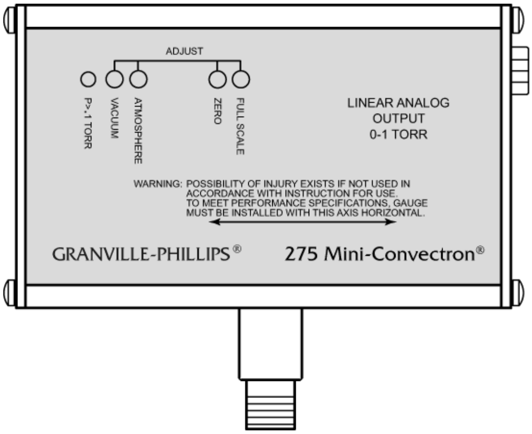
Series 275

Mini-Convectron® Vacuum Gauge Module with Linear Analog Output

Instruction Manual

Instruction manual part number 275539
Revision H - July 2017



Series 275 Mini-Convectron Module with both linear and non-linear analog output, no setpoint relays, and no digital display panel.

0 to 1 Torr linear analog output (0 to 10 Vdc)

1 mTorr to 1000 Torr nonlinear analog output (0.375 to 5.659 Vdc).

Series 275

Mini-Convectron® Vacuum Gauge Module with Linear Analog Output

This Instruction Manual is for use with all Granville-Phillips Series 275 Mini-Convectron Vacuum Gauge Modules with Linear Analog Output. A list of applicable catalog numbers is provided on the following page.

The 275330 product is RoHS Compliant.

Customer Service / Technical Support:

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

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2 Tech Drive, Suite 201
Andover, MA 01810 USA
Tel: 978-645-5500
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Email: mks@mksinst.com

Instruction Manual

Catalog numbers for Series 275 Mini-Convectron Modules with Linear Analog Output

Includes a 9-pin D subminiature electrical connector. Operating power: 13.6 Vdc to 26.5 Vdc.

The 27585X series Mini-Convectron Modules have both linear and non-linear analog output, no setpoint relays, and no digital display panel.

The 275330-XX series Mini-Convectron Modules are the same as the 27585X series, and are also RoHS compliant.

0 to 1 Torr linear analog output (0 to 10 Vdc) and 1 mTorr to 1000 Torr nonlinear analog output (0.375 to 5.659 Vdc).

Mini-Convectron Module with:	Catalog #
1/8 NPT / 1/2 inch tubulation	275850-EU
1/4 inch VCR-type female fitting	275851-EU
1/2 inch VCR-type female fitting	275862-EU
3/8 inch VCO-type male fitting	275852-EU
1.33 inch (NW16CF) ConFlat-type flange	275853-EU
2.75 inch (NW35CF) ConFlat-type flange	275854-EU
NW10KF flange	275855-EU
NW16KF flange	275856-EU
NW25KF flange	275857-EU
NW40KF flange	275858-EU
NW50KF flange	275859-EU
Tailored Function	(20)275580-GQ
Tailored Function	(20)275557-EU
Tailored Function	(20)275935-XX-X

RoHS Compliant Mini-Convectron Module with:	Catalog #
1/8 NPT / 1/2 inch tubulation	275330-GP
1/4 inch VCR-type female fitting	275330-GQ
1/2 inch VCR-type female fitting	275330-GR
3/8 inch VCO-type male fitting	275330-GH
1.33 inch (NW16CF) ConFlat-type flange	275330-GF
2.75 inch (NW35CF) ConFlat-type flange	275330-GG
NW10KF flange	275330-GS
NW16KF flange	275330-GD
NW25KF flange	275330-GE
NW40KF flange	275330-GK
NW50KF flange	275330-GU

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Table of Contents

Chapter 1 Introduction/Safety

1.1 About These Instructions

The instructions in this User Manual explain how to install, operate, and maintain the Granville-Phillips® Mini-Convectron® vacuum gauge module. In these instructions the word "product" refers to the Mini-Convectron Module and all of its approved parts and accessories.

- *This chapter* explains the caution and warning statements used throughout the manual which must be adhered to at all times, your responsibility to read and follow all instructions, how to contact customer service, and product specifications.
- *Chapter 2* explains how to install and connect the module.
- *Chapter 3* explains the theory of operation, how to operate the module, and how to use the module with various gases.
- *Chapter 4* explains troubleshooting, Convectron gauge testing, removal and replacement, and module return-for-repair procedures.

Table 1-1 Terms Describing the Mini-Convectron Module and Components

Term	Description
Module	The Mini-Convectron vacuum gauge module, which contains a Convectron convection-enhanced Pirani heat-loss pressure gauge.
Convectron Gauge	The Convectron convection-enhanced Pirani heat-loss gauge, which measures pressure within the vacuum chamber

1.2 Reading and Following Instructions

You must comply with all instructions while you are installing, operating, or maintaining the module. Failure to comply with the instructions violates standards of design, manufacture, and intended use of the module. Granville-Phillips and MKS Instruments, Inc. disclaim all liability for the customer's failure to comply with the instructions.

- *Read instructions* – Read all instructions before installing or operating the product.
- *Follow instructions* – Follow all installation, operating and maintenance instructions.
- *Retain instructions* – Retain the instructions for future reference.
- *Heed warnings and cautions* – Adhere to all warnings and caution statements on the product and in these instructions.

Parts and accessories – Install only those replacement parts and accessories that are recommended by Granville-Phillips. Substitution of parts is hazardous.

1.3 Safety Instructions

This manual contains caution and warning statements with which you *must* comply to prevent inaccurate measurement, property damage, or personal injury.

NOTES: 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 Granville-Phillips 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.

⚠ CAUTION

Caution statements alert you to hazards or unsafe practices that could result in minor personal injury or property damage.

Each caution statement explains what you *must* do to prevent or avoid the potential result of the specified hazard or unsafe practice.

⚠ WARNING

Warning statements alert you to hazards or unsafe practices that could result in severe property damage or personal injury due to electrical shock, fire, or explosion.

Each warning statement explains what you *must* do to prevent or avoid the potential result of the specified hazard or unsafe practice.

Caution and warning statements comply with American Institute of Standards Z535.1–2002 through Z535.5–2002, which set forth voluntary practices regarding the content and appearance of safety signs, symbols, and labels.

Each caution or warning statement explains:

a. The specific hazard that you *must* prevent or unsafe practice that you *must* avoid,

b. The potential result of your failure to prevent the specified hazard or avoid the unsafe practice, and

c. What you *must* do to prevent the specified hazardous result.

⚠ WARNING

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 Explosion / Implosion

⚠ WARNING

If used improperly, Mini–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 Mini–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.

Danger of injury to personnel and damage to equipment exists on all vacuum systems that incorporate gas sources or involve processes capable of pressuring 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 belljars, etc., are not designed to be pressurized.

⚠ WARNING

If accurate conversion data is not used, or is improperly used, a potential overpressure explosion hazard can be created under certain conditions. Using the N_2 calibration to pressurize a vacuum system above about 1 Torr with certain other gases can cause dangerously high pressures which may cause explosion of the system. See the Chapter 3 before using with other gases.

Series 275 instruments are furnished calibrated for N_2. They also measure the pressure of air correctly within the accuracy of the instrument. 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 *Commonly Used Gases Other than N_2 and Air*, and *Other Gases* in the *Operation Chapter*.

A pressure relief valve should be installed in the system if the possibility of exceeding 1000 Torr (1333 mbar) exists.

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 the gauge tube pins.

Suppliers of pressure relief valves and pressure relief disks can be located via an online search, and are listed at ThomasNet.com under “Relief Valves”. ***Confirm that these safety devices are properly installed before installing the Mini-Convectron Module.***

In addition, check that (1) the proper gas cylinders are installed, (2) gas cylinder valve positions are correct on manual systems, and (3) the automation is correct on automated systems.

1.5 System Grounding

Grounding, though simple, is very important! Be certain that ground circuits are correctly used on your ion gauge power supplies, gauges, and vacuum chambers, regardless of their manufacturer. Safe operation of vacuum equipment, including the Mini-Convectron Module, requires grounding of all exposed conductors of the gauges, the controller and the vacuum system. **Lethal Voltages** may be established under some operating conditions unless correct grounding is provided.

Ion producing equipment, such as ionization gauges, mass spectrometers, sputtering systems, etc., from many manufacturers may, under some conditions, provide sufficient electrical conduction via a plasma to couple a high voltage electrode potential to the vacuum chamber. If exposed conductive parts of the gauge, controller, and chamber are not properly grounded, they may attain a potential near that of the high voltage electrode during this coupling. Potential fatal electrical shock could then occur because of the high voltage between these exposed conductors and ground.

1.6 Operation

It is the installer's responsibility to ensure that the automatic signals provided by the process control module are always used in a safe manner.

Carefully check manual operation of the system and the setpoint 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.

1.7 Service Guidelines

If the product requires service, contact the MKS Technical Support Department at 1-303-652-4400 or 1-800-776-6543 for troubleshooting help over the phone.

If the product must be returned to the factory for service, request a Return Material Authorization (RMA) from MKS, which can be completed at *https://www.mksinst.com/service/servicehome.aspx*. Do not return products without first obtaining an RMA. In most cases a hazardous materials disclosure form is required. The MKS Customer Service Representative will advise you if the hazardous materials document is required.

When returning products to MKS, be sure to package the products to prevent shipping damage. Damaged 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.
6450 Dry Creek Parkway
Longmont, Colorado 80503 USA
Tel: 303-652-4400
Fax: 303-652-2844
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2 Tech Drive, Suite 201
Andover, MA 01810 USA
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Fax: 978-557-5100
Email: mks@mksinst.com

1.8 Specifications

Pressure Measurement

Measurement Range for Air or N_2	Torr	1×10^{-4} to 1000
	mbar	1×10^{-4} to 1333
	Pascal	1×10^{-2} to 1.33×10^{5}
Resolution	Torr	1×10^{-4}
	mbar	1×10^{-4}
	Pascal	1×10^{-2}

Measurements will change with different gases and mixtures. ***Do not use the module with flammable or explosive gases.*** The module is factory calibrated for use with Air or N_2. It measures the pressure of air correctly within the specified accuracy of the instrument. If the module will measure the pressure of a gas other than Air or N_2, you must calibrate the Mini-Convectron Module for the process gas. See *Understanding Convectron Gauge Pressure Measurement In Gases Other Than Nitrogen or Air* in the Operation Chapter.

Temperature Limits

Operating Temperature	+0 to +40 °C (+32 to +104 °F) ambient, non-condensing
Non-operating Temperature	–40 to +70 °C (–40 to +158 °F)

Power Requirements and Electrical Connections

Power Requirement	13.6 to 26.5 Vdc, 0.1 A at 11.5 Vdc, 1.6 W maximum Must be protected against reversals, transients, or over-voltages.
I/O Connector	9-pin male, subminiature D

Analog Outputs

Analog Output	Bridge Output: 0.375 to +5.659 Vdc for 0 to 1000 Torr of N_2, non-linear 0 to 1333 mbar of N_2, non-linear 0 to 1.33 x10^{-1} kPa of N_2, non-linear Linear Output: 0.0 to +10 Vdc minimum for 0 to 1000 mTorr of N_2 (1 Ohm output impedance)

Mini-Convectron Gauge

Sensing Wire Filament	Gold-plated tungsten (standard) or solid platinum (optional)
Internal Volume	40 cc (2.5 cu in.)
Materials Exposed to Vacuum	304 stainless steel, gold, borosilicate glass, kovar, alumina, NiFe alloy, polyimide
Bakeout Temperature	150 °C (302 °F) maximum, non-operating, with electronics removed

Physical Characteristics

Mounting Position	Horizontal axis (see Figure 2-1 on page 17).
Case Material	Powder-coated extruded aluminum
Weight	340 g (12 oz.) with 1/8 NPT fitting
Physical Dimensions	See Figure 1-1 and Table 1-2

Compliance

EMC	EN61326-1
Safety	EN61010-1
Environmental	RoHS Compliant (275330 Product)
IP Rating	IP20

Figure 1-1 Mini-Convectron Module Physical Dimensions

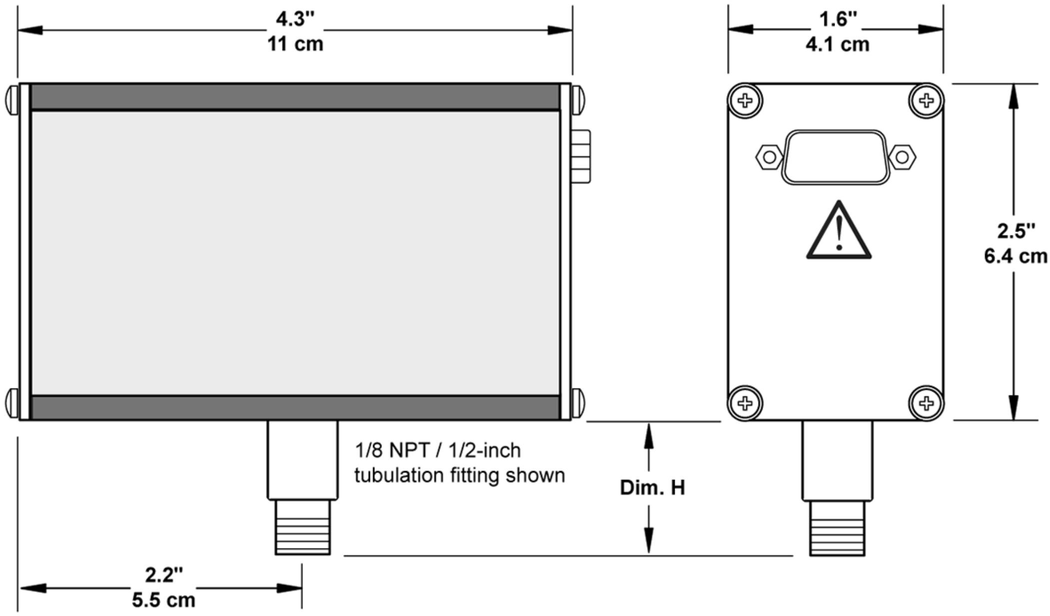


Table 1-2 Mini-Convectron Vacuum Connections

Vacuum Connections	Dim. H	
	cm	in.
1/8 NPT pipe thread, ½-inch inside diameter	2.2	1.0
½-inch 4 VCR® type fitting, female	3.0	1.2
½-inch 8 VCR type fitting, female	3.9	1.5
NW16KF flange	3.1	1.2
NW25KF flange	3.1	1.2
NW40KF flange	3.7	1.5
1.33-inch (NW16CF) ConFlat® flange	3.8	1.5
2.75-inch (NW35CF) ConFlat flange	3.8	1.5

Chapter 2 Installation

2.1 Module Components

The Mini-Convectron Module contains a Convectron convection-enhanced Pirani heat-loss gauge.

> **⚠ WARNING**
>
> **Using the module to measure the pressure of flammable or explosive gases can cause a fire or explosion resulting in severe property damage or personal injury.**
>
> **Do not use the Mini–Convectron Module to measure the pressure of flammable or explosive gases.**

The module is shipped with an instrument screwdriver and a 9-pin female, high-density subminiature D connector that mates to the male connector on the module.

2.2 Installing Pressure Relief Devices

Before you install the module, install appropriate pressure relief devices in the vacuum system.

Granville-Phillips does not supply pressure relief valves or rupture disks. Suppliers of pressure relief valves and rupture disks are listed in the *Thomas Register* under “Valves, Relief” and “Discs, Rupture.”

> **⚠ CAUTION**
>
> **Operating the module above 1000 Torr (1333 mbar, 133 kPa) true pressure could cause pressure measurement error or product failure.**
>
> **To avoid measurement error or product failure due to overpressurization, install pressure relief valves or rupture disks in the system if pressure exceeds 1000 Torr (1333 mbar, 133 kPa).**

2.3 Installation Procedure

The module installation procedure includes the following steps:

1. Determine the best location and orientation for the module.
2. Attach the module vacuum chamber fitting to its mate on the vacuum chamber.
3. Assemble and connect the module wiring.
4. Calibrate the Convectron gauge at atmospheric and vacuum pressures.

⚠ WARNING

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

If the module will measure any gas other than N_2 or air, before putting the module into operation, adjust the setpoint relays for the process gas that will be used.

Step 1 *Location and Orientation of the Module*

Figure 1-1 and Table 1-2 illustrate the physical dimensions of the module and vacuum fittings.

To locate and orient the module, refer to Figure 2-1, and follow the instructions below.

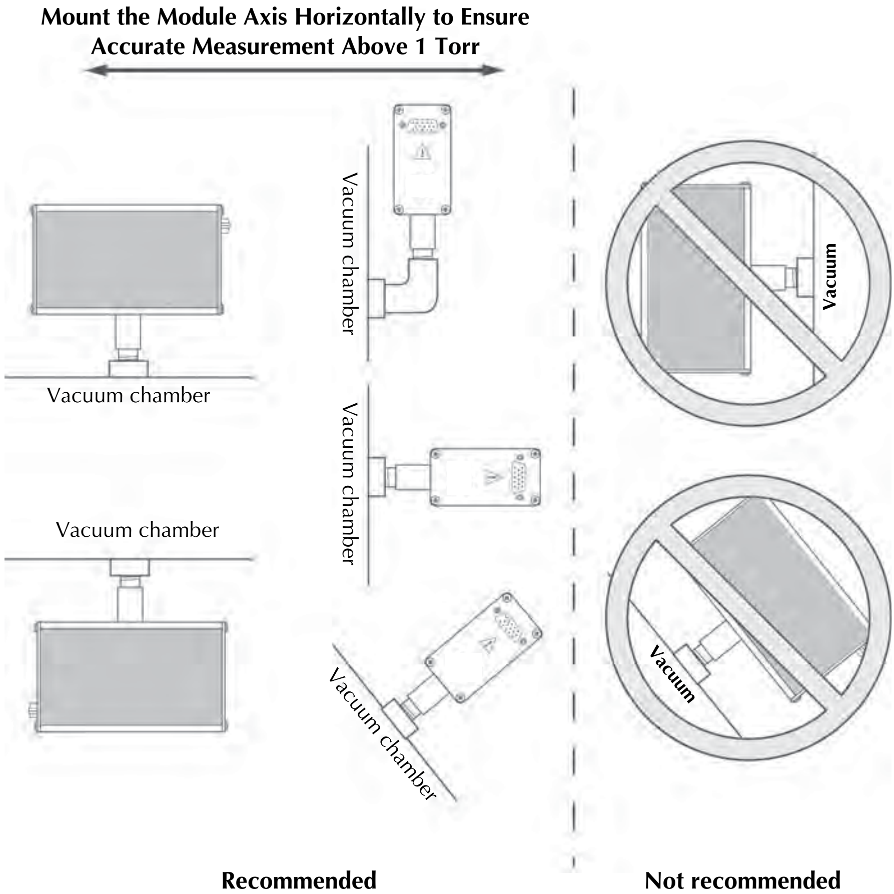
Determine the Best Location for the Module

- For greatest accuracy and repeatability, locate the module in a stable, room-temperature environment. Ambient temperature should never exceed 40 °C (104 °F) operating, non-condensing, or 70 °C (158 °F) non-operating.
- Locate the module away from internal and external heat sources and in an area where ambient temperature remains reasonably constant.
- Do not locate the module where it requires long lengths of tubing or has constricted tubing. Length of tubing depends on the application. Longer tubing will affect vacuum pressure limit and response time.
- Do not locate the module near the pump, where gauge pressure might be lower than normal vacuum chamber pressure.
- Do not locate the module near a gas inlet or other source of contamination, where inflow of gas or particulates causes atmospheric pressure to be higher than system atmosphere.
- Do not locate the module where it will be exposed to corrosive gases such as mercury vapor or fluorine.
- Do not locate the module where it will vibrate. Vibration causes convection cooling, resulting in inaccurate high pressure readings.

Orientation of the Module

For proper operation of the module above 1 Torr, orient the module so the axis is horizontal (see Figure 2-1). Although the Convectron gauge will read correctly below 1 Torr with the module mounted in any position, inaccurate readings will result at pressures above 1 Torr if the module axis is not horizontal.

Figure 2-1 Module Orientation



Step 2 *Attach the Module to the Vacuum Chamber*

Attach the module vacuum chamber fitting to its mate on the vacuum chamber.

CAUTION

Twisting the module to tighten the fitting to the vacuum chamber can damage the module's internal connections.

- **Do not twist the module to tighten the fitting.**
- **Use appropriate tools to tighten the fitting.**

CAUTION

Do NOT use Compression mount/Quick connect fittings for positive pressure applications. The gauge may be forcefully ejected.

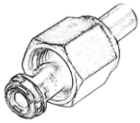
1/8 NPT pipe thread

The 1/8 NPT pipe thread accommodates a standard 1/8 NPT female fitting.

a. Wrap the threads of the port to the vacuum chamber with thread sealant tape.

b. Tighten the module just enough to achieve a seal.

VCR type fitting



VCR-type fitting

a. Remove the plastic or metal bead protector cap from the fitting.

b. If a gasket is used, place the gasket into the female nut.

c. Assemble the components and tighten them to finger-tight.

d. While holding a back-up wrench stationary, tighten the female nut 1/8 turn past finger-tight on 316 stainless steel or nickel gaskets, or 1/4 turn past finger-tight on copper or aluminum gaskets.

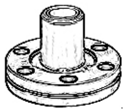
KF flange

The KF mounting system requires O-rings and centering rings between mating flanges.

a. Tighten the clamp to compress the mating flanges together.

b. Seal the O-ring.

ConFlat flange



To minimize the possibility of leaks with ConFlat flanges, use high strength stainless steel bolts and a new, clean OFHC copper gasket. Avoid scratching the seal surfaces. To avoid contamination, install metal gaskets.

a. Finger tighten all bolts.

b. Use a wrench to continue tightening 1/8 turn at a time in crisscross order until flange faces make contact.

c. Further tighten each bolt about 1/16 turn.

Step 3 *Assemble and Connect the Power and Interface Wiring*

Connecting Cable

The cable is user-supplied. Granville-Phillips does not supply the cable. Install externally shielded cable and connect the shield at both ends.

At the module end of the cable, connect the shield to the outer shell of the subminiature D connector.

Connect the 13.6 to 26.5 Vdc power supply to pins #3 and #4.

- Pin 3 (input) is positive (+).
- Pin 4 (ground) is negative (–).

NOTE: The Mini-Convectron Module is ON anytime input power is applied to the module. When power is ON, the sensor wire in the Convectron gauge operates at approximately 110 °C.

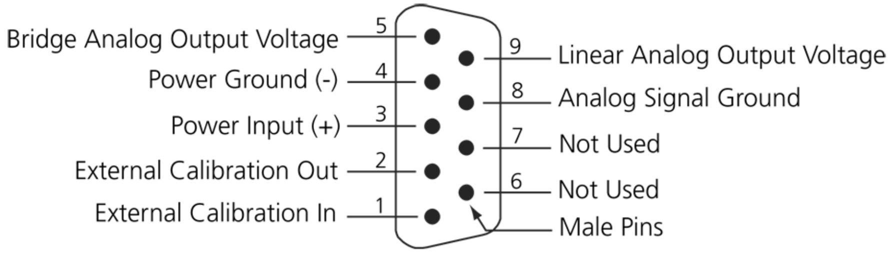
See Figure 3-3 for information on pins 1 and 2 for the external calibration function.

Ground the gauge to the vacuum chamber/facility ground point as explained in Grounding, beginning on page 20.

Wiring Terminals

Figure 2-2 illustrates the 9-pin D subminiature wiring terminals for the module.

Figure 2-2 9-Pin I/O and Power Connector



Grounding

⚠ WARNING

Improper grounding could cause product failure, property damage, or serious personal injury.

To reduce the risk of product failure, property damage, or serious personal injury, follow ground network requirements for the facility.

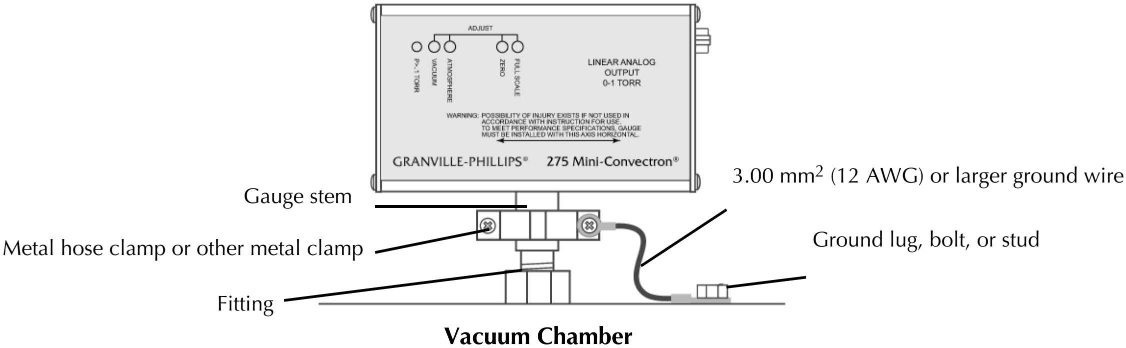
- Maintain all exposed conductors at earth ground.
- Ground the gauge to the vacuum chamber.
- Make sure the vacuum port to which the module is mounted is properly grounded.

If the fitting allows continuous metal-to-metal contact between the housing base and the vacuum chamber, the module is properly grounded via the fitting. If the fitting requires a rubber gasket, rubber O-ring, Teflon tape, or other material that prevents metal-to-metal contact between the housing base and the vacuum chamber, refer to Figure 2-3 and follow these instructions to ground the module to the vacuum chamber:

a. Attach a metal hose clamp or other metal clamp to the gauge stem of the housing.

b. Install a 3.31 mm^2 (12 AWG) or larger copper wire between the clamp and a metal ground lug, bolt, or stud on the vacuum chamber.

Figure 2-3 Ground Connection to the Vacuum Chamber



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WARNING

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

Step 4 *Calibrate the Convectron Gauge*

Calibration improves the accuracy and repeatability of the Convectron gauge. An atmospheric calibration is performed on the Convectron gauge, using N_2, at the factory before the module is shipped. The factory calibration sets the atmospheric calibration point to 760 Torr (101.3 kPa, 1013 mbar) of N_2.

Because performance varies depending on the process gas, you may need to reset the atmospheric calibration point if a gas other than N_2 or Air is being used. Periodic resets of the atmospheric calibration point also improve the accuracy and repeatability of the Convectron gauge near atmospheric pressure, even if the process gas is N_2 or Air. Regardless of the process gas that is being used, you should always use N_2 or Air to calibrate the Convectron gauge at vacuum chamber pressure.

The following calibration procedures (at Atmosphere and at Vacuum) are explained for calibration using N_2 or Air in the vacuum chamber. For calibration using other gases in the vacuum chamber, refer to *Understanding Convectron Gauge Pressure Measurement In Gases Other Than Nitrogen or Air*, beginning on page 28 in the Operation chapter.

Calibrate at Atmosphere

Perform this calibration procedure at Atmospheric pressure, using N_2 or Air in the vacuum chamber.

1. Apply power to the Convectron Module (see Step 3, above).
2. Turn OFF the vacuum pump and allow the vacuum chamber pressure to rise to Atmospheric pressure.
3. With a digital voltmeter, monitor the voltage between pins 5 and 8 of the 9-pin connector on the Mini-Convectron Module.
4. While monitoring the bridge analog output, adjust the ATMOSPHERE potentiometer (on the front of the Mini-Convectron Module) to a voltage that corresponds to the Atmospheric pressure of your location. See Table 2-1 for typical altitude/Torr/voltages.

Table 2-1 Typical Altitude/Torr/Bridge Voltage Relationships

Altitude Above Sea Level		Pressure of N_2 or Air			Analog Output Voltage
Feet	Meters	Torr	kPa	mbar	(Vdc)
0	0	760	101	1013	5.534
1000	305	733	97	977	5.513
2000	610	707	94	942	5.493
3000	914	681	90	908	5.473
4000	1219	656	87	874	5.454
5000	1524	632	84	842	5.435
6000	1829	609	81	812	5.417
7000	2134	586	78	781	5.399
8000	2438	564	75	752	5.382
9000	2743	543	72	724	5.366

Calibrate at Vacuum Chamber Pressure

Periodic resets of the vacuum chamber pressure calibration point improve the accuracy and repeatability of the Convectron gauge.

1. Evacuate the system to a pressure of less than 10^{-4} Torr.
2. With a digital voltmeter, monitor the voltage between pins 5 and 8 of the 9-pin connector on the Mini-Convectron Module.
3. While monitoring the bridge analog output voltage, adjust the VACUUM potentiometer to +0.375 Vdc.

Set the ZERO Adjustment

4. While monitoring the linear analog output voltage (pins 8 and 9 of the 9-pin connector), adjust the ZERO potentiometer to 0.0 Vdc.

Set the FULL SCALE Adjustment

The FULL SCALE adjustment calibrates the linear analog output voltage for the specific gas-type being used in the vacuum chamber.

There are 2 methods to set the FULL SCALE adjustment.

1. Use another gauge that is gas-independent and known to be accurate:
   a. Using the accurate gauge as a reference, raise the pressure in the system by backfilling with the gas type in use to approximately 1 Torr.
   b. Adjust the Full Scale potentiometer for a linear analog output voltage that corresponds to the output of the standard where 1 Torr = 10 Vdc.
2. Use the 1 Torr bridge output voltage as illustrated in Table 3-2 on page 31.
   a. Raise the pressure in the system by backfilling while monitoring the bridge analog output voltage. Stabilize at a voltage that corresponds to the 1 Torr data in Table 3-2 on page 31.
   b. Adjust the Full Scale potentiometer for a linear analog output voltage of 10.00 Vdc.

Notes

Chapter 3 Operation

This chapter explains how to operate the Mini-Convectron Module with a linear analog output. Calibrating the Convectron Gauge, and using the Convectron Gauge with gases other than N_2 or Air are explained.

3.1 Theory of Operation

The module measures gas pressures from 1 x 10^{-4} Torr to 1000 Torr. Vacuum chamber pressure is measured by a Convectron convection-enhanced Pirani heat-loss gauge.

The Convectron gauge operates like a standard Pirani gauge, which employs the principle of a Wheatstone bridge to convert pressure to voltage, but uses convection cooling to enable accurate pressure measurement, when properly calibrated, from 10^{-4} to 1000 Torr.

The sensing wire is an ultra-fine strand of gold-plated tungsten or solid platinum. The heated sensing wire loses more heat as the ambient gas pressure increases. The more molecules contact the sensing wire, the more power is required to keep the sensing wire at a constant temperature. So, as pressure increases, the voltage across the Wheatstone bridge also increases.

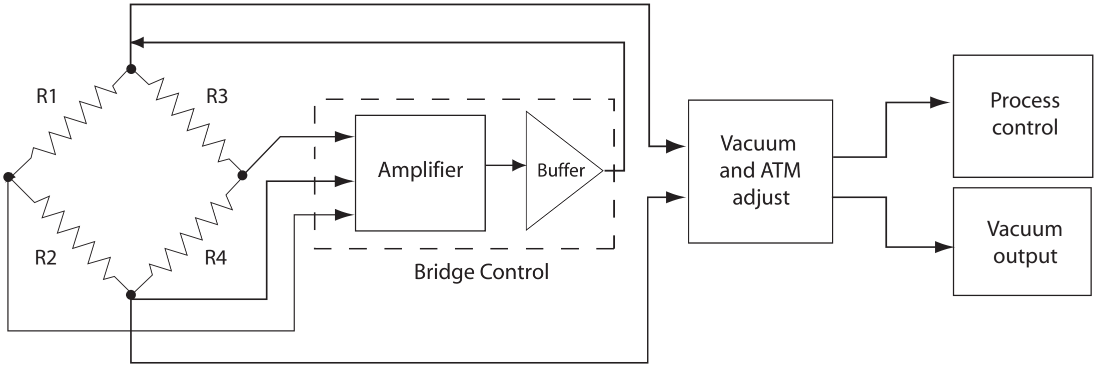
The Convectron gauge has a temperature compensator, which causes bridge voltage to remain unaffected by changes in ambient temperature.

Figure 3-1 is a diagram of the module controller. The Convectron gauge sensing wire is designated R_1 in the Wheatstone bridge circuit. The temperature compensator is designated R_2. At bridge null, the following equation applies:

$$R_1 = \frac{R_2 + R_3}{R_4}$$

Bridge voltage is a non-linear function of pressure. This relationship is illustrated in Figure 3-1. If the ambient temperature does not change, R_1 remains constant.

Figure 3-1 Wheatstone Bridge Diagram



Operation

As vacuum chamber pressure decreases, the number of molecules in the vacuum chamber and the resulting heat loss from the sensing wire also decrease. Temperature and R_1 resistance therefore increase.

The increased resistance through R_1 causes the bridge to become unbalanced and a voltage to develop across the null terminals. The bridge controller senses the null voltage and decreases the voltage across the bridge until the null voltage again equals zero. When the bridge voltage decreases, the power dissipation in the sensing wire decreases, causing R_1 resistance to decrease to its previous value.

A pressure increase causes an opposing series of occurrences, during which the bridge controller increases the bridge voltage to maintain a zero null voltage.

3.2 Front Panel Features

Easy-access potentiometers allow adjustment of the module readings to maintain accurate output signals. See Figure 3-2 on page 27.

P> .1 Torr Indicator: A red LED provides an indicator of the chamber pressure. The LED is OFF when the pressure is below .1 Torr, and gradually illuminates as the pressure increases.

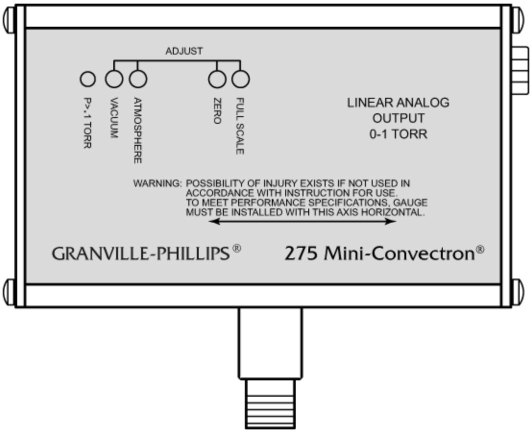
Vacuum Adjustment: Adjusts the bridge analog output voltage at low pressures. See *Calibrate at Vacuum Chamber Pressure* on page 22.

Atmosphere Adjustment: Adjusts the bridge analog output voltage to correspond to the known Atmospheric pressure. See *Calibrate at Atmosphere* beginning on page 21.

Zero Adjustment: Restores the accuracy of the linear analog output voltage at low pressure. See *Set the ZERO Adjustment* on page 22.

Full Scale Adjustment: Calibrates the linear analog output voltage for the specific gas-type being used in the vacuum chamber. See *Set the FULL SCALE Adjustment* on page 23.

Figure 3-2 Mini-Convectron Module Front Panel - Indicator and Adjustments



3.3 Preparing for Operation

Before putting the module into operation, you must perform the following procedures:

1. Install the module in accordance with the instructions on pages 15-23.
2. Develop a logic diagram of the process control function.
3. Attach a copy of the process control circuit diagram to this manual for future reference and troubleshooting.

If you need application assistance, phone a Granville-Phillips application engineer at 1-303-652-4400 or 1-800-776-6543.

Once the module is operating, you can use the module front panel to perform the calibration tasks.

3.4 Nonlinear (Bridge) Analog Output

The module contains a convection-enhanced Pirani thermal conductivity gauge. The gauge measures the heat loss from a heated sensing wire that is maintained at a constant temperature.

The analog output produces a nonlinear voltage that corresponds to measured pressure. Output voltage is measured across pins 5 and 8 of the 9-pin connector.

Refer to Table 3-1 on page 30 to calculate pressure (y) as a function of output voltage (x). Figure 3-5 and Figure 3-6 on pages 35 and 36 are graphs that represent true pressure for N_2 or Air (y axis) versus voltage (x axis).

- Output impedance is 100 Ω.
- The output is normalized to 0.375 Vdc at vacuum chamber pressure and to 5.534 Vdc at 1000 Torr (133.3 kPa, 1333 mbar) for N_2 or air.

The vacuum chamber pressure indicated by the gauge depends on the gas

Operation

type, gas density (pressure), and the module orientation. The module is factory calibrated for N_2 (air has approximately the same calibration). For gases other than N_2 or air, heat loss varies at any given pressure, and you must apply an appropriate conversion factor.

3.5 Understanding Convectron Gauge Pressure Measurement In Gases Other Than Nitrogen or Air

Convectron Gauges are Pirani type thermal conductivity gauges that measure the heat loss from a heated sensor wire maintained at constant temperature. The module electronics convert this measurement into gas pressure readings. For gases other than nitrogen or air the heat loss varies at any given true pressure and can result in inaccurate pressure readings.

It is important to understand that the pressure indicated by a Convectron Gauge depends on the type of gas, the orientation of the gauge axis, and on the gas density in the gauge. Convectron Gauges are normally factory calibrated for N_2 (air has approximately the same calibration). With proper precautions, the Convectron Gauge may be used for pressure measurement of certain other gases.

NOTE: The information in this section applies only when the Convectron Gauge is calibrated for N_2 and the Convectron Gauge is mounted with its axis horizontal.

At pressures below a few Torr, there is no danger in measuring pressure of gases other than N_2 and air, merely inaccurate readings. A danger arises if the N_2 calibration is used without correction to measure higher pressure levels of some other gases. For example, N_2 at 24 Torr causes the same heat loss from the Convectron sensor as argon will at atmospheric pressure. If the pressure indication of the Convectron Gauge is not properly corrected for argon, an operator attempting to fill a vacuum system with 1/2 atmosphere of argon would observe a pressure reading of only 12 Torr when the actual pressure had risen to the desired 380 Torr. Continuing to fill the system with argon to 760 Torr would result in a 24 Torr pressure reading.

Depending on the pressure of the argon gas source, the chamber could be dangerously pressurized while the display continued to read about 30 Torr of N_2 equivalent pressure.

NOTE: This type of danger is not unique to the Convectron Gauge and likely exists with other thermal conductivity gauges using convection to extend the range to high pressures.

To measure the pressure of gases other than air or N_2 with a Convectron Gauge calibrated for N_2 you must use the conversion curves listed specifically for Convectron Gauges to translate between indicated pressure and true pressure. Do not use other data. Never use the conversion curves designed for Convectron Gauges to translate pressure readings for gauges made by other manufacturers. Their geometry is very likely different and dangerously high pressures may be produced even at relatively low pressure indications.

NOTE: You must ensure that the atmosphere adjustments for the Mini-Convectron Module are correctly set. See Calibrate at Atmosphere on page 21.

3.6 Commonly used Gases Other than N_2 or Air

If the gas being used is not included in Table 3-2, or for a gas mixture, you will need to generate a calibration curve using a gas-independent transfer standard such as a capacitance manometer. Use the following equation to determine the maximum usable output voltage:

$$\text{Output voltage} = \text{Input voltage} - 4\ \text{Vdc}$$

Refer to Table 3-2 on page 31 for pressure versus output voltage for 10 commonly used process gases other than N_2 or air.

Figure 3.5 and Figure 3.6 illustrate the relationship of true pressure for N_2 versus the bridge analog output voltage. See *Bridge Analog Output Voltage* on page page 32.

Figure 3-5 illustrates the relationship of true pressure for various gases versus the linear analog output voltage. See Linear Analog Output Voltage on page 32.

Figure 3-8, through Figure 3-13 illustrate the relationship of true pressure versus indicated pressure for several commonly used gases.

⚠ WARNING

Using the Mini–Convectron Module to measure the pressure of flammable or explosive gases can cause a fire or explosion resulting in severe property damage or personal injury.

Do not use the Mini–Convectron Module to measure the pressure of flammable or explosive gases.

Table 3-1 Equations for Calculating N_2 or Air Pressure versus Bridge Analog Output Voltage

Segment	Output Voltage	Equation where y = Pressure and x = Voltage	Coefficients	
1	0.375 to 2.842 V	$y_{Torr} = a + bx + cx^2 + dx^3 + ex^4 + fx^5$ $y_{Pa} = (a + bx + cx^2 + dx^3 + ex^4 + fx^5) \times 133.3$ $y_{mbar} = (a + bx + cx^2 + dx^3 + ex^4 + fx^5) \times 1.333$	a	–0.02585
			b	0.03767
			c	0.04563
			d	0.1151
			e	–0.04158
			f	0.008737
2	2.842 to 4.945 V	$y_{Torr} = \frac{a + cx + ex^2}{1 + bx + dx^2 + fx^3}$ $y_{Pa} = \left(\frac{a + cx + ex^2}{1 + bx + dx^2 + fx^3}\right) \times 133.3$ $y_{mbar} = \left(\frac{a + cx + ex^2}{1 + bx + dx^2 + fx^3}\right) \times 1.333$	a	0.1031
			b	–0.3986
			c	–0.02322
			d	0.07438
			e	0.07229
			f	–0.006866
3	4.94 to 5.659 V	$y_{Torr} = \frac{a + cx}{1 + bx + dx^2}$ $y_{Pa} = \left(\frac{a + cx}{1 + bx + dx^2}\right) \times 133.3$ $y_{mbar} = \left(\frac{a + cx}{1 + bx + dx^2}\right) \times 1.333$	a	100.624
			b	–0.37679
			c	–20.5623
			d	0.0348656

Table 3-2 Bridge Analog Output Voltage (Vdc) for Various Gases

True pressure														
Torr/mTorr	kPa	mbar	N_2 (air)	Argon	Helium	O_2	CO_2	KR	$Freon_{12}$	$Freon_{22}$	D_2	Ne	CH_4
0	1.3×10^{-4}	1.3×10^{-3}	.375	.375	.375	.375	.375	.375	.375	.375	.375	.375	.375
.1 mTorr	1.3×10^{-5}	2.6×10^{-3}	.376	.375	.375	.376	.376	.375	.376	.376	.376	.375	.376
.2 mTorr	2.6×10^{-5}	6.0×10^{-3}	.477	.376	.376	.377	.377	.376	.378	.378	.377	.376	.378
.5 mTorr	6.0×10^{-5}	1.3×10^{-2}	.479	.378	.379	.380	.381	.377	.382	.381	.381	.378	.382
1 mTorr	1.3×10^{-4}	1.3×10^{-3}	.384	.381	.382	.384	.385	.379	.388	.388	.386	.381	.3896
2 mTorr	2.6×10^{-4}	2.6×10^{-3}	.392	.387	.389	.392	.395	.384	.401	.400	.396	.388	.403
5 mTorr	6.0×10^{-4}	6.0×10^{-3}	.417	.403	.409	.417	.412	.395	.437	.432	.425	.405	.438
10 mTorr	1.3×10^{-3}	1.3×10^{-2}	.455	.429	.441	.453	.462	.415	.488	.480	.470	.433	.492
20 mTorr	2.6×10^{-3}	2.6×10^{-2}	.523	.477	.497	.521	.536	.451	.581	.566	.549	.484	.584
50 mTorr	6.6×10^{-3}	6.6×10^{-2}	.682	.595	.637	.679	.705	.544	.778	.764	.727	.608	.796
100 mTorr	1.3×10^{-2}	1.3×10^{-1}	.876	.745	.814	.868	.900	.668	1.009	.990	.944	.768	1.053
0.2 Torr	2.6×10^{-2}	2.6×10^{-1}	1.155	.962	1.068	1.141	1.179	.847	1.315	1.291	1.265	1.002	1.392
0.5 Torr	6.6×10^{-2}	6.6×10^{-1}	1.683	1.386	1.589	1.664	1.668	1.194	1.826	1.805	1.914	1.469	2.014
1 Torr	1.3×10^{-1}	1.3	2.217	1.818	2.164	2.195	2.172	1.536	2.257	2.247	2.603	1.976	2.632
2 Torr	2.6×10^{-1}	2.6	2.842	2.333	2.939	2.814	2.695	1.921	2.647	2.666	3.508	2.631	3.313
5 Torr	6.6×10^{-1}	6.6	3.675	3.028	4.387	3.672	3.316	2.429	3.029	3.090	5.059	3.715	–
10 Torr	1.33	1.33×10^{1}	4.206	3.480	5.774	4.225	3.670	2.734	3.204	3.330	6.361	4.605	4.699
20 Torr	2.66	2.66×10^{1}	4.577	3.801	7.314	4.620	3.903	2.966	3.308	3.414	–	5.406	5/172
50 Torr	6.66	6.66×10^{1}	4.846	4.037	–	4.916	4.071	3.075	3.430	3.509	–	6.159	5.583
100 Torr	1.33×10^{1}	1.33×10^{2}	4.945	4.122	–	5.026	4.154	3.134	3.618	3.660	–	6.483	5.720
200 Torr	2.66×10^{1}	2.66×10^{2}	5.019	4.192	–	5.106	4.336	3.269	3.827	3.883	–	6.661	5.860
300 Torr	3.99×10^{1}	3.99×10^{2}	5.111	4.283	–	5.200	4.502	3.384	3.938	4.005	–	6.726	–
400 Torr	5.33×10^{1}	5.33×10^{2}	5.224	4.386	–	5.315	4.621	3.466	4.016	4.088	–	6.767	6.103
500 Torr	6.66×10^{1}	6.66×10^{2}	5.329	4.477	–	5.422	4.708	3.526	4.076	4.151	–	6.803	–
600 Torr	7.99×10^{1}	7.99×10^{2}	5.419	4.550	–	5.515	4.775	3.573	4.124	4.203	–	6.843	6.342
700 Torr	9.33×10^{1}	9.33×10^{2}	5.495	4.611	–	5.592	4.830	3.613	4.166	4.247	–	6.890	–
760 Torr	1.01×10^{2}	1.01×10^{3}	5.534	4.643	–	5.633	4.860	3.632	4.190	4.271	–	6.920	–
800 Torr	1.06×10^{2}	1.06×10^{3}	5.558	4.663	–	5.658	4.877	3.645	4.203	4.286	–	6.942	6.519
900 Torr	1.19×10^{2}	1.19×10^{3}	5.614	4.706	–	5.713	4.919	3.674	4.237	4.321	–	7.000	–
1000 Torr	1.33×10^{2}	1.33×10^{3}	5.659	4.745	–	5.762	4.955	–	4.270	4.354	–	7.056	6.642

3.7 Bridge Analog Output Voltage

Figure 3-5 and Figure 3-6 illustrate the relationship of true pressure as bridge analog output voltage (Vdc) when using N_2 or Air in the vacuum system. The graphs are plotted using the data in Table 3-2, which lists the bridge analog output voltage at various pressures, using various gases. The data can also be used to plot a graph for a particular gas being used in your vacuum system.

For gases not listed in Table 3-2 (or a mixture of gases), use a gas-independent transfer standard such as a capacitance manometer to record the data to create a graph for your particular process. The maximum usable bridge analog voltage output will depend on the input voltage used. Use the following equation to determine the maximum usable output voltage:

$$\text{Output Voltage} = \text{Input Voltage} - 4\ \text{Vdc}$$

3.8 Linear Analog Output Voltage

Figure 3-5 illustrates the relationship of true pressure as analog output voltage (Vdc) when using various gases in the vacuum system. Using this data, a close approximation of true pressure can be calculated without the need to recalibrate the Mini-Convectron Module. Thus, you can determine a relative gas sensitivity constant and the true pressure of a particular gas for a module that is calibrated for N_2/Air. Use the following equation (or Table 3-3) to determine the true pressure:

$$\text{mTorr} = \frac{\text{Linear Analog Output Vdc}}{\text{Sensitivity}}$$

Table 3-3 Typical Sensitivity/Voltage Relationships

Gas Type	Average Relative Sensitivity
Krypton	.41
Argon	.61
Neon	.73
Helium	.93
CO_2	.95
Oxygen	.97
N_2, Air	1.00
Freon 22	1.18
Freon 12	1.22
D_2	1.37
CH_4	1.56

3.9 External Calibration

It is possible to accomplish a full scale calibration of the linear analog output externally to the Mini-Convectron Module for use in a system where multiple gases are being switched. By varying the feedback resistor of the final amplifier from a nominal of 10 K Ohm, you can compensate for the approximate resistance value shown in Table 3-3. Use a rotary switch or multiple relays to the approximate resistance values listed in Table 3-4.

Figure 3-3 External Calibration Schematic

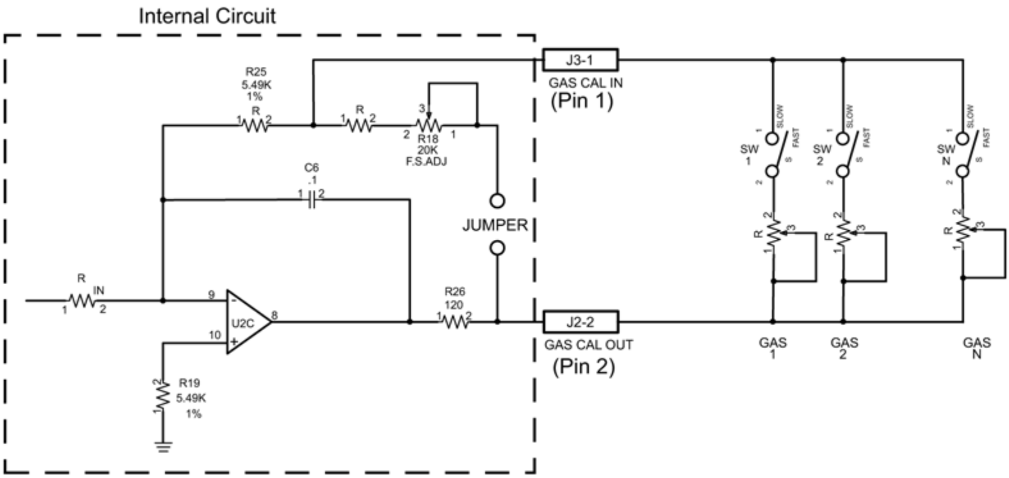


Table 3-4 Typical Altitude/Torr/Voltage Relationships

Gas Type	Approximate R Value (K)	Less R25 (- 5.49K)
Krypton	24.3 K	18.81 K
Argon	16.5 K	11.01 K
Neon	13.7 K	8.21 K
Helium	10.7 K	5.21 K
CO_2	10.5 K	5.01 K
Oxygen	10.3 K	4.81 K
N_2, Air	10.0 K	4.51 K
Freon 22	8.5 K	3.01 K
Freon 12	8.2 K	2.71 K
D_2	7.3 K	1.81 K
CH_4	6.4 K	0.91 K

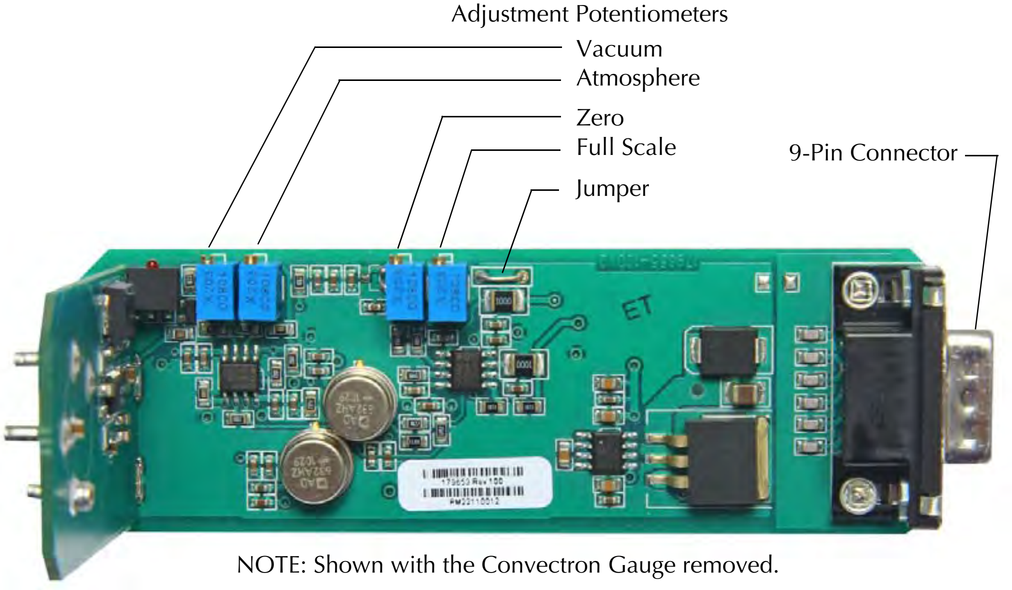
Operation

NOTE: To use the external calibration technique, a jumper inside of the Mini-Convectron Module must be removed.

To remove the internal jumper:

1. Turn OFF power to the Mini-Convectron Module and unplug the 9-pin connector on the side of the module.
2. Remove the 4 screws on each side of the module but not the two D-connector hex head jack screws.
3. Remove the end plate that does *not* have a connector, then remove both sides of the blue housing.
4. Separate the 2 halves of the module body.
5. Locate the 22 AWG bare-wire jumper along the top of the PC Board, labeled "JUMPER".
6. Clip (cut) the jumper wire to remove it.
7. Reassemble the module and reconnect the 9-pin connector.

Figure 3-4 Mini-Convectron Module - Internal Jumper



NOTE: Shown with the Convectron Gauge removed.

Figure 3-5 Analog Output Voltage vs. Indicated N_2 or Air Pressure, 1 mTorr to 100 mTorr

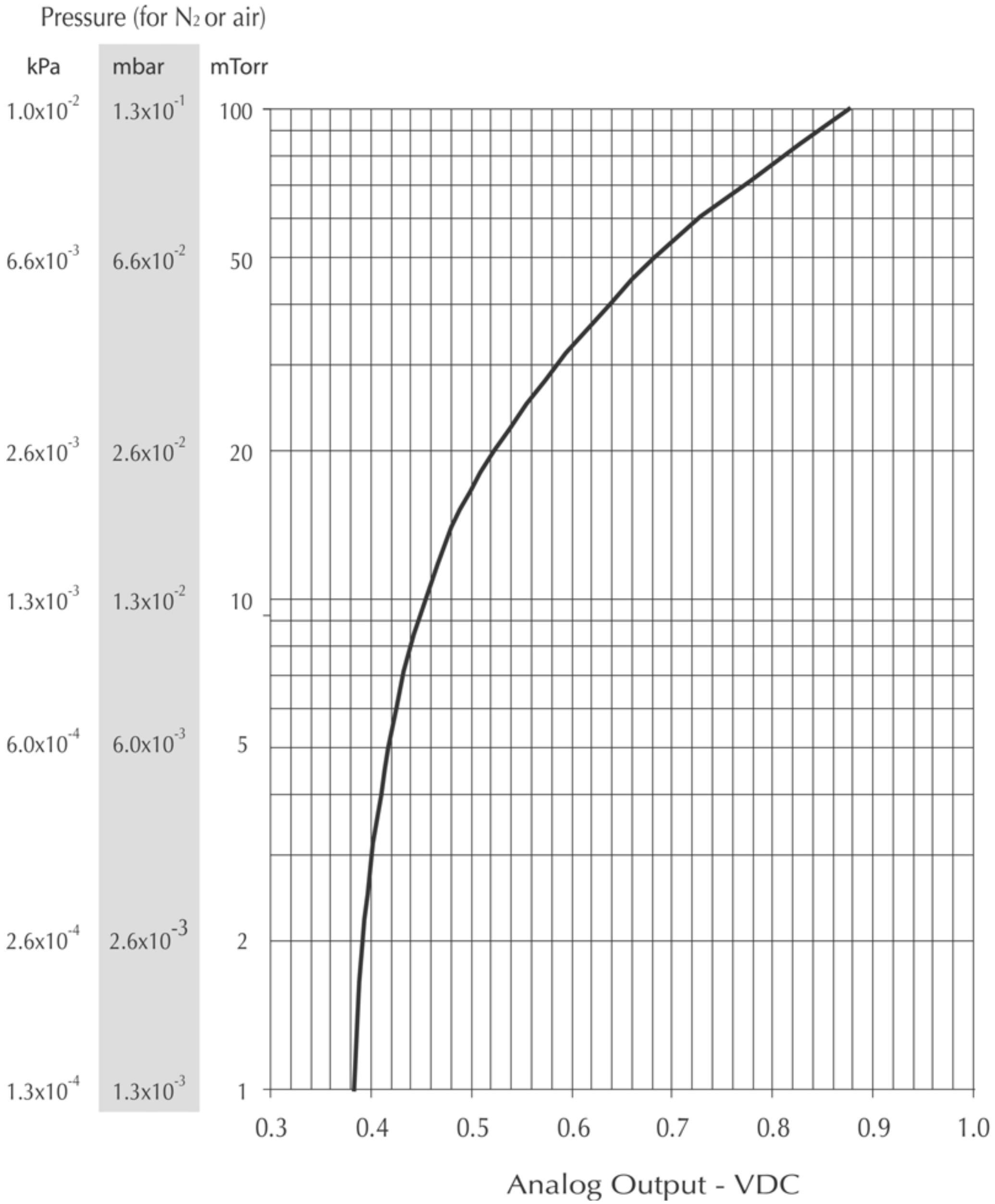


Figure 3-6 Analog Output Voltage vs. Indicated N_2 or Air Pressure, 0.1 Torr to 1000 Torr

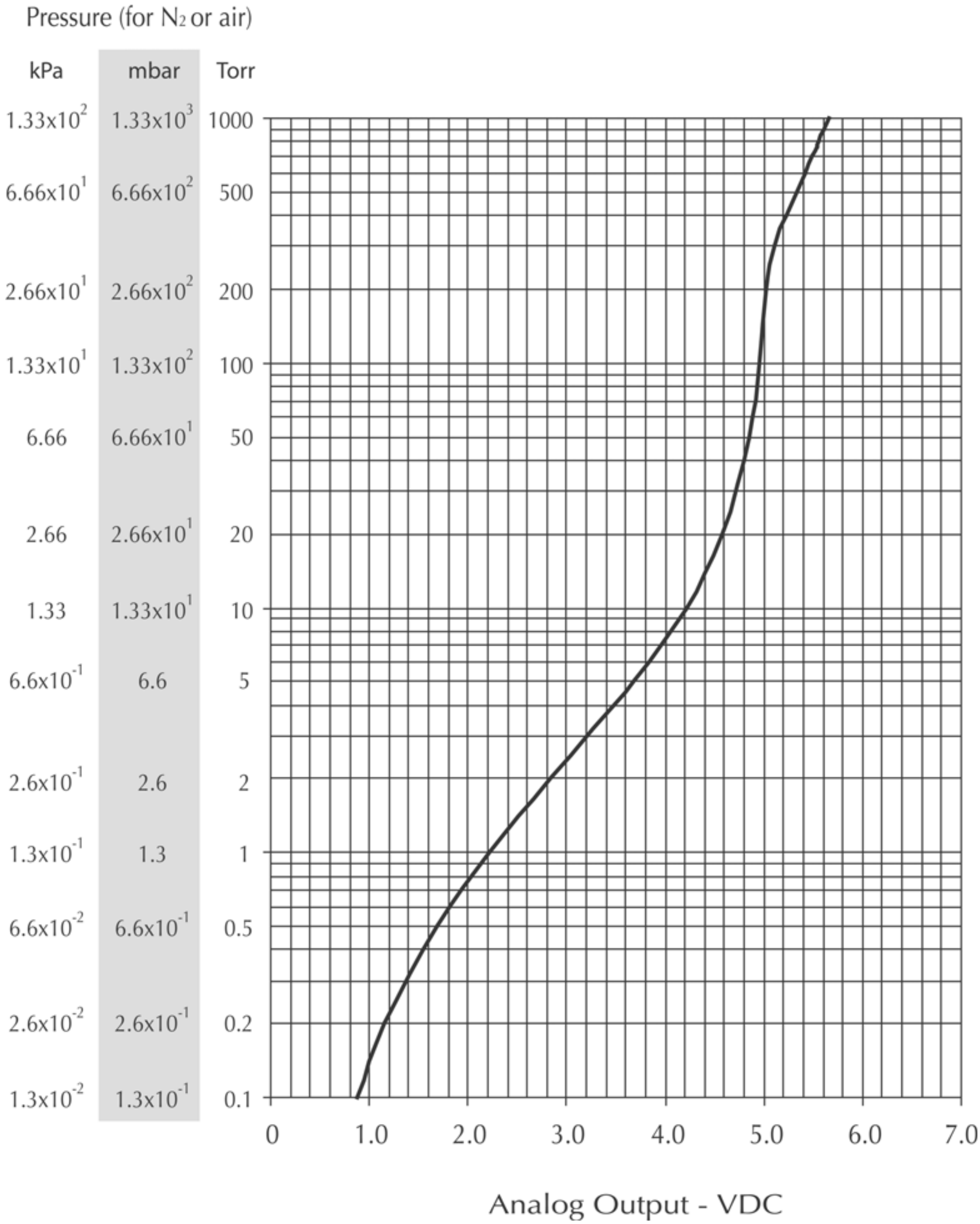


Figure 3-7 Linear Analog Output Voltage (Vdc) for Various Gases

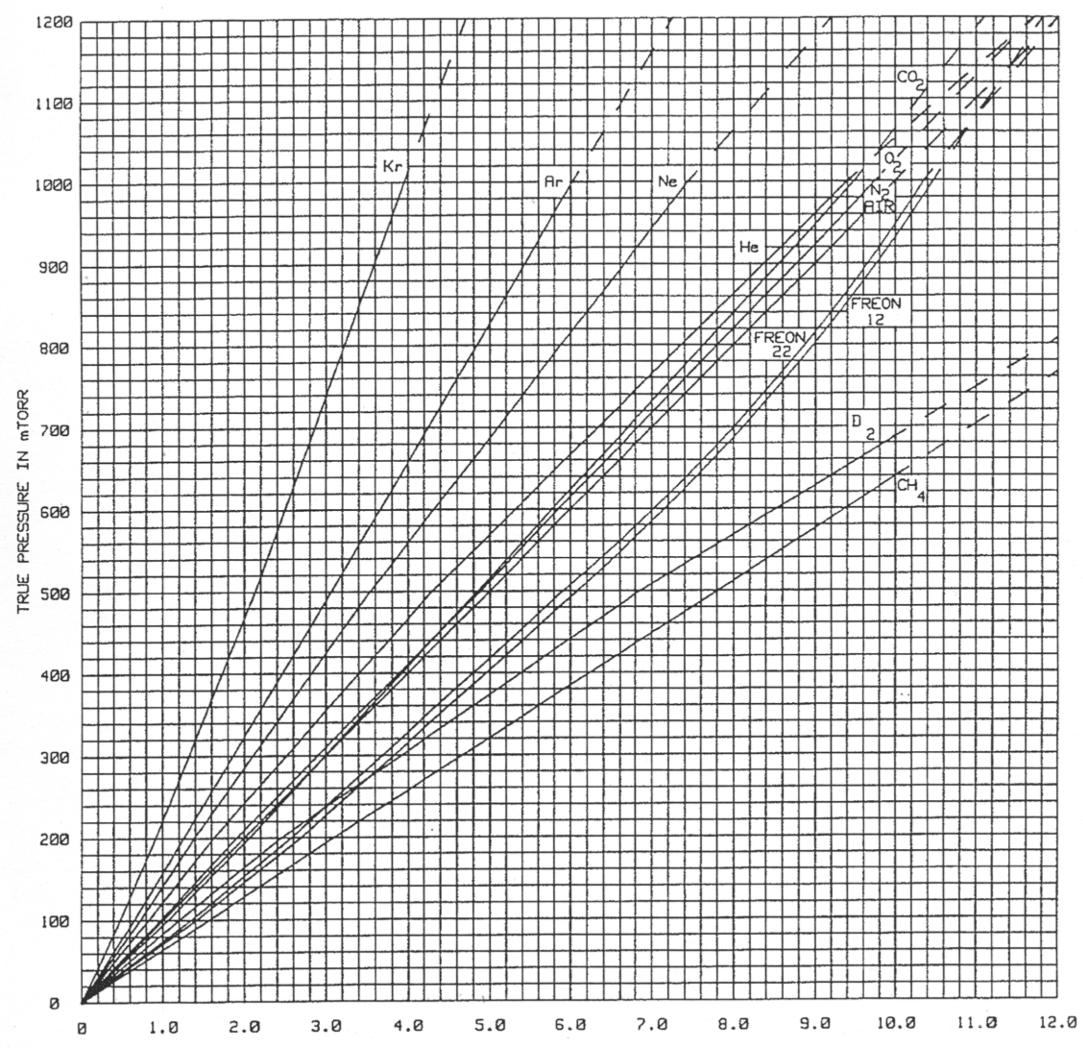
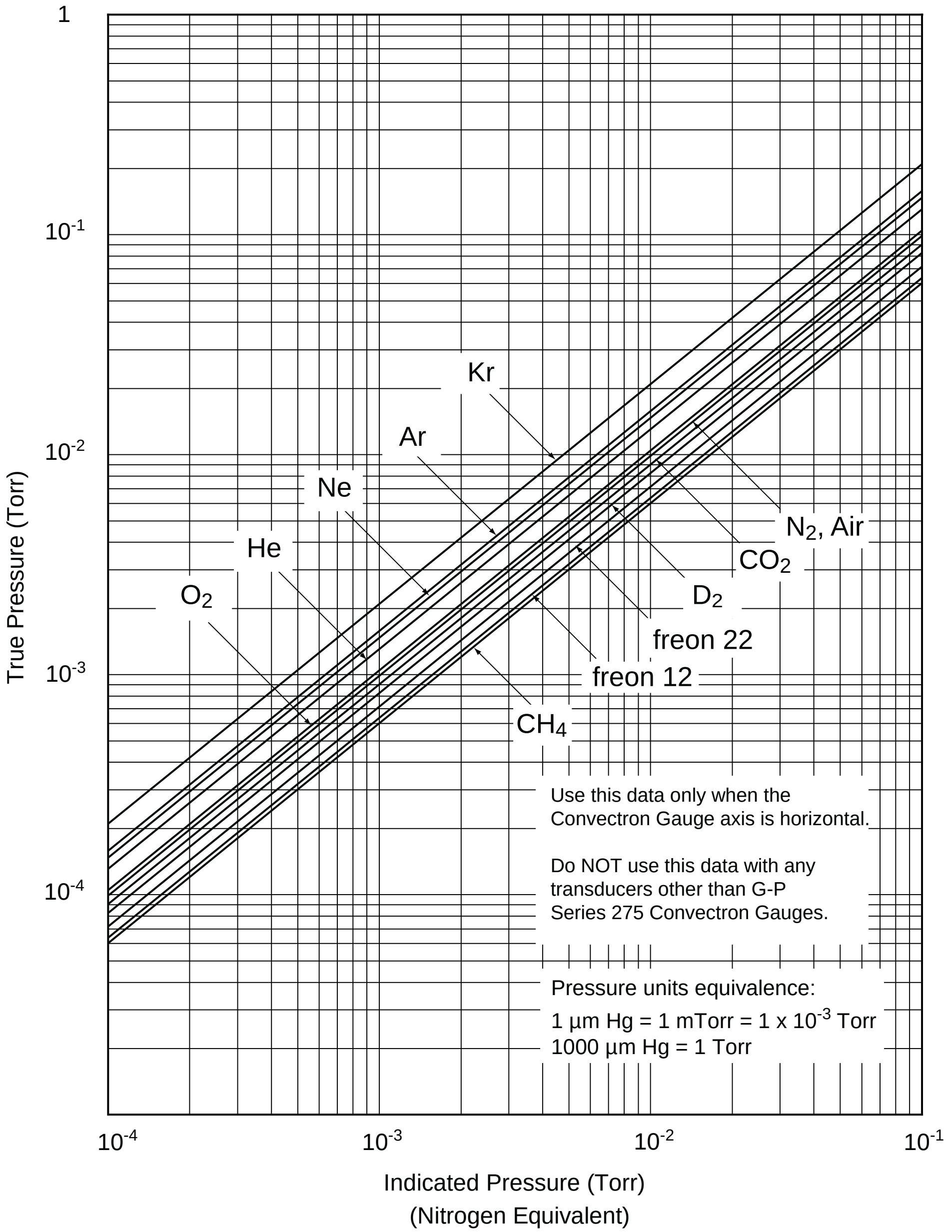
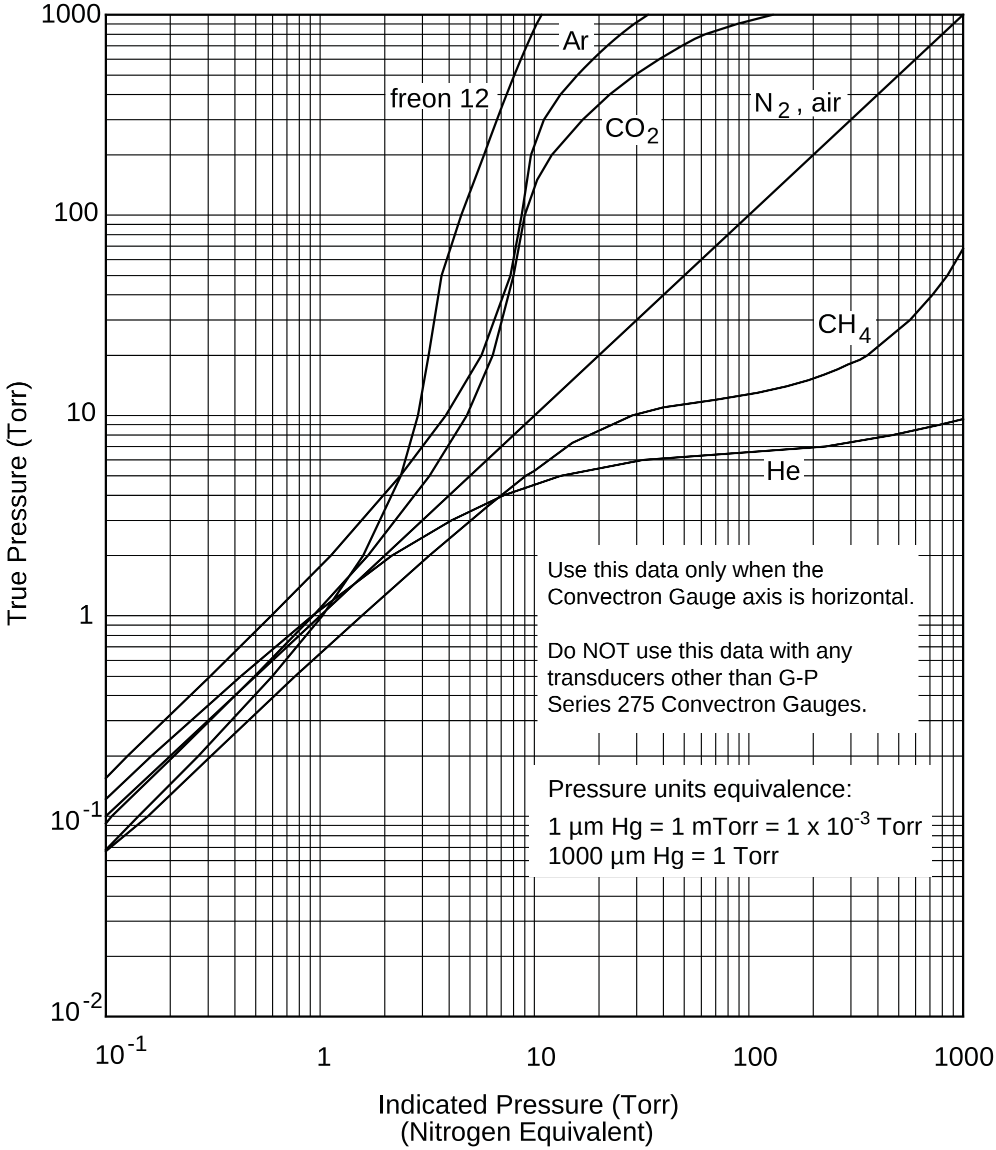


Figure 3-8 True Pressure versus Indicated Pressure for Commonly used Gases, 10^{-4} to 10^{-1} Torr



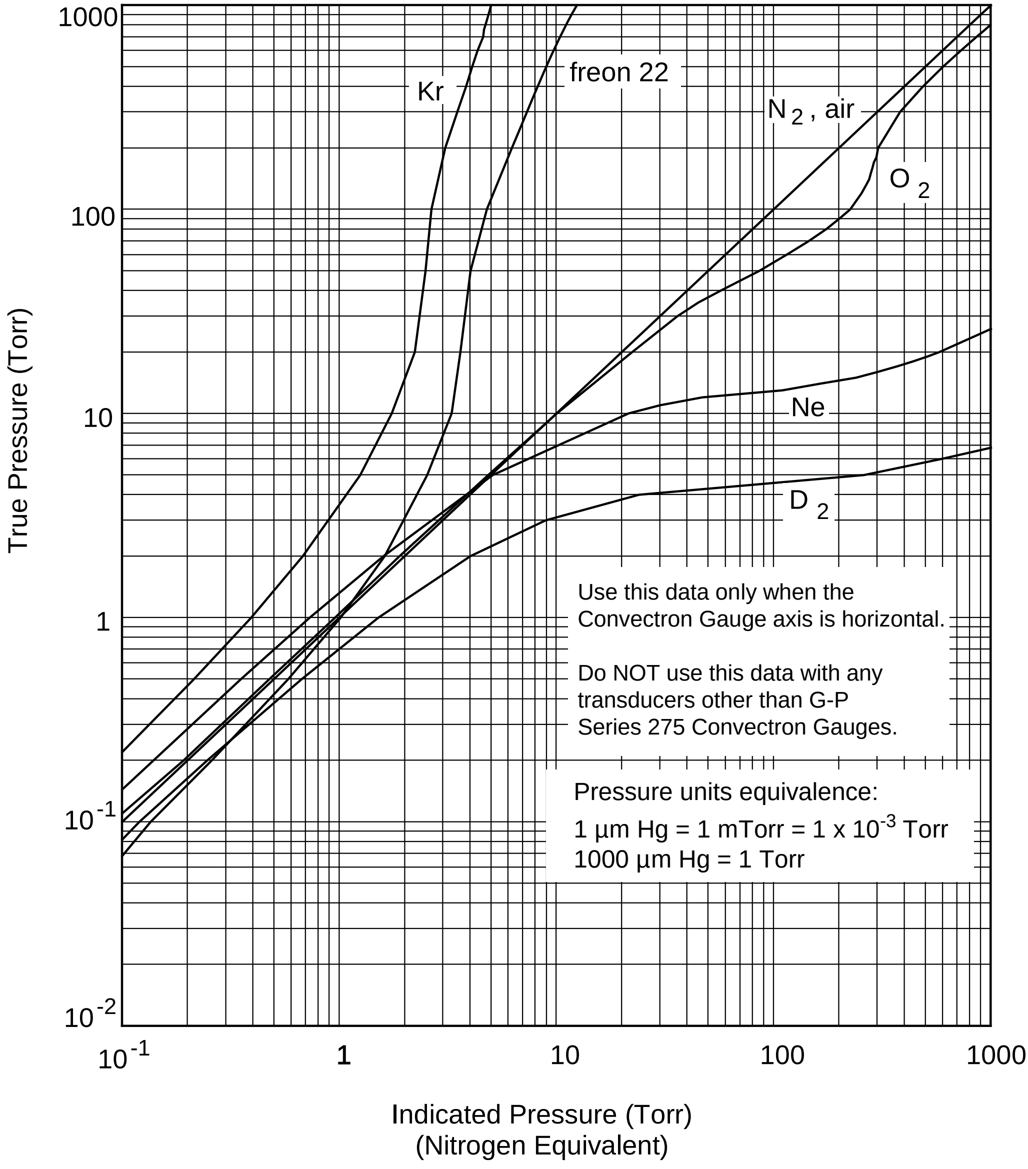
Convectron Gauge Indicated vs. True Pressure Curves: 0.1 to 100 mTorr

Figure 3-9 True Pressure versus Indicated Pressure for Commonly used Gases, 10^{-1} to 1000 Torr



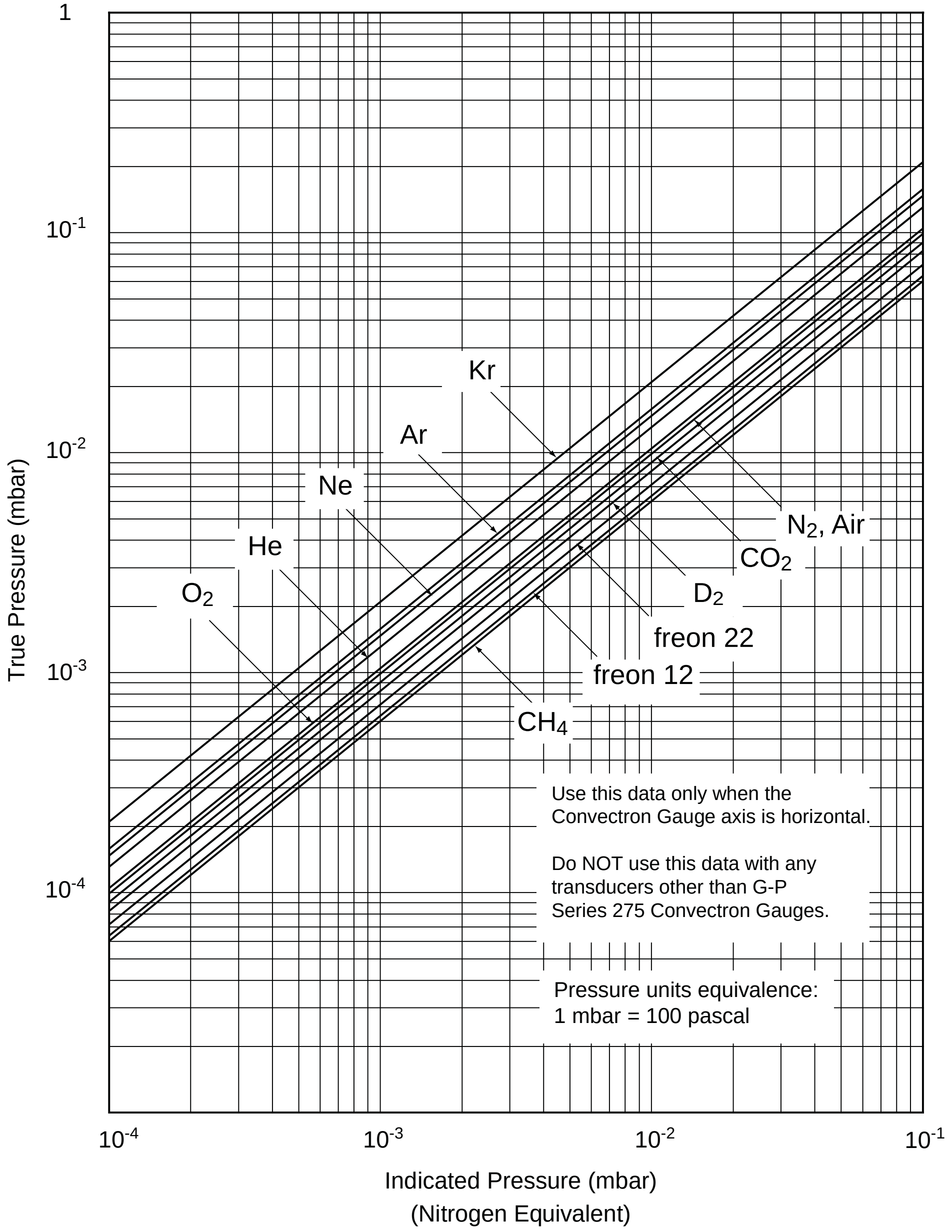
Convectron Gauge Indicated vs. True Pressure Curves: 0.1 to 1000 Torr

Figure 3-10 True Pressure versus Indicated Pressure for Commonly used Gases, 10^{-1} to 1000 Torr



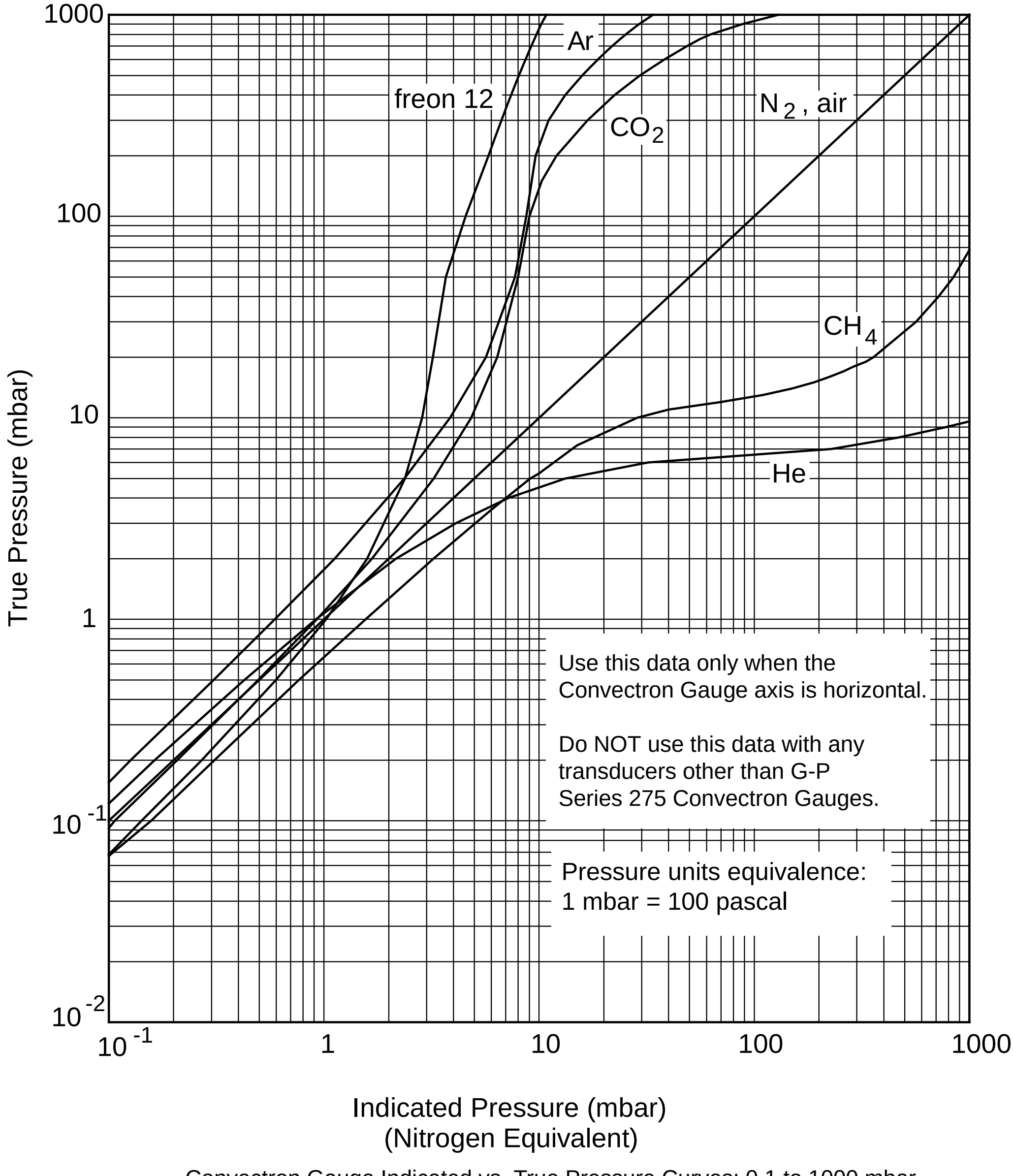
Convectron Gauge Indicated vs. True Pressure Curves: 0.1 to 1000 Torr

Figure 3-11 True Pressure versus Indicated Pressure for Commonly used Gases, 10^{-4} to 0.1 mbar



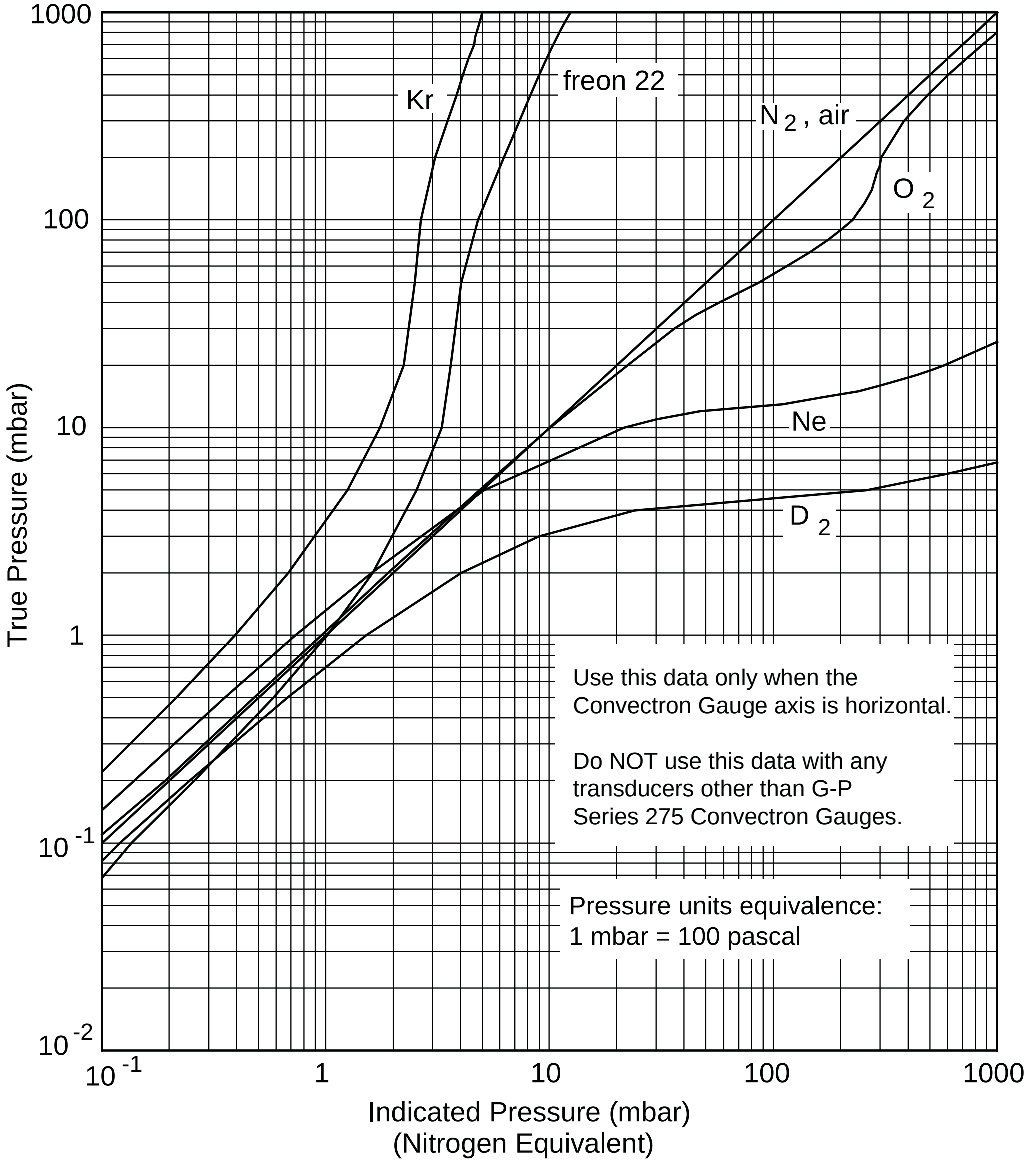
Convectron Gauge Indicated vs. True Pressure Curves: 10^{-4} to 0.1 mbar

Figure 3-12 True Pressure versus Indicated Pressure for Commonly used Gases, 0.10 to 1000 mbar



Convectron Gauge Indicated vs. True Pressure Curves: 0.1 to 1000 mbar

Figure 3-13 True Pressure versus Indicated Pressure for Commonly used Gases, 0.10 to 1000 mbar



Convectron Gauge Indicated vs. True Pressure Curves: 0.1 to 1000 mbar

3.10 Modules Operating at Low Pressure

During a fast pumpdown from atmospheric pressure, thermal effects temporarily prevent the module from measuring pressure accurately below 1×10^{-3} Torr (1.3×10^{-4} kPa, 1.3×10^{-3} mbar). After approximately 15 minutes, pressure indications the 1×10^{-4} Torr (1.3×10^{-5} kPa, 1.3×10^{-4} mbar) range will be accurate.

When pressure indication in the 1×10^{-4} Torr (1.3×10^{-5} kPa, 1.3×10^{-4} mbar) range has stabilized, a Convectron gauge calibration at vacuum chamber pressure may be performed.

The calibration may be performed at a higher pressure if readings in the 1×10^{-4} Torr (1.3×10^{-5} kPa, 1.3×10^{-4} mbar) range are not required. If the module frequently operates in the 1×10^{-4} Torr (1.3×10^{-5} kPa, 1.3×10^{-4} mbar) range, Convectron gauge calibration at vacuum chamber pressure should be performed frequently.

Chapter 4 Maintenance

4.1 Customer Service

For Customer Service / Technical Support:

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

Damage Requiring Service

Turn OFF power to the module and refer servicing to qualified service personnel under the following conditions:

a. If any liquid has been spilled onto, or objects have fallen into, the module.

b. If a circuit board is faulty.

c. If the Convectron gauge sensing wire is open or the gauge is contaminated.

d. If the module has been exposed to moisture.

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

f. If the module has been dropped or the enclosure has been damaged.

g. If the module exhibits a distinct change in performance.

If the module requires repair:

- See *Returning a Product for Repair* on page 50.

4.2 Troubleshooting

If any of the conditions described on page 45 have occurred, troubleshooting is required to determine the repairs that are necessary.

Precautions

Because the Convectron gauge contains static-sensitive electronic parts, follow these precautions while troubleshooting:

- Use a grounded, conductive work surface. Wear a high impedance ground strap for personal protection.
- Do not operate the module 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.
- Rely on voltage measurements for troubleshooting module circuitry. Do not use an ohmmeter.
- Use a grounded, electrostatic discharge safe soldering iron.

⚠ WARNING

Substitution or modifying parts can result in serious product damage or personal injury due to electrical shock or fire.

- Install only those replacement parts that are specified by Granville−Phillips.
- Do not install substitute parts or perform any unauthorized modification to the module.
- Do not use the module if unauthorized modifications have been made.

⚠ WARNING

Failure to perform a safety check after the module has been repaired can result in serious property damage or personal injury due to electrical shock or fire.

If the module has been repaired, before putting it back into operation, make sure qualified service personnel perform a safety check.

Symptoms, Causes, and Solutions

Table 4-1 lists failure symptoms, causes, and solutions.

Table 4-1 Failure Symptoms, Causes, and Solutions

Symptom	Possible Causes	Solution
Output voltage = 0 V	13.6 to 26.5 Vdc power supply cable is improperly connected or faulty.	Repair or replace power supply cable (see page 19).
Pressure reading is too high.	• Conductance in connection to vacuum chamber is inadequate. • Plumbing to module leaks or is contaminated. • Chamber pressure is too high due to leak, contamination, or pump failure. • Power supply or output cable is improperly connected or faulty.	• If conductance is inadequate, reconnect Convectron gauge port to vacuum chamber (see page 20). • If the system plumbing leaks or is contaminated, clean, repair or replace the plumbing. • If the pump has failed, repair or replace it. • If the cable is improperly connected or faulty, repair or replace the cable (see page 19).
Pressure reading is inaccurate.	• Module is not calibrated for the process gas that is being used. • Module is not mounted horizontally. • Convectron gauge is damaged (for example, by reactive gas) or contaminated. • Temperature or mechanical vibration is extreme.	• If the Convectron gauge is out of calibration, recalibrate it (see page 29). • If the module is not mounted horizontally, re-mount it (see page 17). • If the Convectron gauge is damaged, replace it (see page 49). • If the Convectron gauge is contaminated, return it to factory (see pages 49 and 50). • If temperature or vibration is extreme, relocate the module or eliminate the source of heat or vibration.
Indicated pressure is different than pressure indications from other measurement devices.	• Process gas is a not the gas that the user anticipated using in the system. • Convectron gauge is defective.	• If the process gas is not what was anticipated, calibrate the Convectron gauge for the gas that is being used (see page 29). • If the Convectron gauge is defective, return it to factory (see pages 49 and 50).

4.3 Convectron Gauge Test

⚠ CAUTION

Do not perform a Convectron gauge test with an instrument that applies more than 0.1 V of electromotive force.

Performing a Convectron gauge test with instruments that apply more than 0.1 V with the gauge at vacuum chamber pressure can result in property damage.

Even a small amount of voltage can damage the small diameter sensing wire inside the Convectron gauge.

To determine if the Convectron gauge sensing wire has been damaged, follow these instructions:

1. Remove the Convectron gauge as instructed on page 49.
2. Use a *low-voltage (maximum 0.1 V) ohmmeter* to check resistance values across the pins on the base of the gauge. Pin numbers are embossed on the base. Figure 4-1 illustrates the base of the gauge.

The resistance across the pins should be within the ranges listed in Figure 4-1. If resistance across pins 1 and 2 is not approximately 18 to 23 Ω or if other listed resistance values are greater than the listed values, the gauge is defective. Install a replacement Convectron gauge as instructed on page 49.

Figure 4-1 Convectron Gauge Pins

- 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.

  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 may be eroded and the gauge will have to be replaced.

4.4 Convectron Gauge Removal and Replacement

⚠ WARNING

Removing or replacing the Convectron gauge in a high–voltage environment can cause an electrical discharge through a gas or plasma, resulting in serious property damage or personal injury due to electrical shock.

Vent the vacuum chamber to atmospheric pressure and shut off power to the module before you remove or replace the Convectron gauge.

Removing the Convectron Gauge

To avoid contaminating the Convectron gauge, wear sterile gloves during the removal procedure.

1. Vent the vacuum chamber to atmospheric pressure and *turn OFF power to the module*.
2. Unplug the 9-pin electrical connector.
3. Detach the module from the vacuum chamber.
4. Remove the four Phillips-head screws from both module end plates, but do not remove the hex nuts that hold the D subminiature connector in place.
5. Remove the end plate that does *not* have a connector, then remove both sides of the blue housing.
6. *Carefully* unplug the Convectron gauge from the spring-loaded sockets in the printed circuit board.

Replacing the Convectron Gauge

To avoid contaminating the Convectron gauge, wear sterile gloves during the replacement procedure.

1. Align the gauge pins so they mate with spring-loaded sockets in the printed circuit board. *Carefully* insert the Convectron gauge pins into the sockets.
2. Position the end plates and put both blue parts of the housing into place, making sure the gauge grounding springs and cradles are in line with the gauge envelope.
3. Re-install the Phillips-head screws into the end plates.
4. Use the fitting to re-attach the module to the vacuum chamber.
5. Plug in the 9-pin electrical connector.
6. Turn ON power to the Module, and check it for proper operation.

4.5 Returning a Product for Repair

If the product requires service, contact the MKS Technical Support Department at 1-303-652-4400 or 1-800-776-6543 for troubleshooting help over the phone.

If the product must be returned to the factory for service, request a Return Material Authorization (RMA) from MKS, which can be completed at *https://www.mksinst.com/service/servicehome.aspx*. Do not return products without first obtaining an RMA. In most cases a hazardous materials disclosure form is required. The MKS Customer Service Representative will advise you if the hazardous materials document is required.

When returning products to MKS, be sure to package the products to prevent shipping damage. Damaged returned products as a result of inadequate packaging is the Buyer's responsibility.

For Customer Service / Technical Support:

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Index

Series 275

Mini-Convectron® Vacuum Gauge Module with Linear Analog Output

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Instruction Manual

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