SERIES 275

DIGITAL READOUT

CONVECTRON® VACUUM GAUGES

INSTRUCTION MANUAL

GRANVILLE-PHILLIPS

HELIX TECHNOLOGY CORPORATION

FCC VERIFICATION

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

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

INSTRUCTION MANUAL

SERIES 275

DIGITAL READOUT

CONVECTRON VACUUM GAUGES

YOU SHOULD READ THIS INSTRUCTION MANUAL BEFORE INSTALLING, USING, OR SERVICING THIS EQUIPMENT

This manual is for use only with Series 275 Convectron Vacuum Gauges with the following part numbers:

275098	275108	275144	275160	275200	275213
275100	275110	275145	275193	275207	275246
275102	275142	275146	275197	275208	275249
275106	275143	275148	275199	275209	275250

NOTE: A -1 after the catalog number denotes dark gray case and appearance panel.

CERTIFICATION

Granville-Phillips certifies that this product meets its published specifications at the time of shipment from the factory.

LIMITED WARRANTY

This Granville-Phillips product is warranted against defects in materials and workmanship for one year from the date of shipment provided the installation, operating and preventive maintenance procedures specified in this instruction manual have been followed. Granville-Phillips will, at its option, repair, replace or refund the selling price of the product if Granville-Phillips determines, in good faith, that it is defective in materials or workmanship during the warranty period, provided the item is returned to Granville-Phillips together with a written statement of the problem.

Instruction Manual P/N 275174 101
Granville-Phillips
5675 Arapahoe Ave.
Boulder, Colorado 80303
Telephone (303) 443-7660, Fax (303) 443-2546
Revised October 1999

Defects resulting from or repairs necessitated by misuse or alteration of the product or any cause other than defective materials or workmanship are not covered by this warranty. Granville-Phillips EXPRESSLY DISCLAIMS ANY OTHER WARRANTY, WHETHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. UNDER NO CIRCUMSTANCES SHALL GRANVILLE-PHILLIPS BE LIABLE FOR CONSEQUENTIAL OR OTHER DAMAGES RESULTING FROM A BREACH OF THIS LIMITED WARRANTY OR OTHERWISE.

CONTENTS

SPECIFICATIONS

Useful measuring range	1 milliTorr to 1000 Torr, or 1 x 10^{-3} to 1000 mbar N_2 equivalent.
Ambient temperature range, controller, operating	+4 °C to +50 °C
Ambient temperature compensation range, gauge tube	+15 °C to +50 °C
Ambient non-operating gauge tube bakeout temperature	+150 °C max.
Recorder output voltage	0 to 9 volts, ± 5%, non-linear, monotonically increasing with pressure. See curves in Section 6.
Recorder output source impedance	5.1 kohms ± 5%
Process control relay contacts	SPDT, 2 A at 230 Vac resistive load.
Electrical Power	
voltage	90 to 110 Vac, 105 to 125 Vac, or 210 to 250 Vac depending on catalog number. Internally selectable.
power	10 W nominal
frequency	48 to 62 Hz

Controller dimensions	mm	in.
Front of panel, square	97	3.81
Front of panel, depth	19	0.75
Rear of panel, depth with connector	220	8.65
Mounting hole, square	92	33.62

Panel thicknesses	3 mm, 4 mm, 1/8 in., 3/16 in.
Internal volume of gauge tube	40 cc (2.5 cu. in.)
Stability with line voltage variation	Pressure changes no more than 0.02% of reading for a 1% change in line voltage over most of the pressure range.

Readout Resolution of Digital Controllers

Pressure range	Digital step is equal to or less than
millitorr of N_2	millitorr of N_2
0 - 48	1
48 - 193	2
193 - 290	3
290 - 400	4
400 - 850	5
850 - 995	6
Torr of N_2	Torr of N_2
1.00 - 2.00	.01
2.00 - 3.64	.02
3.64 - 4.40	.03
4.40 - 5.60	.04
5.60 - 8.00	.05
8.00 - 8.40	.06
8.40 - 9.00	.07
9.00 - 9.95	.08

Pressure range	Digital step is equal to or less than
Torr of N_2	Torr of N_2
10.0 - 12.3	.1
12.3 - 18.2	.2
18.2 - 22.0	.3
22.0 - 24.0	.4
24.0 - 33.0	.5
33.0 - 50.0	1.
50.0 - 64.0	2.
64.0 - 76.0	3.
76.0 - 90.0	4.
90.0 - 95.0	5.
100 - 240	10.
240 - 535	5.
535 - 960	10.
960 - 999	20.

Pressure range	Digital step is equal to or less than
x 10^{-3} mbar of N_2	x 10^{-3} mbar of N_2
0 - 28	1
28 - 162	2
162 - 232	3
232 - 530	4
530 - 800	5
800 - 996	6
mbar of N_2	mbar of N_2
1.00 - 2.00	.01
2.00 - 4.12	.02
4.12 - 4.80	.03

Pressure range	Digital step is equal to or less than
mbar of N_2	mbar of N_2
4.80 - 7.30	.04
7.30 - 8.80	.05
8.80 - 9.94	.06
10.0 - 15.2	.1
15.2 - 21.2	.2
21.2 - 24.0	.3
24.0 - 32.0	.4
32.0 - 36.0	.5
36.0 - 55.0	1
55.0 - 77.5	2
77.5 - 96.0	3
100 - 999	10

For example, in the range from 48 to 193 millitorr the digital controller has a readout resolution of 2 millitorr or less. The readouts are 48, 50, 51, 52, 53, 54, 55, 56, 58, 59, 60, 61, 62, 64 etc. 1% or better resolution is provided over most of the range.

BCD Output Option

Logic format:

8421 BCD, 3 significant digits.
Positive true logic: "0" = 0 volts.
Range Bit: 0 = mTorr or x 10^{-3} mbar.
1 = Torr or mbar.

Parallel and Series Format.

Outputs Provided:

- 12 lines: Parallel BCD data
- 3 lines: Range Data
- 1 line: Data update pulse - Output latches update during negative transition of this 13 to 20 msec pulse.
- 1 line: Serial clock - 1280 Hz, burst of 16 pulses during each update.
- 1 line: Serial data - Data is valid during first 15 negative serial clock transitions.

Inputs Provided:

Function	Default (no connection)
1. Disable Data: Switches all data output lines to high impedance.	Low = Enabled
2. Disable Sync. Switches Serial Clock and Update output lines to high impedance.	Low = Enable
3. Hold: Prevents data latches from updating.	High = Free-run

4. V_{DD}: 3-16 volt signal required to define "1" voltage level, approx. 1 mA average current drain.

Logic levels, outputs:

"0" = 0 volts
"1" = V_{DD} = 3-16 volts externally supplied.

Output Impedance (max.)	"0"	"1"
V_{DD} = 5 V	250 ohms	3.8 Kohms
V_{DD} = 10 V	150 ohms	2.2 Kohms
V_{DD} = 15 V	120 ohms	2.0 Kohms

	TTL loads: Will drive one standard TTL load over full temperature range. Leakage in disabled state: 12 μA max.
Logic levels, inputs:	Input impedance: 100 KΩ Input capacitance: 30 pf max. V_{IL} = 0 to 0.3 V_{DD} V_{IH} = 0.7 to 1.0 V_{DD} (V_{DD} supplied externally)
Isolation:	Option common is isolated from instrument ground. Voltage rating: 250 Vac Insulation: 10 megohms min.
Update rate:	Approximately 2.4 times per second.
Compatible Logic Families:	CMOS, TTL (all forms), DTL, HTL

WARNING

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

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

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

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

WARNING

275 Convectron gauges are intended for use only on vacuum systems which have suitable devices installed that will limit the pressure from external gas sources to the level the system can safely withstand and which also have suitable pressure relief valves or rupture disks installed. Confirm that these safety devices are properly installed before installing the Convectron gauge. 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.

SECTION 1

SAFETY INSTRUCTIONS

SAFETY PAYS. THINK BEFORE YOU ACT. UNDERSTAND WHAT YOU ARE GOING TO DO BEFORE YOU DO IT. READ THIS INSTRUCTION MANUAL BEFORE INSTALLING, USING, OR SERVICING THIS EQUIPMENT. IF YOU HAVE ANY DOUBTS ABOUT HOW TO USE THIS EQUIPMENT SAFELY, CONTACT THE GRANVILLE-PHILLIPS PRODUCT MANAGER FOR THIS EQUIPMENT AT THE ADDRESS LISTED IN THIS MANUAL.

Explosive Gases

Do not use the gauge tube to measure the pressure of combustible gas mixtures. The sensing element normally operates at only 125 °C but it is possible that momentary transients or controller malfunction can raise the sensor above the ignition temperature of combustible mixtures which might then explode causing damage to equipment and injury to personnel.

Limitation on use of Compression Mounts

Do not use a compression mount (quick connect) for attaching the gauge tube to the system in applications resulting in positive pressures in the gauge tube. Positive pressures might blow the tube out of a compression fitting and damage equipment and injure personnel. The Series 275 gauge should not be used above 1000 Torr or 1333 mbar true pressure.

Tube Mounting Position

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

Overpressure

Series 275 gauges should not be used above 1000 Torr (1333 mbar) true pressure. Do not use above 1000 Torr 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. If accurate conversion data is not used or improperly used, a potential overpressure explosion hazard can be created under certain conditions.

For example, at 760 Torr of argon gas pressure, the indicated pressure on a Series 275 gauge calibrated for N_2 is 24 Torr. At an indicated pressure of 50 Torr, the true pressure of argon is considerably above atmospheric pressure. Thus if the indicated pressure is not accurately converted to true pressure, it is possible to overpressure your system. Overpressure may cause glassware such as ionization gauges to shatter dangerously and if high enough may cause metal parts to rupture thus damaging the system and possibly injuring personnel. See Section 6 for proper use of conversion data.

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

High Indicated Pressure

For some gases, be aware the indicated pressure will be higher than the true pressure. For example, at a true pressure of 9 Torr for helium the indicated pressure on a Series 275 gauge calibrated for N_2 is 760 Torr. The safe way to operate the gauge is to properly use accurate conversion data. See Section 6 for proper use of conversion data.

Electrical

Before connecting your controller to a power source, be sure that the source is compatible with power requirements for the controller.

Electrical Power Requirements

A. C. Frequency: 48 to 62 Hz
Power consumption: 10 W nominal
Line Voltage: 115 V models: 105 to 125 volts
230 V models: 210 to 250 volts

Connect the controller only to a 3-wire grounded receptacle. Do not bypass the ground connection. Have only qualified service personnel trained in electrical safety precautions service your controller. Completely disconnect equipment from all power sources before servicing equipment.

115 V models are supplied with a standard NEMA 5-15P 3-wire plug. 230 V models are supplied with a Western European Dual Grounding CEE(7)-VII plug. If the plug supplied with your controller is not compatible with your power source, the plug may be removed and replaced with a suitable 3-wire grounded plug. It is important that the following color code be followed when replacing the power plug to maintain electrical safety. DO NOT OPERATE THE INSTRUMENT UNGROUNDED because even a minor circuit malfunction could result in dangerous voltages being applied to exposed metal surfaces.

Brown or Black: AC line (hot), Blue or White: AC neutral, Green or Green/Yellow: Earth Ground

Chemical

Cleaning solvents, such as trichloroethylene, perchloroethylene, toluene and acetone produce fumes that are toxic and/or flammable. Use only in areas well ventilated to the outdoors and away from electronic equipment, open flames, or other potential ignition sources.

Sensor Failure

If the gauge tube becomes disconnected from the controller or if the sensor wire in the gauge tube fails, the controller will indicate beyond 1000 Torr or mbar and the process controls will be inactivated. The recorder output will be greater than 9 volts. If the tube is unplugged from a powered controller, there may be an instantaneous (0 to 0.2 seconds) drop in the pressure indication before the failsafe takes over, and the process control relays could activate for this brief time, depending on the order in which the tube pins break contact.

Tube Contamination

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

SAFETY WARNING

CONCERNING INSTALLATION OF VACUUM COMPONENTS

All conductors in, on, or around a vacuum system that are exposed to potential high voltage electrical discharges must either be shielded so as to prevent human contact, or be connected to earth ground for safe operation.

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. The power cord of this product should be connected only to a properly grounded outlet. However, grounding this product does not guarantee that other components of the vacuum system 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 maya be seriously injured or even killed by merely touching an exposed ungrounded conductor at high potential.

This hazard is not peculiar to this product.

Under certain conditions, dangerous high voltage can be coupled directly to an ungrounded conductor through a gas almost as effectively as through a copper wire connection. This hazard, which is not peculiar to this product, is a consequence of the ability of an electric current to flow through a gas under certain circumstances. A person may be seriously injured, or even killed by merely touching an exposed ungrounded conductor at high potential.

WHEN HIGH VOLTAGE IS PRESENT, ALL EXPOSED CONDUCTORS OF A VACUUM SYSTEM MUST BE MAINTAINED AT EARTH GROUND.

- All vacuum components, such as gauges, valves, etc., or parts thereof, that are electrically insulated from the main vacuum system must be reliably connected to an earth ground, or shielded to positively prevent human contact.

- All components utilizing vacuum connections, such as quick connects, taped threads, plastic, glass, rubber tubing, etc., must be reliably grounded.

  For example, a metal gauge envelope that is not reliably grounded through its vacuum connector may be grounded by using a metal hose clamp on the gauge, connected by a 12 awg copper wire to the grounded vacuum chamber.

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

This hazard is not peculiar to this product. It is a characteristic of all vacuum systems having equipment installed that is capable of producing high voltage within the vacuum environment. Check all of your vacuum systems periodically for proper grounding of all exposed conductors.

SECTION 2

GENERAL DESCRIPTION

This manual covers the installation, operation and maintenance of the following gauge system catalog numbers (a gauge system consists of the controller, gauge tube and standard cable assembly). Gauge system catalog numbers are listed by their application.

CATALOG NO. GAUGE SYSTEM	CATALOG NO. CONTROLLER	VOLTAGE[1] REQUIREMENT	PROCESS CONTROLS	SCALES[2]
275098	275106	115	0	Torr
275100	275108	115	1	Torr
275102	275110	115	2	Torr
275142	275146	230	0	mbar
275144	275148	230	2	mbar
	275160 BCD Output Option			
275193		115	2	Customer Special
275197		115	2	Customer Special
275199		115	0	Customer Special
275200		115	1	Customer Special
	275207	100	0	Torr
	275208	100	1	Torr
	275209	100	2	Torr
	275213	230	0	Torr
275246		230	2	Customer Special
	275249	115	1	Customer Special
	275250	115	2	Customer Special

[1] ± 10%, 50 or 60 Hz, 10 watts.

[2] Note: This manual refers to pressure in Torr, mTorr and mbar units. If micron or mm of mercury or pascal units are desired, use the following conversion factors:
1 micron = 1 mTorr
1 mm of Hg = 1 Torr
1 mbar = 100 Pa = 0.750 Torr

Use the information in this manual that pertains to the features furnished on your instrument.

Fig. 2-1 identifies the major components of a typical Series 275 system.

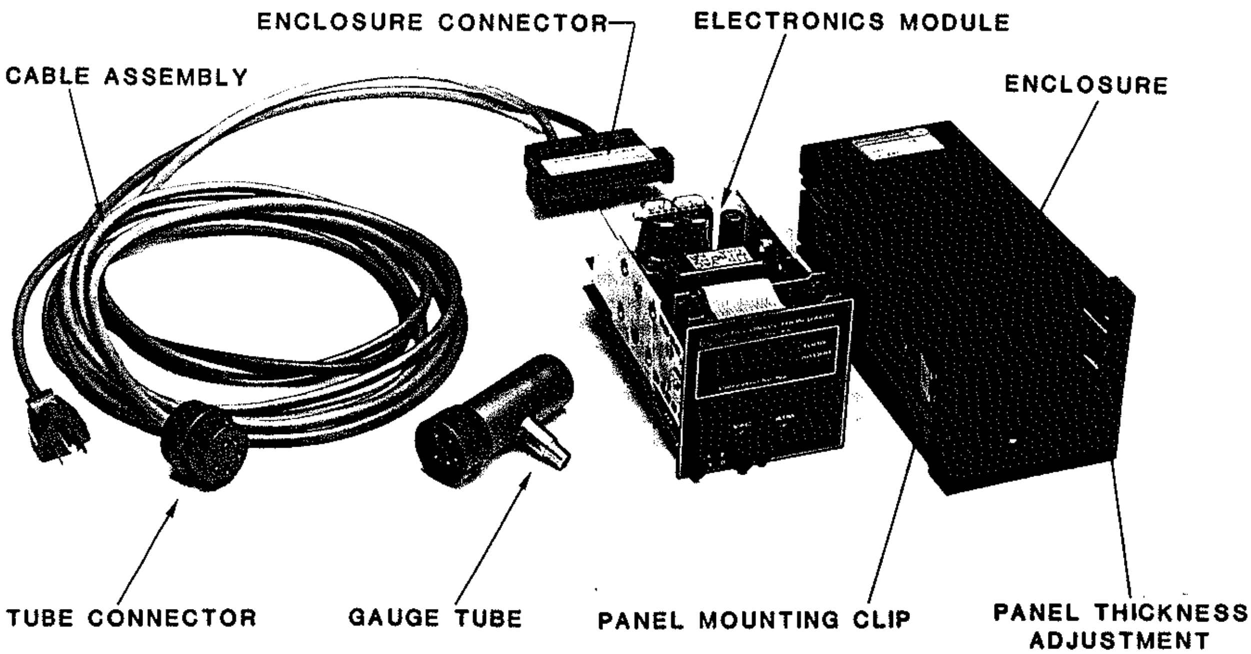


Fig. 2-1 Typical Series 275 System

SECTION 3

INSTALLATION INSTRUCTIONS

Receiving Inspection

Domestic Shipments

Inspect all material received for shipping damage. Confirm that your shipment includes all material and options ordered. If materials are missing or damaged, the carrier that made the delivery must be notified within 15 days of delivery in accordance with Interstate Commerce regulations in order to file a valid claim with the carrier. Any damaged material, including all containers and packing, should be held for carrier inspection. Contact our Customer Service Department, 5675 Arapahoe Avenue, Boulder, Colorado 80303, (303)443-7660 if your shipment is not correct for reasons other than shipping damage.

International Shipments

Inspect all material received for shipping damage. Confirm that your shipment includes all material and options ordered. If items are missing or damaged, the carrier making delivery to the customs broker must be notified within 15 days of delivery.

Example: If an air freight forwarder handles the shipment and their agent delivers the shipment to customs, the claim must be filed with the air freight forwarder.

If an air freight forwarder delivers the shipment to a specific airline and the airline delivers the shipment to customs, the claim must be filed with the airline, not the freight forwarder.

Any damaged material, including all containers and packaging, should be held for carrier inspection. Contact our Customer Service Department, 5675 Arapahoe Avenue, Boulder, Colorado 80303, U.S.A, Telephone (303)443-7660, if your shipment is not correct for reasons other than shipping damage.

Important Precautions for Gauge Tube Installation

When high voltage is present, all exposed conductors of a vacuum must be maintained at earth ground.

The following precautions in the use and installation of the Catalog No. 275071 and 275154 gauge tube must be observed.

1. The gauge tube should be installed with the port oriented vertically downward to ensure that no system condensates or other liquids collect in the gauge tube. The gauge tube axis must be horizontal if it is to be used at pressures above 1

Torr or 1 mbar. Although the gauge tube will read correctly below 1 Torr (1 mbar) when mounted in any position, erroneous readings will result at pressures above 1 Torr (1 mbar) if the tube axis is not horizontal.

2. Do not use a compression mount (quick connect) for attaching the gauge tube to the system in applications resulting in positive pressures in the gauge tube. Positive pressures might blow the tube out of a compression fitting and damage equipment and injure personnel. Pipe thread or flange mounting systems should be used for positive pressure applications. In any case, the absolute pressure in the tube should not exceed 1000 Torr or 1333 mbar.

3. Do not perform electrical continuity tests on the tube with instruments applying voltages in excess of 1 volt when the tube is at vacuum, or 5 volts when at atmospheric pressure. Exceeding these voltages will damage the sensing element.

4. Keep the tube clean. Do not remove the mounting port cover until you are ready to install the tube.

5. Do not mount the gauge tube in a manner such that deposition of process vapors, upon the internal surfaces of the gauge tube, may occur through line-of-sight access to the interior of the gauge tube.

6. Do not install the gauge tube where high amplitudes of vibration are present. Excessive vibration will cause forced convection at high pressure giving erroneous readings.

7. Do not bake the gauge tube to temperatures exceeding 150 °C.

8. Do not install the gauge tubes where they will be subject to corrosive gases such as mercury vapor or fluorine which will attack the gold plated sensor.

9. For greatest accuracy and repeatability the gauge tube should be located in a stable room temperature environment.

10. Under certain conditions, damgerous high voltage can be coupled directly to an ungrounded conductor through a gas almost as effectively as through a copper wire connection. This hazard, which is not peculiar to this product, is a consequence of the ability of an electric current to flow through a gas under certain circumstances. A person may be seriously injured, or even killed by merely touching an exposed ungrounded conductor at high potential.

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

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

All conductors in, on, or around the vacuum system exposed to potential high voltage electrical discharges must either be shielded at all times to protect personnel or must be connected to earth ground at all times.

Gauge Tube Construction

The transducer is a Pirani gauge providing rapid response, six-decades of pressure transduction, stable calibration, and good accuracy. The Pirani sensing element, R1 of the schematic of Fig. 3-1, is one leg of a Wheatstone Bridge. A temperature compensating network, R2, forms the second leg of the bridge. The temperature sensitive component of this network is mounted inside the gauge tube envelope with the sensor. All other resistors of the bridge are mounted upon the exterior electrical feedthru pins of the gauge tube and are protected from damage by the bakeable blue plastic trim cover.

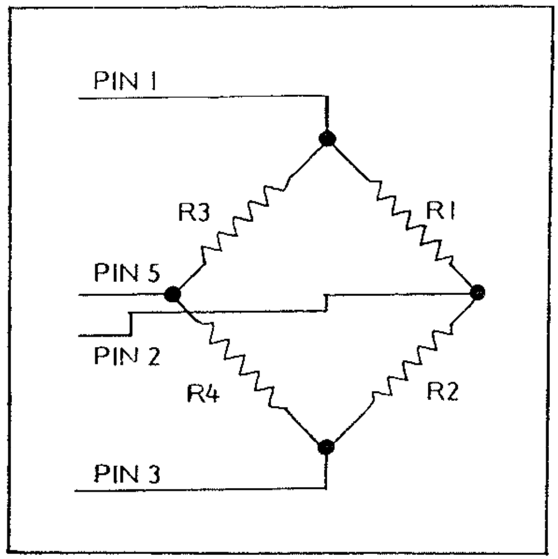


FIG. 3-1 GAUGE TUBE SCHEMATIC

Pin designations are marked on the trim cover. Pin 4 serves as an electrical terminal for construction of the compensating network, R2, but no connection is made therefrom to the controller.

All materials have been chosen for ultra high vacuum service, corrosion resistance and bakeability to 150 °C. The gauge tube envelope is type 304 or 305 stainless steel. All metallic joints in the envelope are TIG welded. No solder is used within the envelope. The following materials are exposed to the vacuum: Type 304 or 305 stainless steel, Carpenter Alloy 52, Kovar,[1] Kapton® gold plated tungsten and borosilicate glass. The blue trim cover is molded of polyetherimide thermoplastic suitable for service to 150 °C.

[1]Trademark of Carpenter Technology

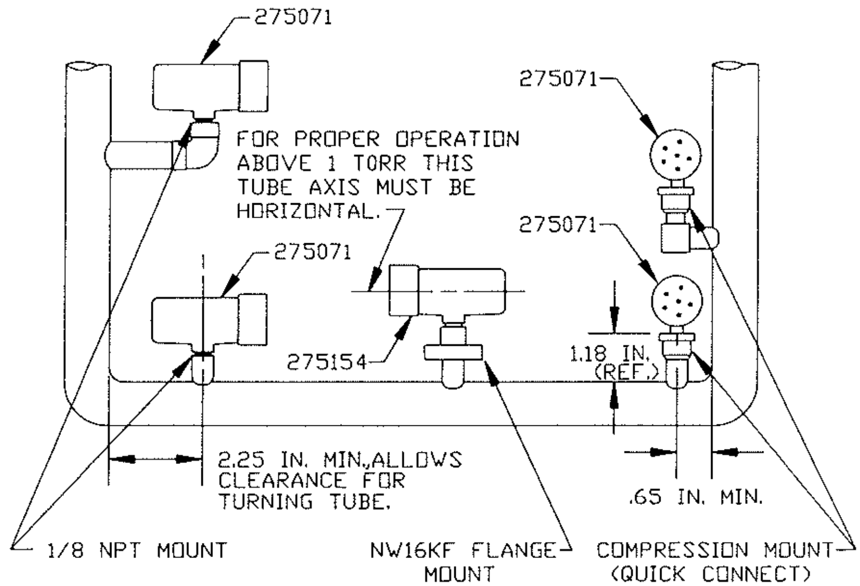


Fig. 3-2 Gauge Tube Mounting

Gauge Tube Orientation

It is important to consider the orientation of the gauge tube if accurate readings above 1 Torr (1 mbar) are necessary to prevent overpressure or for other reasons.

Below 1 Torr (or 1 mbar): The gauge tube will operate and accurately read pressures below 1 Torr (1 mbar) when mounted in any orientation. Above 1 Torr (or 1 mbar): The gauge tube will accurately read pressures above 1 Torr (1 mbar) only when mounted with its axis horizontal, preferably with the port pointing vertically downward, as shown in Fig. 3-2. It is valuable to point the port downward to facilitate the removal of condensation and other contaminants. Furthermore, the gauge is factory calibrated with the port pointing vertically downward. Installation of the gauge with the port in other orientations may affect the accuracy of the indicated pressure.

Installation

Mounting clearance dimensions are shown in Fig. 3-2. Both of the 90° mounting options are dimensioned to provide the proper mounting clearance.

1. Compression Mount (Quick Connect)

   Do not use for positive pressure applications.

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

   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 is likely due to extreme cleanliness of the O-ring. A light film of vacuum grease such as Apiezon[2] 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 degree horizontal circle for optimum routing of the gauge tube cable.

2. 1/8 NPT Mount

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

3. Other Mounts

In addition to the standard 275071 gauge tube which provides a 1/2 in. compression mount and 1/8 NPT male thread, a variety of other mounting options are available. They include 1-5/16 in. and 2-3/4 in. Conflat type flanges, Cajon® VCO® and VCR® type fittings and NW10KF, NW16KF and NW25KF flanges.

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 peculiar to this product.

Cleaning

When the fine sensor wire is so contaminated with oil or other films that its emissivity or its diameter is appreciably altered, a change of calibration will result. Cleaning with trichloroethylene, perchloroethylene, toluene, or acetone is possible but it must be done very carefully so as not to damage the sensor. CAUTION: The fumes from any of these solvents can be dangerous to your health if inhaled and they should be used in well ventilated areas exhausted to the outdoors. Acetone and toluene are highly flammable and should be used away from open flame or electrical equipment. Hold the tube with the main body horizontal and the port projecting upward at an angle of 45° and slowly fill it with solvent using a standard wash bottle with the spout inserted in the port to where it touches the screen. Let the

[2]Trademark of James G. Biddle Co.

solvent stand in the tube for at least ten minutes. Do not shake the tube if the tube is only partially filled as liquid forces on the sensor can become large enough to affect the transducer calibration. If the tube is completely filled, shaking is not helpful. To drain the tube, position it horizontally with the port facing downward. By slightly warming the tube, a positive pressure will build up internally forcing the solvent out past the screen. Then allow tube to dry overnight with port vertically downward and uncapped. Be certain no solvent odor remains before reinstalling tube on system.

Controller Installation Instructions and Precautions

The controller may be used free-standing on desk or laboratory bench. When panel mounting is desired follow these steps in order.

1. Provide an opening in your panel 92 mm (3.625 in.) square. Insert a 9/64 in. Allen wrench in the front panel jack screw and turn counter-clockwise 25 to 30 turns to allow the electronics module to slide freely out of the enclosure.

   Remove the electronics module from the enclosure. Determine the thickness of your mounting panel. The panel thickness adjustment is factory set for 1/8 in. (3.2 mm) thick panels. Any of four standard panel thicknesses, 1/8 in., 3/16 in. ,3 mm and 4 mm can be accommodated by the panel thickness adjustment. If your panel is other than 1/8 in. thick, remove the panel mounting clips from the enclosure by sliding them forward. Reset them for your panel thickness and reinsert them. If your panel is thicker than 3/16 in. (4.8 mm) the panel adjustment can be modified by filing or grinding away enough of the rearward bearing surface of the adjustment to allow the panel-contacting portion of the adjustment to engage the panel. Note that you must have a minimum of 220 mm (8.65 in.) clearance behind your panel to allow for connecting cables to the rear of the enclosure. **CAUTION** - Each series 275 controller dissipates approximately 10 watts inside its enclosure. Sufficient ventilation openings are provided in the enclosure to prevent the internal temperature rising above 70 °C with natural convection cooling. It is important that the effectiveness of these openings not be impaired by mounting too close to adjacent instruments. Install the empty enclosure in the panel by sliding the rear of the enclosure through the mounting hole from the front of your panel. Reinstall the electronics module in the enclosure and secure by tightening the jack screw.

2. If controller outputs are required, open the blue connector enclosure of the cable assembly by removing the two screws. Remove one connector shell half only, leaving the other half bound to the cables by the nylon strain reliefs. Save all the small blue plugs that are freed when one half of the shell is removed. You will need one or more to close unused openings when reassembling the connector. Use 18 or 20 AWG stranded wire. Use care to strip only 3/8 in. (10 mm) of wire so that

free strands cannot protrude through the external connector openings. Connect to the proper output pins using the table below:

Pin(s)	Function
D & 4	Process Control No. 1 relay common
E & 5	Process Control No. 1 relay normally open
F & 6	Process Control No. 1 relay normally closed
H & 7	Process Control No. 2 relay common
J & 8	Process Control No. 2 relay normally open
K & 9	Process Control No. 2 relay normally closed
L & 10	Chassis Ground
M	Recorder Output
N	Recorder Return

Route the added wires through the desired cable openings in the connector shell. Install nylon strain reliefs, supplied, in the same manner as those factory installed. Replace the small blue plugs in the unused cable openings. Place the spare blue plugs inside the connector shell for future use. Replace the connector shell half and the screws and nuts that hold the two halves together. Check the connector to see that no bare wires or strands are exposed which could cause an electrical shock hazard.

3. Plug the enclosure connector into the enclosure. Using the two 4-40 x 1 in. screws provided in the cable assembly package, bolt the connector to the enclosure. PRECAUTION: When properly installed, both the brass jack screw nut insert at the front opening of the enclosure and the gauge cable connector will be at the bottom. Note the keying inside the enclosure connector; note the keying on the rear contactor edge of the printed circuit board; make sure the enclosure connector is correctly oriented to match up these keys. On newer units the keying to the printed circuit board is omitted and the connector shell is keyed to the case instead.

4. With the enclosure connector correctly attached to the enclosure, pass the cables through the opening in your panel. Press the enclosure into the panel opening, jack screw nut insert at bottom, until the rear face of the enclosure bezel is against your panel. The panel mounting clips should then snap outward behind the panel to lock the enclosure to the panel. Press on the interior surface of the mounting clips to ensure that they snap fully outward behind the panel.

5. Your controller is configured and labeled for either 115 Vac or 230 Vac power depending on the particular catalog number. This can be reconfigured if desired by changing the plug-in jumpers and fuse as per Fig. 3-3. Be sure to change the labeling if this is done. J100 is located on the main board next to the fuse holder.

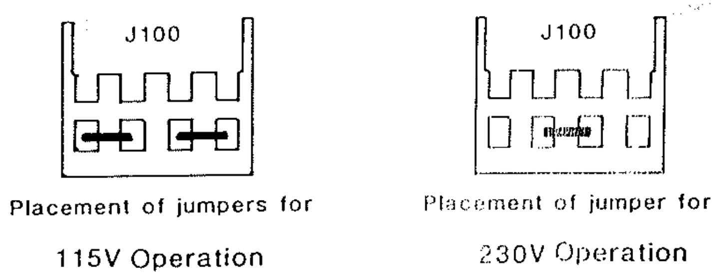


FIG. 3-3 AC POWER CONFIGURATION

6. Align the printed circuit board with the lowermost slots in the enclosure. Push the electronic module into the enclosure until the jack screw hits the jack screw insert. Turn the jack screw clockwise until the electronic module seats against the enclosure. CAUTION: Do not overtorque the jack screw. If the electronic module appears to bind, stop and correct the cause before proceeding.

7. Connect the tube connector to the gauge tube.

8. Plug the power cord into a 3-wire grounded receptacle. Do not operate the instrument ungrounded because even a minor circuit malfunction may result in dangerous voltages being applied to exposed metal surfaces. The controller should now display the system pressure.

Complying with the usual warning to connect the power cable only to a properly grounded outlet is necessary but not sufficient for safe operation of a vacuum system with this product. Grounding this product does not and cannot guarantee that other components of the vacuum system are all maintained at earth ground.

9. As a safety check before using, determine that your instrument reads the local atmospheric pressure correctly to within the accuracy of the instrument. Open the system to atmosphere and compare the indicated reading with the reading of an accurate barometer. Accurate barometric pressure information is usually readily available from government weather bureaus. Be sure that this information is local barometric pressure and not corrected to sea level. If the indicated reading does not agree with the local atmospheric pressure, adjust the ATM potentiometer as described in Section 5.

Procedure for Field Installation of the BCD Option

Unpacking

Read Section 3 for inspection and procedure if damage seems evident.

The BCD option board is shipped in a specially treated plastic bag to provide the on-board CMOS devices protection from electrostatic fields. It is advised that precautions (such as the use of grounded table surfaces and conductive grounded wrist straps) be taken to maintain this protection while the board is unpacked and installed.

Removing Controller From Case

The BCD option board mounts to the electronics module in the 275 controller enclosure. The electronics module is removed from the enclosure by unscrewing the jack screw on the front panel using a 9/64 in. Allen wrench. CMOS devices are used in the 275 controller; observe the precautions noted above. A. C. power is automatically disconnected from the electronics module as it is removed from the enclosure to prevent possibility of electrical shock. Do not defeat this feature.

Installation of the BCD Board

Slide the BCD board between the side rails and engage the pins of the connector to the digital board. Check that all pins of the connector are engaged. Fasten the BCD board to the side rails using the two self fastening screws provided. The BCD board components should face downward and the edge connector face the rear of the unit.

Re-installing Unit in Case

Align the controller board with the lowermost slots in the enclosure; align the BCD board with the uppermost slots. Push the electronic module into the enclosure until the jack screw hits the jack screw insert. Turn the jack screw clockwise until the electronic module seats against the enclosure. CAUTION: Do not overtorque the jack screw. If the electronic module appears to bind, stop and correct the cause before proceeding.

Electrical Connections

Introduction

Wiring of the edge connector will be dependent upon your application needs. Read Section 4, "Operating Instructions" and Section 7 "Circuit Description" to formulate your requirements. The following section describes how to wire and mount the edge connector.

Output Section Electrical Connections

Electrical connections from the BCD board output section to the user's system are made by means of the edge connector provided in the BCD output option package or supplied with the controller if the BCD option was factory installed.

Open the edge connector kit, remove the connector assembly, and disassemble the blue shell halves to gain access to the edge connector. Note that polarizing keys are installed between connector pins 4 and 5, 12 and 13. It is important these keys remain in place to prevent interchanging or reversal of the controller board and BCD board edge connectors.

Wire the edge connector according to application needs using 18 to 26 AWG stranded wire. Use care to strip only 1/4 to 3/8 in. (6-10 mm) of wire so that free strands cannot protrude through the external connector openings. Consult Table 3-1 to determine proper pin connections. For strain relief, wires or cable may be secured to the blue shell halves by means of the cable ties provided. One or more of the small round plugs are used to plug unused holes; spares may be stored inside the connector housing for future use.

Connections to Interface Connector

Table 3-1

Pin	Name	Function
B	800	Data 800 ("8" bit, 100's digit)
2	400	Data 400
3	200	Data 200
D	100	Data 100
4	80	Data 80
5	40	Data 40
E	20	Data 20
F	10	Data 10
H	8	Data 8
9	4	Data 4
8	2	Data 2
7	1	Data 1 ("1" bit, 1's digit)
J	DP10	Dec Pt XX.X = 1 X.XX or XXX = 0
K	DP100	Dec Pt X.XX = 1 XX.X or XXX = 0
10	T mT	Range status: Torr (mbar) = 1; mTorr (x 10^{-3} mbar) = 0
12	Update	Single positive pulse for each conversion. Data latches updated with negative transition. State = 1 during serial data burst. f = 2.4 Hz. PW = 13-20 msec.
11	Serial Data	Burst of serial data during each conversion. Order is reverse of that listed above (Range bit 1st; 100's "8" bit last).
13	Serial Clock	16 positive clock pulses. First 15 negative edges are used to clock serial data bits.
15	V_{SS}	Option common; option ground
		Inputs
Pin	Name	Function
P	V_{DD}	Voltage to define "1" logic level. +3 to +16 Vdc with respect to V_{SS}. 1 mA average current required.
M	HOLD	"1" = Free running (Default*) "0" = Freeze data in output latches. (Controller display will continue to update.)
14	Disable Date	"0" = Data Outputs enabled (Default*) "1" = Data Outputs disabled to high - Z.
N	Disable Sync	"0" = Serial Clock & Update Enabled (Default*) "1" = Serial Clock & Update Disabled to high - Z.

*Default: No connection to input.
Unused pins: 1, 6, A, C, L, R, S

01

Reassemble the connector housing (blue shells) using the screws and nuts provided. Check the connector to see that no bare wires or strands are exposed which could cause shock or equipment damage. On newer units, when assembling the connector housing to the connector, check that the contact letters and numbers agree with the decal information. This assures proper keying of the connector to the case.

Plug the edge connector assembly onto the BCD board fingers protruding through the rear of the case, observing the key alignment. Fasten the connector to the 275 enclosure by means of the two 4-40 x 1 in. screws provided in the edge connector package.

SECTION 4

OPERATING INSTRUCTIONS

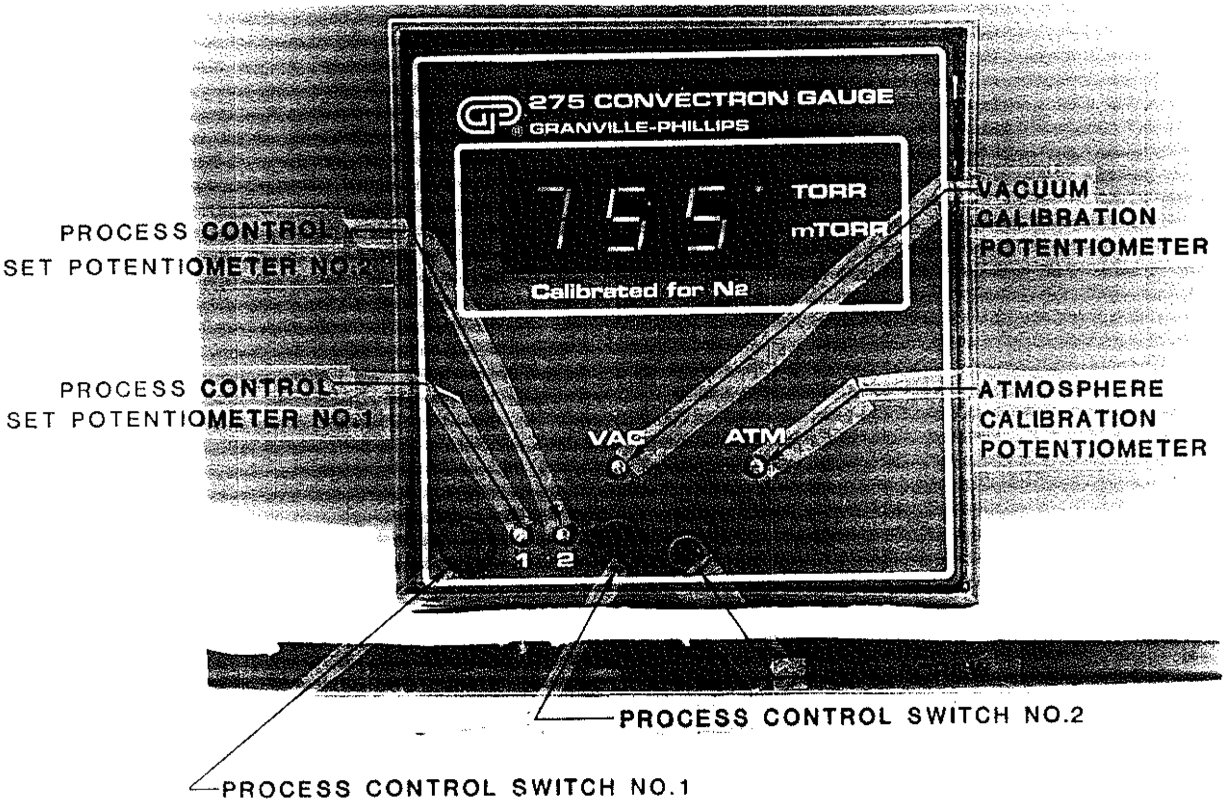


FIG. 4-1 LOCATION OF CONTROLS ON DIGITAL CONTROLLER

Purpose of Controls on Front Panel - (Refer to Fig. 4-1)

VAC (VACuum Calibration Potentiometer) - Adjustment is provided to restore accuracy of readout at low pressure for systems with gauge tubes operated in excessive contamination.

ATM (ATMosphere Calibration Potentiometer) - Adjustment provided to set atmospheric pressure readout to known atmospheric pressure of air.

Process Control Switch No. 1 - Provided so that set point No. 1 can be displayed on readout.

Process Control Set Potentiometer No. 1 - Adjustment provided to set process control point No. 1.

Process Control Switch No. 2 - Provided so that set point No. 2 can be displayed on readout.

Process Control Potentiometer No. 2 - Adjustment provided to set process control point No. 2.

Jack Screw - Used to "jack" the electronic module in and out of the enclosure. Requires a 9/64 Allen wrench to operate jack screw. Do not overtighten.

Process Control Setting

If your controller has more than one process control set point, each circuit is completely independent and must be set per the procedure below:

1. While holding the desired process control switch depressed, adjust the corresponding process control set potentiometer until the readout indicates the desired process control pressure.

2. Release the process control switch. This process control circuit is now set.

The process control set point may be checked by depressing the switch to read the set point pressure indicator without interrupting pressure measurement or control.

Pin information for each process control set point relay output is given in Section 3. In order to prevent oscillation around the trip point, there is a built-in hysteresis band of approximately 2% of the full scale output (approx. 1/3 turn of P.C. set pot). The process control relays may be used separately or together to suit your specific application. Two examples are shown in Fig. 4-2 and 4-3.

Fig. 4-2 can be used to allow a process to operate over a specific pressure band. In the application shown the process would be allowed only if the system pressure is between 20 and 50 Torr.

Fig. 4-3 can be used to control a process where a large pressure rise is expected once the process is initiated. In the application shown, the process would begin when the pressure decreased to 15 mTorr and remain on as long as the pressure remained below 45 mTorr.

Recorder Output

Figs. 6-7 through 6-9 are graphs of the 0 to 9 volt nonlinear analog recorder output. The output impedance of the recorder output is 5.1 kohms.

Long Cable Operation

Your controller may be operated with cables up to 500 feet long. In order to maintain calibration accuracy for tubes operating on long cables, you will need to adjust the ATM potentiometer per the System Calibration Procedure, Section 5. Note, ATM readjustment is usually not required for lengths less than 100 feet.

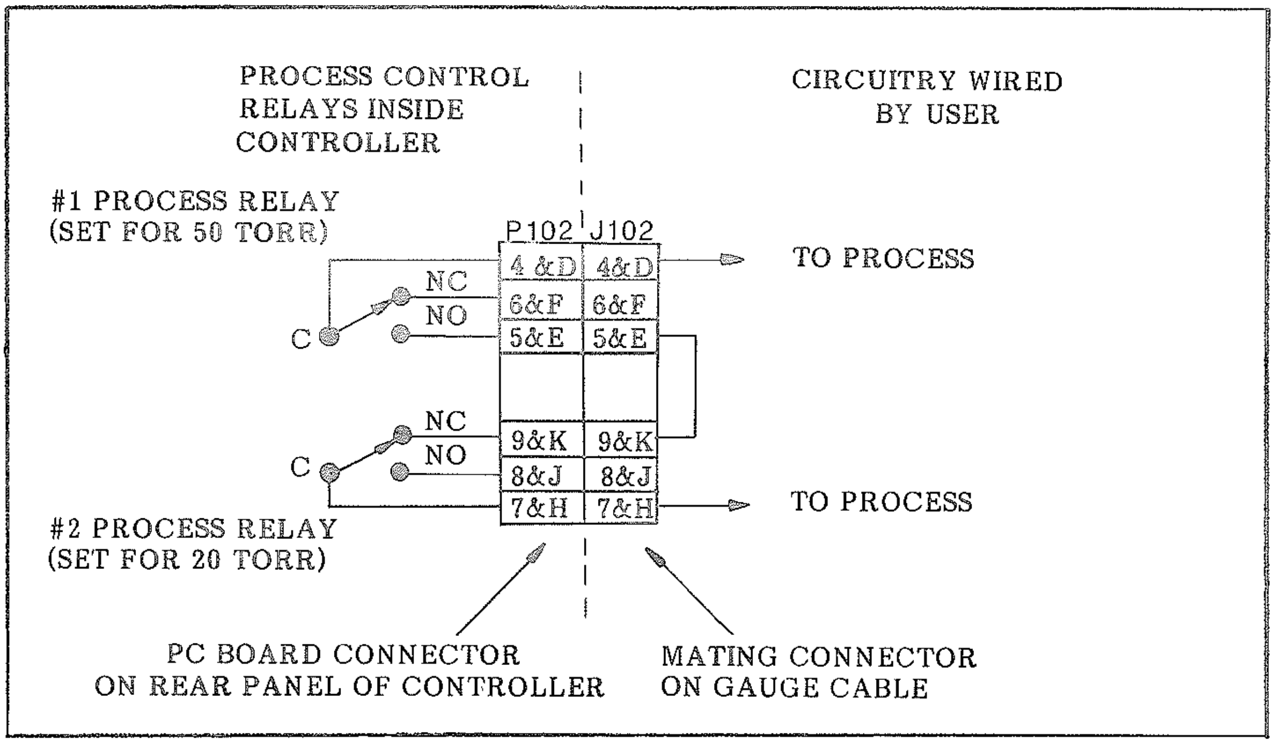


FIG. 4-2 EXAMPLE OF PROCESS CONTROL WITH PRESSURE BAND

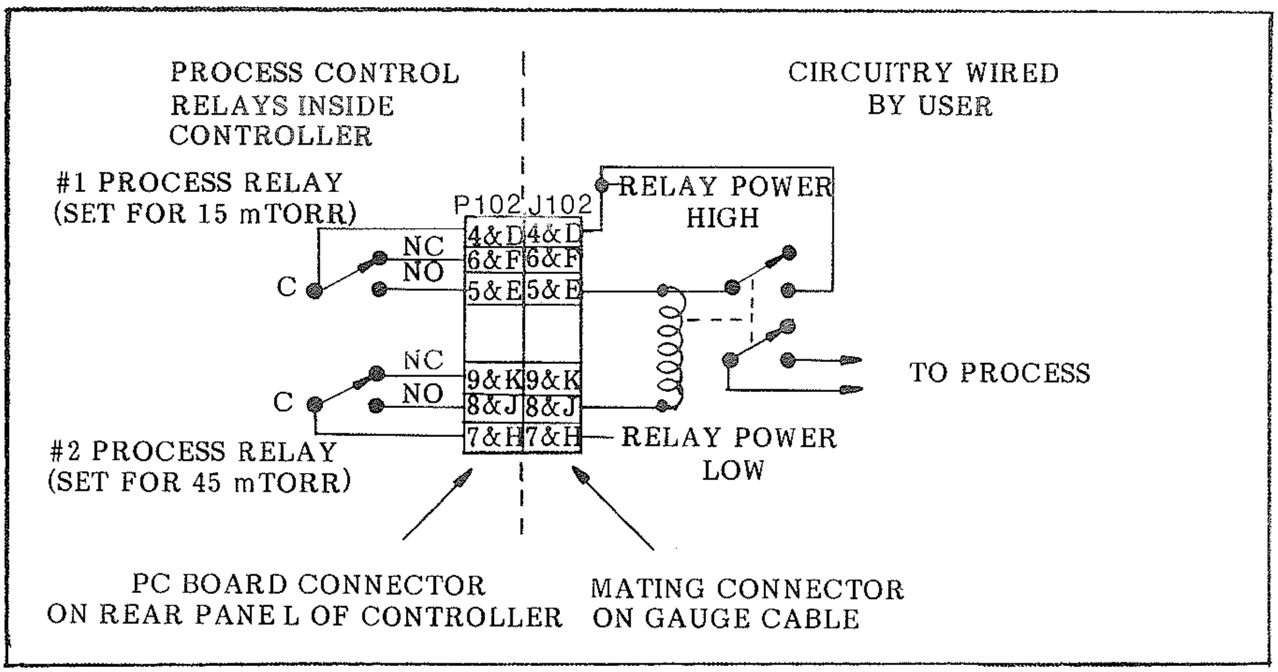


FIG. 4-3 EXAMPLE OF PROCESS CONTROL WITH HYSTERESIS LOOP

BCD Power Requirements

The output section must be powered by the user's system. A positive voltage source capable of delivering 1 mA average current must be connected to pin P (V_{DD}) (+) and to pin 15 (V_{SS}, option common) (-). The magnitude of the voltage applied to pin P must be between 3 and 16 volts with respect to pin 15 and equal to the desired V_{OH} level ("1" voltage level). For example, for TTL applications, 5-volts should normally be supplied.

Parallel Data Outputs

Parallel 8421 BCD data is available at the output pins as listed in Table 3-1. Refer to SPECIFICATIONS section for the drive capability of these outputs. In addition to the three significant digits, there are three output pins for the range status. These signals are fully latched. This means that they all change state simultaneously at the negative transition of the UPDATE pulse (see Fig. 4-4 and paragraph o Updata Output below).

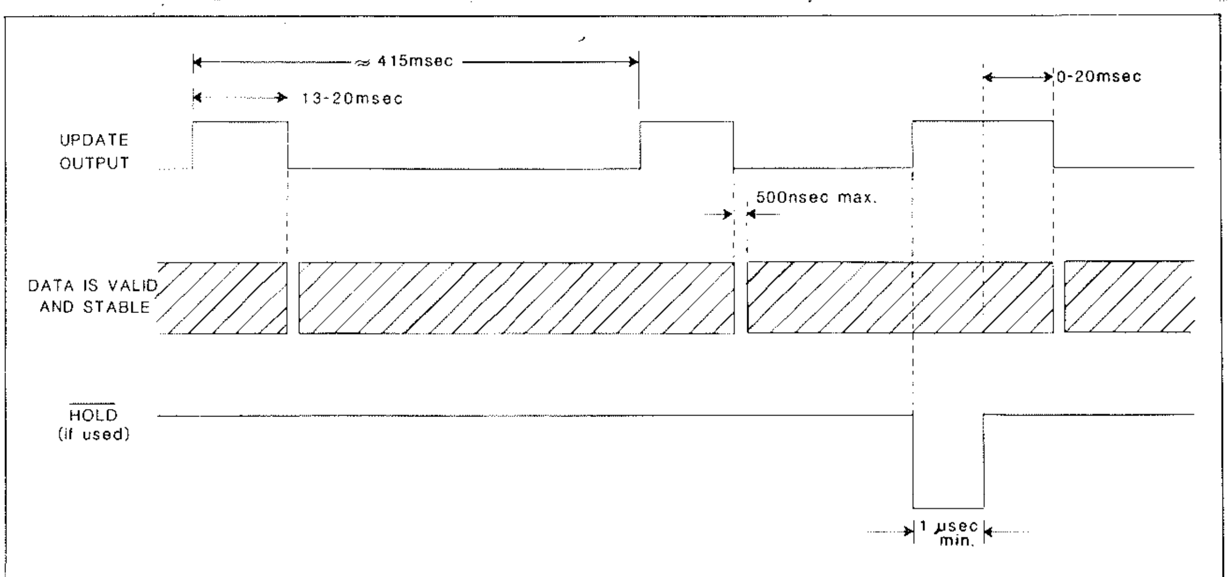


FIG. 4-4 PARALLEL DATA OUTPUT TIMING

Serial Data Output

Serial data is available at the output pins as listed in Table 3-1. Refer to the Specifications Section for drive capabilities of these outputs. See Fig. 4-5 for timing details of this output.

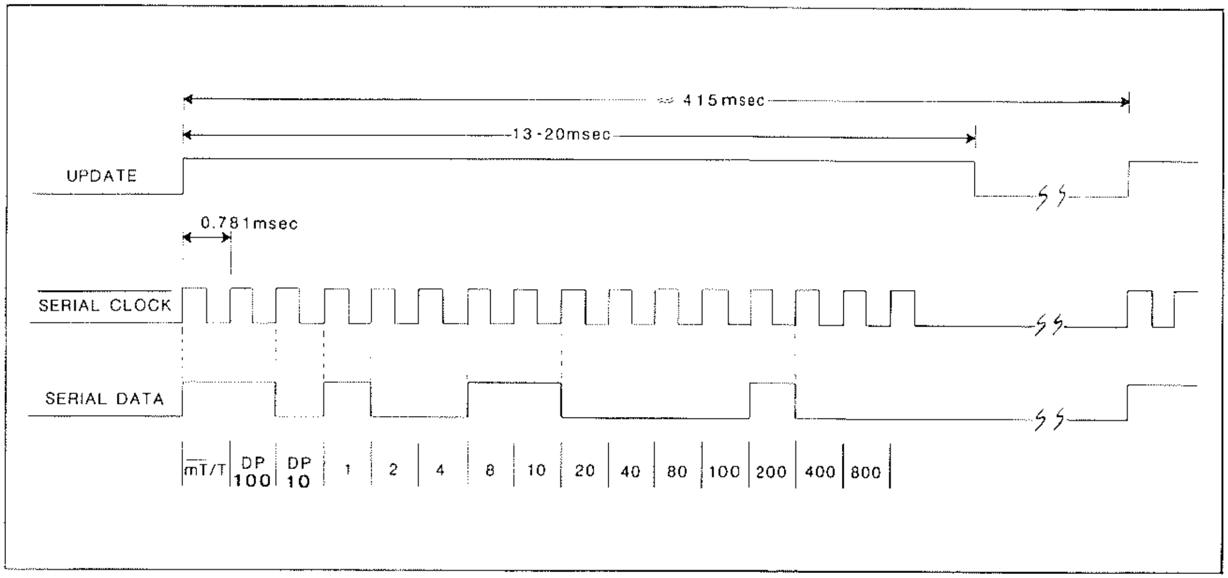


FIG. 4-5 EXAMPLE OF SERIAL OUTPUT FOR "21.9 TORR"

Update Output

This output will switch high in the following three situations:

1. For 13 to 20 milliseconds immediately prior to the parallel data latch update.

2. During the serial data burst.

3. Whenever the $\overline{\text{HOLD}}$ input (See $\overline{\text{HOLD}}$ input below) is hold low.

$\overline{\text{Serial Clock}}$ Output

See Fig. 4-5 for diagram of this signal. It is intended that the first 15 negative transitions of this burst of 16 pulses be used to strobe the acquisition of the series data.

$\overline{\text{HOLD}}$ Input

If no connection is made to this input, or if a "1" is applied, the data will update asynchronously at about a 2.4 Hz rate. If a "0" is applied, the current data in the output latches will be held indefinitely. When this input is switched from an "0" to a "1", the output latches will update to the current pressure reading within 20 msec after the transition.

Disable Data Input

With no connection, or with a "0" applied, the parallel and serial data outputs are active (either "0" or "1" at all times). When a "1" is applied to this input, the parallel and serial data outputs are switched to a high impedance indeterminate third state.

Disable Sync Input

With no connection, or with a "0" applied, the $\overline{\text{Serial Clock}}$ and Update outputs are active (either "0" or "1" at all times). When a "1" is applied to this inut, the $\overline{\text{Serial Clock}}$ and Update outputs are switched to a high impedance indeterminate third state.

SECTION 5

CALIBRATION

Each gauge tube is individually calibrated to N_2 and air and temperature compensated prior to leaving the factory. Each controller is also individually calibrated to provide accurate readout of N_2 and air pressure of any calibrated gauge tube. Therefore, initial calibration should not be necessary. See Section 6 for use with gases other than N_2 and air. If the tube becomes contaminated or does not read correctly, the gauge and controller can be calibrated as a system from the front panel adjustments by performing the following steps. This procedure can also be used to readjust the controller for use with long cables.

For accurate calibration, the vacuum and atmosphere adjustments must be made in the following order.

1. <u>Zero Adjust</u>

   a. Evacuate the system to a pressure less than 10^{-4} Torr or 10^{-4} mbar.

   b. With the Series 275 system operating, set the readout to zero by adjusting the VAC potentiometer CW until a positive pressure is displayed, then slowly rotating the potentiometer CCW until a zero is obtained. Continued further rotation will result in the range LED turning off indicating misadjustment. The optimum setting is where the range LED just lights, or is flashing.

2. <u>Atmosphere Adjust</u>

   a. Allow the system pressure to rise to atmospheric pressure of air.

   b. Adjust the ATM potentiometer until the pressure indication agrees with the absolute atmospheric pressure as read on an accurate barometer. Use absolute pressure, not corrected to sea level.

NOTE: 1 atmosphere normal at sea level = 760 Torr = 1013 mbar.

NOTES

SECTION 6

USE WITH GASES OTHER THAN N_2 AND AIR

Before using the Series 275 gauge to measure the pressure of other gases make certain the ATM adjustment is correctly set for air. See Section 5.

It is important to understand that the indicated pressure on a Series 275 gauge depends on the type of gas in the tube, and on the orientation of the tube axis as well as on the gas pressure in the tube. Series 275 gauges are supplied calibrated for N_2 when the axis of the gauge tube is horizontal. The indicated reading for air is the same as for N_2 within the accuracy of the instrument. With certain safety precautions, the Series 275 gauge may be used to measure pressure of other gases.

Series 275 gauge tubes are thermal conductivity gauges of the Pirani type. These gauges transduce gas pressure by measuring the heat loss from a heated sensor wire maintained at constant temperature. For gases other than N_2 and air the heat loss is different at any given true pressure and thus the indicated reading will be different.

Indicated vs. True Pressure Curves

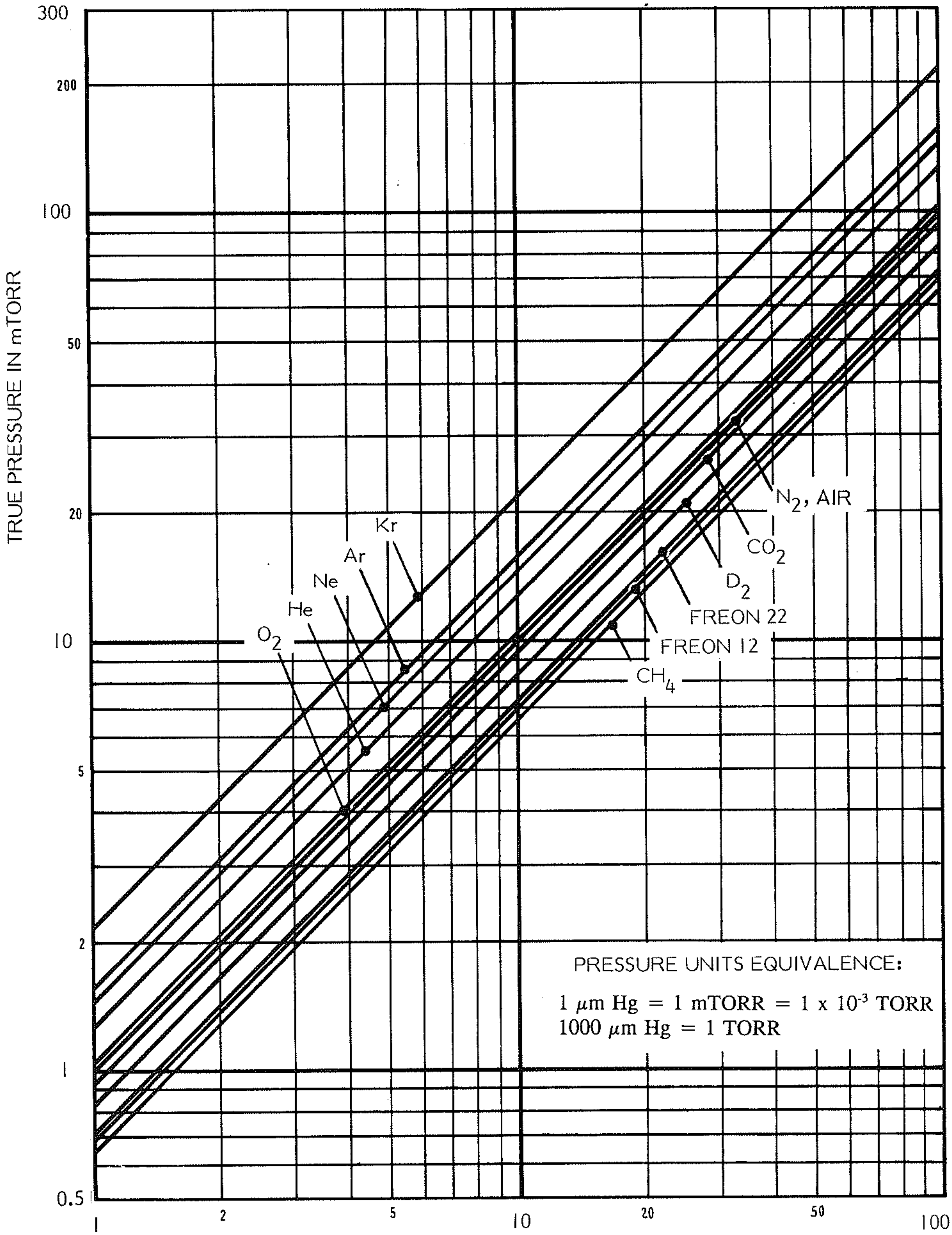
WARNING

IF USED WITHOUT PROPER CALIBRATION OR WITHOUT REFERENCE TO PROPER CONVERSION CHARTS, CONVECTRON GAUGES CAN SUPPLY MISLEADING PRESSURE INDICATIONS. THESE MISLEADING PRESSURE INDICATIONS MAY RESULT IN DANGEROUS OVERPRESSURE CONDITIONS WITHIN THE SYSTEM.

Figures 6-1, 6-2, 6-3, 6-4, 6-5 and 6-6 show the true pressure vs indicated pressure on Series 275 instruments for eleven commonly used gases. The following list will help to locate the proper graph for a specific application:

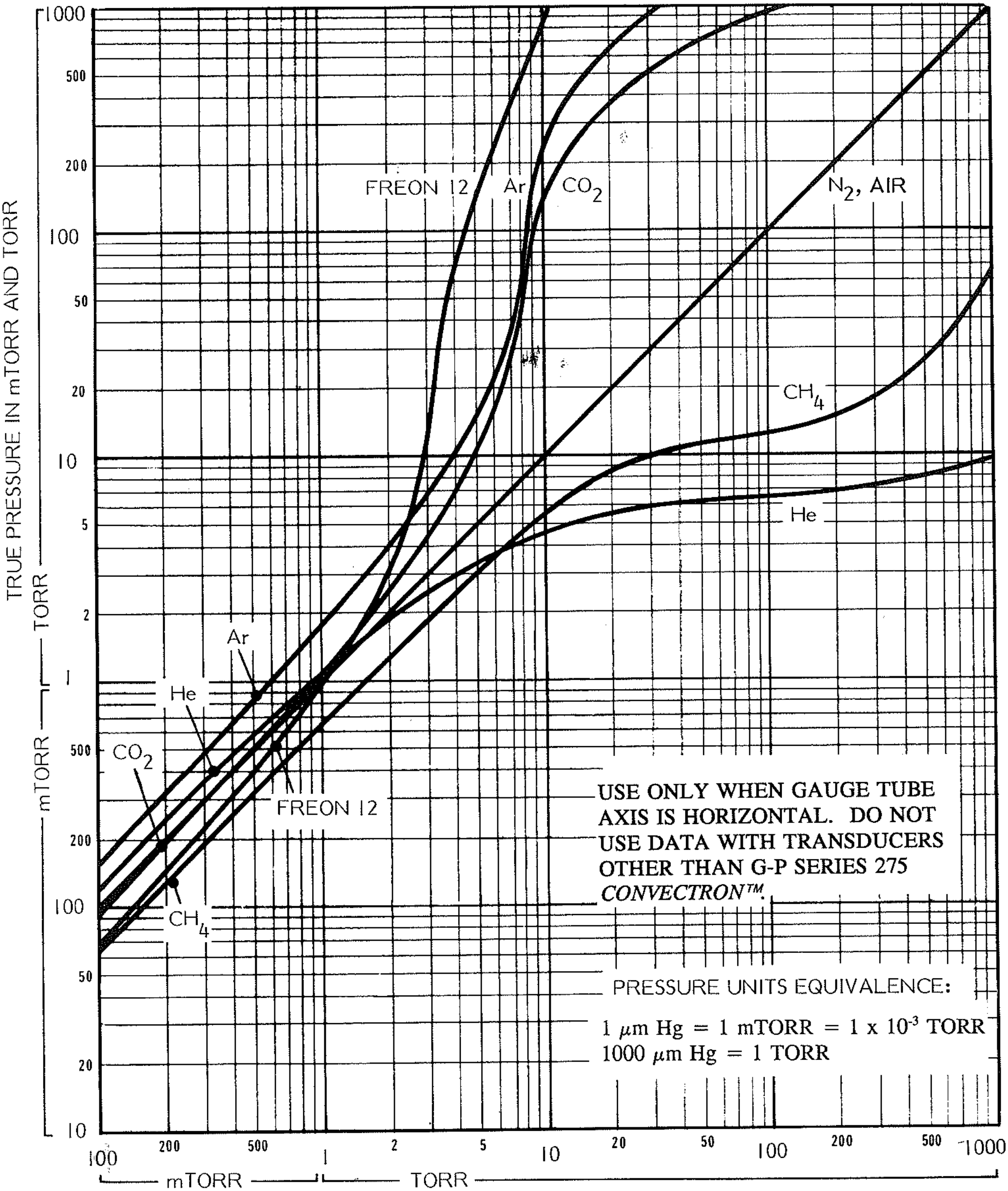
Fig.	Range and Units	Gases
6-1	1 to 100 mTorr	All
6-2	0.1 to 1000 Torr	Ar, CO_2, CH_4, Freon 12, He
6-3	0.1 to 1000 Torr	D_2, Freon 22, Kr, Ne, O_2
6-4	10^{-3} to 10^{-1} mbar	All
6-5	0.1 to 1000 mbar	Ar, CO_2, CH_4, Freon 12, He
6-6	0.1 to 1000 mbar	D_2, Freon 22, Kr, Ne, O_2

A useful interpretation of these curves is, for example, that at a true pressure of 2×10^{-2} Torr of CH_4 the heat loss from the sensor is the same as at a pressure of 3×10^{-2} Torr of N_2 (see Fig. 6-1). The curves at higher pressure vary widely from gas to gas because the thermal losses at higher pressures are greatly different for different gases.



INDICATED PRESSURE IN mTORR
(N_2 EQUIVALENT)

FIG. 6-1



INDICATED PRESSURE IN mTORR AND TORR

(N_2 EQUIVALENT)

FIG. 6-2

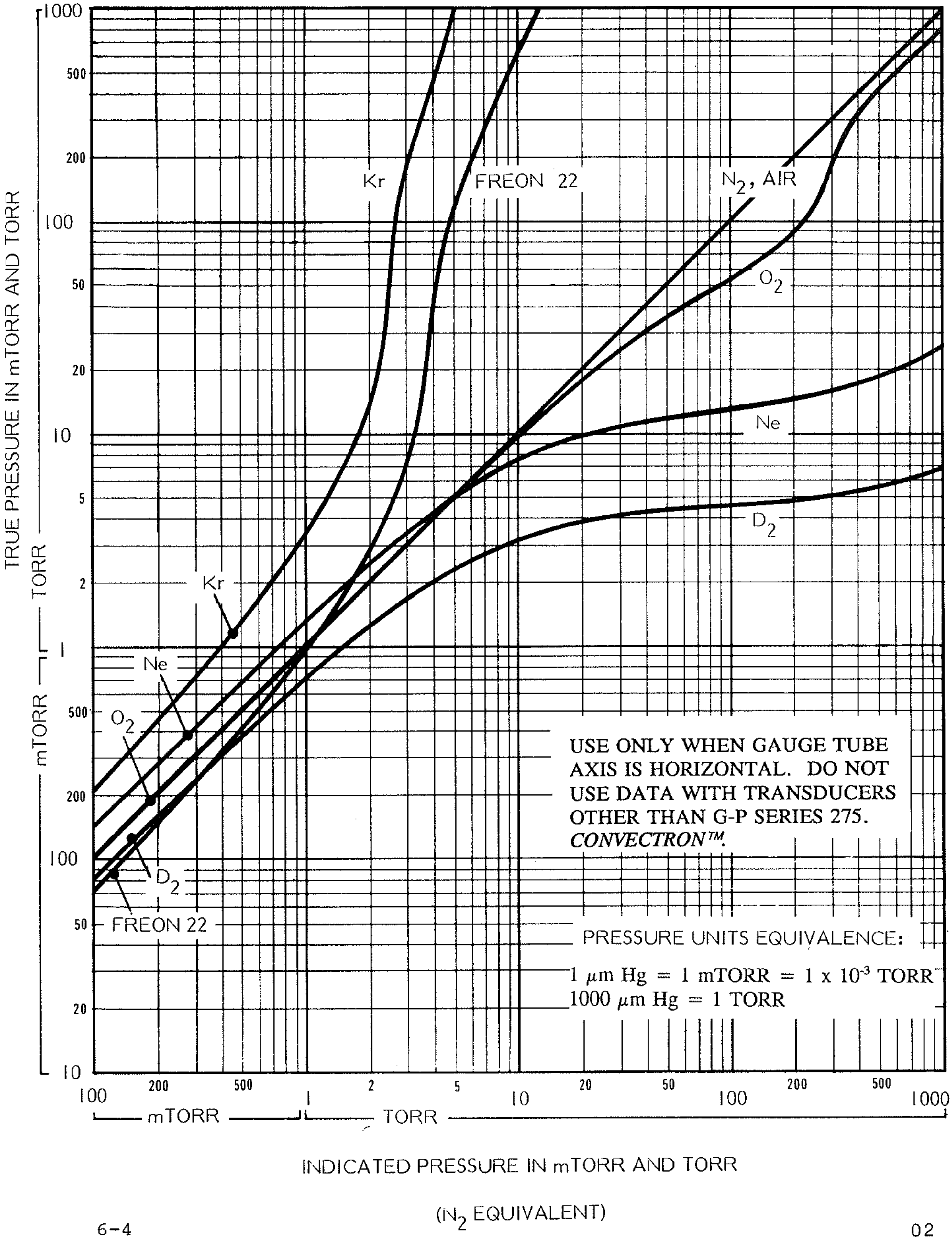
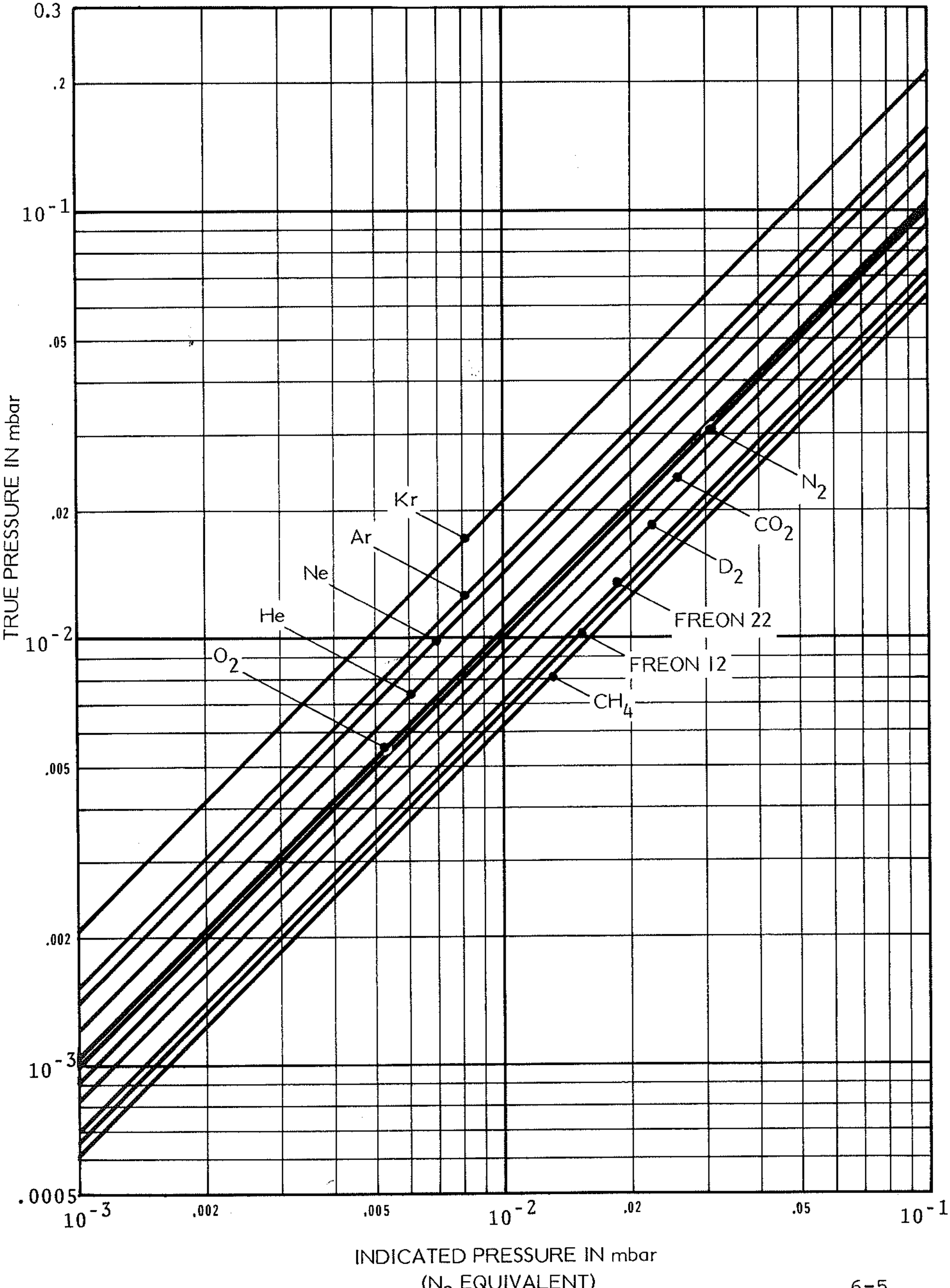

TRUE PRESSURE IN mTORR AND TORR
TORR
mTORR
1000
500
200
100
50
20
10
5
2
1
500
200
100
50
20
10
Kr
FREON 22
N_2, AIR
O_2
Ne
D_2
Kr
Ne
O_2
D_2
FREON 22
USE ONLY WHEN GAUGE TUBE AXIS IS HORIZONTAL. DO NOT USE DATA WITH TRANSDUCERS OTHER THAN G-P SERIES 275. *CONVECTRON™*.
PRESSURE UNITS EQUIVALENCE:
1 μm Hg = 1 mTORR = 1 x 10^{-3} TORR
1000 μm Hg = 1 TORR
100
200
500
1
2
5
10
20
50
100
200
500
1000
mTORR
TORR
INDICATED PRESSURE IN mTORR AND TORR
(N_2 EQUIVALENT)

FIG. 6-3



0.3
.2
10^{-1}
.05
.02
10^{-2}
.005
.002
10^{-3}
.0005
TRUE PRESSURE IN mbar
Kr
Ar
Ne
He
O_2
N_2
CO_2
D_2
FREON 22
FREON 12
CH_4
10^{-3}
.002
.005
10^{-2}
.02
.05
10^{-1}
INDICATED PRESSURE IN mbar
(N_2 EQUIVALENT)

FIG. 6-4

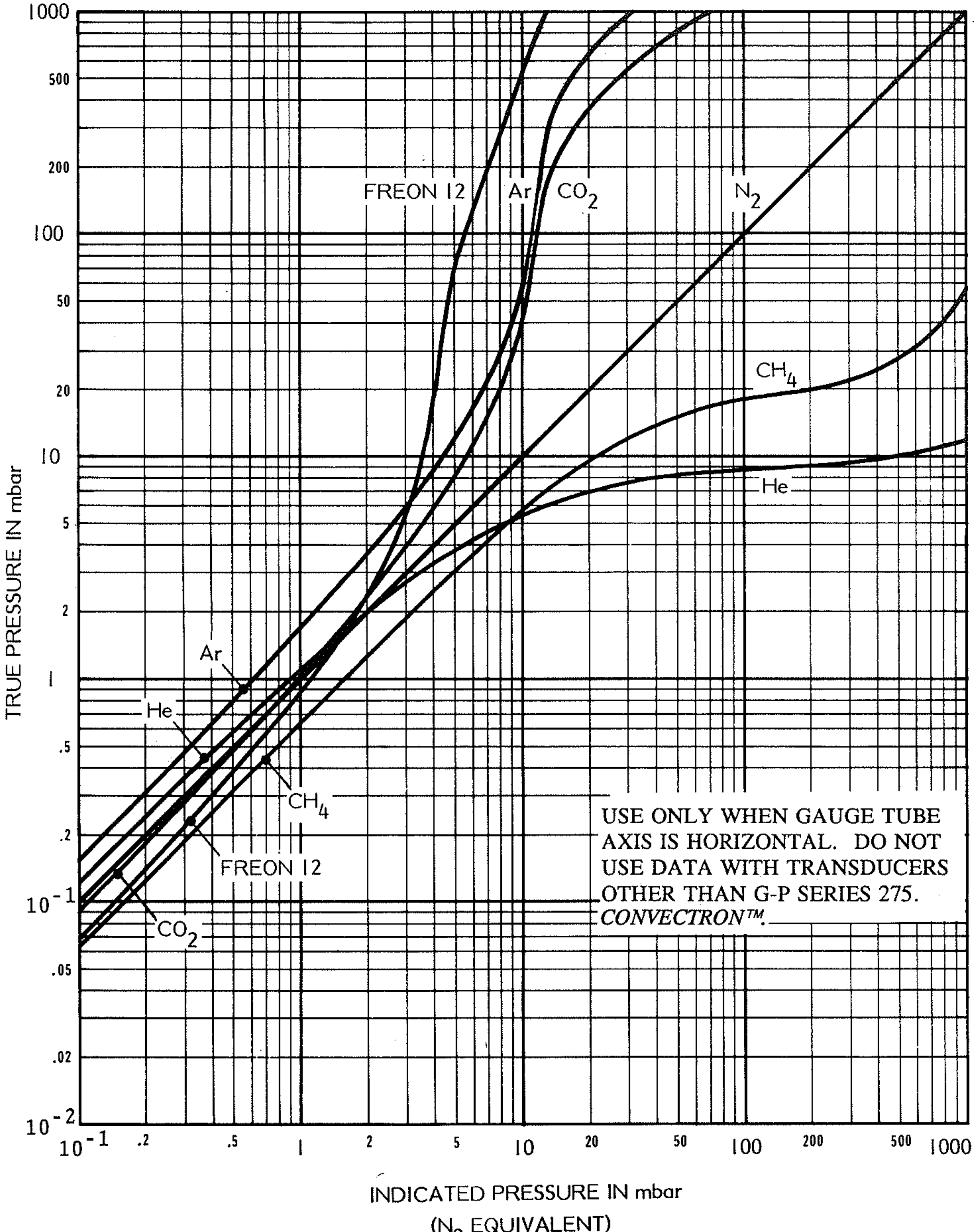

TRUE PRESSURE IN mbar
1000
500
200
100
50
20
10
5
2
1
.5
.2
10^-1
.05
.02
10^-2
10^-1
.2
.5
1
2
5
10
20
50
100
200
500
1000
FREON 12
Ar
CO2
N2
CH4
He
USE ONLY WHEN GAUGE TUBE AXIS IS HORIZONTAL. DO NOT USE DATA WITH TRANSDUCERS OTHER THAN G-P SERIES 275. CONVECTRON™.
INDICATED PRESSURE IN mbar
(N2 EQUIVALENT)

FIG. 6-5

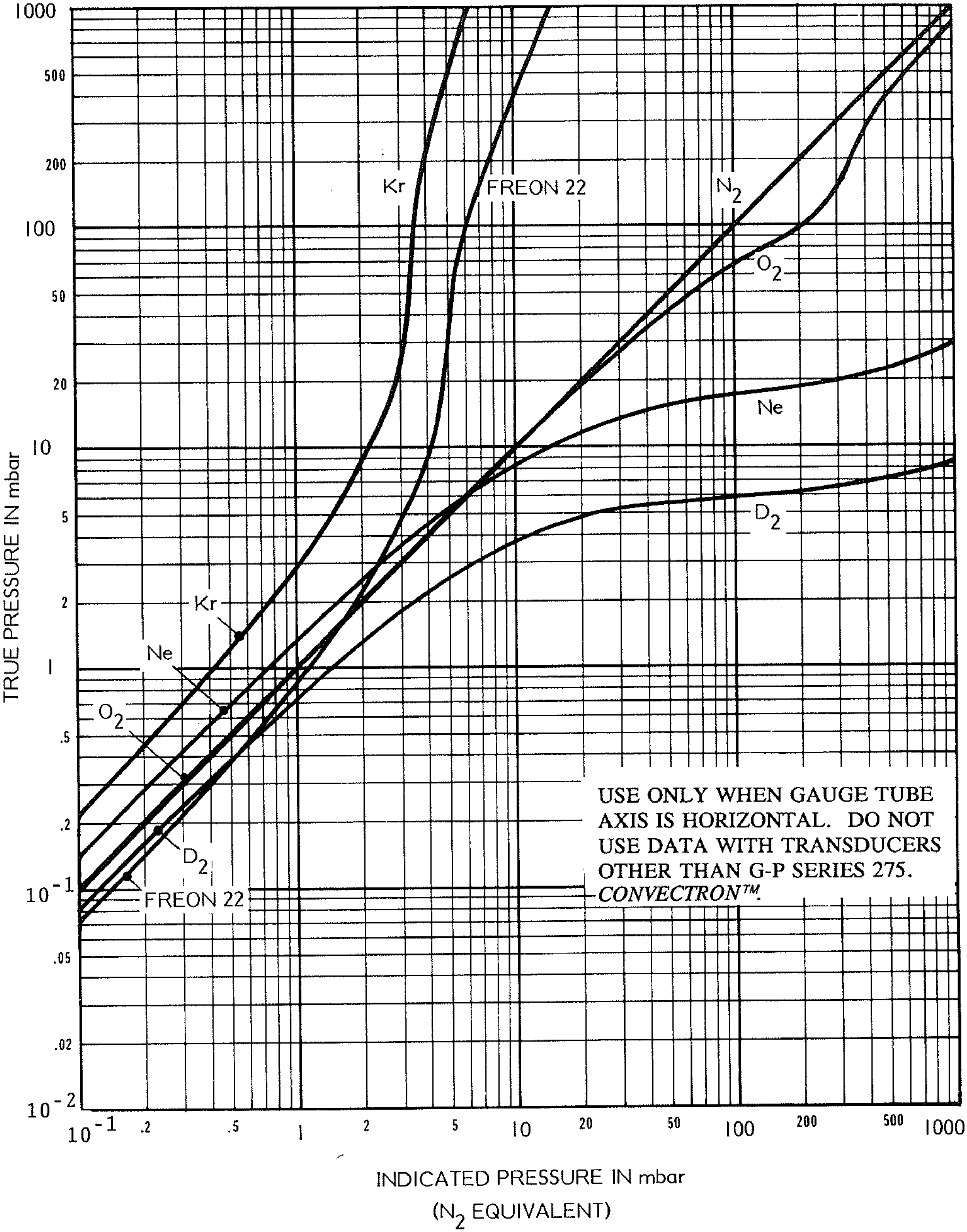

TRUE PRESSURE IN mbar
1000
500
200
100
50
20
10
5
2
1
.5
.2
10^{-1}
.05
.02
10^{-2}
Kr
FREON 22
N_2
O_2
Ne
D_2
USE ONLY WHEN GAUGE TUBE AXIS IS HORIZONTAL. DO NOT USE DATA WITH TRANSDUCERS OTHER THAN G-P SERIES 275. *CONVECTRON™*.
10^{-1}
.2
.5
1
2
5
10
20
50
100
200
500
1000
INDICATED PRESSURE IN mbar
(N_2 EQUIVALENT)

FIG. 6-6

The Series 275 gauge tube utilizes convection cooling to provide resolution superior to any other thermal conductivity gauge near atmospheric pressure of N_2 and air. Because convection effects are geometry dependent, the true pressure vs indicated pressure curves for the Series 275 gauge tube are likely to be much different from curves for heat loss tubes made by others; therefore, it is not safe to attempt to use calibration curves supplied by other manufacturers for their gauges with the Series 275 system nor is it safe to use curves for the Series 275 gauge with gauges supplied by other manufacturers.

If you must measure the pressure of gases other than N_2 or air, use Figures 6-2 and 6-3 to determine the maximum safe indicated pressure for the other gas as explained below.

EXAMPLE 1 Maximum safe indicated pressure.

Assume a certain system will withstand an internal pressure of 2000 Torr or 38.7 psia. For safety you wish to limit the maximum internal pressure to 760 Torr during backfilling. Assume you wish to measure the pressure of argon. On Fig. 6-2 locate 760 Torr on the left hand scale, travel to the right to the intersection with the argon (Ar) curve and then down to an indicated pressure of 24 Torr (N_2 equivalent). Thus in this hypothetical situation the maximum safe indicated pressure for argon is 24 Torr.

For safety, it is prudent to place a warning label on the instrument face which, under the assumed conditions, would read "DO NOT EXCEED 24 TORR FOR ARGON."

The following examples serve to illustrate how to use Figures 6-1, 6-2 and 6-3 to convert indicated pressure to true pressure and vice versa for gases other than N_2 and air.

EXAMPLE 2 Indicated to true pressure conversion.

Assume you wish to determine the true pressure of argon in a system when the Series 275 instrument is indicating 10 Torr. On Fig. 6-2, read up from 10 Torr (N_2 equivalent) indicated pressure to the argon curve and then horizontally to the left to a true pressure of 250 Torr. Thus 250 Torr argon pressure produces an indication of 10 Torr (N_2 equivalent).

EXAMPLE 3 True to indicated pressure conversion.

Assume you wish to set a process control set point at a true pressure of 20 Torr of CO_2. On Fig. 6-2, locate 20 Torr on the true pressure scale, travel horizontally to the right to the CO_2 curve and then down to an indicated pressure of 6 Torr (N_2 equivalent). Thus the correct process control setting for 20 Torr of CO_2 is 6 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 Fig. 6-2, 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.

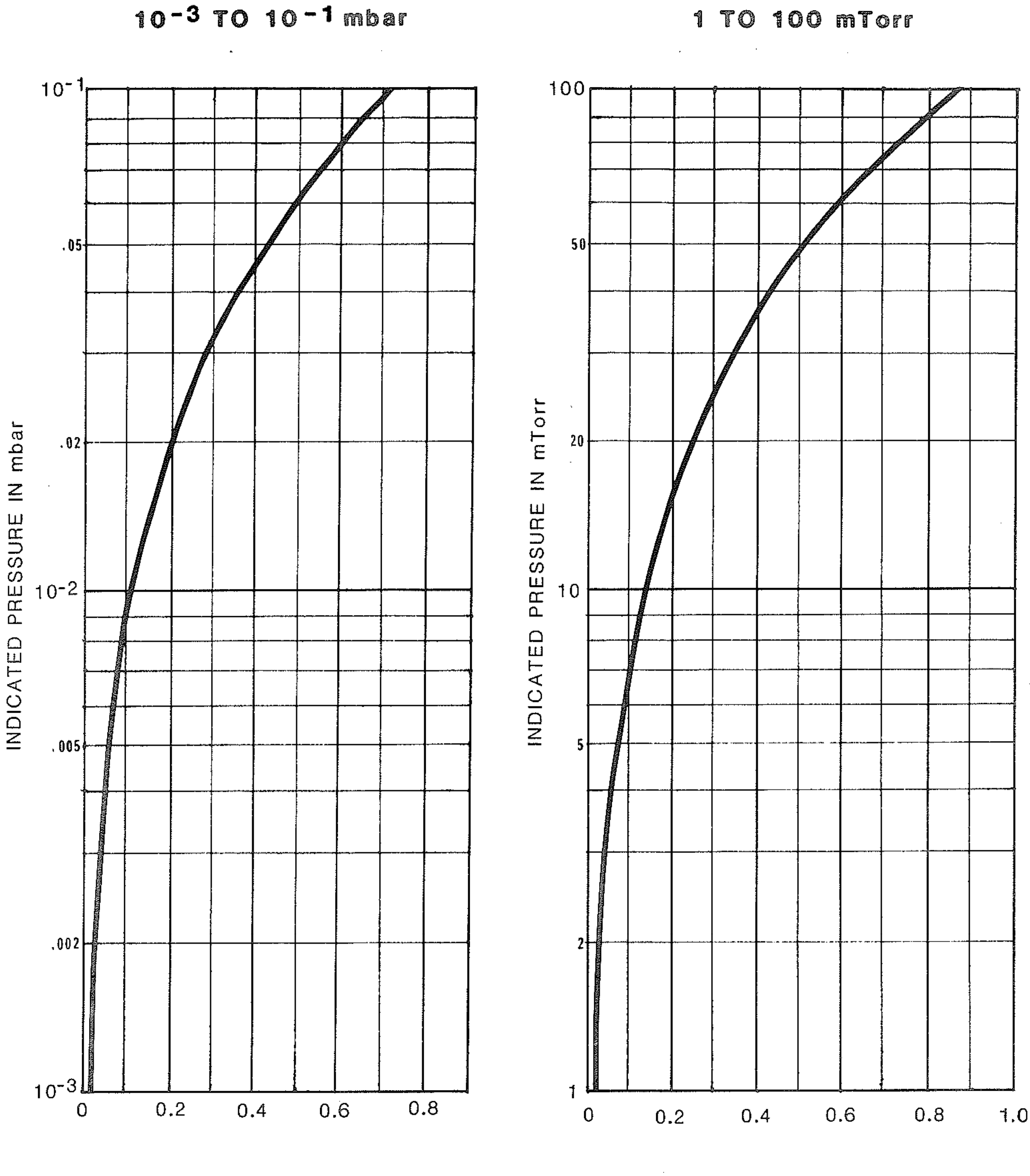
For gases other than those listed, the user must provide accurate conversion data for safe operation. The Series 275 gauge is not intended for use above 1000 Torr true pressure.

Recorder Output Voltage Curves

Figures 6-7 through 6-9 are used to convert a pressure reading at the controller's display into a voltage at the recorder output terminals. These graphs can be used in conjunction with the indicated versus true pressure curves in this section in order to determine the recorder output voltages for various gas types. The accuracy of the voltage scales for these graphs is ±5%. The recorder output source impedance is 5100 ohms ±5%. The recorder output terminals are pins M (positive) and N (negative; return) at the power/gauge/accessory connector.

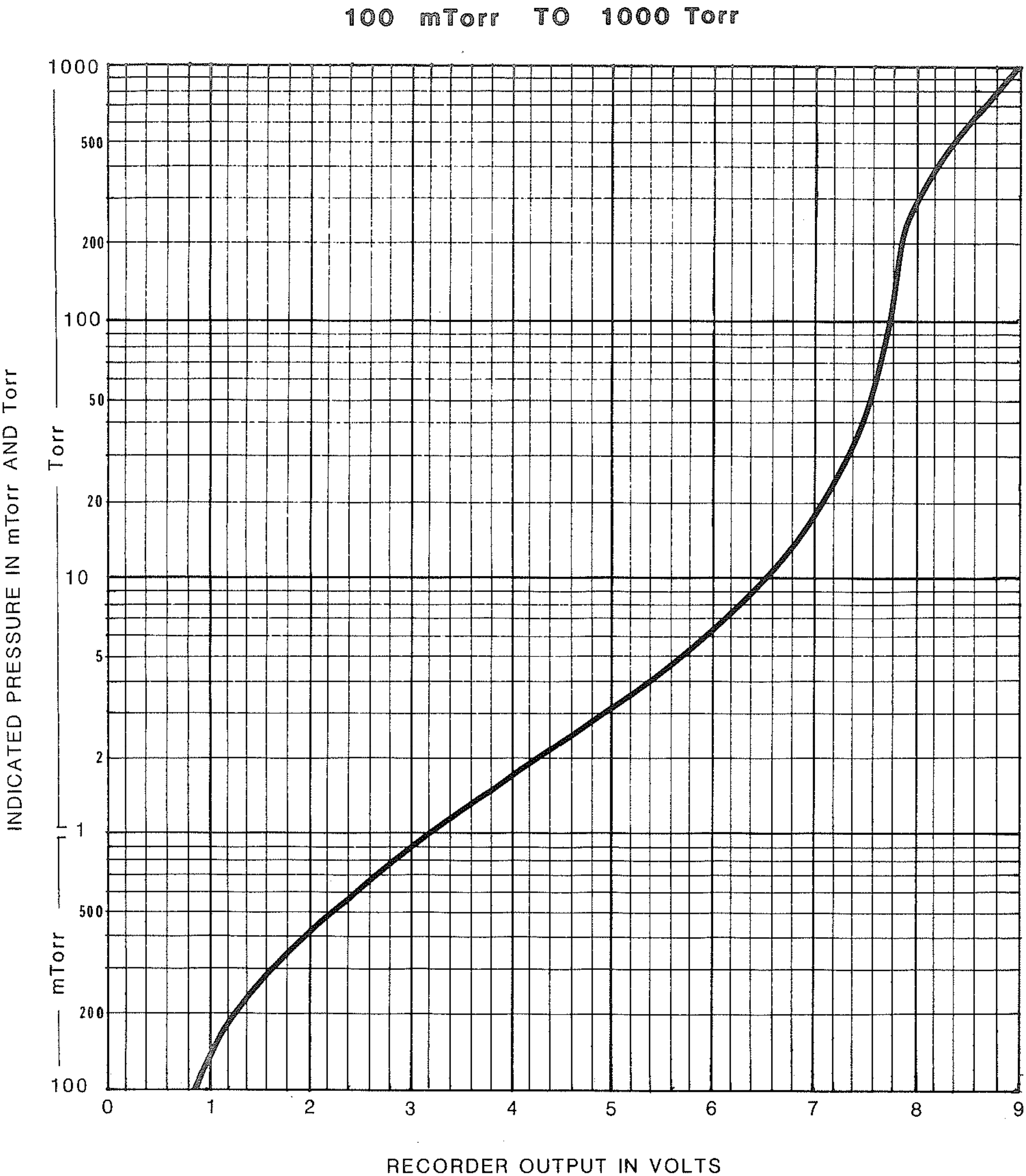
Table of Recorder Output vs Indicated Pressure Graphs

Fig.	Pressure Range
6-7	1 to 100 mTorr 10^{-3} to 10^{-1} mbar
6-8	100 mTorr to 1000 Torr
6-9	10^{-1} to 1000 mbar



NOMINAL RECORDER OUTPUT VS. INDICATED PRESSURE

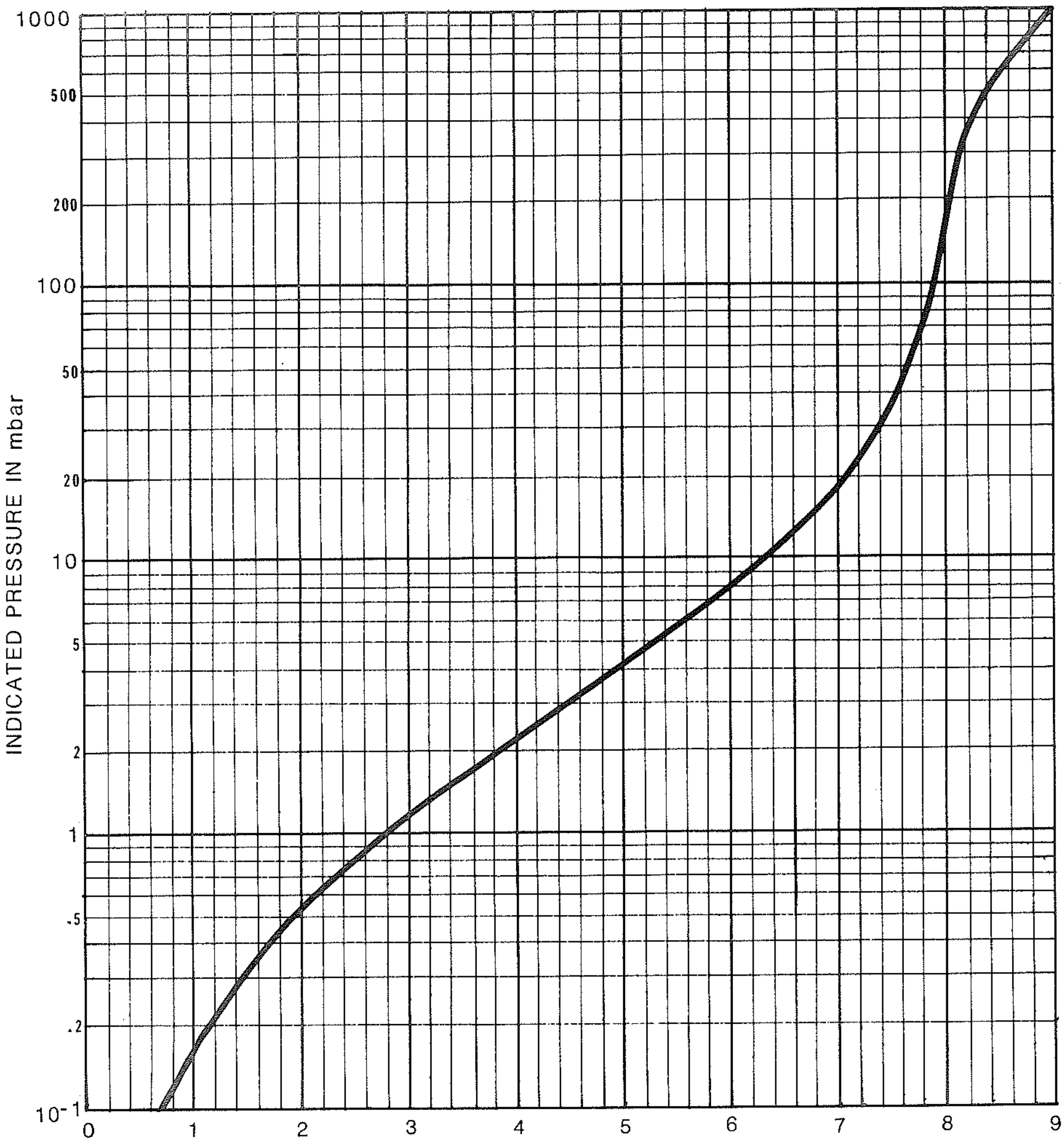
FIG. 6-7



NOMINAL RECORDER OUTPUT VS. INDICATED PRESSURE

FIG. 6-8

10^{-1} to 1000 mbar



RECORDER OUTPUT IN VOLTS

NOMINAL RECORDER OUTPUT VS. INDICATED PRESSURE

FIG. 6-9

SECTION 7

CIRCUIT DESCRIPTION

Operating Principles (Refer to Figures 7-1 and 7-2)

The block diagram for the analog controller is shown in Fig. 7-1. Refer to Fig. 7-1. The tube sensor wire is designated R1 in the Wheatstone bridge circuit. R2 is a resistive network in the tube which compensates for changes in the ambient temperature. At bridge null R1=R2xR3/R4. If there are no changes in the ambient temperature the value of R1 is a constant.

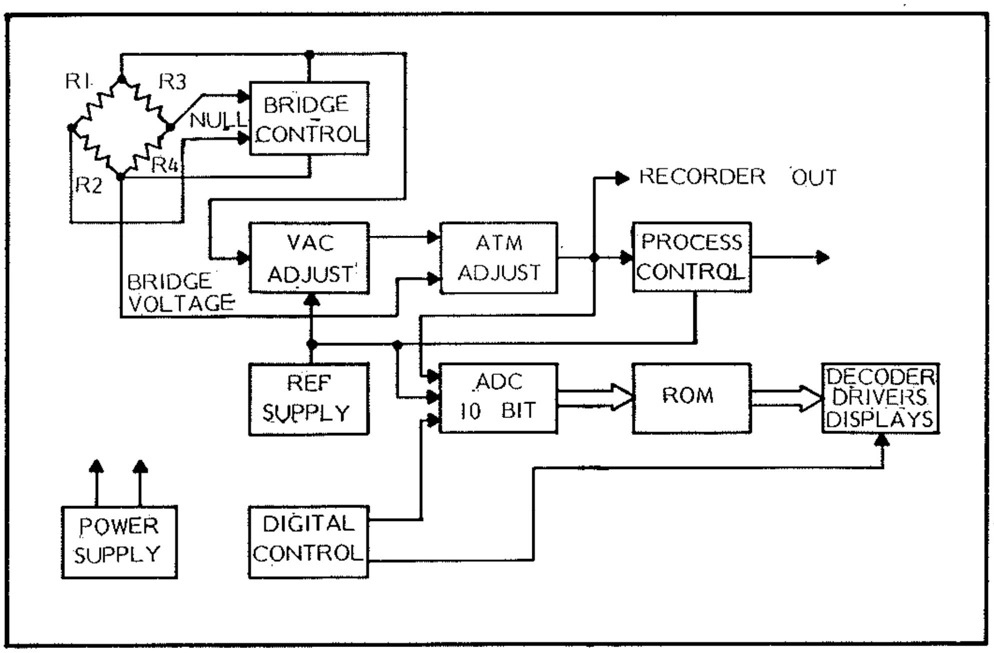


FIG. 7-1 DIGITAL CONTROLLER BLOCK DIAGRAM

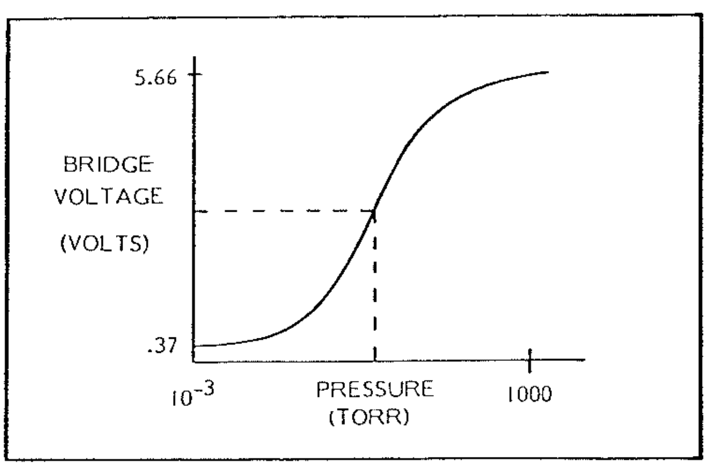


FIG. 7-2 BRIDGE VOLTAGE VS PRESSURE

As the vacuum system pressure is decreased there are fewer molecules in the system to conduct the heat away from the sensor wire causing the temperature and resistance of R1 to increase. The increased resistance of R1 causes the bridge to unbalance and a voltage is developed across the null terminals. The bridge control circuit senses the null voltage and decreases the voltage across the bridge until the null voltage is again zero. When the bridge voltage is decreased the power dissipated in the sensor wire is decreased causing the resistance of R1 to decrease to its previous value. The resulting bridge voltage, properly scaled, is displayed as system pressure. The opposite events happen for a pressure increase. The bridge voltage is a non-linear function of pressure and the relationship is shown in Fig. 7-2.

The remaining blocks in Fig. 7-1, which will be explained in detail later, are briefly described here:

> The VAC adjust and ATM adjust circuits set the end point voltages of the voltage vs pressure relationship to the correct values at the A-D converter and process control input.
>
> The process control circuits provide relay contact outputs for controlling external user equipment.
>
> The 10-bit analog-to-digital converter (ADC), read only memory (ROM), decoders/drivers and displays convert the normalized bridge voltage at the ADC input into the corresponding decimal pressure.

<u>Component Location</u>

Throughout the remainder of the manual all components will be identified by an alpha numeric symbol in order to assist the technician should maintenance be required. The controller circuitry is conveniently packaged on three replaceable printed circuit boards (4 including BCD option) identified as follows:

Printed Circuit Board	Identifier
Main	1XX
Process Control	2XX
Digital	3XX
BCD	4XX

A component labeled C203 therefore is a capacitor located on the process control board.

<u>± Power Supplies</u> (Refer to Fig. 7-3)

CR105 is used as 2 full wave rectifiers and develops ±19 Vdc across the two filter capacitors C110 and C111. VR101 and VR102 are positive and negative 12 volt ±5% voltage regulators, respectively. C112 and C113 provide filtering and stabilize the regulators. RA105A, VR100 and C105 are used to generate +5 Vdc for the digital circuits. C107, C108 and C109 are high frequency filter capacitors. F100 is a fuse protecting the circuitry. J100, P100 and P101 are used to select the operating voltage.

Bridge Control (Refer to Fig. 7-4)

U100 amplifies the bridge null voltage. The gain is determined by R101B and the bridge resistors. C104 is used to provide stability. CR100 and CR101 compensate for the base to emitter voltage variations of the darlington transistor, Q100, due to ambient temperature change. R101D provides sufficient base current to Q100 to ensure that the bridge control circuit goes into the control mode when the controller is turned on. R104 is a positive temperature coefficient overcurrent protection device which activates if the emitter of Q100 is shorted to ground. C100, C101, C102 and C103 are filter capacitors. R100, R102, R103 and CR102, during normal operation, can be disregarded. Should the gauge tube sensor wire break or should the gauge tube become disconnected, they cause the amplifier to give an indication of high pressure.

If the pressure increases, the resistance of the sensor decreases, pin 3 of U100 becomes positive with respect to pin 2 causing pin 6 and the emitter of Q100 to become more positive. The increased bridge voltage causes a larger power dissipation in the sensor which increases its temperature and resistance. The increased resistance causes the null voltage to decrease. The bridge voltage continues to increase until the null voltage is once again zero.

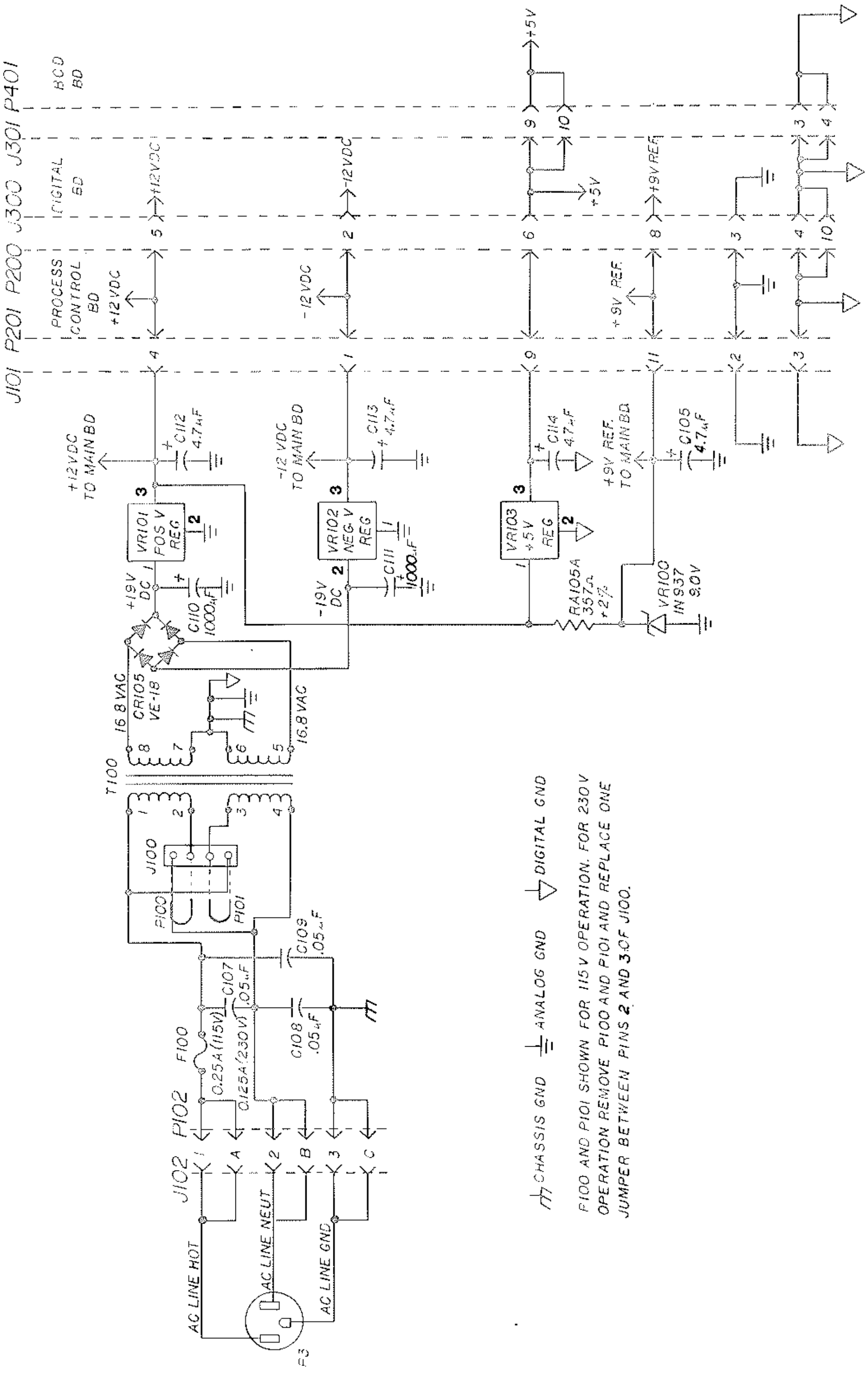
VAC Adjust (Refer to Fig. 7-4)

The bridge voltage-pressure relationship is shown in Fig. 7-2. Note that the bridge voltage does not go to zero for the lowest pressure reading. The desired voltage range of U101B, pin 1, is 0 volts to 9 volts. In order to achieve this range, it is necessary to add a negative voltage to the bridge voltage which will make the voltage at U101B, pin 1, zero for a system pressure below 1 mTorr.

The positive 9 V reference voltage is amplified by U101A, R106, R107 and R201 to produce -0.66 volts at U101A, pin 7, adjustable by R201. This voltage and the bridge voltage are summed by R108 and R109 at their common junction. R201 is a front panel available, 20 turn potentiometer and provides a resolution of 0.6 mTorr per turn.

ATM Adjust (Refer to Fig. 7-4)

The bridge voltage is amplified by U101B, R110, R111 and R200. R200 is a front panel available, 20 turn potentiometer which trims the amplifier's gain to produce 9 V at U101B, pin 1, when the system pressure is 1000 Torr.



CHASSIS GND — ANALOG GND — DIGITAL GND

F100 AND P101 SHOWN FOR 115V OPERATION. FOR 230V OPERATION REMOVE P100 AND P101 AND REPLACE ONE JUMPER BETWEEN PINS 2 AND 3 OF J100.

FIG. 7-3 DIGITAL CONTROLLER POWER SUPPLY CIRCUIT

007201 101

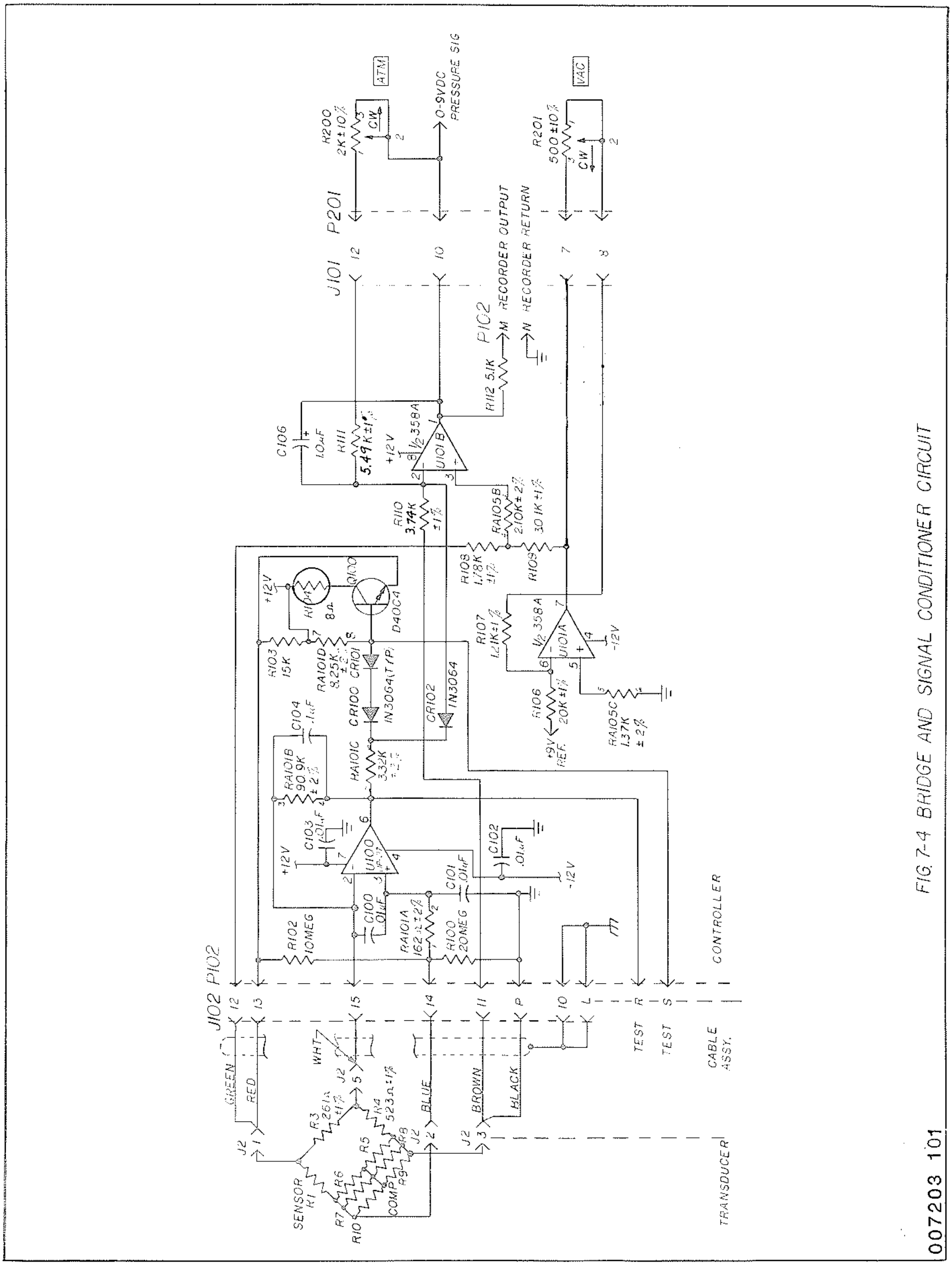


FIG 7-4 BRIDGE AND SIGNAL CONDITIONER CIRCUIT

007203 101

The bridge voltage is brought into the controller by the two voltage sensing cable leads connected to P102, pins 12 and 11. The values of R109, R108, R110, R111 and R200 were selected to minimize the effect of cable length changes on the voltage at U101B, pin 1. R200 is a 20 turn potentiometer and provides a resolution of approximately 30 Torr per turn. C106 reduces the effects of noise picked up by the bridge voltage sensing leads. The output of the ATM adjust circuit goes to the analog to digital converter and to the recorder output, J102-M. R112 protects the circuitry if the recorder output is grounded or subjected to a high voltage.

<u>Process Control</u> (Refer to Fig. 7-5)

Both process control circuits are identical; therefore, only one will be described. The circuit consists of U200, K101 and associated circuitry. The CW end of the process control set point potentiometer, R206, is connected to the 9 V reference supply. The wiper of the potentiometer is connected to a non-inverting amplifier consisting of U200A, R202 and R203 which has a gain of 1.1. When the front panel pushbutton switch, S200, is depressed the set point pressure is displayed without interrupting the process control function. This voltage sets the reference input to a voltage comparator amplifier U200B.

When the measured pressure is above the set point pressure, the voltage from U101B is more positive than the set point voltage; therefore, the comparator output U200B will be at negative saturation and the relay K101 will be de-energized. CR200 is backbiased and is not in the circuit. As the pressure continues to drop to where it is slightly less than the set point voltage, the comparator switches, resulting in its output at pin 7 increasing to positive saturation resulting in the relay K101 energizing.

CR201 and CR200 provide hysteresis to the stage. CR201 is a current regulating diode designed to allow only .43 mA to pass through it. When the output of U200B switches positive, the diode CR200 is forward biased and the .43 mA flows through R205. This raises the voltage at U200B, pin 5, approximately 180 mV above its previous setting which represents 2% of the full scale voltage. Therefore pressure must rise, causing the voltage to increase 2% of full scale before the comparator resets itself. It is possible to vary the percentage of hysteresis by selecting the value of R205 (or R211 for the other channel). Reducing R205 to 50% of its original value, for example, would result in a 1% hysteresis circuit.

<u>Digital Control</u> (Refer to Fig. 7-6 and 7-7)

U302, a binary divider, and the 20.480 KHz oscillator section of U301 form the digital control function. This frequency was selected to provide optimum 50 and 60 Hz noise rejection to the A-D converter. The display multiplexing is synchronized from the divided by 128 and divided by 256 output corresponding to a frequency of 160 and 80 Hz. U304 sections C and D invert the

signals to generate a $\overline{160}$ and $\overline{80}$ function. In addition, 1280, 320 and 1.25 Hz outputs are generated to control the BCD option. The basic conversion rate is determined by resetting U302 through CR300 and CR301 after every 8452 clock pulses which is equal to approximately 2.4 conversions/s
ec.

Fig. 7-7 is a timing diagram showing the main waveshapes controlling the digital section.

<u>Analog to Digital Converter</u> (Refer to Fig. 7-6)

U301 and its associated components form an A to D converter circuit. No attempt will be made to fully explain the operation in this manual. The user can obtain more information by referring to the Intersil data book under ICL7109 if a complete understanding is desired. The basic conversion rate is 2.4 readings/sec. which is controlled by the run/hold input on pin 26 from U302. U301 is a 12-bit binary A-D converter but is only used as a 10-bit device in this application with the two least significant bits unused.

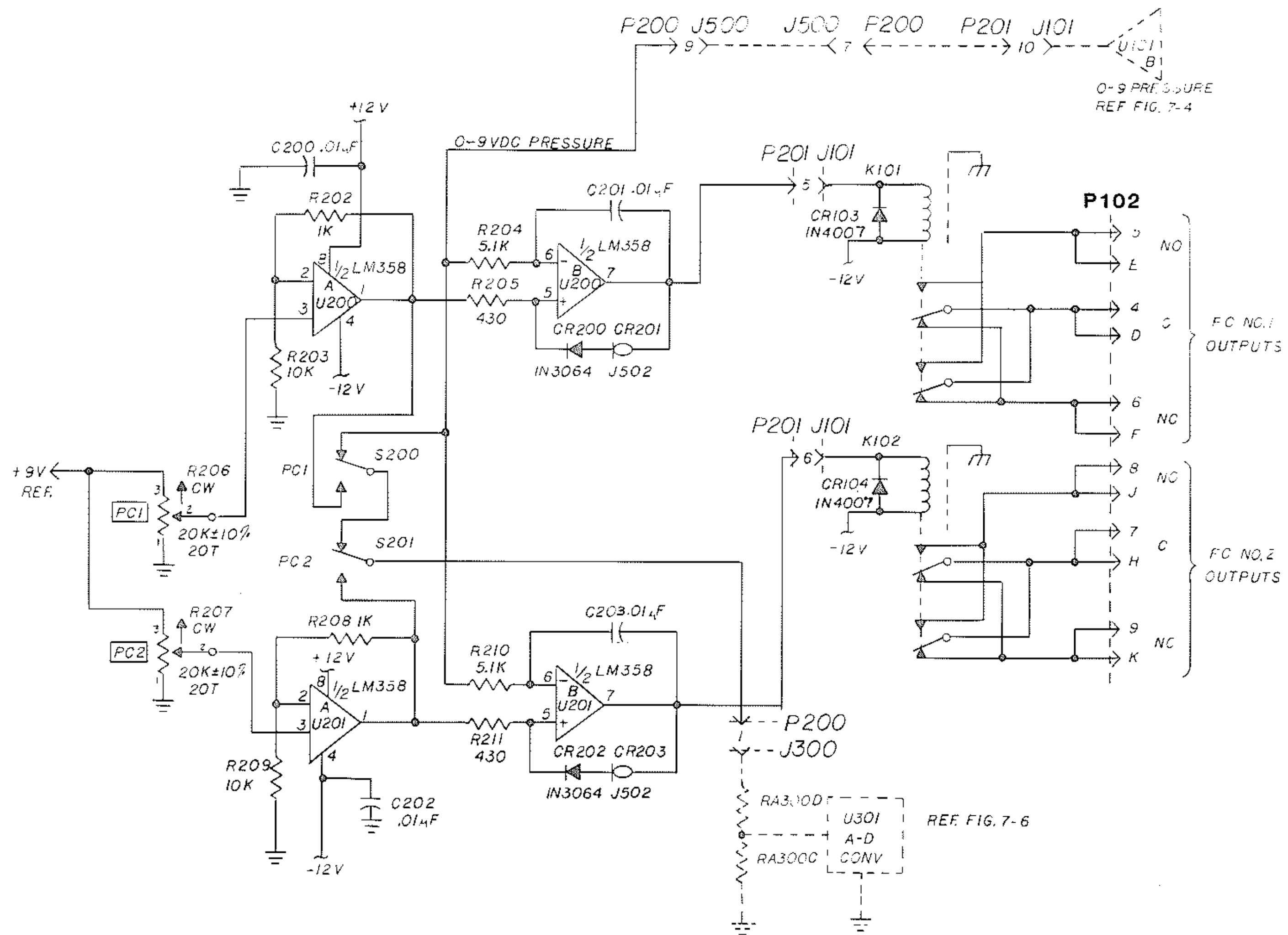


FIG. 7-5 DIGITAL CONTROLLER PROCESS CONTROL CIRCUITS

007198 100

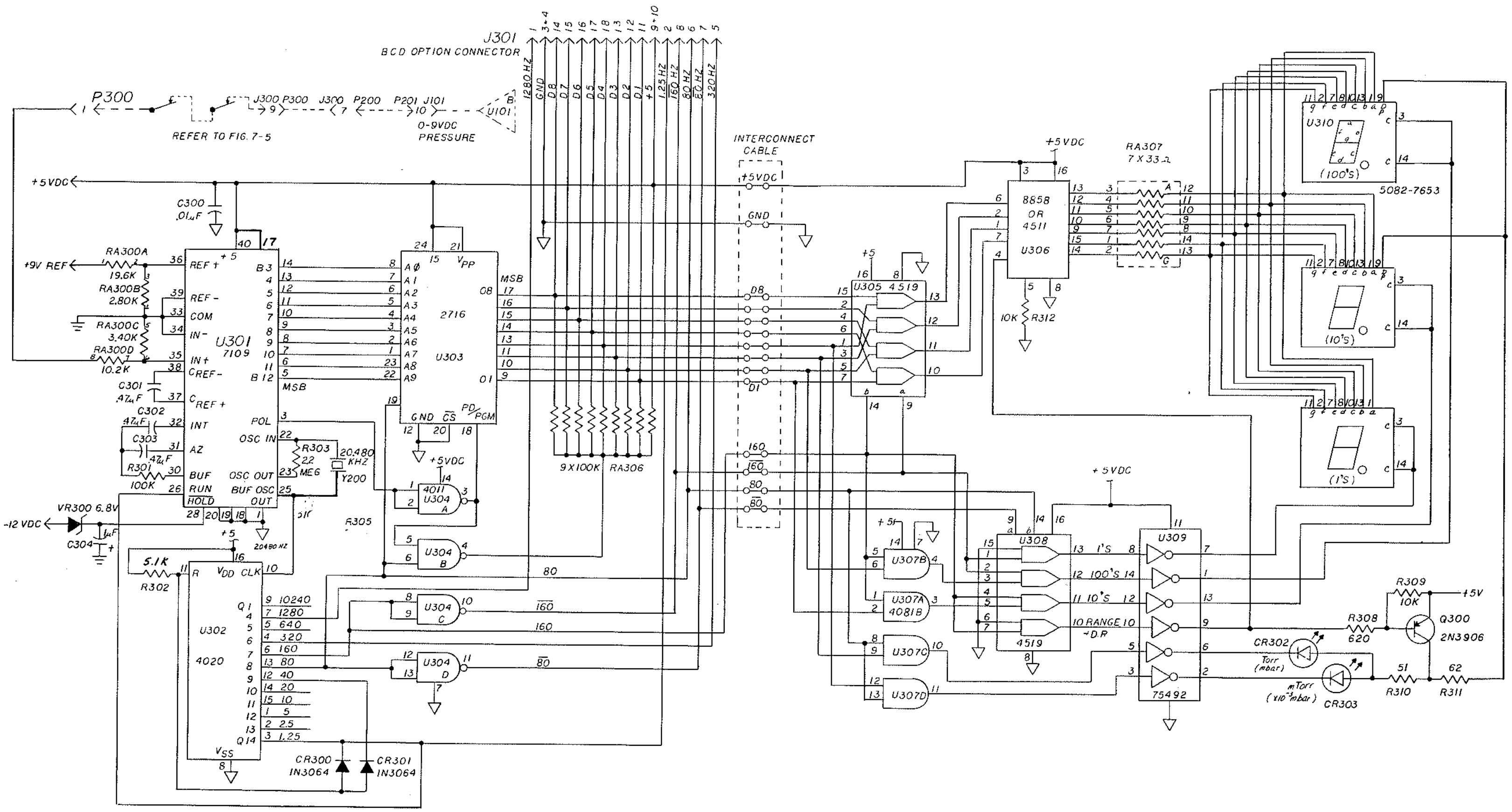


FIG.7-6 DIGITAL CONTROL AND DISPLAY CIRCUIT

007149 101

FIG. 7-6

DIGITAL CONTROL AND DISPLAY CIRCUIT

The ADC, U301, converts the analog input voltage (0 to 9 V) into 10 bits or 1023 equal steps. The least significant bit (LSB) is equal to 9 V/1023 or 8.8 mV. Thus when the analog input increases by 8.8 mV the binary output will increment by one step. The 10 binary outputs are the address inputs to the read-only-memory (ROM), U303.

Read Only Memory (Refer to Fig. 7-6)

U303 is a read only memory which has been programmed as a look up table. Each of the unique 1024 input codes results in a 16-bit output word for use by the multiplexer. Eight bits are transmitted when the 80 Hz input on U303, pin 19, is low and the remaining 8 when the 80 Hz input switches too high.

U304 sections A and B are used to hold the display at 0 and blank the range LED should the output of the A-D indicate a negative polarity. Should the A-D polarity line output a "low", the tri-state output of the ROM, U303, is in a high impedance condition during the last 98 bit byte. At the same time the normal pull up array RA306 becomes a pull down array resulting in a 0 displayed in the 1's place, and no range LED lit.

Digital Display (Refer to Figs. 7-6 and 7-7)

U305, U306, U307, U308 and U309 are used to control the three seven segment displays, range LED's, and the decimal points.

Basically, the 160, $\overline{160}$, 80 and $\overline{80}$ signals are decoded by U307, U308 and U309 to determine the digit select input of the multiplexed display. The sequence as shown in the timing diagram is 100's, 10's, 1's and range/DP. Since the strobing action is at an 80 Hz rate no actual flicker is apparent. U305 and U306 converts the binary coded decimal data to a seven segment format to drive the displays.

Q300 is used as a switch to supply +5 volts to the range LED's, CR302 and CR303 and the decimal points of U310 and U311.

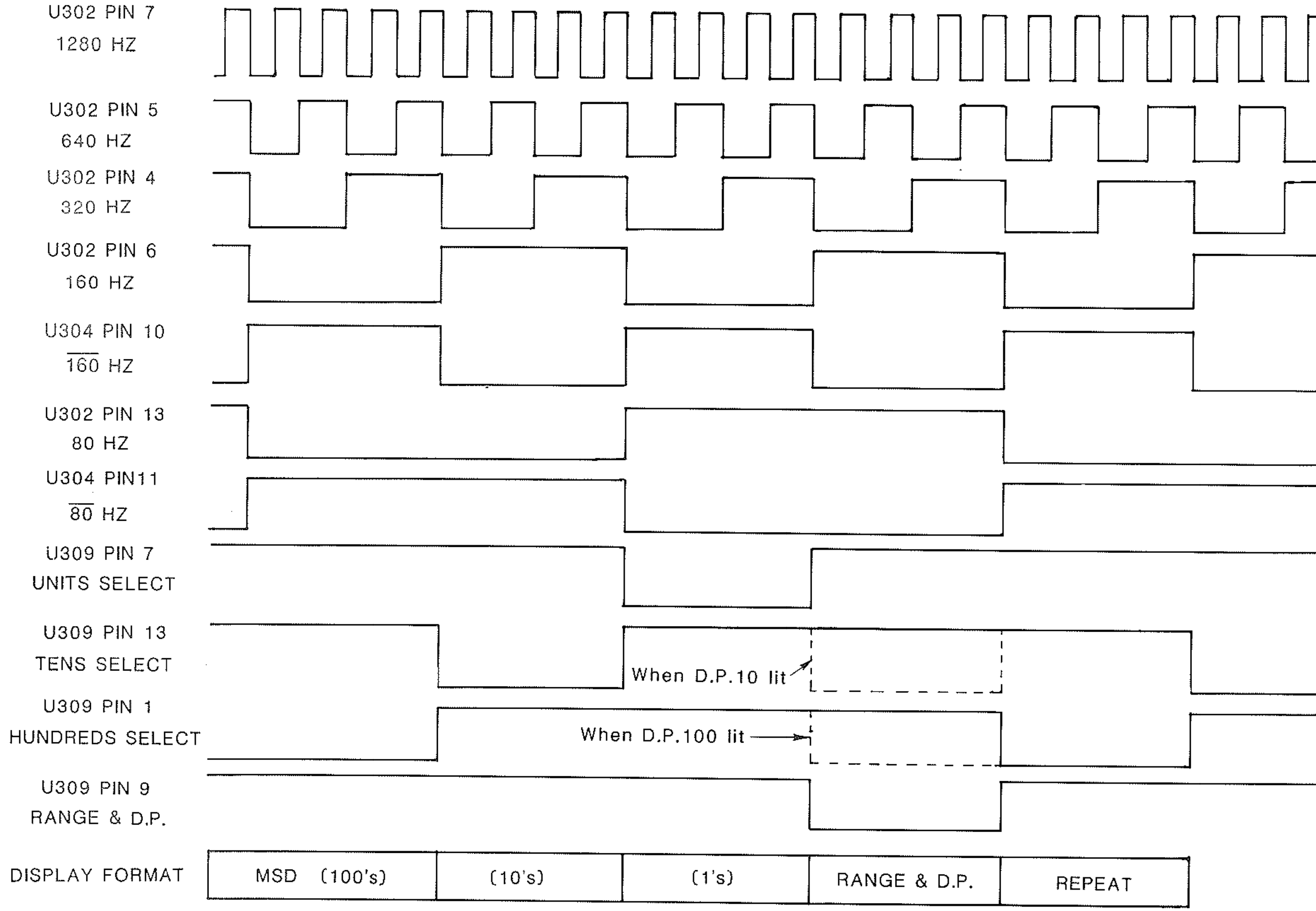


FIG. 7-7 TIMING DIAGRAM

BCD Option Operating Principles

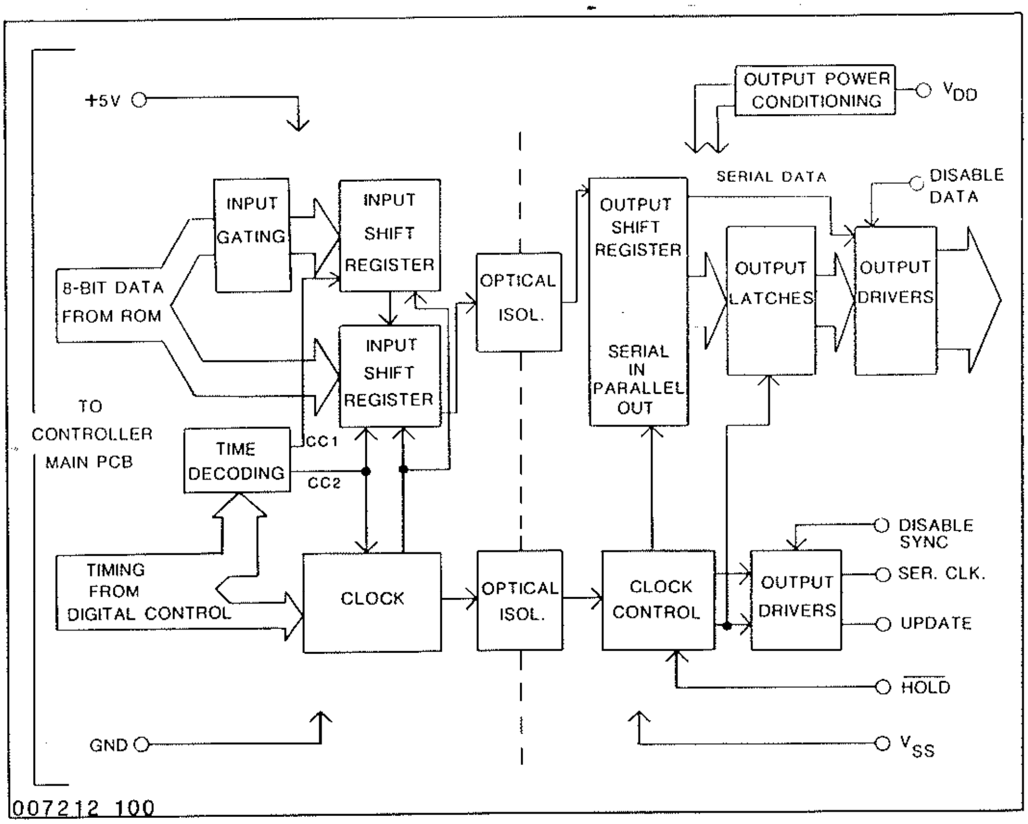


Fig. 7-8 BCD OPTION BLOCK DIAGRAM

There is no electrical connection between the input section which connects to the controller circuitry and the output section which connects to the rear interface connector, as data is transferred via an optical link. Data is transferred from left to right in Fig. 7-8 as follows:

The BCD data from the controller's ROM outputs is loaded into the input shift register's parallel inputs. When the conversion complete (CC2) pulse occurs, a 16-count clock is started, and the data is transmitted through an optical isolator one bit at a time and serially loaded into the output shift register. The 16 clock pulses are transmitted through a second optical isolator and are used to clock the output shift register in synchronization with the data. After the 16 pulses have been generated, the new BCD data will appear at the output shift register's parallel output. The latches are then commanded to pass this data through to the output drivers. The circuit is designed for minimum power consumption both from the controller's and the user's power supplies by using CMOS logic devices and by insuring that the optical isolators are in their off state in-between conversions.

The remainder of this section explains the circuit operation of each functional block, and refers to the schematic diagram, Fig. 7-9, at the end of this section.

Time Decoding U405

The time decoder is used to generate the two control signals CC1, and CC2 which synchronize the circuit. The basic frequencies from the digital board of 320 Hz, 160 Hz, 80 Hz, $\overline{80}$ Hz and 1.25 Hz are combined to form two positive pulses; first CC1 and then CC2.

Input Gating (U400A, B, U401 and U402)

The controller's ROM blanks the leading zeros by generating the code "1111" for leading zeros instead of "0000". The display drivers in the controller's display interpret the code "1111" as a blank digit. The input gating circuit detects this condition and converts a code of "1111" back into a code of "0000" before it is loaded into the input shift register.

Input Shift Register (U403, U404)

A 16-bit parallel in, serial out shift register loads in the parallel data in two 8-bit segments. The 100's and 10's information is loaded into U403 as a function of CC1. The remaining 8-bits are then loaded into U404 when CC2 goes high. When the CC2 pulse switches low the shift register is switched from parallel to serial mode. 16 clock pulses from the clock circuit then shift the loaded data out serially to the data isolator one bit at a time.

Clock U400C, D, U406 and U407)

When the CC2 pulse switches high to lead the BCD data, the counter, U407 is reset to 0 simultaneously. The 1280 Hz signal from the digital board used as a clock advances the shift registers and also the counter through gate U400C. When the counter reaches a count of 16, its Q5 output switches high, stopping the sequence until another CC2 pulse arrives.

Optical Isolators (U408, U409)

The isolators use a light emitting diode (LED) coupled optically to a photo sensitive transistor. When the LED is turned on, the photo transistor switches from an off to an on state. U408 couples the BCD data stream, and U409 couples the clock pulses.

Output Shift Register (U411, U412)

The output shift register is made from two dual 4-bit serial-in, parallel-out devices. The resulting circuit is therefore a 16-bit register. The pulses from the clock control circuit advance the shift register each time new data appears at the serial input. After 16 pulses, parallel BCD data appears at the output pins.

Output Latches (U413, U414, U415, U416)

The output latches are controlled by the clock control circuit. When the 16 clock pulses and 16 data bits are streaming into the output section, the data latches are commanded to hold their previous data until the new data is loaded into the output shift registers.

Clock Control (U410, Q400)

This circuit provides the Serial Clock, the Update pulse, and the signals necessary to clock the output shift register and the output latches. The Serial Clock appears at the emitter of U409, and is passed directly to the Serial Clock driver. This signal is also applied to the base of Q400 which rapidly discharges C403. The time constant of R407 and C400 to recharge C400 back to V_{DD} is very long compared to the clock pulse width.

Therefore, C400 remains discharged for the duration of the 16 clock pulses, and does not recharge until a few milliseconds after the last clock pulse. The output of U410B creates the UPDATE signal from the voltage across C400. U410A speeds up the switching of the UPDATE signal by providing positive feedback. The UPDATE signal is used to control the output data latches. The HOLD input overrides this operation and keeps UPDATE high and the latches latched. The clock signal is delayed slightly by U410C and D and R409 and C404 before it is applied to the output shift registers to ensure that the serial data has stabilized before it is clocked into the shift register.

Output Drivers (U417, U418, U419)

The output drivers provide amplification of the data and clock signals so that direct interface with common logic families such as TTL, CMOS, DTL and HTL is possible. The drivers are powered from the user's power supply so that their "high" level can be tailored to meet the interface requirements. The drivers can be switched into a high impedance third state by applying disable inputs. Separate inputs are provided to disable the data drivers and the sync outputs.

Output Power Conditioning (R6, R7, C2, C3, CR1)

The user supplies power to the output section through the edge connector J402. A positive potential of 3 volts minimum to 16 volts maximum with respect to V_{SS} (pin 15) must be applied at V_{DD} (pin P).

Resistor R405 functions as a current limiter for the 17-volt zener, CR400, to protect the circuitry in the event of excessive or negative applied voltage. Resistor R406 provides current limiting for the output drivers in the event their outputs become shorted to the option ground. C401 and C402 provide ripple suppression and voltage regulation for the output section load.

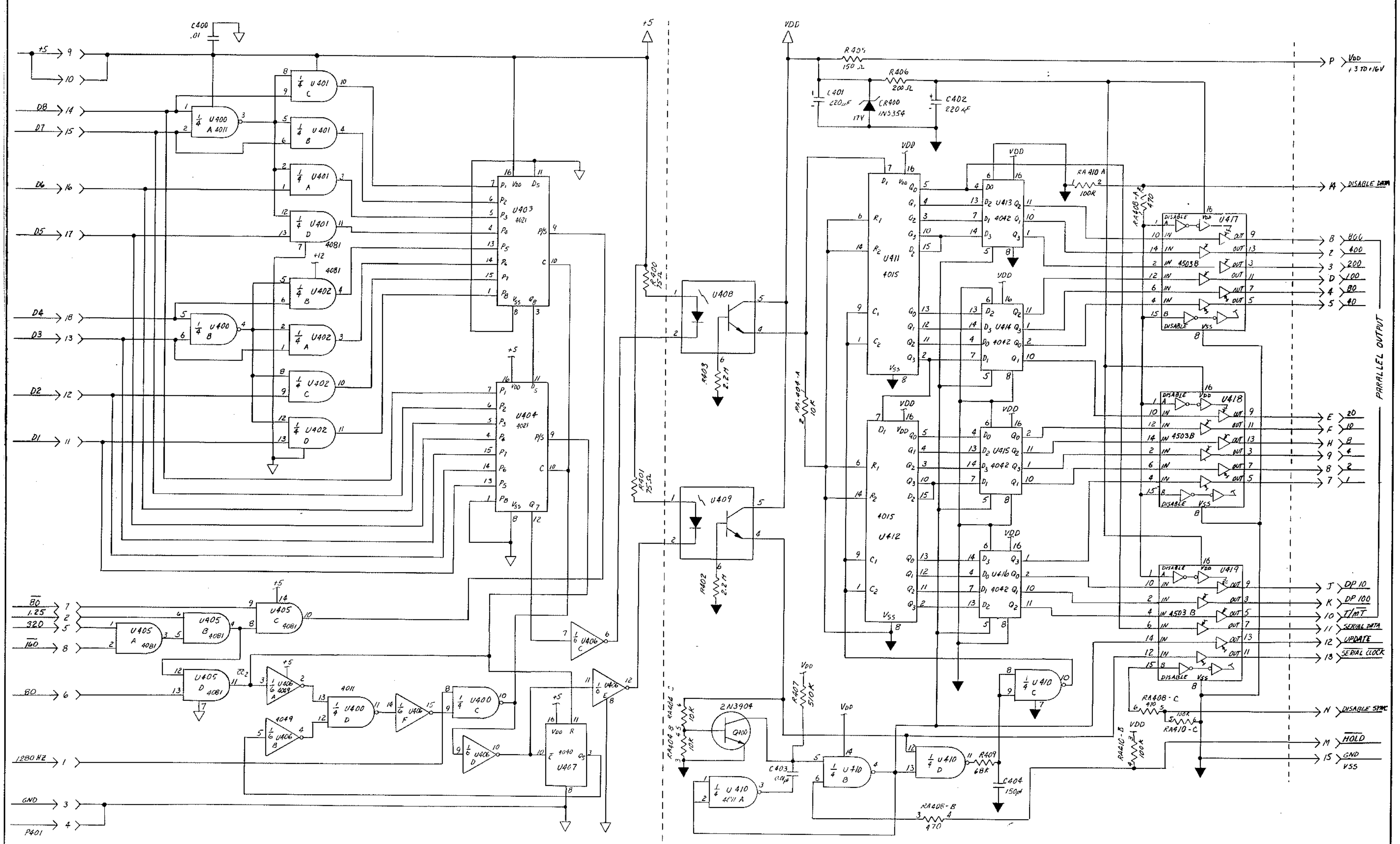


FIG. 7-9 BCD CIRCUIT

007152 100

SECTION 8

MAINTENANCE AND TROUBLESHOOTING

Should difficulties be encountered in the use of your Controller, the following list of symptoms and remedies, along with the circuit descriptions of Section 7, the schematics, and the parts location diagrams can prove useful in quickly getting back into operation.

The warranty on this instrument provides for free service at the factory for the first full year after delivery, and at a reasonable service charge thereafter. However, because the circuits are rather simple and the majority of parts are readily available at your local electronics supply stores, it may, in some cases, prove most expedient for your electronic service technician to repair minor troubles should they occur.

If the prescribed remedies do not correct the troubles, or if additional assistance or special parts are required, contact the Technical Service Department, Granville-Phillips Company, 5675 Arapahoe Avenue, Boulder, Colorado 80303. Telephone: (303) 443-7660. Repairs properly made with equivalent electronic parts and rosin core solder, which do not damage other portions of the unit, do not represent a violation of the warranty. A desoldering tool is required for satisfactory removal of components from the circuit boards.

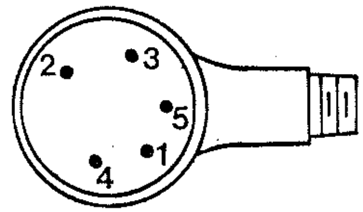
Check the following list for the observed symptoms. This listing of symptoms and remedies is not complete, but should be sufficient to solve most problems. All possible causes of failure should be thoroughly exposed before attempting any component replacement.

DANGER HIGH VOLTAGE

VOLTAGES ARE PRESENT WITHIN THIS UNIT CAPABLE OF CAUSING INJURY OR DEATH. DO NOT TOUCH CABLE CONNECTIONS OR INSIDE OF THE CONTROLLER WHEN POWER IS APPLIED. FOLLOW SAFE PROCEDURES WHEN OPERATING AND WORKING ON THE EQUIPMENT TO AVOID SHOCK HAZARDS.

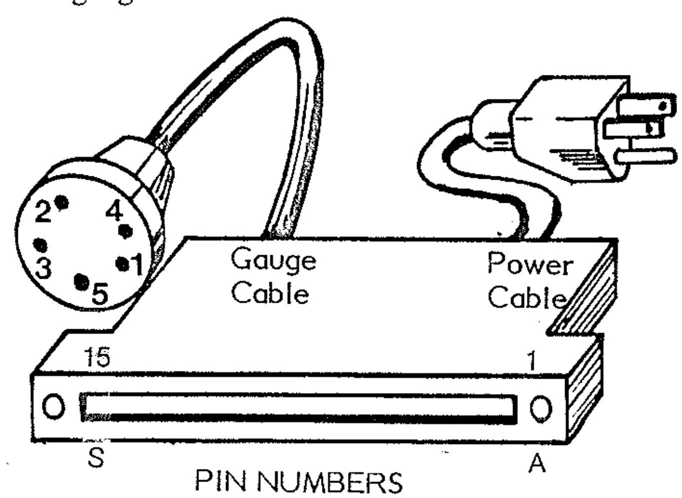
Symptom	Possible Causes & Checks	Remedy
1. No indication on display when power is applied.	1. Power cord not plugged in or no power to outlet.	Plug in power cord or restore power to receptacle.
	2. Loose rear connector.	Tighten screws which secure connector to rear of enclosure.
	3. Control module not fully seated into enclosure.	Verify proper installation of module.
	4. Power fuse, F100 blown.	Replace fuse with proper type.
	5. Broken power wire in line cord, plug, or rear connector. Check continuity of power cord to rear connector contacts.	Repair wires or connectors as required.
	6. Open winding on T100, or open connect-ion to T100. Check continuity of primary and secondary windings, including secondary center top.	Resolder broken connection, or replace T100 if windings are found to be open.
	7. Power supply regulator failure.	Replace VR101,VR102 or VR103 if found defective.
2. Power fuse blows each time power is applied.	1. Defective power transformer, T100.	Replace T100 if found defective.
	2. Shorted rectifier diode in CR-105.	Replace diode bridge CR-105.
	3. Shorted filter capacitor C110 or C111.	Replace C110 or C111.
	4. I.C. regulator failure VR101, CR102 or VR103.	Replace VR101, VR102 or VR103.
3. Digital display reads 0 or 999 Torr:	1. Gauge tube failure. Test for gauge tube	Replace gauge tube.

Symptom	Possible Causes & Checks	Remedy
Gauge tube at atmosphere.	failure: Remove tube from cable and measure resistance between following terminals. Tube should be at atmospheric pressure, and meter must not apply more than 10 mA.	



1 to 2: 20 to 30 ohms
2 to 3: 50 to 60 ohms
1 to 5: 175 to 190 ohms
Any pin to tube envelope: open circuit
Note: If the resistance from pins 1 to 2 reads about 800 ohms, the sensor wire in the gauge tube is broken.

	2. Gauge cable assembly. Remove power plug from AC power and remove rear connector from enclosure. Check continuity of gauge cable.	Repair or replace cable assembly.



Symptom	Possible Causes & Checks	Remedy
	PIN NUMBERS Tube / Connector 1 / 12, 13 2 / 14 3 / 11, P 4 / No connection 5 / 15	Also, verify that there are no short circuits between any two signal leads.
	3. Circuitry associated with U100, U101, and Q100.	Replace faulty components. Note: R104 acts as a fuse in the event the bridge connections become shorted. Replace only with same type and wattage rating.
	4. Bad switch contacts on S200 or S201.	Clean or replace faulty switch.
4. Pressure reading in error.	1. Gauge tube elements dirty.	Refer to Section 3 for tube cleaning instructions.
	2. Faulty gauge tube calibration.	Replace gauge tube.
	3. Gauge tube not mounted properly or subjected to vibration.	Refer to Section 3 for proper installation.
	4. Gas being measured is other than nitrogen or air.	Refer to Section 6 for gas calibration curves.
	5. Controller out of calibration.	Follow calibration procedure, Section 5.
	6. Faulty gauge cable. Test cable per Symptom 3, Cause 2. Proper resistance of each wire in cable is 0.016 ohms per foot.	Repair or replace faulty cable assembly.

Symptom	Possible Causes & Checks	Remedy
	7. Faulty component associated with U100, U101, A100, or VR100.	Replace faulty component.
5. VAC adjustment pot has no or insufficient effect on vacuum calibration.	1. Faulty VAC pot, R201.	Replace R201.
	2. Faulty VR100 or C105.	Replace faulty component.
	3. Faulty component associated with U101A.	Replace faulty component.
	4. Damaged or contaminated tube.	Clean or replace tube.
6. ATM adjustment pot has no effect on atmosphere calibration.	1. Faulty ATM pot, R200.	Replace R200.
	2. Faulty component associated with U101B.	Replace faulty component.
7. ATM adjustment pot has insufficient range to adjust display to atmospheric pressure.	1. Vacuum adjustment out of calibration.	Calibrate controller at vacuum before calibrating at atmosphere.
	2. Damaged or contaminated tube.	Clean or replace tube.
	3. Tube axis not horizontal.	Refer to Section 3, Installation.
8. Process control relay does not close; pressure readout normal; test of set-points normal.	1. Bad process control relay.	Replace relay.
	2. Bad IC U200, U201 or associated component.	Replace faulty component.
9. Process control relay does not open; pressure readout normal; test of set-points normal.	1. Relay contacts stuck in closed position.	Replace relay.
	2. Faulty component associated with U200 or U201 circuitry.	Replace faulty component.

Note: Should problems occur with a controller which utilizes a BCD option board, first unplug the BCD option board and check performance. If the problem still exists the BCD option board is probably not the cause. Leave removed until the problem is corrected.

Symptom	Possible Causes & Checks	Remedy
10. Display completely off, Analog output normal.	1. Defective +5 V power supply regulator VR103 or associated component. Check for +5 Vdc across C114 with digital board removed.	Replace VR103, C114.
	2. Shorted digital IC causing VR103 to turn off.	Locate IC on digital board that is hot to the touch and replace.
11. One digit of display blank, all others normal.	1. Loss of digit strobe to one digit. Defective IC U307, U308, U309.	Replace U307, U308, U309.
	2. Defective display U310, U311, U312.	Replace U310, U311, U312.
12. Same segment of each display not lit when required. All others normal.	1. Defective U306 BCD to seven segment decoder.	Replace U306.
	2. Defective resistor in RA307.	Replace RA307.
13. One segment of one display not lit when required. All others normal.	1. Defective display U310, U311 or U312.	Replace U310, U311 or U312.
14. No range or decimal point display information. All other indications normal.	1. Defective Q300, U309 or U307.	Replace Q300, U309 or U307.
	BCD OPTION PROBLEMS	
1. No indication on display when power is applied and BCD board installed. Display lights when BCD board removed.	1. Short circuit in input section of BCD.	Remove BCD board. Determine if controller now operates. If so, repair or return BCD board.
2. Controller okay, but no output from BCD board.	1. User's system power supply defect.	Troubleshoot and repair.
	2. Edge connector and/or interface cable faulty or loose.	Troubleshoot and repair or tighten connection.

Symptom	Possible Causes & Checks	Remedy
	3. R405 open.	Replace part. Note: R405 is intended to act as a fuse in the event of high potential overvoltage conditions. Verify that cause of fault has been removed.
	4. CR400, C401 or C402 shorted.	Troubleshoot and replace part.
	5. One or more faulty components in output section causing power supply short.	Troubleshoot and repair or return.
3. Some or all data not present, but control signals functioning.	1. One or more faulty components in the data path.	Troubleshoot and repair or return.
	2. Faulty opto isolator U408.	Check for pulse pattern at U408 pin 4 and pin 2. If pulse pattern is present at pin 2 but not at pin 4, replace U408. If there is no pattern at pin 2, troubleshoot input section and repair or return.
4. Data patterns either absent or non-varying; no UPDATE or SERIAL CLOCK signals.	1. One or more faulty components in the gating network.	Troubleshoot and repair or return.
	2. Faulty opto isolator U409.	Check for pulse pattern at U409 pin 4 and 2. If pulse pattern is present at pin 2 but not at pin 4, replace U409. If there is no pattern at pin 2, troubleshoot input section, and repair or return.
5. Control line(s) malfunctioning; output otherwise okay.	1. User system or interface faulty.	Troubleshoot and repair.
	2. One or more components directly	Troubleshoot and repair or return.

Symptom	Possible Causes & Checks	Remedy
	related to control line(s) faulty.	
6. Input circuit fault; incorrect or missing data pattern at U408 pin 2; clock pattern at U404 pin 2 okay.	1. Faulty component(s) in the gating and shift register circuit.	Troubleshoot and repair or return.
7. Input circuit fault; clock pattern faulty or missing at U409 pin 2.	1. Faulty component(s) in the clock circuit.	Troubleshoot and repair or return.

SECTION 9

REPLACEMENT PARTS AND REPAIRS

To minimize customer inconvenience caused by down time, the controller has been designed with as many standard parts as possible. In most cases, the parts required to repair your controller can be most easily obtained from your local electronics parts distributor.

To perform maintenance the unit may be disassembled as follows:

1. Remove electronics module from case. Refer to Section 3.

2. Removal of BCD option board.

   a. Remove the two screws which fasten BCD board to side rails.

   b. Slide BCD board to rear until connector to digital board disengages. Remove BCD board.

   c. When replacing BCD board pay special attention when mating connector to assure that all pins engage.

3. Removal of digital boards and interconnecting cable

   a. Remove the BCD option board as described in 2a and 2b if controller has BCD.

   b. Slowly raise both sections of the digital board vertically from between the side rail slots until the two boards are free of the side rails.

   c. When replacing the digital boards use care that both boards are in the side rail slots and that the connector to the process board mates easily. Replace the BCD board if used.

4. Removal of the main board

   a. With unit resting upright on a work surface remove the two screws which fasten the main p.c. board assembly to the side rails.

   b. Slide the main p.c. board rearward to disengage it from the process control p.c. board.

   c. To replace set main p.c. board assembly in place making sure the mating connector to the process control p.c. board is engaged.

   d. Replace the two side rail mounting screws.

5. Removing the process control p.c. board

   a. Repeat Steps 3a and 3b.

   b. Remove the two screws which fasten main board assembly to side rails.

   c. Slide the main and process control boards rearward to clear side rails.

   d. Unplug process board from main board.

   e. To replace, connect process control board to main board. Slide the assembly between the side rails observing that the process control switches clear front panel cutouts and the pot adjusting screws enter their appropriate holes

   f. Replace the two side rail mounting screws.

   g. Replace digital board as per Step 3c.

Address all replacement/repair orders and correspondence to Granville-Phillips Company, Service Department, 5675 Arapahoe, Boulder, Colorado 80303. Telephone (303) 443-7660, Fax (303) 443-2546.

Main Circuit Board Components (Refer to Fig. 9-1)

Reference Designation	Description	GP Part No.
C100,C101,C102 C103	Capacitor, .01 MFD, 100V, Ceramic Sprague TG-S10	008480
C104	Capacitor, .1 MFD, 25V, Ceramic Erie 5815-000-Y5U0104Z	008306
C106	Capacitor, 1.0 MFD, 35V, Solid Tantalum Elect. Sprague 196D105X0035HA1	005488
C112,C113,C114, C105	Capacitor, 4.7 MFD, 35V, Solid Tantalum Elect. Sprague 196D475X0035JA1	005936
C107,C108,C109	Capacitor, .005 MFD, 250V, Ceramic Roederstein-Resista GMBM RY15-5KPF-250V-20%	007127
C110	Capacitor, 1000 MFD, 35V, Electrolytic Sprague 503D108F035SH	007128
C111	Capacitor, 1000 MFD, 35V, Electrolytic Sprague 515D108M035DK6A	010163
CR105	Rectifier Bridge Assy, 100V, 1A Varo VE-18	005226
CR100 - CR102	Diode, Silicon, Signal, 1N3064	004563
CR103, CR104	Diode, Silicon, Signal, 1N4002	001896
F100	Fuse, .25A, NB, 1/4 x 1-1/4 in. 115V Model Littelfuse 312.250	006979
	Fuse, .125A, 250V, NB, 5.2x20mm, 230V Model Panel Components 034.1507	006500
K101,K102	Relay, 2500 ohm, 2PDT, 3A Contacts American Zettler AZ420-C56-4HUS	006513
XK101,XK102	Socket, Relay, 10 Contact, PCB Mt. Allied Control 30055-3	001165
Q100	Transistor, Darlington NPN, Silicon General Electric D40C4	012776
RA101	Resistor Array, 8 pins, Single-in-line	005543*
R104	Resistor, PTC Overcurrent Protector Raychem P5R20682	009228
RA105	Resistor Array, 6 pins, Single-in-line	005544*
R106	Resistor, 20.0 Kohm, 1%, .1W, 25PPM TC, Metal Film Type RN55E	005704
R108	Resistor, 1.78 Kohm 1%, 1W, 25PPM TC, Metal Film, Type RN55E	005698
R109	Resistor, 3.01 Kohm, 1%, .1W, 25PPM TC, Metal Film Type RN55E	005699

Reference Designator	Description	GP Part No.
R110	Resistor, 3.74 Kohm, 1%, .1W, 25PPM TC, Metal Film Type RN55E	007233
R111	Resistor, 5.49 Kohm, 1%, .1W, 25PPM TC, Metal Film Type RN55E	008324
R100	Resistor, 20 Mohm, 5%, .25W, Carbon	007118
R102	Resistor, 10 Mohm, 5%, .25W, Carbon	007117
R112	Resistor, 5.1 Kohm, 5%, .25W, Carbon	007116
R103	Resistor, 15 Kohm, 5%, .25W, Carbon	007115
T100	Transformer, Power, 115/230VAC Staco 023-3653	007065*
U100	IC, Operational Amplifier PMI OP-07DP	007104
U101	IC, Dual Operational Amplifier National LM358AN	005493
VR101	Regulator, Positive, 12V National Semiconductor LM340T-12	005287
VR102	Regulator, Negative, 12V Motorola MC7912CT	005283
VR103	Regulator, Positive, 5V Motorola MC7805CT	006948
VR100	Zener, 9.0V, .5W, 1N937 selected	006312
	Heatsink, black, anodized Thermalloy 6032B	005339
XF100	Fuseholder, Body Schurter FAC 031.3803	007103
	Fuseholder, Cap, 115V model Schurter FEK 031.1666	006966
	Fuseholder, Cap, 230V model Schurter FEK 031.1663	006965
J100	Connector, Top Entry, 4 Contact Molex 09-52-3043	007135
J101	Connector, Right Angle, 6 Contact Molex 22-15-2061 (Model 4455-A)	007139

Reference Designators	Description	GP Part No.
Process Control Circuit Board Components (Refer to Fig. 9-2)		
C200,C201,C202, C203	Capacitor, .01 MFD, 100V, Ceramic Sprague TG-S10	005377
CR201,CR203	Diode, .43 mA, Current Regulating Siliconix J-502	007133
CR200,CR202	Diode, Silicon, Signal, 1N3064	004563
R200	Potentiometer, 2 Kohm, 10%, 1W, Cermet Dale Type 784	006815
R201	Potentiometer, 500 Ohm, 10%, 1W, Cermet Dale Type 784	005546
R202,R208	Resistor, 1 Kohm, 5%, .25W, Carbon	006940
R203,R209	Resistor, 10 Kohm, 5%, .25W, Carbon	006996
R204,R210	Resistor, 5.1 Kohm, 5%, .25W, Carbon	007116
R205,R211	Resistor, 430 Ohm, 5%, .25W, Carbon	007125
R206,R207	Potentiometer, 20 Kohm, 10%, 1W, Cermet Dale Type 784	005296
S200,S201	Switch, DPDT, Momentary, Pushbutton, PCB Mt. Schadow FG-BLK1G2U-0A-Cut Solder Lugs, No Frame	005356
P200	Connector, Straight, 5 Contact Molex 22-03-2051 (Model 4030)	007140
P201	Connector, Right angle, 6 Contact Molex 22-05-3061 (Series 7478)	007134
U200,U201	IC, Dual Operational Amplifier National Semiconductor LM358N	007193
Digital Circuit Board Components (Refer to Fig. 9-3)		
C300	Capacitor, .01 MFD, 100V, Ceramic Sprague TG-S10	005377
C301,C302,C303	Capacitor, .47 MFD, 63 V, Polyester Siemens B32509 .47/20/63	007130
C304	Capacitor, 1.0 MFD, 35 V, Solid Tantalum Electrolytic Sprague 196D105Z0035HA1	005488
RA300	Resistor Array A-D Input, Custom	007110*
R301	Resistor, 100 Kohm, 5%, .25 W, Carbon	006969
R302,R309,R312	Resistor, 10 Kohm, 5%, .25 W, Carbon	006996
R303	Resistor, 2.2 Mohm, 5%, .25 W, Carbon	007119

Reference Designator	Description	GP Part No.
R304,R305	Resistor, 510 Kohm, 5%, .25 W, Carbon	007120
RA306	Resistor Array, 9X100K Allen-Bradley 110A104	007111
RA307	Resistor Array, 7X33 Ohm Allen-Bradley 314B330	007112
R308	Resistor, 620 Ohm, 5%, .25 W, Carbon	007121
R310	Resistor, 51 Ohm, 5%, .25 W, Carbon	007122
R311	Resistor, 62 Ohm, 5%, .25 W, Carbon	007123
CR300,CR301	Diode, Silicon Signal, 1N3064	004563
CR302,CR303	Diode, Light Emitting Red Texas Instruments TIL 209	005333
VR300	Zener, 6.2 V, 1 W, 1N4735A	005995
Q300	Transistor, PNP Silicon - 2N3906	001881
U301	IC, A-D Converter 12 Bit 7109 Intersil ICL7109	007109
U302	IC, Digital 14 Bit Counter/Divider RCA CD4020BCP	007105
U303 (Torr)	IC, Memory, Read Only, Custom Program	007106*
U303 (mbar)	IC, Memory, Read Only, Custom Program	007107*
U304	IC, Quad 2 Input Nand Gate Motorola MC14011UBCP	004697
U305, U308	IC, Digital, 4 Bit Data Select 4519B National CD4519BCN	006944
U306	IC, Digital, BCD 7-Segment Latch/Decoder/Driver Motorola MC14511CP	005289
C307	IC, Quad 2 Input And Gate National CD408IBC	007029
U309	IC, Digital Display Driver National DS75492N	006946
U310,U311,U312	IC, Display, LED, Red, 7-Segment, .43 High Hewlett-Packard 5082-7653	005549
XU304	Socket, IC 14 Pin Dual-in-Line Texas Instrument C831402	006648
XU302	Socket, IC 16 Pin Dual-in-Line Texas Instrument C831602	004819
XU303	Socket, IC 24 Pin Dual-in-Line Texas Instrument C832402	005329
XU301	Socket, IC 40 Pin Dual-in-Line Robinson Nugent ICN-406S5-T	007169

Reference Designator	Description	GP Part No.
Y200	Crystal, 20480 Hz Statek CX-IH20.480KHZ-C	007132
	Cable, Flat Jumper 2 Inch, 14 Conductor T&B/Ansley No. FSN-22A-14	007143
J300	Connector, Right Angle, 5 Contact Molex 22-25-2051 (Model 4455A)	007137
J301	Connector, Receptacle, 18 Contact Molex No. 22-02-2181 (Model 4455C)	007138

BCD Circuit Board Components (Refer to Fig. 9-4)

Reference Designator	Description	GP Part No.
C400, C403	Capacitor, .01 MFD, 100V, Ceramic Sprague TG-S10	005377
C401, C402	Capacitor, 220 MFD, 35V, Electrolytic Sprague 503D227F035PE	007129
C404	Capacitor, 150 MMFD, 100V, Ceramic Centralab CE-151	005309
R400, R401	Resistor, 75 Ohm, 5%, .25W, Carbon	007124
R402, R403	Resistor, 2.2 Mohm, 5%, .25W, Carbon	007119
RA404	Resistor Array, 3X10 Kohm, 5% Mepco 95061002GL001	006863
R405	Resistor, 150 Ohm, 5%, .125W, Carbon	006935
R406	Resistor, 200 Ohm, 5%, .125W, Carbon	006936
R407	Resistor, 510 Kohm, 5%, .25W, Carbon	007120
RA408	Resistor Array, 3X470 Ohm Allen-Bradley 106B471	007113
R409	Resistor, 68 Kohm, 5%, .125W, Carbon	006937
RA410	Resistor Array, 3X100 Kohm Allen-Bradley 106B104	007114
Q400	Transistor, NPN Silicon, 2N3904	005822
U400, U410	IC, Quad 2 Input Nand Gate Motorola MC1411UBCP	004697
U401, U402, U405	IC, Quad 2 Input And Gate National CD408IBC	007029
U403,U404	IC, Shift Register Motorola MC14021BCP	006872
U406	IC, Hex Inverter Motorola MC14049BCP	006868

Reference Designator	Description	GP Part No.
U407	IC, 12 Bit Binary Counter	005300
U408, U409	IC, Opto Isolator G. E. H11A5	006867
U411, U412	IC, Dual 4 Bit Static Shift Register Motorola MC14015BCP	006871
U413,U414,U415, U416	IC, Quad Clocked Latch Motorola 14042BCP	006870
U417,U418,U419	IC, Hex Tri State Buffer Motorola MC14503BCP	006869
CR400	Diode, Zener, 17 V, 5W, 1N5354B	006942
XU400, XU401 XU402, XU405, XU410, XU403,	Socket, IC 14 Pin Dual-in-Line Texas Instrument C831402	006848
XU404, XU406, XU407, XU408, XU409, XU411, XU412, XU413, XU414, XU415, XU416, XU417, XU418, XU419	Socket, IC 16 Pin Dual-in-Line Texas Instrument C831602	004819

*Available only from Granville-Phillips Co.

NOTE: The manufacturers part numbers given are for reference only to assist in obtaining parts locally. Parts ordered from G-P may or may not have the listed manufacturer and part number but meet the required G-P part number specification.

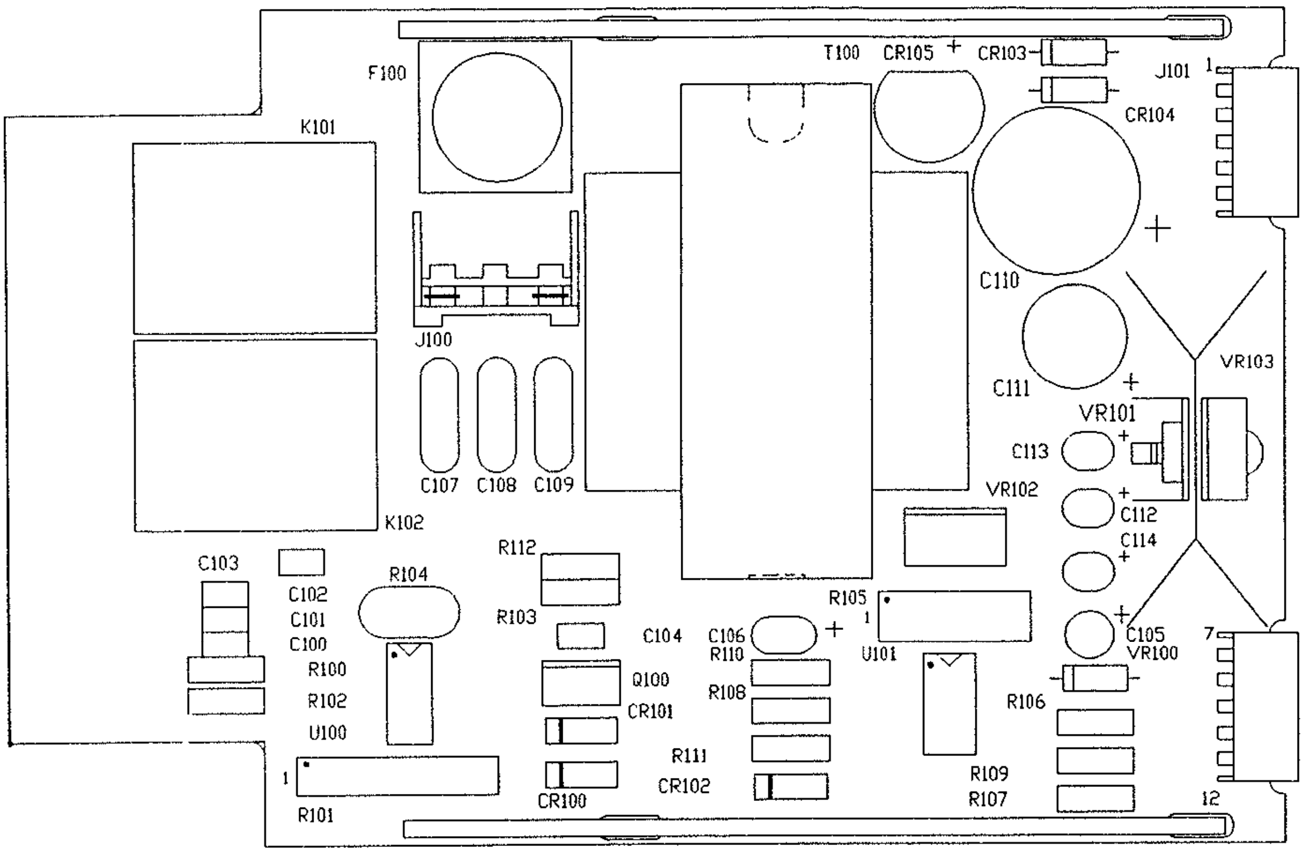


FIG. 9-1 COMPONENT LOCATION DIAGRAM
MAIN BOARD

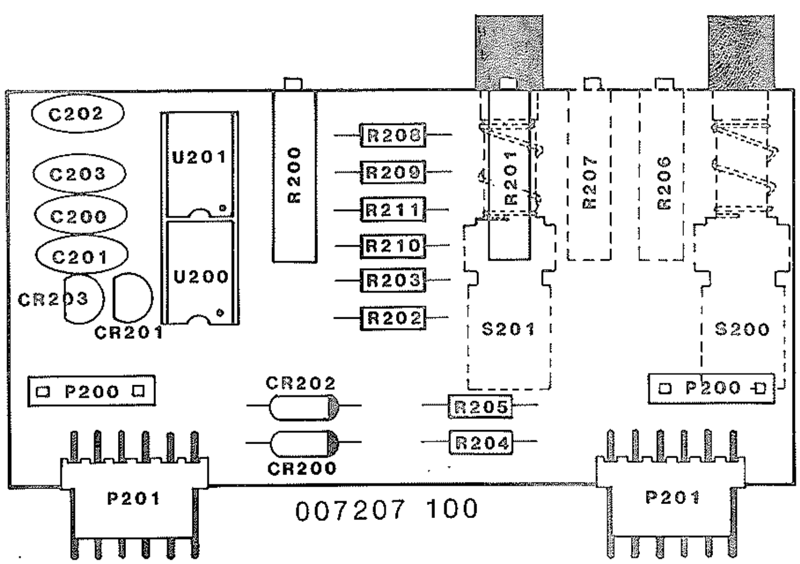


FIG. 9-2 COMPONENT LOCATION DIAGRAM
PROCESS CONTROL BOARD

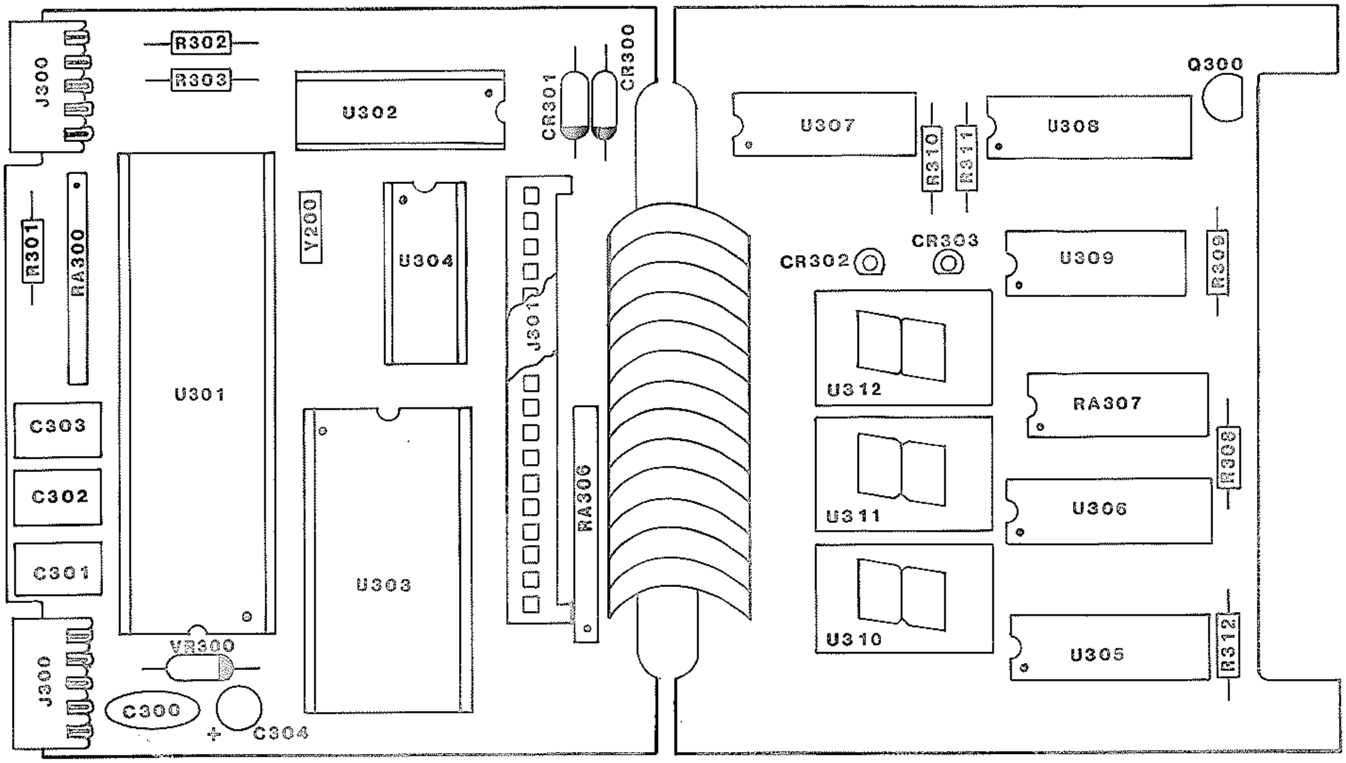


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FIG. 9-3 COMPONENT LOCATION DIAGRAM
DIGITAL BOARD

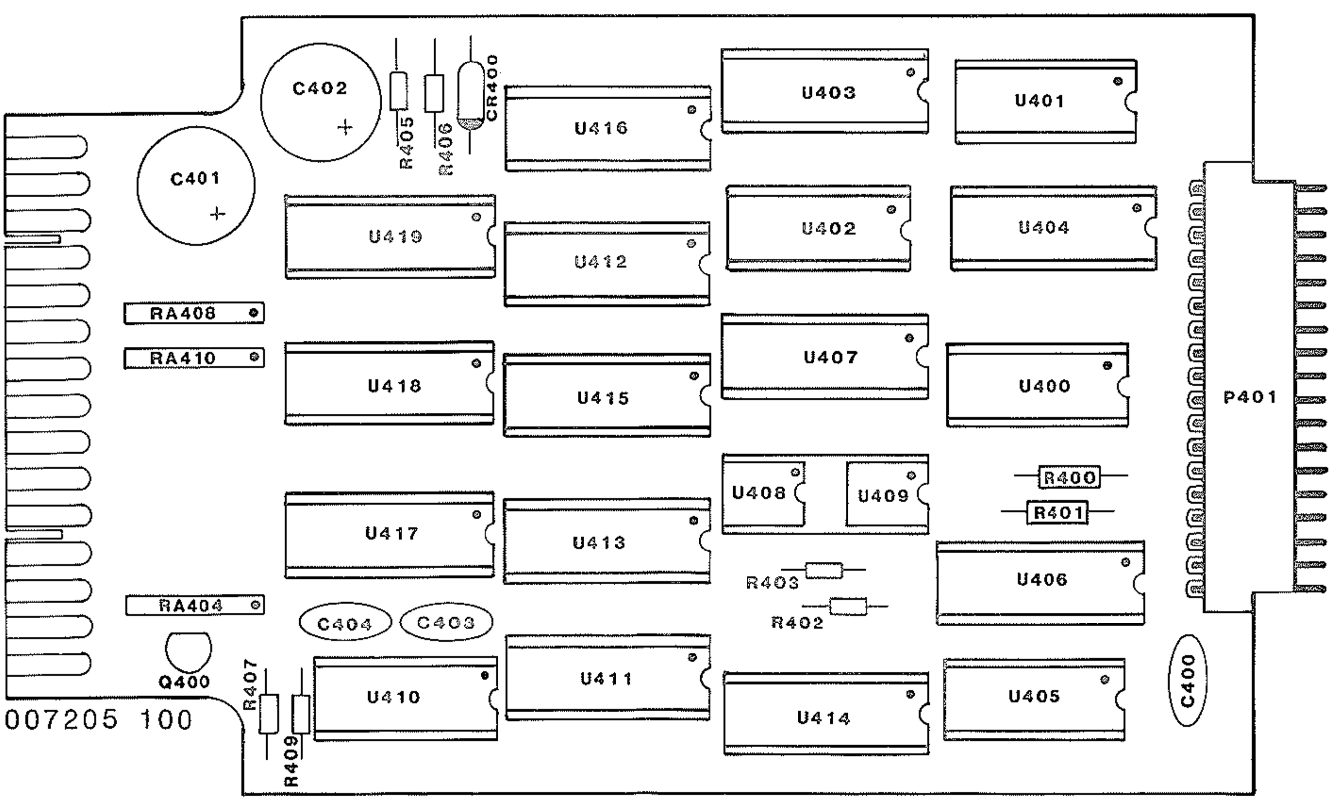

FIG. 9-4 COMPONENT LOCATION DIAGRAM
BCD BOARD