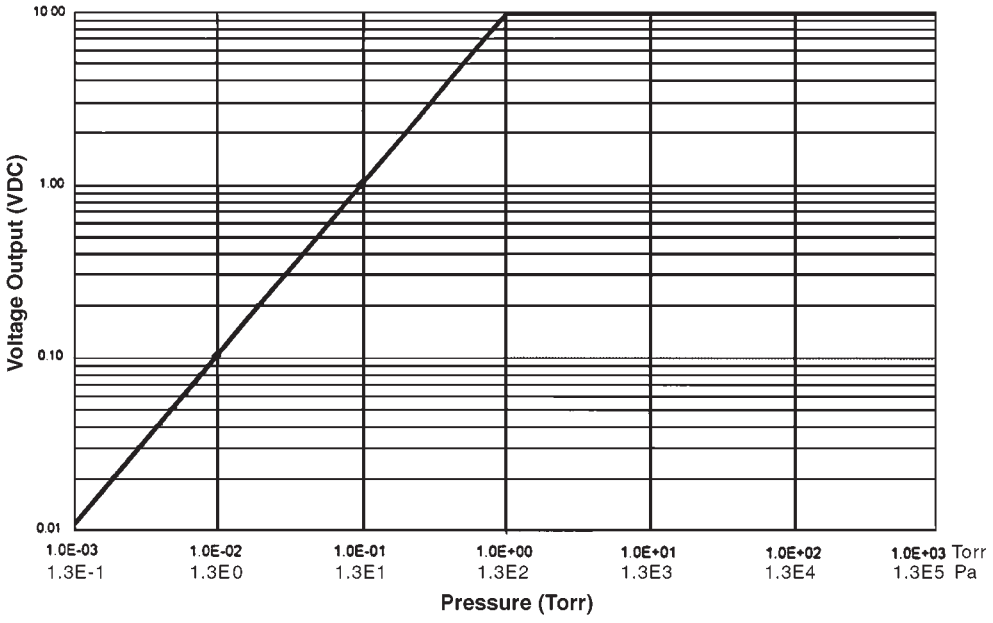


Figure 3-4b. Optional Linear Recorder Output Characteristics

3-6 TC AND CONVECTORR CALIBRATION

Expose the desired thermocouple or ConvecTorr to either atmospheric pressure or to a vacuum greater than 1.3×10^{-1} Pa (1×10^{-3} Torr).

Press the “Cal” key once to calibrate TC1, or twice to calibrate TC2. The respective pressure display will flash either 1×10^{5} Pa/7.6×10^{2} Torr (if the TC has been reading 1.3×10^{1} Pa/1.0×10^{-1} Torr or above) or 1.3×10^{-1} Pa/1.0×10^{-3} Torr (if the TC had been reading less than 1.3×10^{1} Pa/1.0×10^{-1} Torr).

Press the “Enter” key to save the calibration point, or press “Cal” to exit the calibration procedure.

Repeat the procedure for each TC at each end point.

3-7 ACCESS CODES

The senTorr offers several hidden features available through the keypad. This provides some protection for the operator and the system by requiring knowledge of the access code for the desired function. The access code is entered through the keypad sequence “Enter” then “Units”. Use the up and down keys to select the appropriate two-digit code, displayed in the IG readout, using the standard parameter programming method. The codes and their respective functions are:

Code	Function
33 A	Unlock keypad (default)
27 A	Lock keypad, except for Enter, Units, and arrow keys (to allow further access code entry)
17 A	Lock keypad, except for Enter, Units, arrow, Emis, and Degas keys (to prevent parameter changes)
81 A	Reset total system. All parameters except the baud rate settings revert to defaults, and the ion gauge turns off
71 A	Resets TC calibrations to system defaults
61 A	Removes all set point programming.
39A	Set Bayard-Alpert parameters (sensitivity, emission current, and over-pressure shutdown) to standard Bayard-Alpert values (default)
49 A	Set Bayard-Alpert parameters (sensitivity, emission current, and over-pressure shutdown) to broad-range Bayard-Alpert (Varian models 564 and 580) values
79 A	Set thermocouple or ConvecTorr pressure update to slow, allowing more stable readings through data averaging (default)
89A	Set thermocouple or ConvecTorr pressure update to fast, allowing faster response to pressure changes
56A	Enable E02 (pressure burst) and E06 (grid error) fault protection
52 A	Disable E02 (pressure burst) and E06 (grid error) fault protection. The senTorr will override these faults, for systems that are able to handle pressure spikes

3-8 SOFTWARE REVISION

The software revision can be displayed by pressing “Enter” then the down arrow. The revision will light in the IG display for several seconds.

3-9 DISPLAY TEST

By pressing “Enter” and the “Up” arrow, the entire display can be lit for several seconds. This feature can be used to verify LED function.

3-10 BATTERY BACKUP

The senTorr uses a lithium battery and CMOS RAM for storage of all system parameters during power outages or when powered down. Upon restoring power, the senTorr verifies the RAM content. If the RAM is good, the parameters will remain as previously saved; if the RAM is corrupted, all parameters will be reset to their default values.

If the ion gauge was on when power was lost, emission will NOT automatically be re-established unless the TC Auto-On function was programmed to do so.

3-11 ACCESSING SECOND FILAMENT

See Section 3.1, step 8 “EMIS Key” for controlling dual filament tubes.

Section IV

TROUBLESHOOTING

4-1 GENERAL

These troubleshooting procedures are provided to aid the operator in identifying failure modes. For further troubleshooting assistance or for the replacement of a board or unit, contact Varian Vacuum Products Service at 1-800-882-7426.

4-2 ERROR CODES

O2 E Pressure burst caused by a sudden rise in pressure at the ion gauge.

O3 E No ion current or measurement signal (e.g., bad or missing collector cable connection; bad electrometer; emission current too low; cold cathode pressure less than minimum pressure capability – see Specifications page 1-2)

O4 E Filament overcurrent (shorted filament circuit)

O5 E Filament undercurrent (open filament); cable not connected, bad control circuit or not installed correctly

O6 E Grid voltage low (grounded grid, bad grid supply)

O7 E Overtemperature (temperature inside unit over 65°C)

O8 E Board logic failure (bad component, electrical noise)

O9 E Overpressure (indicated pressure above high pressure limit of the ion gauge)

12 E Underpressure (indicated pressure beyond minimum pressure of ion gauge)

13 E Insufficient current (dirty cold cathode gauge, open cable connection)

14 E Invalid keypress (locked keypad)

⚠ WARNING

For continued protection against fire, both fuses must be replaced with fuses of the same type and rating as originally supplied; T, 5A, 250 V.

4-3 CHANGING LINE FUSES

On rare occasions, it may be necessary to change the AC line fuses due to age, overload, etc. There are two fuses which are located on the top of the power entry module marked with the outline of the fuses.

The fuses can be accessed by prying out the cover of the fuse holder with a small screwdriver after removing the power cable. The small fuse board can then be slid out of the holder by lifting the black plastic retainer. Refer to Figure 4-1, Fuse Replacement.

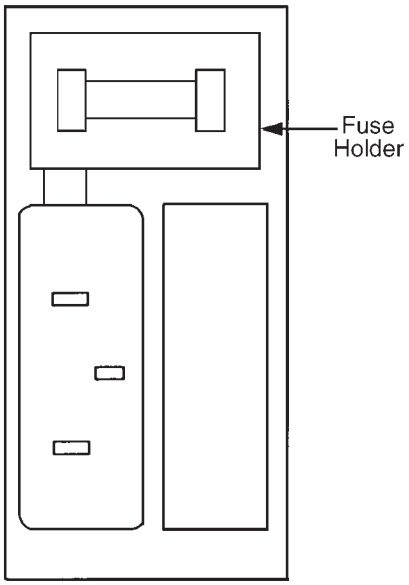


Figure 4-1. Power Entry Module

4-4 APPLICATION FOOTNOTES

Gas Correction

The gas correction factor tables are reproduced for the convenience of the user and do not imply that use with other gases will be safe with filament gauge controllers.

The senTorr gauge controller is normally calibrated to read pressure in nitrogen. To automatically convert readings of the senTorr to a different gas speciesd, enter the relative gas correction constant through the front panel key functions.

By entering the gas correction constant, the gauge will divide the result by the gas correction constant and display the correct adjusted value. However, a proper understanding for the transformation is required. The correction for the different gas species is purely mathematical. The sensitivity of the tube is affected by different gases, which, in turn, are responsible for the tube outpute being manipulated by the pressure equation. There will be some loss in resolution of the instrument when gas correction factors are used. The loss in resolution will become more apparent as the correction factors approach 0.5 from either direction.

When the correction constants are 0.1 or 10, the tube output is 1/10 or 10 times normal. This will cause the instrument to lose the high vacuum decade, respectively.

Programming Gas Correction

Enter the Program mode by pressing the “Option select” key. The first available parameter, beginning from the top of the column and depending on the senTorr model and options installed, will flash in the appropriate gauge display. Repeated “Option Select” key presses will advance through the parameters, returning the unit to the Run mode after the last key press.

When “Gas Corr” has been selected, the up and down arrow keys can be used to set a new value to the flashing digit. The “Enter” key will advance the flashing through the digits, saving the new value after the last digit has been set.

Emission mA

The Emission current is set to 4.00 mA as a default. The emission current will remain constant (4 mA) as long as the pressure is less than 1.3×10^{-3} Pa/1×10^{-5} Torr. The senTorr automatically reduces the current by a factor of 10 when the pressure is greater than 6.6×10^{-3} Pa/5×10^{-5} Torr. Thus, the emission current would drop to 0.4 mA. This promotes an extended pressure range measurement capability and/or prolongs tube life by protecting the filament.

Emission current can be adjusted from 10 µA to 9.99 mA through the keypad on the front panel of the senTorr unit. One reason why a user might possibly consider lowering the emission current is to prevent a small fluctuation in a pressure reading that may occur when operating just below 1.3×10^{-3} Pa/1×10^{-5} Torr and just above 6.6×10^{-3} Pa/5×10^{-5} Torr. If emission current is adjusted to <1 mA, the current will remain constant throughout the entire pressure range.

Another reason why a user might consider lowering the emission current pertains to the applications that require higher pressure readings from the gauge tube. The lower the emission, the higher in pressure the tube is able to measure. This also applies in the opposite direction; the higher the emission current is raised, the lower in pressure the tube can measure.

Programming Emission mA

Enter the Program mode by pressing the “Option Select” key. The first available parameter, beginning from the top of the column and depending on the senTorr model and options installed, will flash in the appropriate gauge display. Repeatedly pressing the “Option Select” key will advance through the parameters, returning the unit to the Run mode after the last key press.

When “Emis mA” has been selected, the up and down arrow keys can be used to set a new value to the flashing digit. The “Enter” key will advance the flashing through the digits, saving the new value after the last digit has been set.

Sensitivity

Default Sens		Tube
3325/Pa 1330/Pa	25/T 10/T	UHV 24 571, 572, 563
665A/Pa	5 A/T	525, 524
1064/Pa	8/T	580, 564
133A/Pa	1 A/T	Inv Mag CC

To improve the accuracy of pressure measurements, sensitivity can easily be adjusted to match gauge tube calibration.

Programming Sensitivity

Varian offers reference ionization B/A gauges, which are sealed off at approximately 6.6E-4 Pa/5E-6 Torr. These gauges are extremely helpful in troubleshooting a vacuum system problem by isolating the defective component. It is important to know that these reference ion gauge tubes are not NIST traceable calibrated gauges but act only as a load for the ion gauge controller.

Enter the Program mode by pressing the “Option Select” key. The first available parameter, beginning from the top of the column and depending on the senTorr model and options installed, will flash in the appropriate gauge display. Repeatedly pressing the “Option Select” key will advance through the parameters, returning the unit to the Run mode after the last key press.

When “Ion Sens” has been selected, the up and down arrow keys can be used to set a new value to the flashing digit. The “Enter” key will advance the flashing through the digits, saving the new value after the last digit has been set.

Troubleshooting Tips

- To aid in troubleshooting and to verify the integrity of the ion gauge controller or the cold cathode gauge itself, one can use a resistive dummy load. Obtain a 5.6 Meg ohm, 2 watt resistor. This value will simulate a pressure reading in the mid E-3 Pa/E-5 Torr region; higher resistor values than this will yield a lower pressure reading and lower resistor values will yield a higher pressure reading.
- Varian offers reference ionization B/A gauges, which are sealed off at approximately 6.6E-4Pa/5E-6 Torr. These gauges are extremely helpful in troubleshooting a vacuum system problem by isolating the defective component. It is important to know that these reference ion gauge tubes are not NIST traceable calibrated gauges but act only as a load for the ion gauge controller

⚠ WARNING

When connecting the resistive load to the back of the cold cathode gauge controller, –2000 volts DC will be present. Make sure the power is off to the unit. Keep all conductive type of material away from the back of the controller when troubleshooting.

The Customer is responsible for taking the necessary safety precautions to avoid electrical shock when performing this test.

Appendix A

GAS CORRECTION FACTOR TABLE

Gas correction factor tables are only reproduced for the convenience of the user and do not imply that use with other gases will be safe with hot filament gauge controllers.

The following table lists relative gauge gas correction factors for various gases. The values are derived by empirical methods substantiated by measurements reported in literature. This table has been compiled and published by Robert L. Summers of Lewis Research Center, NASA Technical Note TND-5285, National Aeronautics and Space Administration, Washington, DC, June 1969.

To automatically convert readings of the senTorr Controller (normally calibrated for nitrogen), enter the relative gas correction constant through the front panel key function GAS CORR. By entering the gas constant, the gauge will divide the result by the gas correction constant and display the correct adjusted value. However, a proper understanding for the transformation of the result is required. The correction for different gas species is purely mathematical. The sensitivity of the tube is affected by different gases which, in turn, are responsible for the tube output being manipulated by the pressure equation. There will be some loss in resolution of the instrument when gas correction constants are used. The loss in resolution will become more apparent as the correction constants approach 0.5 from either direction.

When the correction constants are 0.1 or 10, the tube output is 1/10 or 10 times normal. This will cause the instrument to lose the high vacuum decade or the near atmosphere decade, respectively.

Note: The default for Gas Correction is 1.

Gas Correction Factor Table

Substance	Formula	Relative Ionization Gauge Gas Correction Factor
Acetaldehyde	C_2H_4O	2.6
Acetone	$(CH_3)_2CO$	3.6 4.0 3.6
Acetylene	C_2H_2	1.9 2.0
Air		1.0 0.98
Ammonia	NH_3	1.3 1.2 1.3
Amylene: ISO· cyclo·	 ISO·C_5H_{10} CY·C_5H_{10}	 5.9 5.8
Argon	Ar	1.3 1.1 1.2 0.9
Benzene	C_6H_6	5.9 5.8 5.7 5.9 6.0
Benzoic Acid	C_6H_5COOH	5.5
Bromine	Br	3.8
Bromomethane	CH_3Br	3.7
Butane: n· ISO·	 n·C_4H_{10} ISO·C_4H_{10}	 4.9 4.7 4.6 4.9
Cadmium	Cd	2.3 3.4
Carbon Dioxide	CO_2	1.4 1.4 1.5 1.5 1.4
Carbon Disulfide	CS_2	5.0 4.7 4.8
Carbon Monoxide	CO	1.05 1.05 1.1
Carbon Tetrachloride	CCl_4	6.0 6.3
Cesium	Cs	4.3 2.0 4.8
Chlorine	Cl_2	0.68 2.6 1.6
Chlorobenzene	C_6H_5Cl	7.0
Chloroethane	C_2H_5Cl	4.0
Chloroform	$CHCl_3$	4.7 4.8 4.8
Chloromethane	CH_3Cl	2.6 3.2 3.1
Cyanogen	$(CN)_2$	2.8 3.6 2.7
Cyclohexylene	C_6H_{12}	7.9 6.4
Deuterium	D_2	0.35 0.38
Dichlorodifloromethane	CCl_2F_2	2.7 4.1
Dichloromethane	CH_2Cl_2	3.7
Dinitrobenzene o· m· p·	$C_6H_4(NO_2)_2$	 7.8 7.8 7.6
Ethane	C_2H_6	2.6 2.8 2.5
Ethanol	C_2H_5OH	3.6 2.9
Ethyl Acetate	$CH_3COOC_2H_5$	5.0

Substance	Formula	Relative Ionization Gauge Gas Correction Factor
Ethyl ether	$(C_2H_5)_2O$	5.1 5.1
Ethylene	C_2H_4	2.3 2.4 2.2 2.2 to 2.5
Ethylene oxide	$(CH_2)_2O$	2.5
Helium	He	0.18 0.15 0.13 0.12
Heptane	C_7H_{16}	8.6
Hexadiene: 1.5· cyclo·	 1.5·C_5H_{10} CY·C_6H_{10}	 6.4 6.0
Hexane	C_6H_{14}	6.6
Hexene: 1· cyclo	 1·C_6H_{12} CY·C_6H_{10}	 5.9 6.4
Hydrogen	H_2	0.46 0.38 0.41 0.45 0.44
Hydrogen Bromide	HBr	2.0
Hydrogen Chloride	HCl	1.5 1.6 2.0 1.5
Hydrogen Cyanide	HCN	1.5 1.6
Hydrogen Floride	HF	1.4
Hydrogen Iodide	HI	3.1
Hydrogen Sulfide	H_2S	2.2 2.2 2.3 2.1
Iodine	I_2	5.4
Iodomethane	CH_3I	4.2
Isoamyl Alcohol	$C_5H_{11}OH$	2.9
Isobutylene	C_4H_8	3.6
Krypton	Kr	1.9 1.7 1.7
Lithium	Li	1.9
Mercury	Hg	3.6
Methane	CH_4	1.4 1.5 1.6 1.4 to 1.8 1.5 1.5
Methanol	CH_3OH	1.8 1.9
Mehtyl Acetate	CH_3COOCH_3	4.0
Mythyl ether	$(CH_3)_2O$	3.0 3.0

Substance	Formula	Relative Ionization Gauge Gas Correction Factor
Naphthalene	$C_{10}H_8$	9.7
Neon	Ne	0.30 0.31
Nitrobenzene	$C_6H_5NO_2$	7.2
Nitrogen	N_2	1.0
Nitrotoluene (o·, m·, p·)	$C_6H_4CH_3NO_2$	8.5
Nitric Oxide	NO	1.3 1.2 1.0
Nitrous Oxide	N_2O	1.5 1.7 1.7 1.3 to 2.1
Oxygen	O_2	1.0 1.1 0.9 0.9
Pentane n· ISO· neo·	 n·C_5H_{17} ISO·C_5H_{17} $(CH_3)_4C$	 6.2 6.0 5.7 6.0 5.7
Phenol	C_6H_5OH	6.2
Phosphine	PH_3	2.6
Potassium	K	3.6
Propane	C_3H_8	4.2 3.7 3.7 to 3.9 3.6
Propene oxide	C_3H_6O	3.9
Propene: n· cyclo·	 n·C_3H_6 cy·C_3H_6	 3.3 3.2 to 3.7 3.6
Rubidum	Rb	4.3
Silver perchlorate	$AgClO_4$	3.6
Sodium	Na	3.0
Stannic iodide	SnI_4	6.7
Sulphur Dioxide	SO_2	2.1 2.3
Sulphur Hexafloride	SF_6	2.3 2.8
Toluene	$C_6H_5CH_3$	6.8
Trinitrobenzene	$C_6H_3(NO_2)_3$	9.0
Water	H_2O	1.1 1.0 0.8
Xenon	Xe	2.9 2.2 2.4
Xylene: o· p·	 o·$C_6H_4(CH_3)_2$ p·$C_6H_4(CH_3)_2$	 7.8 7.9

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Health and Safety Clearance
Return Authorization Policy

In compliance with Federal OSHA Safety Standard 1910.1200, Hazard Communications "Right to Know," Varian is enforcing that standard to preclude the potential health risk to its service personnel that can occur when receiving, disassembling, or repairing potentially contaminated products.

Returned products not accompanied by this completed certificate will be held until the completed certificate is received; failure to provide this completed certificate within 30 days of notification will result in the return of held product(s) **unprocessed**.

If a product is received at Varian in a contaminated condition, the customer will be held responsible for all costs incurred to ensure the safe handling of the product.

Company Name: _____

_____ Hereby certify that the product(s) listed below have been cleaned of all hazardous residue and that the residue remaining is of a non-hazardous nature.

_____ Hereby certify that the product(s) listed below have been contaminated by the following toxic or hazardous materials:

RA Number	Model Number	Serial Number
_____	_____	_____

_____ _____ _____
Authorized Signature Title Date

Note: Varian Service will only accept contaminated **Turbo or Mechanical Pumps.** All other products must be decontaminated by the customer before Varian Vacuum Products Lexington will assign a Return Authorization (RA) number and authorize the return of the product (refer to the attached Return Authorization Report on the next page).

Note: Varian Vacuum Products Lexington cannot accept any biological hazards, radioactive material, organic metals, or mercury at its facility.

Varian Vacuum Products
21 Hartwell Avenue
Lexington Massachusetts 02421
Telephone (781)861-7200
FAX (781)860-5405

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VPD Service Operation

Returned Material Report

This report must accompany all products returned for repair, replacement, or warranty evaluation. Full information regarding reasons for return of the product will expedite repair or adjustment. Please fill in all blanks below and furnish any other information which will help identify the nature and cause of failure.

Reason for Return (check appropriate box)

❒ Paid Repair ❒ Advance Exchange ❒ Shipping Error ❒ Credit

❒ Warranty Evaluation ❒ Loaner Return ❒ Shipping Damage

Product Information (use separate forms if more than one model no.)

Varian Model No. _____ Serial No. _____ Quantity _____

Part Description _____

Purchase Information (if product is being returned for warranty evaluation, show your original purchase order number and date purchased)

Varian Sales Order No. (if available) _____ Machine # _____

Original Purchase Order No. _____ Purchase Order Date _____

Company Name _____ **Contact** _____

Address _____

City _____ **State** _____ **Zip** _____

Telephone _____

Failure Report (describe in detail suspected cause or nature of malfunction)

_____

_____

_____

_____

_____

Returned Products

All products returned to Varian/VPD Service Operation for warranty evaluation must be sent **prepaid** and customer must comply with the **warranty replacement and adjustment** provision set forth in the warranty.

Ship directly to: Varian Vacuum Products
Vacuum Products Service Center
121 Hartwell Avenue
Lexington, MA 02421

All products sold by Varian and returned by customer are subject to Varian Vacuum Products standard terms and conditions of sale including, but not limited to, the warranty and damages and liability provisions set forth in the warranty.

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