

## Instruction Manual

# Terranova Model 960

Dual - Vacuum Gauge Controller  
Cold Cathode - CCG-525  
&  
Convection - CVT-075



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rev060409sr

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## Safety Information

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### Explosive Gases and Solvents

#### WARNING!

Do not use the Model 960 Dual-Hybrid Gauge Controller to measure the pressure of combustible gas or solvent mixtures. The Convection gauge normally operates at low temperatures, but it is possible that momentary transients or controller malfunction may cause ignition of combustible mixtures, which then might explode and cause damage to equipment and injury to personnel.



### Limitation on use of Compression Mounts

#### WARNING!

Do not use a compression mount (quick-connect) for attaching the gauge tube to the vacuum system in applications that may develop positive pressures. Positive pressures may cause the tube to be blown out of a compression fitting and damage equipment and injure personnel.



### Caution - High Voltage

The Terranova Model 960 and the 525 Cold Cathode Gauge (CCG) operate at High Voltage. The High Voltage of -2,000 volts can be dangerous to equipment and personnel if exposed and contacted. Connectors and cables protected and normally safe, but care must be exercised. Always turn power OFF prior to connecting and disconnecting cables.

### Please let us Know...

Terranova products are the most advanced instruments of their type available from any manufacturer. We have made this Instruction Manual as complete and clear as possible. Let us know if you have any comments that can make this manual or our products more useful.

# I

## Overview

### A. Front View, Back View and Dimensions



Figure 1: Model 960 Front View

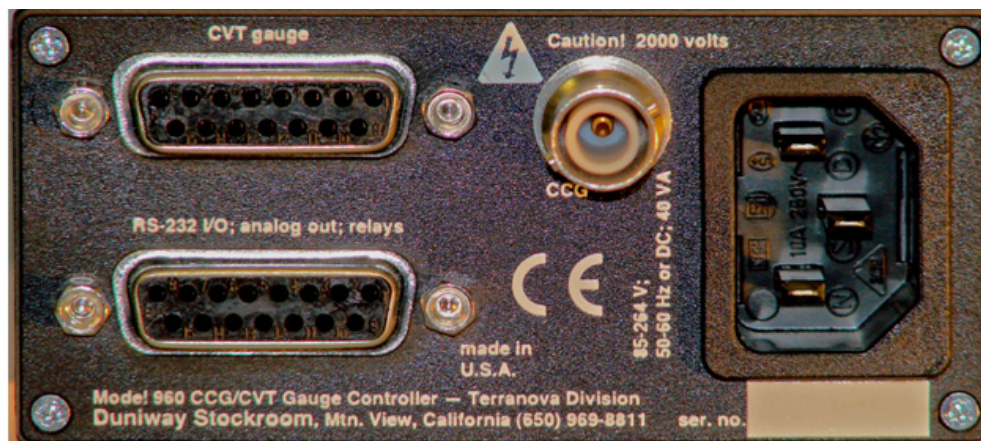


Figure 2: Model 960 Rear View

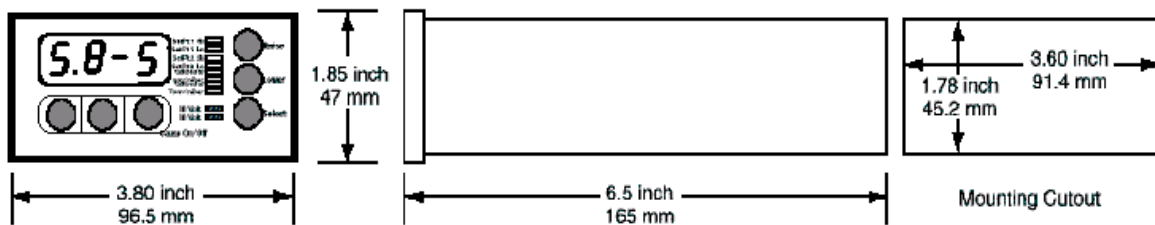


Figure 3: Model 960 Dimensions

## B. General Description

The Terranova Model 960 CVT-CCG Vacuum Controller displays vacuum pressure as measured from both a Cold Cathode gauge (CCG) and a Convection Enhanced Pirani (CVT) gauge. The 960 is housed in a 1/8 DIN enclosure and is simple to operate.

For the CCG, the 960 supplies -2000 VDC and senses/displays the ion current, which is proportional to the pressure.

For the CVT/Convection gauge, the 960 displays vacuum pressure as measured from a CVT-275 Convection Enhanced Pirani gauge tube. It displays vacuum measurements based on thermal conductivity of a gas. The 960 controller covers the range from 0.1 mTorr to 995 Torr, 0.1  $\mu$ Bar to 995 mBar or 0.01 Pascal to 130 kPascal, user selectable.

## C. Specifications

### 1. Useful Measuring Range

CCG:

6 decades; for Duniway CCG-525 and Varian 525 CCG tubes:  $1 \times 10^{-8}$  torr to  $1 \times 10^{-2}$  torr

CVT:

7 decades for CVT-275:  $0.1 \times 10^{-3}$  torr to  $1 \times 10^{+3}$  Torr.

### 2. Display Range

CCG:

$1.0 \times 10^{-8}$  torr to  $1.0 \times 10^{-2}$  torr

CVT:

$1.0 \times 10^{-4}$  torr to  $1.0 \times 10^{+3}$  torr; pressures lower than -19 mTorr ( $\mu$ Bar) display **LO**; pressures higher than 995 Torr (mBar) or no tube attached to cable, display **HI**; if cable is not connected to the unit, display shows **OFF**

### 3. Input to the 960 Controller

CCG:

Ion current is measured in the HV supply

CVT

Pressure is calculated from the gauge output according to gauge supplier's algorithm, conformance to published data is typically within +/- 1%.

### 4. Units of Display

For both CCG and CVT:

Torr, mBar, Pascal, user selectable

5. Full Scale  
CCG:  
1.0 x 10<sup>-2</sup> torr  
CVT  
995 Torr (mBar)
6. Calibration Adjustments:  
CCG:  
CCG Calibrate  
UNITS  
  
CVT:  
GAUGE ZERO adjust  
UNITS  
CONV. ATM adjust
7. Vacuum Gauge  
CCG:  
one Duniway CCG-525 or Varian 525 Cold Cathode gauge  
  
CVT  
one CVT-275 or G-P 275 CONVECTRON®.
8. Operating Temperature Range  
+2 to +50 deg. Celsius
9. Process Control Set Points  
two, with independent High and Low set points for each relay, for flexible control of hysteresis, assignable to either sensor
10. Process Control Relays  
two relays; contacts rated at 2 amp/240 VAC, 300 VDC
11. Nonvolatile Memory for all user specified parameters
12. Analog Output  
logarithmic, 0.5 volts/decade; 0.1 mtorr = 4.00 volts
13. Output Voltage  
CCG  
-2 kv

14. Mounting

The 960 may be used as a bench-top instrument or it may be mounted in an instrument panel. Clips are provided for panel mounting.

15. RS-232 Input/Output

allows user to read pressure, set points and other parameters; 9600 baud, 8-N-1; available through the accessory connector

16. Operating Voltage

The Model 960 has a universal power supply, which operates on input voltages from 90 VAC to 240 VAC 47 to 65 Hz; input is through a power input receptacle on the rear panel.

17. Fuses

Input power is protected by internal, self-resetting, fuses in both lines of the input power. When the input current exceeds 2 amps for 25 seconds, the fuses open. After 30 seconds open, the fuses re-set to closed.

18. Weight, Model 960 only; does not include cable or CVT and CCG tubes

0.9 lb. /0.4 kg

**D. Controls and Indicators**

1. DISPLAY CVT button

allows the user to select CVT (Convection) to be shown on the digital display

2. DISPLAY CCG button

allows the user to select CCG (Cold Cathode Gauge) to be shown on the digital display

3. CCG HV On button allows the user to turn high voltage on/off to the CCG when the 960 is not in the Autorange mode.

4. SELECT button

Allows selection of parameters to be adjusted, e.g. Set Points

5. RAISE and LOWER buttons

used for adjustment of gauge and instrument parameters

6. Digital Display

2-digit pressure, sign (+/-) and 1-digit exponent, 7-segment bright red LED, 10 mm high

7. Display Indicators

bright red individual LED for miscellaneous indicators



## E. Gauge Tube (Sensor) and Cables

<u>Part Number</u>	<u>Description</u>
CVT-275-101	Sensor, Convection, 1/8 NPT port
CBL-275	Cable, Convection Sensor, 10 ft.
CCG-525-KF25	Sensor, Cold Cathode, KF25 flange
CCG-525-KF40	Sensor, Cold Cathode, KF40 flange
CCG-525-CFF	Sensor, Cold Cathode, 2.75" CFF
CCG-525-1	Sensor, Cold Cathode, 1.0" Tube
05-410-SHV	Cable, Cold Cathode Sensor, 10 ft, Bakeable/Radiation Res..
05-110-SHV	Cable, Cold Cathode Sensor, 10 ft. RG-59

CCGs and CVTs may be ordered from:

**Duniway Stockroom Corp.**  
**48501 Milmont Drive**  
**Fremont, CA 94538**  
**Telephone: (800) 446-8811 or (650) 969-8811**  
**Facsimile: (650) 965-0764**  
**Internet: [www.duniway.com](http://www.duniway.com)**

**For other Sensor flanges or Cable lengths, please inquire.**

## II Installation

### A. Unpack the Controller

Carefully unpack the Model 960 Dual - Hybrid Vacuum Gauge Controller. The shipment includes these components:

- controller unit
- power cord
- mounting clips
- D-sub 15 accessory connector
- this instruction manual

If your controller does not have all of these items, call Duniway Stockroom. If anything appears to have been damaged in shipment, contact the shipper.

### B. Mount the Controller

You can rest the controller unit on a bench, table top, or shelf, or you can mount it in a rack or cabinet. The controller unit is housed in a standard 1/8 DIN box. If you are mounting the unit in a panel, the cutout dimensions are 1.78 inch by 3.60 inch (45.2 mm by 91.4 mm), see fig. 3, page 9. One mounting clip attaches to each of the sides of the controller unit. To attach the clip, slide the beveled surfaces of the clip under the cutout on the side of the box and push the clip toward the back of the unit.

Be sure to leave enough clearance at the back of the controller unit for easy access to cable connections and enough space around the vents of the unit to allow heated air to escape.

### C. Select the CCG

The Model 960 controller is designed to work with the Duniway CCG-525 and Varian Model 525 Cold Cathode gauges.

### D. Select the CVT Tube

The Model 960 controller is designed to work with the CVT-275 or the Brooks/Helix/Granville-Phillips type 275 Convectron<sup>®</sup> sensor tubes, both of which are supplied by Duniway Stockroom Corp.



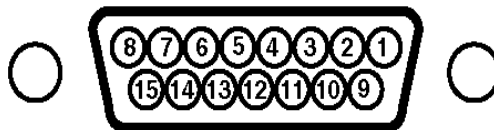
**Figure 4: CVT-275 and CCG-525**

#### **E. Mount the CCG and CVT Tubes on the Vacuum System**

Make sure that the sensor tubes are securely connected to the vacuum system, using good vacuum practice.

#### **F. Attach the CVT Sensor Cable: Part Number CVT-275**

**NOTE:** Be sure that the Terranova 960 power is OFF before connecting/disconnecting sensors. The sensor cable has a 9-pin D-sub connector on one end, which plugs into the 960, see Figure 5, below. Connect the 9-pin D-sub plug of the gauge cable to the 9-pin connector on the back of the 960 controller unit. Push the plug onto the connector until it is firmly in place. Tighten the retaining screws to make certain the connector remains in place. Loose connections can cause faulty readings.



**Figure 5: Model 960 CVT Sensor Connector -- 15 Pin Female D-Sub Connector**

<u>Terranova 960</u>	<u>275</u>
<u>D-15 pins</u>	<u>CVT</u>
	<u>gauge connector pin</u>
8	1
7	1
6	5
5	2
4	3
3	3
2	shield
no connection	4

**Figure 6: Figure Terranova 960 15-D Connector to 275 Connector**

Current available for +15 volts from pins 4 and 5, and for -15 volts from pins 6 and 7 is internally protected and limited to approximately 0.75 amp total for each supply. If excessive current is taken through any of the power output pins, the internal protection will shut off the power for the affected voltage. It will be necessary to disconnect power for the 960 for a few minutes to allow the internal protection device to cool down and reset itself.

**G. Attach the CCG Sensor Cable: Part Number: 05-410-SHV**

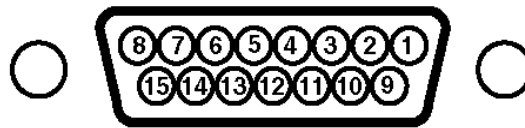


**NOTE:** Be sure that the Terranova 960 power is OFF before connecting/disconnecting sensor cables.

The CCG Sensor Cable is a coaxial high voltage cable, with a type 05 BNC coaxial connector on the 525 sensor end and a type SHV coaxial connector on the 960 end. The operating voltage of the 525 sensor is -2,000 volts

## H. Make Accessory Connections

The 15-pin D-sub Accessory Connector is on the rear panel of the 960, see Figure 8, below. The connector has female pins; the mating connector must have male pins. Mating D-sub 15 connectors are available from many of the normal electronic sources. If you need help identifying a source, please contact us.



RS-232 I/O; analog out; relays

**Figure 7: Model 960 Accessory Connector -- 15 Pin Female D-Sub Connector**

Following are pin assignments for the Accessory Connector:

<u>15-pin</u>	<u>Accessory Connector</u>
pin 1	set point #1 relay, normally closed
pin 2	set point #1 relay, common
pin 3	set point #1 relay, normally open
pin 4	set point #2 relay, normally closed
pin 5	set point #2 relay, common
pin 6	set point #2 relay, normally open
pin 7	Tx, RS-232 signal out of the 960; 9600-N-8-1
pin 8	Rx, RS-232 signal into the 960
pin 9	ground, RS-232 and analog common
pin 10	reserved
pin 11	reserved
pin 12	reserved
pin 13	log analog output, 1Kohm output, 0.5 volts/decade
pin 14	reserved
pin 15	reserved

**Figure 8: 960 -- Accessory Connector Signals and Pins**

**NOTE:** See also Section VI - Application Note - Protective Circuits for Set Point Relays

## I. Check Supply Voltage

The Model 960 incorporates a universal power supply. This allows the 960 to operate on any input voltage from 90 VAC to 240 VAC, 47 to 65 Hz.

## J. Attach the Power Cord

Plug the power cord into the receptacle in the power module on the rear of the 960.

## III Operation

### A. Turn Power On

Plug the AC power end of the power cord into an electrical outlet. The loudspeaker will “beep” and test all indicators while the controller executes its self test. After being turned on, the instrument will go through the following sequence:

- “beeper”
- indicators for TORR, MTORR, MBAR, MBAR, KPASCAL, PASCAL
- 9 LED indicators for set points and other functions
- all four digits will light, including decimal points
- display shows the model number of the instrument, **960**
- display shows software version, e.g. **1.10**

The 960 will go into normal operation and begin measuring pressure. If the CCG or CVT is not connected, the display will show **OFF** when that gauge/sensor is selected from the front panel GAUGE SELECT button. If the system pressure is greater than 100 mTorr for the CCG or 999 Torr for the CVT the display will show **HI**.

### B. Fuses

Input power is protected by internal, self-resetting fuses in both lines of the input power. When the input current exceeds 2 amps for 25 seconds, the fuses open. After 30 seconds open, the fuses re-set to closed.

### C. Front Panel Controls

The Model 960 allows flexible configuration of operation using simple entry from the front panel buttons labeled DISPLAY CVT, DISPLAY CCG, CCG HV ON, SELECT, RAISE and LOWER. Parameters which you may adjust are selected by scrolling through a list (using the SELECT button) which begins with SET PT 1 HIGH. Each time the SELECT button is pushed, the LED indicator advances to the next parameter. The LED indicators will be lit to indicate which parameter is being adjusted and the digital display will flash to indicate the value of the parameter being adjusted.

Each push of a button will give a short “beep” from the loudspeaker to confirm the button was pushed. If you have reached the limit of adjustment or if the button push is not allowed, the loudspeaker will give a long “beep” and error display E02.

Following is a detailed description of parameter selection and adjustment:

### D. Set Pt 1 High Default Value: OFF

This sets the high limit of the set point. Above this pressure, the set point relay will be de-energized. Press the RAISE or LOWER buttons to enter the value desired. The minimum value is OFF; this shuts the set point off.

For the CCG, the next increment is 0.1 in the Least Significant Digit in the range  $1.0 \times 10^{-7}$  torr to  $1.0 \times 10^{-3}$  torr.

For the CVT, the next increment is 0.1 in the Least Significant Digit in the range  $3.0 \times 10^{-3}$  torr to  $5.0 \times 10^{+2}$  torr.

When the RAISE or LOWER buttons are pressed, the display will change slowly at first. If you hold the button down for a few seconds, the rate of change will increase to allow you to make large changes more quickly.

SET PT 1 HIGH operates in conjunction with SET PT 1 LOW. While the 960 is in this mode, the set point may be assigned to either CCG or CVT/275 by pressing either GAUGE DISPLAY button.

#### E. Set Pt 1 Low

**Default Value: OFF**

This sets the low limit of the set point. This is the pressure at which the set point relay will be energized. Operation is similar to that of SET PT 1 HIGH above. The minimum value is OFF; this shuts the set point off.

SET PT 1 LOW operates in conjunction with SET PT 1 HIGH.

**NOTE:** *The High and Low set points allow the user to set the hysteresis of the set point operation. As the system is pumped down, the set point relay will be energized (set point turns on) as the pressure drops below SET PT 1 LOW. The relay will remain energized until the pressure rises above SET PT 1 HIGH.*

It is not possible to adjust the High set point to be lower than the Low set point. If you adjust the High set point below the pressure previously selected for the Low set point, the 960 will automatically reduce the value for the Low set point so that it is two increments lower than that of the High set point.

#### F. Set Pt 2 High

**Default Value: OFF**

This operates in the same manner as SET PT 1 HIGH, described above.

#### G. Set Pt 2 Low

**Default Value: OFF**

This operates in the same manner as SET PT 1 LOW, described above.

#### Set Point Operation

When pressure values have been entered for a set point (1 or 2) and assigned to a gauge (CVT or CCG), the set point relay operates as follows: As the pressure on the assigned gauge falls through the chosen "Set Point N Low" pressure, the relay actuates, either opening (if the Normally Closed pin has been used on the Auxiliary I/O connector) or closing (if the Normally Open pin has been used on the Auxiliary I/O connector). Likewise, as the pressure on the assigned gauge rises through the chosen "Set Point N High" pressure, the relay de-actuates, either closing (if the Normally Closed pin has been used on the Auxiliary I/O connector) or opening (if the Normally Open pin has been used on the Auxiliary I/O connector).

**NOTE:** See also Section VI - Application Note - Protective Circuits for Set Point Relays

**NOTE:** See also Section IV-N - Set Point Activation/Deactivation Diagram

## H. Autorange

**Default Value: Off**

When AUTORANGE is selected during set up, the 960 automatically switches at appropriate pressure points, from CVT to CCG as pressure falls and from CCG to CVT as the pressure rises.

As the pressure falls, the transition from CVT to CCG occurs at  $3 \times 10^{-3}$  torr, at which point, the CCG HV is turned ON, and the display changes from showing CVT pressure to showing CCG pressure.

As the pressure rises, the transition from CCG to CVT occurs at  $6 \times 10^{-3}$  torr, at which point, the display changes from showing CCG pressure to showing CVT pressure. CCG HV is turned OFF as the pressure continues to rise above  $1 \times 10^{-2}$  torr. (This delay is set up to provide better operation during transient pressure spikes).

## I. CCG Calibrate

**Default Value: 1.00 (Internal value)**

This allows the user to modify the reading for the CCG gauge by multiplying by a value between 0.5 and 2.0. This is convenient for calibration of the CCG. The multiplier is internal, and is not seen by the user. The digital display shows the result of the CCG pressure reading multiplied by the internal multiplier.

## J. CVT ATM

**Convection ATM**

**No Default Value - Display Shows CVT Output**

Use the RAISE and LOWER buttons to set the displayed pressure to the desired pressure reading. Initially, the display may read a value which is substantially higher than atmospheric pressure, or it might even indicate "HI". Just proceed to use the LOWER button to bring the reading into the range. If you try to set CVT ATMOS when the pressure is less than approximately 2.0+2 Torr (3.5+2 mBar) you will get a long 'beep' from the unit's annunciator.

You can use this function to set the atmospheric pressure reading for CVT 275 convection gauges. You should know the local barometric pressure before proceeding; your local airport or internet weather web-site ([www.weather.com](http://www.weather.com)) may have this information. Normal barometric pressure is approximately 7.6+2 Torr (1.0+3 mBar) at sea level.



## K. CVT Zero

This allows the user to adjust the zero for the CVT. Before making this adjustment, the CVT should be connected to a vacuum system at a pressure lower than 0.1-3 torr. This adjustment may also be used to set the display to a specific value if you know the pressure through other means. For example, if the CVT to be adjusted is attached to a system that has another gauge which has been independently calibrated, the CVT may be made to read the same as the calibrated gauge. The ZERO function may be adjusted only when the CVT pressure is below 5.0-3 torr (6.5-3 Bar). If you try to set the ZERO when the pressure is above 5.0-3 torr, you will get a long 'beep' from the unit's annunciator.

## L. Units

**Default Value: Torr/mTorr**

On the next press of the SELECT button, you will be in the UNITS mode. This allows selection of the units to be used in display of the pressure for both gauges.

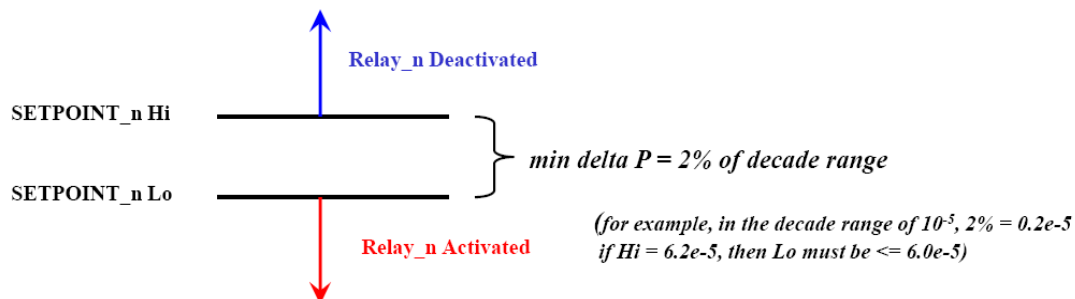
The display will flash with the currently selected UNITS.

Press either the RAISE or LOWER buttons to sequence through the choices: Torr, mBar, Pascal. The UNITS of measure apply to both gauges; it is not possible to select Torr for one gauge and mBar for the other gauge.

## M. Reset of Stored (Default) Values

This allows you to recover the factory (default) settings for all stored values and resets the SET POINTS to off. For a system that is far out of calibration, the factory settings provide a good starting point for re-calibrating or adjusting the gauge controller. To recover the factory settings, unplug the 960 from its power source. Press and hold RAISE and LOWER buttons at the same time; while holding the RAISE and LOWER buttons depressed, plug the power cord in. You will hear a few short 'chirps' from the loudspeaker confirming the factory settings have been entered. The digital display will show RST to confirm the reset has been entered.

## N. Set Point Activation/Deactivation Diagram



**Figure 9: Set Point Activation/Deactivation Diagram**

## O. Summary of 960 Display States and Ranges: Manual and Autorange Settings

Mode	Pressure Range (torr)	HV	Gauge Displayed	“Display CVT”	“Display CCG”	“CCG HV On”	“Autorange”
AUTO	$P \geq 1e-2$	OFF	CVT	ON	OFF	OFF	ON
	$6e-3 \leq P < 1e-2$	ON	CVT	ON	OFF	ON	
		OFF				OFF	
	$3e-3 \leq P < 6e-3$	ON	CVT (if range entered from top)	ON	OFF	ON	
			CCG (if range entered from bottom)	OFF	ON		
		OFF	CVT	ON	OFF	OFF	
	$P < 3e-3$	ON	CCG	OFF	ON	ON	
MANUAL	$P \geq 1e-2$	OFF	CVT	ON	OFF	OFF	OFF
			CCG (“OFF”)	OFF	ON		
	$P < 1e-2$	ON	CVT	ON	OFF	ON	
		OFF				OFF	
		ON	CCG	OFF	ON	ON	
		OFF				OFF	

A

B

C

D

E

F

G

H

Figure 10: 960 Display States and Range

### NOTES:

High Voltage Operation:

AUTO mode: controlled by instrument with following hysteresis: decreasing P turn-on @  $3e-3$  torr, increasing P turn-off @  $1e-2$  torr

MANUAL mode: user-activated / -deactivated when CCG is displayed; if activated, remains on when CVT is displayed  
HV turned off by instrument for  $P \geq 1e-2$  torr

In both MANUAL and AUTO mode, all instrument states are determined from the present values of Mode, Pressure and HV status EXCEPT:

state: AUTO mode -- HV turned-on -- inlet pressure in the range of  $3e-3$  to  $6e-3$  torr (rows 4 and 5)

The pressure gauge displayed depends on the PREVIOUS pressure measured by the 960 before entering this range.

If the previous pressure was  $> 6e-3$  torr, the CVT is displayed (row 4); if P was  $< 3e-3$  torr, the CCG is displayed (row 5).

Since there is no instrument history at AC turn-on, the default AUTO startup state in this pressure range is HV off and CVT selected. (row 6)

960 Setpoint Range (torr)			
CVT	Hi	min $3.2e-3$	max $5.0e+2$
	Lo	min $3.0e-3$	max $4.8e+2$
CCG	Hi	min $1.2e-7$	max $1.0e-3$
	Lo	min $1.0e-7$	max $9.8e-4$

## P. CVT/ Convection Gauge with Other Gases

If you need to measure the pressure of gases other than air/nitrogen, refer to the following table:

True Pressure	Indicated Pressure on Model 960 Display, Torr									
Torr	Argon*	CO <sub>2</sub>	Deuterium	Freon 12	Freon 22	Helium	Krypton	Methane	Neon	Oxygen
0	0	0	0	0	0	0	0	0	0	0
0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0002	0.0001	0.0001
0.0002	0.0001	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0003	0.0001	0.0002
0.0005	0.0003	0.0006	0.0006	0.0008	0.0007	0.0004	0.0003	0.0008	0.0003	0.0005
0.001	0.0007	0.0011	0.0019	0.0015	0.0014	0.0008	0.0005	0.0018	0.0007	0.0010
0.002	0.0013	0.0023	0.0024	0.0030	0.0029	0.0016	0.0010	0.0032	0.0014	0.0020
0.005	0.0033	0.0055	0.0060	0.0075	0.0068	0.0040	0.0023	0.0077	0.0035	0.0049
0.01	0.0065	0.0109	0.0120	0.0147	0.0135	0.0080	0.0046	0.0152	0.0070	0.0097
0.02	0.014	0.022	0.024	0.030	0.027	0.016	0.009	0.031	0.014	0.020
0.05	0.033	0.055	0.060	0.073	0.069	0.041	0.024	0.077	0.035	0.049
0.1	0.064	0.107	0.120	0.142	0.136	0.082	0.046	0.158	0.070	0.097
0.2	0.126	0.208	0.247	0.270	0.259	0.163	0.085	0.310	0.140	0.192
0.5	0.307	0.494	0.673	0.599	0.582	0.427	0.214	0.764	0.353	0.477
1	0.59	0.93	1.51	1.03	1.01	0.92	0.39	1.56	0.73	0.95
2	1.12	1.67	4.02	1.59	1.62	2.16	0.68	3.23	1.60	1.90
5	2.36	3.24	261	2.38	2.54	13.2	1.25	13.3	5.10	4.85
10	3.86	4.84		2.86	3.29		1.74	28.6	21.5	10.1
20	5.67	6.39		3.21	3.61		2.23	359	584	22.4
50	7.72	8.00		3.68	4.02		2.50	845		85.7
100	8.71	9.02		4.56	4.78		2.66			226
200	9.65	12.0		5.81	6.23		3.07			303
300	11.1	16.8		6.69	7.31		3.49			383
500	15.9	29.4		8.06	8.98		4.10			603
700	21.9	48.8		9.20	10.4		4.60			861
760	23.9	56.0		9.52	10.8		4.63			943
900	29.2	88.2		10.2	11.7					
1000	33.8	129		10.8	12.4					

**Figure 11: CVT Indicated vs. True Pressure for Gases Other Than Nitrogen**

For example, if you are measuring the pressure in a system that is backfilled with carbon dioxide (CO<sub>2</sub>), and the Model 960 display shows an indicated pressure of 56 Torr, the true pressure is 760 Torr. If the indicated pressure is 22 mTorr (0.022 Torr), the true pressure is 20 mTorr (0.02 Torr).

These data were compiled from a variety of sources and are believed to be reliable, however Duniway Stockroom Corp. takes no responsibility for errors in the data. If your application is critical, we suggest you use the services of an independent laboratory to calibrate the CVT-275 gauge and Model 960 controller to your specific application.

## Q. CCG-Cold Cathode Ionization Gauge with Other Gases

If you need to measure the pressure of gases other than air/nitrogen, refer to the following table: Divide the indicated pressure by the gas-species correction factor in the table to obtain the true pressure.

### Ion Gauge Gas Correction Factors

The sensitivity of an ionization gauge is related to the ionization rate of the gas being measured. Small atoms are more difficult to ionize, thus give lower readings, and vice versa for larger, heavier atoms.

Gas	Symbol	Factor
Helium	He	0.18
Neon	Ne	0.30
Deuterium	D <sub>2</sub>	0.35
Hydrogen	H <sub>2</sub>	0.46
Nitrogen	N <sub>2</sub>	1.00
Air		1.00
Oxygen	O <sub>2</sub>	1.01
Carbon Monoxide	CO	1.05
Water	H <sub>2</sub> O	1.12
Nitrogen Oxide	NO	1.15
Ammonia	NH <sub>3</sub>	1.23
Argon	Ar	1.29
Methane	CH <sub>4</sub>	1.40
Carbon Dioxide	CO <sub>2</sub>	1.42
Krypton	Kr	1.94
Sulfur Hexafluoride	SF <sub>6</sub>	2.20
Ethane	C <sub>2</sub> H <sub>6</sub>	2.60
Xenon	Xe	2.87
Mercury	Hg	3.64

**Note: In a gauge calibrated for nitrogen, where the dominant gas is other than nitrogen, divide the gauge reading by the appropriate gas ionization factor**

### **Figure 12: CCG Correction Factor for Gases Other Than Nitrogen**

For example, if you are measuring the pressure in a system that is backfilled with carbon dioxide (CO<sub>2</sub>), and the Model 960 display shows an indicated pressure of  $1 \times 10^{-5}$  Torr, the true pressure is  $7 \times 10^{-6}$  Torr. ( $0.7 \times 1 \times 10^{-5}$ )

These data were compiled from a variety of sources and are believed to be reliable, however Duniway Stockroom Corp. takes no responsibility for errors in the data. If your application is critical, we suggest you use the services of an independent laboratory to calibrate the CVT-275 gauge and Model 960 controller to your specific application.

## R. Analog Output

The analog output is calculated from the value of the digital display. The output is logarithmic, 0.5 volt/decade; the source impedance for the output is 1 K ohm. The output voltage is calculated from:

$$V=0.50*(\log 10 (\text{Pressure})+12)$$

where V is the Analog Output in volts; P is the pressure in mTorr or  $\mu$ Bar. Some examples follow; because of normal tolerances in the electronics, there may be minor differences in the values you observe compared to those shown:

<u>Displayed Pressure</u>	<u>Analog Output - volts</u>
LO	0.0
1.0-8	2.0
1.0-7	2.5
1.0-6	3.0
1.0-5	3.5
1.0-4	4.0
1.0-3	4.5
1.0-2	5.0
1.0-1	5.5
1.0+0	6.0
1.0+1	6.5
1.0+2	7.0
1.0+3	7.5
HI	8.5

**Figure 13: Analog Output and Displayed Pressure**

The pressure as a function of the Analog Output voltage is:

$$P=10^{(2V-12)}$$

*NOTES:*

*The analog output is valid for the gauge which is selected on the display.*

*The units selected do not affect this output.*

## S. Serial Interface

The RS-232 serial port gives pressure readings when requested by the terminal. The interface is standard RS-232 format; 9600 baud, 8-bits, no parity, 1 stop bit. The interface is through the 15-pin D-sub accessory connector, see Figure 8, page 13.

pin 7 is Tx (signal from the 960 to the terminal)  
pin 8 is Rx (signal from the terminal to the 960)  
pin 9 is return (ground).

The serial port allows reading pressure and other parameters of the 960; it is not possible to modify stored parameters over the serial port.

The following commands are used in the 960:

### 1. Pressure

To read the pressure of both gauges

Send "p" (ASCII value 112); the 960 sends pressure for gauge 1 and gauge 2 to the terminal. Output is in the format:

when both gauges are on, the fields returned are:

CVT\_gauge, CCG\_gauge, <reserved>

in the format: AB<sub>e</sub>C, DE<sub>e</sub>F, OFF

where AB and DE are multipliers; C and F are exponents.

If a gauge is turned off, its field contains "OFF"

Some examples follow:

<u>Displayed Pressure</u>	<u>Serial Output</u>
<b>OFF</b>	Off
<b>LO</b>	Low
0.0-3	0.0e-3
0.8-3	0.8e-3
2.8-3	2.8e-3
-1.6-3	-1.6e-3
5.7-2	5.7e-2
2.3+0	2.3e+0
1.0+0	1.0e+0
4.1+2	4.2e+2
<b>HI</b>	9.9e+2

**Figure 14: Serial Output and Displayed Pressure**

Since both gauges are maintained in an active state, pressure data taken over the serial port are valid for both gauges at the same time, regardless of which gauge is shown on the digital display.

## 2. Units Of Measurement

To read the chosen units of measure (both gauges), Send “u” (ASCII value 117); the 960 returns **Torr** or **mBar** or **Pasc**

## 3. Set Point #1

To read the setting and status of set point #1

Send “1” (ASCII value 49); the 960 returns information for set point #1 in the format:

ABeC, DEeF, R, XXX

where:

AB is the multiplier and C is the exponent for set point #1 high

DE is the multiplier and F is the exponent for set point #1 low

R is the set point relay status; 0=relay is not energized, 1=relay is energized

XXX is the gauge to which the set point #1 has been assigned: either CCG or CVT.

## 4. Set Point #2

To read the setting and status of set point #2

Send “2” (ASCII value 50); the 960 returns information for set point #2 in the same format as for set point #1, above.

## 5. Model And Software Revision

To read software identification.

Send “v” (ASCII value 118); the 960 returns the model number of the instrument and the revision number, as in the following example:

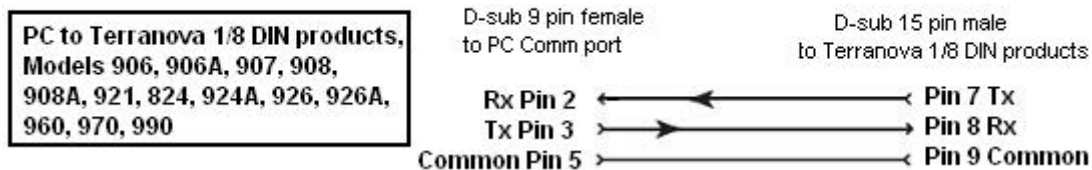
**960,ver. 1.10x**

## 6. Factory Diagnostic

A diagnostic command is included for factory use only, which produces a repeating stream of data.. It is initiated by sending “c” and terminated by sending “e”, or cycling the unit input power. For additional information, please call Duniway Stockroom Corp.

## 7. Serial RS-232 Cable for PC Computer

### Serial Interface Cable: PC Serial Port to Terranova 9XX Products



**Figure 15: Serial RS-232 Cable for PC Computer**

## IV      Trouble Shooting

### A. For the CCG:

The 525 CCG tube may require periodic maintenance, especially if the sensor tube has not been operated for a long period or has been exposed to contaminants, such as pump oil. These conditions will cause gases to be adsorbed onto the internal surfaces of the sensor tube, causing slow starting and/or erratic readings.

To remove the surface contaminants, heat can be applied to the tube, not exceeding 100° C. Or, a better solution, is to clean the inside parts of the sensor tube using solvents and mild surface scrubbing; rinsing in clean water followed by hot-air drying.

#### **Fault Indication**

#### **Possible Causes/Remedies**

960 display does not  
read above  $1 \times 10^{-7}$  Torr

Check high voltage cable: continuity; plus connection,  
at the 525 sensor tube and at the 960 controller.

960 display reads HI even  
when the pressure is  
below  $1 \times 10^{-2}$  Torr

Check high voltage cable for electrical short between  
center conductor and shield. Check 525 sensor tube  
for low resistance between cathode and body.  
Insulator may be contaminated.

525 gauge tube will not  
strike a discharge

Confirm that high voltage is being applied to 525.  
Striking time is longer at lower pressures. To reduce  
striking time, turn on the high voltage at higher pressure.

Reading on 960 is erratic

525 sensor tube may be contaminated.  
Follow cleaning procedure described above.



## B. For the CVT/Convection Gauge

**If pressure readings are unreliable or noisy:** Check the connection to the gauge tube. Check that the gauge tube is clean and not contaminated; a contaminated or dirty gauge tube can cause erratic readings. Use an ohmmeter to check that none of the convection gauge pins are shorted to the metal housing of the tube.

**If readings at VAC or ATM seem wrong:** A new gauge is calibrated by the manufacturer to be within 5 mTorr of true zero at vacuum, and within 20 Torr at 760 Torr. If recovery of factory settings (see **Operation** section) does not give readings which appear reasonable, it is possible that your gauge has become contaminated or damaged. You may try cleaning the gauge using acetone or TCE (1-1-1 trichloroethane). Be careful when using flammable solvents, so that you do not risk explosion from the flammable vapors.

You can measure the CVT-275 or CONVECTRON<sup>®</sup> gauge to see if it has the correct internal resistance values. If the measured values differ from those shown, it is possible that your gauge has become damaged. These measurements must be made while the gauge is at atmospheric pressure; do not use a method which applies more than 10 mA to the pins or you will damage the fine internal wires.

<u>between pins</u>	<u>resistance</u>
1 and 2	20 ohm to 30 ohm
2 and 3	50 ohm to 60 ohm
1 and 5	175 ohm to 190 ohm

If the resistance between pins 1 and 2 measures approx. 800 ohms, it means the internal sensor wire is broken and the CVT-275 gauge must be replaced.

## C. Error Codes

The following Error Codes have been defined:

- E01 Action Not Allowed, e.g. button push not allowed
- E02 Parameter at its Limit, e.g. set point range
- E11 HV Button was pushed while viewing CVT pressure, need to select CCG first
- E12 In Autorange, CVT output is too low, e.g. cable disconnected at 960 end
- E13 In Autorange, CVT output is too high, e.g. cable disconnected at CVT end
- E21 CCG output is too low, e.g. CCG cable not connected
- E22 CCG high voltage is too low, e.g. defective HV supply

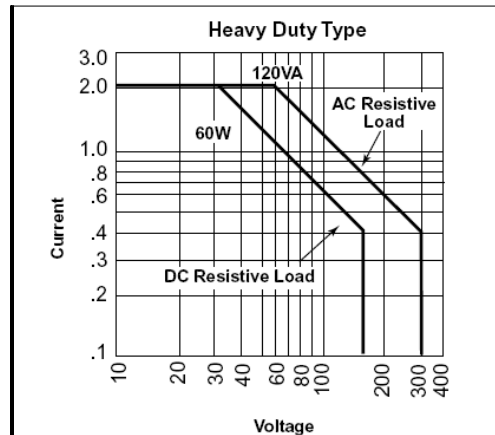
**Figure 16: Model 960 Error Codes**

## V Application Note

### Protective Circuits for Set Point Relays

#### A. Rated Voltage vs. Current – Resistive Loads

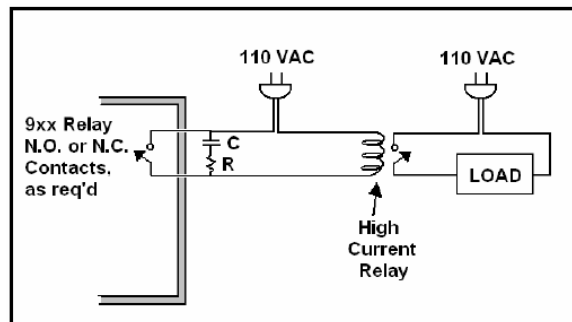
The graph below shows the relationship between the maximum voltage and current ratings specified for Heavy Duty Type AZ5 relays. These relays are used as Set Point Relays in the Terranova 9XX 1/8 DIN Vacuum Gauge Control Display products.



For resistive loads maximum current varies from 2 amps at 30 VDC (60 VAC) downward to 0.4 amps at 150 VDC (300VAC).

#### B. Protective Circuits for Non-Resistive Loads

For application of the Set Point relays for switching inductive or capacitive loads, it is advisable to use so-called "snubber" circuits, consisting of capacitors and resistors across the load. Such a circuit is shown in the diagram below. This circuit quenches any surges or arcs that might occur when switching such non-resistive loads.



To calculate the values of C and R for the “snubber” circuits, the equations below give some guidance.

Snubber equations from CDE Quencharc paper:

$C = \frac{I^2}{10}$ <p>where C = capacitance in uF  I = load current in amperes prior to contact opening  R = resistance in ohms in series with capacitor  Eo = source voltage</p>	$R = \frac{E_o}{10 I (1 + \frac{50}{E_o})}$
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For 1 amp load and 110 VAC, C and R calculate approx to:  
C=0.1 uF and R=6 ohm (use 10 ohm)

For 0.1 amp and 110...  
C=0.001 uF and R=60 ohm (use 100 ohm)

For additional information on protective circuits for set point relays, please see the Potter and Brumfield publication on the following link:

[http://www.pandbrelays.com/appnotes/app\\_pdfs/13c3311.pdf](http://www.pandbrelays.com/appnotes/app_pdfs/13c3311.pdf)

## VI      **Return Procedure**

If you need to return the gauge controller to Duniway Stockroom for service:

- Contact Duniway Stockroom to get a **RMA** (Return Material Authorization) number.
- Then pack the instrument securely.
- Use the original packaging if it is available.
- If the Terranova 960 was shipped with a cable and/or sensors, diagnosis and repair will be more efficient if all components are returned together. If this is not convenient, please consult with your Duniway Stockroom Customer Service Representative
- If you do not have appropriate packing materials, a commercial packing and shipping firm can provide them.
- Be sure to mark the **RMA** number on the outside of the package.

CONVECTRON<sup>®</sup> is a registered trademark of Granville-Philips Inc.

## VII Warranty/CE

*Terranova products are warranted to be free of defects in material and workmanship for a period of one year from the date of shipment. At our option, we will repair or replace products which prove to be defective during the warranty period. Liability under this warranty is limited to repair or replacement of the defective items. Shipping damage is excluded from the scope of this warranty. Gauge tubes of all types are excluded from this warranty.*

*Terranova products are warranted not to fail to execute programming instructions due to defects in materials and workmanship. If Duniway Stockroom receives notice of such defects during the warranty period, Duniway Stockroom will repair or replace firmware that does not execute its programming instruction due to such defects. Duniway Stockroom does not warrant that the operation of the firmware or hardware will be uninterrupted or error-free.*

*If this product is returned to Duniway Stockroom for warranty service, Buyer will pre-pay shipping charges and will pay all duties and taxes for products returned to Duniway Stockroom. Duniway Stockroom will pay for return of products to Buyer, except for products returned to a Buyer from a country other than the United States.*

**LIMITATION OF WARRANTY:** *The foregoing warranty does not apply to the defects resulting from:*

- 1. Improper or inadequate maintenance by Buyer;*
- 2. Buyer-supplied interfacing;*
- 3. Unauthorized modification or misuse;*
- 4. Operation outside of the environmental specifications of the product; or*
- 5. Improper site preparation and maintenance.*

**THE WARRANTY SET FORTH ABOVE IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. Duniway Stockroom DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

**EXCLUSIVE REMEDIES:** *The remedies provided herein are Buyer's sole and exclusive remedies. In no event will Duniway Stockroom be liable for direct, indirect, special, incidental, or consequential damages, including loss of profits, whether based on contract, tort, or any other legal theory.*

# DECLARATION OF CONFORMITY

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**We, Duniway Stockroom, declare under our sole responsibility,  
that the following products, displaying the CE mark on the rear panel:**

Model 960 CVT-CCG Vacuum Gauge Controller

**to which this declaration relates, are in conformity with the following  
standards or normal documents**

EMC Directive (89/336/EEC//93/68/EEC)  
Electromagnetic Compatibility  
Standards: EN 50081-1, -2: 1992, EN 50082-1, -2: 1993



CENELEC EN61326  
Electrical Equipment for Measurement, Control and Laboratory Use  
RMC Requirements Part 1: General Requirements  
IEC 61326; 1997 + A1:1998  
**following the provisions of the EMC directive (89/336/EEC)**

Low Voltage Directive (73/23/EEC//93/68/EEC)  
Electrical/Technical Safety  
Standard: EN 61010-1: 1993/A2: 1995



Standard for Safety for Electrical Equipment for Laboratory Use  
Part 1: General Requirements (UL 61010A-1, 1st Edition)

Safety Requirements for Electrical Equ't for Measurement, Control and Laboratory Use  
Part 1: General Requirements (CAN/CSA C22.2 No. 1010-1-02)

April 1, 2008

**by: Sherman Rutherford**  
Compliance Manager

rev060409sr