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Series 340

Granville-Phillips® Series 340 Vacuum Gauge Controller



Instruction Manual

Instruction manual part number 340005
Revision E - November 2016


340 VACUUM GAUGE CONTROLLER
GRANVILLE-PHILLIPS
IG
1.6 -10
A
4.7 -2
B
8.0 -4
TORR
DEGAS
ON
OFF
GAUGE
ON
OFF

Series 340

Granville-Phillips® Series 340 Vacuum Measurement Controller

This Instruction Manual is for use with all Granville-Phillips Series 340 Vacuum Measurement Controllers. A list of applicable catalog numbers is provided on the following page.



Customer Service / Technical Support:

MKS Pressure and Vacuum Measurement Solutions
MKS Instruments, Inc., Granville-Phillips® Division
6450 Dry Creek Parkway
Longmont, Colorado 80503 USA
Tel: 303-652-4400
Fax: 303-652-2844
Email: mks@mksinst.com

MKS Corporate Headquarters
MKS Instruments, Inc.
2 Tech Drive, Suite 201
Andover, MA 01810 USA
Tel: 978-645-5500
Fax: 978-557-5100
Email: mks@mksinst.com

Instruction Manual

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Granville-Phillips® Series 340 Vacuum Gauge Controller

Catalog numbers for Series 340 Controllers

Controller for one Ionization gauge and two Convectron Gauges, with one-line display, resistive degas, and remote input/output interface

Half-rack mount: 340501 - # #

Left mount for 19-inch rack: 340502 - # #

Center mount for 19-inch rack: 340503 - # #

Bench-top mount: 340504 - # #

Display options (Measurement units):

Torr	T
mbar	M
Pascal	P

Powercord options:

North America 115 Vac and Japan 100 Vac	1
North America 240 Vac	2
Universal Europe 220 Vac	3
United Kingdom 240 Vac	4

This Instruction Manual is also for use with the following catalog numbers:

340001, 340003, 340004, 340018, 340019, 341579
20340042, 20340045, 20340046, 20340-341-T1, 20340-341-T2, 20340-341-T3

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Chapter 1
Safety Instructions

1.1 Safety Introduction

BEGIN BY READING THESE IMPORTANT THESE SAFETY INSTRUCTIONS AND NOTES and repeated with additional information at appropriate points in this instruction manual.



These safety alert symbols in this manual or on the Product rear panel, mean caution – personal safety, property damage or danger from electric shock. Read these instructions carefully.

Throughout this instruction manual the word "product" refers to the Series 340 Vacuum Gauge Controller and all of its approved parts and accessories.

NOTE: These instructions do not and cannot provide for every contingency that may arise in connection with the installation, operation, or maintenance of this product. If you require further assistance, contact MKS, Granville–Phillips Division at the address on the title page of this manual.

This product is designed and tested to offer reasonably safe service provided it is installed, operated, and serviced in strict accordance with these safety instructions.



Failure to comply with these instructions may result in serious personal injury, including death, or property damage.

These safety precautions must be observed during all phases of operation, installation, and service of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. MKS Instruments, Inc. disclaims all liability for the customer's failure to comply with these requirements.



The service and repair information in this manual is for the use of Qualified Service Personnel. To avoid shock, do not perform any procedures in this manual or perform any servicing on this product unless you are qualified to do so.

- *Read Instructions* – Read all safety and operating instructions before operating the product.
- *Retain Instructions* – Retain the Safety and Operating Instructions for future reference.
- *Heed Warnings* – Adhere to all warnings on the product and in the operating instructions.
- *Follow Instructions* – Follow all operating and maintenance instructions.
- *Accessories – Do not* use accessories not recommended in this manual as they may be hazardous.



To reduce the risk of fire or electric shock, do not expose this product to rain or moisture.



Objects and Liquid Entry – Never push objects of any kind into this product through openings as they may touch dangerous voltage points or short out parts that could result in a fire or electric shock. Be careful not to spill liquid of any kind onto the products.



Do not substitute parts or modify the instrument.

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the product. Return the product to a service facility designated by Ganville–Phillips for service and repair to ensure that safety features are maintained. Do not use this product if it has unauthorized modifications.



Replacement Parts – When replacement parts are required, be certain to use the replacement parts that are specified by Ganville–Phillips or that have the same characteristics as the original parts. Unauthorized substitutions may result in fire, electric shock or other hazards.



Safety Check – Upon completion of any service or repairs to this product, ask the Qualified Service Person to perform safety checks to determine that the product is in safe operating order.



Finite Lifetime – After ten years of normal use or even non–use, the electrical insulation in this product may become less effective at preventing electrical shock. Under certain environmental conditions which are beyond the manufacturer's control, some insulation material may deteriorate sooner. Therefore, periodically inspect all electrical insulation for cracks, crazing, or other signs of deterioration. Do not use if the electrical insulation has become unsafe.



Be aware that when high voltage is present in any vacuum system, a life threatening electrical shock hazard may exist unless all exposed conductors are maintained at earth ground.

This hazard is not peculiar to this product.



Be aware that an electrical discharge through a gas may couple dangerous high voltage directly to an ungrounded conductor almost as effectively as would a copper wire connection. A person may be seriously injured or even killed by merely touching an exposed ungrounded conductor at high potential.

This hazard is not unique to this product.



It is the user's responsibility to ensure that the automatic signals provided by the product are always used in a safe manner. Carefully check the system programming before switching to automatic operation.

1.2 Equipment Grounding



Where an equipment malfunction could cause a hazardous situation, always provide for fail–safe operation. As an example, in an automatic backfill operation where a malfunction might cause high internal pressures, provide an appropriate pressure relief device.



Proper Grounding

All components of a vacuum system used with this or any similar high voltage product must be maintained at earth ground for safe operation. The power cord of this product shall be connected only to a properly grounded outlet. Be aware, however, that grounding this product does not guarantee that other components of the vacuum system are maintained at Earth ground.

Complying with the usual warning to connect the power cable only to a properly grounded outlet is necessary but not sufficient for safe operation of a vacuum system with this or any similar high voltage producing product.

Verify that the vacuum port to which the Ionization Gauge or Convectron Gauge is mounted is electrically grounded. It is essential for personnel safety as well as proper operation that the envelope of the gauge be connected to a facility ground. Use a ground lug on a flange bolt if necessary.

1.3 Implosion / Explosion



Install suitable devices that will limit the pressure to the level that the vacuum system can safely withstand. In addition, install suitable pressure relief valves or rupture disks that will release pressure at a level considerably below the pressure that the system can safely withstand.

Glass ionization gauges, if roughly handled, may implode under vacuum causing flying glass which may injure personnel. If pressurized above atmospheric pressure, glass tubes may explode. A substantial shield should be placed around vacuum glassware to prevent injury to personnel.

Danger of injury to personnel and damage to equipment exists on all vacuum systems that incorporate gas sources or involve processes capable of pressurizing the system above the limits it can safely withstand.

For example, danger of explosion in a vacuum system exists during backfilling from pressurized gas cylinders because many vacuum devices such as ionization gauge tubes, glass windows, glass bell jars, etc., are not designed to be pressurized.

Install suitable devices that will limit the pressure from external gas sources to the level that the vacuum system can safely withstand. In addition, install suitable pressure relief valves or rupture disks that will release pressure at a level considerably below that pressure which the system can safely withstand.

Suppliers of pressure relief valves and pressure relief disks can be located via an online search, and are listed on ThomasNet.com under “Relief Valves” and “Rupture Discs. ***Confirm that these safety devices are properly installed before installing and operating the product.***

Confirm that these safety devices are properly installed before installing the product. In addition, check that:

a. The proper gas cylinders are installed,

b. Gas cylinder valve positions are correct on manual systems, and

c. The automation is correct on automated gas delivery systems.

d. Vacuum gauges with compression fittings may be forcefully ejected if the vacuum system is pressurized.



Series 275 Convectron Gauges should not be used above 1000 Torr true pressure.

Series 275 Convectron gauges are furnished calibrated for N_2. They also measure the pressure of air correctly within the accuracy of the controller.



If accurate conversion data is not used, or is improperly used, a potential overpressure explosion hazard can be created under certain conditions.



Do not attempt to use a Series 275 gauge calibrated for N_2 to measure or control the pressure of other gases such as argon or CO_2 unless accurate conversion data for N_2 to the other gas is properly used. See Section 4.3.3 on page 35.



If used improperly, Convectron gauges can supply misleading pressure indications that can result in dangerous overpressure conditions within the system.



Do not operate in an explosive atmosphere.

Do not operate the product in the presence of flammable gases or fumes.

Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Do not use the product to measure the pressure of explosive or combustible gases or gas mixtures. The sensor wire of the Convectron Gauge normally operates at only 125 ˚C, but it is possible that Controller malfunction can raise the sensor temperature above the ignition temperature of combustible mixtures.

Danger of explosion or inadvertent venting to atmosphere exists on all vacuum systems which incorporate gas sources or involve processes capable of pressurizing the system above safe limits.

It is the installer's responsibility to ensure that the automatic signals provided by the product are always used in a safe manner. Carefully check manual operation of the system and the set point programming before switching to automatic operation.

Where an equipment malfunction could cause a hazardous situation, always provide for fail-safe operation. As an example, in an automatic backfill operation where a malfunction might cause high internal pressures, provide an appropriate pressure relief device.



The fumes from solvents such as trichloroethylene, perchloroethylene, toluene, and acetone can be dangerous to health if inhaled. Use only in well ventilated areas exhausted to the outdoors. Acetone and toluene are highly flammable and should not be used near an open flame or energized electrical equipment.

1.4 Damage Requiring Service

Disconnect the product from all power sources and refer servicing to Qualified Service Personnel under the following conditions:

a. When any cable or plug is damaged.

b. If any liquid has been spilled onto, or objects have fallen into, the product.

c. If the product has been exposed to rain or water.

d. If the product does not operate normally even if you follow the operating instructions. Adjust only those controls that are covered by the operation instructions. Improper adjustment of other controls may result in damage and will often require extensive work by a qualified technician to restore the product to its normal operation.

e. If the product has been dropped or the enclosure has been damaged.

If the product exhibits a distinct change in performance, service may be required.

1.5 Service Guidelines

Some minor problems are readily corrected on site. If the product requires service, contact the MKS/Granville-Phillips Technical Support Department at 1-303-652-4400 for troubleshooting help over the phone.

If the product must be returned to the factory for service, request a Return Material Authorization (RMA) from Granville-Phillips. Do not return products without first obtaining an RMA. In some cases a hazardous materials disclosure form may be required. The MKS/Granville-Phillips Customer Service Representative will advise you if the hazardous materials document is required.

When returning products to Granville-Phillips, be sure to package the products to prevent shipping damage. Shipping damage on returned products as a result of inadequate packaging is the Buyer's responsibility.

For Customer Service / Technical Support:

MKS Pressure and Vacuum Measurement Solutions
MKS Instruments, Inc., Granville-Phillips® Division
6450 Dry Creek Parkway
Longmont, Colorado 80503 USA
Tel: 303-652-4400
Fax: 303-652-2844
Email: mks@mksinst.com

MKS Corporate Headquarters
MKS Instruments, Inc.
2 Tech Drive, Suite 201
Andover, MA 01810 USA
Tel: 978-645-5500
Fax: 978-557-5100
Email: mks@mksinst.com

1.6 Warranty Information

MKS Instruments/Granville-Phillips provides an eighteen (18) month warranty from the date of shipment for new Granville-Phillips Products. The MKS Instruments, Inc. General Terms and Conditions of Sale provides the complete and exclusive warranty for Granville-Phillips products. This document may be located on our web site at *www.mksinst.com*, or may be obtained by contacting an MKS, Granville-Phillips Division Customer Service Representative.

1.7 FCC Verification

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with this instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio or television technician for help.

1.8 Canadian Users

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numerique de la classe B respecte toutes les exigences du Reglement sur le material broilleur du Canada.

Chapter 2
Introduction & Specifications

2.1 General Description

The Series 340 Vacuum Gauge Controller (VGC) measures pressures from less than 1 x 10^{-9} Torr (1.3 x 10^{-9} mbar or 1.3 x 10^{-7} pascal) to atmosphere by use of a single ionization gauge and two Convectron® Gauges. Pressure readout is via a front panel display and analog outputs. Resistance heating degas is standard. An interlock is provided to allow degas only when the ion gauge tube is ON and the displayed pressure is below 5 x 10^{-5} Torr. Pressure reading during degas is not possible.

The 340 VGC is a modular instrument with infrequently used controls housed behind a hinged front panel, thus reducing front panel clutter and allowing the VGC to reside in a half-rack space.

2.1.1 Available Options

2.1.1.1 Remote Input/Output

The 340 VGC can be ordered with a factory installed remote I/O option which provides an ion gauge (IG) status relay, remote gauge on/off input and remote degas on/off input functions.

2.1.1.2 Process Control Relays

The 340 VGC can be ordered with a factory installed process relay option which provides automatic ion gauge turn-ON from Convectron channel "1" and a Convectron Gauge process relay output that is user selectable to operate from channel "1" or "2".

2.1.1.3 Ion Gauge Cables

The VGC is capable of operating an ion gauge located up to 50 feet away from the controller by using standard cables. Degas power delivered to the gauge decreases with cable length. Cables are available for use with glass or nude Bayard Alpert (B-A) gauges.

2.1.2 Mounting Options

The 340 VGC can be ordered with a variety of mounting options to fit your needs. This includes half rack (standard), full rack, or bench mounting. See Figure 3-2 on page 20 for dimensional illustrations.

2.2 Receiving Inspection

Inspect all material received for shipping damage. Confirm that your shipment includes all material and options ordered. If materials are missing or damaged, the carrier that made the delivery must be notified within 15 days of delivery in accordance with Interstate Commerce regulations in order to file a valid claim with the carrier.

2.2.1 Damaged Material

Any damaged material, including all containers and packaging, should be held for carrier inspection. If your shipment is not correct for reasons other than shipping damage, contact our Customer Service Department, 6450 Dry Creek Parkway, Longmont, Colorado 80503, phone +1-303-652-4691, email gp-csr@mksinst.com.

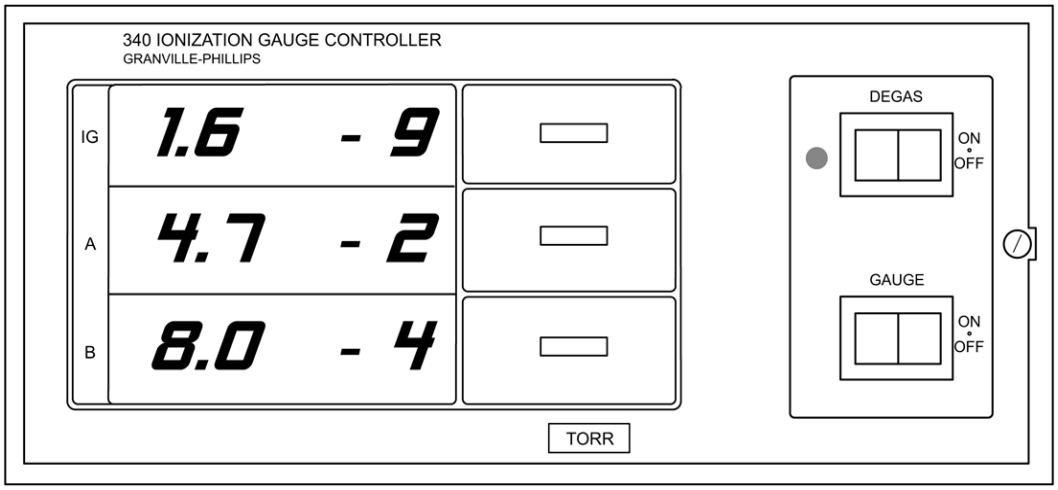


Figure 2-1 Front of Series 340 Vacuum Gauge Controller

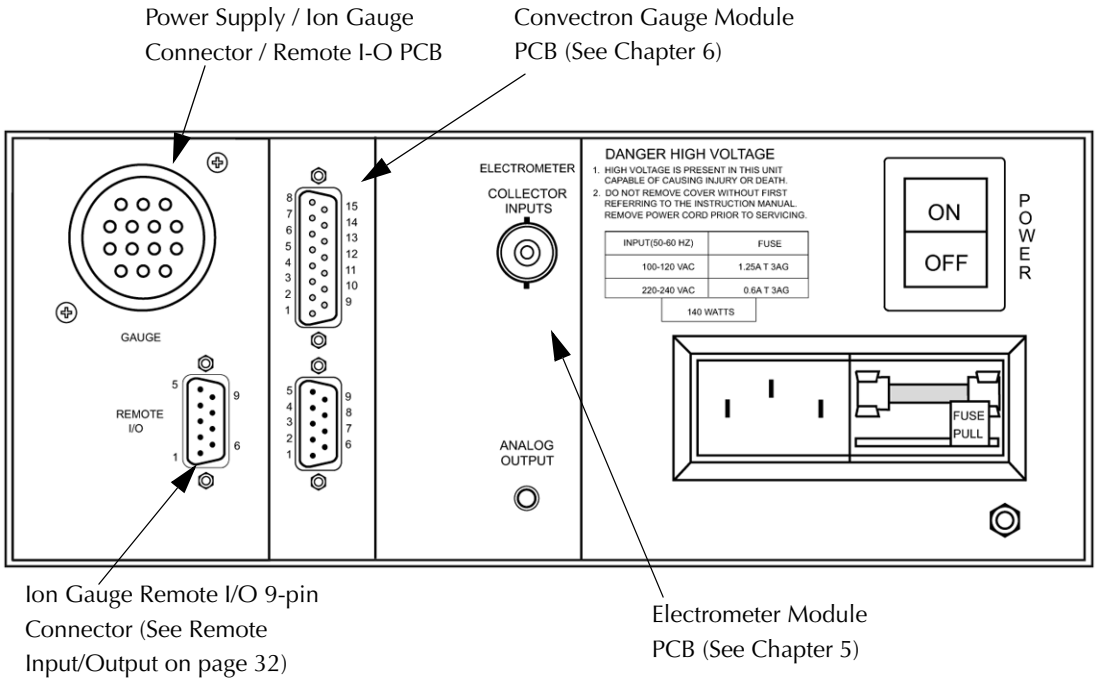


Figure 2-2 Rear of Series 340 Vacuum Gauge Controller

2.3 Specifications

2.3.1 340 VGC Specifications

Table 2-1 Series 340 VGC Physical Specifications

Parameter	Specification
Width	24.13 cm (9.5 in.) with 1/2-rack mounting brackets
Height	8.89 cm (3.5 in.)
Depth	35.56 cm (14 in.) includes 7.62 cm (3 in.) for connectors and cables
Weight	4.8 kg (10.5 lb.)
Environmental Temperature	0 °C to 40 °C

Table 2-2 Series 340 VGC Electrical Specifications

Parameter	Specification
Voltage	90-130 VAC or 200-260 VAC
Frequency	50 to 60 Hz
Power	100 watts max
Fuse Ratings	1.25 A (90-130 V) .60 A (200-260 V)

2.3.2 Electrometer/Ion Gauge Pressure Range Specifications

Table 2-3 Emission Range for Non UHV Ion Gauges

.01mA to .1mA	.1mA to 1mA	1mA to 10mA
1 x 10^{-7} to 1 x 10^{-1} Torr	1 x 10^{-8} to 1 x 10^{-2} Torr	1 x 10^{-9} to 1 x 10^{-3} Torr

An internal overpressure limiter is factory adjusted to trip at a pressure of 1 decade below the upper limits specified above. Refer to Section 5.4.3 for readjustment instructions.

Table 2-4 Pressure Display Specifications

Parameter	Specification
Electronic Accuracy	Typical ± 3% of reading at ambient temperature of 25 ± 5 °C
Display Units	Torr unless otherwise requested. Adjustment and internal selector switch provides readout in mbar or pascal.
Display Resolution	Scientific notation, 2 significant digits.
Display Update Time	0.5 sec. typical as shipped. Internal switch selectable to 3 sec. reading averaged.

Table 2-5 Electrometer/Ion Gauge Specifications

Parameter	Specification
Sensitivity	3/Torr to 50/Torr (the factory setting is 10/Torr)
Emission Current	10 µA to 10 mA in 3 decade ranges (factory setting is 1 mA)
Collector Potential	0 Vdc
Grid Potential	+180 Vdc
Filament Potential	+30 Vdc
Degas	I^2R: 8 VAC, 10 A maximum
Analog Output	0-10 Vdc; Logarithmic; 1 V/decade

2.3.3 Convectron® Specifications

Table 2-6 Convectron Gauge Specifications

Parameter	Specification
Gauge Type	Granville-Phillips Series 275
Pressure Range	1 x 10^{-4} Torr to 990 Torr, N_2 equivalent
Gas Type	N_2, Air
Maximum Gauge Temperature	+150 °C
Gauge Operating Temperature	+4 °C to +50 °C

Table 2-7 Convectron Module Specifications

Parameter	Specification
Display Resolution	2 significant digits (1 significant digit in the 10^{-4} decade)
Analog Output	Nonlinear 0 to 5.3 Vdc (+5% corresponding to 0 to 1000 Torr)
Display Update Time	0.5 sec. typical. Switchable to 3 sec./ reading average
Ion Gauge Turn ON Range	OFF, 5 mTorr to 50 mTorr
Process Relay Setting Max switched power Max switched current Max switched voltage Contact rating	Resistive load. 30 W or 60 VA 2 A 30 Vdc or 300 VAC 1 A at 30 Vdc, 0.5 A at 125 VAC
Process Relay Turn ON Range	OFF, 5 mTorr to 200 mTorr

2.3.4 Remote Input/Output

Table 2-8 Remote I/O Specifications

Parameter	Specification
Gauge and Degas On/Off Inputs	Less then 0.4 V @ 10 µA for 25 msec (min). Must go to greater than 3.5 V for 105 msec (min) before next low state.
Filament Status Relay Contact Rating	4 A, 250 VAC resistive load or 30 Vdc.

NOTES:

Chapter 3
Installation

3.1 Initial VGC Setup and Installation

3.1.1 Line Voltage Selection

Verify that the line voltage selector card displays the line voltage value of the available local AC line voltage. If the card does not display the correct line voltage value as shown in Table 3-1, perform the following procedure and refer to Figure 3-1.

Table 3-1 Selector Card Line Voltage Settings and Fuse Selection

Line Voltage Setting (VAC)	Setting	Selector Card Fuse F2 Type
90-105	100	1.25A SB
105-130	120	1.25A SB
200-230	220	.60A SB
230-260	240	.60A SB

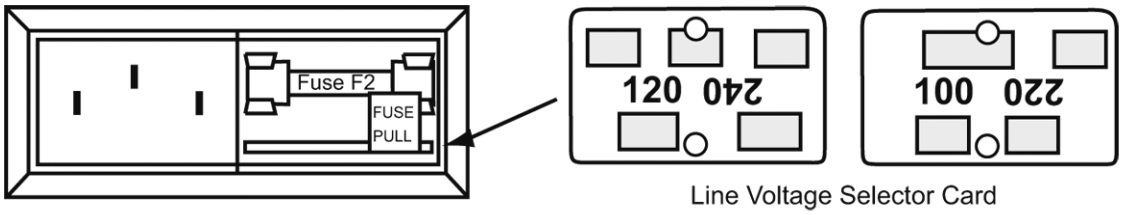


Figure 3-1 Line Voltage Selector on the rear of the 340 VGC

1. On the rear panel (lower right), slide the cover over fuse F2 to the left.
2. Remove the fuse (F2) by pulling the fuse extractor tab FUSE PULL outward and to the left. Leave the extractor tab in the full-left position.
3. Use a pointed tool or small wire hook to extract the line selector card from its holder and pull the card straight out.
4. Reinsert the card so that the correct line voltage (100, 120, 220, or 240V) as shown in Figure 3-1 is readable from the rear of the VGC.

> **Operation of the Series 340 Vacuum Gauge Controller with the line voltage selector card improperly set can cause damage to the Controller and injury to personnel.**

5. Verify that fuse F2 is the correct value as shown in Table 3-1. Position the fuse extractor tab FUSE PULL to the right-hand position and install the fuse (F2) in the fuse holder.
6. Slide the cover to the right over the fuse.

3.1.2 Mounting Configurations

Figure 3-2 illustrates the various configurations available for mounting the Series 340 Vacuum Gauge Controller.

NOTE: The 340 controller should be mounted in a location with free air flow and ambient temperature less than 40 °C.

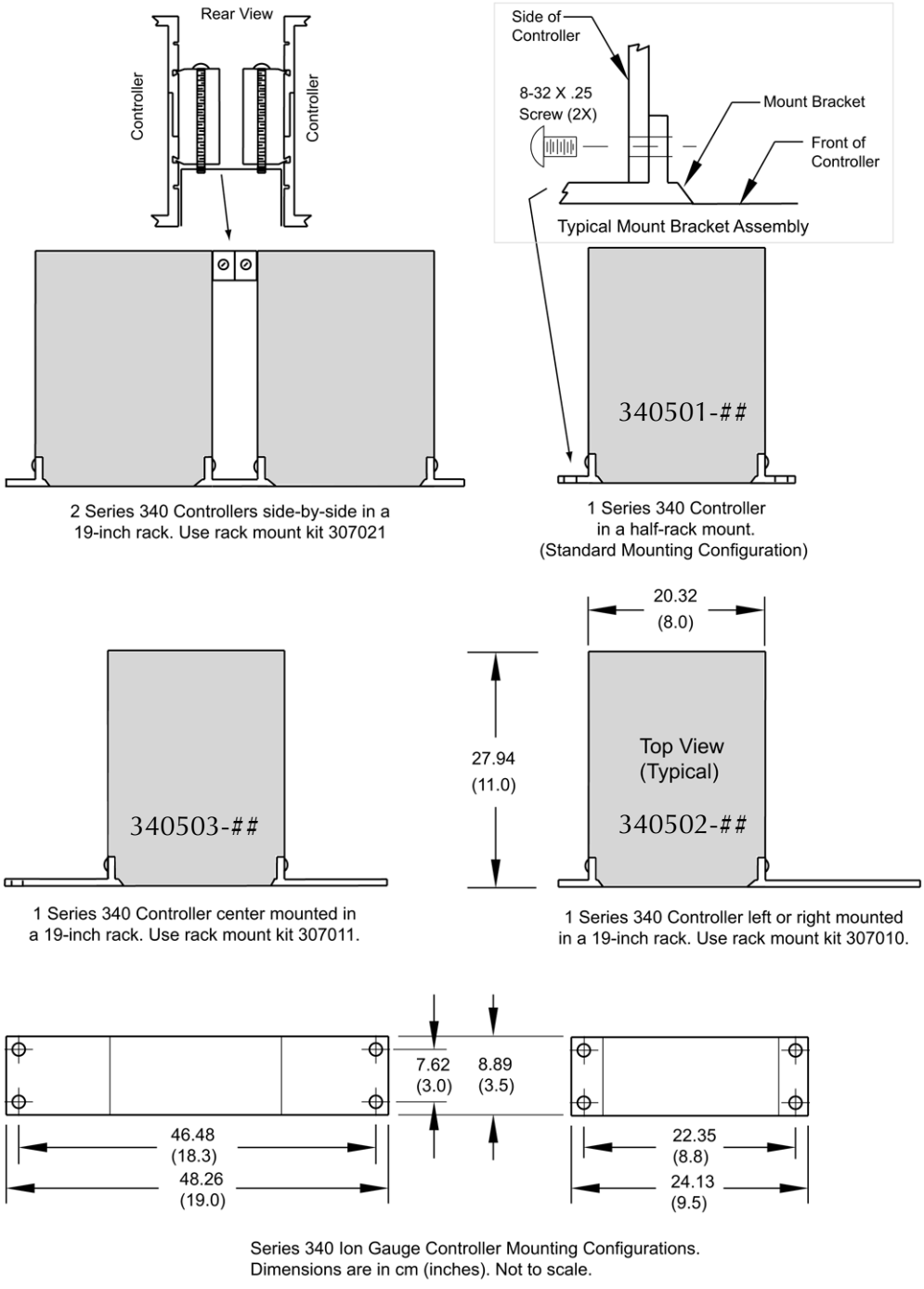


Figure 3-2 340 VGC Mounting Configurations

3.2 Ionization Gauge Types and Installation

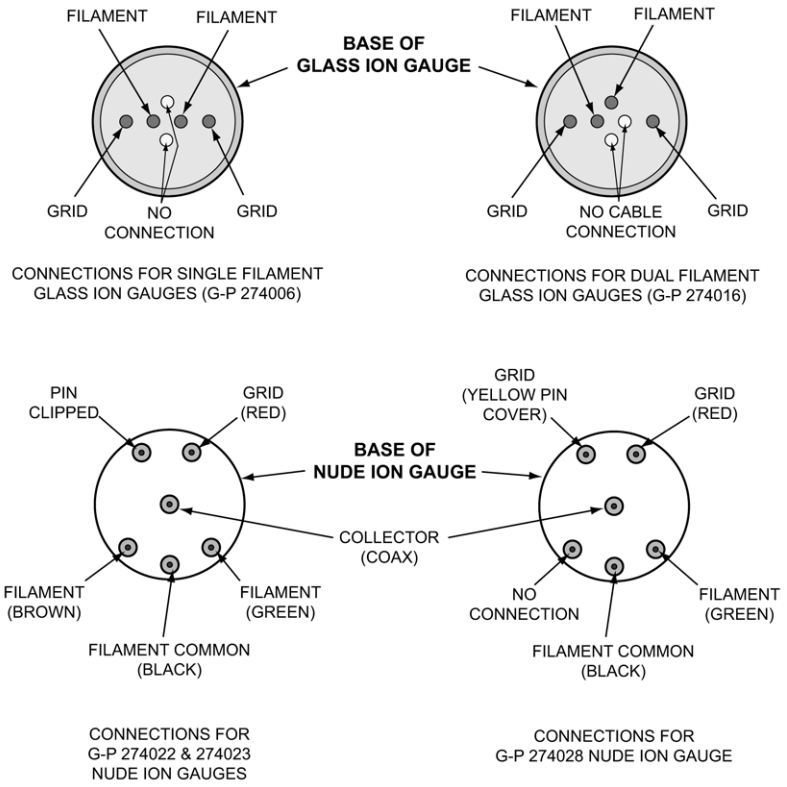
The 340 VGC operates a Bayard-Alpert type or equivalent ionization gauge. It is ideally suited for a nude ionization gauge such as the Granville-Phillips 274022 or 274023 which have an X-ray limit in the low 10^{-11} Torr range. Coated Iridium filament type gauges are recommended since at higher pressures they provide longer operating life and greater burnout resistance.

When installing an ion gauge, note that if it is placed near the pump, the pressure in the gauge may be considerably lower than in the rest of the system. If placed near a gas inlet or source of contamination, the pressure in the gauge may be higher.

If an unshielded gauge is placed near an electron beam evaporation source or used in a sputtering system, spurious electrons or ions may disturb the measurement. Screens or other shielding should be placed between the gauge and the system if spurious charged particles or severe electromagnetic interference is present. Consideration should also be given to electrostatic shielding of glass tubulated gauges when measuring pressures near their x-ray limits.

Granville-Phillips offers 3 cable types for ion gauges. One has a standard connector for the series 274 tubulated gauges; one has a standard connector for series 274 nude gauges; and one has individual pin sockets for use with nonstandard pin configurations as well as Granville-Phillips nude gauges.

Figure 3-3 shows typical gauge base configurations using the cables listed above and shown in Figure 3-4, 3-5, and 3-6.



NOTE: To use the second filament of a dual filament gauge, the cable connector at the gauge is removed and rotated 180°, then reinstalled.

Figure 3-3 Standard Gauge Base Configuration

Do not attach cables to glass gauge pins while the gauge is under vacuum. Accidental bending of the pins may cause the glass to break and implode. Cables, once installed, should be secured to the system to provide strain relief for gauge tube pins.

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

3.2.1 Ion Gauge Cables

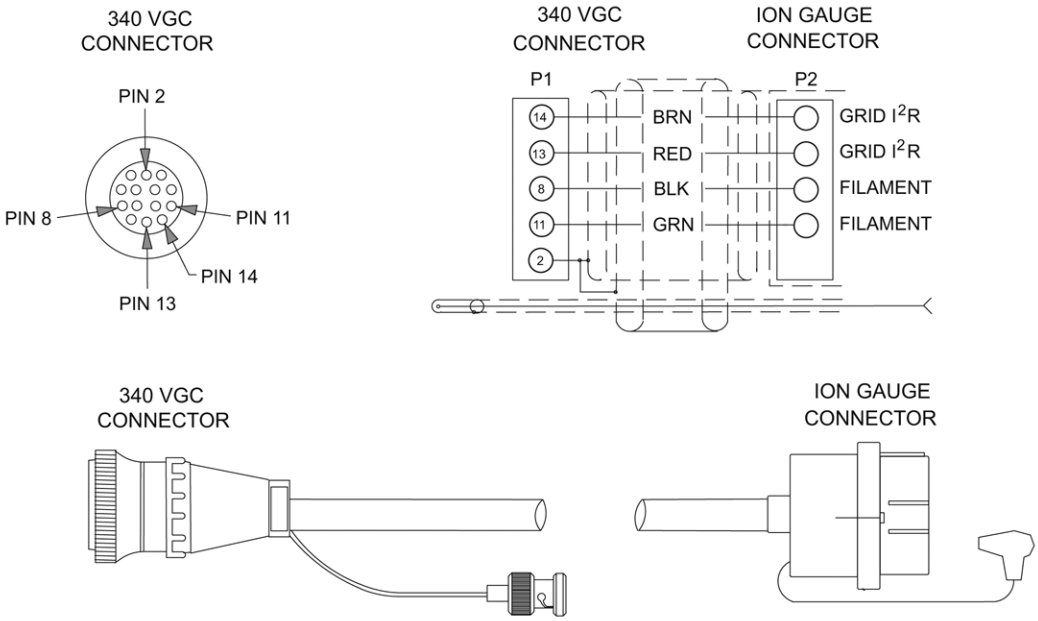


Figure 3-4 Ion Gauge Cable for Granville-Phillips Glass Gauges

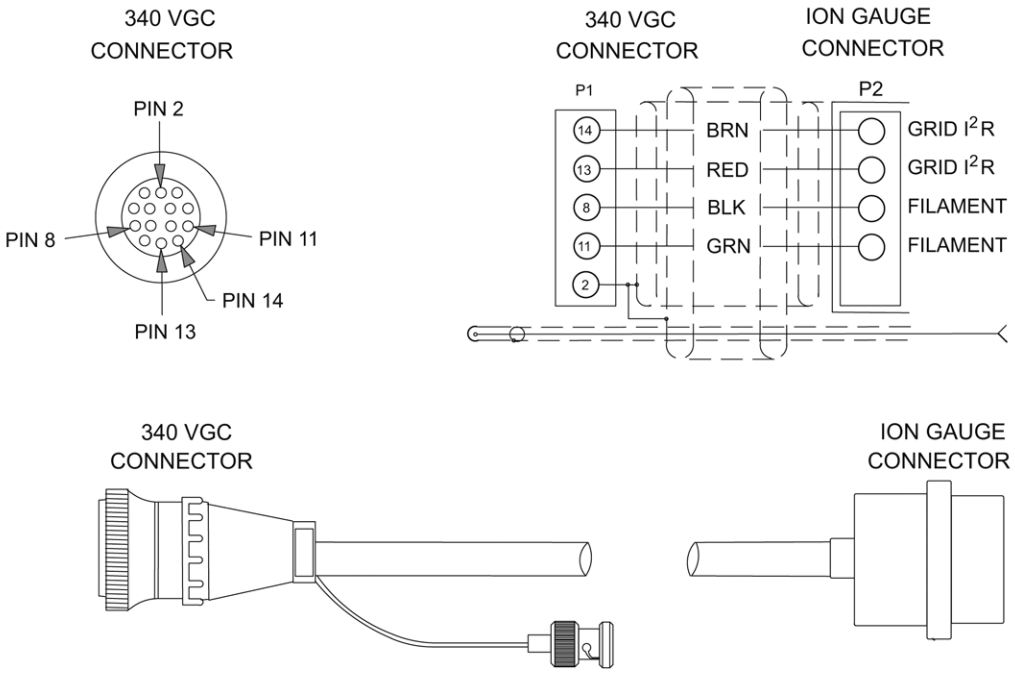


Figure 3-5 Ion Gauge Cable for Granville-Phillips Nude Gauges

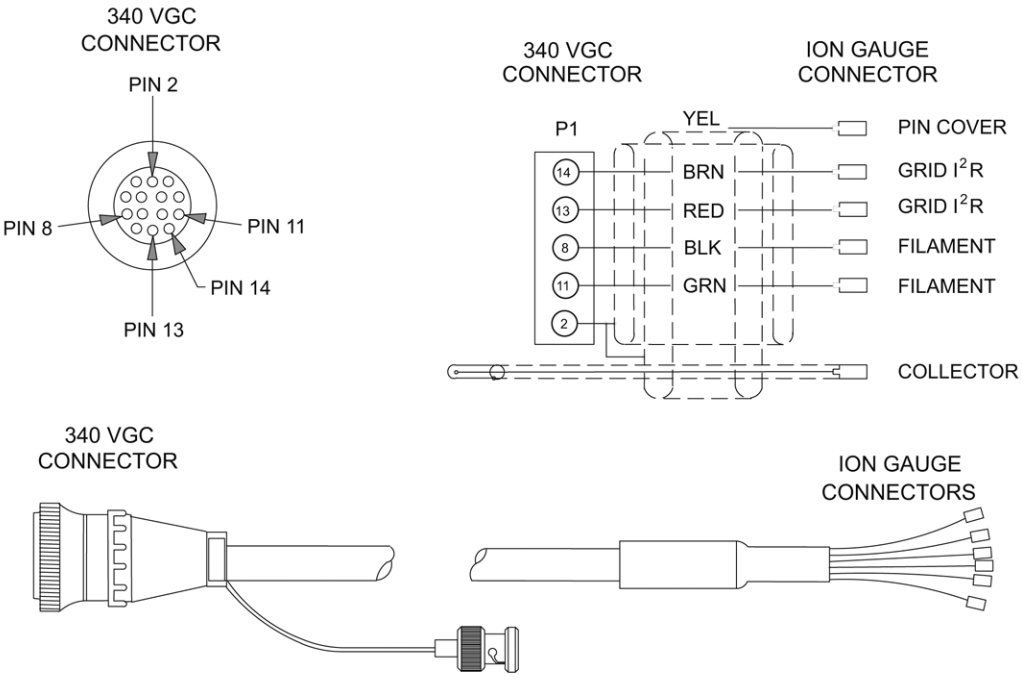


Figure 3-6 Ion Gauge Cable for Granville-Phillips Nude Gauges

3.3 Convectron Gauge Installation

3.3.1 Important Precautions for Gauge Tube Installation



Convectron gauges should not be used above 999 Torr true pressure. The Series 340 Vacuum Gauge Controller is calibrated for Air/N_2.

Do not attempt to use a Convectron gauge calibrated for N_2 to measure or control the pressure of other gases such as argon or CO_2 unless accurate conversion data for N_2 to the other gas is properly used. If accurate conversion data is not used or improperly used, a potential overpressure explosion hazard can be created under certain conditions. For example, at 760 Torr of argon gas pressure, the indicated pressure on a Convectron gauge calibrated for N_2 is 24 Torr. At an indicated pressure of 50 Torr, the true pressure of argon is considerably above atmospheric pressure. Thus if the indicated pressure is not accurately converted to true pressure, it is possible to overpressure your system.

Overpressure may cause glassware such as ionization gauges to shatter dangerously, and if high enough may cause metal parts to rupture thus damaging the system and possibly injuring personnel.

A pressure relief valve should be installed in the system if the possibility of exceeding 999 Torr exist.

For some gases, be aware the indicated pressure will be higher than the true pressure. For example, at a true pressure of 9 Torr for helium the indicated pressure on a Convectron gauge calibrated for N_2 is 760 Torr. The safe way to operate the gauge is to properly use accurate conversion data.



Do not operate a Convectron Gauge in an explosive atmosphere.

Do not use the product to measure the pressure of explosive or combustible gases or gas mixtures. The sensor wire of the Convectron Gauge normally operates at only 125 ˚C, but it is possible that Controller malfunction can raise the sensor temperature above the ignition temperature of combustible mixtures.

Do not use the product in the presence of flammable gases or fumes. Cleaning solvents, such as trichloroethylene, perchloroethylene, toluene and acetone, produce fumes that are toxic and/or flammable. Use only in areas well ventilated to the outdoors and away from electronic equipment, open flames, or other potential ignition sources. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Danger of explosion or inadvertent venting to atmosphere exists on all vacuum systems which incorporate gas sources or involve processes capable of pressurizing the system above safe limits.



Do not use a compression mount (quick connect) for attaching the gauge tube to the system in applications resulting in positive pressures in the gauge tube. Positive pressures might blow the tube out of a compression fitting and damage equipment and injure personnel. The Convectron gauge should not be used above 999 Torr (1333 mbar or 1.33 x 10^{+5} pascal).

If the gauge tube will be used to measure pressures greater than 1 Torr or 1 mbar, the tube must be mounted with its axis horizontal. Although the gauge will read correctly below 1 Torr when mounted in any position, erroneous readings will result at pressures above 1 Torr if the tube axis is not horizontal. Erroneous readings can result in over or under pressure conditions which may damage equipment and injure personnel.

If the gauge becomes disconnected from the controller or if the sensor wire in the gauge fails, the controller will indicate a voltage equal to above atmosphere.

The calibration of the gauge will be seriously affected by any gas which will attack the gold plated sensor, and could result in overpressurizing the system. Two primary gases in this category are mercury vapor and fluorine.

The following precautions in the use and installation of the Convectron gauge must be observed.

1. Observe the precautions in this chapter regarding gauge mounting position and high pressure operation.
2. The gauge should be installed with the port oriented vertically downward to ensure that no system condensates or other liquids collect in the gauge tube.
3. Keep the gauge clean. Do not remove the mounting port cover until you are ready to install the gauge tube.
4. Do not mount the gauge in a manner such that deposition of process vapors upon the internal surfaces of the gauge may occur through line-of-sight access to the interior of the gauge.
5. Do not install the gauge where high amplitudes of vibration are present. Excessive vibration will cause forced convection at high pressure giving erroneous readings.
6. Do not bake the gauge to temperatures above 150 ºC.
7. Do not install the gauge where it will be exposed to corrosive gases such as mercury vapor, chlorine, or fluorine, which will attack the gold plated sensor.
8. For greatest accuracy and repeatability the gauge should be located in a stable room temperature environment.

3.3.2 Gauge Orientation

It is important to consider the orientation of the gauge if accurate readings above 1 Torr are desired.

Below 1 Torr: The gauge will operate and accurately measure pressure below 1 Torr when mounted in any orientation.

Above 1 Torr: The gauge will accurately measure pressures above 1 Torr only when mounted with its axis horizontal, preferably with the port pointing vertically downward, as shown in Figure 3-7. It is valuable to point the port downward to facilitate the removal of condensation and other contaminants.

Furthermore, the gauge is factory calibrated with the port pointing vertically downward. Installation of the gauge with the port in other orientations may affect the accuracy of the indicated pressure.

Mounting clearance dimensions are shown in Figure 3-7.

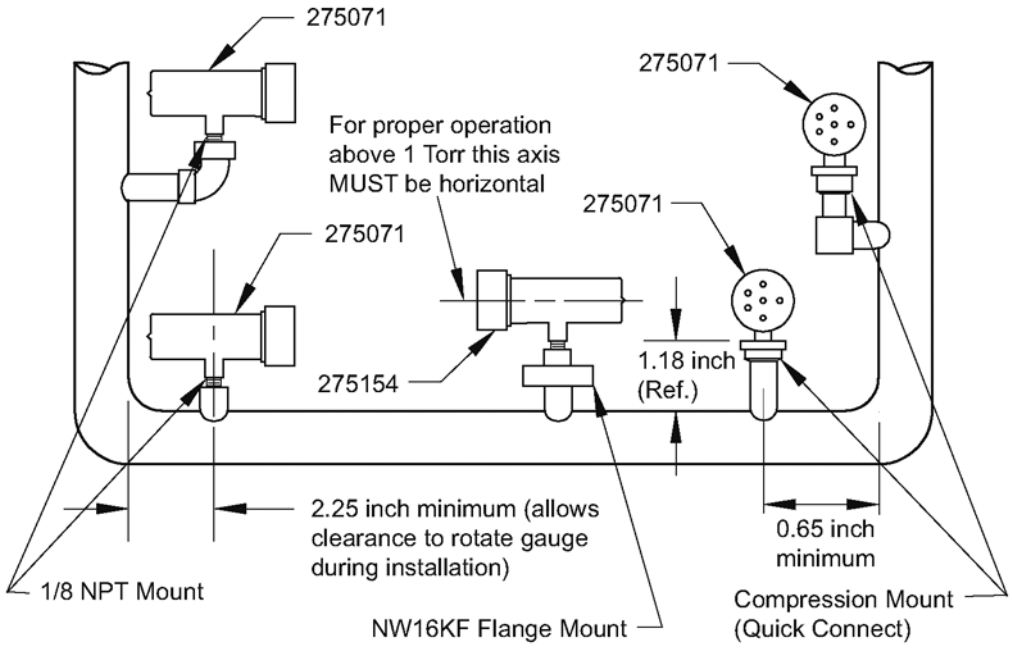


Figure 3-7 Convectron Gauge Mounting Configurations

3.3.3 Compression Mount (Quick Connect)

Do not use this type of fitting for positive pressure applications.

The gauge tube port is designed to fit a standard 1/2 in. compression (quick connect) mount such as the Cajon Co.® Ultra-Torr® fittings.

Remove the cap plug from the gauge tube port, insert the gauge tube port into the compression fitting and finger tighten the press ring. If a seal is not achieved it may be due to extreme cleanliness of the O-ring. A light film of vacuum grease such as Apiezon will insure sealing and is normally preferable to the use of pliers or pipe wrench to further tighten the press ring. You may point the electrical pins of the gauge tube anywhere you wish in a 360 degree horizontal circle for optimum routing of the gauge tube cable.

3.3.4 1/8 NPT Mount

The threads on the gauge tube port will fit a standard 1/8 NPT female fitting. Wrap the threads of the gauge tube port with Teflon® tape and screw these threads into the system fitting hand tight. Do not use any wrench or tool. The gauge tube body functions adequately as its own wrench. Tighten only sufficiently to achieve a seal. When the threads have been tightened to the point where a seal is just achieved, about one-half turn additional tightening is all that can be gained without overstressing the tube port.

3.3.5 NW16KF Flange Mount

The KF mounting system requires an O-ring and centering ring to be placed between the mating flanges. The flanges are then held together with the aluminum flange clamp by tightening the wing nut. Maximum pressure for this style mounting system is 1000 Torr absolute.

3.3.6 Other Mounting Options

The Convectron gauge is also available in several other mounting systems. These include Cajon® SS-4-VCR®-1, SS-4-VCR-3, and SS-6-VCO®-1 fittings, 2-3/4 inch rotatable and non-rotatable CuSeal flanges, 1-5/16 inch non-rotatable CuSeal flange, and welded NW16 and NW25 flanges.

3.3.7 Convectron Gauge Cables

Connect the provided cable(s) to the Controller and Convectron Gauge(s).

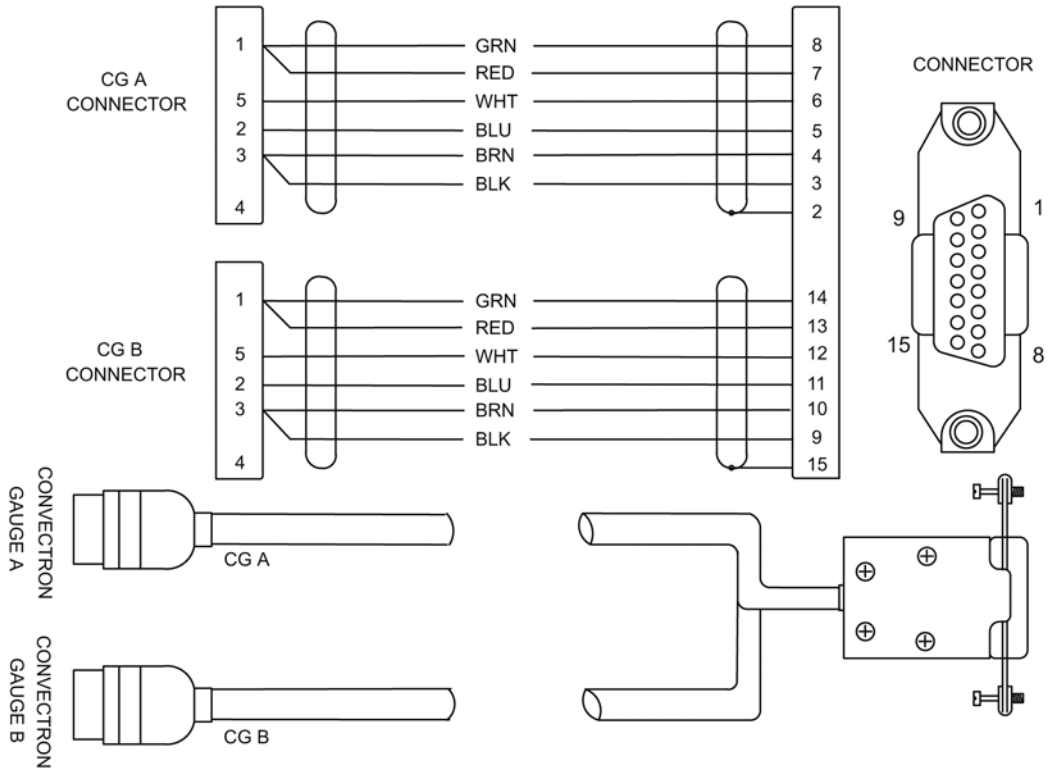


Figure 3-8 Convectron Gauge Cables

3.4 System Grounding Procedure

Improper grounding can cause product damage or personal injury.

- **Follow ground network requirements for the facility.**
- **Maintain all exposed conductors at Earth ground.**
- **Connect the power cord to a properly grounded outlet.**
- **Make sure the vacuum port to which the gauge is mounted is properly grounded.**
- **Connect the gauge envelope to a facility ground. If necessary, use a ground lug on the flange bolt or a hose clamp connected to the gauge/component.**

High voltage can couple through a gas to the internal electrodes of a gauge. Do not touch the exposed pins on any gauge installed on a vacuum system where high voltage is present.

Touching the pins on the gauge in a high−voltage environment can cause an electrical discharge through a gas or plasma, resulting in property damage or personal injury due to electrical shock.

Vent the vacuum chamber to atmospheric pressure and shut OFF power to the controller before you touch the pins on the gauge.

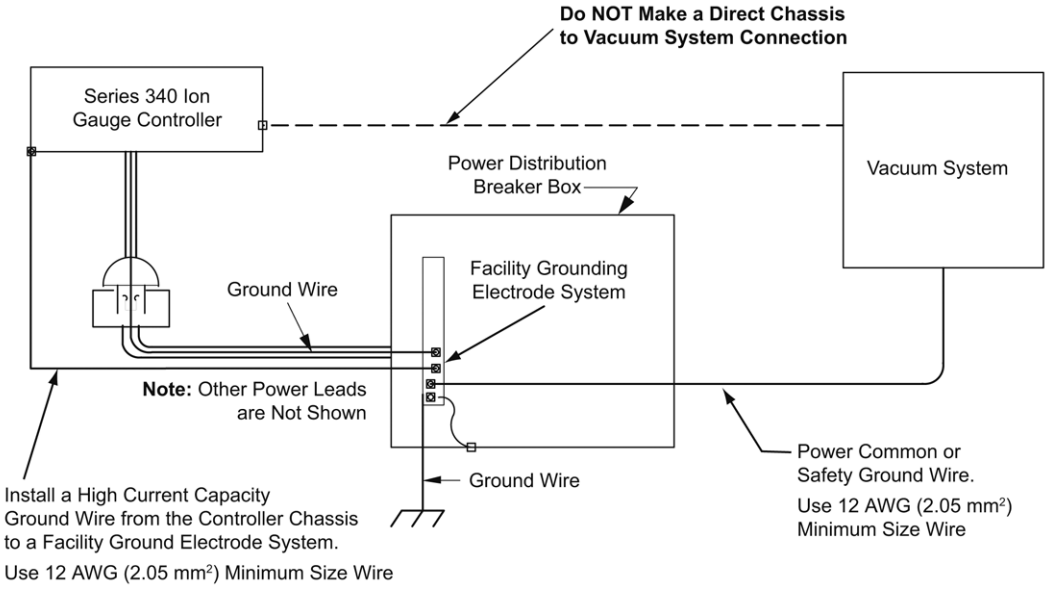


Figure 3-9 System Grounding Diagram

The placement of a second ground wire (dashed line in Figure 3–9) between the vacuum chamber and the 340 Vacuum Gauge Controller chassis is NOT safe – large currents could flow through it.

After each maintenance/service procedure and before operating the controller and vacuum system, make sure that your vacuum system and controller are grounded as shown in Figure 3–9.

When high voltages are used within the vacuum system and the gauge envelope is not reliably grounded through its vacuum connection, either a separate ground wire must be added, or the envelope must be shielded to positively prevent human contact. The gauge envelope may be grounded by using a metal hose clamp on the gauge connected by a #12 awg copper wire to the grounded vacuum chamber. See Figure 3-10.



Figure 3-10 Grounding a Convectron Gauge

1. Connect a heavy duty ground wire #12 AWG or larger from the ground lug on the back of the Controller to your facility grounding electrode system. This will provide an Earth ground for the Controller in the event the interconnect cables are not in place. Do not connect the ground lug to the vacuum system or other component. Connect it directly to the facility grounding system such as a grounded outlet box or a grounded copper water supply pipe. Do not rely on small metal water lines to ground a component. Later on someone may replace the metal tubing with plastic tubing thus unwittingly causing a potentially dangerous situation.
2. Provide a connection to ground for other instruments with electrodes in the vacuum system possibly exposed to high voltage electrical discharges.
3. Provide a connection to ground for each ungrounded metal component in, on, or around the vacuum system, including the gauge envelopes, which personnel may touch and which can potentially be exposed to high voltage electrical discharges within the vacuum system. For example, a metal bell jar resting on an organic O-ring must be connected to ground if a Micro-Ion gauge is to be used or if other high voltage sources are present in the vacuum system.

3.4.1 System Ground Test Procedure

Use the following procedure to test each of your vacuum systems which incorporates an ionization gauge.

NOTE: This procedure uses a conventional multi meter (DMM) and a 10 Ω, 10 W resistor.

1. Examine the grounding of both the 340 power supply and the vacuum chamber. Make sure there is a heavy duty ground connection to all exposed conductors on the chamber and to all exposed conductors on the vacuum chamber.
2. With the 340 VGC turned OFF, test for both DC and AC voltages between the metal parts of the vacuum chamber and the power supply chassis.
3. If no voltages exist, measure the resistance. The resistance should not exceed 2 ohms. Two ohms, or less, implies commonality of these grounds that should prevent the plasma from creating a dangerous voltage between them. This test does not prove that either connection is earth ground, only that they are the same. If more than 2 ohms is indicated, check with your electrician.
4. If AC or DC voltages exist and are less than 10 volts, shunt the meter with a 10 ohm, 10 watt resistor. Repeat the voltage measurement. With the shunt in place across the meter, if the voltage remains at 83% or more of the un-shunted value, commonality of the grounds is implied. Repeat the measurements several times to be sure that the voltage ratio is not changing with time. This should prevent the plasma from creating a dangerous voltage between these grounds. Make sure that no more than 10 volts exists between grounds.

$$\frac{\text{VOLTAGE (SHUNTED)}}{\text{VOLTAGE (UNSHUNTED)}} = 0.83 \text{ OR MORE}$$

5. If the voltage change in step 3 is greater than 17% due to the placement of the shunt, it complicates the measurement. The commonality of the grounds may be satisfactory and the coupling poor, or the commonality could be poor. Be sure to check the electrical continuity between these two ground systems.

Chapter 4
Operation

4.1 Series 340 VGC Controls

A description of the controls and indicators on a basic 340 Vacuum Gauge Controller (VGC) is given in this section. Theory of operation for ion gauges and Convectron gauges is explained in this chapter, as well as Convectron gauge operation and using them with gases other than N2 or Air. Detailed information regarding the Electrometer module and the Convectron module is given in Chapters 5 and 6, respectively.

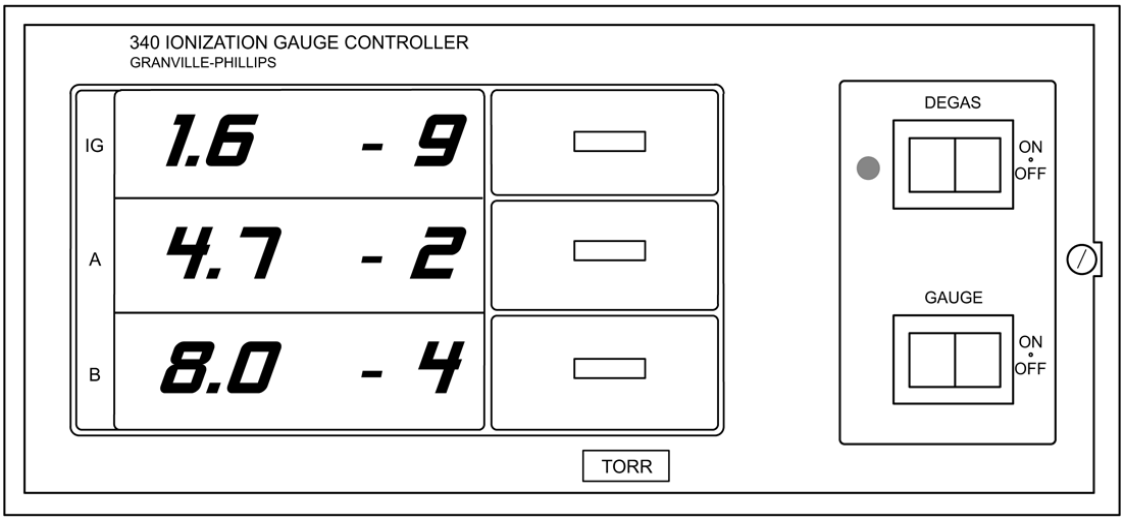


Figure 4-1 **Series 340 Vacuum Gauge Controller Front Panel**

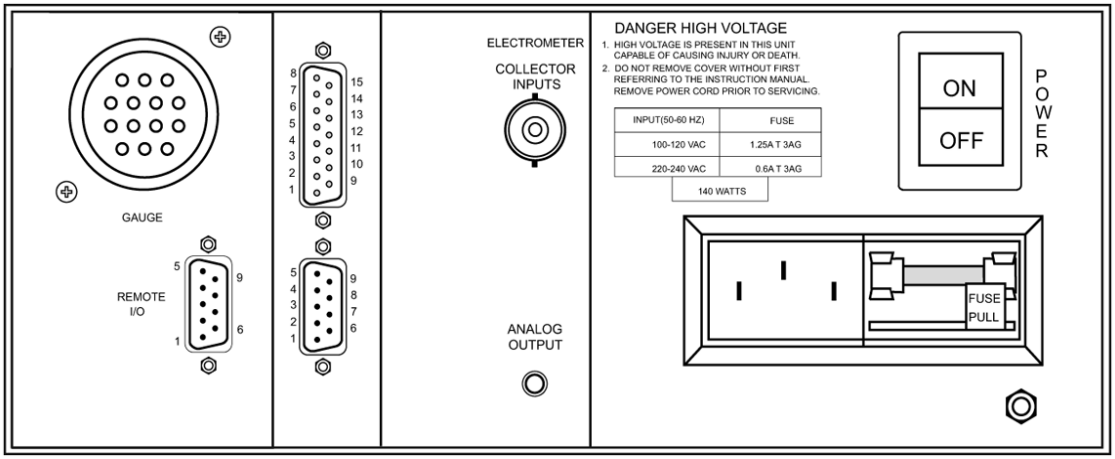


Figure 4-2 **Series 340 Vacuum Gauge Controller - Rear Panel with Convectron Gauge 1 Process Control Channel, and Ionization Gauge Electrometer Modules**

4.1.1 Sensor Failure

If the gauge tube becomes disconnected from the controller or if the sensor wire in the gauge tube fails, the controller will indicate 9.9E+9. If the tube is unplugged for a powered controller, there may be an instantaneous (0 to 0.2 seconds) drop in the pressure indication and the process control relay could activate for this brief time, depending on the order in which the tube pins break contact.

4.1.2 Power ON/OFF

To turn ON the 340 VGC, depress the top half of the power switch located on the rear panel. To turn OFF the VGC, depress the lower half of the power switch.

NOTE: There is NO power switch for the Convectron gauge. When the VGC is turned ON the Convectron gauges are ON.

4.1.3 Electrometer Module Units of Measure

The Units of Measure Display is selectable via a switch on the Electrometer Module. These units are indicated on the front panel label when shipped from the factory.

Refer to Section 5.2 on page 45 for information on changing the units of measure for the Ion gauge; Section 6.2 on page 51 for information on changing the units of measure for the Convectron gauge.

The pressure units label can be changed by the user if the system of units is changed. Slip the label card out of the top of the front panel and insert the appropriate pressure units label.

4.1.4 Ion Gauge ON/OFF

The ionization gauge can be turned ON or OFF with the front panel momentary rocker switch or by remote control.

To turn ON the ion gauge from the front panel, press the momentary rocker switch (see Figure 4-1). To turn it OFF, press the switch again. The digital display on the front panel will illuminate when ON. The display will initially display 9.9+9. After an approximately 2 seconds, the actual pressure will be displayed.

NOTE: The maximum voltage appearing on the gauge tube contacts will be 5.5 Vdc when the ion gauge is OFF.

4.1.5 Degas ON/OFF

The I^2R degas can be turned ON or OFF by the front panel momentary rocker switch (Figure 4-1) or the remote control input. To turn degas ON, press the DEGAS momentary rocker switch. An LED on the front panel illuminates when degas is ON. To turn it OFF, press the rocker switch again or press the GAUGE momentary rocker switch to turn OFF degas and turn ON the gauge.

Degas cannot be activated unless the gauge is first turned ON and indicated system pressure is below 5×10^{-5} Torr. This prevents degas turn-on at pressures that are too high for the gauge materials, or where degas is of no practical use. Pressure measurement is not possible during degas.

NOTE: During degas, the digital display is OFF.

4.1.6 Remote Input/Output

Two TTL compatible inputs are provided through the rear panel allowing control of the ion gauge and degas. The function of the front panel keys is reproduced by either a contact closure or an asserted low (0V) logic state on these inputs. This low state must be held continuously for at least 25 milliseconds. After this, the input must be allowed to pull high for at least 105 milliseconds before another low will be accepted. These inputs have passive pull-ups.

A single-pole, double-throw relay is provided to indicate filament status (the normally open contact is open when the filament is OFF). Refer to Table 4-1.

Table 4-1 Series 340 Remote Input/Output Connector for the Ion Gauge

Pin Number	Function		Pin Number	Function
1	Gauge On/Off Remote*		6	Degas On/Off Remote*
2	Ground		7	Ground
3	Not Used		8	Not Used
4	Gauge Status Common		9	Gauge Status N.O. (Normally Open)
5	Gauge Status N.C. (Normally Closed)			
*Active low inputs				

4.2 Theory of Operation

4.2.1 Ionization Gauge Theory of Operation

The functional parts of a typical ionization gauge are the filament (cathode), grid (anode) and ion collector, shown schematically in Figure 4-3. These electrodes are maintained by the gauge controller at +30, +180, and 0 Vdc, relative to ground, respectively.

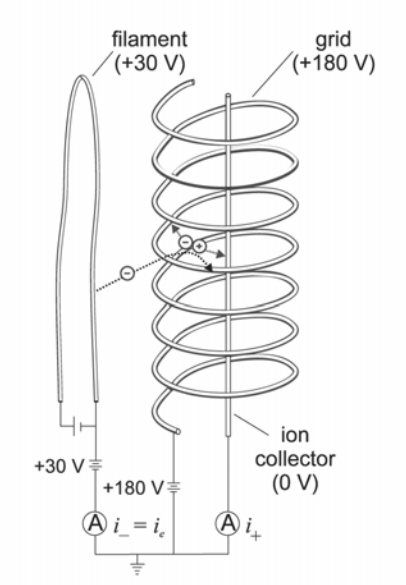


Figure 4-3 Ionization Gauge Schematic

The filament is heated to such a temperature that electrons are emitted, and accelerated toward the grid by the potential difference between the grid and filament. Most of the electrons eventually collide with the grid, but many first traverse the region inside the grid one or more times.

When an energetic electron collides with a gas molecule, an electron may be dislodged from the molecule, leaving it with a positive charge. Most ions are then accelerated to the collector. The rate at which electron collisions with molecules occur is proportional to the density of gas molecules, and hence the ion current is proportional to the gas density (or pressure, at constant temperature).

The amount of ion current for a given emission current and pressure depends on the ion gauge design. This gives rise to the definition of ion gauge *sensitivity*, frequently denoted by *S*:

$$S = \frac{\text{Ion Current}}{\text{Emission Current X Pressure}}$$

Bayard-Alpert type gauges typically have sensitivities of 10/Torr when used with nitrogen or air. Refer to Section 5.3.5 on page 48 for more information on gas sensitivities for other gases.

The ion gauge controller varies the heating current to the filament to maintain a constant electron emission, and measures the ion current to the collector. The pressure is then calculated from these data.

Ion gauge degas is accomplished by resistance heating (I^2R). During I^2R degas, a large current is passed through the grid structure, raising its temperature and driving off contaminants.

NOTE: Some ionization gauge designs do not allow I^2R degas.

4.2.2 Convectron Gauge Theory of Operation

The Convectron transducer is represented in Figure 4-4 as R1, R2, R3, and R4. These four resistances form the legs of a bridge circuit, with R1 designating the sensor wire of the transducer. R2 is a resistive network in the tube which compensates for changes in the ambient temperature. At bridge null, R1 = R2 x R3/R4. If there are no changes in ambient temperature, the value of R1 is a constant and the bridge is balanced.

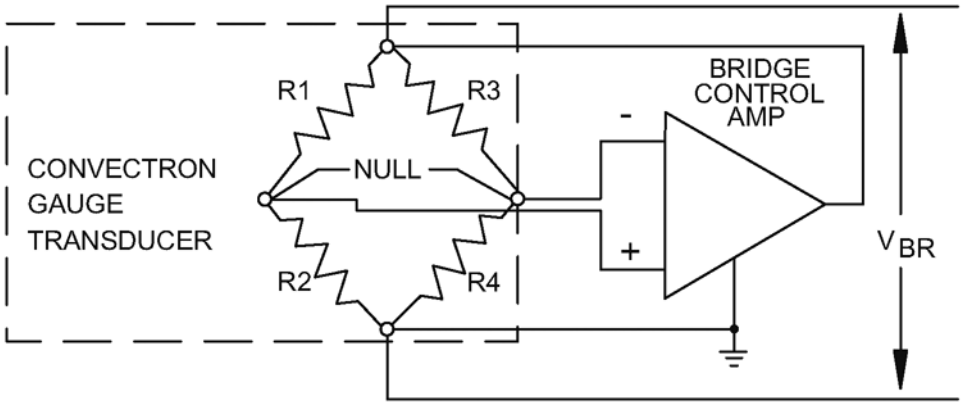


Figure 4-4 Convectron Gauge Schematic

As the vacuum system pressure is decreased, there are fewer molecules in the system to conduct the heat away from the sensor wire causing the temperature and resistance of R1 to increase. The increased resistance of R1 causes the bridge to unbalance and a voltage is developed across the null terminals. The bridge control circuit senses the null voltage and decreases the voltage across the bridge until the null voltage is again zero.

When the bridge voltage is decreased, the power dissipated in the sensor wire is decreased causing the resistance of R1 to decrease to its previous value. The opposite events happen for a pressure increase. The bridge voltage is a non-linear function of pressure.

4.3 Convectron Gauge Operation

4.3.1 Reading Pressure

The Convectron Gauge (CG) Module provides pressure measurement from 1.0 x 10^{-3} Torr (1.3 x 10^{-3} mbar or 1.3 x 10^{-1} Pa) to 1000 Torr, and one meaningful digit pressure indication down to 1 x 10^{-4} Torr, air equivalent. Two transducers are displayed simultaneously in the second and third display lines and are denoted by "CGA" and "CGB", respectively.

Analog output is also provided. The Convectron can also be used to automatically turn ON or OFF the ion gauge and the process relay.



If used without proper calibration or without reference to proper calibration tables, Convectron gauges can supply misleading pressure indications. This may result in dangerous overpressure conditions within the system. As supplied from the factory, the controller is designed to read pressure for nitrogen. For use with any other gases, consult the gas type correction charts found later in this chapter.

4.3.2 Special Considerations For Use Below 10^{-3} Torr

During a fast pumpdown from atmosphere, thermal effects will prevent the Convectron from tracking pressure rapidly below 10^{-3} Torr. After about 15 minutes, readings in the 10^{-4} range will be valid and response will be rapid. Calibration at vacuum may be performed at this time, or sooner if readings in the 10^{-4} range are not needed.

The 10^{-4} Torr range is accurate to about 0.1 milliTorr provided the instrument has been carefully zeroed at vacuum. See Section 6.6 on page 53 for vacuum and atmosphere calibration procedures. For accurate use in the 10^{-4} Torr range, zeroing should be repeated frequently.

Pressure readings in the 10^{-4} Torr range may differ from those measured by ion gauges, since ion gauges usually lose sensitivity near their upper pressure limits.

4.3.3 Use With Gases Other Than N_2 and Air

Before using the Convectron gauge to measure the pressure of other gases make certain the ATM adjustment is correctly set for air. Refer to Section 6.6 on page 53.

It is important to understand that the indicated pressure on a Convectron gauge depends on the type of gas in the gauge, and on the orientation of the gauge axis as well as on the gas pressure in the gauge. Convectron gauges are supplied calibrated for N_2 within the accuracy of the instrument. With certain safety precautions, the Convectron gauge may be used to measure pressure of other gases.

Convectron gauges are thermal conductivity gauges of the Pirani type. These gauges transduce gas pressure by measuring the heat loss from a heated sensor wire maintained at constant temperature. For gases other than N_2 and Air the heat loss is different at any given true pressure and thus the indicated reading will be different.

4.3.4 Indicated vs. True Pressure Curves

Figures 4-5 to 4-10 show the true pressure vs. indicated pressure of a Convectron gauge for eleven commonly used gases. The following list will help to locate the proper graph for a specific application:

Table 4-2 Indicated vs. True Pressure Curves

Figure	Range and Units	Gases
4-5	1 to 100 mTorr	All
4-6	0.1 to 1000 Torr	Ar, $C0_2$, CH_4, Freon 12, He
4-7	0.1 to 1000 Torr	D_2, Freon 22, Kr, Ne, 02
4-8	10^{-3} to 10-1 mbar	All
4-9	0.1 to 1000 mbar	Ar, $C0_2$, CH_4, Freon 12, He
4-10	0.1 to 1000 mbar	D_2, Freon 22, Kr, Ne, 02

NOTE: 1 mbar = 100 pascal, so the mbar charts may be used for pascal units by multiplying the values on the axes by 100.

A useful interpretation of these curves is: at a true pressure of 2 x 10^{-2} Torr of CH_4 the heat loss from the sensor is the same as at a pressure of 3 x 10^{-2} Torr of N_2 (refer to Figure 4-6). The curves at higher pressure vary widely from gas to gas because the thermal losses at higher pressures are greatly different for different gases.

The Convectron gauge uses convection cooling to provide resolution superior to any other thermal conductivity gauge near atmospheric pressure of N_2 and Air. Because convection effects are geometry dependent, the true pressure vs. indicated pressure curves for the Convectron gauge are likely to be much different from curves for heat loss tubes made by others. ***It is not safe to attempt to use calibration curves supplied by other manufacturers for their gauges with the Convectron, nor is it safe to use curves for the Convectron gauge with gauges supplied by other manufacturers.***

If you must measure the pressure of gases other than N_2 or Air, use Figures 4-5 through 4-10 to determine the maximum safe indicated pressure for the other gas as explained below.



For gases other than those listed, the user must provide accurate conversion data for safe operation. The Convectron gauge is not intended for use above 999 Torr true pressure.

Example 1: Maximum Safe Indicated Pressure

Assume a certain system will withstand an internal pressure of 2000 Torr or 38.7 psia. For safety you want to limit the maximum internal pressure to 760 Torr during backfilling. Assume you want to measure the pressure of argon. On Figure 4-6, locate 760 Torr on the left hand scale, travel to the right to the intersection with the argon (Ar) curve and then down to an indicated pressure of 24 Torr (N_2 equivalent). Thus in this hypothetical situation the maximum safe indicated pressure for argon is 24 Torr.

Example 2: Indicated to True Pressure Conversion

Assume you want to determine the true pressure of argon in a system when the Convectron is indicating 10 Torr. On Figure 4-6, read up from 10 Torr (N_2 equivalent) indicated pressure to the argon curve and then horizontally to the left to a true pressure of 250 Torr. Thus 250 Torr argon pressure produces an indication of 10 Torr (N_2 equivalent).

Example 3: True to Indicated Pressure Conversion

Assume you want to set a process control setpoint at a true pressure of 20 Torr of CO_2. On Figure 4-6, locate 20 Torr on the true pressure scale, travel horizontally to the right to the CO_2 curve and then down to an indicated pressure of 6.5 Torr (N_2 equivalent). Thus the correct process control setting for 20 Torr of $C0_2$ is 6.5 Torr (N_2 equivalent).

Example 4: True to Indicated Pressure Conversion

Assume you want to obtain a helium pressure of 100 Torr in the system. On Figure 4-6, locate 100 Torr on the left hand scale, travel horizontally to the right to attempt to intersect the He curve. Because the intersection is off scale it is apparent that this true pressure measurement requirement for helium exceeds the capability of the instrument.

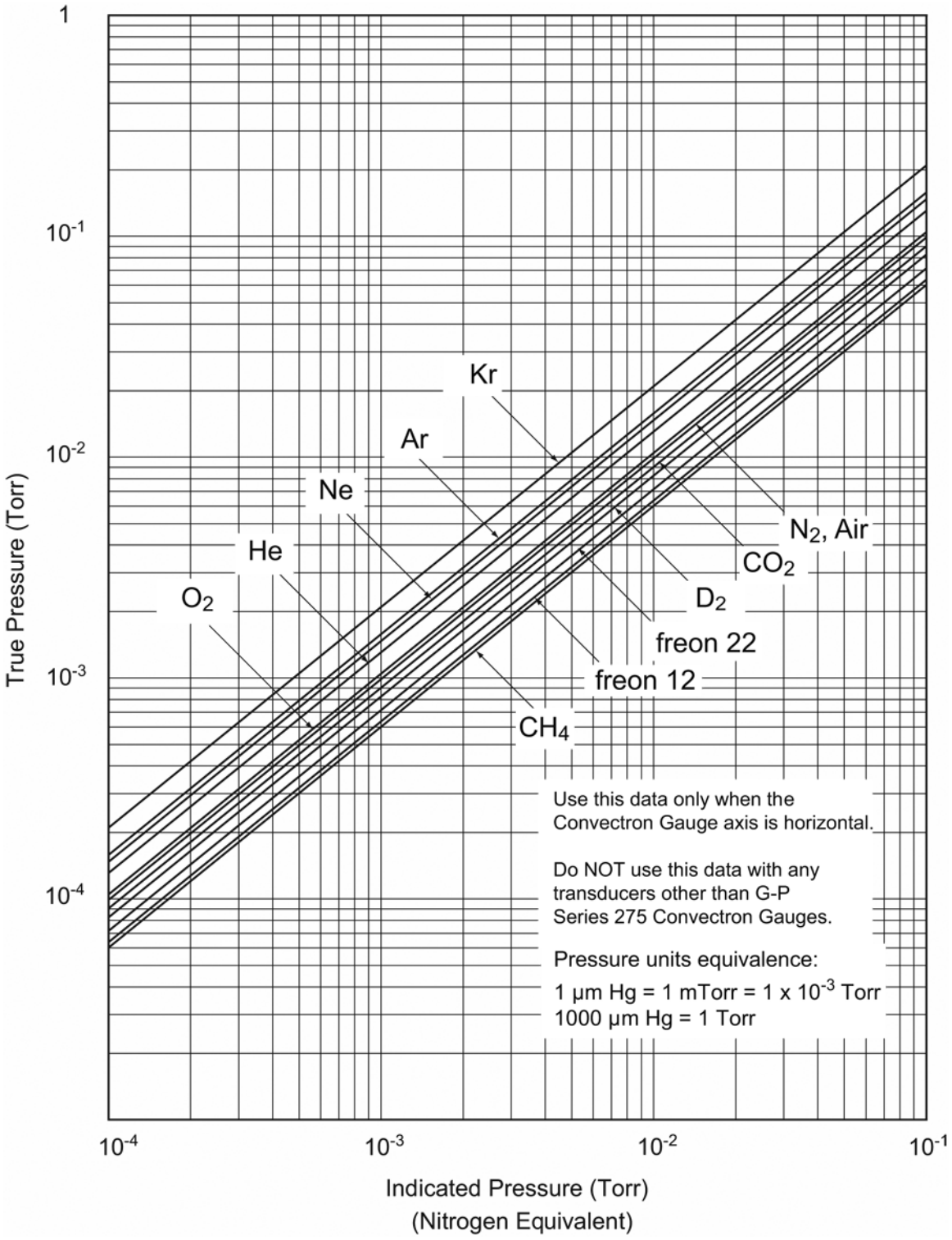


Figure 4-5 Convectron Gauge Indicated vs. True Pressure Curve; 0.1 to 100 mTorr

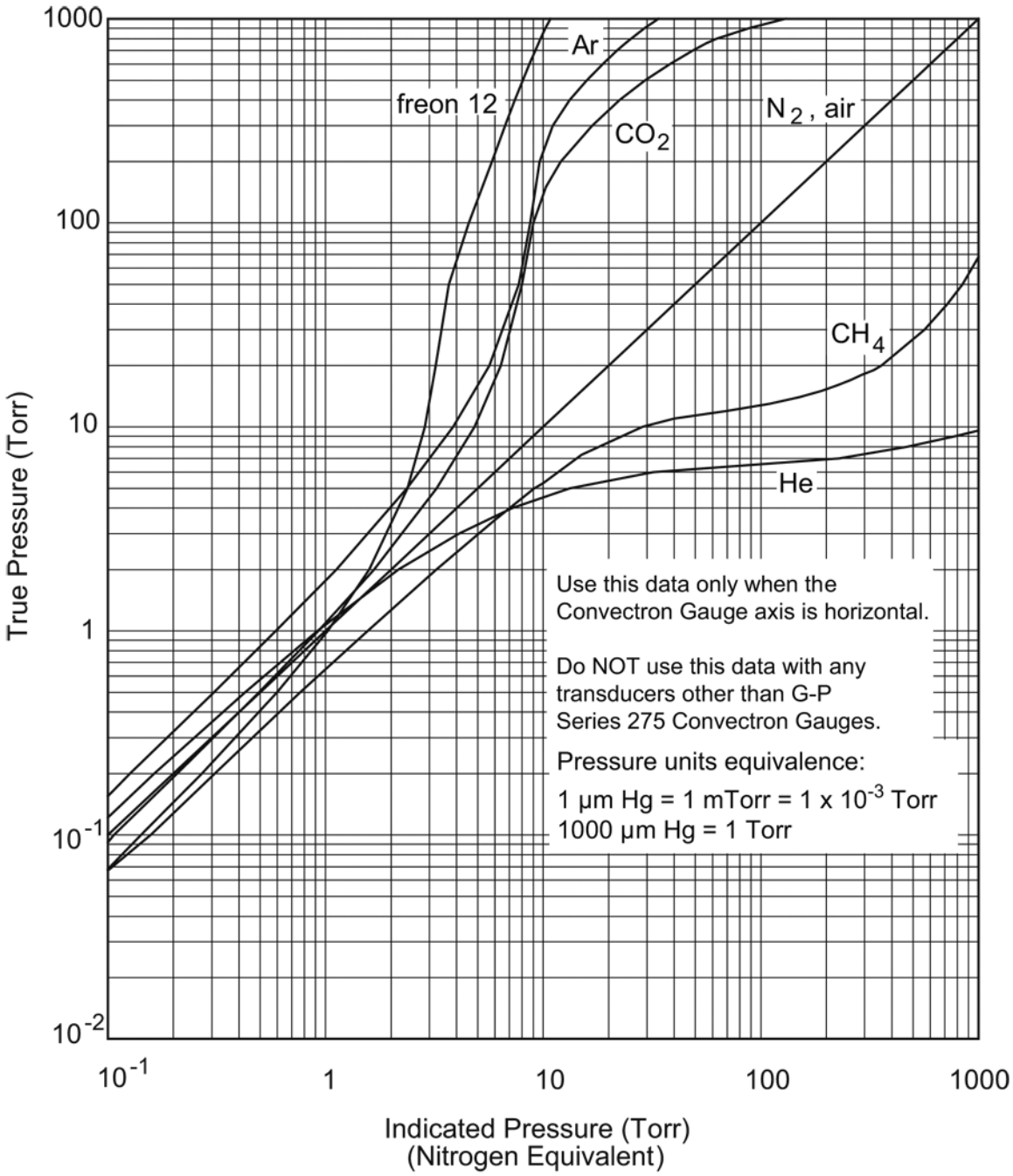


Figure 4-6 Convectron Gauge Indicated vs. True Pressure Curve; 0.1 to 1000 Torr

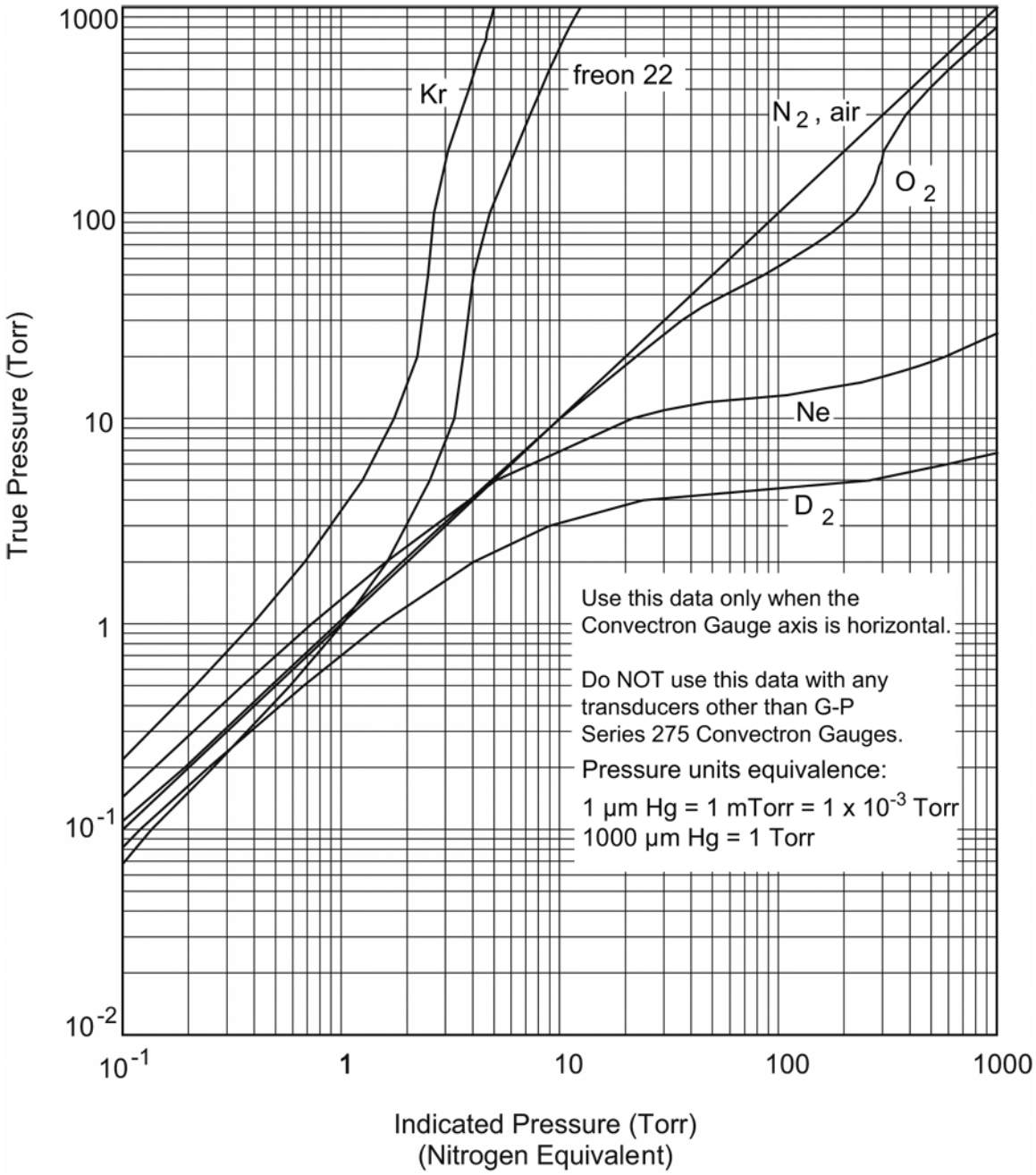


Figure 4-7 Convectron Gauge Indicated vs. True Pressure Curve; 0.1 to 1000 Torr

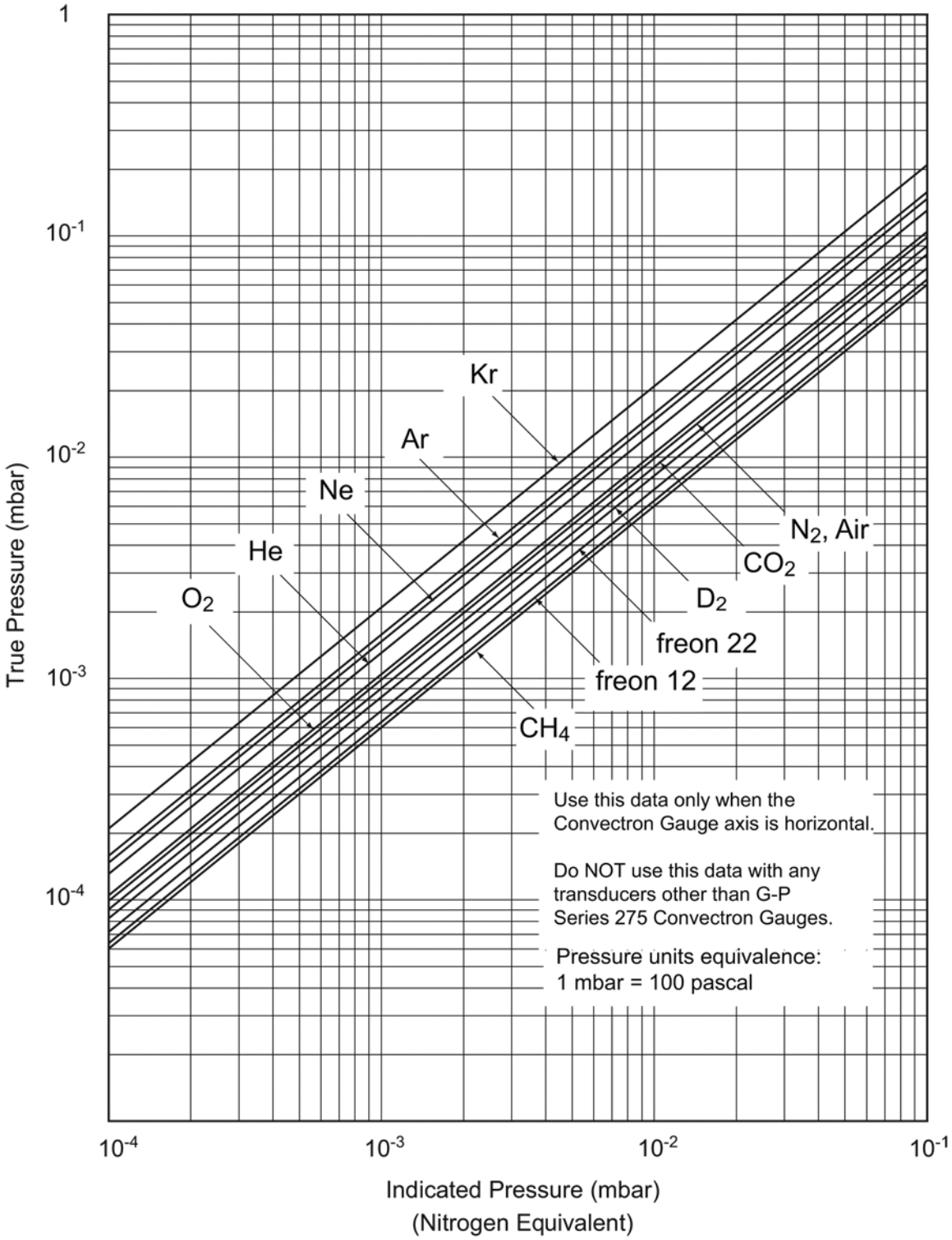


Figure 4-8 Convectron Gauge Indicated vs. True Pressure Curve; 10^{-4} to 0.1 mbar

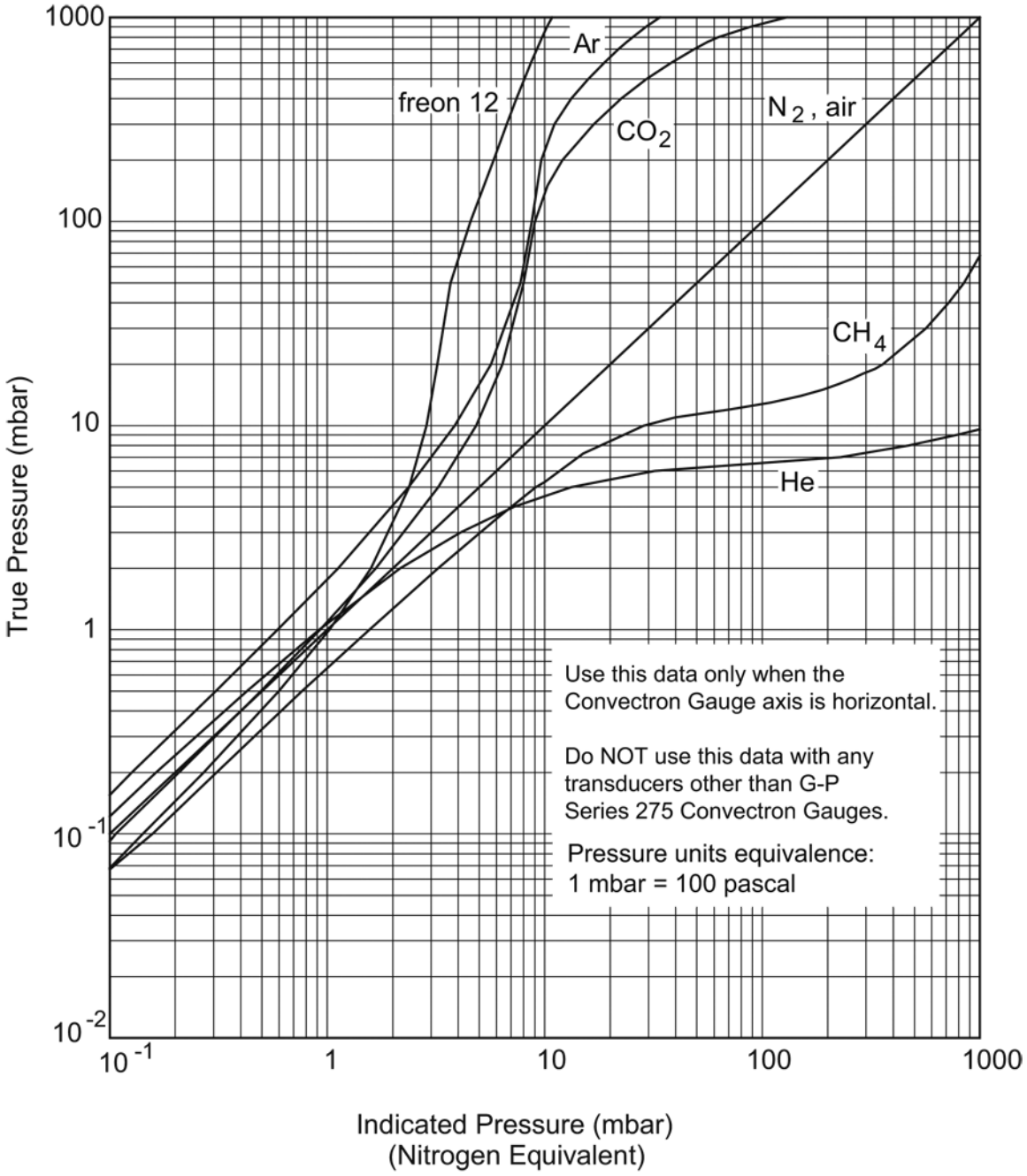


Figure 4-9 Convectron Gauge Indicated vs. True Pressure Curve; 0.1 to 1000 mTorr

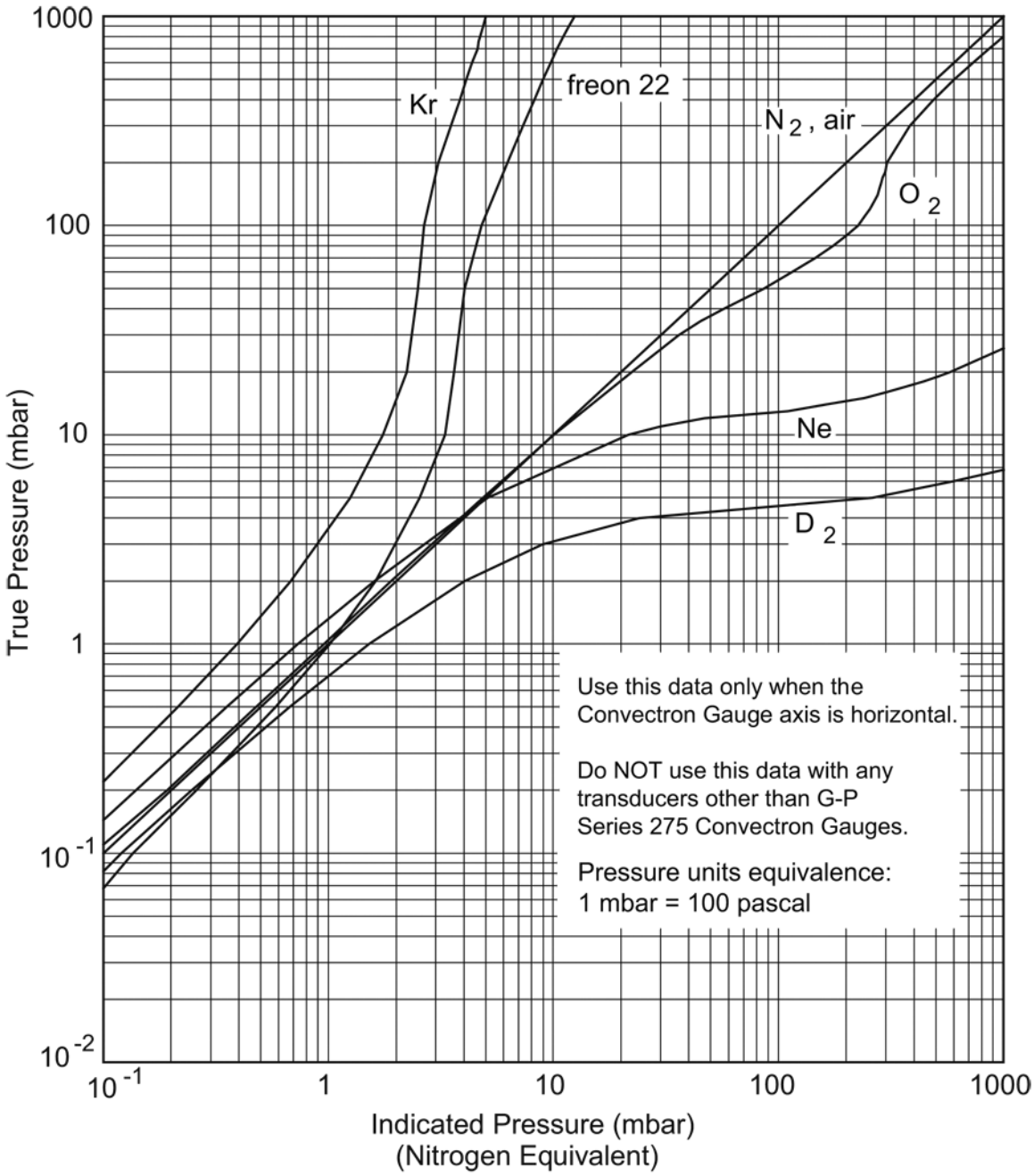


Figure 4-10 Convectron Gauge Indicated vs. True Pressure Curve; 0.1 to 1000 mbar

4.4 Convectron Gauge Module Setup

The Convectron Gauge Module provides capabilities such as auto turn ON/OFF if the ion gauge and process rely, and calibration of the Convectron Gauge pressure display. See Chapter 6 for detailed information.

Chapter 5
Electrometer Module

5.1 Introduction to the Electrometer Module

The Ion Gauge (IG) Electrometer Module provides ion gauge pressure readout from less than 1 x 10^{-9} Torr (1.3 x 10^{-9} mbar or 1.3 x 10^{-7} pascal) to 1 x 10^{-1} Torr, air equivalent, depending on the gauge and emission current used.

Adjustments are provided for gauge sensitivity and emission current. Adjustment and an internal switch allow change to mbar or pascal pressure units. A user selectable *slow update* feature triggers measurement averaging, resulting in a display update frequency of about once every three seconds. The overpressure shutdown threshold is adjustable on the Electrometer Module PC board. See Figure 5-1.

Internal failure-indicator LED's, Figure 5-1, aid diagnosis of problems by indicating certain out-of-bounds electronic conditions.

5.2 Units of Measure

The Series 340 Vacuum Gauge Controller (VGC) is shipped from the factory preset to display the unit of measure — Torr, millibar, or pascal — that you requested. To change the units, proceed as follows:

1. Turn OFF power to the control unit.
2. Remove the top cover. Locate the ion gauge (IG) electrometer module.
3. Locate the unit of measure control switch.
4. Set the switch to the desired position: OFF = Torr/mbar units; ON = pascal units.

   NOTE: If a Convectron gauge will be connected to the 340 VGC, see Section 6.2 on page 51 for the Convectron gauge to set the Units of Measure to be consistent with the Electrometer module setting.

5. Slip the label card out of the top of the front panel and insert the appropriate pressure units label.

Selection between Torr and mbar units is accomplished by adjusting the IG tube sensitivity for the appropriate units. For example, a typical Bayard-Alpert gauge has a sensitivity of 10/Torr or 7.5/mbar. Thus, for this gauge, adjusting the sensitivity for a display reading of 1.0+1 will result in display of pressure in Torr. Adjusting to 7.5+0 will result in display in mbar. See Section 5.3.4 for adjustment procedures.

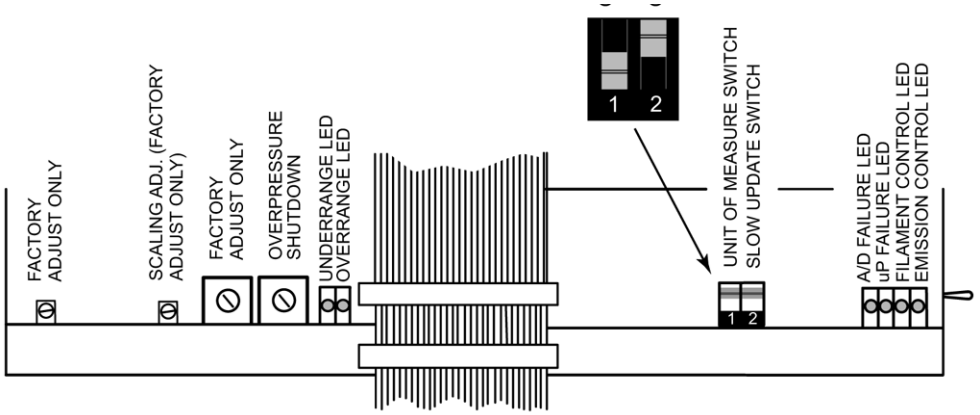


Figure 5-1 Ion Gauge Electrometer Module - Top View (Controller Cover Removed)

5.2.1 Display Update Rate Switch

Locate the Slow Update Switch See Figure 5-1. Set the switch to the ON position to enable pressure averaging. The display will update about every 3 seconds rather than the normal 0.5 second typical period.

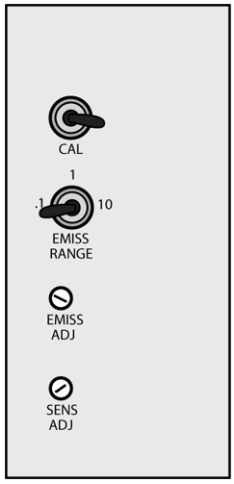


Figure 5-2 Electrometer Module Front Panel

5.3 Operation

5.3.1 Displaying Sensitivity, Pressure, and Emission with the Calibration Switch

The Calibration Switch (Figure 5-2) is a 3-position switch that is used to display gauge sensitivity, pressure, or emission current. To display the sensitivity, set the switch to the left or to the right with the ion gauge OFF. To display the emission, set the switch to the left or to the right with the ion gauge ON. The center position displays pressure. The function of the switch depends on the state of the ion gauge.

NOTE: If the CAL switch is not in the center position, the display will blink at a two second rate in this mode to warn the user that pressure is not being displayed.

Do not leave the calibration switch set to the left or right after you are done viewing sensitivity or emission; otherwise, the displayed reading may be mistaken for an actual pressure reading.

5.3.2 Emission Range Switch

The Emission Range Switch (Figure 5-2) selects between three emission ranges; 0.1 milliampere, 1.0 milliampere, or 10.0 milliamperes. Adjustment within each range is achieved with the emission adjustment potentiometer. See Section 5.3.3 below.

In general, higher emissions are used at lower pressures. For example, if you are using a broad range Ion gauge and want to measure to its upper pressure limit, the 0.1 mA range is recommended. If you are measuring very low pressures or have a low-sensitivity ion gauge, the 10.0 mA range is better. In general, lower emissions will increase gauge life.

NOTE: Changing the emission range by one decade will also change the overpressure shutdown point by one decade. Refer to Section 5.4.3 for details of the overpressure shutdown adjustment. Adjustment of emission within a range (see below) will not affect the overpressure shutdown point.

5.3.3 Emission Adjustment

The Emission Adjustment Potentiometer (Figure 5-2) provides control of the emission within the decade value selected by the emission range switch. The Calibration Switch must be set with the IG tube turned on to view emission during adjustment. The span of adjustment is from approximately 10% to 120% of the range value.

Theoretically, varying the emission current will not affect the pressure reading since the electrometer is actually calculating:

$$P = \frac{I +}{S\ (I-)} \qquad \text{OR} \qquad \text{PRESSURE} = \frac{\text{ION CURRENT}}{\text{SENSITIVITY (EMISSION CURRENT)}}$$

NOTE: There can be slight differences depending on the gauge cleanliness and gauge pumping.

5.3.4 Sensitivity Adjustment

The Sensitivity Adjustment Potentiometer (Figure 5-2) is used to match pressure outputs to ion gauges of different sensitivities. The Calibration Switch must be set to the left or to the right with the ion gauge OFF to view the sensitivity during the adjustment.

The 340 VGC is shipped from the factory set for a gauge sensitivity of 10/Torr, which is typical for glass Bayard-Alpert gauges. UHV nude gauges, such as the Granville-Phillips 274022, 274023 and 274028, typically have a sensitivity of about 25/Torr for N_2. If an ion gauge of this type is being used, the sensitivity potentiometer should be adjusted for the proper sensitivity (25/Torr); otherwise, a measurement error will result. The approximate range of the adjustment is 3 to 50/Torr.

5.3.5 Relative Gas Sensitivities

Sensitivity depends on the gas being measured as well as the type of ion gauge being used. Table 5-1 lists the relative gauge sensitivities for common gases.

NOTE: The values in Table 5–1 are from NASA Technical Note TND 5285, "Ionization Gauge Sensitivities as Reported in the Literature", by Robert L. Summer, Lewis Research Center, National Aeronautics and Space Administration. Refer to this technical note for further definition of these average values and for the gauge sensitivities of other gases.

To adjust the 340 VGC to be direct reading for gases other than air or N_2, calculate the sensitivity S_x for gas type x as follows:

$$S_x = (R_x)\ (SN_2)$$

where SN_2 is the gauge sensitivity for N_2 and R_x is found from Table 5-1.

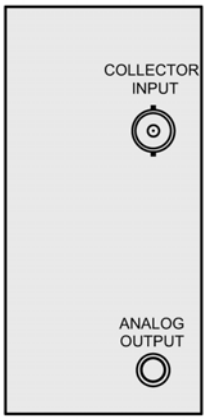
For example: if the normal sensitivity for the ion gauge you are using is 25/Torr, and you want to measure Argon, the sensitivity should be set to 1.29 x 25/Torr, or, 32.25 or 3.2+1.

Table 5-1 Relative Gas Sensitivities

Gas	R^X	Gas	R^X
He	0.18	H_20	1.12
Ne	0.30	N0	1.16
D_2	0.35	Ar	1.29
H_2	0.46	$C0_2$	1.42
N_2	1.00	Kr	1.94
Air	1.00	SF_6	2.5
O_2	1.01	Xe	2.87

5.3.6 Analog Output

The Analog Voltage Output (Figure 5-4) is proportional to the logarithm of the pressure, scaled to 1 volt per decade with 0 volts at 1 x 10^{-12} Torr at 10 mA emission current. Emission range setting affects the scaling of the analog output, refer to Figure 5-4. When the ion gauge is turned OFF, the output will switch to slightly over +10 V.



Analog output is available through the miniature phono connector.

Figure 5-3 Electrometer Module Rear Panel

For 10 mA emission, PRESSURE = $10^{(volts-12)}$

For 1 mA emission, PRESSURE = $10^{(volts-11)}$

For 0.1 mA emission, PRESSURE = $10^{(volts-10)}$

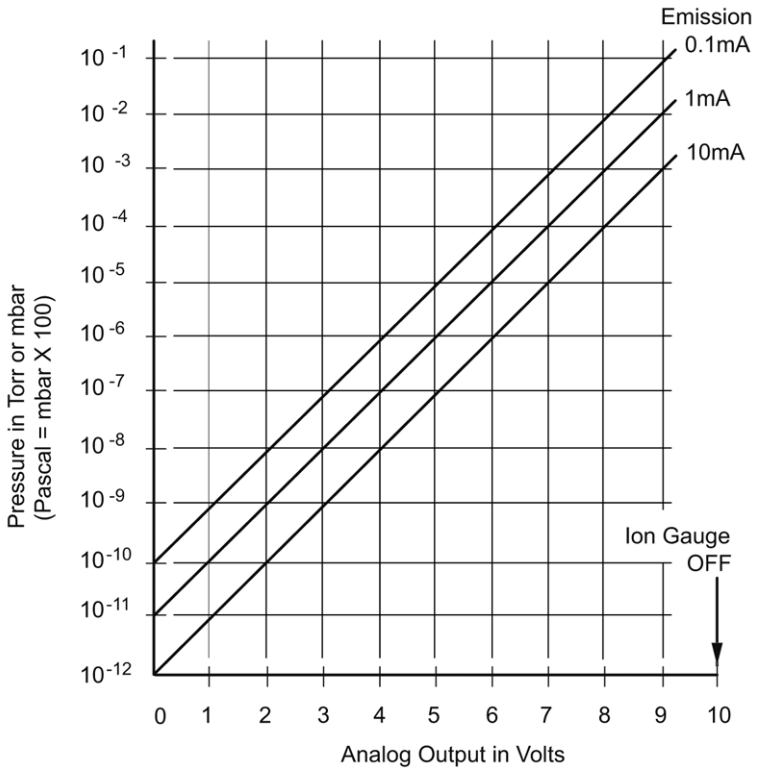


Figure 5-4 Analog Output (in Vdc)

5.4 Electrometer Calibration

Refer to Section 5.3.4 for instructions on setting the ion gauge sensitivity and Section 5.3.3 for instructions on setting the emission current.

5.4.1 Electrometer Minimum Adjustment

The Electrometer Minimum Adjustment potentiometer calibrates the electrometer for very low inputs. This is a factory calibration point and should not be changed by the user.

5.4.2 Electrometer Scale Adjustment

The Electrometer Scale Adjustment potentiometer is a factory calibration point and should not be changed by the user.

5.4.3 Overpressure Shutdown Adjustment

The Overpressure Shutdown Adjustment potentiometer (Figure 5-1) is factory set so the ion gauge will shut down when the pressure rises above the levels listed in Table 5-2.

Table 5-2 Overpressure Shutdown Levels

Emission Current (mA)	Overpressure Point (Torr)
0.1 range	1×10^{-2}
1.0 range	1×10^{-3}
10.0 range	1×10^{-4}

The overpressure shutoff point does not depend on the adjustment of the emission level within a range. To adjust the overpressure shutoff point to a different level:

1. Maintain system pressure at the desired shutoff point.
2. Rotate the overpressure adjustment potentiometer fully counterclockwise.
3. Turn ON the ion gauge.
4. Rotate the adjustment potentiometer clockwise slowly until the ion gauge turns OFF.

5.4.4 A/D Calibration

This is a factory calibration point and should not be changed by the user.

Chapter 6
Convectron Gauge Module

6.1 Introduction to the Convectron Gauge Module

The Convectron Gauge (CG) module provides pressure measurement from 1.0 x 10^{-4} Torr (1.0 x 10^{-4} mbar or 1.0 x 10^{-2} pascal) to 990 Torr.

An analog output proportional to the logarithm of pressure (1V per decade) is provided on the rear of the Convectron Module. See Figure 6-2.

6.2 Units of Measure for a Convectron Gauge

The Series 340 Controller is shipped from the factory preset to display the units of measure, Torr, mbar, or pascal, that you requested. To change the units of measure for the Convectron Gauge:

1. Turn OFF power to the Controller.
2. Remove the top cover.
3. Locate the Convectron gauge module. See Figure 4-2, Figure 6-1, and Figure 6-2.
4. Locate the mbar and pascal units switches. See Figure 6-1.
5. Leave both switches “OFF” for Torr units. Turn ON the switch for either mbar or pascal units.
6. Set the units of measure of the Electrometer module to be consistent with the Convectron gauge module. See Section 5.2 on page 45.
7. Replace the top cover of the controller.

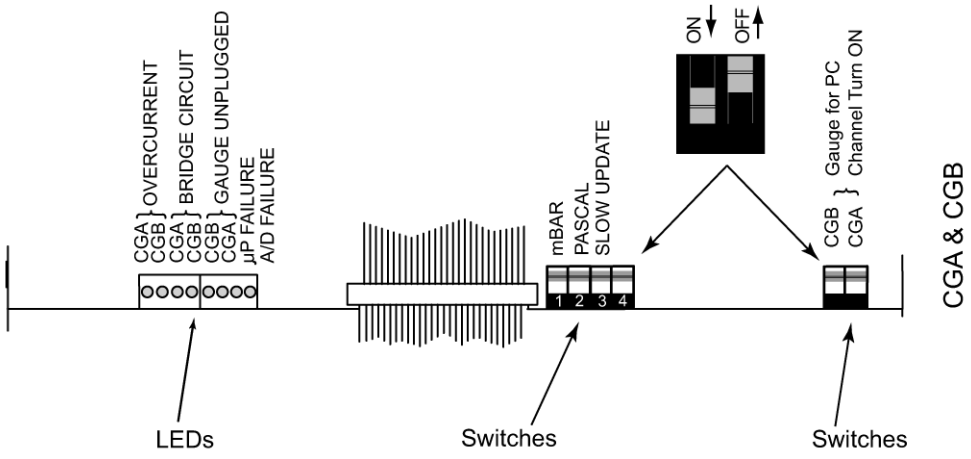


Figure 6-1 Convectron Module - Top View (Controller Cover Removed)

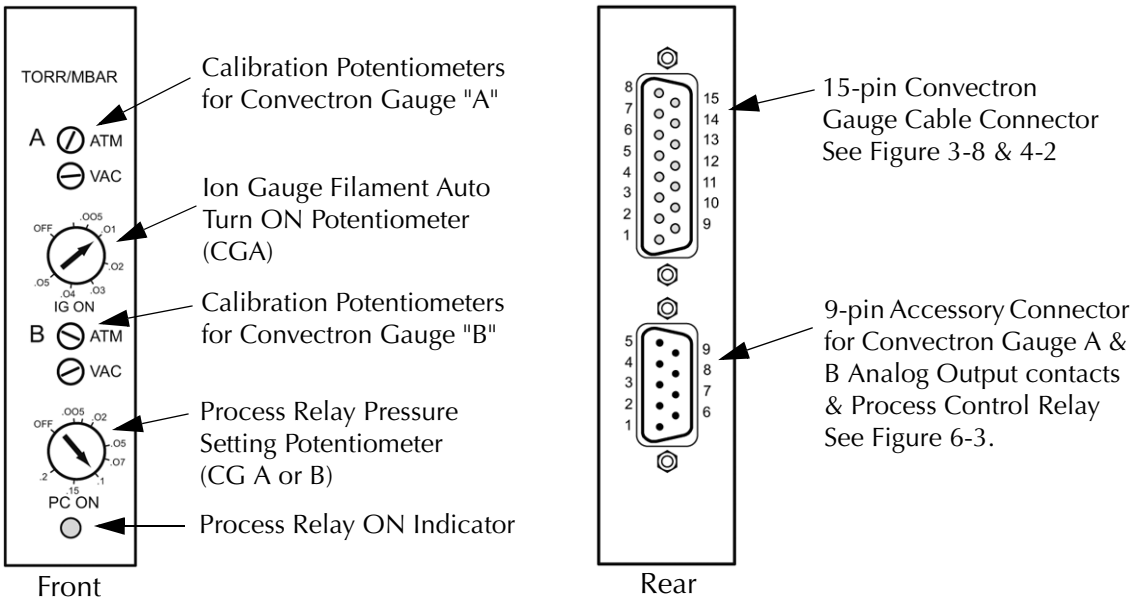


Figure 6-2 Convectron Module - Front and Rear Panels

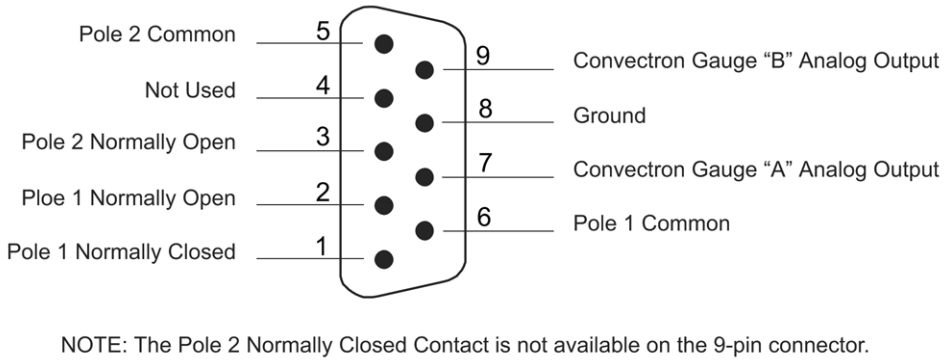


Figure 6-3 Convectron Module - 9-pin Accessory Connector

6.3 Ionization Gauge Filament Auto Turn ON

Convectron Gauge "A" can be used to turn ON the ionization gauge (IG). Auto turn-ON occurs when the pressure in the Convectron Gauge (CG) drops below the setpoint defined by the auto turn-ON adjustment potentiometer. The automatic OFF/ON function will execute only once per setpoint crossing. For example, the IG can be turned OFF manually when below the setpoint, and the auto-ON function will not turn it back ON again until the pressure in the Convectron Gauge has risen above the setpoint and once again dropped below.

The auto turn-ON potentiometer (Figure 6-2) is marked with rough pressure calibration markings. To set the pressure at which the IG will turn ON with falling CG pressure, and OFF with rising pressure, simply adjust the potentiometer to the desired pressure.

More precise control may be achieved by fixing the system pressure at the desired auto turn-ON pressure, and adjusting the potentiometer slowly until the gauge turns ON.

To disable the auto turn ON function, adjust the CG auto turn-ON potentiometer counterclockwise to the OFF position.

6.4 Process Relay Turn ON

Depending on the switch position of the two internal selector switches shown in Figure 6-1, either CG "A" or CG "B" can be used to control the process relay. The process relay turn ON occurs when the selected CG pressure drops below the setpoint defined by the process relay adjust potentiometer (see Figure 6-2). The process relay will also automatically turn OFF when the pressure rises slightly above the setpoint. To disable the process relay, adjust the process relay turn-ON potentiometer (Figure 6-2) completely counterclockwise to the OFF position.

6.4.1 Setting the Internal CGB & CGA Switches

CG "B" Select Switch - See Figure 6-1.

When the switch is in the ON position, Convectron Gauge B is selected as the controlling gauge for the process relay.

CG "A" Select Switch - See Figure 6-1.

When the switch is in the ON position, Convectron Gauge A is selected as the controlling gauge for the process relay.

6.5 Process Relay Turn ON Indicator

The process relay ON indicator LED will illuminate anytime the process relay is energized.

6.6 Gauge Zero and Atmospheric Pressure Calibration



Failure to use accurate pressure conversion data for N_2 or air to other gases can cause an explosion due to over pressurization.

If the controller will measure any gas other than N_2 or air, before connecting the controller to system control devices, adjust pressure outputs for the process gas that will be used. See Section 4.3 beginning on page 35 for detailed information on gases.

Each Convectron gauge is individually computer-calibrated for N_2. Adjustment of the zero should not be necessary unless readout accuracy is required below 1 x 10^{-3} Torr. Adjustment of the atmospheric indication should not be necessary unless compensating for long cables or variations in mounting orientation. The Convectron gauge has a stable, temperature compensated design and each Controller is calibrated to provide accurate readout of N_2 pressure with any gauge when it is properly installed with the gauge axis horizontal.

Calibrations are made using the potentiometers accessed on the front panel of the Convectron Gauge module. See Figure 6-2.

6.6.1 Zero Calibration

1. Evacuate the system for Convectron Gauge "A" to a pressure known to be less than 1 x 10^{-4} Torr.
2. With power ON and at vacuum less than 1 x 10^{-4} Torr, adjust the VAC potentiometer for gauge "A" until the display on the front of the 340 VGC reads 0.0 0.
   If the potentiometer is adjusted too far below Zero, a minus sign (-) will appear before the exponent (0.0 -0). Proper calibration is achieved only when 0.0 0 is displayed.
3. Repeat this procedure for Convectron Gauge "B", if used.

6.6.2 Atmosphere Calibration

1. Allow the pressure in the gauge increase to the local atmospheric pressure.
2. Read the local atmospheric pressure on a nearby, accurate barometer.
3. With power ON, adjust the ATM until the pressure displayed on the front panel of the 340 VGC indicates the local atmospheric pressure in the pressure units you have selected.

   NOTE: 1 atmosphere at sea level is 7.6 x 10^{+2} Torr; 1.0 x 10^{+3} mbar; 1.0 x 10^{+5} pascal.

4. Repeat this procedure for Convectron Gauge "B", if used.

6.7 Convectron Gauge Analog Output Signal

A nonlinear dc voltage output signal for both Convectron Gauges is provided on the rear panel of the Convectron Gauge module through the 9-pin accessory connector. See Figure 6-2 and Figure 6-3. These voltage signals are used primarily to drive a strip chart recorder.

I

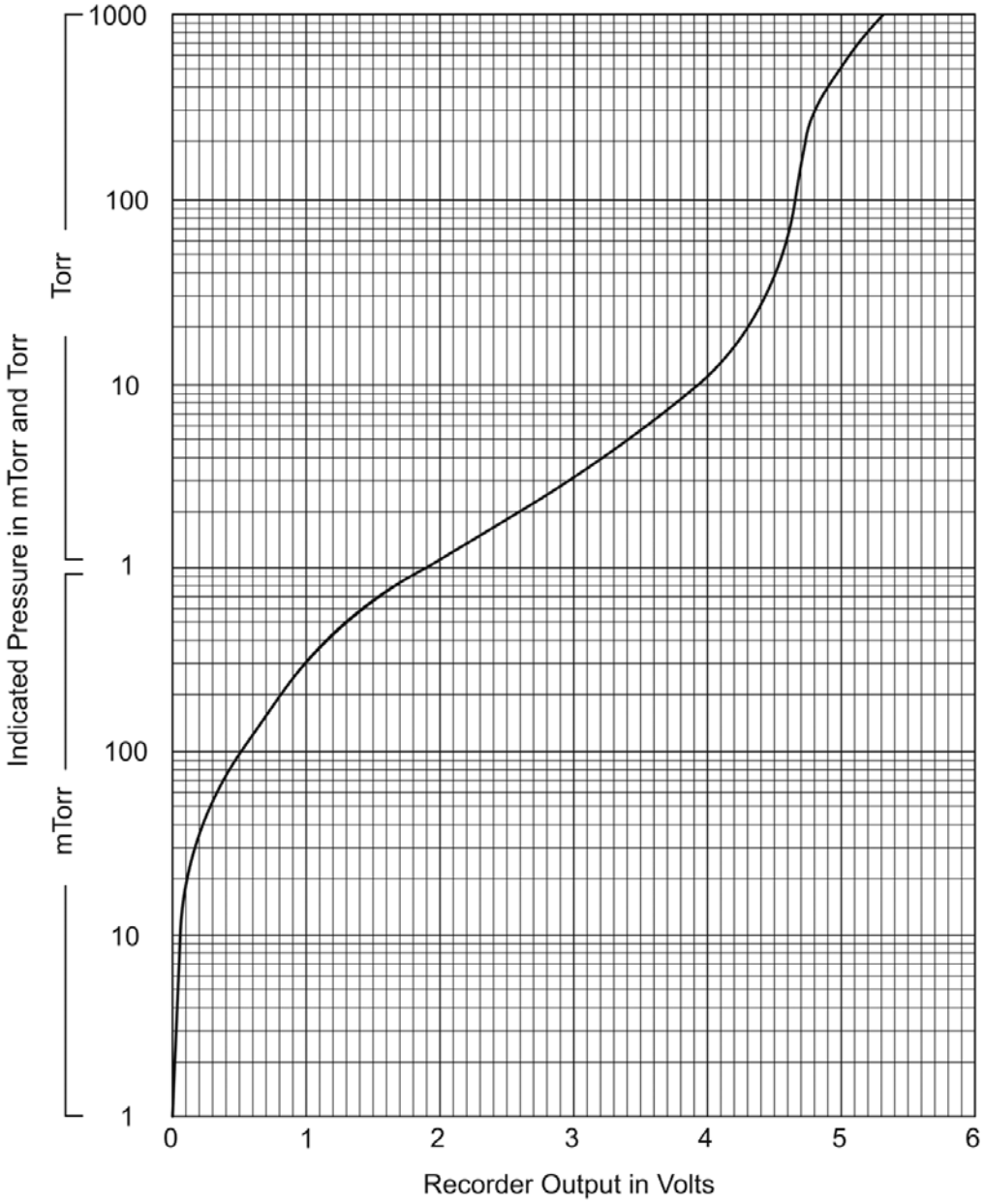


Figure 6-4 Convectron Gauge Pressure Analog Output

Chapter 7
Service and Maintenance

7.1 Service Guidelines

If a qualified service person makes repairs at the component level, repairs properly made with equivalent electronic parts and rosin core solder do not void the warranty.
Some minor problems are readily corrected on site. If the product requires service, contact the MKS/Granville-Phillips Technical Support Department at 1-303-652-4400 for troubleshooting help over the phone.

If the product must be returned to the factory for service, request a Return Material Authorization (RMA) from Granville-Phillips. Do not return products without first obtaining an RMA. In some cases a hazardous materials disclosure form may be required. The MKS/Granville-Phillips Customer Service Representative will advise you if the hazardous materials document is required.

When returning products to Granville-Phillips, be sure to package the products to prevent shipping damage. Shipping damage on returned products as a result of inadequate packaging is the Buyer's responsibility.

For Customer Service / Technical Support:

MKS Pressure and Vacuum Measurement Solutions
MKS Instruments, Inc., Granville-Phillips® Division
6450 Dry Creek Parkway
Longmont, Colorado 80503 USA
Tel: 303-652-4400
Fax: 303-652-2844
Email: mks@mksinst.com

MKS Corporate Headquarters
MKS Instruments, Inc.
2 Tech Drive, Suite 201
Andover, MA 01810 USA
Tel: 978-645-5500
Fax: 978-557-5100
Email: mks@mksinst.com

Because the 340 Vacuum Gauge Controller contains static-sensitive electronic parts, the following precautions must be followed when troubleshooting:

- Use a grounded, conductive work surface. Wear a high impedance ground strap for personal protection.
- Use conductive or static dissipative envelopes to store or ship static sensitive devices or printed circuit boards.
- Do not operate the product with static sensitive devices or other components removed from the product.
- Do not handle static sensitive devices more than absolutely necessary, and only when wearing a ground strap.
- Do not use an ohmmeter for troubleshooting MOS circuits. Rely on voltage measurements.
- Use a grounded, electrostatic discharge safe soldering iron.

NOTE: This product was designed and tested to offer reasonably safe service provided it is installed, operated, and serviced in strict accordance with these safety instructions.



The service and repair information in this manual is for the use of Qualified Service Personnel. To avoid shock, do not perform any procedures in this manual or perform any servicing on this product unless you are qualified to do so.



Do not substitute parts or modify the product.

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the product. Return the product to a service facility designated by Granville–Phillips for service and repair to ensure that safety features are maintained. Do not use this product if it has unauthorized modifications.

7.2 Damage Requiring Service

Disconnect this product from the power source and refer servicing to Qualified Service Personnel if any the following conditions exist:

- The gauge cable, power-supply cord, or plug is damaged.
- Liquid has been spilled onto, or objects have fallen into, the product.
- The product does not operate normally even if you have followed the Operation Instructions. Adjust only those controls that are covered in this instruction manual.
- The product has been dropped or the enclosure has been damaged.



Replacement Parts – When replacement parts are required, be certain to use the replacement parts that are specified by Granville–Phillips, or that have the same characteristics as the original parts. Unauthorized substitutions may result in fire, electric shock or other hazards.



Safety Check – Upon completion of any service or repairs to this product, ask the Qualified Service Person to perform safety checks to assure that the product is in safe operating order.

7.3 Troubleshooting

7.3.1 Power Input Troubleshooting

High voltages are present within the power supply, capable of causing injury or death. Use extreme care while troubleshooting while power is applied.

Table 7-1 Power Input Troubleshooting

Symptom	Possible Causes	Corrective Action
1. The Power light does not illuminate (all functions inoperative).	1. Power cord not plugged in. 2. No power to receptacle. 3. Controller input power fuse blown. 4. Defective power transformer T1, power switch, or line filter.	1. Plug in power cord. 2. Restore power to receptacle. 3. Replace fuse with correct type and value as indicated on rear panel. 4. Check secondary voltages of T1 at connector of transformer P4 where it plugs into the power supply module.
2. The Controller input power fuse blows as soon as the power switch is turned ON.	1. Incorrect power source. 2. Incorrect fuse rating. 3. Defective line filter, transformer, power switch, or transient suppressor. 4. Defective component on the power supply module.	1. Check the power source vs. controller requirements. Connect the controller to a proper source of power or reset the selector card to the voltage specified in Section 3.1.1. 2. Install the correct fuse as indicated on the rear panel of the controller and in Table 3-1. 3. Unplug the transformer secondary from the power supply module (P4). If fuse does not blow, proceed to the next step. 4. Repair or replace the module.

7.3.2 Power Supply Troubleshooting

If a problem persists after elimination of possible external causes by removing all cables except the power cable, and thus appears to be in the controller, the power supplies should be checked first. Use a standard Digital Volt Meter to check the test points listed in Table 7-2 for the outputs with respect to ground. Test points are located near the top edge of the power supply module as shown in Figure 7-1.

NOTE: It is permissible to remove the 34 pin bus cable to eliminate the electrometer or display module as a source of the problem.

Table 7-2 Power Supply Test Point Voltages

Test Point	Voltage (Vdc)
+5	+4.75 to +5.25
+20	+18 to +23
+12	+11.4 to +12.6
-12	-11.4 to -12.6
+180	+170 to +190
+220	+190 to +250

NOTE: If measured voltages do not agree with these readings, it will be necessary to correct this problem before proceeding further. In most cases, correcting the power supply problem will correct the original problem as well.

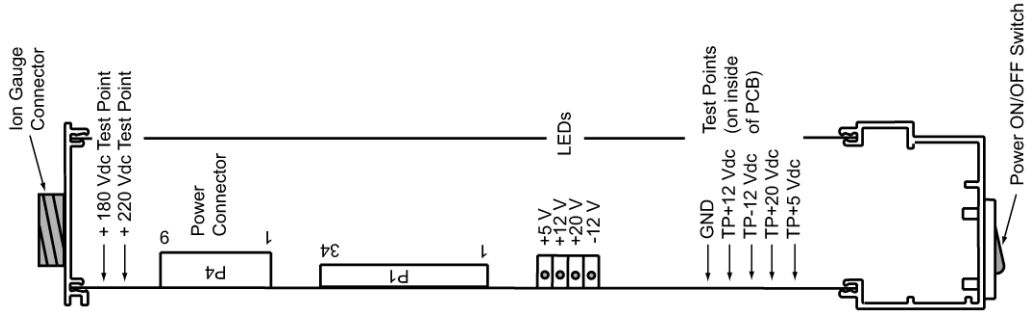


Figure 7-1 Power Supply Module - Top View (Controller Cover Removed)

7.3.3 Ionization Gauge Filament Turn ON and Emission

Table 7-3 Filament Turn On and Emission Troubleshooting

Symptom	Possible Causes	Corrective Action
1. The ionization gauge filament does not illuminate when the gauge switch is toggled. The display indicates 9.9+9 and then after approximately one second, turns OFF.	1. The gauge cable is not connected to the gauge or to the controller. 2. An open filament in the ion gauge. 3. An open in the ion gauge cable.	1. Connect the gauge cable. 2. Replace the ion gauge or switch to the second filament (if available). 3. Repair or replace the gauge cable.
2. The ion gauge filament does not illuminate when the gauge switch is toggled. The display does NOT momentarily indicate 9.9+9.	1. Power supply voltage problem.	1. Refer to Section 7.3.2.
3. The ion gauge filament illuminates when the filament switch is toggled ON and then turns OFF after approximately one second.	1. The pressure in the gauge is too high to permit emission. 2. Normal operation. The pressure in the gauge is greater than the overpressure shutdown level from the electrometer circuit. 3. Low line voltage. 4. Open in the gauge cable grid wire. 5. Grid bias supply shorted by either the gauge or the gauge cable. 6. Degraded filament emissive coating not providing required emission.	1. Decrease the system pressure. 2. Decrease the system pressure or decrease the emission by selecting a lower emission. 3. Connect the controller to a power line with the appropriate voltage level. 4. Repair or replace the gauge cable. 5. Troubleshoot and repair. 6. Replace the ion gauge.

7.3.4 Degas Troubleshooting

There will not be a pressure reading displayed on the front panel of the 340 Controller during a degas function.

Table 7-4 Ion Gauge Degas Troubleshooting

Symptom	Possible Causes	Corrective Action
The Degas switch does not turn-ON the ion gauge and the degas indicator on the front panel of the 340 Controller.	System pressure is too high	Turn ON the ion gauge and lower the system pressure to less than 5×10^{-5} Torr.
The grid in the ion gauge does not heat up during degas, but the degas indicator on the front panel is ON.	1. Defective ion gauge 2. The gauge cable is unplugged or defective	1. Replace the ion gauge. 2. Check the cable connection or replace the cable if necessary.
The ion gauge filament does not turn ON, and no pressure reading is displayed on the front panel of the 340 controller.	Normal operation	No corrective action required.

7.3.5 Electrometer Troubleshooting

The electrometer design is based on a log-type amplifier, and conversion is accomplished via a dual-slope A/D converter.

Table 7-5 Electrometer Module Troubleshooting

Symptom	Possible Cause	Corrective Action
The pressure reading displayed on the front panel of the 340 controller is less than the system is capable of producing, but the ion gauge appears to operating normally.	1. The collector cable is not connected to the ion gauge. 2. The collector cable is shorted or defective.	1. Connect the cable. 2. Check the continuity of the cable and replace or repair the cable.
The pressure reading displayed on the front panel of the 340 controller is higher than the expected system pressure or the display is erratic.	1. The inside ion gauge may be contaminated. 2. Current leakage from the +180V grid.	Clean (degas) or replace the ion gauge. If necessary, install a baffle in the vacuum system connection for the gauge to minimize materials from the process entering the gauge.
The displayed pressure reading is blank or erratic.	Defective electrometer PCB.	Check the A/D Failure, µP Failure, Underrange, and Overrange indicator LEDs on the electrometer PCB. See Figure 5-1 on page 46. If illuminated, replace the electrometer PCB.

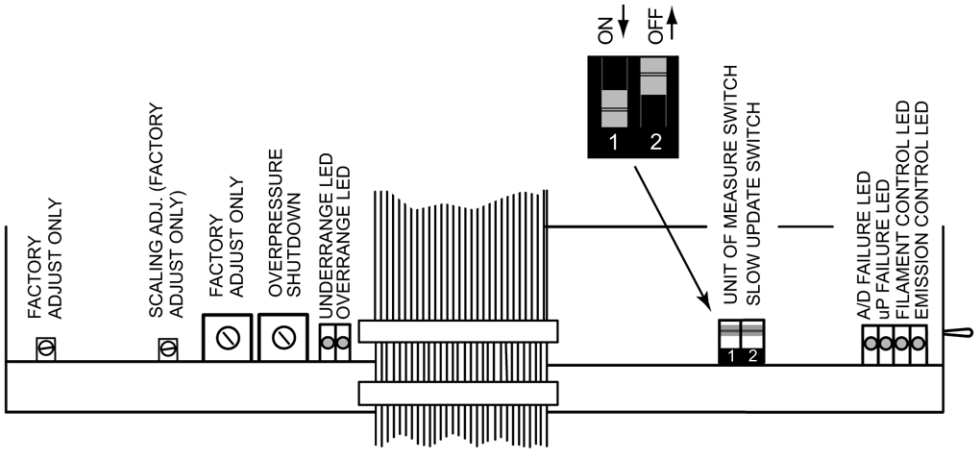


Figure 7-2 Electrometer Module - Top View (Controller Cover Removed)

7.3.6 Convectron Gauge Troubleshooting

Table 7-6 Convectron Module PCB Troubleshooting

Symptom	Possible Causes	
The displayed pressure reading for a Convectron gauge is very inaccurate	1. The controller is out of calibration 2. Unknown gas type 3. The Convectron gauge is not mounted horizontally 4. The sensor wire inside the Convectron gauge is contaminated or damaged 5. Extreme variations in ambient temperature or mechanical vibration	1. Check the calibration - see Gauge Zero and Atmospheric Pressure Calibration on page 53. 2. See Use With Gases Other Than N2 and Air on page 35 and Indicated vs. True Pressure Curves on page 35. 3. See Gauge Orientation on page 25. 4. See Convectron Gauge Test Procedure on page 64, Gauge Tube Contamination on page 65, and Cleaning a Convectron Gauge Tube on page 65. 5. Reinstall the Convectron gauge at another location on the vacuum system. See Convectron Gauge Installation on page 24.
The pressure display for a Convectron gauge is blank or "-"	1. The Convectron gauge cable is unplugged or defective 2. The sensor wire inside the Convectron gauge is damaged or broken	1. Check the cable and reconnect or repair as required. 2. See Convectron Gauge Test Procedure on page 64.
CG "A" or CG "B" Overcurrent LED is illuminated*	The cable for Convectron gauge is shorted between pins 1-3	Repair or replace the cable.
CG "A" or CG "B" Gauge Unplugged LED is illuminated*	The Convectron gauge is unplugged or the sensor wire inside the gauge is broken.	Check to be sure the cable is properly connected between the controller and the Convectron gauge. If so, check the Convectron gauge as instructed in Convectron Gauge Test Procedure on page 64.
CG "A" or CG "B" Bridge Circuit LED is illuminated*	Bridge amplifier circuit failure	Replace the Convectron module PCB.
The Microprocessor Failure LED is illuminated or flashing*	Microprocessor failure	Replace the Convectron module PCB.
The A/D Failure LED is illuminated or flashing*	A/D integration failure	Replace the Convectron module PCB.
* Refer to Figure 7-3 for component locations.		

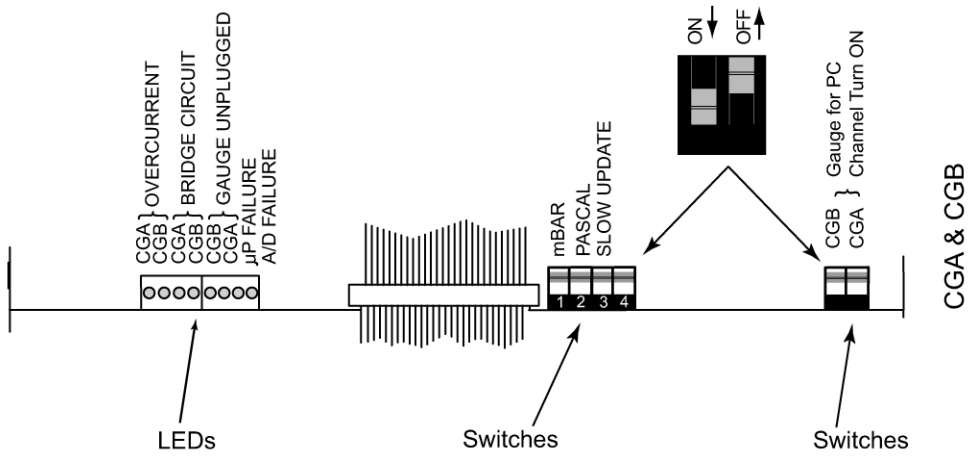
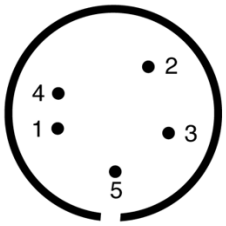


Figure 7-3 Convectron Module PCB - Top View (Controller Cover Removed)

7.3.6.1 Convectron Gauge Test Procedure

The small diameter sensor wire inside the Convectron gauge can be damaged by small voltages. Do not perform electrical continuity tests with instruments applying in excess of 1 volt when the gauge is at vacuum, or 5 V when at atmospheric pressure.

The Convectron gauge should show the following resistances (pin numbers are embossed on the gauge connector):



- Pins 1 to 2: 18 to 23 ohms
- Pins 2 to 3: 50 to 60 ohms
- Pins 1 to 5: 180 to 185 ohms

If the resistance from pins 1 to 2 reads about 800 ohms, the sensor wire in the gauge is broken. Replace the gauge tube.

Figure 7-4 Convectron Gauge Connector

NOTE: If the resistance values shown here are correct, but you still think the gauge is not reading correctly, the gold plating on the sensor wire inside the gauge may be eroded and the gauge will have to be replaced.

7.3.6.2 Gauge Tube Contamination

The calibration of the gauge will be seriously affected by any gas which will attack the gold plated sensor, and could result in over pressurizing the system. Two primary gases in this category are mercury vapor and fluorine.

7.3.6.3 Cleaning a Convectron Gauge Tube

The Convectron gauge can be baked to 150 ºC.

When the fine sensor wire is so contaminated with oil or other films that its emissivity or its diameter is appreciably altered, a change of calibration will result. Cleaning with trichloroethylene, perchloroethylene, toluene, or acetone is possible but it must be done very carefully to prevent damaging the sensor.



The fumes from any of these solvents can be dangerous to your health if inhaled and they should be used in well ventilated areas exhausted to the outdoors. Acetone and toluene are highly flammable and should be used away from open flame or electrical equipment.

1. Hold the gauge tube with the main body horizontal and the port projecting upward at an angle of 45º. Slowly fill it with solvent using a standard wash bottle with the spout inserted in the port to where it touches the screen.
2. Let the solvent stand in the gauge tube for at least ten minutes. ***Do not shake the gauge tube*** if the gauge tube is only partially filled—liquid forces on the sensor can become large enough to affect the transducer calibration. If the gauge tube is completely filled, shaking is not helpful.
3. To drain the gauge tube, position it horizontally with the port facing downward. Rotate the gauge tube slowly and tip it end-to-end so all of the solvent drains out. By slightly warming the gauge tube, a positive pressure will build up internally forcing the solvent out past the screen.
4. Allow gauge tube to dry overnight with the port vertically downward and uncapped. Be certain no solvent odor remains before reinstalling gauge tube on the system.

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Series 340

Granville-Phillips® Series 340 Vacuum Gauge Controller



Customer Service / Technical Support:

MKS Pressure and Vacuum Measurement Solutions
MKS Instruments, Inc., Granville-Phillips® Division
6450 Dry Creek Parkway
Longmont, Colorado 80503 USA
Tel: 303-652-4400
Fax: 303-652-2844
Email: mks@mksinst.com

MKS Corporate Headquarters
MKS Instruments, Inc.
2 Tech Drive, Suite 201
Andover, MA 01810 USA
Tel: 978-645-5500
Fax: 978-557-5100
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Instruction Manual

Instruction manual part number 340005
Revision E - November 2016

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