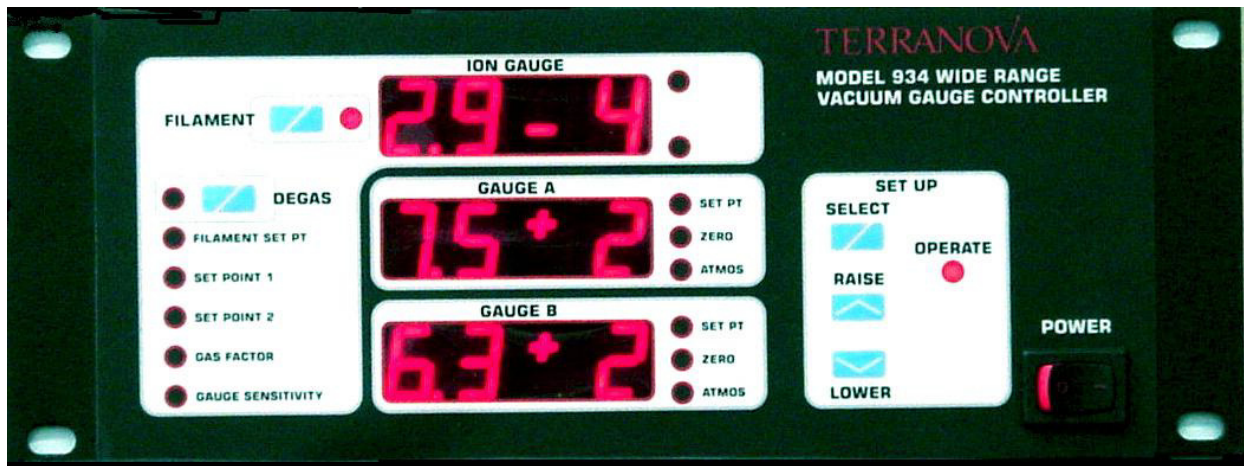


# Instruction & Installation Manual

## Terranova Model 934

## Terranova Model 934-UHV

# Wide-Range Vacuum Gauge Controller



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**Model 934**

**Model 934-UHV**

## **Wide-Range Vacuum Gauge Controller**

### **Safety Considerations**

#### **General**

This product and related documentation must be reviewed for familiarization with safety markings before operation.

#### **Safety Symbols**

These safety symbols may appear in this manual:

#### **WARNING**

The warning sign denotes a hazard to the operator, which could result in injury. Do not proceed beyond a warning sign until the indicated conditions are fully understood and met.

#### **CAUTION**

The caution sign denotes a hazard to equipment, which could result in damage to or destruction of part or all of the product. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.

---

#### **WARNING**

Do not use the Terranova Model 934 Vacuum Gauge Controller to measure explosive gas mixtures at high pressures.

#### **WARNING**

The Terranova Model 934 Vacuum Gauge Controller has lethal voltages present within the control unit and at the ion gauge. Service should be performed only by Duniway Stockroom Corp. or by other qualified personnel.

# Preface

## Purpose

This manual tells you how to install, operate, and maintain the Terranova Model 934 Wide-Range Vacuum Gauge Controller. In addition, it gives detailed specifications and a general theory of operation.

## Target Reader

This manual is written for the scientist, engineer, or technician who will install, operate, and/or maintain the Model 934 Vacuum Gauge Controller. We assume that you have experience with vacuum systems in general and with vacuum gauge controllers in particular. (Note, however, that an inexperienced user with general technical skills and an aptitude for independent investigation should be able to learn enough from this manual to operate the instrument with a reasonable level of proficiency.)

## Organization

The organization of this manual is:

|           |  |
|-----------|--|
| Chapter 1 | product description and specifications         |
| Chapter 2 | installation procedure                         |
| Chapter 3 | operating instructions                         |
| Chapter 4 | warranty provisions and maintenance procedures |
| Chapter 5 | theory of operation and general references     |

## Note on Schematic Diagrams

Because of the proprietary design of the Model 934 controller, we do not supply schematic diagrams with the instruction manual. If you have a special need for the schematic diagrams (or portions of them), please contact us.

# 1 General Information

## Product Description

The Model 934 and Model 934-UHV Wide-Range Vacuum Gauge Controllers provide pressure measurements across a broad range of vacuum environments. The Model 934 controller connected to a single Bayard-Alpert ion gauge covers a pressure range that formerly required two instruments. The Model 934-UHV extends this range even farther when using a UHV-24 ion gauge.

Features of the gauge controller include:

### Wide range:

ion gauge:  $2 \times 10^{-10}$  Torr to 1 Torr (Model 934)  
ion gauge:  $2 \times 10^{-11}$  Torr to 1 Torr (Model 934-UHV)

low-vacuum gauges:  $10^{-3}$  Torr to 990 Torr (thermocouple)  
low-vacuum gauges:  $10^{-3}$  Torr to 1200 Torr (convection)

### Controls and displays:

easy-to-use, intuitive front panel  
large, bright, digital displays for ion gauge and low-vacuum gauges

### Degassing:

resistance heating of the grid (Model 934)

### Degassing:

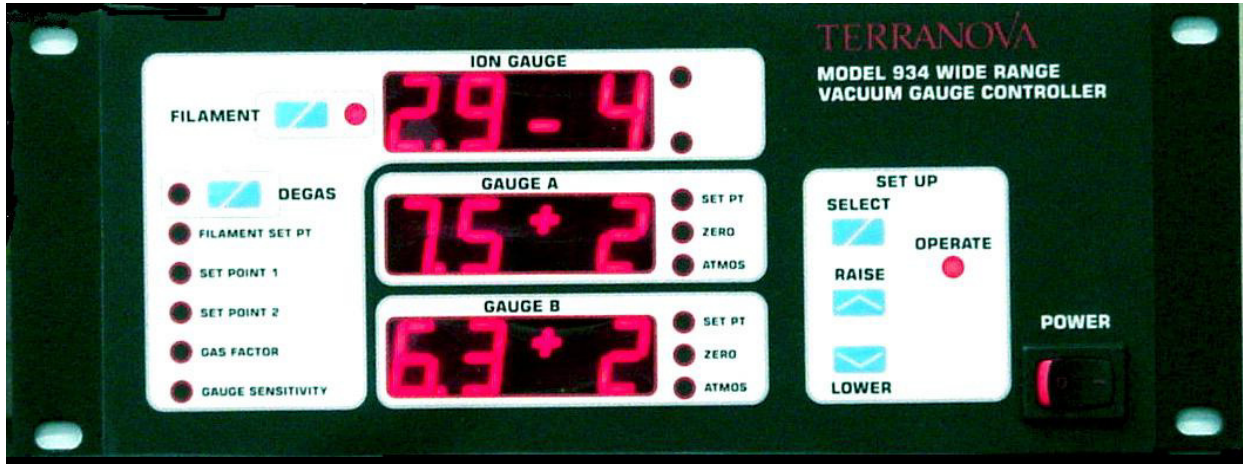
electron bombardment (Model 934-UHV)

### Relay control:

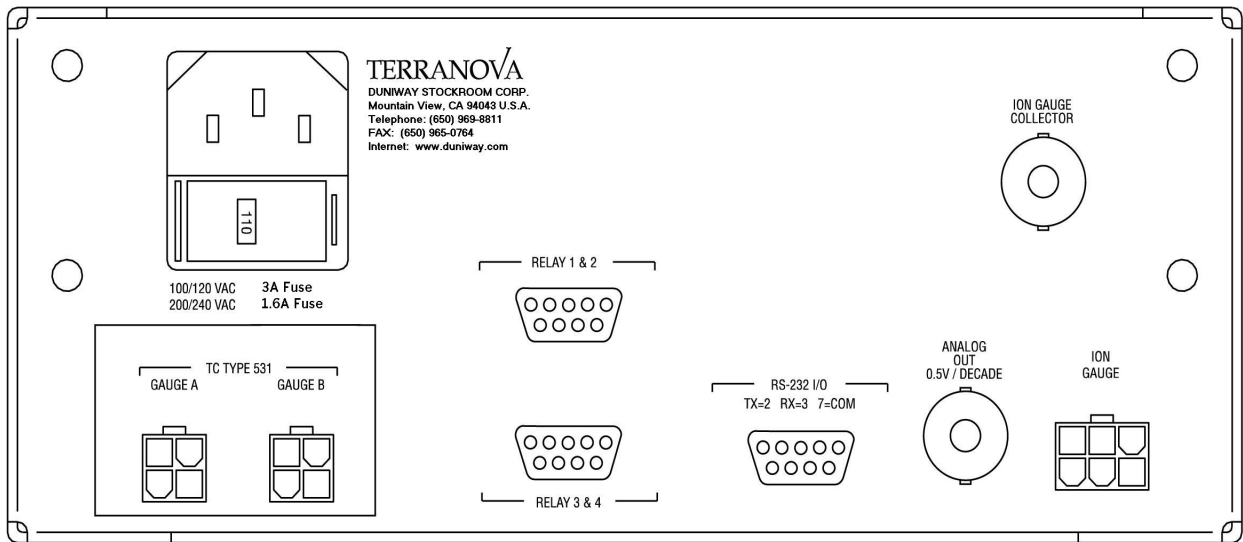
set points for four relays; each relay has independent normally-open and normally-closed contacts

Duniway Stockroom Corp. can also provide customized instruments. If you have special requirements not covered by the standard vacuum gauge controller, call or write us.





**Figure 1-1. Front Panel of Model 934 Vacuum Gauge Controller**



**Figure 1-2. Back Panel of Model 934 Vacuum Gauge Controller**

## Detailed Specifications

### Controller Configuration

#### Gauges

Model 934 displays pressure from one 563-type Bayard-Alpert ion gauge (for high- and ultra-high-vacuum environments) and two low-vacuum gauges (either 531-type thermocouple gauges or convection gauges, depending on the 934 configuration that was purchased). Model 934-UHV displays pressure from either a Bayard-Alpert ion gauge or a UHV-24 nude ion gauge and two low-vacuum gauges.

#### Displays

Large, bright red, digital LED displays -- one for ion gauge and two for low-vacuum gauges.

#### Gas Factor

A multiplier that allows you to compensate the display for gases other than air or nitrogen. The range of the gas factor is from 0.50 to 1.50, and can be set from the front panel.-

#### Ranges

##### Ion gauge:

air, nitrogen, argon:  $2 \times 10^{-10}$  Torr to 1 Torr (Model 934)

air, nitrogen, argon:  $2 \times 10^{-11}$  Torr to 1 Torr (Model 934-UHV)

oxygen:  $2 \times 10^{-10}$  Torr to  $10^{-2}$  Torr Model 934)

oxygen:  $2 \times 10^{-11}$  Torr to  $10^{-2}$  Torr (Model 934-UHV)

##### Thermocouple gauge:

$10^{-3}$  Torr to 990 Torr

##### Convection gauge:

$10^{-3}$  Torr to 1200 Torr

## Set Points

Models 934 and 934-UHV store five set points in nonvolatile memory. One set point controls the ion gauge filament; the other four set points control relays, as follows:

one set point for automatic turn-on of ion gauge filament

two set points for ion gauge

two low-vacuum-gauge set points (one for each thermocouple or convection gauge)

Relays activate when system pressure is below set point pressure. LED on front panel lights to indicate that relay is activated.

All four relays have independent sets of normally-open and normally-closed contacts.

Relay contacts are rated for: 6 A at 250 Vac or 4 A at 30 Vdc

Recommended minimum load is 1 mA at 1 Vac.

## Set-Point Protection

A switch inside the unit enables set-point protection. This prevents changes to the set points; however, the set points may still be read. (See chapter 2, Installation, for instructions on setting this protection.)

## Analog Output

Analog output is pseudo-logarithmic at 0.5 volts per decade. For pressure display in the form:

x.y E-z

analog output in volts is approximately:

$$(5.00 / 4095) * ((410 * (10 - z)) + (40 * x.y))$$

## Computer Interface

RS-232 port on back panel provides computer interface for front panel controls and indicators. For interface details, see the end of chapter 3, Operation.

## Measurement Electronics

### Ion Gauge

Grid-voltage modulated, +140 Vdc to +180 Vdc; emission current regulated to <2%; emission current limited to 3 mA at higher pressures for maximum filament life. Emission current is limited to 1 mA at high vacuum to minimize outgassing due to high gauge temperatures.

### Ion Current Detection

Ultra-low bias current electrometer with lock-in amplifier for noise rejection.

### Range Selection

Automatic ion gauge ranging over 7 decades, depending on emission current, within the ranges:

$10^{-10}$  Torr to 1 Torr for Model 934

$10^{-11}$  Torr to 1 Torr for Model 934-UHV.

### Filament Control

Front panel control or RS-232 computer control.

Automatic filament shutoff at pressures > than  $9.9 \times 10^{-1}$  Torr for air.

### Degassing

Resistance heating of grid at approximately 30 watts (Model 934) or electron bombardment, 50 mA at 700 eV (Model 934-UHV).

## Power Requirements

100, 120, 220, or 240 Vac (10%), 50-60 Hz; 100 VA.  
Input voltage is user-selectable from back panel.

## **Dimensional Data**

Standard EIA 19-inch rack mount:  
width: 9.5 in (242 mm)  
height: 3.5 in (89 mm)  
depth: 15 in (381 mm)  
weight: 9 lb (4.1 kg)

## **Warranty**

Model 934 or 934-UHV is warranted to be free from defects in material and workmanship for one year from the date of shipment.

## **Equipment Supplied**

The items supplied with the Model 934 or Model 934-UHV Wide-Range Vacuum Gauge Controller are listed below. Note that these do not include ion gauges or low-vacuum gauges.

Vacuum gauge controller (Model 934 or 934-UHV)

Connectors, pins, and jumpers for relay connections

Power cord, 8 ft (2.4 m)

Instruction manual

You will also need the following cables, which need to be ordered separately from The Duniway Stockroom Catalog or our web site, [www.duniway.com](http://www.duniway.com).

Ion gauge cable, 10 ft (3 m)

Two low-vacuum gauge cables, 10 ft (3 m) each

## 2. Installation

This chapter provides instructions for installing the vacuum gauge controller, connecting the cabling between the controller and the ion gauge, and verifying that the installed equipment works properly.

### Site Preparation

There are no special site preparation requirements for the Model 934 Vacuum Gauge Controller. The controller can be positioned on a bench or mounted in a standard (480 mm or 19 inch) equipment rack using a mounting bracket available from Duniway Stockroom Corp. (refer to next paragraph). We recommend using a rack with at least a 500 mm (20 inch) internal depth.

**Mounting brackets.** A blank half-rack mounting bracket is available from Duniway Stockroom Corp.. This allows you to mount one Model 934 controller in a single rack space, and provides panel space for any switches or indicator lights you may wish to add. Also available from Duniway Stockroom Corp. is an adapter that allows you to mount two Model 934 controllers side by side in a single rack space.

**Space.** We recommend that you allow at least 15 cm (6 in) at the back of the vacuum gauge controller for cable routing, and 3 cm (1.5 in) on each side for ventilation.

**Tools.** If you are mounting the controller in an equipment rack, you will need a screwdriver appropriate for the screws on your rack.

**Power.** Make sure that suitable power is available for the controller. Power should be 100-120 or 220-240 Vac (10%), 50-60 Hz, 100 VA.

### Unpacking:

Before you unpack the vacuum gauge controller from its shipping container, inspect the container for any signs of damage during shipping. If damage is apparent, it is best to have a representative of the shipping company on hand when you open the container.

Carefully unpack the contents of the shipping container. As you unpack the components, place them on a workbench. Save the container and the packing material in case you need to store or ship the vacuum gauge controller at some time in the future. If there appears to be any shipping damage to the vacuum gauge controller, notify the shipping company and Duniway Stockroom Corp. as soon as possible.

Make sure that you received all of the components of the vacuum gauge controller. You should have these items:

- \_\_\_ the vacuum gauge controller unit
- \_\_\_ connectors and pins for relay connection
- \_\_\_ a power cord
- \_\_\_ this manual

You will also need the following cables, which can be ordered separately from the Duniway Stockroom Catalog or our web site, [www.duniway.com](http://www.duniway.com):

- \_\_\_ the signal cable that connects the controller unit to an ion gauge
- \_\_\_ signal cabling for connecting the controller unit to two low pressure gauges

If you do not have all of these items, contact Duniway Stockroom Corp. as soon as possible.

## **Installation**

Follow the instructions below to install the Model 934 Vacuum Gauge Controller.

### **Experienced Users: Just Read the Headings**

Many readers of this manual already have experience with vacuum instruments that are similar to the Model 934 Vacuum Gauge Controller in general setup and operation. If you have such experience, you'll probably find all the instructions you need by reading the headings and looking at the drawings. (You can think of the headings and drawings as a built-in quick reference guide.) If you're less experienced, or if you simply like to have all the details, you'll find the information you need by reading the full text.

### **Optional: Set Internal Switches**

Two banks of switches inside the vacuum gauge controller determine the operation of four functions:

Baud rate for the RS-232 port. Choices are 1200, 2400, 4800, or 9600 baud.  
The factory setting is 9600 baud.

Automatic filament control. If the auto filament function is enabled, the auto filament set point and low-vacuum gauge A control the operation of the ion gauge's filament.  
The factory setting is DISABLED.

Set-point protection. Enabling this function prevents the set points for the ion gauge and the low-vacuum gauges from being changed at the front panel. The factory setting is DISABLED. (There is a secret switch hidden behind the front panel that allows disabling of the set-point protection if you have enabled it with the internal switches. This lets you make changes to the set points without disassembling the instrument. Use of the secret switch is described in chapter 3, Operation.)

High-pressure shutoff for ion gauge. If the shutoff is enabled, the ion gauge filament shuts off at pressures higher than  $9.9 \times 10^{-3}$  Torr. The factory setting for this switch is for the shutoff to be ENABLED. This setting is provided for non-563-type ion gauges. Since the Model 934 controller's unique performance at high pressures is calibrated only for 563-type ion gauges, you should leave the shutoff enabled when using non-563-type ion gauges; this will prevent the gauge from reporting inaccurate pressures in ranges for which it is not calibrated. If you are using a 563-type ion gauge, you can use the full range of the Model 934 controller by disabling the high-pressure shutoff; this provides pressure readings through the full range to 1 Torr.

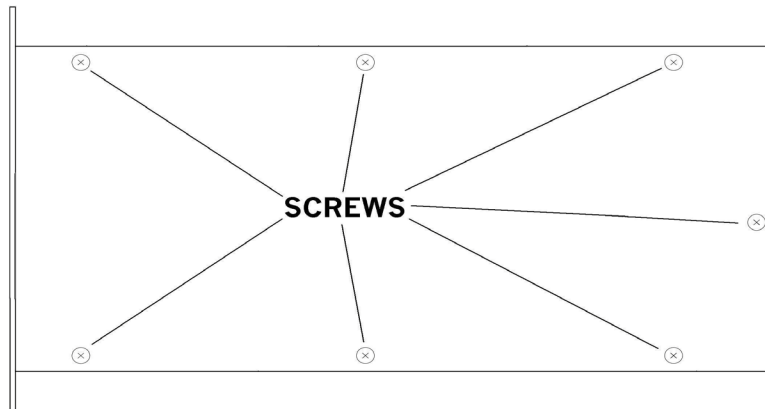
You will probably find it most convenient to make any necessary changes to these internal switches before you mount the Model 934 controller in its operating location.

Note: If you are wiring the relays to supply 24 volts dc to any circuits actuated by the Model 934 controller's set points, this would also be a good time to install the required jumpers (described near the end of this chapter, under Optional: Make Relay Connections).

If you need to change the setting of the internal switches, place the vacuum gauge controller on a suitable workbench and follow the steps listed below.

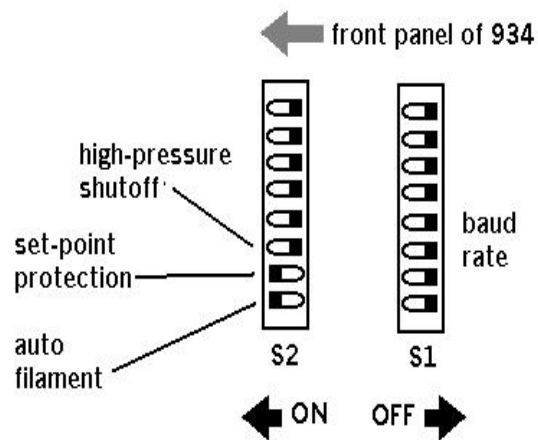
1. Make sure that the power is switched off. If the power cord is connected to the vacuum gauge controller, disconnect it.
2. Unscrew the seven screws from the top of the controller (shown in figure 2-1) and remove the cover from the controller.
3. Locate the two 8-position DIP switches, S1 and S2, under the front edge of the large transformer. You may find the switches somewhat inconvenient to reach, due to the overhang of the transformer; however, you will be setting only the outermost two or three switches in each bank.





**Figure 2-1. Top view of vacuum gauge controller.**

Switch S1 is the bank of switches nearer the back panel of the instrument. On each bank of switches, the switch segment nearest the center of the circuit board is switch 1, and the one next to it is switch 2. The segments are ON when pushed toward the front panel of the instrument. See figure 2-2.



**Figure 2-2. Detail of switches S1 and S2.**

4. Set the switches, using a nonconductive stylus. The settings are as follows:

Baud rate setting:

9600 baud: S1-1 ON, S1-2 ON

4800 baud: S1-1 OFF, S1-2 ON

2400 baud: S1-1 ON, S1-2 OFF

1200 baud: S1-1 OFF, S1-2 OFF

Auto filament function (filament control by low-vacuum gauge A and the auto filament set point):

auto filament ENABLED: S2-1 ON

auto filament DISABLED: S2-1 OFF

Set-point protection (prevents changing the ion gauge and low-vacuum gauge set points from the front panel):

protection ENABLED: S2-2 ON

protection DISABLED: S2-2 OFF

High-pressure shutoff (shuts off ion gauge filament at pressures above  $9.9 \times 10^{-3}$  Torr):

**Model 934:**

shutoff ENABLED (non-563-type gauge): S2-3 ON

shutoff DISABLED (563-type gauge): S2-3 OFF

**Model 934-UHV:**

shutoff ENABLED (non-UHV-24-type gauge): S2-3 ON

shutoff DISABLED (UHV-24-type gauge): S2-3 OFF

5. Replace the cover and secure it with the screws.

## Check the Voltage Setting

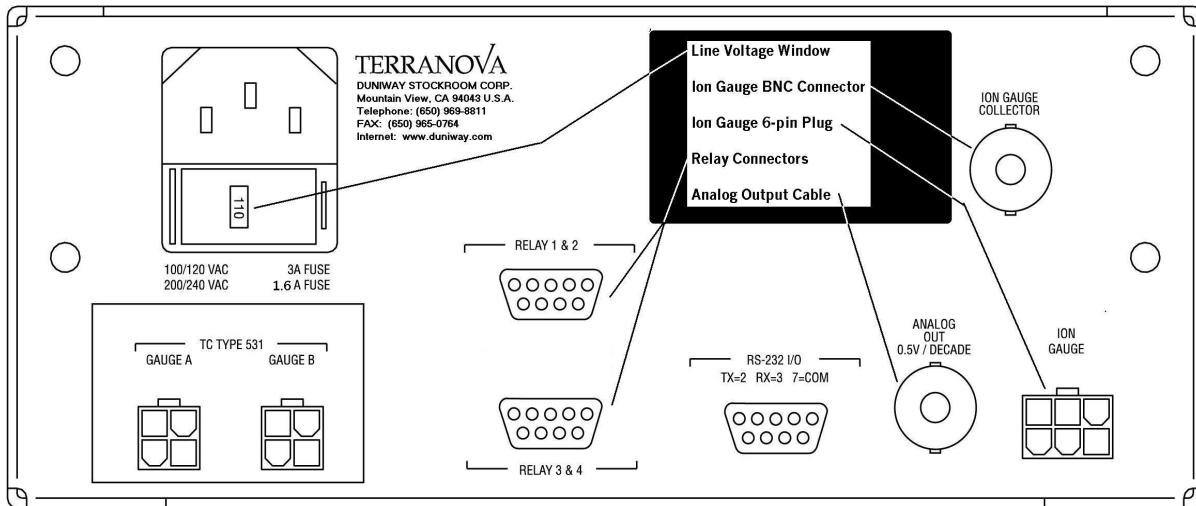
The controller's voltage setting must match the voltage available at your location. You can set the controller for either 110- or 220-volt ac operation. It normally comes from the factory set for 110 volts ac.

If you are operating at a line voltage of 100 volts ac, set the voltage setting of the Model 934 controller to 110 volts ac.

## CAUTION:

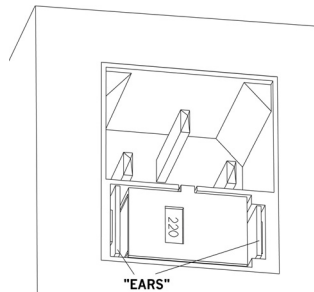
The Model 934 controller is designed to blow its fuse if it is set for 110-volt operation and is then plugged into a 220-volt line. If the instrument is set for 220-volt operation and is plugged into a 110-volt line, the low-vacuum gauges and the front panel may appear to operate correctly; the ion gauge will give an error message or will return grossly inaccurate readings.

The voltage setting is shown in a window in the power module on the back panel of the controller. If the voltage setting is incorrect, follow the steps listed below to change to the correct voltage setting. If the operating voltage is set correctly, skip to the next portion of the installation procedure. Mount the Gauge Controller, below.



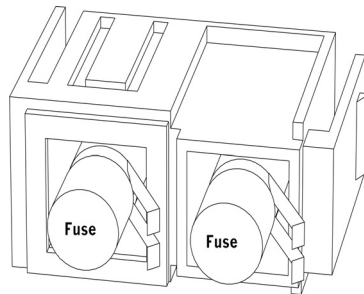
**Figure 2-3. Selected Back Panel Functions.**

1. First, unplug the power cord. Then pinch the ears on the sides of the fuse assembly and withdraw the assembly from the power module. See Figure 2-4.



**Figure 2-4. Withdraw fuse assembly.**

2. Turn the fuse assembly around so that the fuses are facing you, as shown in figure 2-5. Use a fingernail or a small, flat-bladed screwdriver to lift the tab that secures the voltage cup.



**Figure 2-5. Lift tab to release voltage cup.**

3. Slide the voltage cup out of the fuse assembly, rotate it one half turn, and re-insert it into the fuse assembly. Check to see that the correct voltage shows in the window.

4. Slide the fuses out of their holders and replace them with fuses that are appropriate for your operating voltage. Suitable fuses are:

for 100-120 Vac: (3 Amp Rating)  
Littlefuse 216 3.15 or 217 3.15  
Schurter 034.1521 or 034.2521

for 220-240 Vac: (1.5 Amp Rating)  
Littlefuse 216 01.6 or 217 01.6  
Schurter 001.1006 or 034.1518

5. Re-insert the fuse assembly into the power module. As you push the assembly into the power module, you will feel the pressure of the springs that hold the fuses in place. Keep pushing, gently but firmly, until the ears of the fuse assembly click into place.

## **Mount the Vacuum Gauge Controller**

Mount the gauge controller in its working location. The gauge controller can be mounted in an equipment rack, or placed on a table or workbench. Make sure that you allow at least 15 cm (6 in) at the back of the gauge controller for cable routing, and at least 3 cm (1.5 in) on each side for ventilation.

## **Connect the Power Cord**

Connect the power cord to the power receptacle on the back panel of the gauge controller. Then connect the other end of the power cord to an electrical outlet. (The gauge controller will generally be supplied with a line cord and connector for 110 V ac U. S. sockets. You may need to modify the plug end for your application.) Do not switch on the power yet.

## **Select the Ion Gauge**

The Model 934 and 934 UHV Vacuum Gauge Controllers are designed to interface to a wide variety of ion gauges. However, to take advantage of the full pressure range, you must use the correct ion gauges. For the Model 934 controller, you must use a 563-type ion gauge for full-range response from  $2 \times 10^{-10}$  Torr to 1 Torr. For the Model 934-UHV controller, you must use a UHV-24 ion gauge for full-range response from  $2 \times 10^{-11}$  Torr to 1 Torr.

The response of different types of ion gauges varies greatly above 100 mTorr. For the Model 934 controller we use the 563-type ion gauge as the standard for measurement up to 1 Torr because of its predictable behavior and wide availability. Accordingly, we have calibrated the upper pressure ranges of the Model 934 controller to match the characteristics of the 563-type ion gauge. Similarly, for environments that can take advantage of the extended response of the Model 934-UHV controller, we have calibrated that controller's upper pressure ranges to match the characteristics of the UHV-24 ion gauge.

If your measurement needs do not require pressure measurements above  $9.9 \times 10^{-3}$  Torr, you may use any Bayard-Alpert ion gauge with a sensitivity between 5 per Torr and 15 per Torr (with a Model 934 controller), or any UHV-24 ion gauge with a sensitivity between 10 per Torr and 30 per Torr (with a Model 934-UHV controller). We believe that triode gauges may also be used, but will be limited by their X-ray limits for low-pressure measurement.

We do not recommend use of the 564-type broad range ion gauge, due to its poor repeatability.

If you have any questions regarding selection of ion gauges, please contact us.

Table 2-1, below, lists ion gauges that are suitable for use with the Model 934 Vacuum Gauge Controller. Chapter 5 gives additional information on selection of tubulation and filament material. Additional information is available in the Duniway Stockroom Corp. Catalog and in our web-site: [www/duniway.com](http://www.duniway.com).

| Duniway Catalog # | Tube Type      | Sensitivity Torr <sup>-1</sup> | Tubulation Diameter | Tubulation Material  | Filament Type |
|-------------------|----------------|--------------------------------|---------------------|----------------------|---------------|
| I-075-N           | Glass-Uncoated | 10                             | ¾ inch              | Schott <sup>tm</sup> | Iridium       |
| I-075-P           | Glass-Uncoated | 10                             | ¾ inch              | Pyrex <sup>tm</sup>  | Iridium       |
| I-075-K           | Glass-Uncoated | 10                             | ¾ inch              | Kovar <sup>tm</sup>  | Iridium       |
| I-100-N           | Glass-Uncoated | 10                             | 1 inch              | Schott <sup>tm</sup> | Iridium       |
| I-100-P           | Glass-Uncoated | 10                             | 1 inch              | Pyrex <sup>tm</sup>  | Iridium       |
| I-100-K           | Glass-Uncoated | 10                             | 1 inch              | Kovar <sup>tm</sup>  | Iridium       |
| I-CFF-133         | Glass-Uncoated | 10                             | 1.33 inch CFF       | CFFlange             | Iridium       |
| I-CFF-275         | Glass-Uncoated | 10                             | 2.75 inch CFF       | CFFlange             | Iridium       |
| I-KF25            | Glass-Uncoated | 10                             | KF25                | KFFlange             | Iridium       |
| I-KF40            | Glass-Uncoated | 10                             | KF40                | KFFlange             | Iridium       |
|                   |                |                                |                     |                      |               |
| I-075-NC          | Glass-Coated   | 10                             | ¾ inch              | Schott <sup>tm</sup> | Iridium       |
| I-075-KC          | Glass-Coated   | 10                             | ¾ inch              | Kovar <sup>tm</sup>  | Iridium       |
| I-100-NC          | Glass-Coated   | 10                             | 1 inch              | Schott <sup>tm</sup> | Iridium       |
| I-100-KC          | Glass-Coated   | 10                             | 1 inch              | Kovar <sup>tm</sup>  | Iridium       |
| 1C-CFF-275        | Glass-Coated   | 10                             | 2.75 inch CFF       | CFFlange             | Iridium       |
|                   |                |                                |                     |                      |               |
| T-075-N           | Glass-Uncoated | 10                             | ¾ inch              | Schott <sup>tm</sup> | Tungsten-Dual |
| T-075-P           | Glass-Uncoated | 10                             | ¾ inch              | Pyrex <sup>tm</sup>  | Tungsten-Dual |
| T-075-K           | Glass-Uncoated | 10                             | ¾ inch              | Kovar <sup>tm</sup>  | Tungsten-Dual |
| T-100-N           | Glass-Uncoated | 10                             | 1 inch              | Schott <sup>tm</sup> | Tungsten-Dual |
| T-100-P           | Glass-Uncoated | 10                             | 1 inch              | Pyrex <sup>tm</sup>  | Tungsten-Dual |
| T-100-K           | Glass-Uncoated | 10                             | 1 inch              | Kovar <sup>tm</sup>  | Tungsten-Dual |
| T-CFF-133         | Glass-Uncoated | 10                             | 1.33 inch CFF       | CFFlange             | Tungsten-Dual |
| T-CFF-275         | Glass-Uncoated | 10                             | 2.75 inch CFF       | CFFlange             | Tungsten-Dual |
| T-KF25            | Glass-Uncoated | 10                             | KF26                | KFFlange             | Tungsten-Dual |
| T-KF40            | Glass-Uncoated | 10                             | KF40                | KFFlange             | Tungsten-Dual |

**Table 2-1 Part 1:  
Suitable Ion Gauges**

| Duniway Catalog # | Tube Type        | Sensitivity Torr <sup>-1</sup> | Tubulation Diameter | Tubulation Material | Filament Type |
|-------------------|------------------|--------------------------------|---------------------|---------------------|---------------|
| I-164-N           | Glass-Coated-BR  | 8                              | 1 inch              | Schott™             | Iridium       |
| I-164-K           | Glass-Coated-BR  | 8                              | 1 inch              | Kovar™              | Iridium       |
| I-164-275         | Glass-Coated-BR  | 8                              | 2.75 inch CFF       | CFFlange            | Iridium       |
| I-164-KF25        | Glass-Coated-BR  | 8                              | KF25                | KFFlange            | Iridium       |
| I-164-KF40        | Glass-Coated-BR  | 8                              | KF40                | KFFlange            | Iridium       |
|                   |                  |                                |                     |                     |               |
| I-SLD-N           | Glass-Uncoated   | 10                             | ¾ inch, sealed      | Schott™             | Iridium       |
|                   |                  |                                |                     |                     |               |
| T-NUDE-F          | Nude-UHV         | 25                             | 2.75 inch CFF       | CFFlange            | Tungsten-Dual |
| I-NUDE-F          | Nude-UHV         | 25                             | 2.75 inch CFF       | CFFlange            | Iridium-Dual  |
| I-NUDE-BAC        | Nude-BA          | 8                              | 2.75 inch CFF       | CFFlange            | Iridium       |
| I-NUDE-303        | Nude-BA          | 8                              | KF40                | KFFlange            | Iridium       |
| I-NUDE-DI         | Nude-BA          | 8                              | 2.75 inch CFF       | CFFlange            | Iridium-Dual  |
| I-NUDE-40         | Nude-BA          | 8                              | KF40                | KFFlange            | Iridium       |
|                   |                  |                                |                     |                     |               |
| DST-531           | Thermocouple     | na                             | 1/8 inch NPT        | SST                 | na            |
|                   |                  |                                |                     |                     |               |
| CEP-HPS           | Convection (MKS) | na                             | 1/8 inch NPT        | SST                 | na            |
| GP275-071         | Convectron™      | na                             | 1/8 inch NPT        | SST                 | na            |
|                   |                  |                                |                     |                     |               |

Trade marks: Schott is a trademark of Schott Glass Corp.; Kovar is a trademark of Westinghouse Electric Corp.; Pyrex is a trademark of Corning Glass Works; Convectron is a trademark of Granville-Phillips

### **Table 2-1 Part 2: Suitable Ion Gauges, Thermocouple Gauges, and Convection Gauges**

Additional information about ionization gauges, filament choices, thermocouple gauges, convection gauges and other flange combinations is available in the Duniway Stockroom Corp. Catalog and in our web-site: [www.duniway.com](http://www.duniway.com).

## **Connect the Cable to the Ion Gauge**

There are two different signal cables for connecting the ion gauge to the vacuum gauge controller: one for a glass ion gauge and one for a nude ion gauge. The cables are the same on the end that connects to the vacuum gauge controller, but different on the end that connects to the ion gauge. The following instructions describe the connection of the signal cable; where necessary, the instructions will differentiate between glass ion gauges and nude ion gauges.

### **Connect the BNC Connector to the Back Panel**

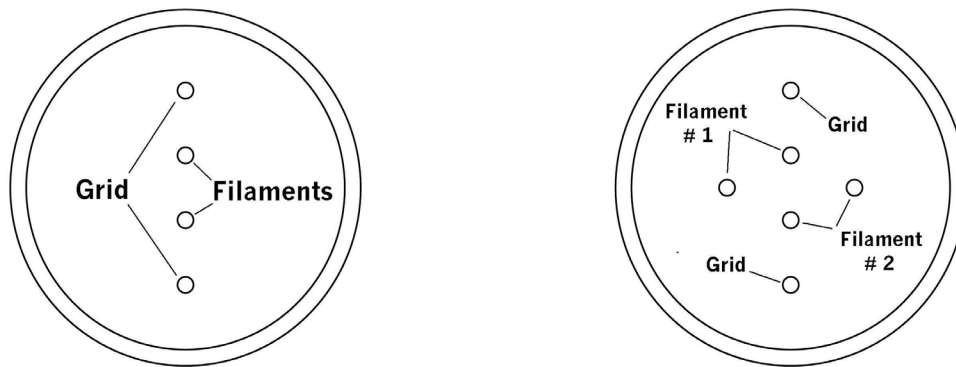
Connect the signal cable's BNC connector to the back panel of the gauge controller, as shown in figure 2-3. Push the connector all the way onto the BNC receptacle, then turn the connector one quarter-turn clockwise until it clicks firmly into place.

### **Connect the 6-pin Plug to the Back Panel**

Connect the signal cable's 6-pin plug to the 6-pin receptacle on the back panel of the gauge controller, as shown in figure 2-3.

### **Glass Ion Gauge: Connect the 6-pin Connector to the Base of the Ion Gauge**

The 6-pin connector is wired for ion gauges with either thoria/iridium filaments or twin tungsten filaments. (Tungsten filaments are allowable, but not recommended for pressures above  $10^{-3}$  Torr.)

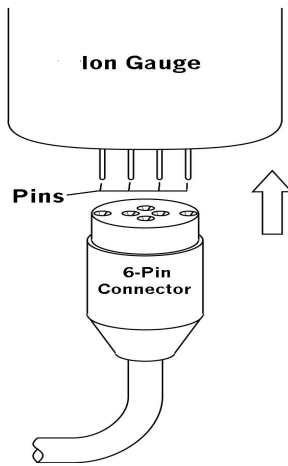


**Figure 2-6. Pins of glass ion gauges, viewed from base .**

The 6-pin connector can connect to the ion gauge in two ways. (One is rotated 180 from the other.) For ion gauges with thoria/iridium filaments, the pin arrangement of the ion gauge is symmetrical, so both ways of attaching the connector are equivalent. For ion gauges with twin tungsten filaments, the pin arrangement is such that one of the two filaments is not connected. If a filament burns out, you can switch to the other filament by turning the connector around, without having to replace the ion gauge.

Connect the 6-pin connector to the base of the ion gauge, as shown in figure 2-7. Align the connector with the pins of the gauge, then push the connector onto the pins until it seats firmly.



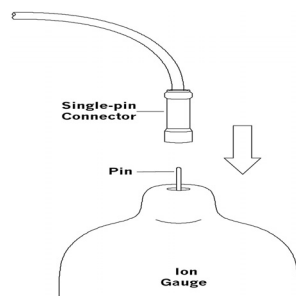


**Figure 2-7. Connect the 6-pin connector to the ion gauge**

When the 6-pin connector is attached to the pins of the ion gauge, it is recessed into the base of the gauge; this offers protection from the high voltages that are present at the pins.

**Glass Ion Gauge:  
Connect the Single-Pin Connector to the Top of the Ion Gauge**

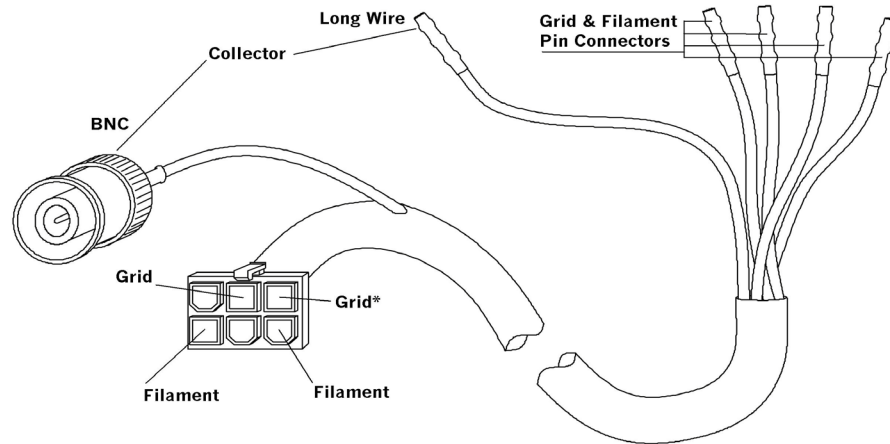
The single-pin connector connects to the collector pin on the top of the ion gauge. Figure 2-8 shows the connection. Push the connector onto the pin until it seats firmly.



**Figure 2-8. Connect the single-pin connector to the ion gauge**

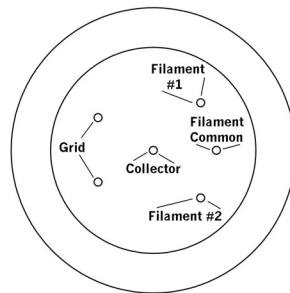
## Nude Ion Gauge: Connect the Cable Connectors to the Base of the Ion Gauge

The ion gauge cable that connects to a nude ion gauge has five connectors on the end that connects to the ion gauge. Figure 2-9 shows this cable. A label on the cable tells which connectors attach to which pins on the ion gauge. As an alternative, you can trace the color of the wires from the controller end to the gauge end to determine the proper connections.

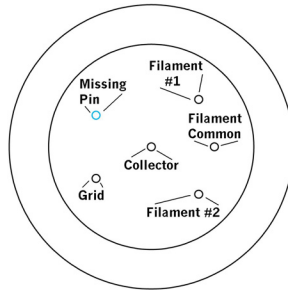


**Figure 2-9. Universal gauge cable for nude ion gauge**

Figure 2-10 shows the pin arrangement of a standard 580 nude ion gauge, as viewed from the base end. Figure 2-11 shows the pin arrangement for a UHV-24 (ultra-high-vacuum) nude ion gauge. The two ion gauges are similar, except that the UHV-24 gauge has only one grid pin. (The grid conductor of the ion gauge cable that is marked with a \* in figure 2-9 is not used with a UHV-24 nude ion gauge.)



**Figure 2-10. Pins of BAC nude ion gauge, viewed from base**



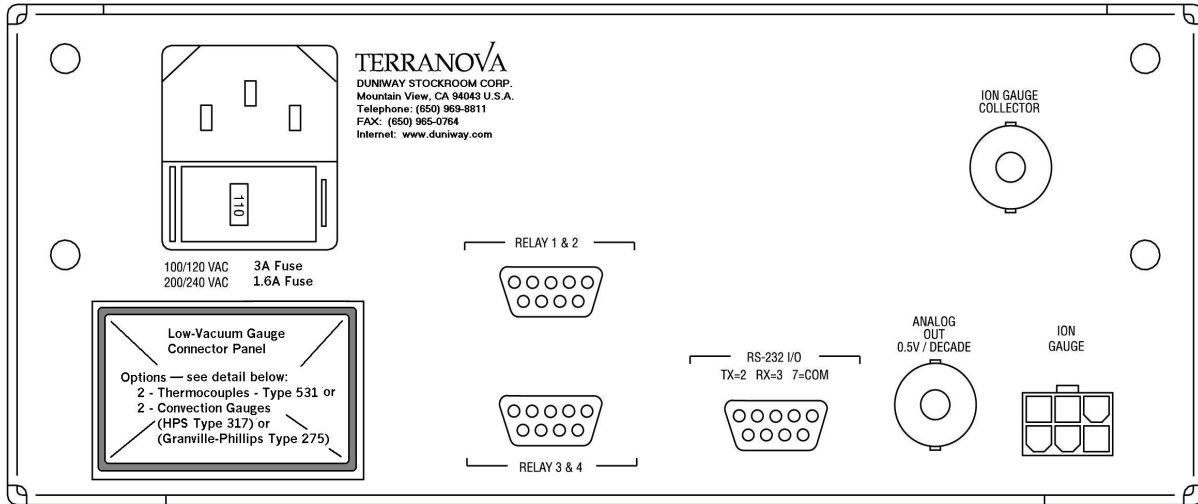
**Figure 2-11. Pins of UHV-24 nude ion gauge, viewed from base**

Only one of the numbered filament pins of a two-filament ion gauge is connected at any one time. If one of the filaments burns out, you can change to the other filament without having to replace the ion gauge. For example, if filament #1 burns out, you would disconnect the wire from the filament #1 pin and connect it to the filament #2 pin.

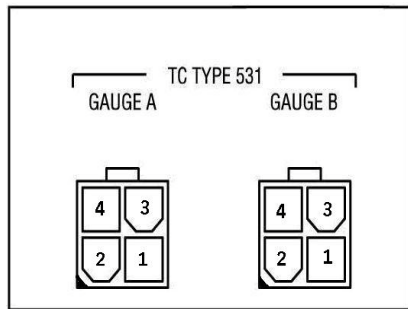
Connect the cable connectors to the appropriate pins on the base of the ion gauge. Make sure that one filament lead connects to the common filament pin, and the other filament lead connects to one of the numbered filament pins. Push each connector onto its pin until it seats firmly.

### **Connect Cables to the Low-Vacuum Gauges**

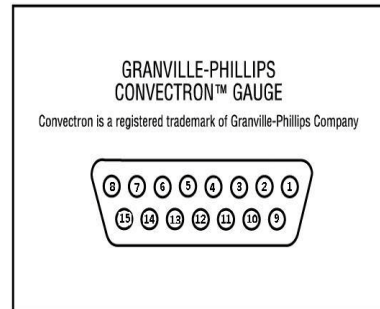
The Model 934 Vacuum Gauge Controller is available in versions that can accept inputs from either two thermocouple gauges or two convection gauges. The controller is shipped with cables that have the appropriate connectors.



**Figure 2-12. Low-vacuum gauge connections on back panel**



**Figure 2.12A - TC Gauge Panel**



**Figure 2.12B - Convection Gauge Panel**

**Terranova 934  
Thermocouple Gauge Pin Connections**

| <b>934 'Molex'<br/>4-Pin Plug<br/>Pin Number</b> | <b>Wire<br/>Color</b> | <b>TC 8-Pin<br/>Socket<br/>Pin Number</b> |
|--|-----------------------|---|
| 4  | Red                   | 1 and 8                                   |
| --   | --                    | 2   |
| 1  | Black                 | 3   |
| --   | --                    | 4   |
| 2  | Clear                 | 5   |
| --   | --                    | 6   |
| 3  | Drain                 | 7   |

**Table 2-2: Thermocouple Gauge Pin Connections**

**Terranova 934  
Convection Gauge Pin Connections**

| <b>934 'D-Sub'<br/>15-Pin Connector<br/>Pin Number</b> | <b>275 Convection<br/>Gauge Connector<br/>Pin Number</b> | <b>MKS/HPS CEP-317<br/>'D-Sub' 9-Pin Connector<br/>Pin Number</b> |
|--|--|---|
| 1  | No Connection  | No Connection   |
| 2  | Ground   | Gauge 1: Pins 2, 4, 5 & 9   |
| 3  | Ground   | Gauge 1: Pins 2, 4, 5 & 9   |
| 4  | No Connection  | Gauge 1: Pins 2, 4, 5 & 9   |
| 5  | Gauge 1: Pin 2   | Gauge 1: Pin 7  |
| 6  | Gauge 1: Pin 5   | Gauge 1: Pin 8  |
| 7  | Gauge 1: Pin 1   | Gauge 1: Pins 1, 3 & 6  |
| 8  | Gauge 1: Pin 1   | Gauge 1: Pins 1, 3 & 6  |
| 9  | Ground   | Gauge 2: Pins 2, 4, 5 & 9   |
| 10   | No Connection  | Gauge 2: Pins 2, 4, 5 & 9   |
| 11   | Gauge 2: Pin 2   | Gauge 2: Pin 7  |
| 12   | Gauge 2: Pin 5   | Gauge 2: Pin 8  |
| 13   | Gauge 2: Pin 1   | Gauge 2: Pins 1, 3 & 6  |
| 14   | Gauge 2: Pin 1   | Gauge 2: Pins 1, 3 & 6  |
| 15   | Ground   | Gauge 2: Pins 2, 4, 5 & 9   |

**Table 2-3: Convection Gauge Pin Connections**

Figure 2-12 shows the low-vacuum gauge connections on the back panel of the gauge controller. The thermocouple version of the Model 934 controller, shown in Figure 2.12A, has two 4-pin receptacles for making connections to two thermocouple gauges, and comes with cabling for making those connections. Each cable has a 4-pin plug on one end and an octal receptacle on the other end. Thermocouple gauge #1 connects to the left-hand 4-pin receptacle, and is displayed on the GAUGE A display on the front panel. Thermocouple gauge #2 connects to the right-hand receptacle and is displayed on the GAUGE B display.

The convection version of the Model 934 controller has a single DB-15 receptacle, as shown in Figure 2-12B, for making connections to two convection gauges. The supplied cabling has a DB-15 plug that is wired according to standard convection practice and serves both gauges; two cables lead from this plug, and each cable has a 5-pin connector at the other end. Outputs from the gauges are displayed on the GAUGE A and GAUGE B displays on the front panel.

## **CAUTION**

Make sure that the power to the controller unit is off when connecting the low-vacuum gauges. If the power is on when the gauges are being connected, the gauges may burn out.

### **Select the Low-Vacuum Gauge**

The correct type of thermocouple gauge for this application is the Varian 531 or equivalent. Other thermocouple gauges will not work, and may be damaged if connected. 531-type gauges are available from Duniway Stockroom Corp. or other vendors. Table 2-1, earlier in this chapter, gives ordering information for these gauges.

### **Mount the Low-Vacuum Gauge**

Install a thermocouple gauge in accordance with standard vacuum practice with the axis of the gauge vertical and the gauge opening downward.

Install a convection gauge with the axis of the gauge horizontal and the gauge opening downward. (Readings above 30 Torr will be erroneous if the gauge is not horizontal.)

### **Connect the Cabling to the Back Panel**

For thermocouple gauges, plug the 4-pin plug of the first cable into the left-hand 4-pin receptacle on the back panel of the vacuum gauge controller. If there is a second gauge, plug the 4-pin plug of the second cable into the right-hand 4-pin receptacle on the back panel.

For convection gauges, plug the DB-15 plug of the cable into the DB-15 receptacle on the back panel of the vacuum gauge controller.

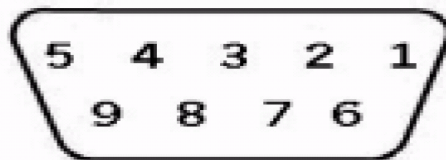
## Connect the Cabling to the Low-Vacuum Gauge

For each thermocouple gauge, plug the octal receptacle of the cable onto the base of the thermocouple gauge. Push the receptacle onto the gauge until it seats firmly.

For each convection gauge, align the guide pin of the 5-pin plug with the slot in the end of the gauge; push the plug onto the pins of the gauge until it seats firmly.

## Optional: Make Relay Connections

The vacuum gauge controller's four set points (set from the front panel) control the four relays that are accessible through the 8-pin receptacles on the back panel. The 8-pin receptacles are shown in figure 2-x.



**Figure 2.13 Relay contact wiring pin-out, looking at the back panel**

The set points and the relays they control are related in the following ways:

**Table 2-4. Set-Point Relay Pin Assignments**

**Terranova 934  
Set-Point Relay Pin Assignments**

| Upper Connector Relays 1 & 2 |                      |       | Lower Connector Relays 3 & 4 |                      |       |
|------------------------------|----------------------|-------|------------------------------|----------------------|-------|
| Pin Number                   | Conductor            | Relay | Pin Number                   | Conductor            | Relay |
| 1                            | Normally Closed (NC) | 2     | 1                            | Normally Closed (NC) | 4     |
| 2                            | Common               | 2     | 2                            | Common               | 4     |
| 3                            | Chassis Ground       | All   | 3                            | Chassis Ground       | All   |
| 4                            | Normally Open (NO)   | 1     | 4                            | Normally Open (NO)   | 3     |
| 5                            | Normally Closed (NC) | 1     | 5                            | Normally Closed (NC) | 3     |
| 6                            | Normally Open (NO)   | 2     | 6                            | Normally Open (NO)   | 4     |
| 7                            | Power Source         | All   | 7                            | Power Source         | All   |
| 8                            | Chassis Ground       | All   | 8                            | Chassis Ground       | All   |
| 9                            | Common               | 1     | 9                            | Common               | 3     |

| Set Point               | Relay | Connector  | Pin | Conductor            |
|-------------------------|-------|------------|-----|----------------------|
| Gauge A 'SET PT'        | 1     | Upper DB-9 | 4   | Normally Open (NO)   |
|                         |       |            | 5   | Normally Closed (NC) |
|                         |       |            | 9   | Common (COM)         |
| Gauge B 'SET PT'        | 2     | Upper DB-9 | 6   | Normally Open (NO)   |
|                         |       |            | 1   | Normally Closed (NC) |
|                         |       |            | 2   | Common (COM)         |
| Ion Gauge 'SET POINT' 1 | 3     | Lower DB-9 | 9   | Common (COM)         |
|                         |       |            | 5   | Normally Closed (NC) |
|                         |       |            | 4   | Normally Open (NO)   |
| Ion Gauge 'SET POINT' 2 | 4     | Lower DB-9 | 2   | Common (COM)         |
|                         |       |            | 1   | Normally Closed (NC) |
|                         |       |            | 6   | Normally Open (NO)   |

**Table 2.5 Set-Point Relays, Connectors and Pin Assignments**



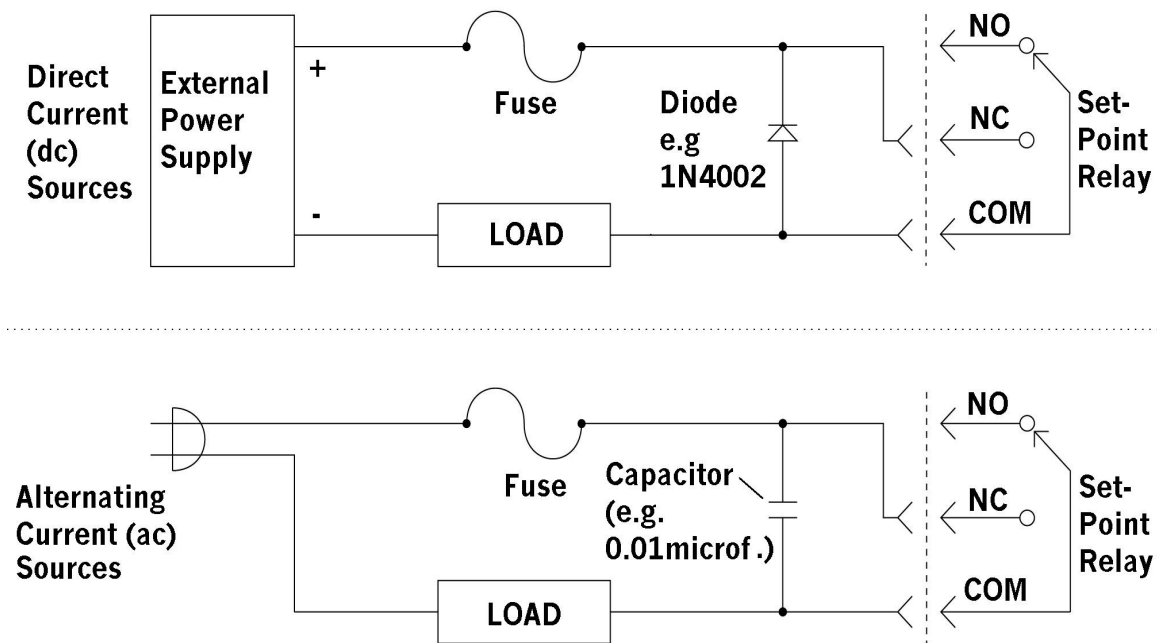
**CAUTION:**

Before making connections to the relays, verify that +24 volts dc is present or absent (as appropriate for your application) between the common pin (pin 2 or 5, depending on the relay) and the chassis ground (pin 7) of the relay connector(s) on the back panel of the controller.

The relay is de-energized as long as the system pressure (as measured by the ion gauge or low-vacuum gauge associated with the set point) is higher than the set point; whenever the system pressure falls below the set point, the relay energizes and switches the contacts.

Figure 2-13 shows the pin numbering for the DB-9 connectors; the female DB-9 receptacle is shown.

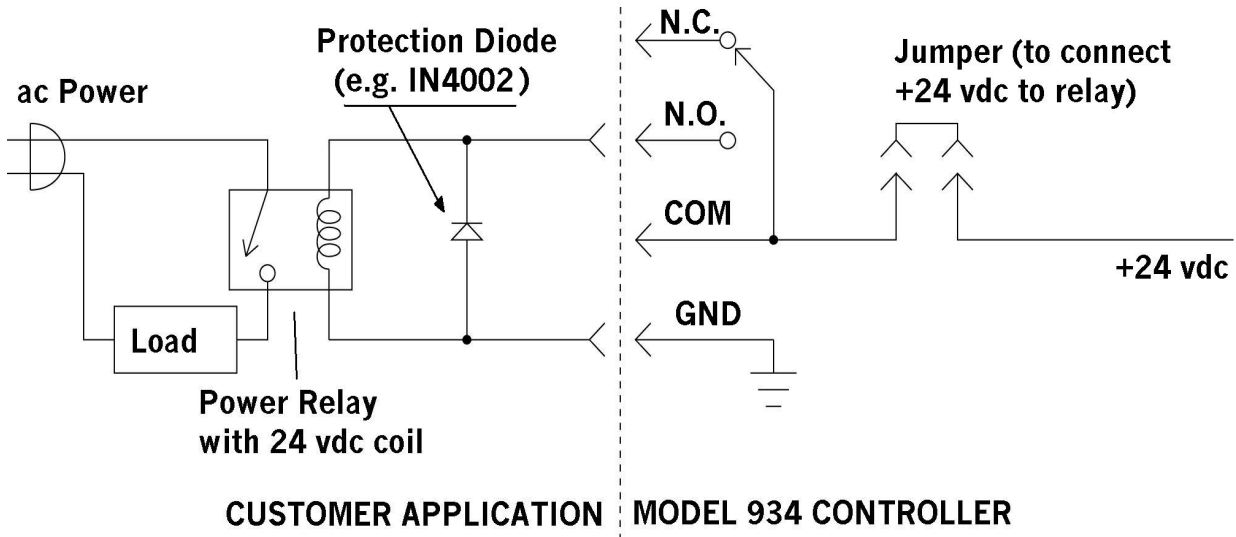
When connecting loads to the set point relays, it is good practice to add transient absorbers to minimize the possibility of electrical interference, particularly with inductive loads such as solenoids or motors.



**Figure 2-14. Connecting external loads to set point relays**

If switching the load causes interference in the Model 934 controller, it may be necessary to use a remote power relay that is driven by the set point relay in the controller.

A unique feature of the Model 934 Vacuum Gauge Controller allows you to configure the set point relays to supply 24 volts dc to the load. This is useful for actuating external devices such as pneumatic valve operator solenoids or high-power relays for motor control. The 24 volts dc is limited to a total current of 0.5 amp for all relays combined. The following figure shows a typical application.



**Figure 2-15. Using internal 24 volts dc to drive external device**

To supply 24 volts dc to a given relay, you must install a jumper on the jumper block that corresponds to the relay. The location of the jumper blocks inside the Model 934 controller is immediately adjacent to the relays on the printed circuit board just inside the back panel. Simply slide the jumper (supplied) onto the pins of the jumper block.

### **Optional: Connect Analog Output**

The Model 934 Vacuum Gauge Controller provides an analog output at the BNC receptacle next to the ion gauge connections on the back panel. Figure 2-x shows the location of the receptacle. This output is typically used for pressure control purposes, or as input to a strip chart recorder.

The voltage at the analog output is derived directly from the value shown by the digital display on the front panel. The output is pseudo logarithmic (the mantissa values are linear within each decade), according to the following formula:

For a pressure reading in the form:

x.y E-z

the analog output is approximately:

$$(5.00 / 4095) * ((410 * (10 - z)) + (40 * x.y))$$

Thus, the output range is from 0 to 5 volts (approximately). Because of minor voltage offsets, the actual output voltages may differ from the calculated values by a few millivolts. The nominal output impedance is 10 ohms, and the maximum current is 1 mA.

For more details, refer to the section on analog output in chapter 3.

### **Optional: Set Up for Remote Control Using RS-232 Port**

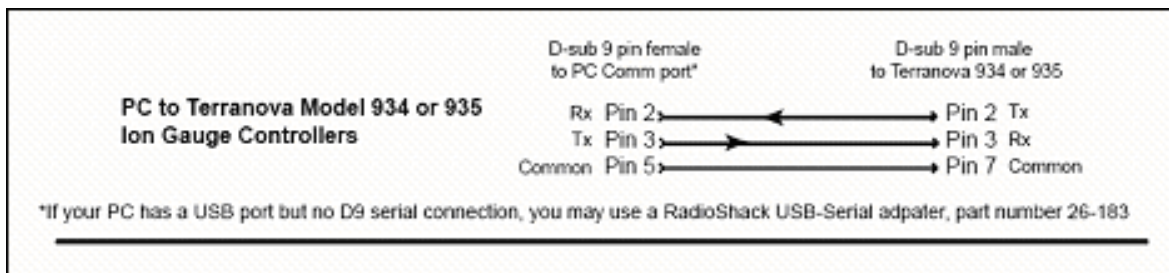
Many of the front-panel functions of the vacuum gauge controller can be controlled through the RS-232 I/O port on the back panel. You can connect either a terminal or a computer to the I/O port. The functions that can be controlled remotely are:

degassing  
filament ON/OFF  
pressure readings

The vacuum gauge controller's RS-232 port is a female 9-pin D-connector with the following pin assignments:

Pin 2 = TX (data transmitted from Model 934)  
Pin 3 = RX (data received by Model 934)  
Pin 7 = ground/common/signal ground

Make sure that your terminal or computer has an RS-232 interface and cabling that can provide these signals on these pins.



**Figure 2-16**

In addition, make sure that your terminal or computer can communicate as follows:

selectable baud rate: 1200, 2400, 4800, or 9600 baud

no parity

8 bits

1 stop bit

full duplex

at least 50 milliseconds between successive characters sent to the vacuum gauge controller

The vacuum gauge controller is normally set to 9600 baud at the factory. See note 4 under Verification, below, for information on verifying that your baud rate is set correctly.

The character sequences used for remote control are described in the Remote Control section near the end of chapter 3, Operation.

## Verification

Once you have finished installing the Model 934 Vacuum Gauge Controller, you can verify that it is working properly by running the self-test. The self-test runs whenever you switch on the power to the gauge controller, and goes through these stages:

1. All front-panel indicators turn on, and the audio annunciator sounds for one second.
2. All indicators turn off, and the display shows the software version for one second (for example, 1.69).
3. The display shows the decimal value of internal switch S2 for one second (for example, 0.0 4).
4. The display shows the baud rate for one second (for example, 1.2<N>0, 2.4<N>0, 4.8<N>0, or 9.6<N>0).
5. The display shows “\_ \_.” to indicate that the ion gauge is off; low-vacuum gauges are unplugged.
6. When this sequence completes, the controller is ready for normal operation.

## 3 Operation

### General Operation

Most functions of the Model 934 vacuum gauge controller are controlled by the SELECT, RAISE, and LOWER switches on the front panel. The functions controlled by these switches are indicated by the columns of LEDs on the left side of the front panel and to the right of the gauge displays. You select a function by pressing the SELECT switch until the appropriate LED lights, and then set the value you want by pressing the RAISE and LOWER switches. (The value is shown in one of the digital displays on the front panel.) Each time you press a switch you will hear a short chirp to indicate normal operation, or a long beep to indicate a disallowed action. If the selection is left at any function other than OPERATE for longer than two minutes, the gauge controller automatically saves any changes that were made and returns to OPERATE.

In addition, two switches located to the left of the digital displays control degassing and filament operation.

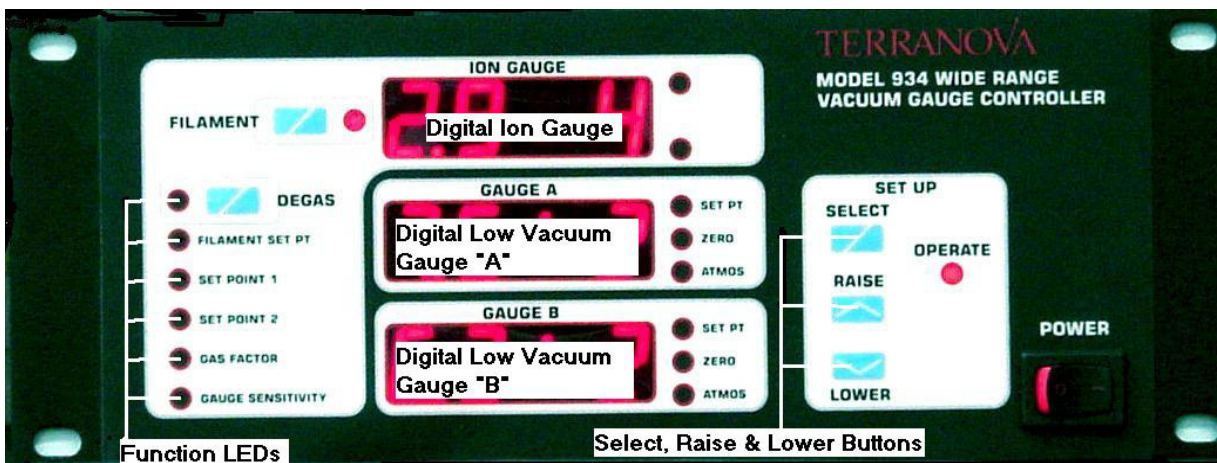


Figure 3-1. Front panel switches and displays

**Displays in normal operation.** When the vacuum gauge controller is in normal operation (the OPERATE function has been selected), the digital display shows pressure readings from the ion gauge and the analog displays show pressure readings from the low-vacuum gauges.

**Remote control.** Most functions can be controlled remotely by a computer or terminal connected to the gauge controller's RS-232 port.

**Resetting to factory default values.** Occasionally, electromagnetic interference may corrupt the stored values of selected variables. To reset to the factory default values, first switch off the Model 934 controller. Then press and hold both the RAISE and LOWER switches while you switch on the power again. There will be a series of 20 chirps to confirm that the default settings have been reinstated. The values of the default settings are:

all set points set to the minimum (relays off)

gas factor set to 1.00

gauge sensitivity set to 10.0 for Model 934, 25.0 for Model 934-UHV

filament emission current set to  $1 \times 10^{-4}$  amps

low-vacuum gauge zero correction set to zero

Normal operation may be resumed without restarting the instrument.

**Watchdog timer.** The controller's microprocessor is equipped with an independent watchdog timer. This timer resets the microprocessor if it fails to execute its program for any reason; this can happen in the presence of heavy electrical interference. The reset occurs within 5 seconds after the microprocessor experiences a fault. The vacuum gauge controller will return to its power-on state.

**Bypassing the set point protection.** Switch S2-2 on the motherboard controls set point protection. (This is described in chapter 2.) If set point protection is enabled, the set points for the ion gauge and the low-vacuum gauges can not be changed from the front panel; the values of the gas factor and the gauge sensitivity are also protected. There is, however, a secret switch hidden behind the front panel that lets you bypass the set point protection and change the set points, gas factor, and gauge sensitivity without removing the controller from its mounting and taking the cover off.

The procedure for bypassing the set point protection is:

1. Switch off the power to the gauge controller.
2. Locate the secret switch. It is below the OPERATE LED and to the right of the LOWER switch. You can feel the switch go in when you push in that location. See figure 3-2.
3. Press firmly on the secret switch while you switch on the controller's power. There will be five short chirps to indicate that the set point protection has been bypassed.
4. Make changes to the set points, gas factor, and gauge sensitivity as needed.
5. To enable the set point protection again, switch the power off and then on again.

## Switch On the Power

Switch on the power to the vacuum gauge controller by setting the POWER switch in the lower right portion of the front panel to the 1 position. The controller will execute its power-on self-test (described in the section on Verification at the end of the previous chapter), completing the sequence by showing \_ in one or more of the digital displays. At that point, the controller is ready for normal operation.

To switch off the power, set the POWER switch to the 0 position.

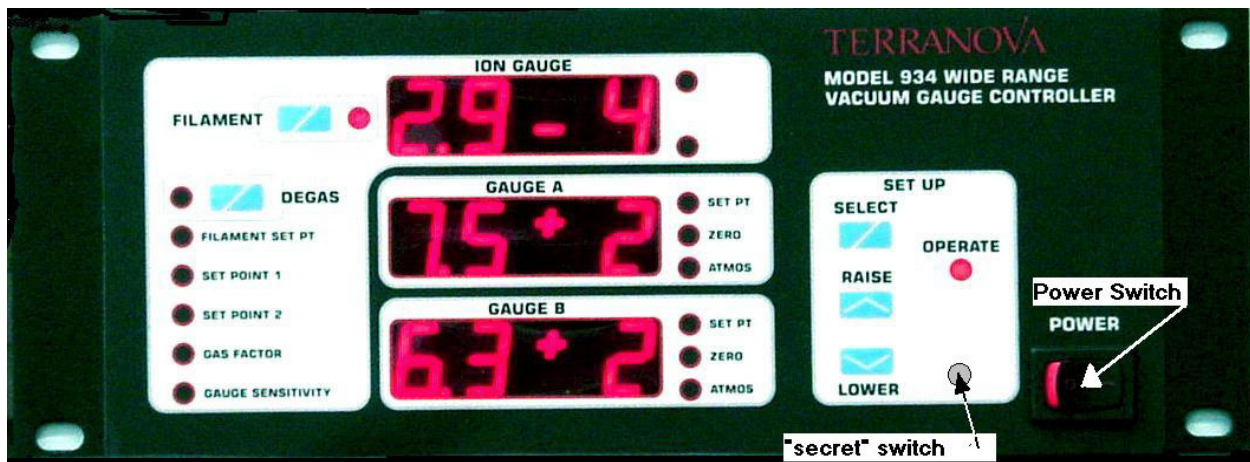


Figure 3-2. Switch on the power

## Ion Gauge Functions

The next several pages describe the ion gauge functions of the Model 934 vacuum gauge controller in detail.

### Optional: Set the Gas Factor

The gas factor setting allows the Model 934 vacuum gauge controller to display corrected readings if your system uses a gas other than air or nitrogen. The gas factor is a multiplier that the vacuum gauge controller applies to a reading before it shows the result on the digital ion gauge display.

To set the gas factor: (refer to Figure 3.1)

1. Press the SELECT switch on the front panel until the GAS FACTOR LED lights. The gas factor setting is shown by the digital display.
2. Use the RAISE and LOWER switches to set the appropriate gas factor. The gas factor has a range of 0.50 to 1.50.
3. Select OPERATE to return to normal operation.

For protection of the filament, the vacuum gauge controller switches off power to the filament if the gas factor setting is other than 1.00 and the pressure rises above  $9.9 \times 10^{-3}$  Torr. If this occurs, the ion gauge display shows a message of HI 12.

Table 3-1 shows the gas factors for commonly used gases. (Note that there is not particularly good agreement in the literature on these conversion factors. The table was constructed using a variety of sources, along with our own observations and judgment.) Because of differences in higher pressure operation, these conversion factors may not be valid for pressures above  $10^{-3}$  Torr.

**Table 3-1. Conversion Factors for Gases (Nitrogen = 1.00)**

| <u>Gas</u>      | <u>Factor</u> | <u>Gas</u>     | <u>Factor</u> | <u>Gas</u>     | <u>Factor</u> | <u>Gas</u>       | <u>Factor</u> |
|-----------------|---------------|----------------|---------------|----------------|---------------|------------------|---------------|
| Air             | 1.08          | Hg             | 0.29          | Ar             | 0.80          | Kr               | 0.53          |
| CO              | 0.95          | Xe             | 2.8           | Ne             | 3.3           | He               | 5.6           |
| CO <sub>2</sub> | 0.73          | H <sub>2</sub> | 2.0           | O <sub>2</sub> | 1.11          | H <sub>2</sub> O | 1.11          |

For example, if you were taking pressure measurements in a carbon dioxide environment (with the gas factor set to 0.73), and the controller read a value of  $3.2 \times 10^{-5}$  Torr for a nitrogen environment, the pressure shown on the ion gauge display would be:

$$3.2 \times 10^{-5} \text{ Torr} * 0.73 = 2.3 \times 10^{-5} \text{ Torr}$$

For gases that have conversion factors outside the range of the gas factor settings, you can choose a gas factor value with an easy correction. For example, xenon's conversion factor, 2.8, is outside the range of the gas factor settings; but you could set the gas factor at 1.4 and then double the readings.

Note that the conversion factors in the Model 934 assume a pure gas. If the gas composition is a mixture, you will need to calculate a weighted average of the conversion factors and apply the method described in the carbon dioxide example, above.

The GAS FACTOR setting is saved in the vacuum gauge controller's nonvolatile memory. This setting is maintained even when the controller's power is switched off, and the controller will come up with this gas factor when power is switched back on.



## Optional: Set the Gauge Sensitivity

The gauge sensitivity setting allows you to modify the ion gauge calibration. This may be useful if you are using an ion gauge type other than type 563. The gauge sensitivity is a multiplier that the vacuum gauge controller applies to a reading before it is shown on the ion gauge display. The normal value for a type 563 ion gauge is 10.0.

To set the gauge sensitivity: (refer to Figure 3.1)

1. Press the SELECT switch on the front panel until the GAUGE SENS LED lights.
2. Use the RAISE and LOWER switches to set the appropriate gauge sensitivity. The gauge sensitivity adjustment has a range from 5.0 to 15.0 per Torr for the Terranova 934 and from 5.0 to 25.0 for the Terranova 934-UHV.
3. Select OPERATE to return to normal operation.

For protection of the filament, the vacuum gauge controller switches off power to the filament if the gauge sensitivity setting is other than 10.0 and the pressure rises above  $9.9 \times 10^{-3}$  Torr. If this occurs, the ion gauge display shows a message of HI 12.

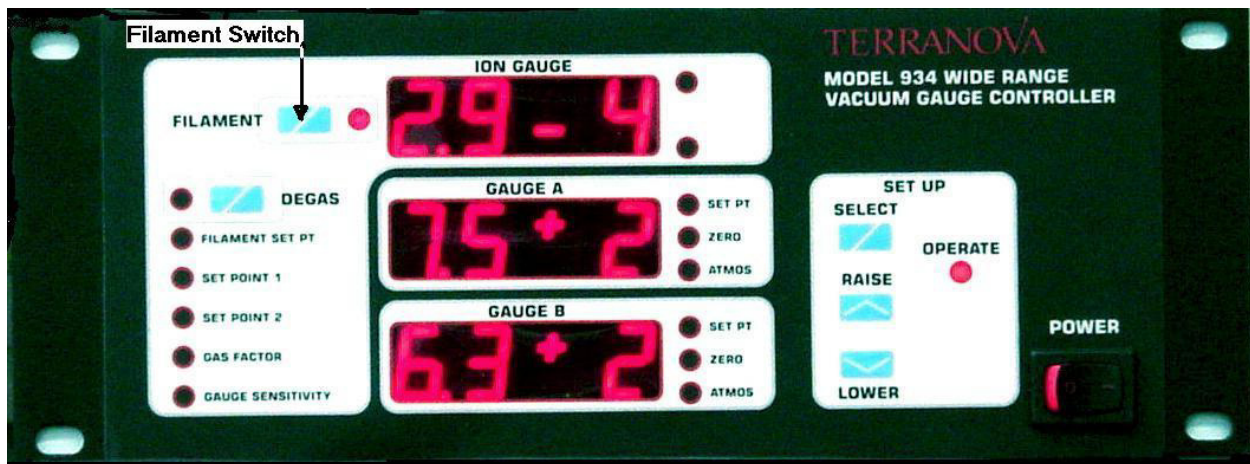
## Switch On the Filament and Read the Pressure

After the power is switched on, there is a delay of 10 seconds before the filament may be energized. This delay allows the electrometer to reach equilibrium.

Switch on the filament of the ion gauge by pressing the FILAMENT switch, as shown in Figure 3-3. You should switch on the filament only at pressures lower than 1 Torr. Near 1 Torr the gauge may shut itself off, due to uncertainty in the initial readings.

Note: The Model 934 controller is shipped from the factory with an internal switch set to limit the upper pressure measurement to  $9.9 \times 10^{-3}$  Torr. To enable measurement up to 1 Torr you must change the switch setting. See the section Optional: Set Internal Switches in chapter 2, Installation.

To switch off the filament, press the FILAMENT switch again. Note that after the filament is switched off, either manually or automatically (as described below), a four-second delay is imposed before the filament can be switched on again. This allows the electrometer and the detector time to settle and re-zero properly. If you try to switch on the filament during this four seconds, the alarm will give a long error beep.

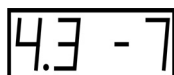


**Figure 3-3. Switch on the filament**

As soon as you switch on the filament, the electrometer will go through an automatic zero adjustment. The display will show E.0 -3, and will then begin normal ranging. While the ion gauge is starting, the filament LED flashes several times per second until emission is established. After emission is reached, the filament LED remains on without flashing.

If the display shows a constant E as the first digit of the reading, it means that the zero adjustment is out of the normal range, possibly indicating a shorted collector cable or other offset. If this happens, switch off the power and disconnect the BNC connector at the back panel of the gauge controller; leave the 6-pin ion gauge connector plugged in. Then, with the system pressure lower than  $10^{-5}$  Torr (to prevent excess drive to the filament), switch the power back on and attempt to energize the filament again. If the display ranges properly, switch off the power, re-connect the BNC connector, switch the power back on, and try the filament again. Do not leave the gauge controller operating very long without the collector cable (BNC connector) connected, since this prevents the gauge controller from knowing the true pressure in the ion gauge, and thus does not allow it to properly protect the gauge.

The readings on the display are in an exponential form that converts directly to scientific notation. For instance, if the display shows



then the reading has a value of  $4.3 \times 10^{-7}$  Torr.

Ion gauge ranging is automatic throughout the range of  $0.1 \times 10^{-10}$  Torr to  $9.9 \times 10^{-1}$  Torr. The display ranges to the next higher decade when the indicated pressure is greater than  $9.9 \times 10^{-n}$ , and to the next lower decade when the indicated pressure is lower than  $0.8 \times 10^{-n}$ .

If the ion gauge has adsorbed a quantity of gas or water vapor, the controller may range back and forth between ranges for a short time. This occurs when the ion gauge filament emission is increased, as in the transition from the  $10^{-4}$  range to the  $10^{-5}$  range, or from  $10^{-3}$  to  $10^{-4}$ . This is not a defect; rather, it is an indication of increased outgassing of the ion gauge, and commonly occurs with ion gauges that have been exposed to air or high-pressure operation. The effect usually disappears as the ion gauge operates at lower pressures for a few minutes.

The current to the ion gauge may shut off automatically, due to loss of emission or other conditions. If this happens, the internal detection circuitry reports an error code on the ion gauge display. The codes are:

**Table 3.2: Filament Emission Error Codes**

| <u>Code</u> | <u>Explanation</u>  |
|-------------|---|
| 3 --        | Ion gauge shut off due to loss of emission after start, reason unknown.   |
| 4 --        | Filament failed to switch on within the allowed time (ion gauge may be defective).  |
| 5 --        | Filament failed to switch on from Autostart, reason unknown.  |
| 6 --        | No high voltage was present at the ion gauge connector.   |
| 7 --        | There is no filament current,, possibly due to an open filament or cable. If you get a 7 message and you have verified that the cable and ion gauge are not defective, an internal fuse in the emission regulator may be open. Please contact Duniway Stockroom Corp. for details.  |
| 8 --        | There was excess filament current (due, for example, to a shorted filament or cable).   |
| 9 --        | Ion gauge shut off at a pressure above maximum value determined by SET UP.  |
| 12 --       | Ion gauge shut off at a pressure above $9.9 \times 10^{-3}$ Torr, for a gas factor other than 1.00 (air) or for a gauge sensitivity other than 10/Torr (standard Bayard-Alpert gauge) or 25/Torr (UHV-24 nude gauge).   |
| 14 --       | Ion gauge shut off at a pressure above $9.9 \times 10^{-3}$ Torr due to insufficient ion current, ion gauge may be defective.   |
| 15 --       | Ion gauge shut off at a pressure greater than $9.9 \times 10^{-3}$ Torr because of the setting of the high-pressure shutoff switch (switch S2-3). This setting prevents erroneous pressure readings from non-563-type ion gauges in the high pressure ranges. If you are using a 563-type ion gauge and want to see pressure readings all the way up to 1 Torr, you must change the setting of switch S2-3, as described in the section Optional: Set Internal Switches in chapter 2, Installation. |
| 16 --       | Ion gauge shut off normally while in auto filament mode.  |
| 17 --       | Ion gauge shut off manually while in auto filament mode.  |

The error message disappears if the FILAMENT switch is pressed again.

If the filament is manually shut off while low-vacuum gauge A is within the automatic turn-on range, the display will show a message of 17 to indicate that the ion gauge was manually shut off. (See the section on Optional: Set the Set Points under Low-Vacuum Gauge Functions, below.) The auto filament function will be disabled until the filament is manually switched on again, or until power to the gauge controller is switched off and then on again. If gauge A rises in pressure above the auto filament set point, the display will show 16 to indicate that the ion gauge shut off via the auto filament function. If you try to switch on the ion gauge manually while gauge A is above the auto filament set point, the gauge will shut itself off. If you wish to switch on the filament manually, defeat the auto filament set point by setting it to its minimum value.

## Optional: Degas the Ion Gauge

You can degas the ion gauge only when the filament is on. Pressure must be lower than  $9.9 \times 10^{-4}$  Torr for a standard ion gauge, or lower than  $9.9 \times 10^{-6}$  Torr for a UHV gauge. This assures the proper conditions for degassing.

It is generally considered good practice to degas ion gauges only at pressures lower than  $10^{-5}$  Torr for a standard ion gauge or  $10^{-6}$  Torr for a UHV ion gauge. At sustained pressures above  $10^{-3}$  Torr, the ion gauge may become contaminated by system outgassing or process chemicals, making it necessary to replace the ion gauge with one known to be clean. A contaminated gauge may cause a plasma glow or other unexpected phenomena. If this happens, switch off degassing and continue pumping until the system pressure is as low as possible before switching on degassing again.

For the Model 934 controller, the ion gauge will continue to measure pressure while degassing is active. (For the Model 934-UHV controller, pressure is not displayed while degassing is active.) You will typically notice a rise in the indicated pressure as the adsorbed gases are evolved. The indicated pressure normally drops in a few minutes, as the gases are driven out of the ion gauge.

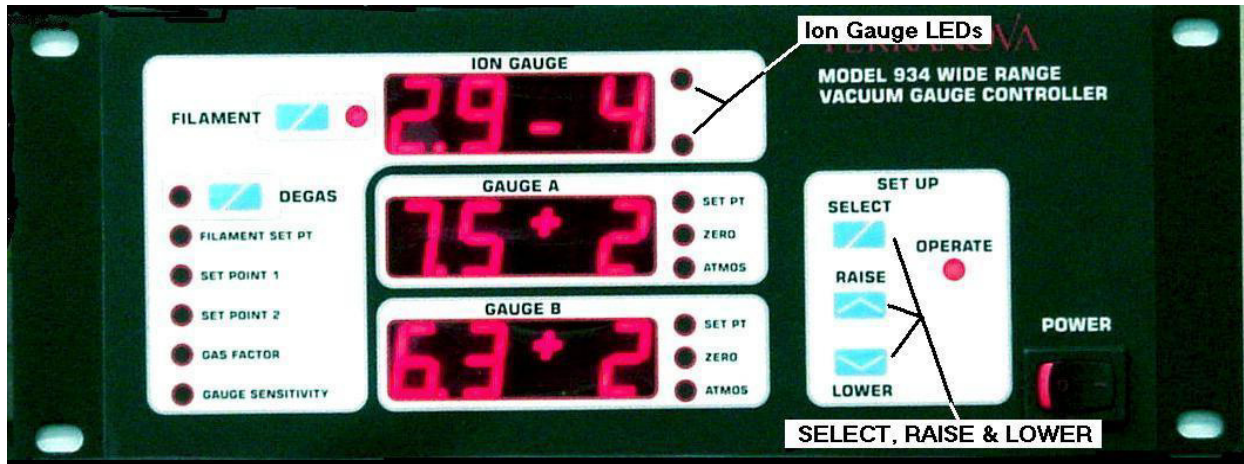
The degassing function is controlled by the DEGAS switch on the front panel, shown in figure 3-1. The DEGAS switch toggles the state of the degassing circuitry from OFF to ON, or vice versa. The Model 934 Vacuum Gauge Controller uses resistive heating of the grid to evaporate contaminants in the ion gauge. The Model 934-UHV uses electron bombardment (50 mA at 700 eV).

To switch on degassing, press the DEGAS switch. (refer to Figure 3.1) The LED above the DEGAS switch will flash every two seconds to indicate that degassing is in progress.

The degassing function switches off automatically after five minutes to prevent excessive stress on the ion gauge. If you want to switch off degassing manually, press the DEGAS switch again. If the filament power is switched off, degassing is automatically switched off also.

## Optional: Set the Set Points

The ion gauge, in conjunction with its set points, controls the state of relays 3 and 4. SET POINT 1 controls relay 3, and SET POINT controls relay 4. Values for these set points are set using the SELECT, RAISE, and LOWER switches on the front panel. Figure 3-4 shows the locations of the relevant switches and LEDs.



**Figure 3.4 Set Point Switches**

Relay 3 energizes whenever the system pressure is less than the value of SET POINT 1. Similarly, relay 4 energizes whenever the system pressure is less than the value of SET POINT 2. The red ion gauge LEDs indicate the states of the relays: if the LED is on, the relay is energized; if the LED is off, the relay is de-energized. Since each relay has electrically isolated sets of contacts, you can easily wire the relays to control the operation of various devices (pumps, recorders, and so on) when the system reaches a certain pressure. (Wiring of the relays, and their power rating, are discussed in chapter 2.)

The set points incorporate a 10% hysteresis to minimize cycling of the relays near the set points. The relays de-energize when the pressure rises to 10% above the set point.

**To check the value of a set point,** use the SELECT switch to select either the SET POINT 1 or SET POINT 2 function; the corresponding LED will flash to indicate that the function is selected. The digital display will show the value of the set point for as long as the function is selected; when the function returns to OPERATE, the display will return to showing the system pressure.

For example, to check the value of SET POINT 1, toggle the SELECT switch until the SET POINT 1 function is selected (its LED flashes), then read the value of the set point from the digital ion gauge display. When you have finished reading the set point, toggle the SELECT switch until the OPERATE function is selected.

**To change the value of a set point**, use the SELECT switch to select either the SET POINT 1 or the SET POINT 2 function; the corresponding LED will flash to indicate that the function is selected. The digital display will show the value of the set point. Press the RAISE or LOWER switch to adjust the set point up or down. You can make a single-digit change to the set point value with a single, quick press of the RAISE or LOWER switch. To change to a value that is significantly different from the current value, press and hold the RAISE or LOWER switch; the set point values will change increasingly rapidly (at a rate of approximately 3 seconds per decade), and the chirps will stop, as long as you hold the switch. Once you are near the value you want, release the switch and then use single, quick presses to get to the exact value.

Example. Assume that the value of SET POINT 1 is  $2.3 \times 10^{-3}$ , and you want to change it to  $5.6 \times 10^{-8}$ . You would take the following steps:

1. Toggle the SELECT switch until the SET POINT 1 function is selected. The SET POINT 1 LED will flash and the digital display will show the current value of SET POINT 1:  $2.3 \times 10^{-3}$ .
2. Press and hold the LOWER switch. The display will show the rapidly decreasing value of the set point. When the value gets down to about  $6.0 \times 10^{-8}$ , release the LOWER switch.
3. Make single digit changes by quickly pressing and releasing the LOWER switch, until the display shows a value of  $5.6 \times 10^{-8}$ .
4. Toggle the SELECT switch until the OPERATE function is selected.

That's all there is to it. You could probably do it in less time than it took to read this example.

## Low-Vacuum Gauge Functions

The Model 934 Vacuum Gauge Controller can take readings from two low-vacuum gauges and display the results on the two lower digital displays on the front panel. Figure 3-1 shows the location of the displays on the right-hand side of the front panel.

See Figure 3-1 for displays for low-vacuum gauges.

The inputs from the low-vacuum gauges connect to the back panel of the vacuum gauge controller. (Refer to chapter 2 for installation instructions.)

## Optional:

### Adjust the Low Vacuum Gauge Zero and Atmospheric Points

You adjust the zero points of thermocouple gauges, and the zero and atmospheric points of convection gauges, using the RAISE and LOWER switches. Each gauge is adjusted separately, and the adjustment should last for the life of the gauge, or until the gauge becomes contaminated.

See Figure 3-1 and 3-4 for switches and indicators for zero point adjustment

### Thermocouple Zero Adjustment

Follow these steps to adjust the zero point of a thermocouple gauge. Repeat the procedure for a second gauge, if necessary.

1. Pump the vacuum system to a pressure below  $10^{-3}$  Torr.
2. Use the SELECT switch to select the ZERO LED for the thermocouple gauge you want to set.
3. Adjust the zero point by pressing the RAISE or LOWER switch until the display reads **0.0 E-3** Torr. This reading is the minimum reading possible.
4. Release all switches.  
Alternatively, the RAISE, and LOWER switches can be used to set to a known pressure in the range of **-9.0 E<sup>-3</sup> to ~4.0 E<sup>-2</sup> Torr.**

### Convection Zero Adjustment

The convection gauge should be adjusted to read zero when the system pressure is below  $10^{-4}$  Torr. To adjust the zero, press the SELECT button until the desired gauge display and its ZERO LED are flashing. Press either RAISE or LOWER; the display will show a reading close to zero, such as 0.2 -3 ( $0.2 \times 10^{-3}$  torr). For this adjustment, the RAISE and LOWER buttons do not have their normal raise and lower functions. Normal variations in output of the convection gauge result in some random display near zero pressure.

At high vacuum, a convection gauge in good condition will normally indicate between -5. -3 and 5.0 -3 (between  $-5.0 \times 10^{-3}$  Torr and  $+5.0 \times 10^{-3}$  Torr). If the convection becomes contaminated, it may indicate outside this range. The convection must be at a pressure lower than approximately  $4.0^{-2}$  ( $4.0 \times 10^{-2}$  Torr) to make the zero adjustment; this is to prevent the use of a defective gauge. If you are sure that the system pressure is below  $10^{-4}$  Torr and the convection indicates a pressure of  $3.0^{-2}$  or higher, and you can not make the zero adjustment (as indicated by a long error beep), then you may need to replace the convection with a new gauge.



## Convection Atmospheric Adjustment

The convection gauge should be adjusted to read the local atmospheric pressure when the system is open or vented to air. To adjust the atmospheric pressure, press the SELECT button until the desired gauge display and its ATMOS LED are flashing. Press either RAISE or LOWER until the desired pressure is displayed; pressure at sea level is normally 760 Torr. You can usually obtain the local pressure from a local airport. You may need to make a conversion to Torr.

760 Torr = 760 mm (mercury) = 1013 mbar = 29.92 in (mercury) = 14.60 psi (absolute).

At sea level, a convection gauge in good condition will normally indicate between 700 and 800 Torr. If the convection becomes contaminated, it will usually indicate much lower than 700 Torr. The convection must be at a pressure higher than approximately 400 Torr to make the atmospheric adjustment; this is to prevent use of a defective gauge. If you cannot make the atmospheric adjustment (as indicated by a long error beep), you may need to replace the convection with a new gauge.

## Optional: Set the Set Points

The set point procedure applies to three different set points:

the low-vacuum gauge A set point, which controls the operation of relay 1

the low-vacuum gauge B set point, which controls the operation of relay 2

the Auto filament set point, which can be programmed to turn on the ion gauge filament automatically (if the internal Auto filament switch is enabled, as described in chapter 2)

See figure 3-1 and 2-2 for set point switches and indicators.

Each low-vacuum gauge has its own relay and set point. Relay 1 energizes whenever the pressure shown on the gauge A display is less than the value of its set point. The relay de-energizes whenever the pressure is equal to or greater than the set point. Similarly, relay 2 energizes when the pressure shown on the gauge B display is less than the value of its set point; and it de-energizes whenever the pressure is equal or greater. The set points incorporate hysteresis to minimize cycling of the relays.

The Auto filament function is governed by the pressure shown on gauge A. The ion gauge filament switches on whenever that pressure is less than the value of the Auto filament set point; and it switches off whenever the pressure is equal to or greater than the set point. Note that when the filament has been switched on via the Auto filament set point, you can still switch off the filament manually using the FILAMENT switch on the front panel. This causes the ion gauge display to display an E5 message until the filament is restarted manually (using the FILAMENT switch again). Once the filament is restarted manually, the Auto filament function is automatically re-enabled.

The red SET PT LEDs (to the right of the low-vacuum gauge displays) indicate the states of the relays: if the LED is on, the relay is energized; if the LED is off, the relay is de-energized.

For the FILAMENT SET PT, if the LED is on, the auto filament set point is active and should have switched the filament on.

The procedures for reading and setting the set points use the SELECT, RAISE, and LOWER switches, and show the set point values on the two low-vacuum gauge displays.

**To check the value of a set point**, use the SELECT switch to select the FILAMENT SET PT, gauge A SET PT, or gauge B SET PT function; its LED will flash to show that the function is selected. The corresponding display will blink on and off while it shows the value of the set point, for as long as the function is selected; when the function returns to OPERATE, the display will return to showing the pressure.

For example, to check the value of the gauge A set point, toggle the SELECT switch until gauge A's SET PT is selected (its LED flashes), then read the value of the set point from the gauge A display. When you have finished reading the set point, toggle the SELECT switch until the OPERATE function is selected.

**To change the value of a set point**, use the SELECT switch to select the FILAMENT SET PT, the gauge A SET PT, or the gauge B SET PT function; its LED will flash to show that the function is selected. The corresponding display will blink on and off while it shows the value of the set point. Press the RAISE or LOWER switch to adjust the set point up or down. You can make a small change to the set point value with a single, quick press of the RAISE or LOWER switch. To change to a value that is significantly different from the current value, press and hold the RAISE or LOWER switch; the set point value will change rapidly as long as you hold the switch. Once you are near the value you want, release the switch, release the switch and then use single, quick presses to get to the desired value.

Note that setting a set point to its minimum keeps the relay or the filament off.

## Analog Output

Output from the Analog Out connector on the back of the gauge controller is governed by the pressure indicated on the ion gauge display. The output is 0.5 volts per decade, with a least change of 0.005 volts. If desired, the output may be configured to operate around zero volts at 1 volt/decade by installing a shunt on J28 (just under the front right corner of the power transformer).

The output is linear between decades, approximately as follows:

**Table 3.3: Analog Output Voltage vs. Pressure**

| Normal, 0 to +5 volts<br>(no shunt on J28) | Option +/- 5 volts<br>(shunt installed on J28) |
|--|--|
| 0.0 x 10 <sup>-10</sup> = 0.000 volts      | -5.000 volts                                   |
| 0.3 x 10 <sup>-10</sup> = 0.015 volts      |  |
| 0.4 x 10 <sup>-10</sup> = 0.020 volts      |  |
| 0.9 x 10 <sup>-10</sup> = 0.044 volts      |  |
| 1.0 x 10 <sup>-10</sup> = 0.049 volts      |  |
| 9.9 x 10 <sup>-10</sup> = 0.484 volts      |  |
| 1.0 x 10 <sup>-9</sup> = 0.549 volts       | -3.888 volts                                   |
| 9.9 x 10 <sup>-9</sup> = 0.984 volts       |  |
| 1.0 x 10 <sup>-8</sup> = 1.050 volts       | -2.890 volts                                   |
| 1.0 x 10 <sup>-7</sup> = 1.551 volts       | -1.890 volts                                   |
| 1.0 x 10 <sup>-6</sup> = 2.051 volts       | -0.893 volts                                   |
| 1.0 x 10 <sup>-5</sup> = 2.552 volts       | +0.105 volts                                   |
| 1.0 x 10 <sup>-4</sup> = 3.053 volts       | +1.103 volts                                   |
| 1.0 x 10 <sup>-3</sup> = 3.553 volts       | +2.100 volts                                   |
| 1.0 x 10 <sup>-2</sup> = 4.054 volts       | + 3.100 volts                                  |
| 1.0 x 10 <sup>-1</sup> = 4.554 volts       | + 4.100 volts                                  |
| 9.9 x 10 <sup>-1</sup> = 4.989 volts       | + 4.966 volts                                  |

The calculation is based on the following equation.

For pressure displayed in the form:

$$x.y \text{ E-}z$$

analog output is approximately:

$$(5.00 / 4095) * ((410 * (10 - z)) + (40 * x.y))$$

Note that one characteristic of presenting pressure values in this logarithmic form is that values between  $0.0 \times 10^{-n}$  and  $0.9 \times 10^{-n}$  will never be displayed. In consequence, the corresponding voltages will never be present at the analog output. This means that the function shows a non-linearity as it crosses each decade boundary. Since the typical uses for analog output from a vacuum gauge controller do not require absolute precision, these small nonlinearities should not pose any problems.

## RS-232 Remote Control

If you have attached a terminal or computer to the RS-232 port on the back panel of the vacuum gauge controller, you can control many of the controller's functions remotely. (Connection of the terminal or computer is described in chapter 2, Installation.) The functions you can control remotely are:

- degassing
- filament ON/OFF
- pressure readings

In addition, you can read the status of these settings. You can send control sequences to the vacuum gauge controller either interactively (typing one character at a time) or under program control.

## Configure the Terminal

Make sure that your terminal or computer is set up with the following configuration:

- 1200, 2400, 4800, or 9600 baud  
(see chapter 2, Installation, for instructions on setting the baud rate)
- no parity
- 8 bits
- 1 stop bit
- full duplex

In addition, allow at least 50 milliseconds between successive characters.

## Send Control Sequences

Send the following characters to execute the commands listed below. Characters should not be sent faster than approximately 2 characters per second, or before a response has been received (where appropriate) from the vacuum gauge controller. Note that these are all UPPERCASE (capital) letters. (A = ASCII 65, B = ASCII 66, &c.)

### **NOTE: SERIAL FORMATS FOR EXPRESSING PRESSURE & SETPOINT VALUES**

#### **1 Pressure Readings**

All gauges (Items 24, 25, 26, F, G, H)

Serial output xy z, where pressure is  $xy \cdot 10^Z$  torr

Example 1: 14 -6 is  $14 \cdot 10^{-6} = 1.4 \cdot 10^{-5}$  torr

Example 2: 47 0 is  $47 \cdot 10^0 = 47$  torr

Example 3: 91 1 is  $91 \cdot 10^{+1} = 910$  torr

#### **2. Set Point Settings**

All Gauges (Items 17, 18, 19, 22, 23)

Serial output: xy z, where setting is  $xy \cdot 10^{Z-2}$  torr

Example: 14 -6 is  $14 \cdot 10^{-6-2} = 1.4 \cdot 10^{-7}$  torr

### **Table 3.4: Remote Command Codes**

A= turn ion gauge filament on

B= turn ion gauge filament off

C= turn degas on

D= turn degas off

E= status register dump; entries separated by carriage returns<

(1) = degas; 1 = on, 0 = off

(2) = filament; 1 = on, 0 = off

(3) = ion gauge emission; 1 = OK, 0 = off

(4) = set point 1/low-vacuum gauge A: 1 = relay on, 0 = relay off

(5) = filament error codes (see Table 3.3, above)

(6) = not used

(7) = set point 2/low-vacuum gauge B: 1 = relay on, 0 = relay off

(8) = set point 3/ion gauge : 1 = relay on, 0 = relay off

(9) = set point 4/ion gauge : 1 = relay on, 0 = relay off

(10) = filament status, auto filament; 1 = filament on, 0 = filament off

(11) = not used

(12) = not used

(13) = not used

(14) = not used

(15) = set point protection disabled, via secret switch;  
0 = protected, 1 = protection disabled

(16) = auto-filament; 1 = enabled, 0 = disabled

(17) = auto-filament set point; xy z, where pressure =  $xy \cdot 10^{Z-2}$  Torr

- (18) = ion gauge set point 1: xy z, where pressure =  $xy \cdot 10^{Z-2}$  Torr
- (19) = ion gauge set point 2: xy z, where pressure =  $xy \cdot 10^{Z-2}$  Torr
- (20) = gas factor; shown as 50 to 150 for values of 0.50 to 1.50
- (21) = ion gauge sensitivity; shown as 50 to 150 for values of 5.0 to 15.0
- (22) = gauge A set point; xy z, where pressure =  $xy \cdot 10^{Z-2}$  Torr
- (23) = gauge B set point; xy z, where pressure =  $xy \cdot 10^{Z-2}$  Torr
- (24) = ion gauge pressure; xy z, where pressure =  $xy \cdot 10^Z$  Torr; "0" if OFF
- (25) = gauge A pressure; xy z, where pressure =  $xy \cdot 10^Z$  Torr
- (26) = gauge B pressure; xy z, , where pressure =  $xy \cdot 10^Z$  Torr
- F= ion gauge pressure; xy z, where pressure =  $xy \cdot 10^Z$  Torr
- G= gauge A pressure; xy z, where pressure =  $xy \cdot 10^Z$  Torr
- H= gauge B pressure; xy z, where pressure =  $xy \cdot 10^Z$  Torr

If you enter a disallowed character, 999x will be sent to the terminal, where "x" varies.

Note that if the ion gauge is off, the value returned is 0.

If a low-vacuum gauge is not plugged in, the value returned is -900.

If a low-vacuum gauge has not been zeroed, and the displayed pressure is negative (flashing display), the value returned is -999.

Note that the form for expressing the pressure in items E17, E18, E19, E24, E25, E26, F, G, and H differs from the display of pressures on the front panel of the vacuum gauge controller. On the front panel the pressure is displayed in the form:

$$a.b * 10^{-c} \qquad \text{(Note the decimal point.)}$$

whereas the pressure reading through the RS-232 port is in the form:

$$xy * 10^{-z} \qquad \text{(Note the lack of a decimal point.)}$$

This difference is due to the limitations of integer arithmetic there is no way to manipulate decimal fractions using integer variables. Thus, the value reported via the RS-232 port has a mantissa that is 10 times larger but an exponent that is lower by 1.

For example, a pressure displayed on the front panel as:

$$2.3 * 10^{-5}$$

would be reported through the RS-232 port as though it were:

$$23 * 10^{-6}$$

That is, the value returned would be 23-6.

Though the form of expressing it differs, the pressure is the same.

## 4 Maintenance

### Warranty

*Terranova products of Duniway Stockroom Corp. are warranted to be free of defects in material and workmanship for a period of one year from the date of shipment. At our option, we will repair or replace products which prove to be defective during the warranty period. Liability under this warranty is limited to repair or replacement of the defective items. Shipping damage is excluded from the scope of this warranty. Gauge tubes of all types are excluded from this warranty.*

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

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

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

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

*THE WARRANTY SET FORTH ABOVE IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. DUNIWAY STOCKROOM DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.*

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

## Technical Assistance

For technical assistance with the Model 934 Vacuum Gauge Controller, call your local representative or Duniway Stockroom Corp. at 650-969-8811.

## Service Policy

With the exception of the parts listed under Replaceable Parts, below, no parts of the Model 934 Vacuum Gauge Controller are user-serviceable. For repair on non-user-serviceable parts you must return your vacuum gauge controller to Duniway Stockroom Corp. Any attempt to service these non-user-serviceable parts may void your warranty.

## Repacking and Shipment

Any items returned to Duniway Stockroom Corp., either for warranty service or for other repair, must have a return authorization number marked clearly on the outside of the shipping container. If your Duniway Stockroom Corp. product needs service or repair, call your representative or Duniway Stockroom Corp. at 650-969-8811 for a Return Material Authorization (RMA) number.

If possible, pack any items to be returned in the original shipping container and packing material. If these are not available, a commercial packer in your area should be able to pack the equipment for you.

## Replaceable Parts

There are three general classes of replaceable parts in the Model 934 Vacuum Gauge Controller:

cables

fuses

EPROM (the integrated circuit that contains the operating program)



## Cables

The following signal cables are available from Duniway Stockroom Corp.:

Signal cable for Bayard-Alpert ion gauge

Signal cable for nude ion gauge

Signal cable for thermocouple gauge

In addition, the following power cord is available:

Power cord for North American (120 Vac) operation

## Fuses

The ac power fuses listed below are suitable for use with the Model 934 Vacuum Gauge Controller. The fuse dimensions are 5mm x 20mm (0.2 in x 0.8 in).

for 100/120 Vac: (3 Amp Rating)

Littlefuse 216 3.15, 217 3.15, or 218 3.15

Schurter 001.1009, 034.1521, 034.2521, or 001.2509

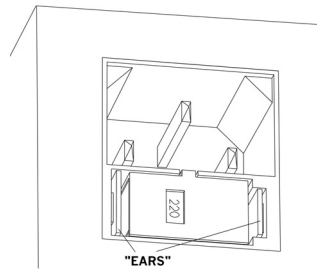
for 220/240 Vac: (1.5 Amp Rating)

Littlefuse 216 01.6, 217 01.6, or 218 01.6

Schurter 001.1006, 034.1518, 034.2518, or 001.2506

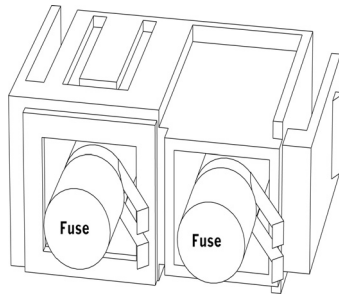
If you need to replace a fuse in your vacuum gauge controller, take the following steps:

1. Switch off the power to the vacuum gauge controller.
2. Disconnect the power cord from the power input module on the back panel of the vacuum gauge controller.
3. Check for any obvious causes of a blown fuse, such as a worn or frayed power cord or incorrect voltage setting.
4. Remove the fuse assembly from the power input module. You can do this by pinching the ears on the sides of the fuse assembly, and then pulling the assembly out of the power input module.



### **Figure 4-1. Remove the fuse assembly**

5. Replace the faulty fuse. Turn the fuse assembly around so that the fuses are facing you. Pull out the fuses in inspect them to determine which fuse is faulty. Replace the faulty fuse with a new one, and put both fuses back in the fuse assembly.



### **Figure 4-2. Replace the faulty fuse**

6. Re-insert the fuse assembly into the power module.
7. Reconnect the power cord to the power receptacle on the power input module.

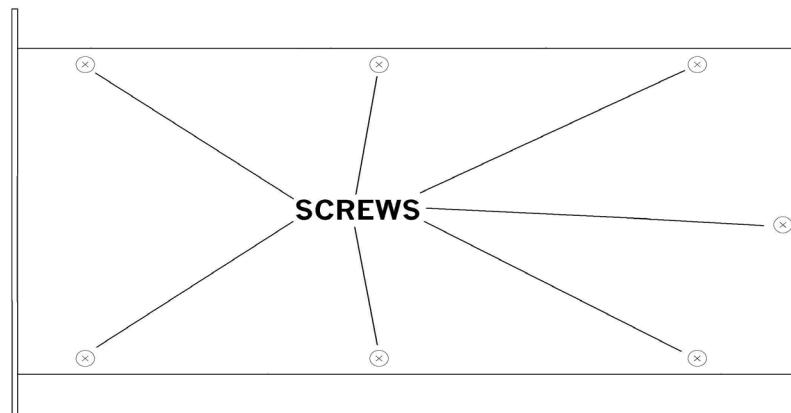
Note: If the power fuses are good and the Model 934 controller still does not turn on, it may be that an internal fuse needs replacement. Please contact us for details.

## EPROM

There is one 28-pin EPROM integrated circuit on the motherboard of the vacuum gauge controller. It contains the firmware that controls the operation of the vacuum gauge controller. From time to time this firmware may be updated, to enhance the functions of the controller or to improve basic operation. If you wish to determine whether the firmware in your system is the current version, call the factory (650-969-8811).

Take the following steps to install a new EPROM:

1. Switch off the power to the vacuum gauge controller and disconnect the power cord.
2. Place the vacuum gauge controller on a work surface. If the controller is mounted in a rack, remove it from the rack and place it on a table, bench, or other work surface.
3. Remove the top cover of the vacuum gauge controller. Unscrew the screws that secure the cover to the controller and lift off the cover.



**Figure 4-3. Remove the top cover**

4. Locate the EPROM. The EPROM is visible near the front edge of the large power transformer. Note the three 28-pin chips; the EPROM is the chip nearest the front panel, with a paper label showing the revision code (for instance, 934 1.69 E342).
5. Remove the old EPROM. The method of removal depends on the type of socket used in your controller. If the EPROM is in a standard chip socket, you can, with care, pry out the old EPROM from its socket with a small flat-bladed screwdriver. If the EPROM is in a ZIF (zero insertion force) socket, lift the lever to release the pressure on the pins of the EPROM, and then lift the EPROM out of the socket.

6. Using proper anti-static precautions, place the new EPROM in the socket. Make sure you do the following:

Touch both the EPROM's container and the chassis of the vacuum gauge controller to equalize the static potential. This ensures that static discharge will not harm the EPROM.

Handle only the body of the EPROM. Do not touch the pins.

Orient the notch in the EPROM toward the center of the controller chassis.

If the socket is a ZIF socket, make sure that the lever is in the up position; this opens the socket for insertion of the EPROM.

Insert the EPROM's pins carefully into the socket, making sure that the pins do not become bent.

Push the EPROM into the socket until it seats firmly.

If the socket is a ZIF socket, move the lever to the down position; this clamps the pins of the EPROM in place and holds the EPROM firmly in the socket.

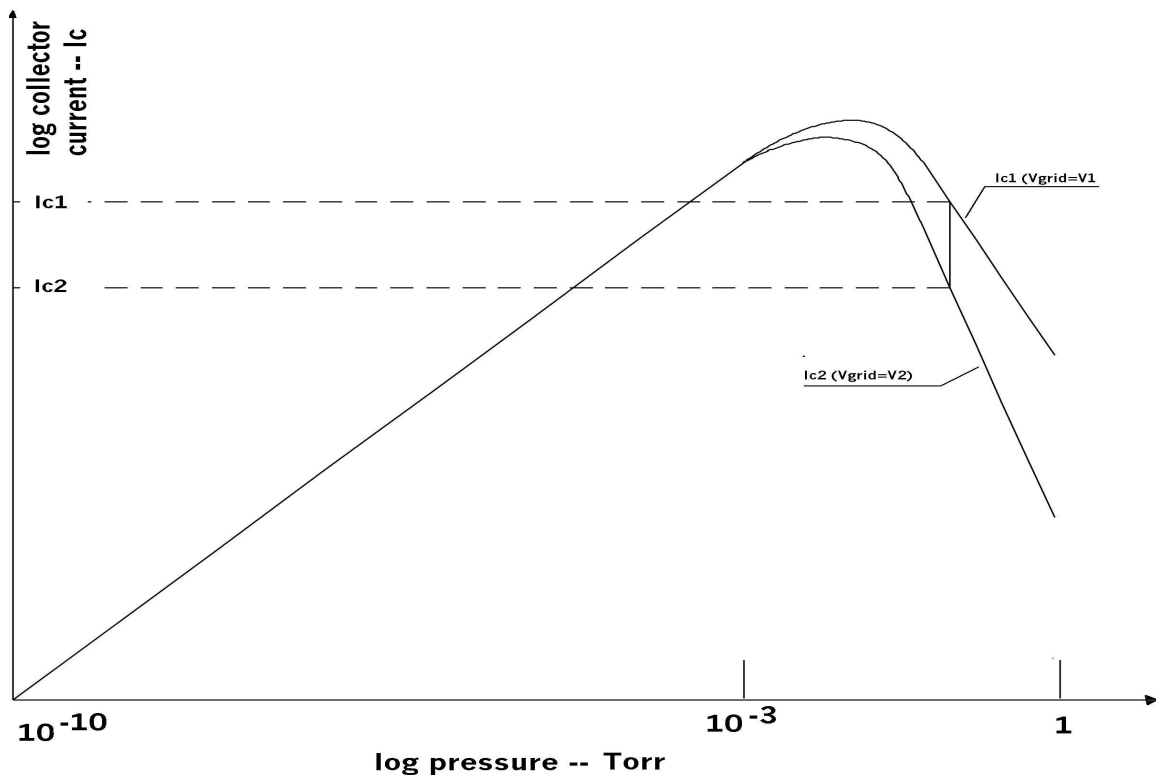
7. Replace the top cover.

8. Mount the vacuum gauge controller; reconnect the signal cables and power cord.

# 5 Principles of Operation

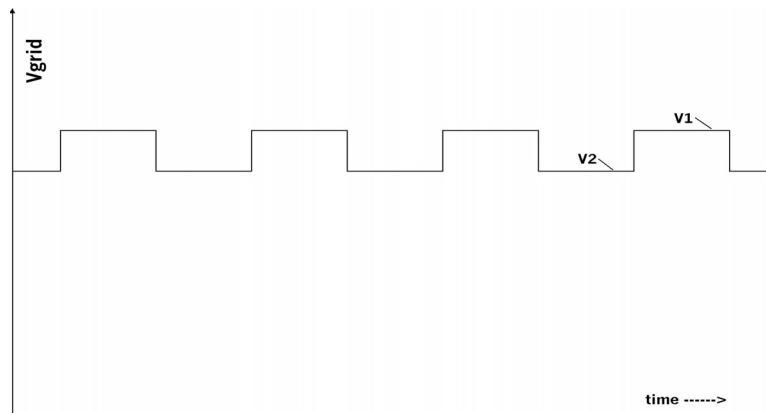
## Wide-Range Vacuum Measurements

The Terranova Model 934 Vacuum Gauge Controller operates as a conventional Bayard-Alpert ion gauge controller from the x-ray limit (approximately  $10^{-10}$  Torr, or  $10^{-11}$  Torr in the case of UHV gauges) up to  $10^{-3}$  Torr. In that range, the relationship of the collector current to pressure is linear, as shown in figure 5-1. Above  $10^{-3}$  Torr, for a standard-geometry ion gauge, the collector current begins to deviate from its linear relationship to pressure. This is due to ion and electron scattering.



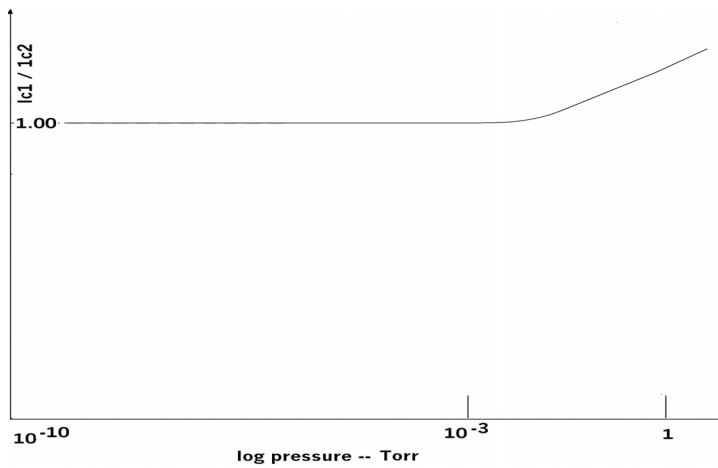
**Figure 5-1. Relationship of collector current and pressure**

Above  $10^{-3}$  Torr, the Model 934 Vacuum Gauge Controller derives two signals from the ion gauge by supplying two (time-multiplexed) grid voltages, as shown in figure 5-2.



**Figure 5-2. Grid voltages**

A comparison of the collector currents derived from these two voltages yields the monotonically increasing function shown in figure 5-3.



**Figure 5-3. Ratio of collector currents**

This nonlinear function is interpreted in a computer algorithm to calculate pressure in the range of  $10^{-3}$  Torr to 1 Torr.

In addition, a number of other proprietary algorithms are employed, which are required for the design and production of a reliable commercial instrument.

The Model 934 Vacuum Gauge Controller is protected under Japanese patent number 1,502,953 and U. S. patent number 4,314,205, as well as the U. S. laws governing Trade Secrets.

## Glass Ion Gauges

There are two characteristics you should consider when selecting glass ion gauges:

Tubulation  
(the means of connecting the glass envelope of the ion gauge to the vacuum system)

Filament material

In addition, you should be aware of:

Protection of ion gauges during operation

## Tubulation

In the simplest form of ion gauge construction, the envelope and the tubulation are made from the same material. Nonex and Pyrex are two types of glass used extensively for ion gauge envelopes, and they can also be used for tubulation.

Ion gauge tubes made from Nonex are usually connected to the vacuum system through an O-ring compression fitting. Pyrex can be connected in the same way, but is often purchased so that the gauge tube can be directly glass-blown to a glass vacuum system.

Another common material for tubulation of glass envelopes is Kovar, a metal alloy whose thermal expansion is compatible with the glass envelope. Kovar tubulation allows the gauge tube to be welded to a stainless steel flange for attachment to a metal vacuum system. Alternatively, Kovar tubulation can be connected through an O-ring compression fitting.

## Filament

Filaments for Bayard-Alpert gauges are of two types: thoria-coated iridium (ThO-Ir) and tungsten.

ThO-Ir filaments are known as burn-out resistant. Iridium is the most corrosion-resistant metal known. The surface of the iridium filament is coated with an oxide of thorium. If oxygen is accidentally admitted to the vacuum system while the filament is on, there is less chance that it will burn out than with a tungsten filament.

A thoria-coated filament is somewhat less stable in operation than tungsten, and its electron emission may be adversely affected by fluorine- or chlorine-containing compounds in the vacuum system. Tungsten, by contrast, is not seriously affected by the halogens, but is quickly damaged by oxygen at higher pressures.

Because of its durability, a gauge with a ThO-Ir filament has only a single filament. A gauge with a tungsten filament has dual filaments, with only one in operation. If the first filament fails, operation may be resumed by switching to the second filament without breaking vacuum. Simply unplug the cable from the ion gauge, rotate it 180 degrees, and plug it back on to the base of the gauge.

The use of iridium as a filament material has become more common, due to its durability.

Note that for performance to 1 Torr, all gauges for use with the Model 934 Vacuum Gauge Controller require an internal conductive coating on the glass, shunted to the filament or to ground. This eliminates electrostatic charge on the surface of the glass and is essential for operation at pressures above  $10^{-3}$  Torr.

## Protection of Ion Gauges During Operation

Certain vacuum processes, such as electron beam evaporation or sputtering, produce energetic particles that may interfere with proper operation of the gauge. A suitable shield, such as a right-angle elbow with a grounded screen, should be used to isolate the gauge from the process.

You will find the Model 934 Vacuum Gauge Controller to be more immune to electrical interference than conventional ion gauge controllers. This is due to the superior noise rejection circuitry employed in the lock-in amplifier.

The gauge is not intended for use with reactive gases such as chlorine and fluorine.



## **WARNING:**

Do not use the ion gauge with explosive gases at high pressures. Explosion could result.

## **Additional Reading**

For general information on vacuum systems and pressure measurements in those systems, refer to the following books:

Vacuum Technology; Andrew Guthrie; John Wiley and Sons, Inc., New York, 1963

Vacuum Technology; A. Roth; North-Holland Publishing Company, Amsterdam, 1982

Scientific Foundations of Vacuum Technique; Saul Dushman; John Wiley and Sons, Inc., New York, 1962

Total Pressure Measurements in Vacuum Technology; A. Berman; Academic Press, Inc., New York, 1985

A User's Guide to Vacuum Technology; John F. O'Hanlon; John Wiley and Sons, Inc., New York, 1980

Basic Vacuum Practice; Varian Associates, Inc., Palo Alto, California, 1986