KJL-6000 Series
Thermocouple Vacuum Gauge Tube
Operator's Manual

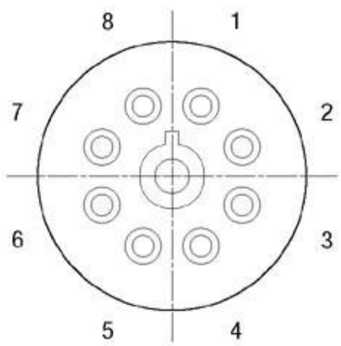
Specifications:

Pressure Range:	1×10^{-3} to 1 Torr 1 to 1000 milliTorr (mTorr) 1 to 1000 Microns 1.33×10^{-3} to 1.33 mbar 0.133 to 133 Pascal
Accuracy:	Controller dependent, but generally: ± 1 mTorr from 1 to 20 mTorr Better than 5% from 20 to 1000 mTorr Note: Readings are meaningless above 1000 mTorr
Response Time:	Controller dependent, but generally: < 1 second for 1 mTorr up to atmosphere
Bakeout Temperature:	100 °C (212 °F) in air or vacuum
Positive Pressure Rating:	Tested to 1200 PSIG for operation up to 300 PSIG without damage.
Mounting Orientation:	Any, but ideally the open end should point down so as to be self-draining should any vapors condense.
Standard Tube Materials:	All materials, except sensor wires, in contact with process are stainless steel (cup, stem and flange). Connector pins are nickel plated Kovar.

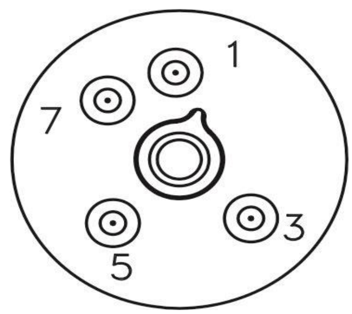
TROUBLESHOOTING PROCEDURE:

In order to verify if a KJL-6000 thermocouple tube is still functional, use the ohmmeter setting on a multimeter. The figures below aid in identifying the proper pinout.

Measure the resistance between pins 3 and 5. Generally a reading of 19 ohms +/- 2 ohms indicates that the tube is still good.



Standard KJL-6000 Tube



Stainless Steel KJL-6000 Tube

TROUBLESHOOTING NOTES:

The readings delivered by thermocouple tubes are affected by the length of the cable between the thermocouple tube and the controller. It is usually a good idea to recalibrate your controller whenever you change the thermocouple tube or the cable, particularly if you are using a shorter or longer interconnect cable.

Ideally the open end of the tube should point down so as to be self-draining should any vapors condense in it.

If the tube has 1/8" male NPT threads, wrap the threads with PTFE (Teflon®) thread sealing tape or use a potting compound to seal the tube into a 1/8 female NPT tapped fitting or port.

For the best accuracy, allow the tube to outgas in the vacuum system for approximately 24 hours, but allow at least 15 minutes for the tube to stabilize.

Read the *Thermcoule Vacuum Gauge Tube Operating Principles* for additional insight.

THERMOCOUPLE VACUUM GAUGE TUBE OPERATING PRINCIPLES:

Thermocouple vacuum gauges rely upon the ability of various gas molecules to carry away heat from a heated filament. An internal wire filament is heated by a constant electrical current passing through it. A thermocouple is attached to the center of the heated filament, generating a voltage as the filament temperature changes. The heat transfer between the filament and the gas molecules varies with the vacuum pressure. The higher the pressure, the more gas molecules that are available to carry way heat, thus cooling the filament wire. The lower the temperature, the fewer gas molecules that are available to carry away heat from the filament, thereby causing the filament to become hotter. The thermocouple voltage is directly proportional to the increased temperature of the filament and thus generates an increase in voltage. At pressures below about 1×10^{-3} Torr, the heat loss from the filament is primarily through radiation since the number of gas molecules available is so low. Since the heat loss due to radiation is constant, the resulting temperature corresponds to a "zero" reading on the display meter.

In a typical pumpdown cycle that is being monitored using a thermocouple vacuum gauge, the gauge tube filament wire will become hotter and hotter as the pressure drops and fewer and fewer molecules are available to transfer heat away from the wire. Heat is also transferred by conduction through both the thermocouple wire, the filament support posts, and the feedthrough pins. This means that the entire sensor module must be constructed of conducting metal leads that are of as small a diameter as possible in order to avoid excessive heat loss. This problem is further compounded at the gauge's lowest pressures when the wire is at it hottest. Since the heated filament wire in most thermocouple gauges needs to operate at temperatures between 200°C to 300 °C, they are usually constructed from a noble metal such as platinum in order to avoid oxidation problems.

At the lowest pressures, the hot filament wire is often exposed to vacuum pump oil vapors if oil-sealed mechanical pumps are used. The oil vapors can either crack thereby leaving carbon deposits, or they may polymerize leaving a layer of thermal insulation on the wire. Because the backstreaming rate of a vacuum pump's oil is greatest at low pressures, this can cause significant problems as it will change the gauge's calibration.

Please note that, while it is sometimes possible to clean the gauges by rinsing with solvents, success is not always assured and the solvents may not totally remove coatings. In addition, the electrode arrays can be somewhat delicate due to the filament and thermocouple wires needing to be relatively thin by design. Sloshing solvent liquids may potentially cause mechanical damage. The delicacy also means that most thermocouple tubes will not withstand severe shocks such as a free drop onto a concrete floor. The KJL-6000 series thermocouple tubes are designed to minimize the length of the filament and thermocouple wire while maximizing wire diameters, thereby providing the best resistance to mechanical shock in the industry, but there are still limits.

Thermocouple gauges are calibrated such that the filament wire's temperature is displayed as a pressure reading. This permits compensation for problems such as variations in heat flow through supporting electrodes. Unfortunately, there is no way to calibrate for the time delay that occurs when a temperature change is caused by a pressure change. Every effort is taken to minimize the heat capacity and thermal flow characteristics of the sensor module, but there still will be some time delay lag that will result in a given response time. In most situations, this is not a problem, but it should be noted that a rapid pressure change caused by a fast pumpdown or backfilling operation may have a significant response time delay.

It should be noted that thermocouple gauges deliver useful pressure readings between 10^{-3} and 10 Torr, with the best accuracy occurring below 1 Torr. Pressure readings above the upper limit are virtually useless, making it impossible, for example, to tell the difference between an overpressure condition caused by a malfunctioning pump or an accidental venting to ambient air by improper use of the foreline valves. While pumping down a system, a thermocouple gauge cannot indicate if the pumps are working until pressures are in the 1 to 10 Torr range are achieved and valid readings start to be displayed.

WARNING ***Thermocouple gauges should definitely not be used to monitor the backfilling of loadlocks as it is possible to create a dangerous overpressure situation***

CAUTION Claims of thermocouple gauge readings extending to atmospheric pressures must be treated with extreme caution and skepticism

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