Ideal® Vacuum

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XACTGAUGE™ THERMOCOUPLE METER

USER'S MANUAL

For XG-120 Gauge Controllers

XG-120-07112022 - V 1.31

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If you have any questions concerning the installation or operation of this equipment, or if you need warranty or repair service, please contact us. Customer Service and Technical Support is available weekdays, from 8am-5pm, Mountain Time.

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- Ideal Vacuum XactGauge XG-120 with gauge tubes

SAFETY

IMPORTANT SAFETY INFORMATION

Thank you for purchasing this equipment from Ideal Vacuum Products. We want you to operate it safely.

- **Read this manual before installing or operating this equipment. Failure to follow the warnings and instructions may result in serious injury or equipment damage.**
- **Keep this manual in a safe location for future reference.**
- **This equipment should only be installed and operated by trained, qualified personnel, wearing appropriate protective equipment.**
- **Follow all codes that regulate the installation and operation of this equipment.**

WARNING SYMBOLS AND DEFINITIONS

This is the universal safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER	**Indicates an imminently hazardous situation that, if not avoided, will result in death or severe injury.**
WARNING	**Indicates an imminently hazardous situation that, if not avoided, could result in death or severe injury.**
CAUTION	**Indicates a potentially hazardous situation that, if not avoided, could result in moderate or minor injury. It may also be used to alert against unsafe practices.**
NOTICE	**Indicates an potentially hazardous situation that, if not avoided, could result in equipment or property damage.**
NOTE	**Indicates helpful tips and recommendations, as well as information for efficient, trouble-free operation.**

Internationally recognized safety symbols may be used with safety warnings to specify the type of hazard or a safety protocol to follow. For example:

Indicates an electric shock hazard

Indicates safety glasses are required

1. GENERAL INFORMATION

1.1 INTRODUCTION

The Ideal Vacuum XactGauge XG-120 Thermocouple (TC) Gauge Controller is a compact, all-in-one solution that provides low-noise, stable and repeatable roughing and foreline vacuum pressure measurements from 1 x 10^{-3} Torr to 1.999 Torr (1 to 1,999 mTorr).

The XG-120 controller is housed in a 1/8 DIN enclosure, which can be either panel mounted or located on a bench top. It has tactile front control buttons and a large, 6 digit red LED display for easy reading from across a room or in dimly lit locations. The gauge displays in mTorr, µbar and Pa and includes LED indicators for the two set points.

The gauge is equipped with two (Type C) set point relays that can be used to activate valves or to control other external devices. The XG-120 also has RS232 serial and 5V analog linear outputs for quick integration into a wide variety of systems.

The XG-120 uses inexpensive TC sensors, which are used as 'rough' indicators to monitor mechanical pump vacuum levels and to signal when crossover (to high-vacuum) pressure has been reached. The controller does not require recalibration when thermocouple gauge tubes are replaced.

The XG-120 controller is available separately for use with existing thermocouple gauge tubes (Figure 1) and includes a power supply, a 10 ft. gauge tube sensor cable (RJ12 to female octal connector) and panel mounting hardware.

Figure 1 - XG-120 controller package includes power supply and sensor cable)

Complete systems (Figure 2) also include a thermocouple gauge tube with choice of vacuum port (KF-16, KF-25, 1/8" NPT, or 4 VCR®).

Instructions for RS232 remote monitoring are located in Chapter 4.

Figure 2 - XG-120 system (also includes thermocouple gauge tube)

1.2 GAUGE CONTROLLER SPECIFICATIONS

PARAMETER	VALUE/MEASURE
Display units	mTorr, µbar and Pa
Accuracy	1 to 9 mTorr, +/- 1 mTorr 10 to 1999 mTorr, +/- 15% of reading
Input Voltage/Power supply	0.5A @ 5VDC
Maximum relay voltage and current	250VAC @ 7A
Recommended wire gauge (for analog and set point wiring)	14-28 AWG
Maintenance interval	1-10 years depending on use
Overall dimensions	3.75 in. wide, 1.90 in. high, 5.65 in. deep
Panel cutout dimensions	3.64 in. wide, 1.78 in. high
Ambient operating range	0° C to 70° C
Measurement media	Clean, dry air or nitrogen

Table 1 - XG-120 controller specifications

1.3 CONFIGURATIONS

Complete XG-120 systems include a Teledyne-Hastings DV-6 gauge tube, which has a rugged, but sensitive, noble metal thermocouple and corrosion resistant, stainless steel and nickel plated components. These TC gauge tubes operate in the 1-to-1000 milliTorr range and are temperature and temperature change-rate compensated, making them well suited for ambient installations. The gauge tube houses the thermocouple sensing, heating and compensating elements, terminating in an octal (male) connector. Regulating circuitry in the controller provides proper current for sensor excitation. Standard DV-6 gauge tubes are rated for a maximum temperature of 100° C. Ruggedized gauge tubes are rated for 150° C.

Table 2 shows the available XG120 configurations and the Ideal Vacuum part numbers for ordering. Table 3 shows the available replacement gauge tubes.

SYSTEM	GAUGE TUBE FITTING	PART NUMBER
XG-120	Controller Only	P108447
	1/8” NPT	P108369
	1/8” NPT R (ruggedized)	P108443
	KF-16	P108444
	KF-25	P108445
	4-VCR®	P108446

Table 2 - XG-120 system configurations

Gauge Tube Fitting	Teledyne-Hastings Model	Part Number
1/8” NPT	DV-6M	P102046
1/8” NPT R (ruggedized)	DV-6R	P102045
KF-16	DV-6M, KF-16	P102616
KF-25	DV-6M, KF-25	P102617
4-VCR®	DV-6M-VCR	P102618

Table 3 - XG-120 gauge tube replacement spares

1.4 PRINCIPLE OF OPERATION

The Ideal Vacuum XG-120 operates by measuring the temperature of a filament inside a thermocouple (TC) gauge. As vacuum increases (absolute pressure decreases), fewer molecules of gas are available to cool the filament and temperature inside the gauge rises. The filament (hot wire) temperature is converted into a voltage, which is then translated into the current vacuum reading and displayed by the XG-120. TC's measure the thermal energy-transfer "heat transport" property of the vacuum gas to indirectly calculate the vacuum pressure and they will provide different pressure readings for different gases at the same pressure. TC's must be calibrated for the gas-type used in the vacuum application. Most TC gauges are shipped from the factory set up to display the vacuum pressure reading as if the gas-type is air.

In a TC gauge, a wire is heated by a constant current power supply (Figure 3). A thermocouple is attached to the hot wire and is used to measure its temperature. As gas molecules collide with the hot wire, they carry away heat and transfer it to the walls of the thermocouple tube sensor (the thermal sink). The distance between the hot wire and sensor body is small to allow for effective thermal conductivity. The heated sensor wire is cooled as pressure increases. While in free molecular flow, thermal conductivity by molecular collisions increases linearly with pressure. However, heat removal from the hot wire to the sensor body becomes non-linear as pressure is further increased into the viscous flow regime, where gas-gas collisions can reorient molecules back toward the filament.

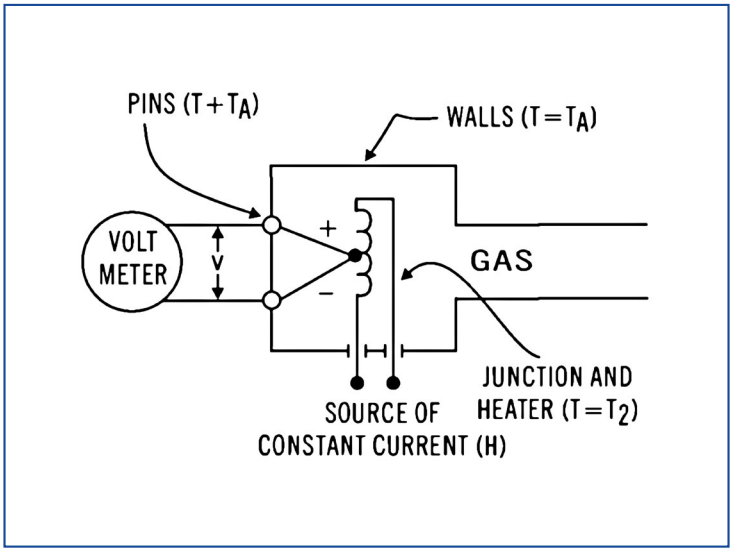

Figure 3 - Inside a thermocouple gauge

The graph of heat removal versus pressure (Figure 4) would converge to a constant value if not for the convection current which helps transfer heat to the sensor body walls. In viscous gas flow, molecules closest to the hot wire heat up and undergo thermal expansion, where buoyancy forces cause the hot gas to rise producing the convection current. For this reason, thermocouple sensors typically measure pressure in the 0.001 to 1 Torr range. It is possible to extend the range of a thermocouple sensor towards atmospheric pressure if it accounts for the heat transfer from convection currents.

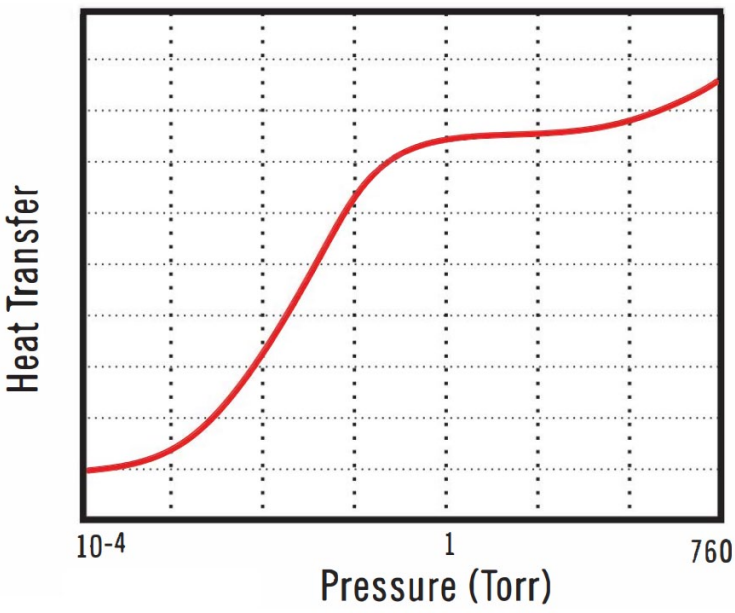

Figure 4 - Graph of heat removal vs. pressure

2. INSTALLATION

DANGER

Thermocouple wire filaments can exceed 400 degrees Celsius.

Use with clean, dry air or inert gasses only. Do not use with any process that uses explosive, pyrophoric, corrosive, or toxic gases.

CAUTION

Always wear protective equipment, including safety glasses and gloves. Exercise care when working with any vacuum component.

NOTICE

XG-120 systems are calibrated for nitrogen, which has thermal properties virtually identical to air. Other gasses will affect the readings by an amount proportional to the thermal conductivity of the gases and the XG-120 system must be calibrated appropriately.

2.1 MOUNTING THE GAUGE TUBE

The TC gauge tube must be installed vertically, port down, in a clean, dry vacuum system. Since it works on the principle of temperature rise, the TC sensor will not work if it becomes filled with liquid, such as vacuum or diffusion pump oil. A good practice is to mount the gauge tube in the most vertically distant place from oil and other contaminants and in the most stable pressure region of the vessel to be measured. For example, it is better to install the gauge tube on a tank rather than on the line that is directly connected to a vacuum pump. In the event of contamination, see Chapter 6 for gauge tube cleaning instructions.

To avoid twisting the cable and putting stress on the sensor's octal connector, do not connect the gauge cable until after the sensor is physically mounted to the vacuum manifold.

After the TC is mounted and the controller located in a panel or on a work surface, connect the sensor and any relay or analog cables.

2.2 USE WITH OTHER GASES

The XG-120 is factory calibrated in nitrogen, which has thermal properties virtually identical to air. Other gases will affect the pressure readings by an amount proportional to the thermal conductivity of the gases. In most cases, the gases present in a vacuum system will be air or nitrogen, and no appreciable errors will occur. However, other gases, such as water vapor, fluorocarbon refrigerants and acetone, have thermal conductivity significantly greater than air and will cause the gauge to read higher than the actual pressure. Conversely, gases that have thermal conductivity significantly lower than air, such as helium and to a lesser extent CO_2, will cause the gauge to read lower than the actual pressure.

2.3 ELECTRICAL CONNECTIONS

All electrical connections are located on the back of the XG-120 (Figure 5):

- Input power barrel jack (5VDC, center +)
- RJ12 sensor jack (6 position telephone type)
- RS232 serial port (DB9, female)
- Analog output (2 position euroblock connector)
- Set point relays SP1 and SP2 (3 position euroblock connectors)

See Chapter 4 for detailed information about RS232 connectivity.

The 5V Analog output should be connected to a high (1KΩ) impedance input. This is a linear output and reads from 0 to 5 Volts from a pressure of 1 micron (1 milliTorr) to 5 Torr. There is a graduation of 1 milliVolt per milliTorr. Therefore, 10 milliVolts = 10 milliTorr, and 4 Volts = 4 Torr.

The relay (set point) connections are marked SP1 and SP2. Both connectors have 3 contacts and are wired similarly (Figure 5):

- C = Common
- NC = Normally Closed
- NO = Normally Open

Figure 5 - XG-120 rear panel connections

The common and either the NC or NO wire is used for each relay.

Normally Closed Connection:

- **When pressure is ABOVE the stored set point value, the relay will be energized** and electricity will flow. When pressure is below the set point value, the relay will be de-energized and electricity will not flow.
- At lower pressure (higher vacuum) the relay is OFF. At higher pressure (lower vacuum) the relay is ON.

Normally Open Connection:

- **When pressure is BELOW the stored set point value, the relay will be energized** and electricity will flow. When pressure exceeds (is above) the set point value, the relay will be de-energized and electricity will not flow.
- At lower pressure (higher vacuum) the relay is ON. At higher pressure (lower vacuum) the relay is OFF.

Make sure that all wire connections are made fast, and the controlled device's voltage and current draw does not exceed 250V or 7A. To control a device that draws more power than the controller's internal relays can supply, use a second (larger) relay in between the gauge output and the device.

3. OPERATION

After the controller location is chosen, the TC is mounted on the vacuum system and all wire connections have been made, the XG-120 is ready for immediate operation. The gauge is on as soon as power is supplied. It does not have a power switch.

The gauge will normally provide accurate readings immediately. However, occasionally a sensor will have absorbed material during storage, and may require as much as 24 hours of operation before accurate readings are attained. We recommend that the XG-120 be energized continuously during vacuum system operation so that the hot filament does not allow contaminants to condense.

In cases where the system has contaminants (e.g., with metalizing and coating equipment), it is often effective to isolate the gauge tube with a solenoid or manual valve during periods when contamination is most active.

3.1 CHANGING THE DISPLAY UNITS

One of the red LEDs to the right of the display will always be lit, indicating which pressure unit is being displayed (Figure 6). The XG-120 can be set to the desired pressure units at any time:

1. Press the "**SEL**" key three times. The currently selected pressure units will blink.
2. Press "▲" or "▼" to change the units.
3. Press "**ENT**" to accept and save the selection.

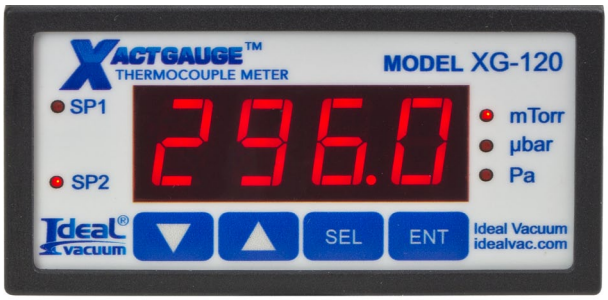

Figure 6 - Front panel controls

3.2 ENTERING SET POINTS

The Ideal Vacuum XG-120 has 2 set points that can be used to actuate valves or other external equipment. Set points are adjusted from the front of the controller in your currently selected units.

To change SP1:

1. Press the "**SEL**" key once. The SP1 LED will blink.
2. Press the ""▲" or "▼" arrows to get to the desired set point value. Set point units are displayed in the currently selected pressure units (mTorr, µbar or Pa).
3. Press "**ENT**" to accept and save your selection. Normal run mode will resume.

To change SP2:

1. Press the "**SEL**" key twice. The SP2 LED will blink. Follow steps 1-3 above.

NOTE

Set point values are retained even after the XG-120 is turned off.

If you don't want the set points to actuate or the LEDs to illuminate at all, program the set points for "000.0"

4. REMOTE MONITORING USING RS232

For remote vacuum pressure monitoring by a PLC or computer, XG-120 controllers have an RS232 serial interface located on the back of the gauge (Figure 5).

4.1 STANDARD SERIAL COMMUNICATION

The XG-120 serial interface is transmit only and provides a standard RS232 serial stream. Pressure readings are output in the currently selected pressure units (mTorr, µbar or Pa) at a sample rate of approximately 1 reading per second. Whatever reading is on the controller display is replicated in the serial bitstream.

Serial Configuration	
Baud Rate	9600
Data Bits	8
Stop Bits	1
Parity	None
Flow Control	None

Table 4- XG-120 serial configuration specifications

The XG-120 controller acts as a DCE and a straight serial cable (male-to-female, DB9, not included) is used to connect the gauge to a PLC or computer equipped with a serial interface.

4.2 SERIAL TO USB COMMUNICATION

If the computer does not have a built in serial interface, pressure data can be received through a USB connection. A serial to USB cable (supplied in our RS232 Serial to USB Cable Connectivity Kit, P1010935), is required to connect the controller to the computer.

Free online terminal emulation software, such as PuTTY, will allow you to remotely monitor pressure measurements.

1. Download PuTTY (search the internet for **putty.exe**).
2. Make sure the XG-120 is unplugged.
3. Connect the gauge tube to the controller with the sensor cable (RJ12 to octal connector).
4. Screw the USB to DB9 cable into the controller.
5. Plug the USB cable end into the computer.
6. Plug in (power up) the XG-120(E) controller.

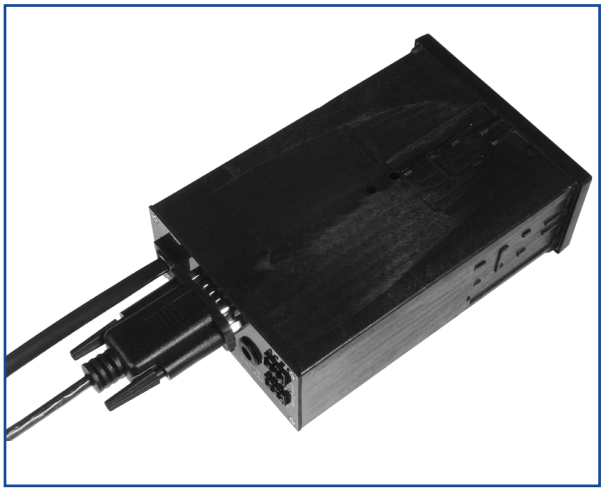

Figure 7 - Connect the USB to DB9 cable

Windows 8 (and newer) users:

1. Once the controller and computer are connected, open the Device Manager. Right click the Windows Start button at the bottom left of the screen. Select Device Manager (Figure 8).

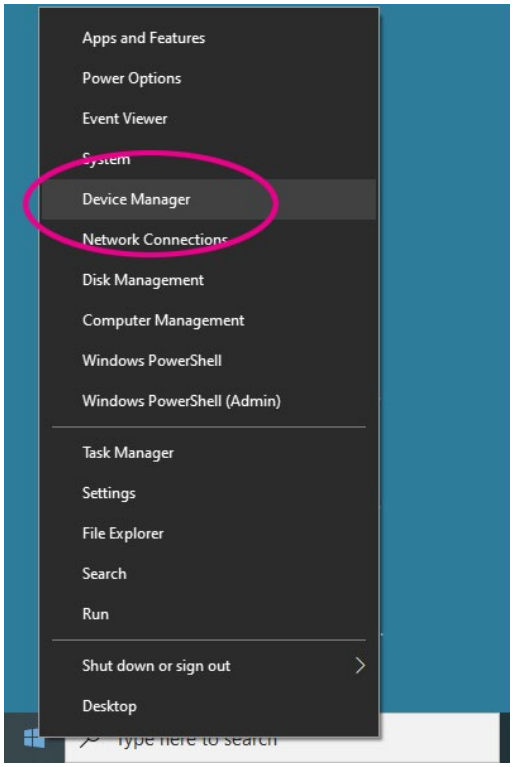

Figure 8 - Go to the Device manager

2. Double-click Ports (COM & LPT) to determine the port your gauge is connected through. In the example below (Figure 9), the COM3 USB Serial Port is used.

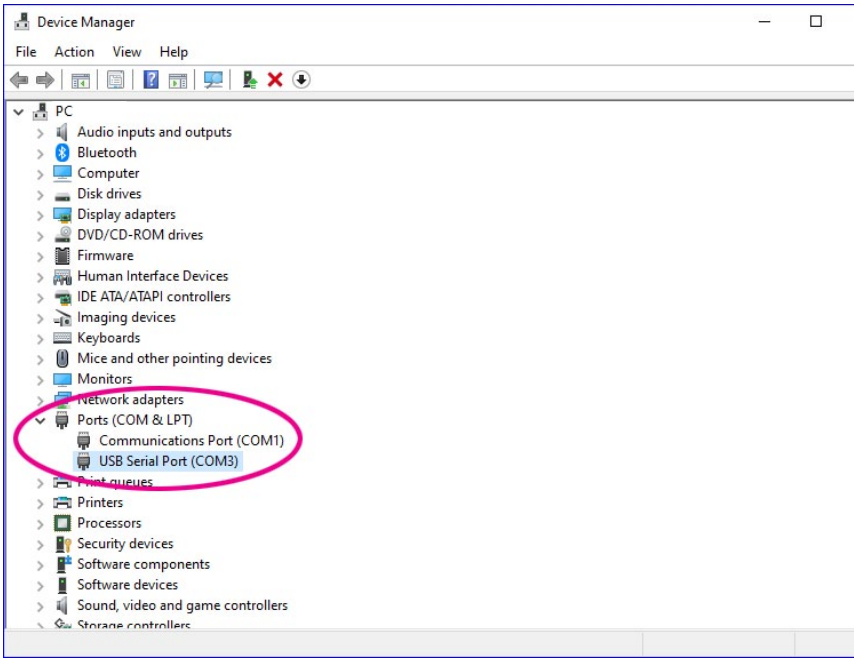

Figure 9 - Determine the USB Serial port

3. Close the Device Manager.

4. Run (double-click) **putty.exe.**

5. In the PuTTY Configuration window, select Serial as the Connection type. Enter the correct COM port (from step 2 above) in the Serial line field (Figure 10). Click Open.

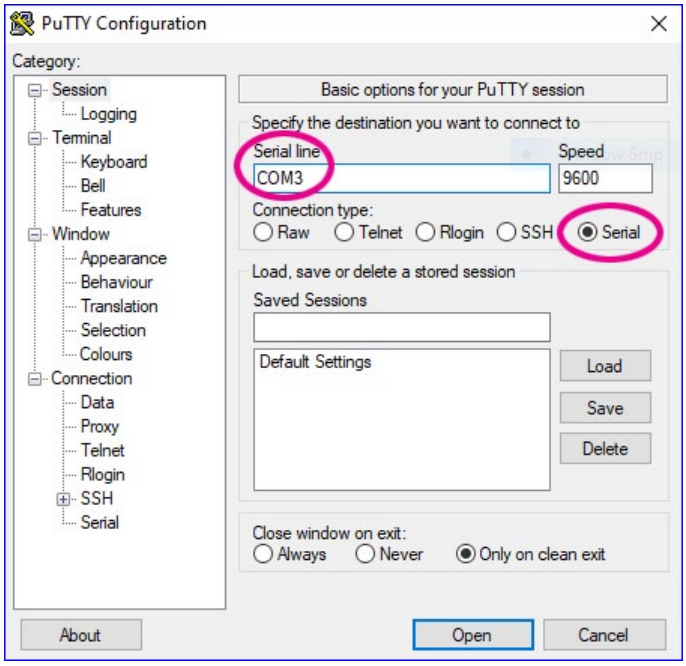

Figure 10 - PuTTY configuration window

6. The black PuTTY terminal window will appear and pressure data will begin streaming at about 1 reading per second. Pressure data is presented as raw values without units. In the example (Figure 11), the pressure units were changed, from mTorr to Pa, midway through the run.

Figure 11 - Streaming pressure data in PuTTY

5. SERVICE AND MAINTENANCE

The XG-120 gauge controller should give you many years of trouble-free service. There are no regularly scheduled maintenance or calibration intervals. The gauge tube, however, may require occasional maintenance or replacement.

A gauge tube can become fouled with oil or other foreign matter during use, which can cause it to give incorrect readings or become completely inoperable. It is often possible to restore the functionality of a contaminated sensor with cleaning. If the contaminant is known, the tube should be filled with a solvent known to break up or dissolve that contaminant. Acetone, methanol or isopropyl alcohol (IPA) are often effective in removing pump oil residue. Commercial carburetor cleaners are very powerful solvents and are highly effective against some contaminants as well. After cleaning, to prevent system contamination, the gauge tube should be completely flushed with a volatile solvent, such as acetone, then completely dried prior to re-installation.

We recommend that a spare sensor be kept on hand and stored in a clean, dry place. In cases of suspect readings, the gauge tube should be cleaned or changed before sending the gauge back to Ideal Vacuum for recalibration.

If consistent accuracy is required, it is recommended that the gauge, tube, cable and power supply be returned to Ideal Vacuum for a yearly calibration check.

5.1 FACTORY ASSISTANCE

Please contact the Ideal Vacuum Customer Support Team to assist you with any issue regarding the XG-120 thermocouple gauge controller or thermocouple gauge tubes. We are here to help.

Customer Service and Technical Support is available weekdays, from 8am-5pm, MST.

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