17208 Discovery 18

17150 cleaning procedure for cold cathode gauge

varian
vacuum products

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senTorr Gauge Controller

Instruction Manual

Manual No. 6999-08-165
Revision E
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November, 1995

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SAFETY CONSIDERATIONS

READ THE FOLLOWING INSTRUCTIONS;
TAKE ALL NECESSARY PRECAUTIONS

HAZARDS

Operators and service personnel must be aware of all hazards associated with this equipment. They must know how to recognize hazardous and potentially hazardous conditions, and know how to avoid them. The consequences of unskilled, improper, or careless operation of the equipment can be serious. This product must only be operated and maintained by trained personnel. Every operator or service person must read and thoroughly understand operation/maintenance manuals and any additional information provided by Varian Associates. All warnings and cautions should be read carefully and strictly observed. Consult local, state, and national agencies regarding specific requirements and regulations. Address any safety, operation, and/or maintenance questions to your nearest Varian office.

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 SERIOUS INJURY OR DEATH.

CAUTION
CAUTIONS ARE USED WHEN FAILURE TO OBSERVE INSTRUCTIONS COULD RESULT IN DAMAGE TO EQUIPMENT, WHETHER VARIAN-SUPPLIED OR OTHER ASSOCIATED EQUIPMENT.

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

SAFETY CONSIDERATIONS

READ THE FOLLOWING INSTRUCTIONS;
TAKE ALL NECESSARY PRECAUTIONS

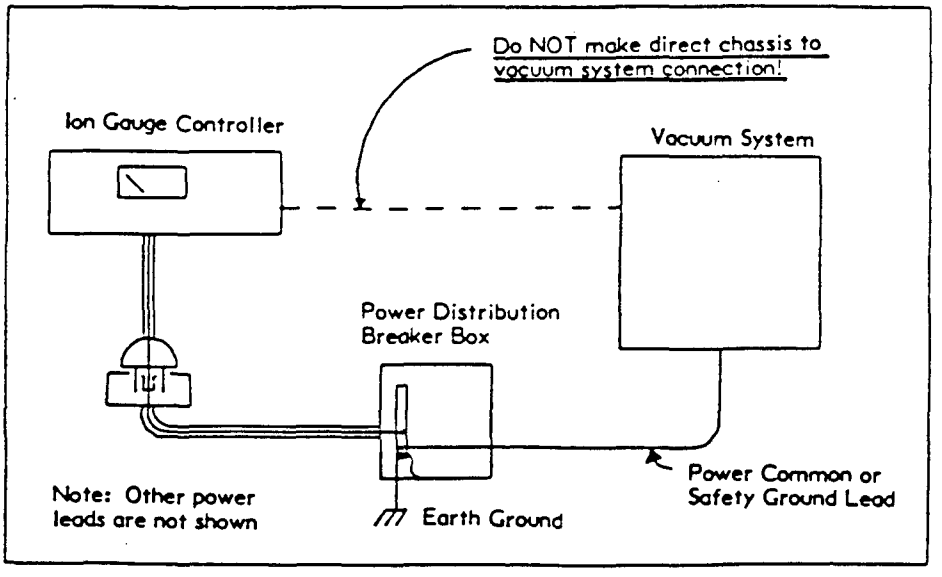
⚠WARNING

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 to 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!

SAFETY CONSIDERATIONS

READ THE FOLLOWING INSTRUCTIONS;
TAKE ALL NECESSARY PRECAUTIONS

⚠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.

SAFETY CONSIDERATIONS

READ THE FOLLOWING INSTRUCTIONS;
TAKE ALL NECESSARY PRECAUTIONS

Note

This 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 generates, 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 in a 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.

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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.

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 . 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.

Bayard-Alpert Gauge (BA2, BA2C, and BA models)

Minimum pressure capability	1×10^{-9} Torr
Maximum pressure capability	1×10^{-3} Torr (standard BA) 1×10^{-1} Torr (broad-range BA)
Degas (optional)	40 watts, resistive
Sensitivity (1/Torr to 99/Torr)	10/Torr (standard BA) 8/Torr (broad range BA)
Emission current (0.1 mA to 9.9 mA)	4 mA (standard BA) 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, CC2, and CC2C configurations only, set to TC1 only

Cold Cathode Gauge (CC2 and CC models)

Minimum pressure capability	1×10^{-8} Torr
Maximum pressure capability	1×10^{-2} Torr
Operating voltage	-2 kV
Sensitivity (1 A/Torr to 99 A/Torr)	5 A/Torr
Analog output	1 V/decade Optional Linear Recorder Out available
Auto-on (standard)	available on BA2, BA2C, CC2, and CC2C configurations only, set to TC1 only

Thermocouple Gauge (BA2 and CC2 models)

Minimum pressure capability	1×10^{-3} Torr
Maximum pressure capability	2 Torr
Heater current	165 mA ± 10%
Calibration (two points)	1×10^{-3} Torr (vacuum) $7.6 \times 10^{+2}$ Torr (atmosphere)
Auto-on (available on TC1 only)	1×10^{-3} Torr to 5×10^{-2} Torr

Analog output	1 V/decade 1 V at 1 x 10^{-3} Torr 7 V at 7 x 10^{-3} 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 BA2, BA2C, and BA configurations, with the following restrictions: one set point board, one resistive I^2R 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.

1-4 PART NUMBERS AND DESCRIPTIONS

Part Number			Description
Standard W/display	Black Box no display	Remote Display Used only with Black box	
L9120301	L9145301	L9144301	BA Controller, operates a single Bayard-Alpert tube
L9120302	L9145302	L9144302	BA2 Controller, operates two TC's and one B/A tube
L9120303	L9145303	None	BA2C Controller, operates two ConvecTorrs and one B/A tube
L9121301	L9146301	L9144303	CC Controller, operates a single Cold Cathode gauge
L9121302	L9146302	L9144304	CC2 Controller, operates two TC's and one Cold Cathode gauge
L9121303	L9146303	None	CC2C Controller, operates two ConvecTorrs and one Cold Cathode gauge

L9131310	TC cable, 10 feet long
L6455310	B/A cable, 10 feet long, (non-bakeable), for use with 563, 564, 571, or 572 gauge tubes
L6441310	UHV cable, 10 feet long, (non-bakeable), for use with 580 nude tubes
0881-L5571-310	CC cable, 10 feet long, (bakeable), for use with 524 gauge tube
0881-L5572-310	CC cable, 10 feet long, (non-bakeable), for use with 525 gauge tube
L9122310	ConvecTorr cable, 10 feet long
L9135002	Degas option, factory-installed, BA2, BA2C, and BA models only
L9132002	Set point option, factory-installed only
L9141301	RS232 board, option, factory- or field-installed
L9143301	RS485/422 board, option, factory- or field-installed
L6423301	Center rack mount kit
L6422301	Off-center rack mount kit
L6426301	Dual senTorr rack mount kit

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.

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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

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

2-2 INSTALLATION

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

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.

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

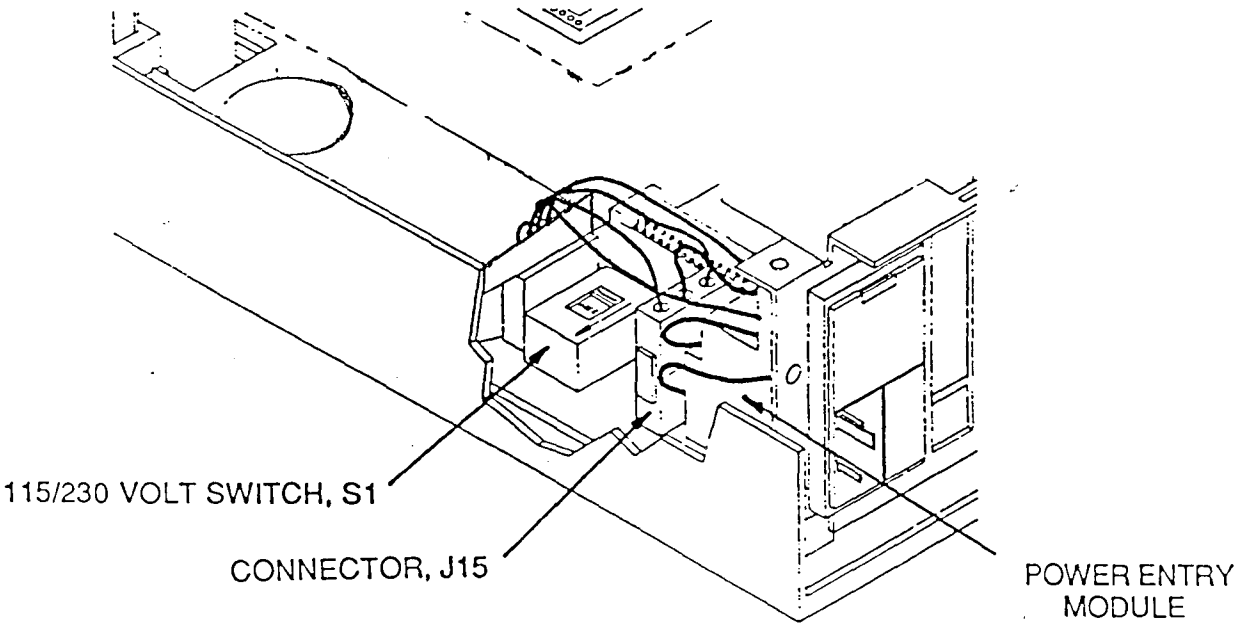

Figure 2-1. Setting Line Voltage

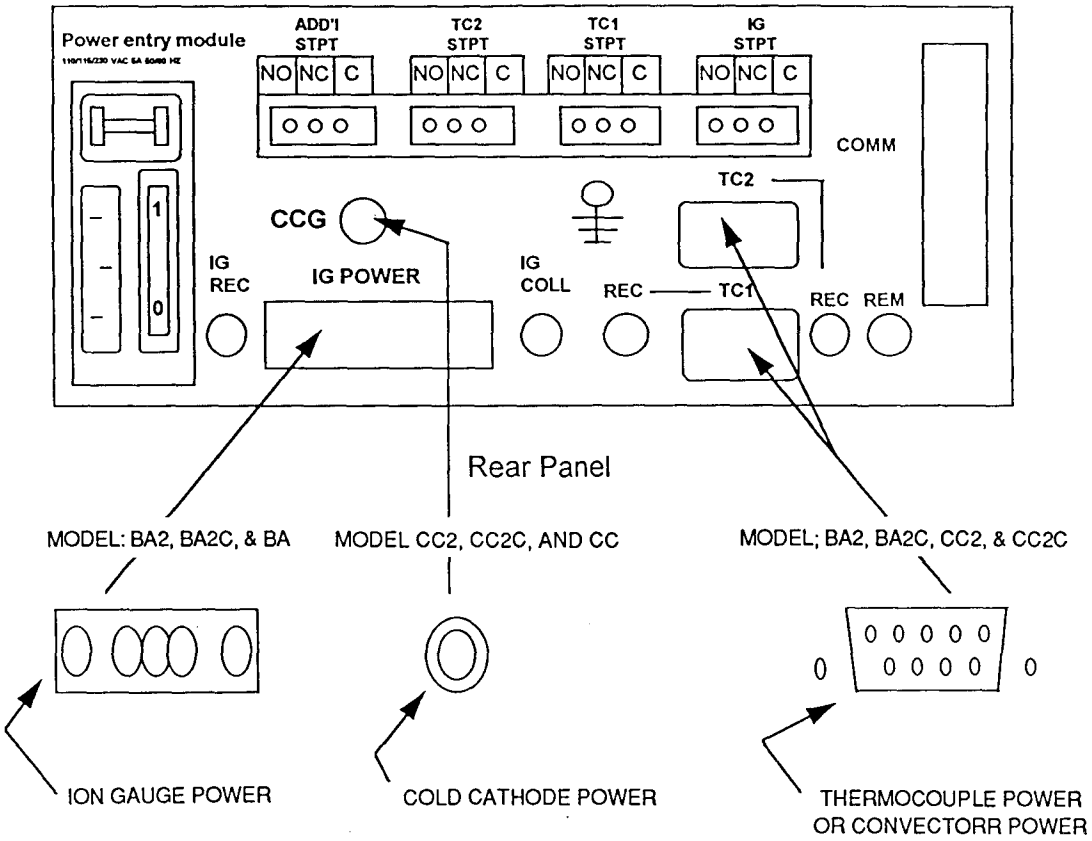

Figure 2-2. Rear Panel Connections

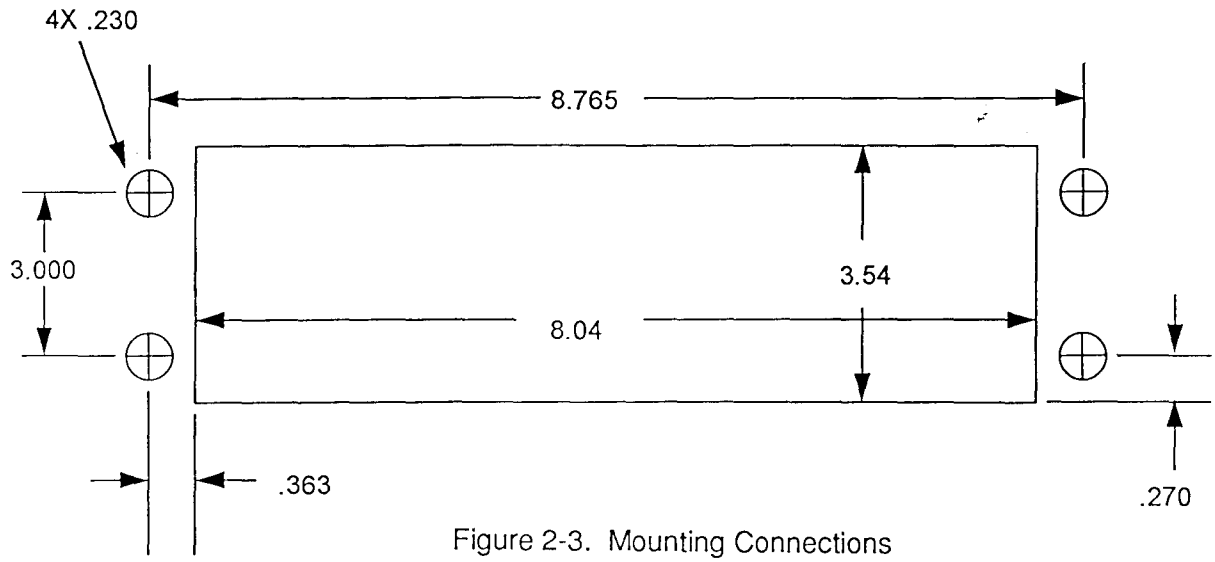

Figure 2-3. Mounting Connections

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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 and mBar for all pressure readings. The front panel legends will reflect the pressure units.

6. Cal Key (BA2, BA2C, CC2, CC2C 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.

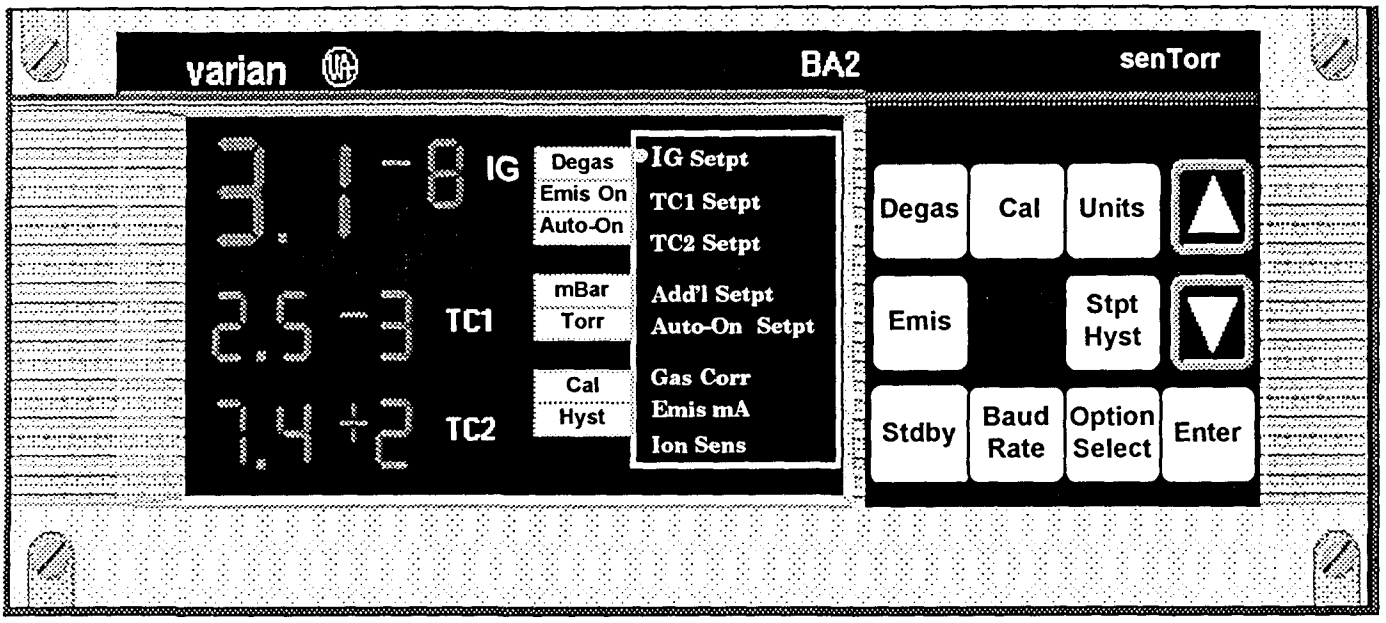


Figure 3-1. Front Panel, senTorr Gauge Controller

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 (BA2, BA2C, BA Models, with degas option))

Can only activate if the pressure at the Bayard-Alpert ion gauge is $\leq 10^{-5}$. 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. The degas option L9135002 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 "Enter"ed 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 (BA2, BA2C, CC2, and CC2C 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 (BA2, BA2C, CC2, and CC2C Models, 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 1.0×10^{-3} Torr to 5.0×10^{-3} Torr and additionally between 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 N2 (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 Bayard-Alpert gauge 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 Bayard-Alpert 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 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. For standard Bayard-Alpert gauges, the default is 10/Torr. Broad-range Bayard-Alpert gauges have a default sensitivity of 8/Torr. The cold cathode gauge defaults at 5 amperes/Torr. Sensitivity can range from 1/Torr to 99/Torr (BA gauges) or 1A/Torr to 99A/Torr (Cold Cathode gauge tube only).

3-3 SET POINT HYSTERESIS

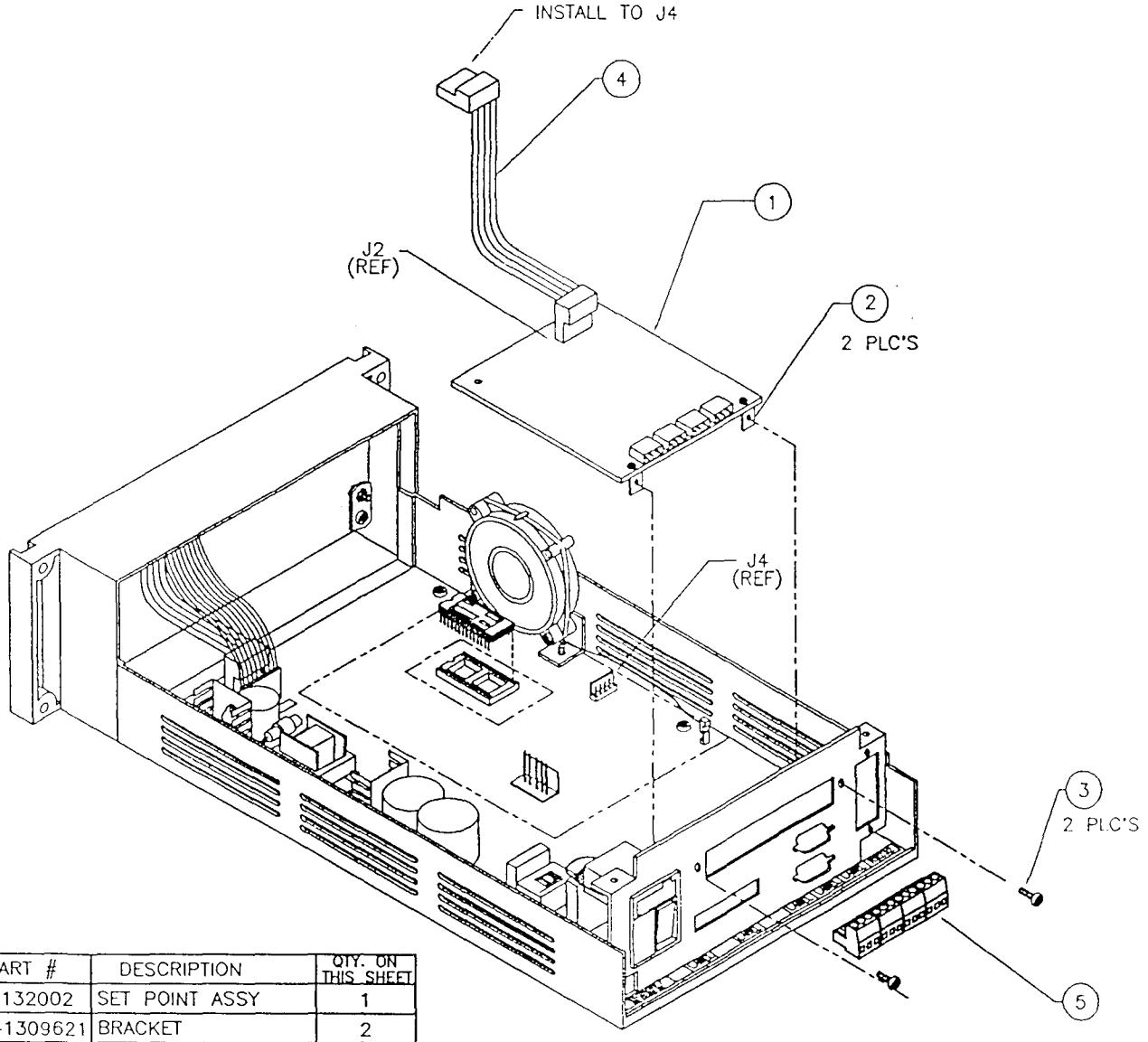
A set point will energize when the pressure of its pre-assigned gauge drops below the set point's programmed threshold pressure. The set point will de-energize when the gauge pressure rises above the set point hysteresis pressure. The set point hysteresis automatically defaults to 10 percent above the 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.

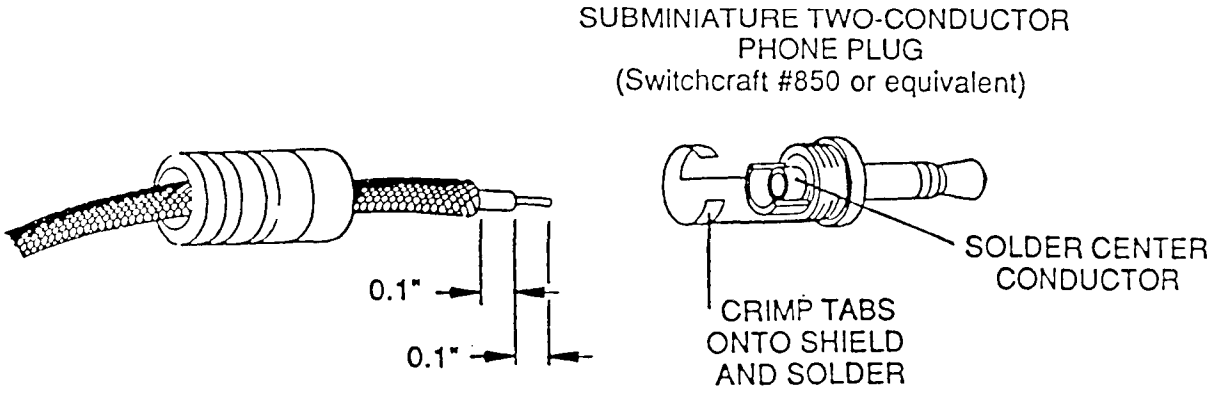


Figure 3-3. Assembling the Cable

3-6 TC AND CONVECTORR CALIBRATION

Expose the desired thermocouple or ConvecTorr to either atmospheric pressure (760 Torr) or to a vacuum greater than 1×10^{-3} Torr.

Press the "Cal" key once to calibrate TC1, or twice to calibrate TC2. The respective pressure display will flash either $7.6 \times 10^{+2}$ Torr (if the TC has been reading 1.0×10^{-1} Torr or above) or 1.0×10^{-3} Torr (if the TC had been reading less than 1.0×10^{-1} Torr.

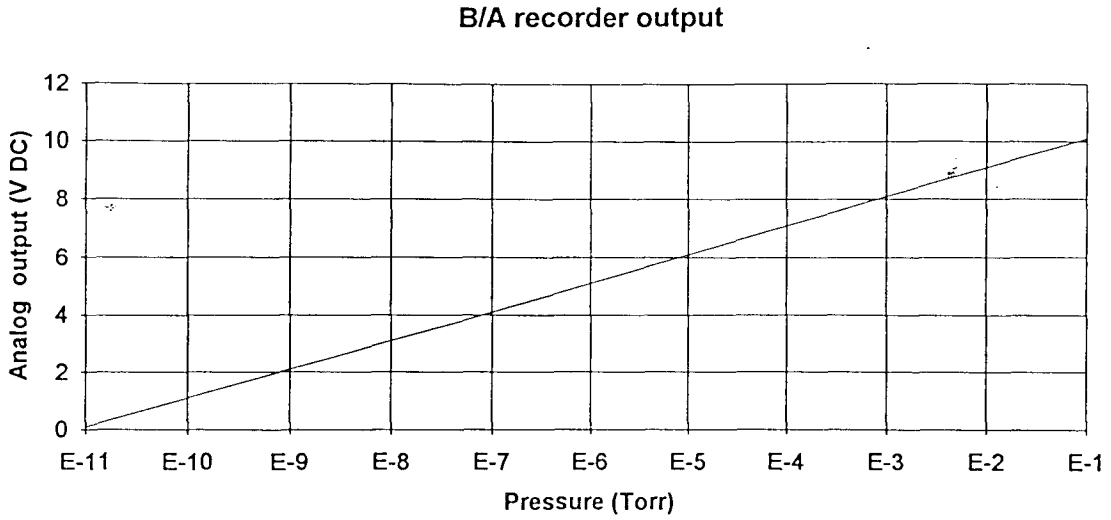
Press the "Enter" key to save the calibration point, or press "Cal" to exit the calibration procedure.

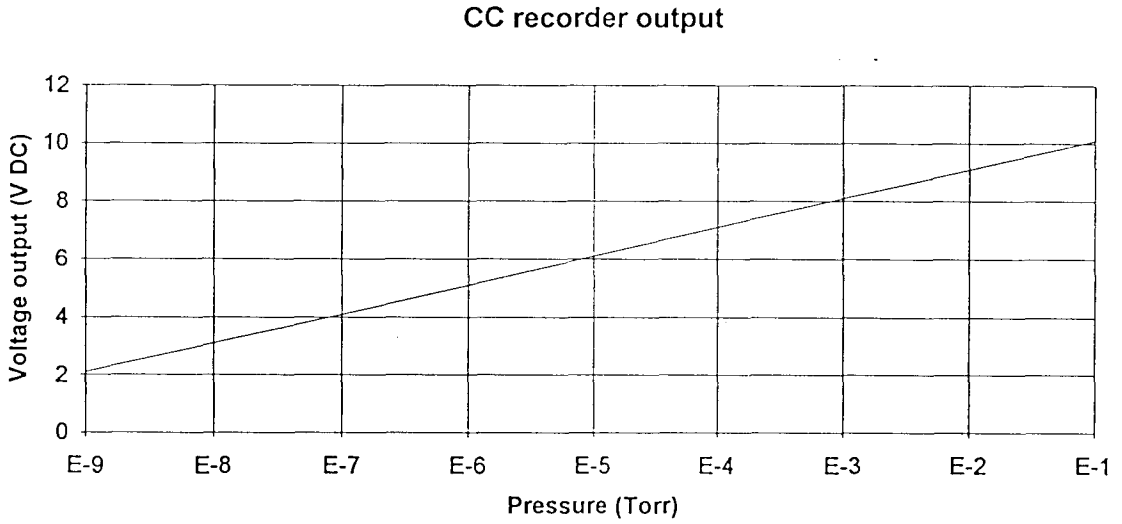
Repeat the procedure for each TC at each end point.

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)





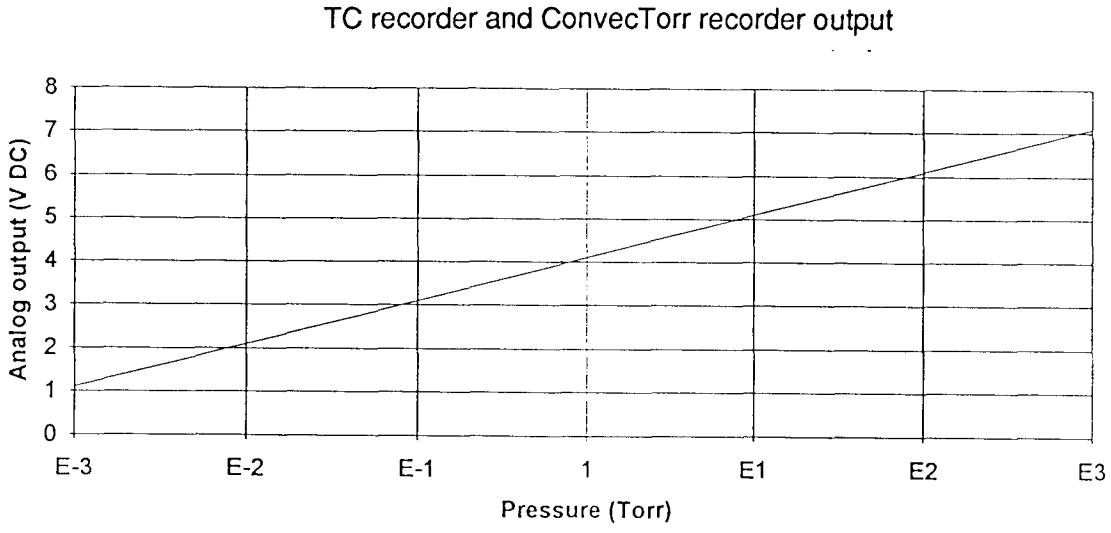


Figure 3-4a. Standard Recorder Output Characteristics

Linear recorder output for TC configuration

Pressure	Voltage
≥ 1E +0 Torr	10
1E-1	1
5E-2	0.5
1E-2	0.1
≤ 1E-3	0.01
E03	10.156 (over scale)

Linear recorder output option for BA and CC configurations

Full-scale setting	Access Code
1E-3 Torr	93 (Default)
1E-4	94
1E-5	95
1E-6	96

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

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

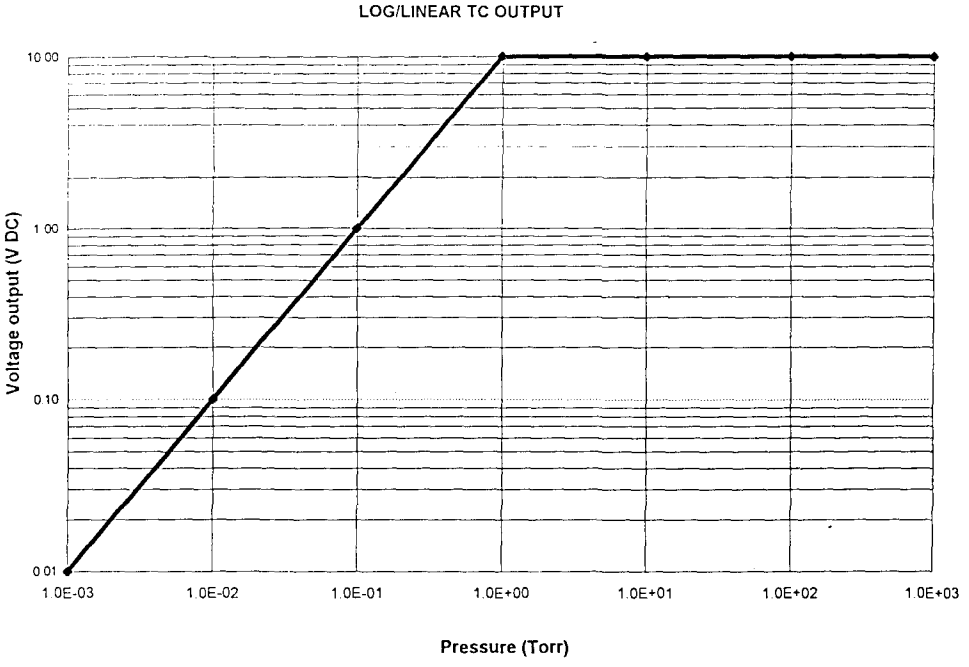


Figure 3-4b. Linear Recorder Output Characteristics

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

To engage the second filament, the cable connection to the Bayard-Alpert gauge must be physically removed from the tube, turned 180 degrees, then reattached to the tube. The gauge will then be ready to properly light the second filament.

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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 current or measurement signal (e.g., bad or missing collector cable connection; bad electrometer)

O4 E Filament overcurrent (shorted filament circuit)

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

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)

4-3 CHANGING LINE FUSES

WARNING
For continued protection against fire, both fuses must be replaced with fuses of the same type and rating as originally supplied.

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.

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 $< 1 \times 10^{-5}$ Torr. the senTorr automatically reduces the current by a factor of 10 when the pressure is $> 5 \times 10^{-5}$ 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 1×10^{-5} Torr and just above 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

The default setting is 10.0 amperes per Torr for standard Bayard-Alpert tubes (Varian 563, 571, and 572), 8.0 amperes per Torr for broad-range Bayard-Alpert tubes (Varian 564 and 580), and 5 amperes per Torr for Cold Cathode tubes (524 and 525). Sensitivity can be adjusted from 0.1 to 99.9 per Torr through the front panel keypad.

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

Programming Sensitivity

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.

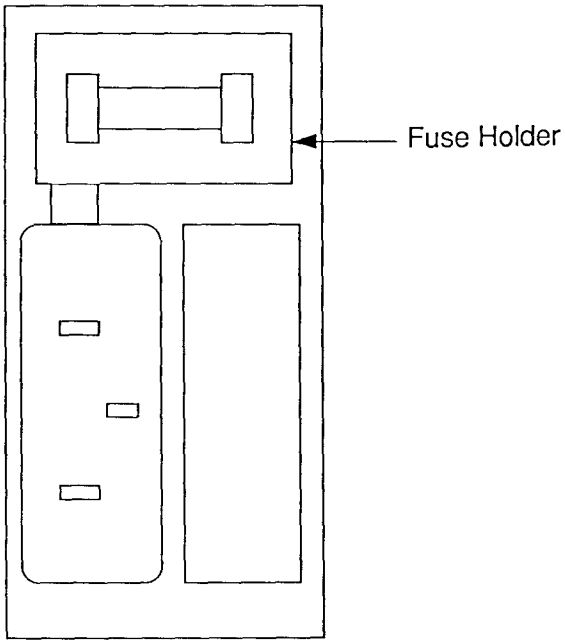

Figure 4-1. Power Entry Module

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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.

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-	1,5-C_6H_{10}	6.4
cyclo-	cy-C_6H_{10}	6.0
Hexane	C_6H_{14}	6.6
Hexene:		
1-	1-C_6H_{12}	5.9
cyclo-	cy-C_6H_{10}	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
Methyl acetate	CH_3COOCH_3	4.0
Methyl 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
		.9
		.9
Pentane:		
n-	n-C_5H_{17}	6.2
		6.0
		5.7
iso-	iso-C_5H_{17}	6.0
neo-	$(CH_3)_4C$	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-	n-C_3H_6	3.3
		3.2 to 3.7
cyclo-	cy-C_3H_6	3.6
Rubidium	Rb	4.3
Silver perchlorate	$AgClO_4$	3.6
Sodium	Na	3.0
Stannic iodide	SnI_4	6.7
Sulfur dioxide	SO_2	2.1
		2.3
Sulfur 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-	o-$C_6H_4(CH_3)_2$	7.8
p-	p-$C_6H_4(CH_3)_2$	7.9

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-	iso-C_5H_{10}	5.9
cyclo-	cy-C_5H_{10}	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-	n-C_4H_{10}	4.9
		4.7
iso-	iso-C_4H_{10}	4.6
		4.9
Cadmium	Cd	2.3
		3.4
Carbon dioxide	CO_2	1.4
		1.4
		1.5
		1.5
		1.4

Substance	Formula	Relative Ionization Gauge Gas Correction Factor
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
Dichlorodiflоromethane	CCl_2F_2	2.7
		4.1
Dichloromethane	CH_2Cl_2	3.7
Dinitrobenzene:	$C_6H_4(NO_2)_2$	
o-		7.8
m-		7.8
p-		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