Series 275

Granville-Phillips® Convectron® Vacuum Gauge Bridge Amp PC Board with Analog Output Signal

Instruction Manual

Instruction manual part number 275331
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Series 275

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Instruction Manual

Table of Contents

Notes:

Chapter 1

Safety Instructions

1.1 Safety Introduction

BEGIN BY READING THESE IMPORTANT SAFETY INSTRUCTIONS AND NOTES collected here for your convenience and repeated with additional information at appropriate points in these instructions.

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

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 page 2 or the back cover of this instruction 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 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 Granville–Phillips for service and repair to ensure that safety features are maintained. Do not use this product if it has unauthorized modifications.

1.2 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 onto, 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 damaged.

f. When the product exhibits a distinct change in performance. This indicates a need for service.

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 determine that the product is in safe operating order.

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.

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.

1.3 Overpressure Conditions

Series 275 Gauges should not be used above 1000 Torr (1333 mbar, 133 kPa, 19 psi) true pressure.

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 Section 4.5

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

Vacuum gauges with compression fittings may be forcefully ejected if the vacuum system is pressurized. A pressure relief valve should be installed in the system if the possibility of exceeding 1000 Torr (1333 mbar, 133 kPa, 19 psi) exists.

Suppliers of pressure relief valves and pressure relief disks are listed in the *Thomas Register* under "Valves, Relief" and "Discs, Rupture."

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.

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 Section 4.5 in the Operation Chapter before using with gases other than N_2 or air.

Warning – 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 a malfunction could 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.

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.

1.4 System Grounding

Be certain that ground circuits are correctly used on vacuum chambers and components, regardless of their manufacturer. Safe operation of vacuum equipment, including the Convectron Gauge, requires grounding of all exposed conductors of the vacuum system.

Proper Grounding:

All components of a vacuum system must be maintained at Earth ground for safe operation. The power supply of this product must 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 supply 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 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.

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:

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1.6 Warranty Information

MKS Instruments, Inc. 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 MKS, Granville-Phillips Division 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.

Notes:

Chapter 2

Specifications

2.1 General Specifications

- Do not use the Convectron Gauge or control electronics in an area of high vibration, extreme shock, or an environment that exceeds +50 °C during operation.
- Do not use the Convectron Gauge to measure pressures of explosive gases.
- Always be sure that all components of the vacuum system are properly grounded.

Table 2-1 Specifications

Function	Description
System	
Measuring range for Air or N_2 (*See the Operation Chapter of this instruction manual for correction curves for other gases.*)	1 mTorr to 1000 Torr N_2 or equivalent
Resolution	1 x 10^{-4} Torr
Bridge Amplifier PC Board	
Power required	±12 Vdc, 200 mA max
Connector	15-pin "D" connector
Ambient operating temperature range	+15 °C to +50 °C (+59 °F to +122 °F)
Non-operating temperature range	-40 °C to +70 (-40 °F to 158 °F)
Dimensions	2.47 x 3.00 inches. See Figure 2-2.
Analog (Recorder) output voltage	0 to 9 volts, ±5%, ±0.05 v, non-linear, monotonically increasing with pressure. See Section 4.6 in the Operation Chapter.
Convectron Gauge	
Gauge tube internal volume	40 cc (2.5 cu in.)
Weight	340 gm (12 oz) with 1/8 NPT fitting
Sensor wire	Gold-plated Tungsten
Gauge mounting position	Horizontal preferred. See Figure 3-1.
Gauge tube temperature compensation range	+15 to +50 °C (+59 °F to +122 °F)
Bakeout temperature (non-operating)	+150 °C max. (+302 °F)

2.2 Convectron Gauge Tube Construction

All materials are compatible for ultra high vacuum service, corrosion resistance and bakeability to 150 °C. The gauge tube envelope is type 304 stainless steel. All metallic joints in the envelope are welded. No solder is used within the envelope. The following materials are exposed to the vacuum: Type 304 stainless steel, Carpenter Alloy 52, Kovar, Kapton®, gold-plated Tungsten, and borosilicate glass.

2.3 Convectron Gauge Dimensions

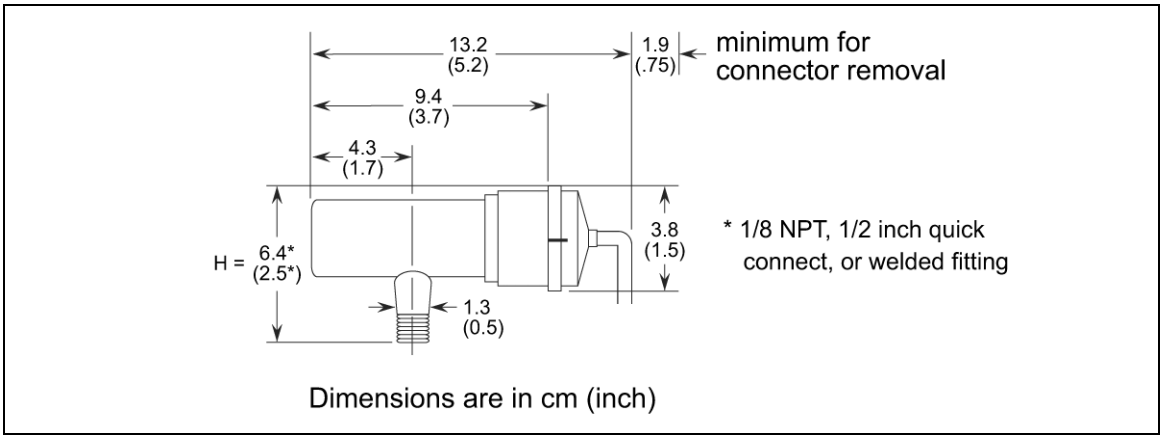

Figure 2-1 Convectron Gauge Dimensions

Table 2-2 Fitting/Flange Dimensions

Fitting		Description	Dimension H
	1/8 NPT pipe thread 1/2 inch compression fitting	1/8 NPT pipe thread / 1/2 inch tubulation	6.4 cm (2.52 in.)
	VCR-type female fitting	1/4 inch VCR-type female fitting (standard) 1/2 inch VCR-type female fitting	7.2 cm (2.83 in.) 8.1 cm (3.19 in.)
	ConFlat-type flange	1.33 inch (NW16CF) ConFlat-type 2.75 inch (NW35CF) ConFlat-type	8.0 cm (3.15 in.) 8.0 cm (3.15 in.)
	KF flange	NW16KF flange NW25KF flange NW40KF flange	7.3 cm (2.87 in.) 7.3 cm (2.87 in.) 7.9 cm (3.11 in.)

2.4 Bridge Amplifier PC Board

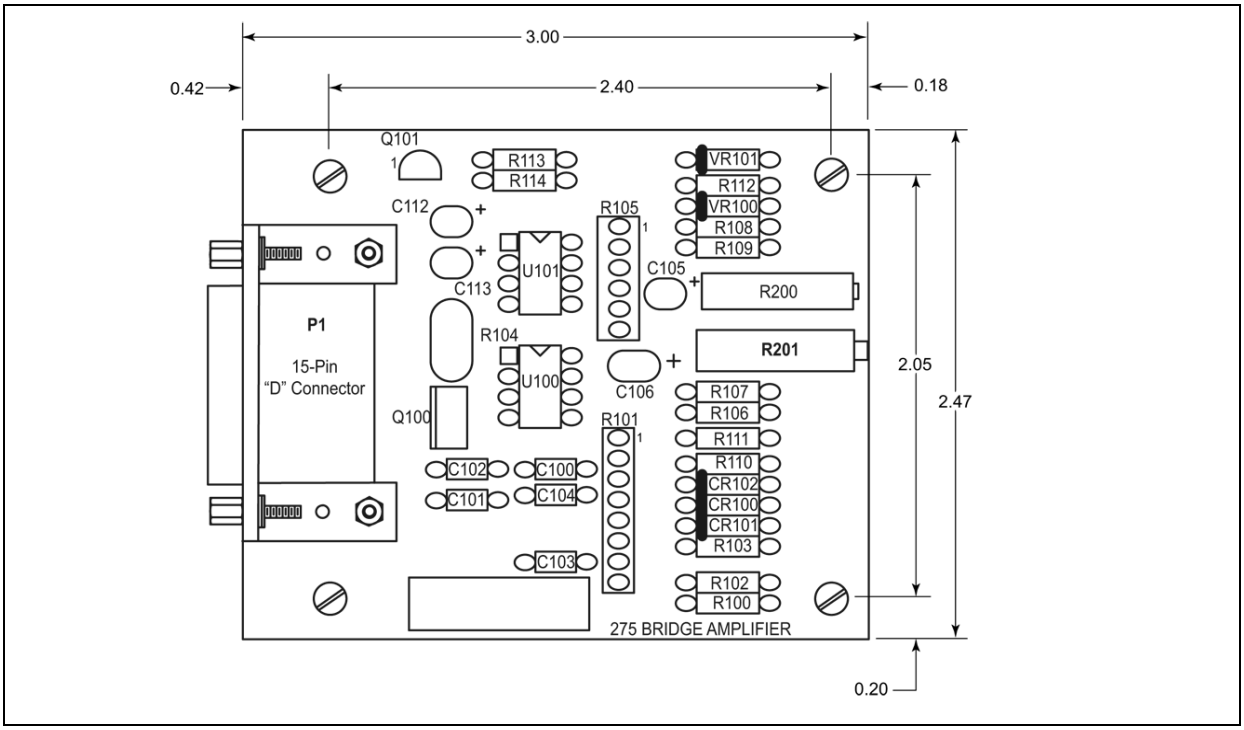

Figure 2-2 Bridge Amplifier PC Board

Notes:

3.1 Install the Convectron Gauge

For proper operation above about 1 Torr, install Convectron gauges with the gauge axis horizontal. To minimize pressure indication errors, avoid installing the Convectron gauge where it will vibrate. Vibration causes convection cooling of the sensor and will cause the pressure indication to be high.

For proper operation of the module above 1 Torr, orient the module so the axis is horizontal (see Figure 3-1). 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.

3.1.1 Mounting Options

- **Compression Mount/Quick Connect**
  Do not use for positive pressure applications. The gauge may be forcefully ejected.

  The gauge port is designed to fit a standard 1/2 in. compression/quick connect mounting such as an Ultra-Torr fitting.

  Remove the caplug 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 will ensure 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° horizontal circle for optimum routing of the gauge tube cable.
- **1/8 NPT Mount**
  Fits standard 1/8 NPT female fitting. Wrap the threads of the gauge port with thread seal tape and hand tighten. Do not use a wrench or tool. Tighten only sufficiently to achieve a seal.
- **VCR/VCO Mount**
  Remove the plastic or metal bead protector cap from the bead. When using gasket, place it into the female nut where applicable. Assemble components and snug finger-tight. While holding a backup wrench stationary, tighten the female nut 1/8 turn past finger-tight for 316 stainless steel and nickel gaskets; or 1/4 turn past finger-tight for copper and aluminum gaskets.
- **NW10KF, NW16KF, NW25KF and NW40KF 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.
- **ConFlat Flange Mount**
  To minimize 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, do not use nonmetal gaskets.

  After finger tightening all bolts, continue tightening about 1/8 turn in crisscross order, e.g., 1, 4, 2, 5, 3, 6, 4 . . . until the flanges are in contact. After contact, further tighten each bolt about 1/16 turn.

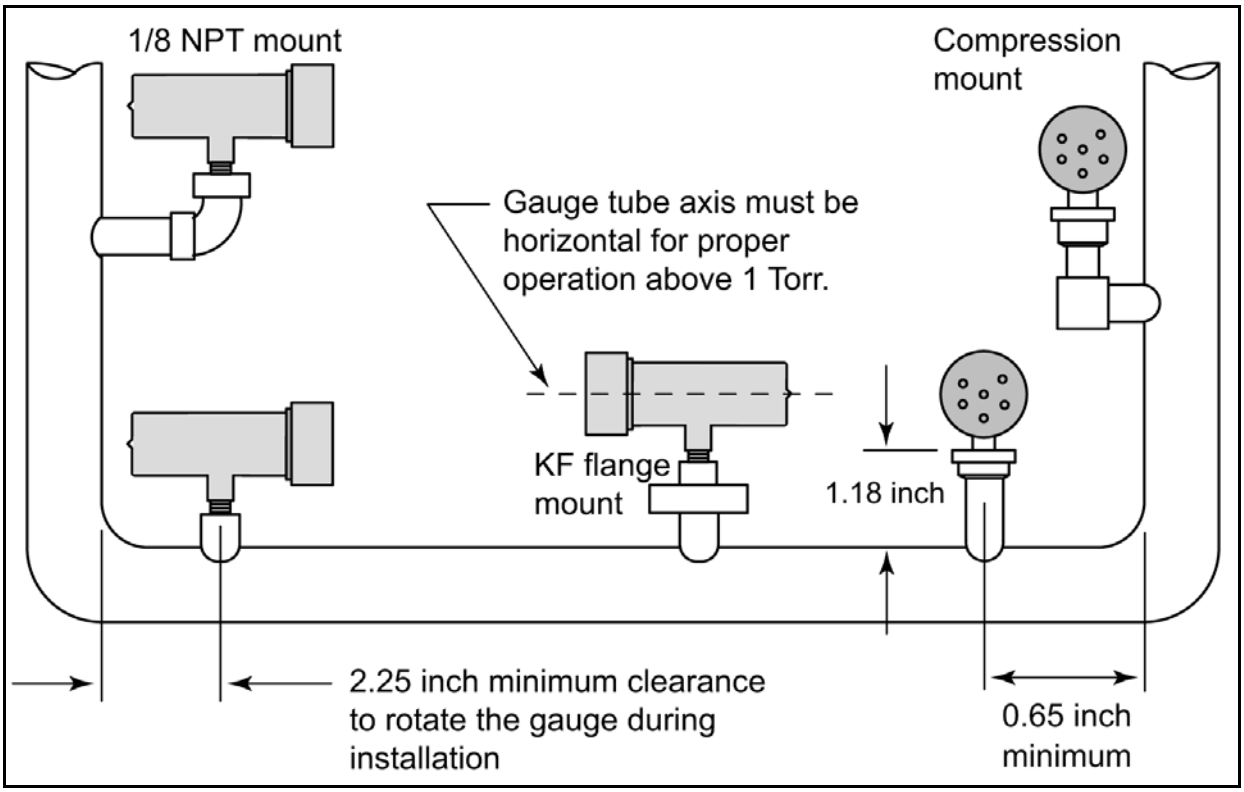

Figure 3-1 Recommended Convectron Gauge Installation

3.1.2 Grounding

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 Convectron Gauge to the vacuum chamber as instructed below.

Make sure the vacuum port to which the Convectron Gauge 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, pipe sealing tape, or other material that prevents metal-to-metal contact between the Convectron Gauge and the vacuum chamber, refer to Figure 3-2 and follow these instructions to ground the module to the vacuum chamber:

1. Attach a metal hose clamp or other metal clamp to the gauge stem.
2. Install a 3.31 mm2 (12 AWG) or larger copper wire between the clamp and a metal ground lug, bolt, or stud on the vacuum chamber.

Figure 3-2 Ground Wire Attached to the Convectron Gauge

3.2 Install the Bridge Amplifier PC Board

Install the bridge amplifier PC board in your existing enclosure. Dimensions are given in Figure 3-3.

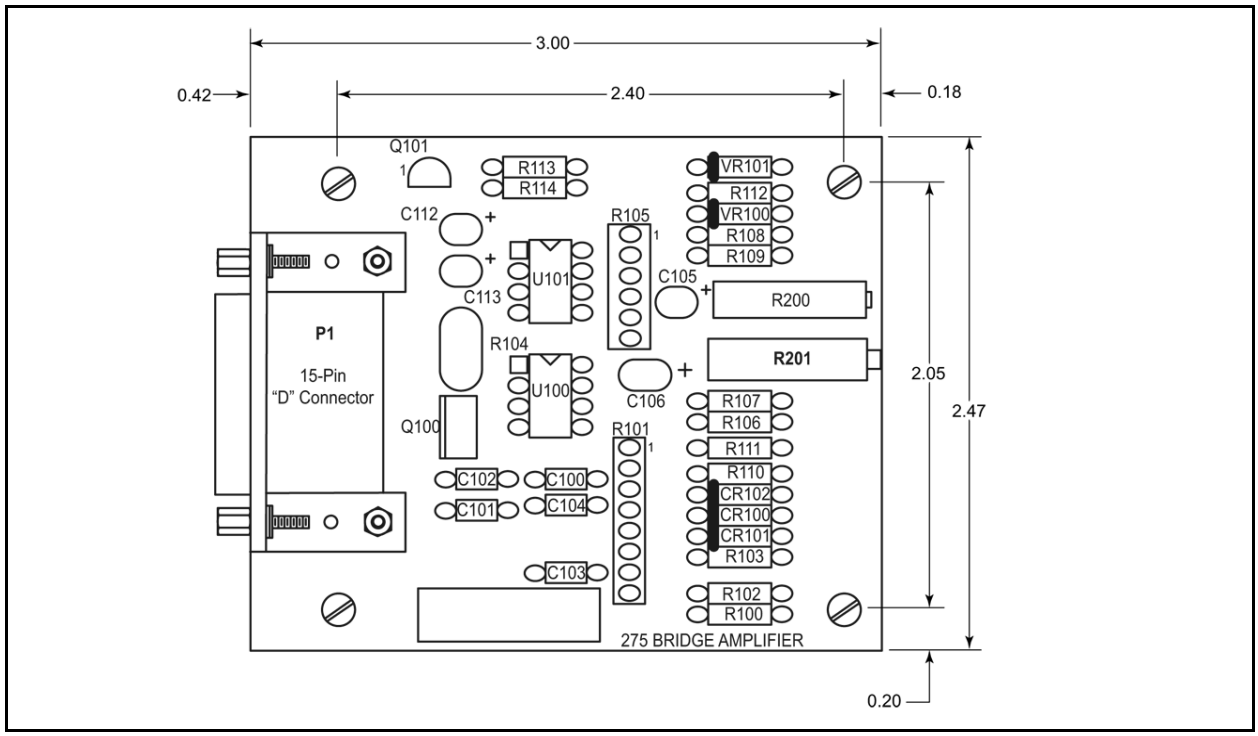

Figure 3-3 Convectron Gauge Bridge Amplifier PC Board

3.2.1 Install the Interconnect Cable

1. Connect the cable between the bridge amplifier PC board and the Convectron Gauge. See Figure 3-4.
2. Connect ±12 Vdc power to the PCB (pins 13, 14, and 15). See Figure 3-4.
3. Connect the analog output wires to monitor pressure output (pins 11 and 12).

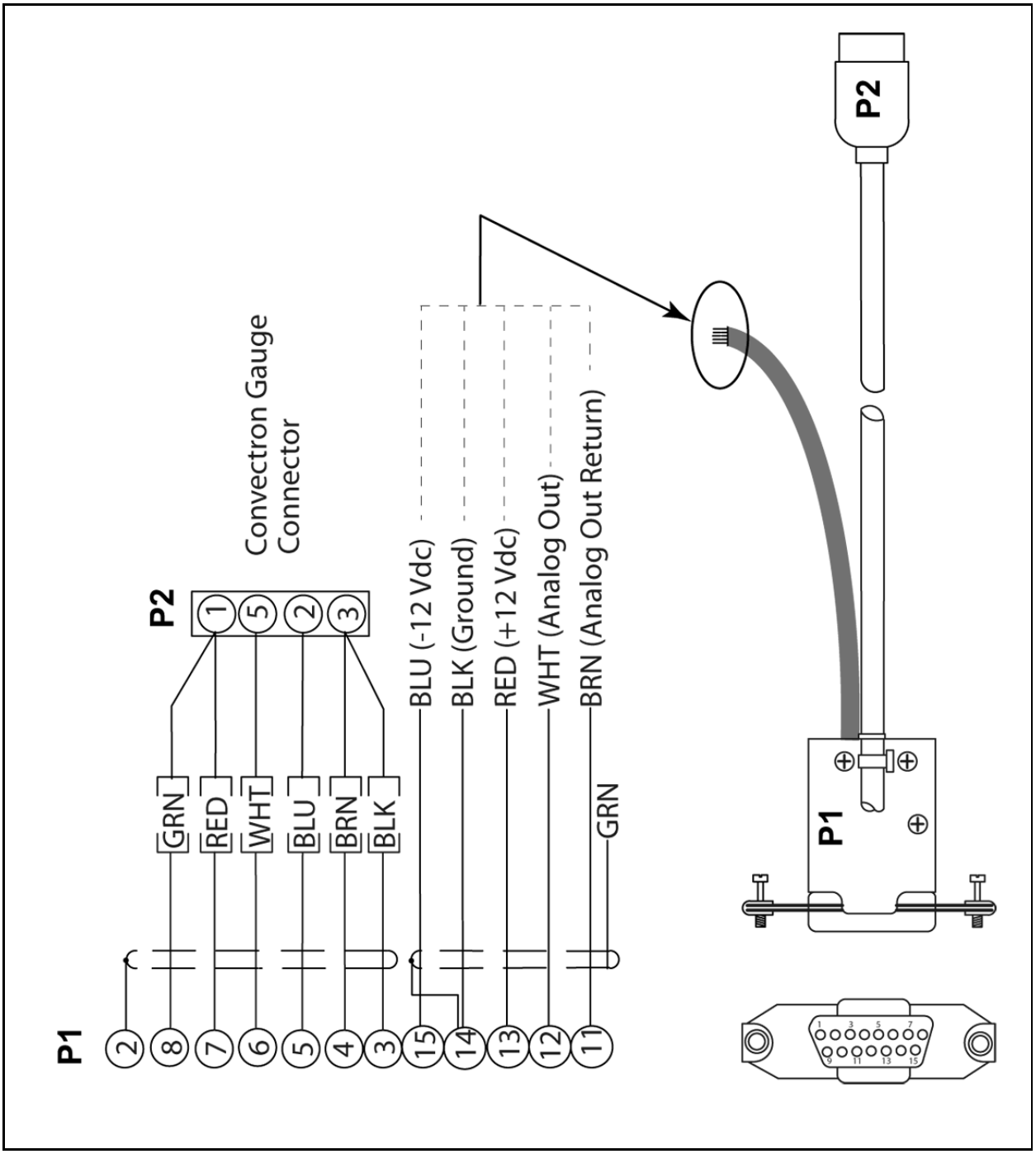

Figure 3-4 Convectron Gauge to Bridge Amplifier Interconnect Cable

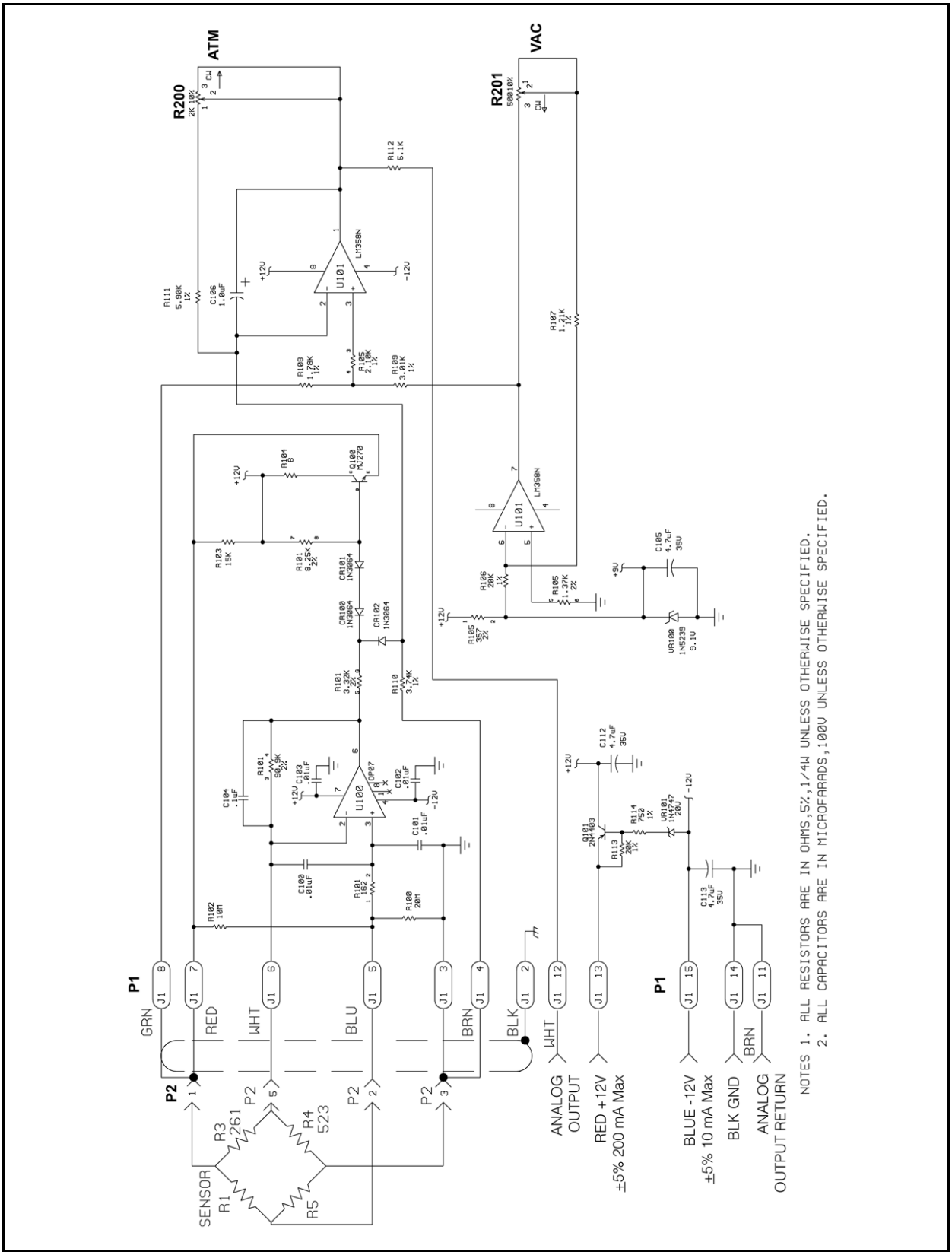

Figure 3-5 Convectron Gauge Bridge Amplifier Schematic

Notes:

4.1 Theory of Operation

The module measures gas pressures from 1 x 10^{-4} Torr to 1000 Torr. Vacuum chamber pressure is measured by a 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 (R1) is an ultra-fine strand of gold-plated tungsten. 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. 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. The 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 4-1. If the ambient temperature does not change, R_1 remains constant.

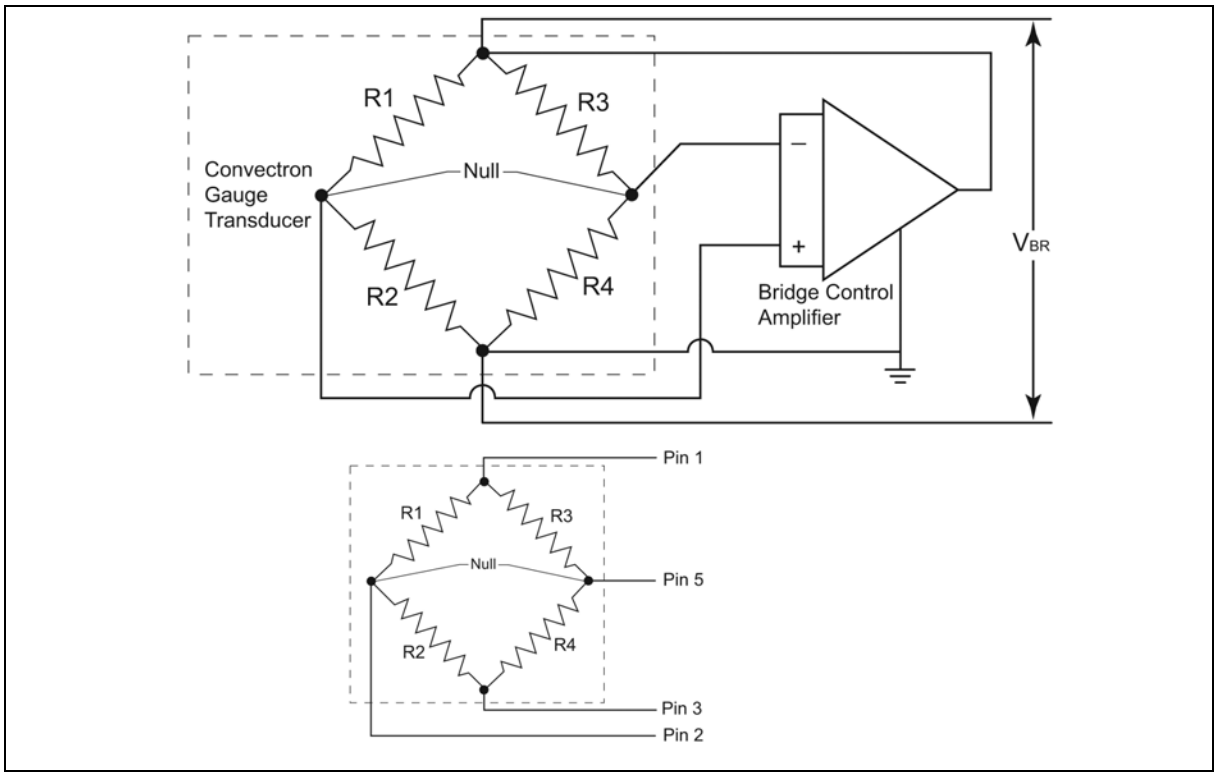

Figure 4-1 Convectron Gauge Circuit

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.

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 module to measure the pressure of flammable or explosive gases.

4.1.1 General Precautions

- Do not use the Convectron Gauge in an area of high vibration or extreme shock.
- Do not use the Convectron Gauge to measure pressures of explosive gases.
- Always be sure that all components of the vacuum system are properly grounded.

4.2 Preparing for Pressure Measurement

The steps in this chapter assume:

- The 275 Convectron Gauge was properly installed per the instructions in Chapter 3.
- The gas in your vacuum system is air or N_2. If you are using other gases you must follow the instructions in Section 4.5.
- You are reasonably familiar with the general theory of operation of thermal conductivity gauges.

It is recommended that you consult a good textbook if you are unfamiliar with vacuum technology or if you require more information on the general theory behind operating a thermal conductivity gauge. The following books are useful reference volumes.

- Dushman, S., Lafferty, J. M., *Scientific Foundations Of Vacuum Technique,* John Wiley & Sons, Inc., Second Edition, New York, 1962.
- Redhead, P. A., et al., *Ultrahigh Vacuum,* Chapman and Hall, London, 1968.
- O'Hanlon, J. F., *A User's Guide To Vacuum Technology,* John Wiley & Sons, New York, 1980.

4.3 Gas Type

The Convectron Gauge is calibrated for N_2 unless otherwise labeled for custom applications.

Warning – If used improperly, Convectron Gauges can supply misleading pressure indications that can result in dangerous overpressure conditions within the system. For use with gases other than air, or N_2 consult the gas type correction charts in Section 4.5.

4.4 Preparing For Convectron Gauge Operation

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

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 Section 4.5 before using with other gases.

Suppliers of pressure relief valves and pressure relief disks can be located via an internet search, and are listed in the *Thomas Register* under "Valves, Relief" and "Discs, Rupture." Confirm that these safety devices are properly installed before operating the Series 275 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 settings are correct on automated gas delivery systems.

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

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

Convectron Gauges are Pirani type thermal conductivity gauges. These gauges measure the heat loss from a heated sensor wire maintained at constant temperature. The bridge amplifier PC board converts this measurement into gas pressure voltage 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.

Figures 4-2 through 4-7 show the true pressure vs. the indicated pressure for eleven commonly used gases. Table 4-1 will help to locate the proper graph.

Table 4-1 Pressure vs. Indicated N_2 Pressure Curve.

Fig. No.	Pressure Range and Units	Gases
4-2	10^{-4} to 10^{-1} Torr	All
4-3	10^{-1} to 1000 Torr	Ar, $C0_2$, CH_4, Freon 12, He
4-4	10^{-1} to 1000 Torr	D_2, Freon 22, Kr, Ne, 0_2
4-5	10^{-4} to 10^{-1} mbar	All
4-6	10^{-1} to 1000 mbar	Ar, $C0_2$, CH_4, Freon 12, He
4-7	10^{-1} to 1000 mbar	D_2, Freon 22, Kr, Ne, 0_2

1 mbar = 100 Pa = 1.33 Torr, so the charts can be used for pascal and mbar units.

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

If you must measure the pressure of gases other than N_2 or air, use Figure 4-2 through Figure 4-7 to determine the maximum safe indicated pressure for the other gas as explained in the examples that follow.

4.5.1 Examples

Example 1 – *Maximum safe indicated pressure.*

Assume a given vacuum system will withstand an internal pressure of 2000 Torr or 38.7 psia. For safety, you wish to limit the maximum internal pressure to 760 Torr during the backfilling process. Assume you wish to measure the pressure of Freon 22. On Figure 4-4, locate 760 Torr on the left hand scale, travel to the right to the intersection with the Freon 22 curve, and then down to an indicated pressure of 11 Torr (N_2 equivalent). In this hypothetical situation, the maximum safe indicated pressure for Freon 22 is 11 Torr.

For the sake of safety, it is prudent to place a label on the system stating “DO NOT EXCEED 11 TORR FOR FREON 22" for this example.

Example 2 – *Indicated to true pressure conversion.*

Assume you wish to determine the true pressure of helium in a system when the Convectron is indicating 10 Torr. On Figure 4-3, follow the vertical graph line up from the 10 Torr (N_2 equivalent) indicated pressure to the Helium curve and then move horizontally to the left to reveal a true pressure of 4.5 Torr. Thus 4.5 Torr Helium pressure produces an indication of 10 Torr (N_2 equivalent).

Example 3 – *True to indicated pressure conversion.*

Assume you wish to set a process control setpoint at a true pressure of 20 Torr of $C0_2$. On Figure 4-3, locate 20 Torr on the true pressure scale, travel horizontally to the right to the $C0_2$ curve and then down to an indicated pressure of 6.4 Torr (N_2 equivalent). The correct process control setting for 20 Torr of $C0_2$ is 6.4 Torr (N_2 equivalent).

Example 4 – *True to indicated pressure conversion.*

Assume you wish to obtain a helium pressure of 100 Torr in the system. On Figure 4-3, 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.

> *NOTE: 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 approximately 1000 Torr true pressure.*

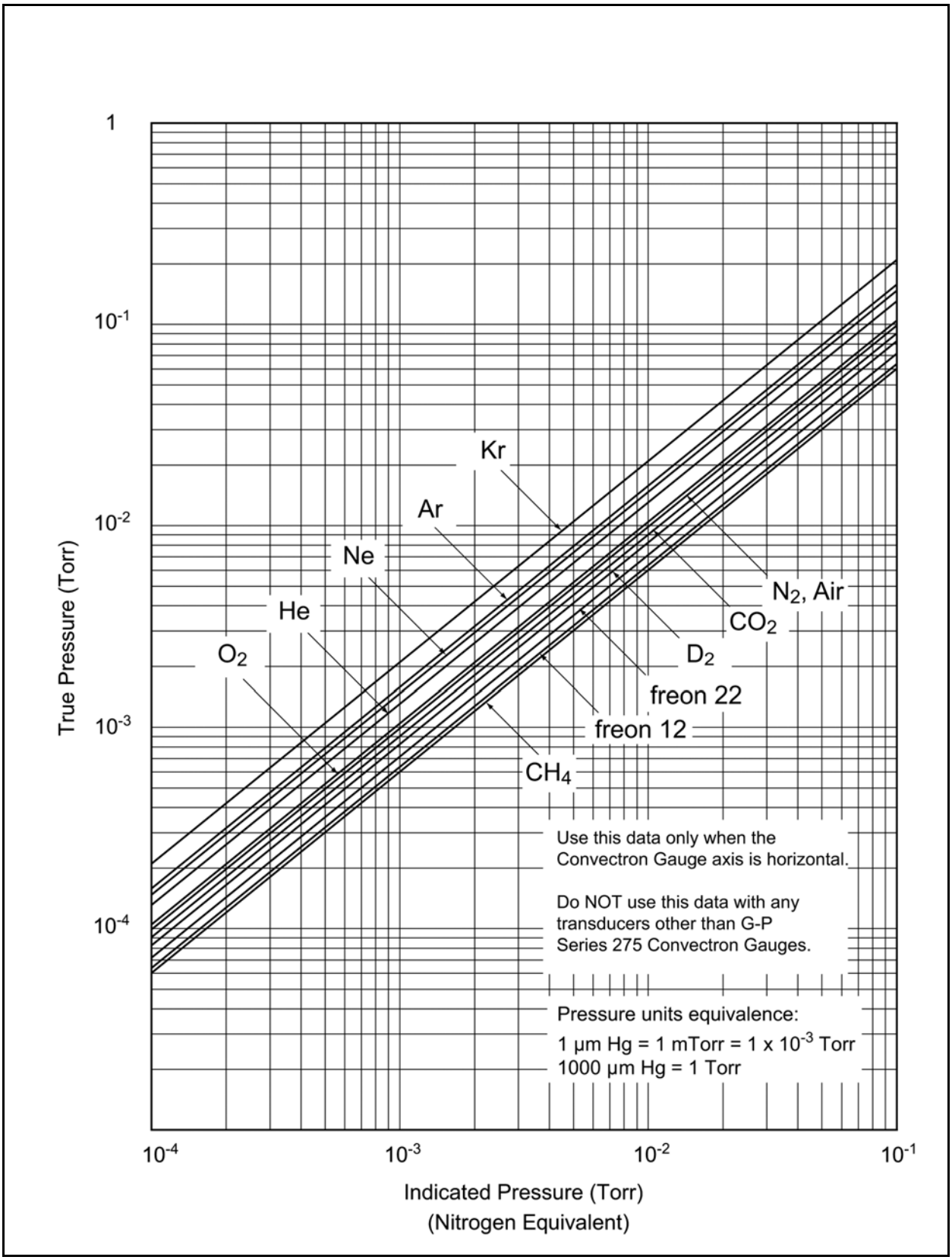

Figure 4-2 Convectron Gauge Indicated vs. True Pressure Curve; 10^{-4} to 10^{-1} Torr.

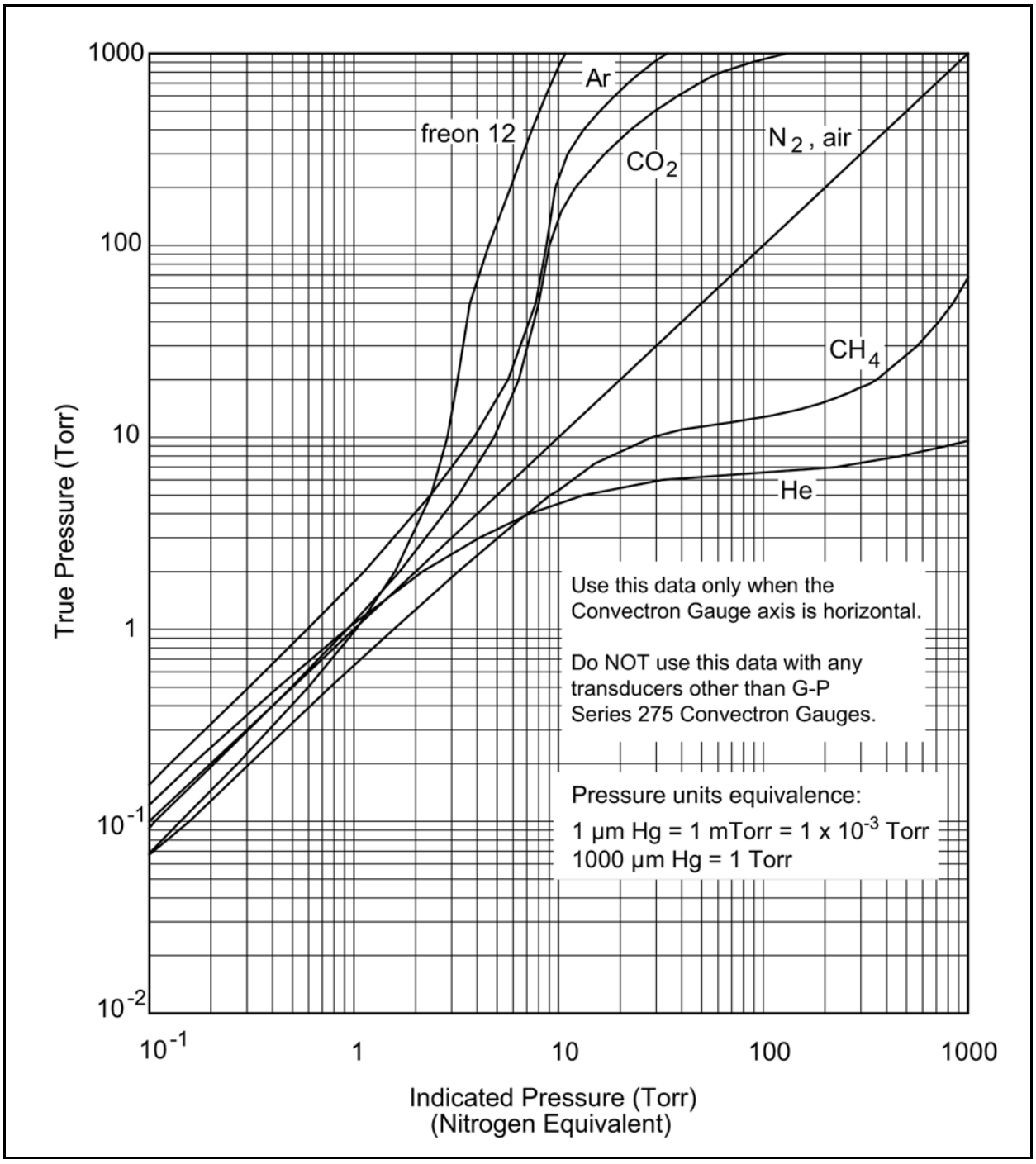

Figure 4-3 Convectron Gauge Indicated vs. True Pressure Curve; 10^{-1} to 1000 Torr.

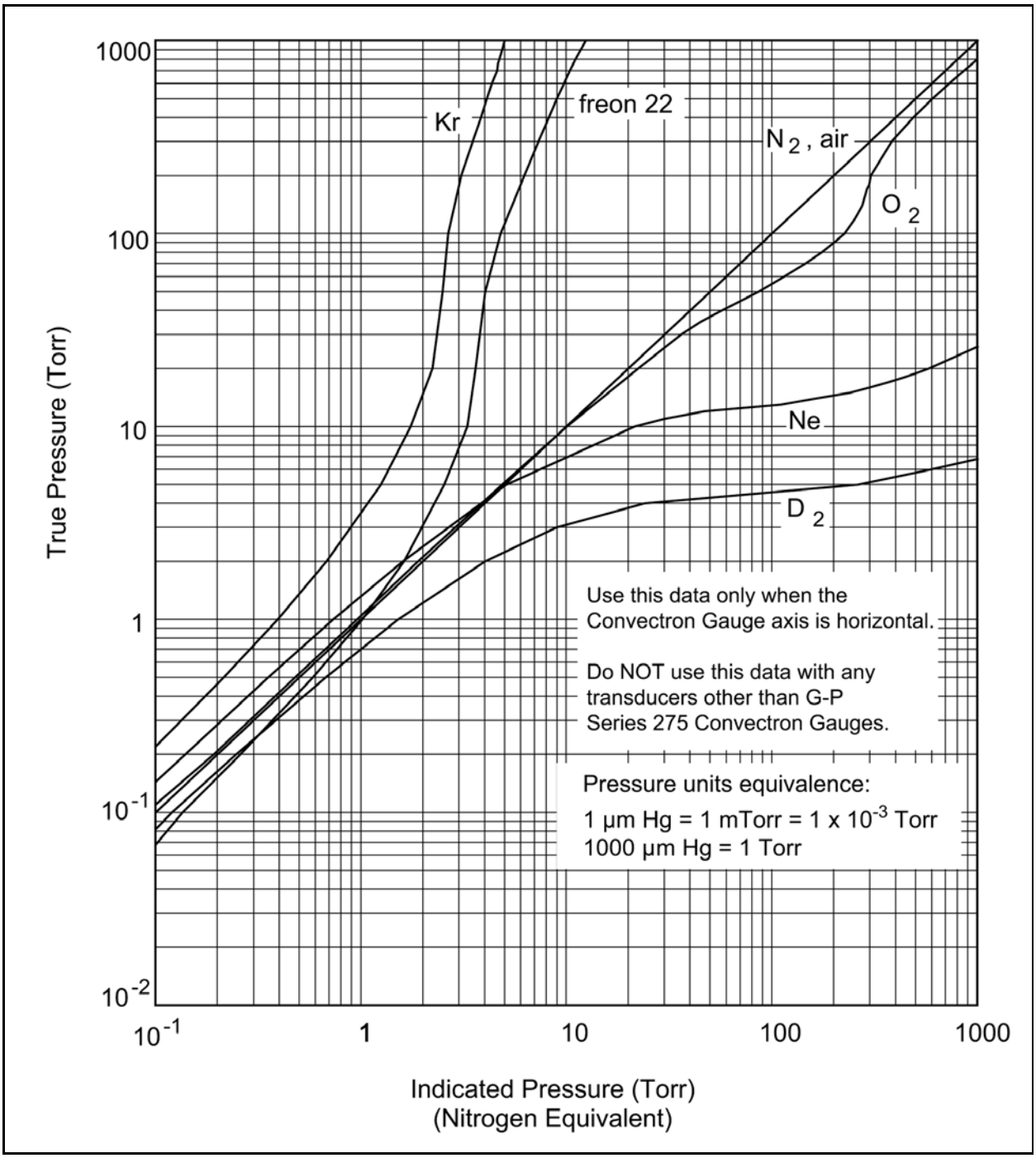

Figure 4-4 Convectron Gauge Indicated vs. True Pressure Curve; 10^{-1} to 1000 Torr.

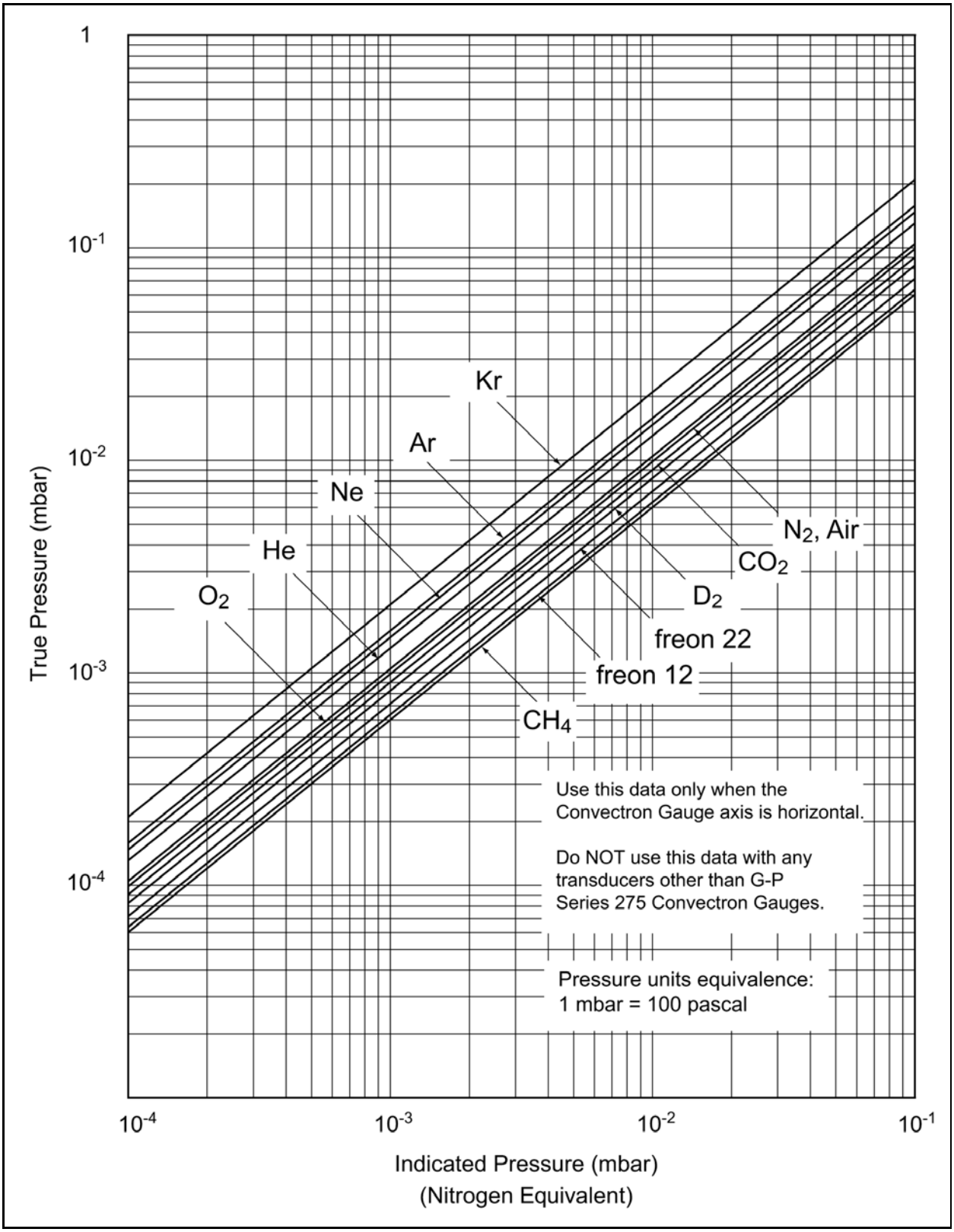

Figure 4-5 Convectron Gauge Indicated vs. True Pressure Curve; *10^{-4} to 10^{-1} mbar.*

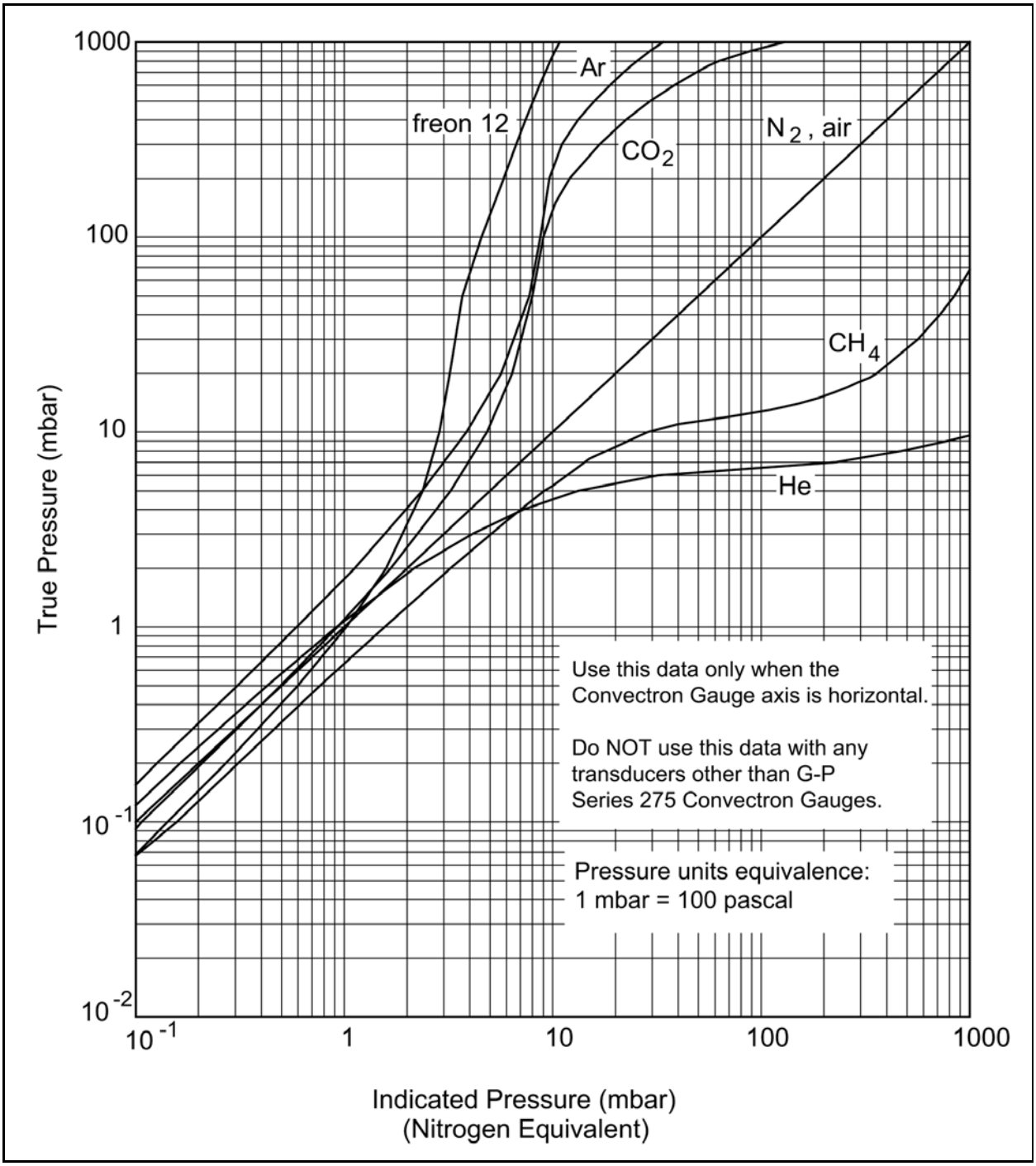

Figure 4-6 Convectron Gauge Indicated vs. True Pressure Curve; *10^{-1} to 1000 mbar.*

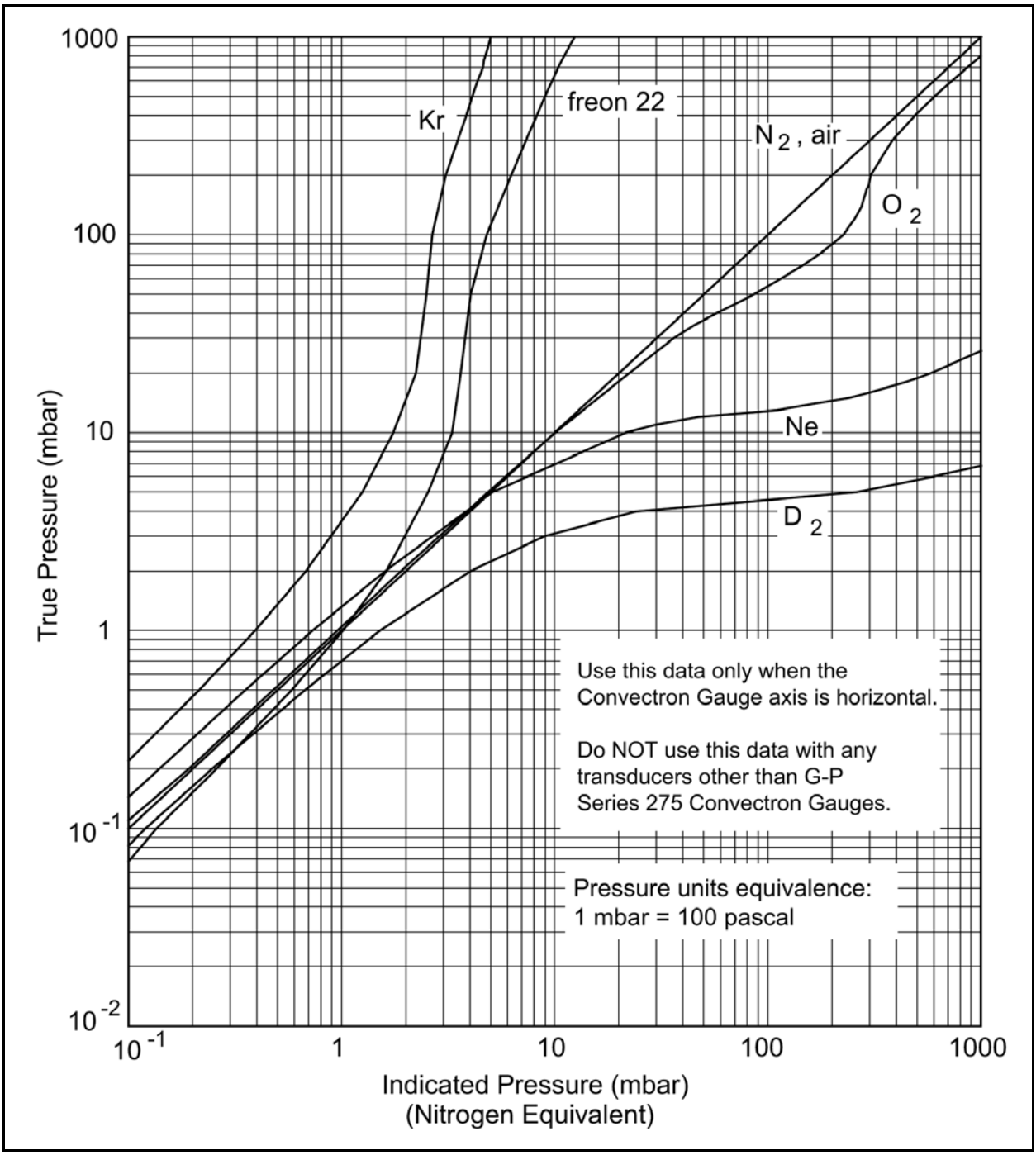

Figure 4-7 Convectron Gauge Indicated vs. True Pressure Curve; *10^{-1} to 1000 mbar.*

4.6 Analog Output Voltage Signal

The analog output voltage signal provides a specific voltage at specific pressures as illustrated in Figure 4-8. Use the pin numbers 11 and 12 of the connector on the bridge amplifier PC board (see Figure 3-4) to use the voltage signal.

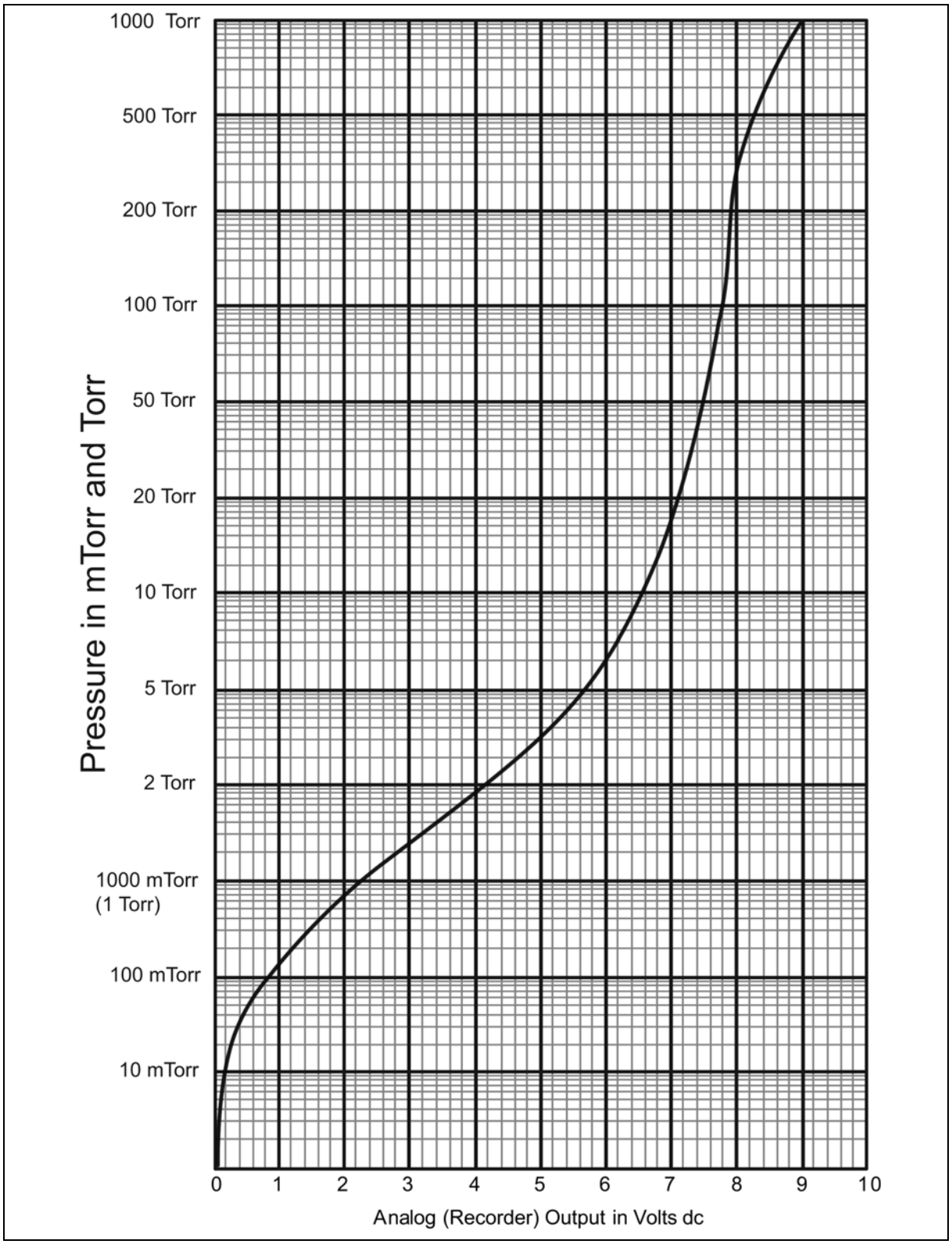

Figure 4-8 Analog Output Voltage Signal

Chapter 5

Service and Maintenance

5.1 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:
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Because the Convectron Bridge Amplifier PC Board 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.

5.2 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 the analog out cord is damaged.
- Liquid has been spilled onto, or objects have fallen onto, the product.
- The product does not operate normally even if you have followed the Operation Instructions. Adjust only those controls that are covered in the instruction manual.
- The product has been dropped or 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. Do not substitute parts or modify the product. 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.

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.

5.3 Troubleshooting and Repair

5.3.1 Symptoms and Possible Causes

Table 5-1 General Symptoms/Possible Causes.

Symptom	Possible Causes	Solution
Output voltage = 0 V	1. The ±12 Vdc power supply is faulty. 2. The power supply interconnect cable is faulty or improperly connected.	1. Repair or replace the power supply. 2. Repair or replace the interconnect cable.
Pressure reading is too high.	1. Conductance in the connection to vacuum chamber is inadequate. 2. Plumbing to Convectron Gauge leaks or is contaminated. 3. Chamber pressure is too high due to a leak, contamination, or pump failure. 4. The power supply or output cable is improperly connected or faulty.	1. Reconnect the Convectron Gauge port to vacuum chamber. 2. Clean, repair or replace the plumbing. 3. Repair the leak or replace the vacum pump.. 4. Repair or replace the cable.
Pressure reading is inaccurate.	1. The bridge amp PC board is not calibrated for the process gas that is being used. 2. The Convectron Gauge is not mounted horizontally. 3. The Convectron Gauge is damaged (for example, by reactive gas) or contaminated. 4. Temperature or mechanical vibration is extreme.	1. Recalibrate the PC board. See Section 5.3.2. 2. Re-mount the gauge to a horizontal position. 3. Replace the gauge. 4. Return the gauge to the factory. 5. Relocate the gauge or eliminate the source of the heat or vibration.
Indicated pressure is different than pressure indications from other measurement devices.	1. The process gas is a not the gas that the user anticipated using in the system. 2. The Convectron Gauge is defective.	1. Adjust the Convectron Gauge reading for the gas being used. See Section 4.5 and Figures 4-2 through 4-7. 2. Check the gauge - see Section 5.3.3. If the Convectron Gauge is defective, replace it.

5.3.2 Convectron Gauge Calibration

An atmospheric pressure calibration is performed on the Convectron Gauge using N_2 at the factory before the gauge is shipped. The factory calibration sets the atmospheric calibration point for N_2 to 760 Torr.

Periodic resets of the vacuum chamber calibration point improve the accuracy and repeatability of the Convectron Gauge. Regardless of the process gas being used, always use N_2 or air to calibrate the Convectron Gauge at vacuum chamber pressure.

1. Using N_2 or air, pump down the vacuum chamber pressure to a pressure that is lower than 10^{-4} Torr. When the pressure indication in the 1 x 10^{-4} Torr range has stabilized, a Convectron Gauge calibration at vacuum chamber pressure may be performed.
2. Use a high-precision, high-input impedance (Zin > 1 MW) DVM to measure the voltage across the analog output connections (pins #11 & 12 of the interconnect cable - see Figure 3-4).
3. Use a flat-head instrument screwdriver to adjust the ADJUST VACUUM potentiometer to a reading of 0.0 Vdc. The vacuum adjust potentiometer is # R201, shown on Figure 2-2 and Figure 3-5.

5.3.3 Convectron Gauge Test Procedure

The small diameter sensor wire inside the gauge tube can be damaged by even small voltages. Do not perform electrical continuity tests with instruments applying in excess of 0.1 volt when the gauge is at vacuum, or 2 volts when at atmospheric pressure.

1. Vent the vacuum chamber to atmosphere and allow the gauge to cool to ambient temerature.
2. Disconnect the cable fromthe gauge.
3. Use a *low-voltage (maximum 0.1 V) ohmmeter* to check resistance values across the pins on the gauge. See Figure 5-1.

The gauge should show the resistances values listed in Figure 5-1. Pin numbers are embossed on the blue plastic pin feed-through of the gauge. Measure the resistance across the pins with the gauge at atmospheric pressure, using an ohmmeter that will not apply more than 10 mA.

4. Replace the gauge tube if required.
5. Connect the cable and check the gauge for proper operation.

- Pins 1 to 2: 19 to 22 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.

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.

Figure 5-1 Convectron Gauge Connector and Resistance in Ohms

5.3.4 Cleaning a Contaminated Convectron Gauge

The fumes from solvents such as trichloroethylene, perchloroethylene, toluene, and acetone can be dangerous to health if inhaled. Only use these solvents 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.

The Convectron Gauge may be baked to 150 °C nonoperating while under vacuum.

All materials are compatible for ultra high vacuum service, corrosion resistance, and bakeability. The envelope is type 304 stainless steel. All metallic joints in the envelope are welded. No solder is used within the envelope. The following materials are exposed to the vacuum: Type 304 stainless steel, Carpenter Alloy 52, Kovar, Kapton, gold-plated Tungsten or Platinum (for the sensor), borosilicate glass, and Dow-Corning 9015 glass. The blue trim cover is rated at 150 °C.

When the small sensor wire is contaminated with oil or other films, its emissivity or its diameter may be appreciably altered and a change of calibration will result. Cleaning with trichloroethylene, perchloroethylene, toluene, or acetone is possible but it must be done very carefully to not damage the sensor.

1. Hold the gauge with the main body horizontal and the port projecting upward at an angle of 45 degrees. Slowly fill it with solvent using a standard wash bottle with the spout inserted in the port to the point where it touches the screen. Let the solvent stand in the gauge for at least ten minutes. **Do not shake the gauge.** Shaking the gauge with liquid inside can damage the sensor wire. To drain the gauge, position it horizontally with the port facing downward. Slightly warming the gauge will help dry the gauge.
2. Allow the gauge to dry overnight with the port vertically downward and uncapped. Before re-installing the gauge on the system, be certain no solvent odor remains.
3. Install the gauge onto the vacuum chamber and check it for proper operation.

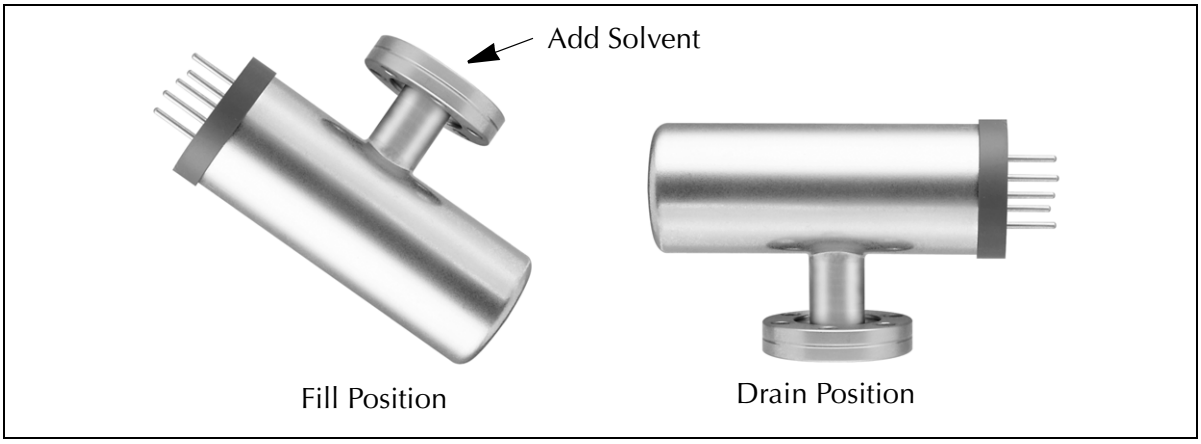

Figure 5-2 Add and Drain Solvent to Clean a Convectron Gauge

5.3.5 Baking the Vacuum Chamber with the Convectron Gauge Attached

Bakeout temperature of the Convectron Gauge must not exceed 150 °C (302 °F).

1. Bake the process chamber at the desired temperature for the desired time. The Convectron gauge tube must not exceed 150 °C.
2. Allow the system to cool to ambient temperature and reconnect the cable to the Convectron Gauge.

Series 275

Granville-Phillips® Convectron® Vacuum Gauge Bridge Amp PC Board with Analog Output Signal

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Instruction Manual

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