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**IG4400**  
Ionization Gauge Controller  
Instruction Manual

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# SAFETY

**DANGEROUS VOLTAGES** are present during the operation of this ion gauge controller. Do not enter the controller cabinet. Do not touch any cable connections when power is being applied to the unit. Follow safe procedures to avoid electrical shock hazards.

Safety Pays. Determine what action you are going to take and study this instruction manual before beginning any action. If there is any concern about the best way to proceed, return the controller to JC Controls for repairs or contact JC Controls for repair procedures.

## Explosive Gases

Do not use this equipment to measure the vacuum pressure of explosive, combustible, corrosive or unknown gases. Ionization gauge filaments operate at high temperatures.

## Implosion and Explosion

Ion gauges in glass enclosures should not be treated roughly or be bumped. If the glass is damaged, it may implode causing glass to fly. If a positive pressure is developed inside the glass enclosure the glass may explode, again causing glass to fly. A shield may be installed around the glass enclosure to help prevent damage.

Install the ion gauge cable on the ion gauge pins before the gauge reaches vacuum pressures. This will prevent bending the gauge pins and possibly causing the glass to crack and the gauge to implode. The gauge cables should be securely fastened to prevent strains or stress on the gauge tube pins.

Do not allow the gauge tube temperature to exceed 100° C. Sustained high temperatures can damage the tube, causing air leakage into the vacuum system.

Over pressurization of a gauge tube is as dangerous as implosion. Always remember that ion gauges are calibrated for Nitrogen gas. Other gas pressures should be carefully calculated to be sure that over pressurization and the possible explosion of the gauge tube does not occur.

## Danger - High Voltage

+180 VAC is present in the gauge during operation. Do not touch the ion gauge tube, Ion Gauge Connector or tube connectors while the controller is in operation.

## Grounding

For safe operation of vacuum equipment the vacuum chamber and all instrumentation, pumps, etc. **MUST** be grounded. **LETHAL VOLTAGES** may be established in the vacuum system if all chamber surfaces are not grounded. Check with an Ohmmeter to make sure that all chamber surfaces are at ground potential, sometimes vacuum chamber gaskets will isolate parts. The ground screw on the back of the IG4400 must be directly connected to the vacuum chamber.

# RECEIVING - DAMAGED / MISSING PARTS

Confirm that the shipped controller is the same as listed on the packing list and that it includes all the materials and options that were ordered. If materials are damaged, the carrier that delivered the carton or cartons must be notified in accordance with the Interstate Commerce Commission regulations - normally within 15 days. A damage claim must be filed with the carrier, do not call the manufacturer to file a claim, as all claims must be made by the recipient through the delivering carrier. JC Controls will be happy to help with shipping identification numbers, routing and/or shipment tracing.

Any damaged materials including all shipping containers, boxes and packing materials should be kept for the carriers inspection.

Contact the manufacturer:

**JC Controls**  
**1522 Second Ave**  
**Walnut Creek, CA. 94596**  
**(877) 837-6677**

If the shipment is not identical to the packing list or not what was ordered.

## International Shipments

Inspect all materials received for shipping damage. Check to be certain your shipment includes all materials and controller options ordered. Any items damaged must be reported to the carrier making the delivery to the customs broker within 15 days of delivery.

# WARRANTY

The JC Controls IG4400 Ionization Gauge Controller is guaranteed for **three years** against defects in parts, materials and workmanship. Any misuse or attempts to reprogram the controller during the warranty period will void the warranty. No other warranties are expressed or implied. If the unit malfunctions during the warranty period, return it to JC Controls and it will be repaired at no charge. Please include a written statement of the problem with a contact name and phone number.

# IG4400 SPECIFICATIONS

<u>Power Requirements :</u>	95 - 125 VAC (50/60 Hz), 185 Watts 200-250 VAC (50/60 Hz), 185 Watts - OPTIONAL
<u>Size:</u>	3 ½" H (90 mm), 15" W (381 mm), 10.5" D (267 mm) 19" W (483mm), with Rack Mount
<u>Weight:</u>	14 Lbs. (6.4 Kg)
<u>Temperature Range :</u>	0 - 40° C
<u>Thermocouple Tubes :</u>	
Type	DV-6M or Compatible
Range	Atmosphere to $1.0 \times 10^{-3}$ Torr
<u>Ion Gauge :</u>	
Type	Bayard - Alpert
Range	$9.9 \times 10^{-4}$ to $1.0 \times 10^{-10}$ Torr
Sensitivity	Adjustable, 1/Torr to 64/Torr (Factory set to 10/Torr)
Emission Current	Adjustable, 0.1 mA to 25.5 mA (Factory set to 10.0 mA)
Collector Potential	0 VDC
Grid Potential	+180 VDC
Filament Potential	+30 VDC
Degas	I <sup>2</sup> R, 7V, 8A max; Adjustable timer from 1 to 99 min.
<u>Display:</u>	
Ion Gauge	Main Display; Scientific notation, 2 significant digits (Torr)
TC1	Main Display; Scientific notation, 2 significant digits (Torr) 30 segment bar graph (Millitorr)
TC2	30 segment bar graph (Millitorr)
Sensitivity	Main Display; 2 digits (/Torr)
SP1	Main Display; Scientific notation, 2 significant digits (Torr)
SP2	Main Display; Scientific notation, 2 significant digits (Torr)
Emission Current	Main Display; 3 digits (Milliamps)
Degas Time	Main Display; 2 digits (Minutes) If Degas is on, then remaining time is also displayed
<u>Accessories:</u>	
Recorder Output	0-10V; Logarithmic, 1 V/decade
Setpoint Outputs	SPDT relay output; 3 Amp @ 115 VAC

# IG4400 INSTALLATION

## Thermocouple Installation

Situate the gauge tube in a clean, dry vacuum system with the open end pointing down so as to be self-draining should any vapors condense in it. Thread metal tubes into 1/8" female NPT threads. Pyrex tubes have 3/8" (10mm) OD tabulation. Allow the tube to outgas in the vacuum system for approximately 24 hours before operating with the controller.

Connect the Thermocouple (TC) Cable to the TC tube base. The plastic base of the tube might break off if force is used and the plug is not properly lined up with the tube. Plug the other end of the cable into the TC1 Connector on the back of the IG4400. (Or TC2 Connector if TC1 is already installed) Route the TC Cables so that they won't get tripped on or pulled.

## Ionization Gauge Installation

**WARNING - Connect the IG Cable to the glass tube before it is under vacuum. Accidental bending of the tube pins, while under vacuum, could cause the tube to crack and implode.**

Use only a **Standard Bayard-Alpert Ion Gauge** tube with this controller. This controller has resistive degas and is not designed to be used with an Ultra High Vacuum Tube. Using this controller with a UHV tube, that requires E Beam degas, will damage the unit and **void the warranty**.

Mount the ionization gauge in a central location in the vacuum system. The ion gauge reading will read a higher vacuum if mounted near the vacuum pumps. The reading will be lower if mounted near a gas inlet or source of contamination. If your vacuum system has an electron beam source the tube should have a shield around it to keep any spurious charged particles out of it.

Connect the IG cable to the tube; don't force the cable head onto the tube. The pins on the tube can bend easily. Connect the collector plug onto the collector pin on the top of the tube. Plug the other end of the cable into the Ion Gauge Connector on the back of the IG4400. Also connect the BNC Plug into the Ion Collector Connector next to the Ion Gauge Connector. Route the IG Cable so that it won't be tripped on or pulled.

## Controller Installation

Place the controller in a secure place, or mount into an equipment rack with the Optional Rack Mount Kit. The unit comes from the factory, wired for either 115 or 230 VAC, check the back panel for input voltage type and connect the power cord to the appropriate voltage.

## Grounding

Make sure the IG4400 and the vacuum chamber are properly grounded to each other and to all vacuum instrumentation being used. See GROUNDING on page iii.



# OPERATION

## Controls

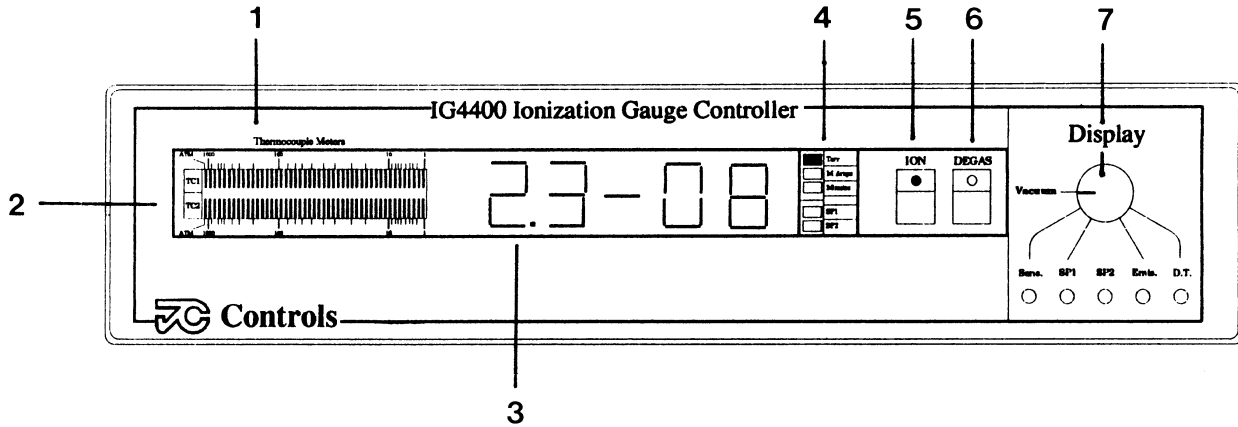


Figure 1

- |                               |                            |
|-------------------------------|----------------------------|
| 1. Thermocouple 1 Bar Graph   | 5. Ion Gauge On/Off switch |
| 2. Thermocouple 2 Bar Graph   | 6. Degas On/Off switch     |
| 3. Main Display               | 7. Mode select switch      |
| 4. Unit & Setpoint indicators |                            |

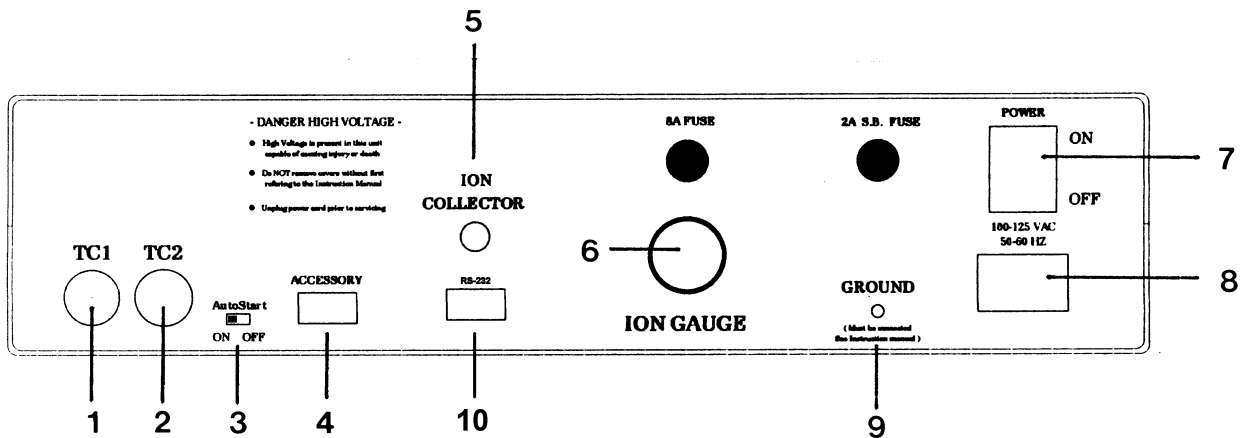


Figure 2

- |                              |                        |
|------------------------------|------------------------|
| 1. Thermocouple 1 connector  | 6. Ion Gauge connector |
| 2. Thermocouple 2 connector  | 7. Power switch        |
| 3. AutoStart switch          | 8. Power connector     |
| 4. Accessory connector       | 9. Ground Screw        |
| 5. Collector (BNC connector) | 10. RS-232 connector   |

## Simple Operation

### **READ THE SAFETY PAGE BEFORE PROCEEDING**

Follow the instructions in the installation chapter and install the tubes and cables. If you are using a TC tube and an ion gauge tube and want the ion gauge to turn on automatically, set the AutoStart switch on the back of the controller to "ON". If you do not want the controller to automatically turn on the ion gauge tube, set the AutoStart switch to " OFF ".

Turn on the power switch on the back panel. Make sure the Mode (Display) Selector Switch is set to Vacuum. The main display will be reading the TC1 gauge or if no tube is connected you will see 5 dashes. If the AutoStart is enabled and the pressure on the TC tube is Less than  $1.0 \times 10^{-3}$ , the controller will turn on the ion gauge tube and the ion indicator will light. After a few seconds, the controller will display the ion gauge pressure.

If you are not using a TC tube or the AutoStart is disabled, you will have to turn the ion gauge tube on. To do this, press the ION Switch on the front panel, the ion indicator will light. Wait a few seconds for the controller to display the pressure. To turn off the ion gauge, press the switch again.

## Operation Modes

The IG4400 has 7 different modes of operation; they are selected by turning the Mode Select Switch and are displayed on the main display.

Here is a list of the modes and what they do:

Mode	Switch Position	Operation
Thermocouple	Vacuum *	Display the vacuum on TC1
Ion Gauge	Vacuum **	Display the Vacuum on the IG
Sensitivity	Sens.	Display & adjust sensitivity
Setpoint 1	SP1	Display & adjust setpoint 1
Setpoint 2	SP2	Display & adjust setpoint 2
Emission	Emis.	Display & adjust emission
Degas Time	D.T.	Display & adjust degas time

\* Ion Gauge Tube must be off

\*\* Ion Gauge Tube must be on

## Sensitivity Adjustment

Turn then Mode Select Switch to the "Sens." position. The sensitivity value is displayed on the main display. To adjust the value, insert a small screwdriver in the "Sens." hole and turn the potentiometer. The range of adjustment is from 1 to 64 /Torr.

There are two factors in ion gauges that have a sensitivity value. The first is the sensitivity of the gauge tube and the second is the sensitivity of the gas in the vacuum system. These two values should be multiplied together to form the sensitivity value. For more information on sensitivity see page 11.

$$\text{Sensitivity} = \text{Tube Sensitivity} * \text{Gas Sensitivity}$$

## Process Control Set Points

The IG4400 has two process control set points. They are activated by the vacuum pressure on the main display. Only TC1 and the ion gauge effect the operation of the setpoints.

To display or adjust the setpoints turn the Mode Select Switch to the SP1 or SP2 position depending on which setpoint you are adjusting. The setpoint value is displayed on the main display. To adjust the value, insert a small screwdriver in the setpoint hole and turn the potentiometer. The range of adjustment is from  $9.9 \times 10^{-1}$  to  $1.0 \times 10^{-10}$  torr.

The output of the setpoints are two relays rated at 3A @ 115 Vac. They can be connected to external equipment via the Accessory Connector.

### IG4400 Accessory Connector

Pin Number	Setpoint	Operation
1	Recorder Output	Positive DC
2	Recorder Output	Ground
3	SP2	Comm.
4	SP2	N.C.
5	SP2	N.O.
7	Sp1	Comm.
8	SP1	N.C.
9	SP1	N.O.

## Emission Adjustment

Turn the Mode Select Switch to the "Emis." position. The emission current value will be displayed on the main display. To adjust the value, insert a small screwdriver in the "Emis." hole and turn the potentiometer. The range of adjustment is from 0.1 to 25.5 milliamps.

The emission may need adjustment to accommodate different tubes or filaments. Do not use the emission adjustment to correct for different sensitivity. The IG4400 has its own sensitivity adjustment and that should be used to change sensitivity.

## Degassing

The IG4400 uses resistive heating for degassing the ion gauge tube. Before degassing, the ion gauge tube must be on and in a good vacuum (i.e.  $9.9 \times 10^{-4}$  or lower). The degas cycle is started by pressing the Degas Button, the degas indicator should come on to indicate degassing. Degas will only start if the controller is in the vacuum mode and the ion gauge is turned on. The IG4400 will degas for the amount of time set on the timer. To see how much time is left on the degas timer, turn the Mode Select Switch to the "D.T." position. The number on the left of the main display is the remaining time.

There are 3 ways to shut off the degas cycle, first the degas timer can run out and the controller will turn off the degas, second you can press the degas button again, or you can turn off the ion gauge tube and the degas will also shut off.

## Degas Timer

Turn the Mode Select Switch to the "D.T." position. The degas time value is displayed on the main display. To adjust the value, insert a small screwdriver in the "D.T." hole and turn the potentiometer. The range of adjustment is from 1 to 99 minutes.

## Automatic Pumpdown Tracking

The JC Controls Ion Gauge Controller features automatic pumpdown tracking (AutoStart). If AutoStart is turned on, by switching the AutoStart switch to "On", it will monitor the thermocouple output and automatically switch to the ion gauge when the vacuum system reaches the correct crossover pressure. The thermocouple reads the vacuum system from atmosphere (1000 millitorr) to 1 millitorr. At 1 millitorr the controller automatically samples the ion gauge to see if it will turn on. If it will not, the controller shuts off the power to the ion gauge tube for 60 seconds. The controller is programmed to try and turn on the tube every 60 seconds thereafter, until the pressure reaches  $9.9 \times 10^{-4}$  torr. After this pressure is reached the controller continually tracks the system pressure during the high vacuum pumpdown; changing scales automatically as the vacuum lowers. The lowest pressure that can be read with the IG4400 is  $1.0 \times 10^{-10}$  torr. Because the ion gauge filament could oxidize or burnout at vacuum levels in the  $10^{-3}$  torr range the controller will not allow the ion gauge tube to be operated in these ranges. The system pressure must be  $9.9 \times 10^{-4}$  torr or lower before the JC Controls controller will allow the filament to be kept on.

If the user doesn't want the controller to turn on and off the ion gauge, then set the AutoStart switch to "Off".

## Analog Recorder Output

The Recorder Output of the IG4400 is a 0 to 10 VDC signal accessible through the accessory connector. Pin 1 is the positive DC signal and Pin 2 is ground. It is a representation of what vacuum is displayed on the main display ( TC1 or Ion Gauge). The Output is a linear 1 volt per decade.

The formula for the recorder output is:

$$\mathbf{V_{out} = ( -Vac. Exponent \times 1.0 \text{ VDC} ) + ( 1 - ( Vac. Mantissa / 10 ) )}$$

Examples:

$4.4 \times 10^{-1}$	=	1.56 VDC
$1.0 \times 10^{-3}$	=	3.90 VDC
$3.5 \times 10^{-5}$	=	5.65 VDC
$9.9 \times 10^{-8}$	=	8.01 VDC
$5.0 \times 10^{-6}$	=	6.50 VDC

# IONIZATION GAUGE

## Operating Principles

All ionization gauges operate on the basis of ionizing a fraction of the gas molecules present in the gauge and the collecting the gas ions. The gas ions are positively charged and cause an electrical current flow to the ion collector circuit. The magnitude of this current indicates the amount of pressure. A higher pressure (density of gas molecules) will cause a larger rate of ionization, resulting in a greater rate of positive ionic charge on the collector. These positive charges form a current in the collector circuit, from which the pressure is calculated.

Simple hot filament ionization gauges are available in several forms; such as the triode geometry or the more popular inverted triode (Bayard-Alpert) geometry.

A schematic view of a Bayard-Alpert gauge is shown in figure 3. These tubes usually have glass enclosures, however they are also available with no enclosure (nude gauge). The nude gauges are inserted directly into the vacuum system. As shown in figure 3 the ion collector is a slender wire down the center of a grid structure. The electron emitting filaments are outside the grid structure. Since the traditional triode gauge arrangement has the electron emitter inside the grid and the ion collector outside the grid, the Bayard-Alpert gauge is often referred to as an inverted triode gauge.

Figure 3 shows two electron emitting filaments; however only one filament is used during the operation of the gauge. The second one is available for use when the first one burns out. The filaments are usually made of tungsten but thoriated iridium filaments are offered as an option. The thoria coated iridium filaments have a longer life because they can withstand operation in higher partial pressures of oxygen and water vapor.

In the normal operation of the gauge, power is applied to the filament. The filament heats and electrons are emitted. The emission current is usually a few milliamperes when the gauge is operated in the high vacuum pressure range. The emitted electrons are accelerated toward the positively biased grid. Usually this accelerating potential difference is 150 volts. The grid is a relatively open structure therefore, most of the electrons pass through the grid, slow down, turn around and are accelerated back toward the grid again. The electrons pass through the grid and may oscillate back and forth through the grid structure many times before they hit the grid. This long mean free path for the electrons improves the probability that they will hit a gas molecule and ionize it even though the pressure may be in the ultra-high vacuum range. When such an ionizing collision takes place the positively charged gas ion is attracted to the most negative element in the gauge tube, the ion wire. Usually the ion collector wire is held at ground potential or zero volts. The ionized gas molecules are attracted to the ion collector and create a current in the collector circuit, which provides the pressure indication.

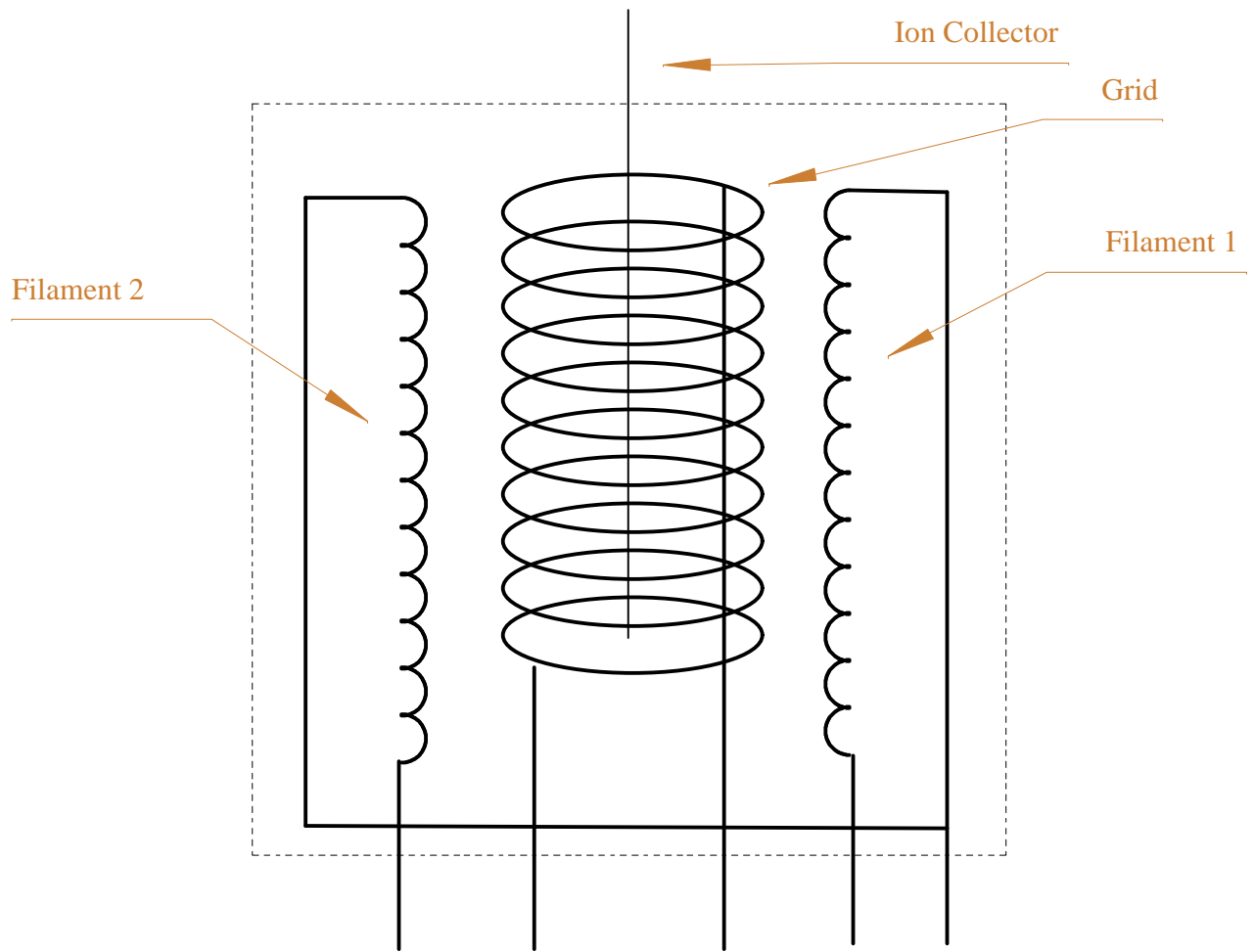


Figure 3

Schematic view of a Bayard-Alpert Ion Gauge Tube

Note: Do not use as reference for connecting IG4400 cable to tube

## Pressure Calculation

In hot filament ion gauges, the ionizing electrons are emitted from the hot filament. The rate at which electrons are emitted is measured by the emission current ( $I_e$ ) of the filament. The gas ions produced in the gauge are attracted to the ion collector and produce an ion current ( $I_c$ ) in the ion collector circuit. In order to determine the pressure ( $P$ ) measured by the ion collector current we need to know what relationship exists among the variables;  $P$ ,  $I_e$  and  $I_c$ .

There is a direct relationship between the ion current and the emission current. If the user increases the emission current more electrons are emitted from the filament. Therefore more gas molecules will be contacted and ionized and the ion current will be increased. The ion current is a direct function of the density of the gas molecules present. As the pressure increases, the density of gas molecules increases. Hence there will be more gas molecules hit by the emitting electrons, resulting in an increase of ion current. The ion current is also a function of the geometry of the elements in the tube and to some degree the electrical potentials of the various elements. If the emitted electrons have a very long mean free path from emitter to collector there is an increased probability of hitting a gas molecule, ionizing it and producing an increased ion current. We must remember that the probability of ionization is also a function of the gas species present in the gauge tube. The effect of geometry, electrical potentials and gas species are combined to form the gauge sensitivity ( $S$ ).

The equation that relates all these quantities is:

$$P = \frac{I_c}{I_e * S}$$

$$S = \text{Tube Sensitivity} \times \text{Gas Sensitivity}$$

## Effects of Various Gases (Relative Sensitivity)

Various gases in the gauge tube will different effects have on the indicated pressure. We have to make the distinction between the true pressure in the gauge tube and the pressure that is indicated by the controller. Almost all manufacturers calibrate their gauges so that the indicated pressure is nearly identical with the true pressure when the gas is a normal air mixture.

In any gauge tube that has a fixed volume and operates at a constant temperature, the true pressure is determined solely by the number of gas molecules present. However the indicated pressure in an ionization gauge is determined by the rate at which gas ions are collected. Typically this rate of collection is determined by the rate gas molecules are ionized. This ionization rate varies with gases, other than normal air or nitrogen, causing a discrepancy between the indicated pressure and the true pressure (when nitrogen or normal air is not being used). The relative sensitivity of a gas is the relationship between the ionization rate of the gas and nitrogen. When not using nitrogen, the indicated pressure of the ion gauge controller must be divided by the relative sensitivity number for that gas.

Gas Type	Relative Gas Sensitivity S/SN	IG4400 Adjustment
Helium	0.178	02
Neon	0.316	03
Hydrogen	0.410	04
Oxygen	0.780	08
Water Vapor	0.90	09
Nitrogen	1.00	10
Carbon Monoxide	1.01	10
Carbon Dioxide	1.39	14
Argon	1.42	14
Krypton	1.94	19
Xenon	2.75	28

## Degas

There is a possibility at some time during ion gauge operation that the pressure in the gauge tube will be higher than the pressure in the vacuum system because of gases and vapors desorbing from the surfaces of the gauge tube. Degassing is the process by which we attempt to speed up desorption or outgassing of the surfaces inside the gauge tube. Once these surfaces are outgassed or degassed, the pressure in the gauge tube is more likely to be equal to the pressure in the vacuum system.

Degassing is usually accomplished by applying an additional amount of electrical power to some of the elements in the tube, thus causing those elements to heat. Heated surfaces outgas more rapidly than cool surfaces. Heat flow, by radiation and conductance, causes all the gauge surfaces to heat, and thus to outgas.

The IG4400 performs degas by using Resistive heating ( $I^2R$ ). An electrical current is passed through the grid structure. This causes these wires and all the gauge elements to get hot. In order to thoroughly outgas a hot filament gauge tube allow 15 to 45 minutes of operation in the degas mode. It may take a longer period of degas time or repeated degas cycles if the gauge is extremely contaminated.

## X-ray Limit

The x-ray limit is one of the fundamental factors, which limit the minimum pressure that is measurable by the hot filament ionization gauge. In any gauge there is a hot, electron emitting filament on the axis of a cylindrical electrode structure. Surrounding the filament is a positively biased electron collecting grid, and a negatively biased ion collector surface. Electrons emitted from the filament are accelerated to the grid. Some of the electrons hit gas molecules and ionize them. The positively charged ions are attached to the ion collector circuit. The arriving charged ions give rise to a current in the ion collector circuit. The ion current is supposed to be proportional to the pressure in the gauge tube.

When the emitted electrons hit the grid they impact with enough energy that soft (low energy) x-rays are generated. These x-rays are emitted from the grid structure in all directions, so that many of the x-rays hit the ion collector surface. When a x-ray hits the ion collector it simulates the emission of a negative electron from the ion collector. A negatively charged electron leaving the ion collector is electrically equivalent to a positively charged ion arriving at the collector. The electronics in the ion collector circuit cannot distinguish the difference. Therefore as long as the arriving ion current is much greater than the x-ray stimulated (leaving electron) current, the gauge can accurately indicate the pressure. But, if the pressure is so low that the ion current becomes comparable to or less than the x-ray stimulated electron current, the gauge electronics will only indicate a lowering pressure down to that "stimulated pressure," analogous to the value of the x-ray stimulated electron current. At this point the gauge is said to be at its x-ray limit.

## Electrometer

The electrometer collects and monitors the current in the collector circuit and thus indicates the vacuum level by the amount of current. The electrometer is a high precision integration amplifier that converts the current to a pulse width. The microprocessor computes the vacuum by timing the width of the pulse. The electrometer must be able to monitor a large current flow in the  $10^{-4}$  torr range and a very minute current flow in the  $10^{-9}$  torr range.

# THERMOCOUPLE GAUGE TUBE

## Operating Principles

The thermocouple sensing mechanism consists of a tube with an internal filament, which is heated by passing a current through it. A thermocouple filament is welded to the center of the heated filament. The thermocouple filament generates an output voltage as it is heated. The heat transfer between the filaments varies with the vacuum pressure, thus the output voltage varies.

The thermocouple voltage is directly proportional to the increased temperature of the filament and thus generates an increase in voltage. A sensitive millivolt-meter, calibrated and marked to read directly in microns provides a reading of the thermocouple output. The reading in microns is displayed on a bar graph on the front panel of the ion gauge controller.

## Controller Interface

The IG4400 Ion Gauge Controller has provisions for two thermocouple tubes. Thermocouple 1 is for use in monitoring the vacuum system pressure and is displayed on a bar graph located on the front panel of the controller. Thermocouple 1 is also displayed on the main display when the ion gauge's filament is off and the controller is in the vacuum mode. Thermocouple 2 is usually used to measure a secondary vacuum like in a foreline, roughing pump or insulation vacuum. TC2 is displayed on a bar graph of its own.

The output of both thermocouple 1 and thermocouple 2 are amplified by a precision OP AMP circuit for an accurate reading. The signals are sent to the microprocessor via the A/D Converter. The microprocessor then converts the voltage to a vacuum pressure, using a lookup table located in the microprocessor.

## Calibration of Thermocouple's

The DV-6M thermocouple tubes are designed with very close drive current specs, for this reason if the tubes are switched or replaced, there is no need to recalibrate IG4400 Controller.

If you wish to recalibrate the TC tubes the following procedure should be used:

### Zero Adjust

Connect a DV-6M tube that is at atmosphere, to the unit. Using the Adjustment potentiometers set the reference voltages to .10 VDC. The voltage reading for TC1 is between the side of R53 closest to the front and ground (chassis). For TC2, the voltage reading is between the side of R50 closest to the front and ground.

### Gain Adjustment

Connect a TC tube that is in a known vacuum from  $10^{-2}$  to  $10^{-3}$  Torr, to the IG4400. Turn the Gain potentiometer until the reading is the same as the vacuum

### **Potentiometer Names**

<b>Adjustment</b>	<b>TC1</b>	<b>TC2</b>
Zero	R49	R46
Gain	R42	R39

## Remote Operation (RS-232)

The IG4400 Ion Gauge Controller has a full functioning remote computer port. All aspects of the IG4400 can be controlled via the RS-232 interface by sending simple commands to the controller. Any computer or terminal with a serial RS-232 port can be connected to the IG4400. If the controller is connected when the power is turned on the software version name will be sent to the computer.

### RS-232 Interface

The RS-232 interface uses a standard 9 pin serial port. The port specifications are listed in table 1 below. The Pin out of the controllers RS-232 port is listed in table 2, you can get by with only the TX, RX & Ground wires connected. The DTR is connected internally to the DSR and the RTS to the CTS.

Interface Type	RS-232
Interface Mode	DTE
Baud Rate	2400
Stop Bits	1
Data Bits	8
Parity Bits	None
Flow Control	None
Voltage of Logic 0	+12 VDC
Voltage of Logic 1	-12 VDC

Table 1

Pin	Function
1	NC
2	TX (Transmit Data)
3	RX (Receive Data)
4	DTR
5	Ground
6	DSR
7	RTS
8	CTS
9	NC

Table 2

## Software Commands

- All commands must terminate with a <CR>
- The controller will echo back the characters received (unless disabled).
- Standard ASCII is used
- "n, nn, nn.n" refer to a numerical value
- "m.m" refer to a mantissa value
- "ee" refer to an exponent

Command	Response	Example	Description
=RS	S=nn (1 to 64)	=RS S=10	Read Sensitivity
=RE	E=nn.n (1.0 to 25.5)	=RE E=10.0	Read Emission Current
=RT	T=nn (1 to 99)	=RT T=30	Read Degas Time
=R1	1=m.m-ee (9.9-01 to 1.0-10)	=R1 1=2.3-04	Read Setpoint 1
=R2	2=m.m-ee (9.9-01 to 1.0-10)	=R2 2=5.0-09	Read Setpoint 2
=RV	V=m.m-ee (2.0-00 to 1.0-10)	=RV V=5.0-07	Read Vacuum
=R*	*=b <sub>1</sub> b <sub>2</sub> b <sub>3</sub> b <sub>4</sub>	=R* *=1010	Read Status b1 = Ion On b2 = Degas On b3 = SP1 On b4 = SP2 On
=SS:nn (1 to 64)	S:OK	=SS:25 S:OK	Set Sensitivity
=SE:nn.n (1.0 to 25.5)	E:OK	=SE:4.0 E:OK	Set Emission Current
=ST:nn (1 to 99)	T:OK	=ST:20 T:OK	Set Degas Time
=S1:m.m-ee (9.9-01 to 1.0-10)	1:OK	=S1:1.0-4 1:OK	Set Setpoint 1
=S2:m.m-ee (9.9-01 to 1.0-10)	2:OK	=S2:1.0-05 2:OK	Set Setpoint 2
=SF1	F=: On	=SF1 F=On	Turn On Ion Gauge (you should check the status to see if the filament stays on or gets shut off)
=SF0	F=Off	=SF0 F=Off	Turn Off Ion Gauge
=SD1	D=On	=SD1 D=On	Turn On Degas (you will get an Error 3 if the Ion gauge is not on)
=SD0	D=Off	=SD0 D=Off	Turn Off Degas

Command	Response	Example	Description
	Error 1	sdkcjb Error 1	Syntax Error
	Error 2	=ST:99 Error 2	Number Out of Range
	Error 3	=SD1 Error 3	Operation Not Allowed
	Error 4		Tx Buffer Overflowed
=R#	IGS400 V?.???.?? SN: <serial number>	=R# IGS400 V1.00.00 SN:KA88	Read Serial Number
=X	IGS400 V?.???.??	=X IGS400 V1.00.00	Reset IG4400 ( Displays Software Version)

# Maintenance

## Ion Gauge Shut Down Codes

When the IG4400 turns off the ion gauge tube, the controller will display a CODE# on the main display. This will stay on the display for about 2 seconds. Here is the list of the code numbers and what they mean:

### **CODE 1**

The Ion Gauge shuts off because it can not get or hold the Emission Current.

Possible Problems: Vacuum is too low  
Ion Gauge Cable is disconnected  
Filament Fuse is blown

### **CODE 2**

The Ion Gauge shuts off because it can not establish Collector Current.

Possible Problems: Vacuum is too high  
Ion Collector BNC is disconnected

### **CODE 3**

The Ion Gauge shuts off because the vacuum lower than  $9.9 \times 10^{-4}$ . This is the normal shut down mode when bringing the pressure up in the vacuum system.

### **CODE 4**

There is a problem with the EEPROM. If this Code is displayed call JC Controls for repair.

### **CODE 6**

There is a problem with the RS-232 receiver routine.

Possible Problems: RS-232 Cable is loose or broken  
Baud Rate or Communication Setting is wrong

## Troubleshooting Guide for the IG4400

### Symptom

Unit won't power up, no response to power switch.

3A Power fuse blows repeatedly.

8A fuse blows repeatedly.

Tube and ION LED won't turn on

AutoStart won't work

Ion Gauge tube won't come on, or comes on briefly then shuts off with **CodE1** displayed.  
(The Tube does **NOT** light up at all)

Ion Gauge tube won't come on, or comes on briefly then shuts off with **CodE1** displayed.  
(The Tube light's up briefly)

Ion Gauge tube won't come on, or comes on briefly then shuts off with **CodE2** displayed.

Ion Gauge tube won't come on, or comes on briefly then shuts off with **CodE3** displayed.

Degas won't come on

Thermocouple reading stays at ATM

Thermocouple reading is low or never reaches  $1.0 \times 10^{-3}$  Torr

**CodE4** is being displayed on the controller.

**CodE6** is being displayed on the controller.

### Possible Cause

- No power to unit
- Power cord not inserted tightly
- Power fuse is blown
- Wrong line voltage
- Wrong Power fuse rating
- Defective Power Supply
- Ion Gauge tube filament is shorted
- Ion Gauge cable is shorted
- Mode select switch is not in vacuum
- AutoStart switch set to "Off"
- TC1 is calibrated wrong
- Unplugged Ion Gauge Cable
- Burned out filament
- Blown 6A fuse
- Broken Ion Gauge Cable
- Defective Power Supply
- System pressure is too high
- Badly contaminated Ion Gauge tube
- Defective Ion Gauge Cable
- Defective Ion Gauge tube
- System pressure is too low
- Ion Collector BNC is unplugged
- Ion Collector wire is off of the tube
- Defective Ion Gauge Cable
- System Pressure is too high
- Ion Gauge is not turned on
- Mode switch is not in vacuum
- Blown thermocouple tube
- Bad cable or connection
- TC tube out of calibration
- Send Unit back for repair
- RS-232 Cable is loose or broken
- Wrong Communication Settings

# Tube Drawings

## TVT-6M Thermocouple Vacuum Gauge Tube

**Outline Dimensions, full scale  
All measurements in inches.**

Operation Specifications	
Measurement range	1 to 1000 microns
Heater current	21 mA
Thermocouple output	10 mv at 1 micron
Thermocouple load	55 Ohms
Connection	1/8" IPS threaded port
Basing	JEDEC 8 FR

IGT Ionization

Gauge Tube

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**JC Controls**

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Ion Gauge Controllers • Thermocouple Vacuum Gauges • Liquid Nitrogen Level Controllers

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