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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 Kurt J. Lesker Co. for repairs or contact Kurt J. Lesker Co. 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 connections 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 KJL6600 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. Kurt J. Lesker Co. 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 if the shipment is not identical to the packing list or not what was ordered.

Kurt J. Lesker Co.
1515 Worthington Avenue
Clairton, PA 15025
(412) 387-9200

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 Kurt J. Lesker Co. KJL6600 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 Kurt J. Lesker Co. and it will be repaired at no charge. Please include a written statement of the problem with a contact name and phone number.

KJL6600 SPECIFICATIONS

Power Requirements :	95 - 125 VAC (50/60 Hz), 185 Watts 200-250 VAC (50/60 Hz),185 Watts
Size:	3 ½" H (90 mm), 15" W (381 mm), 10.5" D (267 mm) 19" W (483mm), with Rack Mount
Weight:	18 Lbs. (6.4 Kg)
Temperature Range :	0 - 40° C
Convection Tubes :	
Type	VRC 912 series Convection Tubes
Range	760 to 1.0 x 10^{-3} Torr
Thermocouple Tubes :	
Type	Hasting DV-6M
Range	1 to 1.0 x 10^{-3} Torr
Ion Gauges :	
Type	Bayard - Alpert
Range	9.9 x 10^{-4} to 1.0 x 10^{-9} Torr
Sensitivity	Adjustable, 1/Torr to 80/Torr (Factory set to 10/Torr)
Emission Current	Adjustable, 1.0 mA to 20 mA (Factory set to 10.0 mA)
Collector Potential	0 VDC
Grid Potential	+180 VDC
Filament Potential	+30 VDC
Degas	I^2R, 7V, 8A max; Adjustable timer from 1 to 99 min.
Display:	
Ion Gauge 1	IG1 Display: Scientific notation, 2 significant digits (Torr)
Ion Gauge 2	IG2 Display: Scientific notation, 2 significant digits (Torr)
Convection 1 - 4	Convection Display: 9 to 1.0x10^{-3} Torr - Scientific notation, 2 significant digits / 10 to 760 Torr - 2 to 3 significant digits
Thermocouple 1 - 4	TC Display: 1.0 to 1.0x10^{-3} Torr - Scientific notation, 2 significant digits
Setpoint 1 - 8	IG1 Display: Scientific notation, 2 significant digits (Torr) IG2 Display: Gauge assigned to trigger setpoint
Autostart	IG1 Display: Convection gauge assigned to start IG1 IG2 Display: Convection gauge assigned to start IG2
Emission Current	IG1 And IG2: 3 digits (Milliamps)
Degas Time	IG1 And IG2: 2 digits (Minutes)
Recorder Output	0-10V: Logarithmic, 1 Volt/decade
Setpoint Outputs	SPDT: relay output; 3 Amp @ 115 VAC

KJL6600 INSTALLATION

Convection Gauge Installation

Thread the gauge tube into a 1/8 inch NPT female fitting(or other fitting or flange as per your gauge tube), in the vacuum system. The radial stem of the tube should be vertical to insure that the tube stay horizontal. The axis of the tube must be horizontal.

Connect the Convection (CVC) Cable to the Convection tube base. Plug the other end of the cable into the Convection Connector on the back of the KJL6600. Route the Convection Cables so that they won't get tripped on or pulled.

Thermocouple Gauge 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" NPT female fitting. 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 TC Connector on the back of the KJL6600. 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 gauges in central locations 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 be shielded 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 KJL6600. 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 Rack Mount Kit. The unit comes from the factory, wired for 115 VAC. This maybe changed to 220 VAC by reversing the fuse block in the power cord module on the back of the KJL6600 controller. Be sure to connect the power cord to the appropriate voltage.

Grounding

Make sure the KJL6600 and the vacuum chamber are properly grounded to each other and to all vacuum instrumentation being used. See GROUNDING on page iii.

OPERATION

Controls

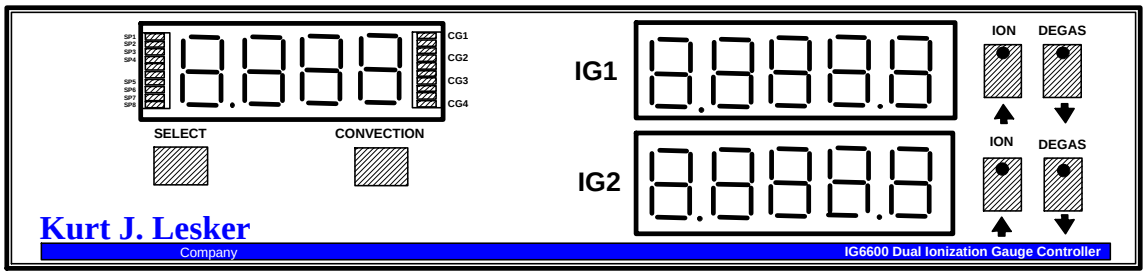


Figure 1

1. Convection/TC Display
2. Setpoint indicators
3. Mode select switch
4. Convection Display Switch
5. Convection Display Indicators
6. IG1 Main Display
7. IG1 Ion Gauge/(+) switch
8. IG1 Degas /(-) switch
9. IG2 Main Display
10. IG2 Ion Gauge/(+) switch
11. IG2 Degas /(-) switch

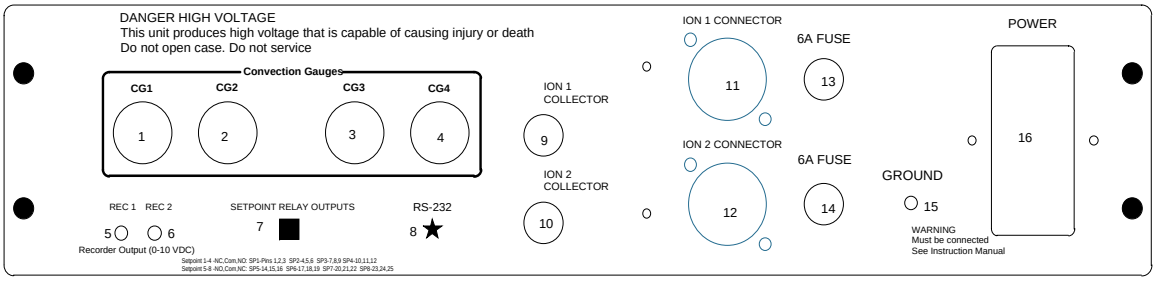


Figure 2

1-4. Convection connector
5-6. Recorder output
7. Setpoint connector
8. RS-232 connector
9. IG1 Collector (BNC connector)
10. IG2 Collector (BNC connector)
11. Ion Gauge 1 connector
12. Ion Gauge 2 connector
13. 6A fuse
14. 6A Fuse
15. Ground Screw
16. Power connector, fuse & switch

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 convection/TC gauge tube with an ion gauge tube and want the ion gauge to turn on automatically, couple the appropriate convection/TC tube to the Ion gauge in the "AS" mode.

Turn on the power switch on the back panel. Make sure the Select Switch is set to Vacuum. The main displays will be reading a convection/TC gauge or if no tube is connected you will see 5 dashes. If the AutoStart is enabled and the pressure on the convection/TC tube is less than 1.0×10^{-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 convection/TC tube or the AutoStart is disabled, you will have to turn the ion gauge tubes 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 KJL6600 has 15 different modes of operation; they are selected by pushing the Select Switch, The mode is displayed on the Convection display while the adjustment are displayed on the IG displays. Adjustment are made using the +/- (ion/degas) keys that correspond to the IG displays.

Here is a list of the modes and corresponding displays. Factory presets are in parenthesis i.e (10). To reset factory presets hold down the SELECT and CONVECTION switches while turning on power:

Mode	Convection Display	IG1 Display	IG2 Display
Vacuum	Convection gauge Reading	IG1 Vacuum reading	IG2 Vacuum Reading
Sensitivity	SEnS	1 to 80 torr (10)	1 to 80 torr (10)
Emission	E C	1.0 to 20.0 mA (10.0)	1.0 to 20.0 mA (10.0)
Degas Time	dE	1 to 99 min (20)	1 to 99 min (20)
AutoStart	AS	Convection tube 1-4 (C1)	Convection tube 1-4 (C2)
Setpoint 1	SP 1	760 to 1.0 x 10^{-9} (1.0 x10^{-8})	Ion1,Ion2,C1,C2,C3,C4,On,OFF(Ion1)
Setpoint 2	SP 2	760 to 1.0 x 10^{-9} (2.0 x10^{-7})	Ion1,Ion2,C1,C2,C3,C4,On,OFF(Ion2)
Setpoint 3	SP 3	760 to 1.0 x 10^{-9} (3.0 x10^{-6})	Ion1,Ion2,C1,C2,C3,C4,On,OFF(Ion1)
Setpoint 4	SP 4	760 to 1.0 x 10^{-9} (4.0 x10^{-5})	Ion1,Ion2,C1,C2,C3,C4,On,OFF(Ion2)
Setpoint 5	SP 5	760 to 1.0 x 10^{-9} (5.0 x10^{-1})	Ion1,Ion2,C1,C2,C3,C4,On,OFF(C1)
Setpoint 6	SP 6	760 to 1.0 x 10^{-9} (6.0 x10^{-0})	Ion1,Ion2,C1,C2,C3,C4,On,OFF(C2)
Setpoint 7	SP 7	760 to 1.0 x 10^{-9} (70)	Ion1,Ion2,C1,C2,C3,C4,On,OFF(C3)
Setpoint 8	SP 8	760 to 1.0 x 10^{-9} (760)	Ion1,Ion2,C1,C2,C3,C4,On,OFF(C4)
Recorder Output	rEC	Ion1,Ion2,C1,C2,C3,C4.OFF(Ion1)	Ion1,Ion2,C1,C2,C3,C4,OFF(Ion2)
Convection auto calibration	CAdJ	Press Ion	

Sensitivity Adjustments

Push SELECT switch until "SEnS" appears on the Convection display. The sensitivity values are displayed on the IG1 and IG2 display. To adjust the values press the + (ION) or – (DEGAS) buttons . The range of adjustment is from 1 to 80 /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 13.

Sensitivity = Tube Sensitivity * Gas Sensitivity

Emission Adjustments

Push SELECT switch until "EC" appears on the Convection display. The emission current values are displayed on the IG1 and IG2 displays. To adjust the values press the + (ION) or – (DEGAS) . The range of adjustment is from 1.0 to 20.0 mA.

The emission may need adjustment to accommodate different tubes or filaments. Do not use the emission adjustment to correct for different sensitivity. The KJL6600 has its own sensitivity adjustment and that should be used to change sensitivity.

Degas Timers

Push SELECT switch until "dE" appears on the Convection display. The degas time value is displayed on the IG1 and IG2 displays. To adjust the value press the + (ION) or – (DEGAS) . The range of adjustment is from 1 to 99 minutes.

The degas timers control the degas cycle on the KJL6600. After pushing the degas button to start the degas cycle, the controller will stop the degas when the preset time expires.

Degassing

The KJL6600 uses resistive heating for degassing the ion gauge tube. The controller can degas only one tube at a time. Before degassing, the ion gauge tube must be on and in a high vacuum (i.e. 9.9×10^{-4} or lower). The degas cycle is started by pressing the DEGAS Button for either IG1 or IG2, the appropriate 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 KJL6600 will degas for the amount of time set on the timer. 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.

Automatic Range Changing (Autostart)

The Kurt J. Lesker Co. Ion Gauge Controller features automatic range changing (AutoStart). If AutoStart is turned on, it will monitor the convection or thermocouple output and automatically switch to the ion gauge when the vacuum system reaches the correct crossover pressure. The convection reads the vacuum system from atmosphere to 1.0×10^{-3}. At this pressure 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. 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 9.9×10^{-4} torr or lower before the Kurt J. Lesker Co. controller will allow the filament to be kept on. 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 KJL6600 is 1.0×10^{-9} torr.

Push the SELECT switch until "AS" appears on the Convection display. The Autostart displays C1,C2,C3,C4, or OFF on the IG1 and IG2 display. Simply select one low vacuum gauge to automatically start the corresponding ion gauge. If the user doesn't want the controller to turn on and off the ion gauge, then set the AutoStart "Off".

The convection gauges that are assigned to IG1 and IG2 will be displayed on the IG1 and IG2 displays until the ion gauges turn on and are displayed

Process Control Set Points

The KJL6600 has eight process control setpoints. They may be assigned to any of the Ion gauges or Convection/TC gauges. They are activated by the vacuum pressure read by their assigned tube.

To display or adjust the setpoints push SELECT switch until “SP1” (setpoint 1) appears on the Convection display. The setpoint value is displayed on the IG1 display. To adjust the value press the + (ION) or – (DEGAS) corresponding to IG1. The setpoint may be assigned to any tube , this assignment is displayed on the IG2 display. To change the assignment press the + (ION) or – (DEGAS) corresponding to IG2.

Setpoints 2-8 maybe accessed by pushing the Select Switch and scrolling through them. Adjustments are made as described above. The output of the setpoints are eight SPDT relays rated at 3A @ 115 Vac. They can be connected to external equipment via the Setpoint Connector.

KJL6600 Setpoint Connector

Pin Number	Setpoint	Operation
1	SP1	N.C.
2	SP1	Comm.
3	SP1	N.O.
4	SP2	N.C.
5	SP2	Comm.
6	SP2	N.O.
7	SP3	N.C.
8	SP3	Comm.
9	SP3	N.O.
10	SP4	N.C.
11	SP4	Comm.
12	SP4	N.O.
13	Empty	
14	SP5	N.O.
15	SP5	Comm.
16	SP5	N.C.
17	SP6	N.O.
18	SP6	Comm.
19	SP6	N.C.
20	SP7	N.O.
21	SP7	Comm.
22	SP7	N.C.
23	SP8	N.O.
24	SP8	Comm.
25	SP8	N.C.

Analog Recorder Outputs

Push the SELECT switch until "rEC" appears on the Convection display. The recorder output displays Ion1,Ion2,C1,C2,C3, or C4 on the IG1 and IG2 display. Recorder output 1 is selected on IG1 display and recorder output 2 on IG2 display. Simply choose the tube for the outputs to track. The recorder outputs of the KJL6600 are accessible on the back panel. The output is a logarithmic 1 volt per decade of vacuum.

There are four types of recorder outputs depending on the tubes selected:

1. If a convection tube is selected the output will track from 760 torr to 1.0 x 10^{-3} torr at one volt per decade (0.25 – 5.9VDC).

The formula for the recorder output with a convection gauge is:

Vout = 2 + (*Vac. Exponent* x -1.0 VDC) + (1 - (*Vac. Mantissa* / 10))

Examples:

450	=	0.55 VDC
9.3 x 10^{-0}	=	2.07 VDC
4.4 x 10^{-1}	=	3.56 VDC
1.0 x 10^{-3}	=	5.90 VDC

2. If a thermocouple tube is selected the output will track from 2 torr to 1.0 x 10^{-3} torr at one volt per decade (0.8 – 3.9VDC).

There are two output for ion gauges, one if a low vacuum gauge is attached to autostart the ion gauge and the other for just tracking the ion gauge range:

3. If the autostart function is activated the output will track the full vacuum range from 2 torr to 1.0 x 10^{-9} torr at one volt per decade (0.8 – 9.9 VDC).
4. If the auto start is not selected then the output will track only the ion gauge range from 9.9 x 10^{-4} to 1.0 x 10^{-9} torr at one volt per decade (4.0 – 9.9 VDC).

The formula for the recorder output with an ion or thermocouple gauge is:

Vout = (*Vac. Exponent* x -1.0 VDC) + (1 - (*Vac. Mantissa* / 10))

Examples:

4.4 x 10^{-1}	=	1.56 VDC
1.0 x 10^{-3}	=	3.90 VDC
3.5 x 10^{-5}	=	5.65 VDC
9.9 x 10^{-8}	=	8.01 VDC

Convection Auto Calibration

Recalibration of convection gauges maybe necessary after they have been in a vacuum system for sometime. The KJL6600's microprocessor can automatically recalibrate the gauge tubes.

Push the SELECT switch until "CAdJ" appears on the Convection display. The convection tubes must be in a vacuum higher than 1.0×10^{-4} torr to be calibrated. Use the Convection switch to scroll through the tubes to be calibrated. If the IG1 display flashes "Press" and "Ion", the tube is out of adjustment. Simply press the IG1 ION button and the KJL6600 will recalibrate the tube.

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.

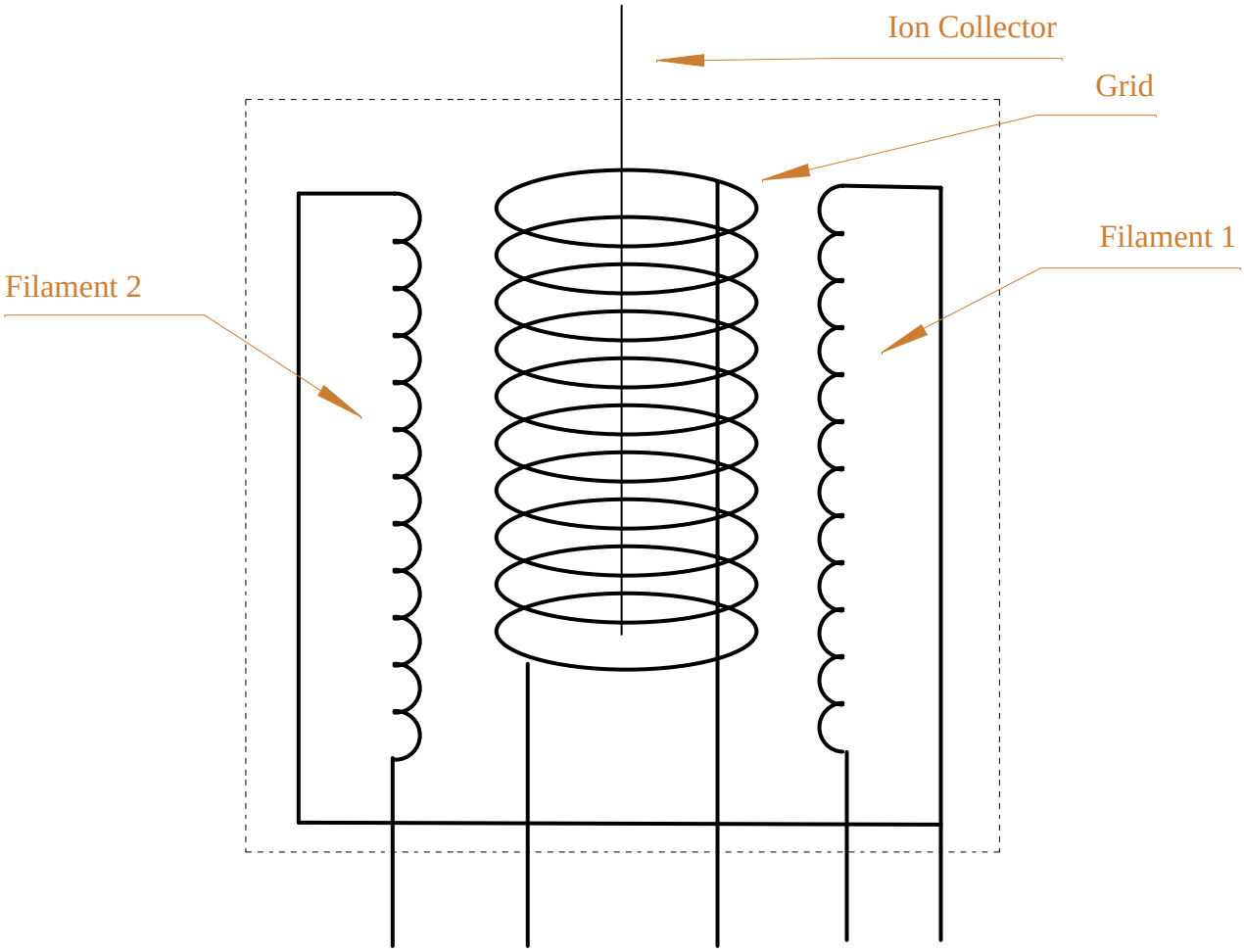


Figure 3

Schematic view of a Bayard-Alpert Ion Gauge Tube

Note: Do not use as reference for connecting KJL6600 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 (Ie) of the filament. The gas ions produced in the gauge are attracted to the ion collector and produce an ion current (Ic) 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, Ie and Ic.

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:

$$P = \frac{Ic}{Ie * S}$$

S = Tube Sensitivity x Gas Sensitivity

Effects of Various Gases
(Relative Sensitivity)

Various gases in the gauge tube will have different effects 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. 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 desorbtion 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 KJL6600 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.

Electrometers

The electrometers collect and monitors the current in the collector circuits and thus indicates the vacuum level by the amount of current. The electrometers are high precision integration amplifiers that convert 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.

LOW VACUUM GAUGE TUBES

Convection Gauge Operating Principles

The convection enhanced pirani tube uses two platinum alloy filaments as resistance in two arms of a wheatstone bridge. The reference filament is sealed in a low pressure while the measurement filament is exposed to the vacuum. The filament 's temperature is determined by the heat conductivity of the residual gas, which, in turn, depends on the pressure. Since the filaments have a high temperature coefficient of electrical resistance any change in pressure will unbalance the bridge. The reading in torr is displayed on the front panel of the ion gauge controller.

Thermocouple Gauge 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.

Controller Interface

The KJL6600 Ion Gauge Controller has provisions for four low vacuum tubes. They may be viewed on the CONVECTION / TC display by scrolling through them with the CONVECTION / TC switch. They may also be viewed on the IG1 and IG2 displays if they are attached using the Autostart function. They may also be monitored by the recorder output.

Remote Operation (RS-232)

The KJL6600 Ion Gauge Controller has a full functioning remote computer port. All aspects of the KJL6600 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 KJL6600. 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 3 below. The pin out of the controllers RS-232 port is listed in table 4, 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 3

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 4

Software Commands

- All commands must terminate with a <CR>
- The controller will echo back the characters received (unless disabled).
- Standard ASCII is used

RS-232 Command Processor for IGS601
Version 1.00.00 JC Controls

COMMAND	RESPONSE	DESCRIPTION
=X	<IGS60x "ver.">	Reset Program x= 1 for Convection Unit and 3 for TC Unit "ver" = Version Number
=RA1	A1=*asm*	Read AutoStart 1
	A1=0	= Off
	A1=1	= TC / Convection Gauge 1
	A1=2	= TC / Convection Gauge 2
	A1=3	= TC / Convection Gauge 3
	A1=4	= TC / Convection Gauge 4
=SA1: *asm*	A1:Ok	Set AutoStart 1
=RA2	A2= *asm*	Read AutoStart 2
=SA2: *asm*	A2:Ok	Set AutoStart 2
=RR1	R1=*rom*	Read Recorder Output 1 Select
	R1=0	= Ion1
	R1=1	= Ion2
	R1=2	= TC / Convection Gauge 1
	R1=3	= TC / Convection Gauge 2
	R1=4	= TC / Convection Gauge 3
	R1=5	= TC / Convection Gauge 4
=SR1: *rom*	R1:Ok	Set Recorder 1 Select
=RR2	R1= *rom*	Read Recorder 2 Select
=SR2: *rom*	R1:Ok	Set Recorder 2 Select
=RS1	S1=*sens*	Read Sensitivity for IG1 *sens* = 01 to 99
=SS1: *sens*	S1:OK	Set Sensitivity for IG1
=RS2	S2= *sens*	Read Sensitivity for IG2
=SS2: *sens*	S2:OK	Set Sensitivity for IG2
=RE1	E1=*emis*	Read Emission Current for IG1 *emis* = 01.0 to 20.0
=SE1: *emis*	E1:OK	Set Emission Current for IG1
=RE2	E2=*emis*	Read Emission Current for IG2
=SE2: *emis*	E2:OK	Set Emission Current for IG2
=RT1	T1=*nn*	Read Degas Time for IG1 *nn = 1 to 99*
=ST1: *nn*	T1:OK	Set Degas Time for IG1
=RT2	T2= *nn*	Read Degas Time for IG2
=ST2: *nn*	T2:OK	Set Degas Time for IG2

COMMAND	RESPONSE	DESCRIPTION
=R1	1=t:m.msee	Read Setpoint 1
=S1:t:m.msee	1:OK	Set Setpoint 1
=R2	2=t:m.msee	Read Setpoint 2
=S2:t:m.msee	2:OK	Set Setpoint 2
=R3	3=t:m.msee	Read Setpoint 3
=S3:t:m.msee	3:OK	Set Setpoint 3
=R4	4=t:m.msee	Read Setpoint 4
=S4:t:m.msee	4:OK	Set Setpoint 4
=R5	5=t:m.msee	Read Setpoint 5
=S5:t:m.msee	5:OK	Set Setpoint 5
=R6	6=t:m.msee	Read Setpoint 6
=S6:t:m.msee	6:OK	Set Setpoint 6
=R7	7=t:m.msee	Read Setpoint 7
=S7:t:m.msee	7:OK	Set Setpoint 7
=R8	8=t:m.msee	Read Setpoint 8
=S8:t:m.msee	8:OK	Set Setpoint 8
=RV1	V=m.msee	Read Vacuum from IG1
=RV2	V=m.msee	Read Vacuum from IG2
=RV3	V=m.msee	Read Vacuum from TC/CG1
=RV4	V=m.msee	Read Vacuum from TC/CG2
=RV5	V=m.msee	Read Vacuum from TC/CG3
=RV6	V=m.msee	Read Vacuum from TC/CG4
=R*	*=b1b2b3b4	Read Status b1=Ion 1 On = 1 b2=Degas 1 On b3=In 2 On b4=Degas 2 On
=SF11	F1=On	Turn On Filament 1
=SF10	F1=Off	Turn Off Filament 1
=SD11	D1=On	Turn On Degas 1
=SD10	D1=Off	Turn Off Degas 1
=SF21	F2=On	Turn On Filament 2
=SF20	F2=Off	Turn Off Filament 2
=SD21	D2=On	Turn On Degas 2
=SD20	D2=Off	Turn Off Degas 2
	Error 1	Syntax Error
	Error 2	Number Out of Range
	Error 3	Operation Not Allowed
	Error 4	Tx Buffer Overflowed

Setpoint / Vacuum Format t:m.msee

t = type 0 = Off, 1 = IG1, 2 = IG2, 3 = CG1, 4 = CG2, 5 = CG3, 6 = CG4, 7 = On

m.m = Mantisa

s = + or -

ee = Exponent

Troubleshooting

Ion Gauge Shut Down Codes

When the KJL6600 turns off the ion gauge tube, the controller will display a CODE# on the appropriate 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 to 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 is lower than $9.9x10^{-4}$. 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 Kurt J. Lesker Co. for repair.

CODE 6

There is a problem with the RS-232.

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

Symptom	Possible Cause
Unit won't power up, no response to power switch.	No power to unit Power cord not inserted tightly Power fuse is blown
2A Power fuse blows repeatedly.	Wrong line voltage Wrong Power fuse rating Defective Power Supply
6A fuse blows repeatedly.	Ion Gauge tube filament is shorted Ion Gauge cable is shorted
Tube and ION LED won't turn on	SELECT switch is not in vacuum
AutoStart won't work	Wrong tube assigned to IG1 or IG2 TC or CG tube is calibrated wrong
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)	Unplugged Ion Gauge Cable Burned out filament Blown 6A fuse Broken Ion Gauge Cable Defective Power Supply
Ion Gauge tube won't come on, or comes on briefly then shuts off with **CodE1** displayed. (The tube light's up briefly)	System pressure is too high Badly contaminated Ion Gauge tube Defective Ion Gauge Cable Defective Ion Gauge tube
Ion Gauge tube won't come on, or comes on briefly then shuts off with **CodE2** displayed.	System pressure is too low Ion Collector BNC is unplugged Ion Collector wire is off of the tube Defective Ion Gauge Cable
Ion Gauge tube won't come on, or comes on briefly then shuts off with **CodE3** displayed.	System Pressure is above 9.9×10^{-4}
Degas won't come on	Ion Gauge is not turned on
CG reading: ---- TC reading: ----	Blown TC or CG tube Bad cable or connection Tube not plugged in
TC or CG reading never reaches 1.0×10^{-3} Torr	TC or CG tube out of calibration
CodE4 is being displayed on the controller.	Send Unit back for repair
CodE6 is being displayed on the controller.	RS-232 Cable is loose or broken Wrong Communication Settings

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