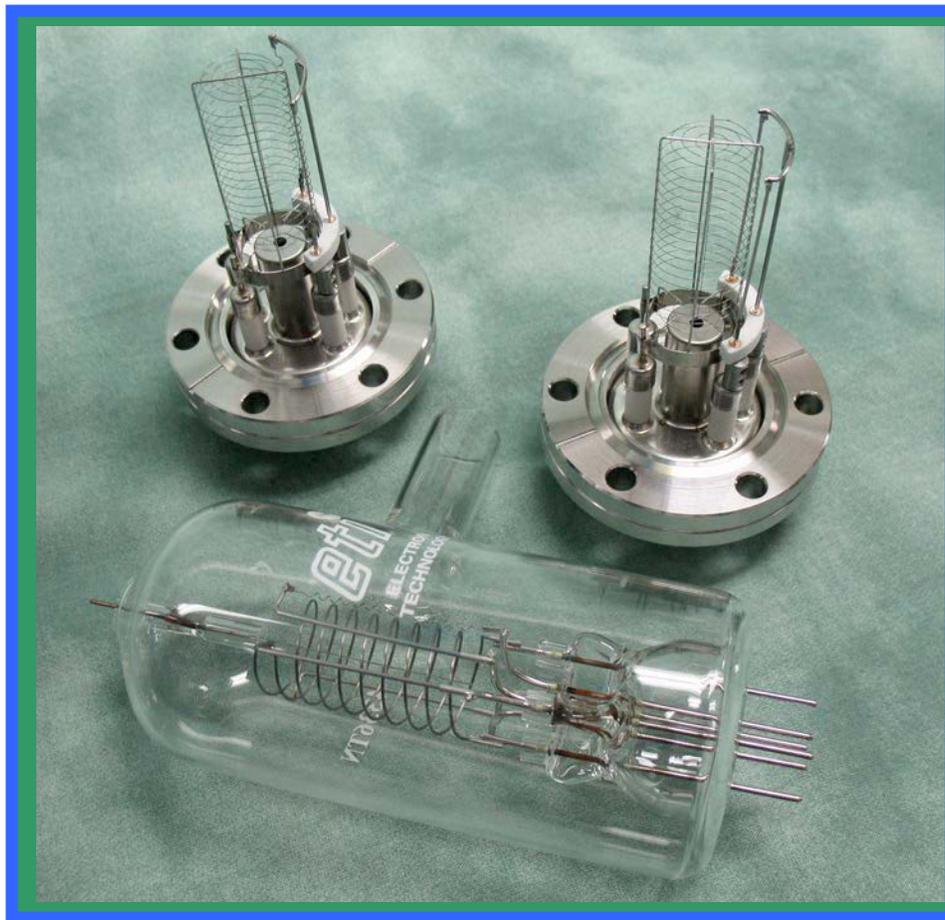




## BAYARD-ALPERT TYPE IONIZATION GAUGE TUBES



## INSTALLATION and OPERATING INSTRUCTIONS



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ETI BAYARD ALPERT GAUGE MANUAL REV -



Inspect all material received for; shipping damage and accuracy of order

**IT IS IMPORTANT TO READ THIS INSTRUCTION MANUAL BEFORE INSTALLING, USING OR SERVICING THIS EQUIPMENT**

This manual is for use with the following ionization gauge tubes;

Glass gauges: 4336\_\_, 8136\_\_, 8142\_\_

Nude gauges: 8130\_\_, 8140\_\_

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## 1.0 SAFETY INSTRUCTIONS

**SAFETY FIRST.** Think before you act. Read this instruction manual and understand it before installing, using or servicing this equipment. If, for any reason, you are in doubt, contact The Fredericks Company for assistance.

### 1.1 ELECTRICAL SHOCK

**WARNING:** Ionization gauges are safe for use only if all exposed conductors on the gauge and on the controller and on the vacuum system are grounded.

During electronic bombardment degas, as much as 500 volts may be applied to some electrode pins. **Do not** touch any gauge tube electrodes while the tube is connected to the controller.

All Connections to the gauge tube pins should be covered by insulation. All gauge tube pins should be covered by connectors or by pin covers. In normal operation, 180 volts is on the grid connections.

### 1.2 IMPLOSION AND EXPLOSION

Glass ionization gauges, if roughly handled, may implode under vacuum causing flying glass, which may injure personnel. Be sure that the cabling to the gauge tube has proper strain relief so that the cable tension cannot break the glass. If pressurized above atmospheric pressure, glass tubes may explode, causing dangerous flying glass. A substantial shield should be placed around the vacuum glassware to prevent injury to personnel.

### 1.3 OVERPRESSURE

Do not use quick connectors or other friction type connections where positive pressure will exist within the gauge tube, such as during backfilling operations.

### 1.4 TEMPERATURE

During degas, the envelope of the gauge tube becomes heated much more than in normal operation. Be sure that materials that are heat sensitive are not in contact with the gauge tube. Be sure that the gauge tube is not located where personnel performing necessary system operations might come in contact with the gauge tube.

## 2.0 INSTALLATION INSTRUCTIONS

### 2.1 VACUUM CONNECTIONS

- a. Location on system: The gauge tube should be located as close as possible to the section of the vacuum system where pressure measurement is important. Valves or other constrictions between the gauge tube and the area where pressure measurement is required may cause erroneous readings.
- b. Gauge port: Pressure measurement in the high vacuum range does not require special attention to port size. However as the pressure of interest approaches the ultra-high vacuum range, a small conductance between the gauge tube and the system volume of interest can cause a significant difference in the two pressures. One inch tubulation is minimal, and at the extreme vacuum the nude tube geometry is best whereby the gauge tube actually protrudes into the chamber volume.
- c. Mounting orientation: All orientations are acceptable, but vertical is preferable for longevity and accuracy of the tube.
- d. Connections: When using O-ring quick connects on glass tubulations, care must be used when sliding the glass tubulation into the quick connect. Gently tighten the compression ring so that the glass tubulation is not chipped or cracked. Non-rotatable flanges are ordinarily installed on glass tubes. The bolt ring of a rotatable flange can inadvertently be dropped on the tube and break the glass tubulation.

2.2 ELECTRICAL CONNECTIONS:

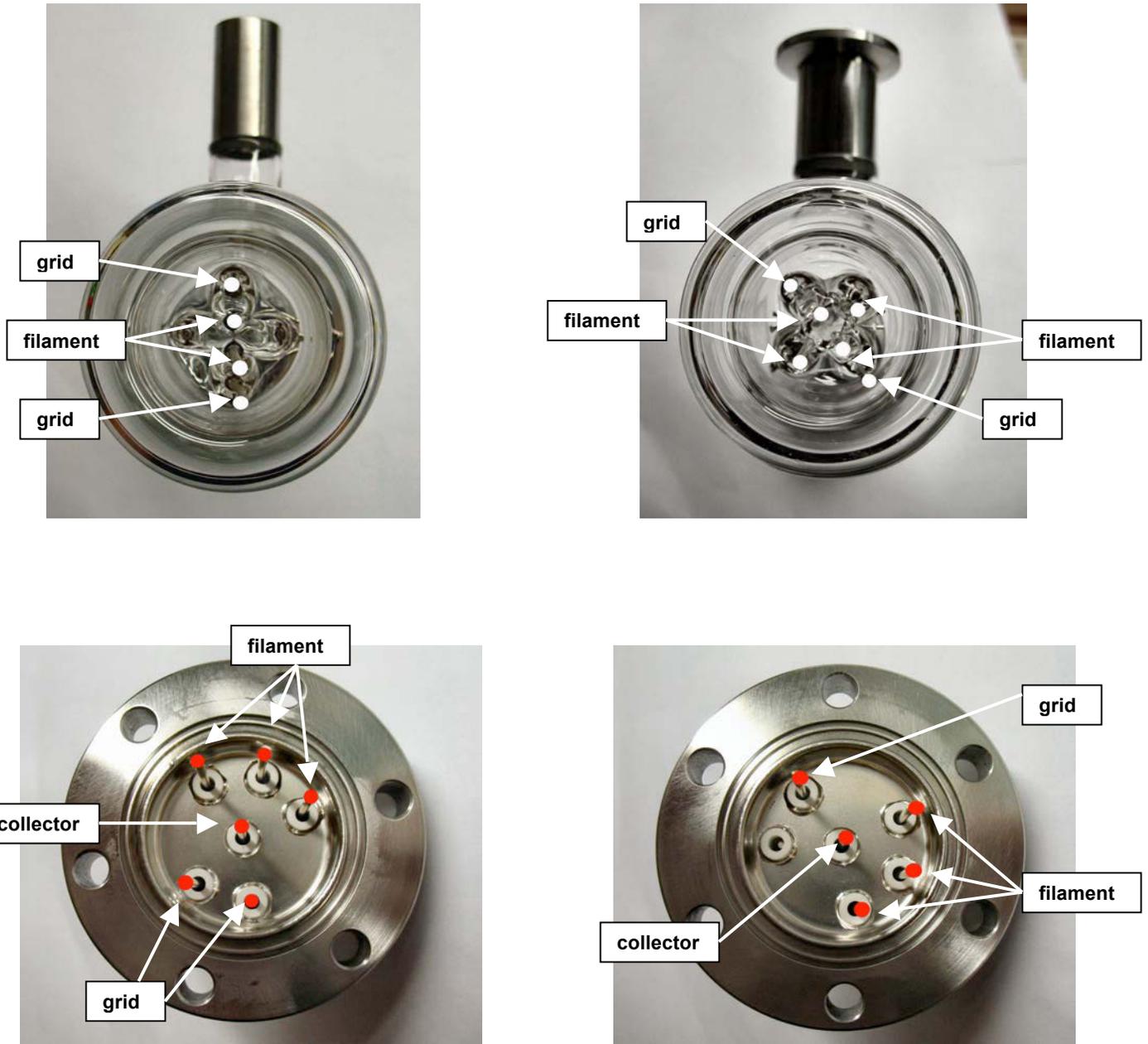


Figure # 1

Figure #1 shows the pin connection code for the various ionization gauge tubes.

Do not use gauge cables with exposed conductors such as alligator clips. All gauge tube pins should be covered by connectors or by pin covers. Gauge cables should be firmly clamped to the vacuum station to provide strain relief. This ensures there will be negligible strain transmitted to the gauge tube pins if there is relative motion between the vacuum station and the ionization gauge controller.

If the resistance heated degassable nude gauge is being used with an electron bombardment degas controller, be sure that the unused grid pin is not exposed. Cover it with a suitable insulator, if necessary.

### 3.0 OPERATION

#### 3.1 OPERATING VOLTAGE POTENTIALS

The recommended potentials are:

Collector, 0V; Grid, +180V  
Filament, +30V.

The dependence of ion current on variations of these parameters is shown in the Specification Section (6.0).

#### 3.2 FILAMENT EMISSION

As a general rule, low emission current is used in the high-pressure end of the range of the gauge tube. This helps to avoid ion current turn-around phenomenon and glow discharge. High emission current is used at ultrahigh vacuum to obtain ion currents that are large enough for convenient measurement. Typical values are 100 $\mu$ A at  $10^{-3}$  Torr and 10mA at  $10^{-9}$  Torr. The trade-offs on emission current are that high emission current gives better readout stability and sensitivity but more gauge tube pumping if the gauge tube is clean and more gauge tube outgassing if the gauge tube is contaminated. Likewise, low emission currents minimize gauge tube outgassing (important for a contaminated gauge tube) and minimize gauge tube pumping (important for a clean gauge tube at low pressures). However low emission currents yield low ion currents which are sensitive to electronic noise and which may be too low for a given electrometer to measure.

#### 3.3 GAUGE TUBE DEGAS

The contamination level and thus the outgassing rate of a gauge tube may be greatly reduced by heating the electrodes. The hot electrodes heat the envelope thereby cleaning the tube further. The two types of cleaning (degassing) used are resistive heating ( $I^2R$ ) of the grid, and electron bombardment (E.B.) of the grid. E.B. degassing is preferable only at ultra high vacuum and is more expensive.  $I^2R$  heating requires longer degassing periods. Gauge tube degas is only useful at pressures below  $10^{-5}$  Torr and only a few minutes degas is required at pressures  $10^{-6}$  Torr since at these higher pressures, the recontamination of surfaces occurs readily. If a system is going ultimately to the UHV range, it is useful to degas in the  $10^{-6}$  Torr range and then again as the system pressure approaches the expected ultimate. The tubulated gauge and the  $I^2R$  degassable nude tube may be degassed by either  $I^2R$  or E.B. degas. The E.B. degassable nude tube may be **only** E.B. degassed.

#### 3.4 GAUGE TUBE BAKEOUT

It is also useful to externally bake the gauge tube if the entire system is expected to pump down to an ultraclean state. Gauge tubes must not be baked over 450°C as glass softening occurs just above that temperature.

#### 3.5 X-RAY LIMIT

The X-ray limit refers to the lowest pressure indication which may be obtained in a Bayard-Alpert gauge. Beyond the limit the collector current is mainly due to X-ray induced photo-emission. The photo-electron current has a value equivalent to a pressure indication of approximately  $3 \times 10^{-10}$  Torr in glass gauge tubes, approximately  $4 \times 10^{-10}$  Torr in  $I^2R$  degassable nude gauge, and approximately  $2 \times 10^{-11}$  Torr in E.B. degassable nude gauge tubes.

#### 3.6 GAUGE TUBE ACCURACY

Due to geometric variations in electrode structures, a given gauge tube is typically accurate to within  $\pm 20\%$  when reading the gas type for which it is specified.

## 4.0 TECHNICAL INFORMATION

### 4.1 PRESSURE INDICATION

Ionization gauge controllers actually measure the positive ion current in amperes from the gauge tube but the readout is in pressure units. Even more specifically, these pressure units are direct reading only for the gas for which it is specified, usually nitrogen (also air); this is called a readout of nitrogen equivalent pressure. Other gases may give much different readings from nitrogen.

### 4.2 GAUGE TUBE SENSITIVITY

To be able to present conversion tables from gas type to gas type, the gauge tube sensitivity, K, is defined:

$$K = \frac{i_+}{i_- P}$$

where  $i_+$  is the positive ion current to the collector,  $i_-$  is the electron emission current from filament to grid, and P is the pressure. The glass envelope gauge tube and the I<sup>2</sup>R degassable nude gauge tube have  $K = 10/\text{Torr}$  for nitrogen (or air), and the E.B. degassable nude gauge tube has  $K=25/\text{Torr}$  for nitrogen (or air).

### 4.2 GAS TYPE CONVERSIONS

In general there are two ways to read the pressure of a gas other than the gas for which a gauge tube is specified.;

Method A: Perform a mathematical conversion on the direct pressure readout (usual nitrogen equivalent pressure).

Method B: Use an emission current other than the value for which the ion gauge controller is set up.

Method A: To correct for an ionization gauge controller which is set up for some other sensitivity ( $K_{N2 \text{ cont.}}$ ) than the gauge tube ( $K_{N2 \text{ tube}}$ ), the following correction to the pressure readout will yield the nitrogen equivalent pressure:

$$P_{N2} = P_{\text{ind}} \left[ \frac{K_{N2 \text{ cont.}}}{K_{N2 \text{ tube}}} \right]$$

To convert the readout to some other gas, the equation must also include  $K_{\text{gasx tube}}$  thusly,

$$P_{\text{gasx}} = P_{\text{ind}} \left[ \frac{K_{N2 \text{ tube}}}{K_{\text{gasx tube}}} \right] \left[ \frac{K_{N2 \text{ cont.}}}{K_{N2 \text{ tube}}} \right]$$

this then can be written either

$$P_{\text{gasx}} = P_{\text{ind}} \left[ \frac{K_{N2 \text{ cont.}}}{K_{\text{gasx tube}}} \right] \quad \text{or} \quad P_{\text{gasx}} = \left[ \frac{P_{\text{ind}}}{r_x} \right] \left[ \frac{K_{N2 \text{ cont.}}}{K_{N2 \text{ tube}}} \right]$$

Example: For the nude tube of  $K_{N2} = 25/\text{Torr}$  using a controller of  $K_{N2 \text{ cont}} = 10/\text{Torr}$  and for gas<sub>x</sub>, of argon for which  $r_x = 1.2$

$$P_{Ar} = \frac{P_{ind}}{1.2} \cdot \frac{10}{25} = \frac{P_{ind}}{3}$$

Method B: The usual ionization gauge controller is designed for some calibrated set-point of emission =  $i_-$ . The new emission that will correct both for controller sensitivity and for gas type is

$$i'_- = i_- \left[ \frac{K_{N2 \text{ cont}}}{K_{\text{gasx tube}}} \right] \quad \text{or} \quad i'_- = \left[ \frac{1}{r_x} \right] \left[ \frac{K_{N2 \text{ cont}}}{K_{N2 \text{ tube}}} \right]$$

If actual emission current is not read out in current units, then these equations may be expressed as fractions of full scale as

$$\frac{i'_-}{i_-} = \frac{K_{N2 \text{ cont}}}{K_{\text{gasx tube}}} \quad \text{and} \quad \frac{i'_-}{i_-} = \left[ \frac{i_-}{r_x} \right] \left[ \frac{K_{N2 \text{ cont}}}{K_{N2 \text{ tube}}} \right]$$

Note that Method B is useful only for decreases in emission current or small increases.

### 4.3 GAS SENSIVITY TABLES

The following table lists **relative** gauge sensitivities for various gases. The values listed are averages of several gauges and several references from the literature. These values are from Table II, Ionization Gauge Sensitivities As Reported in the Literature, from NASA Technical Note TND 5285, by Robert L. Summers, Lewis Research Center, National Aeronautics and Space Administration. Please see this reference for further definition of these average values and for calculations of the gauge sensitivities of other gases. To convert ionization gauge readout from nitrogen equivalent pressure, divide the readout by the values listed for  $r_x$ .

Gas	$r_x = \frac{K_{gasx}}{K_{N_2}}$
He	0.18
Ne	0.30
D <sub>2</sub>	0.35
H <sub>2</sub>	0.46
N <sub>2</sub>	1.00
Air	1.00
O <sub>2</sub>	1.01
CO	1.05
H <sub>2</sub> O	1.12
NO	1.16
Ar	1.29
CO <sub>2</sub>	1.42
Kr	1.94
SF <sub>6</sub>	2.50
Xe	2.87
Hg	3.64

## 5.0 ORDERING INFORMATION

### 5.1 TUBULATED IONIZATION GAUGE TUBES

TFC PART #	PART	DESCRIPTION
3200-0103-00	4336N	Iridium/Thoria filament, Nonex ¾" tubulation
3200-1103-00	4336P	Iridium/Thoria filament, Pyrex ¾" tubulation
3200-2103-00	4336K	Iridium/Thoria filament, Kovar ¾" tubulation
3202-0102-00	4336TN	2 Tungsten filaments, Nonex ¾" tubulation
3202-1102-00	4336TP	2 Tungsten filaments, Pyrex ¾" tubulation
3202-2102-00	4336TK	2 Tungsten filaments, Kovar ¾" tubulation
3200-0203-00	4336N/1	Iridium/Thoria filament, Nonex 1" tubulation
3200-1203-00	4336P/1	Iridium/Thoria filament, Pyrex 1" tubulation
3200-2203-00	4336K/1	Iridium/Thoria filament, Kovar 1" tubulation
3202-0202-00	4336TN/1	2 Tungsten filaments, Nonex 1" tubulation
3202-1202-00	4336TP/1	2 Tungsten filaments, Pyrex 1" tubulation
3202-2202-00	4336TK/1	2 Tungsten filaments, Kovar 1" tubulation
3202-0103-00	4336S	Test gauge, for testing control units, with sealed
3200-2113-00	8142K	BA Platinum coated Kovar ¾" tubulation
3200-2213-00	8142K/1	BA Platinum coated Kovar 1" tubulation
3202-2112-00	8142TK	BA Platinum coated dual tungsten ¾" tubulation
3202-2212-00	8142TK/1	8142 6 pin DT 1.5", 1 " kovar
3200-0113-00	8142N	BA Platinum coated Nonex ¾" tubulation
3200-0213-00	8142N/1	BA Platinum coated Nonex 1" tubulation
3200-1113-00	8142P	BA Platinum coated Pyrex ¾" tubulation
3205-0110-00	8136N/1	Broad range Nonex 1" tubulation
3205-1210-00	8136P/1	Broad range Pyrex 1" tubulation
3205-2210-00	8136K/1	Broad range Kovar 1" tubulation
3205-2210-01	8136F	Mounted 2 ¾" Conflat Flange

### 5.2 NUDE IONIZATION GAUGE TUBES

TFC PART #	PART	DESCRIPTION
3302-8305-02	8130T	BA Gauge, 2 ¾" Flange, 2 Tungsten filaments
3301-8305-02	8130	BA Gauge, 2 ¾" Flange, 2 Iridium filaments
3303-8305-42	8140	BA Gauge, 2 ¾" Flange, Replace, Iridium
3304-8305-42	8140-DI	8140 with Dual Iridium filaments

### 5.4 ACCESSORIES

TFC PART #	PART	DESCRIPTION
5-8325-02	8130T-RFA	Replacement filament assy. For 8130T
5-8325-01	8130-RFA	Replacement filament assy. For 8130
5-8325-03	8140-RFA	Replacement filament assy. For 8140
5-8325-04	8140-DI RFA	Replacement filament assy. For 8140-DI

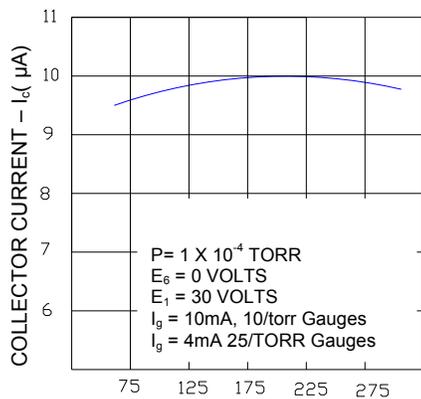
In formation regarding order placement, technical assistance is available through our corporate office.

### 6.0 SPECIFICATIONS

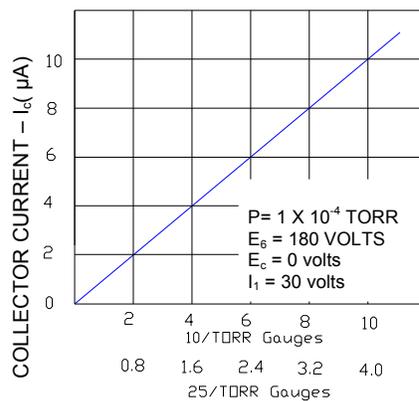
	Tubulated gauge	Electron Bombardment Degassable Nude Gauge	Resistance Heated Degassable Nude Gauge
<b>Tubulation</b>	3/4" in. (19.1mm) or 1 in. (25.4mm) dia. X 2 1/4 in. (57mm) long, Tungsten or Pyrex glass or flanged	N.A.	N.A.
<b>Envelope</b>	8487/ 7720 glass 2 1/4 in. (57mm) dia. X 5 in. (127mm) long	Nude	Nude
<b>Mounting Position</b>	Any	Any	Any
<b>Collector</b>	Tungsten	Tungsten	Tungsten
<b>Filament</b>	Dual Tungsten or thoria coated iridium	Dual Tungsten or thoria coated iridium	Thoria coated iridium
<b>Grid</b>	Refractory Metals	Refractory Metals	Refractory Metals
<b>Overall Length</b>	6 in. (152mm)	4 1/8 in. (105)	4 1/8 in. (105)
<b>Insertion Length</b>	N.A.	3 in. (76mm)	3 in. (76mm)

### OPERATING DATA

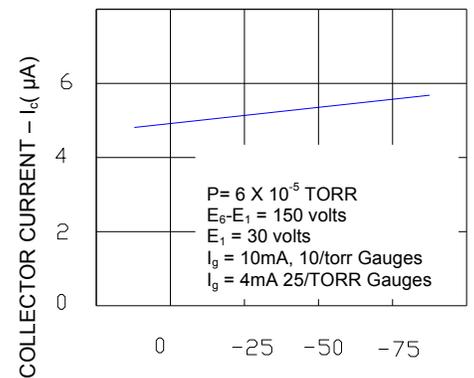
	Tubulated gauge	Electron Bombardment Degassable Nude Gauge	Resistance Heated Degassable Nude Gauge
<b>Sensitivity</b>	10/Torr	25/Torr	10/Torr
<b>Typical Accuracy</b>	±20%	±20%	±20%
<b>X-ray Limit</b>	About 3 X 10 <sup>-10</sup> Torr	About 2 X 10 <sup>-11</sup> Torr	About 3 X 10 <sup>-10</sup> Torr
<b>Electron Bombardment Degas</b>	100 watts max.	40 watts max.	100 watts max.
<b>Resistance Heated Degas</b>	6.3 to 7.5V at 10A	N.A.	6.3 to 7.5V at 10A
<b>Bakeout</b>	450°C max.	450°C max.	450°C max.



GRID VOLTAGE - E<sub>g</sub> (volts)



GRID CURRENT - I<sub>g</sub> (Ma) (volts)



COLLECTOR VOLTAGE - E<sub>c</sub>(volts)

## 7.0 LIMITED WARRANTY

This ETI product is warranted against defects in materials and workmanship for one year from the date of shipment provided the installation, operating and preventative maintenance procedures specified in this instruction manual have been followed. The Fredericks Company will, at its option, repair, replace or refund the selling price of the product if TFC determines, in good faith, that it is defective in materials or workmanship during the warranty period, provided the item is returned to The Fredericks Company together with a written statement of the problem.

Defects resulting from repairs necessitated by misuse or alteration of the product or any cause other than defective materials or workmanship are not covered by this warranty. TFC EXPRESSLY DUSCLAIMS ANY OTHER WARRANTY, WHETHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE UNDER NO CIRCUMSTANCES SHALL THE FREDERICKS COMPANY BE LIABLE FOR CONSEQUENTIAL OR OTHER DAMAGES RESULTING FROM A BREACH OF THIS LIMITED WARRANTY OR OTHERWISE.



**WARNING!** – Safe operation of vacuum equipment requires grounding of all exposed conductors of the gauges and the controller and the vacuum system.

**LETHAL VOLTAGES** may be established under some operating conditions unless correct grounding is provided.

Research at The Fredericks Company has established that ion producing equipment, such as ionization gauges, mass spectrometers, sputtering systems, etc. from many manufacturers may, under some conditions, provide sufficient electrical conduction via a plasma to couple a high voltage electrode potential to the vacuum chamber. If exposed conductive parts of the gauge, controller, and chamber are not grounded, they may attain a potential near that of the high voltage electrode during this coupling. Potentially fatal electrical shock could then occur because of the high voltage between these exposed conductors and ground.

During routine pressure measurement using ionization gauge controllers from any manufacturer, about 160V may become present on ungrounded conductors at pressures near  $10^{-3}$  Torr. All isolated or insulated conductive parts of the controller, the gauge, and the vacuum system must be grounded to prevent these voltages from occurring.

Grounding, though simple, is very important! Please be certain that the ground circuits are correctly utilized on your ion gauge power supplies, gauges, and vacuum chambers, regardless of their manufacturer, for this phenomenon is not peculiar to The Fredericks Company equipment. If you have questions, please contact one of our technical personnel.



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