# 307
# VACUUM GAUGE CONTROLLER


**for use with ionization, Convectron™, and thermocouple gauges**

**...performance and reliability in vacuum measurement and process control**

GRANVILLE-PHILLIPS
HELIX TECHNOLOGY CORPORATION

*Advanced Vacuum Measurement Solutions*

## General Description

The 307 Vacuum Gauge Controller (VGC) measures pressure, and utilizes pressure-related outputs to control a variety of vacuum system functions and processes. To fit a wide range of needs and applications, the 307 VGC is available in a variety of configurations and prices. In its simplest form the 307 VGC runs a single ionization gauge (IG) in the range from $1 \times 10^{-10}$ to $1 \times 10^{-1}$ Torr. With available modules, the 307 controls four gauges, measuring pressure from $2 \times 10^{-11}$ Torr to atmosphere, and six system or process functions. Unique design improvements have resulted in:

- capability of pressure measurement at up to four locations in your system or process using two ionization gauges sequentially and two Convectron gauges (or two thermocouple gauges) simultaneously.
- excellent system control: up to six process control set points are available, and can be enabled automatically at pre-selected pressures, or manually.
- increased reliability: dramatically decreased probability of component failure due to conservative design and cooler operating temperature achieved by removing the separately-packaged power supply to a remote location. This increased reliability is backed by Granville-Phillips' **five-year limited warranty.**
- greater safety: electric shock danger significantly reduced by using only low voltage circuits in the control unit.
- improved economy: modular design enables users to purchase only required capabilities, and allows for easy upgradability in the future.
- panel space savings: only half the conventional rack width is occupied by the 307 control unit. Since no ventilation is required, space above and below the control unit can be used more efficiently.
- improved security: tamper-resistant design with controls securely located behind a lockable front panel.

**Figure 1:** 307 Control Unit


**1.** All data easily read from 3-in-1 digital display. One glance gives three simultaneous pressure readings.

**2.** Six available set points provide control of six pressure-related process or system functions: 1, 2 for IG; 3, 4 and 5, 6 for each of two Convectron (or thermocouple) gauges.

**3.** Unit of measure user-controlled: Torr, mbar, or Pascal.

**4.** Greater operational safety: IG grid voltage is present only when filament is on.

**5.** To suit the cleaning requirements of your gauge tube and pressure range, degas is available, either $I^2R$ or EB, specified with order.

**6.** ON/OFF status clearly indicated by lighted switches.

**7.** Inside controls protected by lockable front panel.

**8.** One IG capability included in 307 basic Controller package.

**9.** Second IG available.

**10.** User-labelled set point descriptions.

**11.** Saves valuable panel space: 8.9 cm (3.5 in.) x 24.1 cm (9.5 in.)

**12.** All controls/readouts clearly labelled for intuitive operation.

**13.** Ionization gauge readout.

**14.** Convectron or thermocouple gauge readouts.

**15.** Display resolution selectable to one decimal place or single integers.

## 307 Basic Controller Specifications

**Display**
- type
  digital, (green LED)
- units
  Torr, mbar, Pascal
  (user-controllable)
- update time
  0.5 second typical

**Controller Pressure Range**
Lower Measurement Limit
$1 \times 10^{-10}$ Torr with 10 mA emission and tube sensitivity of 10/Torr

Upper Measurement Limit
$1 \times 10^{-1}$ Torr with 0.1 mA emission and tube sensitivity of 10/Torr

Pressure Range
7 decades within above limits for given emission setting and tube sensitivity

**Emission Current**
Controlled, adjustable from 0.01 to 10.0 mA

**Ionization Gauge**
- analog output;
  Logarithmic: 1V/decade,
  0-10 VDC
- Bayard-Alpert (B/A) and other compatible filament-type ionization gauges

**Sensitivity Adjustment Range**
3/Torr to 50/Torr

**Standard Electrometer**
Sensitivity adjustment and emission adjustment for IG tube

**Cables**
3.1 m (10 ft.), 7.7 m (25 ft.), 15.4 m (50 ft.) or specify up to 61.5 m (200 ft.)

**Control Unit Dimensions**
8.9 cm (3½ in.) h,
24.1 cm (9½ in.) w,
27.3 cm (10¾ in.) d
[allow +5 cm (+2 in.) depth for connectors]

**Power Supply Dimensions**
8.9 cm (3½ in.) h,
20.3 cm (8 in.) w,
without mounting brackets,
24 cm (9½ in.) d

**Operating Temperature**
40°C maximum ambient

**Power Input**
100/115/230 ± 10% VAC
(user-specified)
250 watts
50 or 60 Hz

## Additional Available Module & Function Specifications

**Available Computer Interfaces**
- **IEEE-488** (parallel) or
- **RS-232C** (serial)
  Baud rates: 75, 150, 300, 600, 1200, 2400, 3600, 4800 or 9600 selectable
- for pressure data output and set point status
- provides remote ON/OFF control for IG1, IG2, and degas
- both with two-way communication* and switch selectable talk-only mode

*OEMs should consult Granville-Phillips for customization of computer interface capabilities

**High Performance Ultra High Vacuum (UHV) Electrometer**
- extends pressure readout limit to $2 \times 10^{-11}$ Torr with 10 mA of emission
- provides Electron Bombardment Degas power adjustment control
- contains separate sensitivity adjustments and separate emission controls for independent control of two ion gauges

**High Pressure Operation**
- readout resolution to two significant digits over entire range of applicable gauge (except $10^{-4}$ Torr range)

**Convectron Gauge Function**
- operates two Granville-Phillips' 275 gauge tubes
- pressure range: $1 \times 10^{-4}$ to 990 Torr
- temperature:
  - bake-out up to 150°C
  - operating 4-50°C
  - tube environmental compensating range 15-50°C
- keyed connector for easy transducer installation (even in "blind" locations)
- analog output;
  Logarithmic: 1V/decade,
  0-7 VDC. Adjustable offset of +1 to -7 VDC.

**Thermocouple Gauge Function**
- operates two Granville-Phillips' 270 gauge tubes
- pressure range:
  $1 \times 10^{-3}$ to 1 Torr
- analog output; non-linear:
  0-10 VDC

Note: Both the Convectron and thermocouple gauge board options include automatic ion gauge turn-on capability.

**Process Controls**
- **two channel** (for IG only)
- **six channel** (for all gauges)
- **one to four channels, user selectable** (for all gauges)
- pressure-related relays (set points) enabled manually or automatically at user-selected pressures
- relay configuration: SPDT (single pole, double throw)
- relay contact rating:
  250V AC; 5A resistive load
  30V DC; 5A
  Gold plated contacts for low level switching

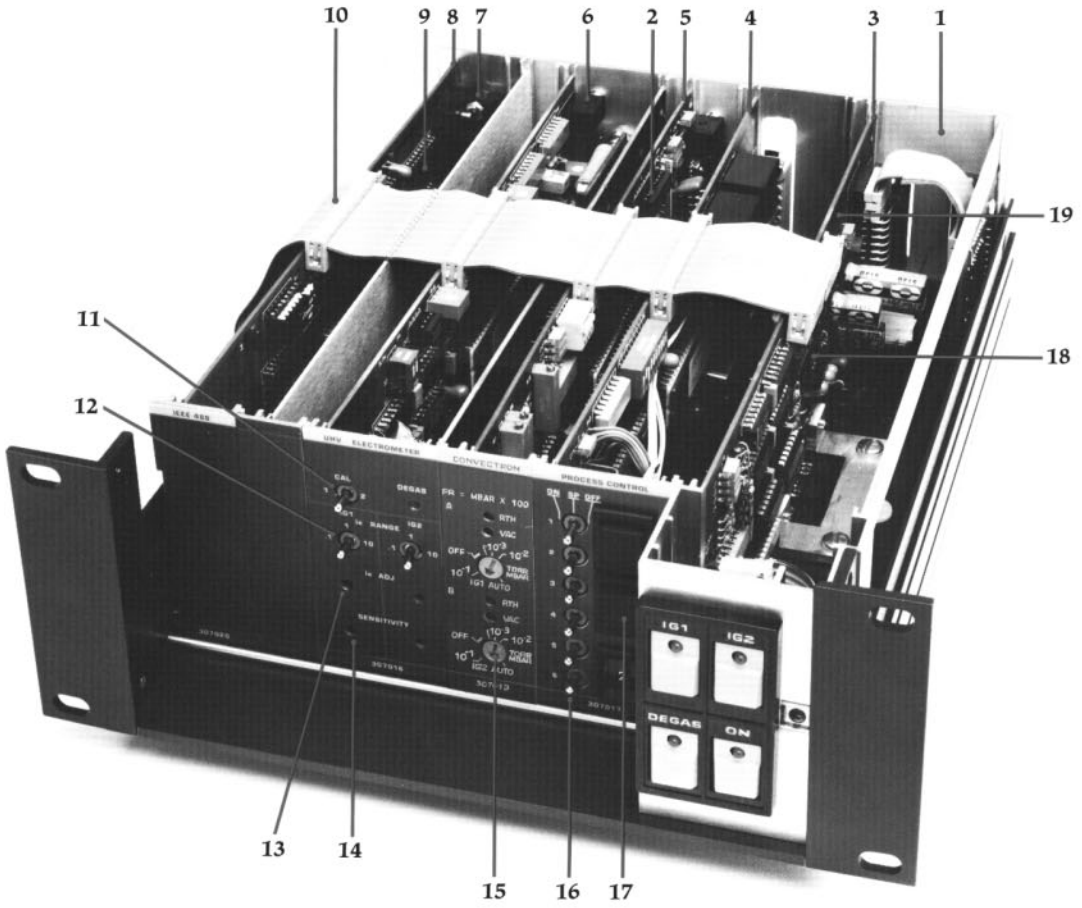
**Two Ion Gauge Operation**
- two tube sequential operation
- filament-type ionization gauges, such as Bayard-Alpert

**Remote Input/Output**
- provides status relay contacts for IG1, IG2, fault detection
- provides remote ON/OFF control for IG1, IG2, and degas
- provides lockout of front panel switches and IG1/IG2 turn on capability via computer interface

**Degas**
- Electron Bombardment:*
  10-40 watts adjustable
- $I^2R$: 8V nominal, (fixed)
  80 watts maximum

* If EB degas is selected the UHV Electrometer is recommended to provide for degas power adjustment independent of emission current settings.

**Figure 2:** Excellent performance and reliability, intuitive operation and easy, quick maintenance are provided by 307's clean design.




**1.** Cooler operating temperature since high power-dissipating components are located in the power supply enclosure, not in the control unit.

**2.** Helps isolate malfunctioning circuits with fault indicators.

**3.** System control board: voltage regulators, remote and local controls, interface to power supply.

**4.** Increase process or system control with available control boards for 2 or 6 setpoints, or one to four setpoints, user selectable.

**5.** Extend upper pressure measurement with available Convectron or thermocouple gauge board.

**6.** Electrometer.

**7.** Remote reading of pressure and set point status via available computer interface board: RS-232C or IEEE-488.

**8.** Quick repair and minimal down-time with field-replaceable boards.

**9.** Safer servicing — Maximum of 35 volts DC in control unit.

**10.** Easy field upgrade with pin-and-socket connectors.

**11.** Switch allows viewing of emission current or sensitivity calibration.

**12.** Improve pressure measurement accuracy with constant emission current: three decade range settings: adjustable from 0.01 mA to 10.0 mA.

**13.** Continuously adjustable emission control.

**14.** Adjustable IG tube sensitivity settings to calibrate electrometer for various tube sensitivity factors, or for direct readout of various gases.

**15.** Turn on IG automatically during pump-down with IG auto-on control.

**16.** Take control of process during set-up or system maintenance with manual override switches for each of up to six process channels.

**17.** Digital set point controls adjustable for any pressure within the range of associated tube. Digital set points are stable and easy to adjust.

**18.** Power supply status indicators aid troubleshooting.

**19.** Low-cost boards are practical to inventory.

## More Accurate Pressure Measurement

- increased pressure measurement accuracy: by controlling emission current, tube temperature is stabilized, thus stabilizing thermal transpiration and its effects, outgassing, and wall charges — each of which could otherwise dramatically affect pressure readings.
- for extended pressure range measurement capability and/or to prolong tube life, emission current can be adjusted. (See Fig. 3).
- to improve the accuracy of pressure measurements, sensitivity can be easily adjusted, independent of emission, to match gauge tube calibration.
- pressure measurements with the Convectron gauge are largely immune to temperature changes. A temperature compensation device monitors the gas temperature around the sensing wire rather than monitoring a remote outside wall temperature.
- each Granville-Phillips Convectron gauge tube is individually calibrated before shipment to be within ± 2% of reading over most of its range.
  (Note: Numerous studies[1] have shown Bayard/Alpert type gauges to be 30 to 40% inaccurate. Although the 307 VGC will very accurately measure the ion current, these inaccuracies are inherent in the design of the B/A gauge and cannot be consistently compensated for by any IG controller.

- RF immunity
  - high quality shielded cables are used between the control unit and power supply, and to the gauge tubes
  - to help prevent electrical disturbance, RF filters are used at critical junctions
  - no measurable change in pressure indication was observed with RF power when in the presence of 13.56 MHz 500W sputtering system with the control unit separated from the power supply by 10 ft. cable.
- less circuit drift and greater pressure measurement accuracy are achieved with a lower temperature rise in the instrumentation enclosure by removing the power supply from the vicinity of the control unit. (See Figure 4).

## Excellent Control

- enhanced process control with up to 6 set points: 2 on the ionization gauge and 2 on each of two Convectron or thermocouple gauges.
- available Convectron or thermocouple gauge capability allows for automatic turn-on of ionization gauge at preselected pressure.
- set points can be overridden manually to facilitate system set-up and maintenance.
- set point polarity can be user-selected such that relays are activated for pressures either above or below programmed set point.
- status of set points — indicated on front panel. Can be identified with user-customized labels.
- Convectron gauge lower limit of $1 \times 10^{-4}$ Torr, achieved with careful individual zeroing at vacuum, makes this gauge more suitable to control processes such as sputtering in the $1 \times 10^{-3}$ Torr range.

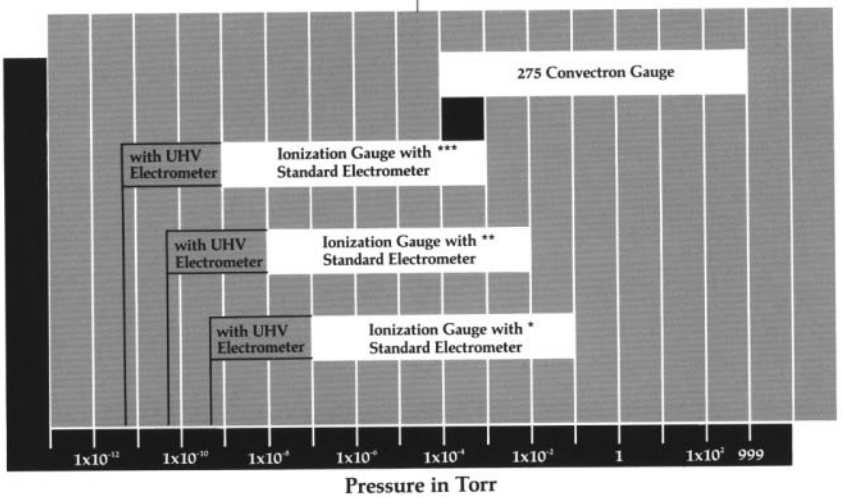


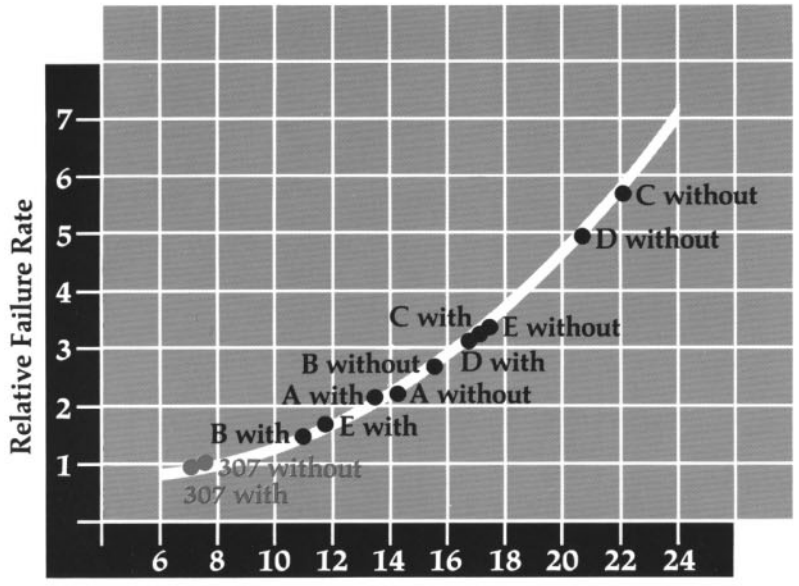

**Figure 3:** Operating Range
The 307 VGC measures pressure and controls systems or processes in the entire operating range from $2 \times 10^{-11}$ to 990 Torr.

■ Overlapping Convectron and ionization gauge range for better pressure control.

Emission current setting:
* at 0.1 mA
** at 1.0 mA
*** at 10.0 mA

Assumes tube sensitivity of 10/Torr.

[1] C. R. Tilford, J. Vac. Sci. Technol. A 1, 152 (1983).
P. A. Redhead, J. Vac. Sci. Technol. 6, 848 (1969).
K. E. McCulloh and C. R. Tilford, J. Vac. Sci. Technol. 18, 994 (1981).
K.F. Poulter and C.M. Sutton, Vacuum 31, 147 (1981).




Granville-Phillips' 307 and various competitive controllers (A-E) with and without space allowed for air ventilation (1-3/4 in. above and below controller).

**Figure 4:** Longer operating life (less probability of component failures) is a benefit of a remote power supply, and cooler operating temperature.

The curve itself is derived from the Arrhenius Model, which is used to predict long-term semiconductor failure mechanisms. It demonstrates that increases in temperature lead to an increase in the probability of component failures. (This assumes that all other variables are held constant.)

Plotted on the line are actual internal temperature readings of the 307 control unit and other available vacuum gauge controllers, with and without space allowed for air ventilation (1-3/4 in. above and below controller).

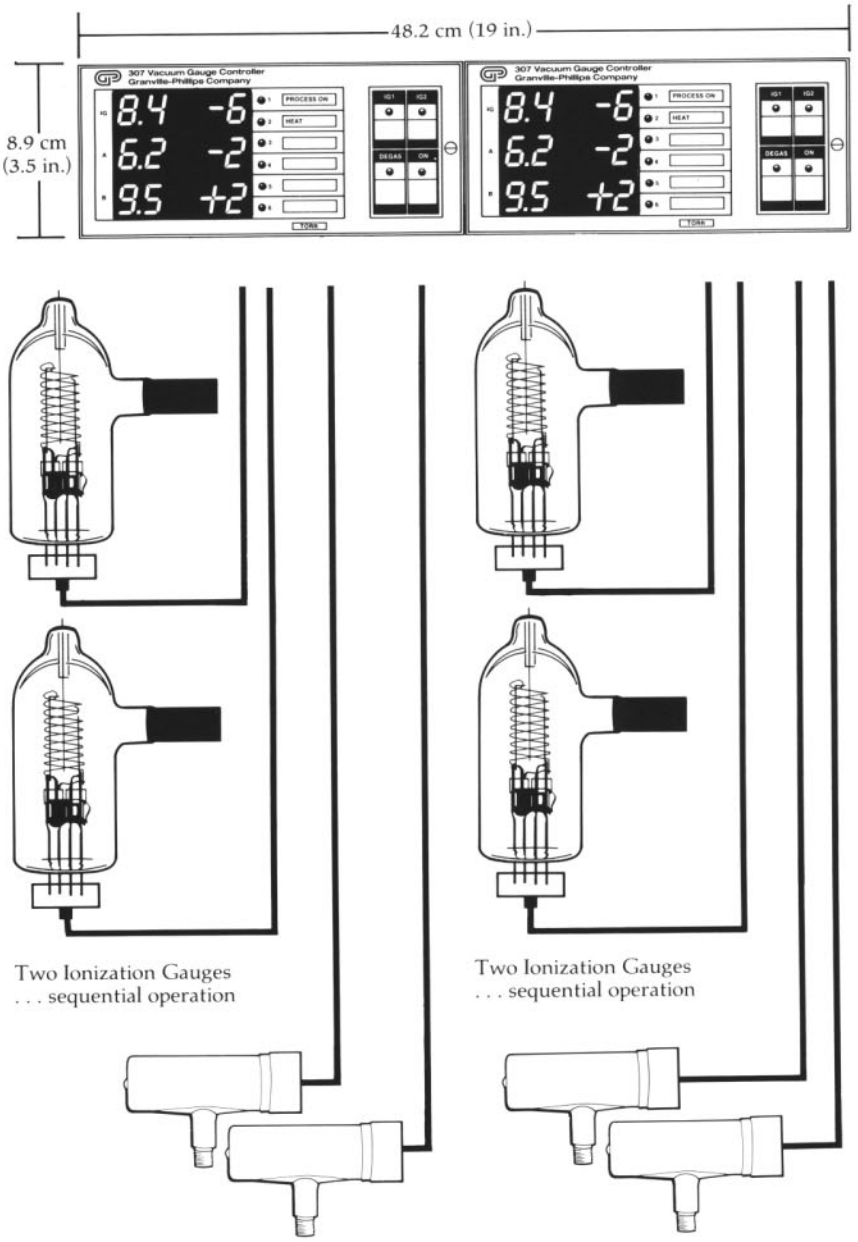
## Increased Reliability

- supported by Granville-Phillips' 5-year limited warranty against defects in materials and workmanship.
- power-outage protection: all settings are non-volatile so that programmed information is saved in case of power loss or surges. Process control action has selectable relay status so that power-off condition is user-definable. IGs will return on when power recovers, if automatic IG on/off control is in use.
- damage protection designed-in:
  - controller protected from short circuits in the gauge tube by special circuitry
  - gauge protected from overpressure
  - arcs during degas are prevented since plasma build-up causes the control unit to shut down without damage
  - dangers of Convectron gauge tube misconnection or pin breakage are reduced by improved Convectron gauge and connector design
- dramatically decreased probability of component failures due to low operating temperature, achieved by remoting the power supply (see Figure 4).
- a continuous check and automatic recovery for software-related faults provided by designed-in lock-up monitors
- more reliable connections achieved by using only pin-and-socket connectors (no board edge connectors)

## Greater Safety

- dangerous high voltages are removed from IG electrodes when filament power is off.
- minimized danger of electric shock provided by remoted power supply, control unit runs at less than 35V DC (peak) internally.
- reduced danger of touching collector lead provided by enclosed cable connector to IG collector. (This is important because, if improperly grounded, the collector lead can float at near grid voltage.)
- protection from unauthorized operation provided by tamper-resistant design
  - available lockable front panel cover helps protect programmed critical data on sub-panel controls from unauthorized tampering.
  - remote I/O board allows option of rendering front panel IG and degas controls inoperable.

**Figure 5.**

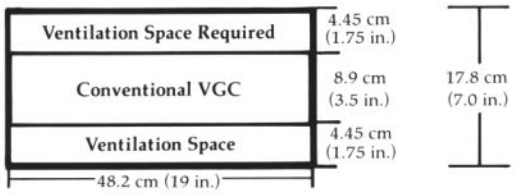



## Convenient Multi-Point Measurement Readout

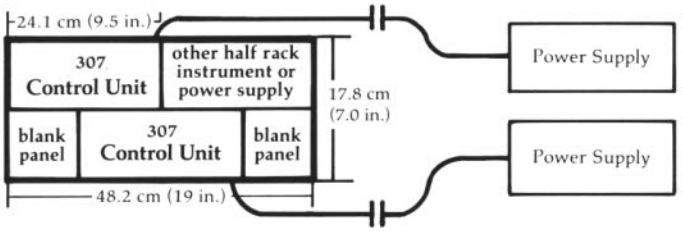
- Readout of six pressure values shown in close proximity by mounting two control units side-by-side. Each control unit is capable of measuring pressure at up to four points in the system. (See Figure 5).

**Figure 6:** Vacuum Gauge Controller Mounting Configurations

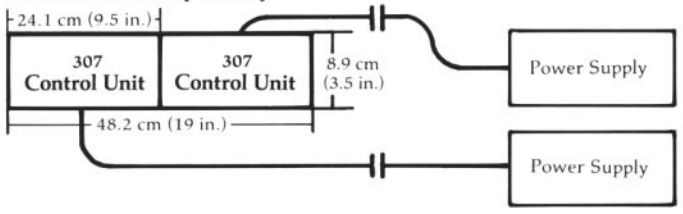
1: Traditional




2: Recommended




3: Extended Capability




## Greater Flexibility in Mounting

- no ventilation space needed above or below control unit.
- two control units can be mounted in rack space of one conventional controller.
- power supply can be located anywhere within ten feet of control unit where ventilation is adequate, such as vertically attached to inside wall of system, horizontally on the floor or bottom of system, or rack mounted elsewhere in the panel.

## Improved Economy

- easy customization — modular design allows purchase of only those plug-in modular capabilities needed for current application.
- easy field upgrade to more complex capabilities at a reasonable cost.
- saves valuable panel space with small size (half-rack width)
- no extra space required for ventilation since low power dissipation of control unit permits mounting against other instruments
- minimal downtime:
  - locate failed circuits with the help of fault lights
  - boards are easy to inventory since each board contains primarily those circuits relevant to its capability
  - easily replaceable modules allow quick in-field repair

# How To Order

**Select One in Each Group 1-3**

## 1. Control Unit & Power Supply

**307001** ☐ Can be configured to include any option on the following page.

**307002** ☐ Cleanroom model. Same as above, except with solid front panel plate with all control switches behind door.

For each Controller ordered, specify voltage: 100/115, or 230 VAC and initial units of measure: Torr, mbar, or Pascal.

2.5 m (8 ft.) power cable included with each of the above two controllers. Order IG tubes and cable sets separately (one cable set per tube).

3.1 m (10 ft.) interconnect cable included to connect power supply to control unit, unless 307009 is ordered.

## 2. Ionization Gauges

Thoria Coated Iridium Filament

| Connection | ¾ in. | 1 in. |
|---|---|---|
| Pyrex | ☐ 274002 | ☐ 274005 |
| Kovar | ☐ 274003 | ☐ 274006 |
| 2¾ in. o.d. ConFlat® flange | ☐ 274007 | ☐ 274008 |
| 1-5/16 in. o.d. Mini-ConFlat® flange | ☐ 274020 | — |

Dual Tungsten Filament

| | ¾ in. | 1 in. |
|---|---|---|
| Pyrex | ☐ 274012 | ☐ 274015 |
| Kovar | ☐ 274013 | ☐ 274016 |
| 2¾ in. o.d. ConFlat® flange | ☐ 274017 | ☐ 274018 |
| 1-5/16 in. o.d. Mini-ConFlat® flange | ☐ 274021 | — |

Broad range 564 gauge

| | |
|---|---|
| Kovar, 1 in. | ☐ 303039 |
| 2¾ in. o.d. ConFlat® flange | ☐ 303041 |

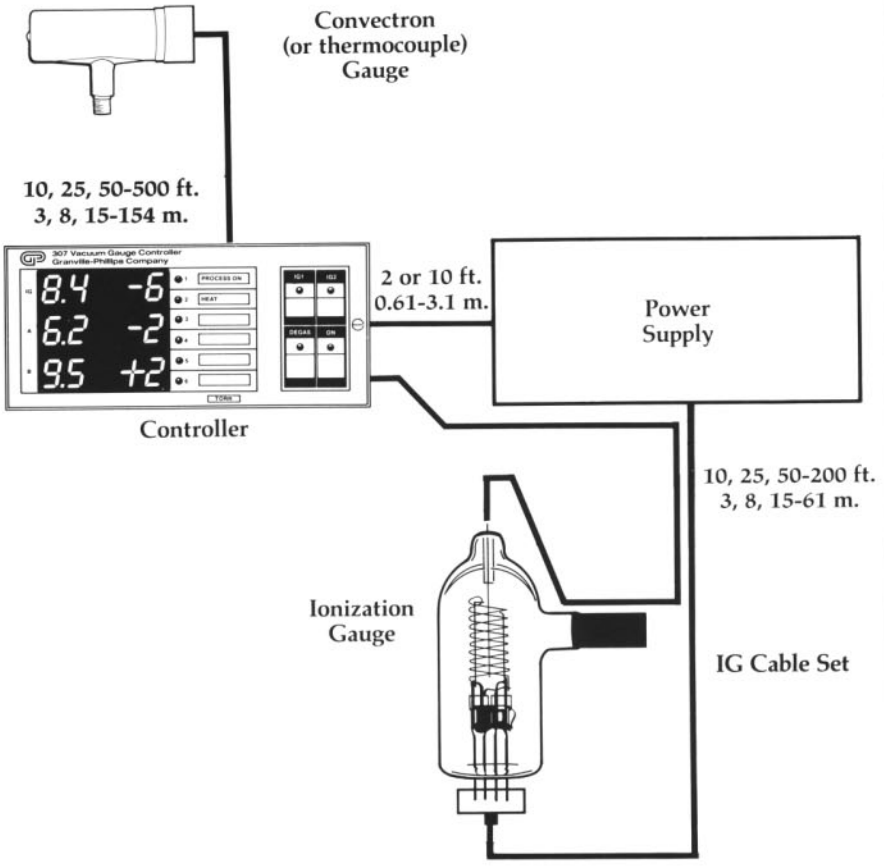
Nude ionization gauges*

| | |
|---|---|
| Dual tungsten filaments, electron bombardment degas only | ☐ 274022 |
| Dual thoria coated iridium filaments, electron bombardment degas only | ☐ 274023 |
| Thoria coated iridium filament $I^2R$ and electron bombardment degas | ☐ 274028 |

*Supplied on 2¾ in. o.d., non-rotatable ConFlat® flange.

®ConFlat-Varian/Vacuum Products Division, Lexington, MA

**Figure 7:** Cable Information




## 3. IG Cable Sets (Select one IG set for each IG).

Includes Ion Gauge Cable and Collector Cable

| | | Cable Length | | | |
|---|---|---|---|---|---|
| | | 3.1m (10 ft.) | 7.7m (25 ft.) | 15.4m (50 ft.) | 15.5-61.5m (50-200 ft.) |
| For Remote Mounting of Power Supply from Control Unit | Series 274 Tubulated Gauge | 307030 | 307031 | 307032 | 307033 |
| | Nude Gauge Series 274 | 307034 | 307035 | 307036 | 307037 |
| | 564 Broad Range Tube | 307038 | 307039 | 307040 | 307041 |
| For Combined Mounting of Control Unit and Power Supply | Series 274-Tubulated Gauge | 307042 | 307043 | 307044 | 307045 |
| | Nude Gauge Series 274 | 307046 | 307047 | 307048 | 307049 |
| | 564 Broad Range Tube | 307050 | 307051 | 307052 | 307053 |

Choose length here for IG cable which runs from Power Supply to IG tube. Collector cable runs from Control Unit to IG tube and is 3.1m (10 ft.) longer than IG cable in remote mounting configurations.

### Low Vacuum Operation

**Select 4abc, 5abc or Nothing**

**4. Convectron**

a. 307013 ☐ Convectron gauge option

b. Convectron gauge tubes

275071 ☐ with Universal connection; for 1/8 in. NPT or 1/2 in. compression fitting

275154 ☐ with NW16KF flange

275185 ☐ with Cajon® VCR® fitting

275198 ☐ with 2¾ in. ConFlat® flange

Please contact GPC if other fittings are desired.

c. Convectron Cable - runs two Convectron gauge tubes from control unit

303030 ☐ 3.1 meters (10 ft.)

303031 ☐ 7.7 meters (25 ft.)

303032 ☐ 15.4 meters (50 ft.)

303040 ☐ 15.5-154 meters (50-500 feet) (specify length)

**5. Thermocouple**

a. 307014 ☐ Thermocouple gauge option

b. 270006 ☐ Thermocouple gauge tube for use with 1/8 in. NPT or .410 in. compression fitting

c. Thermocouple Cable - runs two thermocouple gauge tubes from control unit

307054 ☐ 3.1 meters (10 ft.)

307055 ☐ 7.7 meters (25 ft.)

307056 ☐ 15.4 meters (50 ft.)

307057 ☐ 15.5-154 meters (50-500 ft.) (specify length)

®Cajon, VCR, VCO-Cajon Company, Macedonia, OH
®ConFlat-Varian Vacuum Products Division, Lexington, MA

### Other Options

**Select one of each (Groups 6-12) as required**

**6. Computer Interfaces**

307019 ☐ RS-232C
307020 ☐ IEEE-488

Available IEEE-488 Cables

☐ 303042 1m (3 ft.)
☐ 303043 2m (6 ft.)
☐ 303044 4m (12 ft.)

**7. Degas**

307004 ☐ EB degas.*
307005 ☐ $I^2R$ degas.*

(Note: $I^2R$ degas will not degas ion gauges 274022 or 274023).
*Factory-installed; not for future retrofit.

**8. Additional IG**

307006 ☐ Second ionization gauge capability.* (go back to 3).

*Factory-installed; not for future retrofit.

**9. Process Control**

307017 ☐ six channel process control option: two for IG, two for each Convectron (or thermocouple) gauge

307018 ☐ two channel process control option: two set points for IG only

307082 ☐ one to four channels, user selectable. Note: maximum two channels per display

**10. Ultra High Vacuum Electrometer**

307016 ☐ Factory - installed at the time of original order.

307023 ☐ Field - installed Useable with either degas, however, EB is recommended with UHV electrometer for adequate gauge cleaning in the UHV range.

**11. Remote Operation**

307012 ☐ Remote Input/Output option.

**12. Mounting**

If mounting is not specified, unit will be equipped with half-rack 24.1 x 8.9 cm (9.5 x 3.5 in.) remote mounting.

307008 ☐ 48.3 cm (19 in.) rack mount for one or two power supplies

307009 ☐ 307 control unit/ power supply combined to form a single 48 x 9 cm (19 x 3.5 in.) unit., with 61 cm (2 ft.) interconnect cable

| Control Unit | Power Supply |
|---|---|

307010 ☐ 48.3 cm (19 in.) offset rack mounting

| Blank Panel | Control Unit |
|---|---|

307011 ☐ 48.3 cm (19 in.) center

| | Control Unit | |
|---|---|---|

307021 ☐ 2 - unit mounting adapter

| Control Unit | Control Unit |
|---|---|

307022 ☐ Bench or table top mounting

## Where To Order

Information regarding order placement, technical assistance, or the location of the sales office nearest you is available through our corporate office:
Granville-Phillips
5675 Arapahoe Avenue
Boulder, Colorado 80303-1398, USA.
Telephone: (303) 443-7660 or (800) 776-6543 Fax: (303) 443-2546

## Price Policy

Granville-Phillips reserves the right to change prices and specifications without notice.

## Terms

F.O.B. Plant, Boulder, Colorado, USA. Other terms will be quoted on request.

## Limited Warranty

This equipment is warranted for a period of five years to be free of defects in materials and workmanship subject to certain exceptions and limitations which are expressly stated in our Limited Warranty for this equipment, a copy of which is included in each instruction manual or which will be mailed to you upon request.

GRANVILLE-PHILLIPS
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307007 100 9/02 1.5M