TELEDYNE HASTINGS INSTRUMENTS
Everywhere**you**look™

DIGITAL CVT SERIES

INSTRUCTION MANUAL

TELEDYNE
HASTINGS INSTRUMENTS
Everywhere**you**look™

C E

ISO 9001
C E R T I F I E D

Manual Print History

The print history shown below lists the printing dates of all revisions and addenda created for this manual. The revision level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new revision is created, all addenda associated with the previous revision of the manual are incorporated into the new revision of the manual. Each new revision includes a revised copy of this print history page.

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Visit www.teledyne-hi.com for WEEE disposal guidance.

CAUTION: The instruments described in this manual are designed for INDOOR use only.

CAUTION: The instruments described in this manual are designed for Class 2 installations in accordance with IPC standards

Table of Contents

1. General Information

This manual contains technical and general information relating to the installation, operation, and calibration of Teledyne Hastings Vacuum Gauges, and Gauge Tubes.

For best performance, Hastings vacuum gauges should be operated with the appropriate Hastings gauge tube. Attempting to use a Hastings vacuum gauge with other manufacturer's tubes may result in damage to both the gauge and tube.

1.1. FEATURES

The Teledyne Hastings Instrument's Digital CVT, is a digital readout version of the successful CVT-Series "Hastings Gauge" which has generated loyal customers for over 50 years. A reputation has been built on exceptional stability, accuracy, and reliability. This instrument has been designed for laboratory or light industrial applications. It is not suitable for outdoor or heavy industrial areas where spraying liquid or wash-downs may occur.

A precision A/D converter, with a microprocessor is used to measure the gauge tube's signal output; it converts the measurement to a pressure reading using the gauge tube's well defined output/pressure function, and then displays the result. A 0 – 1 volt amplified non-linear gauge tube output version along with 0-1volt, 0-5volt, 0-10volt, 0-20mA, and 4-20mA linear gauge tube output versions are available on the back panel. The current pressure reading can also be acquired digitally through the standard RS232 port. The dual control points are durable 10 amp single pole double throw relays which can be configured normally open or normally closed.

The Digital CVT Vacuum Gauge Meter is available for Teledyne Hastings Instruments most popular gauge tube families: DV-4, DV-5, and DV-6. The DV-4 range is 0.2-20 Torr. The DV-5 range is 0.1 – 100 m Torr. The DV-6 & DV-33 range is 1-999 mTorr. All VT-Series Vacuum Gauges feature long life and minimal maintenance.

These instruments utilize Teledyne Hastings rugged noble metal thermocouple gauge tubes that are designed specifically for each range.

Tubes are matched and interchangeable without calibration adjustments. They are compensated for temperature, rate of temperature change and are corrosion resistant.

1.2. SPECIFICATIONS

DIGITAL CVT VACUUM METER:

ACCURACY .... DV4, 0.02 – 20 Torr, ± (20% of Reading + 0.01 Torr)

.... DV5, 0.1 – 100 mTorr, ± (20% of reading + 0.2 mTorr)

.... DV6, 0.001 – 1.0 Torr, ± (15% of Reading + 0.001 Torr)

.... DV33, 0.001 – 1.0 Torr, ± (15% of Reading + 0.001 Torr)

INPUT POWER .... 90-250 volts AC, 5 Watts

Optionally 24 VDC, 5 Watts

CABLES (Approx.) .... 6-ft. power cable and 8-ft. sensor cable included

PRESSURE UNITS .... Torr/DV-4, mTorr/DV-5, m Torr/DV-6 standard

.... Optionally mbar, Pascal

WEIGHT (Approx.) .... 0.7 lb (0.3 kg)

OPERATING TEMPERATURE RANGE .... -20°C to 70°C

RELAYS .... Max Switching Voltage 250 VAC, 100 VDC

.... Max Switching Current 10 Amps (AC), 5 Amps (DC)

.... Min DC switching 5 VDC/100 mA

NON-LINEAR ANALOG OUTPUT .... 0-1 VDC

LINEAR ANALOG OUTPUT .... 0-1, 0-5, 0-10, VDC and 0-20mA, 4-20mA

DIGITAL OUTPUT .... RS232 (9600 / 19.2k baud) (6 pin modular connector)

AC TUBE DRIVE .... 0.3 – 0.4 VAC, true RMS, 1 kHz square wave

(Compatible with DV-4, DV-5, and DV-6 tubes)

TUBE SIGNAL .... 0 – 10 mVDC, (compatible with DV-4, DV-5, and DV-6 tubes)

AC CONNECTION IEC-320

ANALOG OUT, TUBE DRIVE, TUBE INPUT, RELAY CONNECTIONS, 24 VDC .... 12 pin terminal block

SERIAL PORT .... 6 pin modular connector

CE STANDARD COMPLIANCE	
Test	Standard
SAFETY	EN61010
EMC/EMI Family	EN61326
CONDUCTED/RADIATED	EN55011
ESD	EN61000-4-2
RF	EN61000-4-3
FAST TRANSIENTS	EN61000-4-4
SURGE	EN61000-4-5
CONDUCTED IMMUNITY	EN61000-4-6
VOLTAGE DIPS	EN61000-4-11

1.3.SAFETY

The following symbols and terms may be found on THI products and/or in THI manuals and indicate important information.

⚠️ When found on the device, this symbol indicates that the operator should refer to the manual for important instructions on the proper use of this device. When found in a manual, this symbol indicates that the reader should understand the implications contained in the text before operating the device.

The WARNING label indicates important information that should be heeded for safe and proper performance of the device.

The label, CAUTION, is used to indicate that the damage to the power supply or equipment connected to it could occur if directions are not followed. Warranty could be invalidated if the instructions in this manual are not followed.

1.4.ACCESSORIES

1.4.1. INSTALLATION ACCESSORIES

Teledyne Hastings Instruments offers a complete line of system attachments that permit easy maintenance for contaminated operations. Gauge tubes are offered with various system fittings to match almost any system requirement. Additionally, Teledyne Hastings' complete line of quick disconnect attachments allows customers to install these special fittings and easily replace sensors without vacuum sealant or Teflon® tape. For particularly dirty systems, Teledyne Hastings offers a particle dropout trap containing a series of nine separate baffles which prevent solid contaminants from having a direct path to the sensor's thermopile.

1.4.2. CALIBRATION REFERENCE TUBES

Teledyne Hastings Instruments Reference Tubes employ the same Hastings metal thermopiles used in all Teledyne Hastings Vacuum Gauge Tubes. The thermopile is sealed in a glass capsule that has been evacuated, baked, out gassed, and then aged to ensure long-term stability. The sealed capsule is then housed in a protective metal shell to provide a rugged, trouble-free assembly.

Once assembled, the reference gauge tube is accurately calibrated to precisely simulate a gauge tube at a given operating pressure. It provides quick and easy instrument re-calibration by merely plugging the instrument and adjusting the zero potentiometer until the display reads the exact pressure noted on the reference tube.

Vacuum Gauge Tubes and Cables

Vacuum Gauge Tubes 20Torr Range

Stock #	Model #	Description
55-19	DV-4D	20 T Vac Gauge Tube (Purple Base)
55-19R	DV-4R	20 T Vac Gauge Tube/Rugged
55-258	DV-4D-KF-16	20 T Vac Gauge Tube/KF-16™
55-266	DV-4D-KF-25	20 T Vac Gauge Tube/KF-25™
55-227	DV-4D-VCR	20 T Vac Gauge Tube/VCR™
55-69	DV-34	20 T Vac Gauge Tube/316SS
55-101	DB-16D	Ref Tube (DV-4D) for VT-4 Calibration

Vacuum Gauge Tubes 100 mTorr Range

55-19	DV-5M	1/8" NPT (Red Base)
55-230	DV-5M -VCR	VCR™
55-103	DB-18	Ref Tube (DV-5M) for VT-5 calibration

Vacuum Gauge Tubes 1000 mTorr Range

55-38	DV-6M	1000 mTorr (Yellow Base)
55-38R	DV-6R	1000 mT Vac Gauge Tube/Rugged
55-38S	DV-6S	1000 mT Vac Gauge Tube/Rugged w/ protective cup
55-139	DV-20	1000 mT Vac Gauge Tube/Glass
55-251	DV-6-KF-16	1000 mT Vac Gauge Tube/KF-16™
55-267	DV-6-KF-25	1000 mT Vac Gauge Tube/KF-25™
55-283	DV-6-VCR	1000 mT Vac Gauge Tube/VCR™
55-38R-CF	DV-6R-CF	1000 mT Vac Gauge Tube/Mini Conflat™
55-66	DV-36	1000 mT Vac Gauge Tube/316SS
55-104	DB-20	Ref Tube (DV-6) for VT-6 Calibration

Digital CVT Cables

CB-DCVT-8	Cable, Digital CVT,8' (std)
CB-DCVT-25	Cable, Digital CVT,25'
CB-DCVT-50	Cable, Digital CVT,50'
CB-DCVT-100	Cable, Digital CVT,100
CB-DCVT-XXX	Cable, Digital CVT,SPCL'

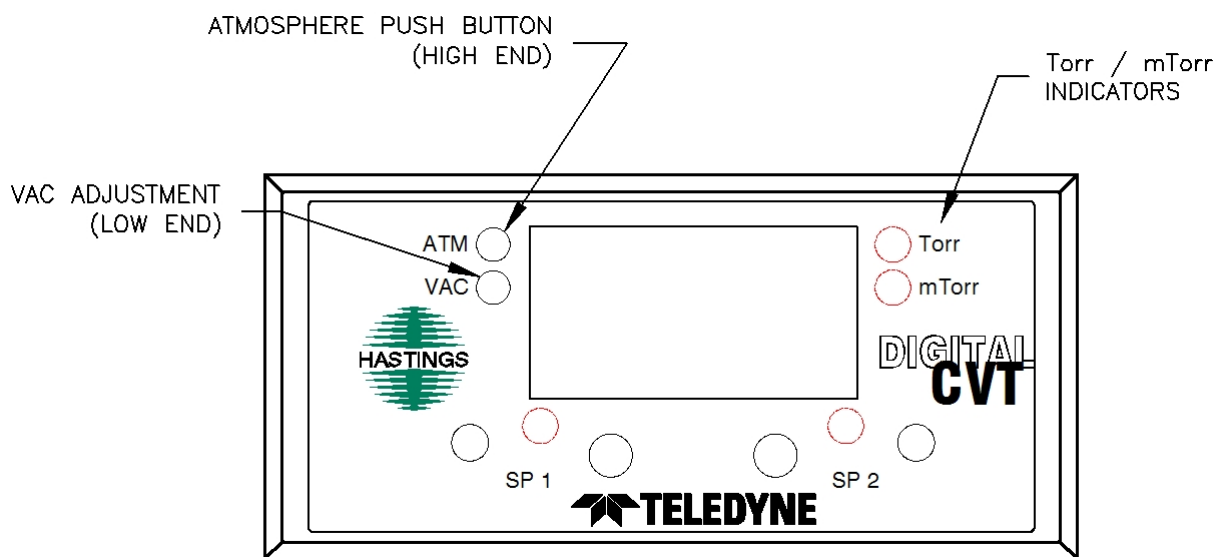## Extension Cables for VT Series (DVT & DCVT)

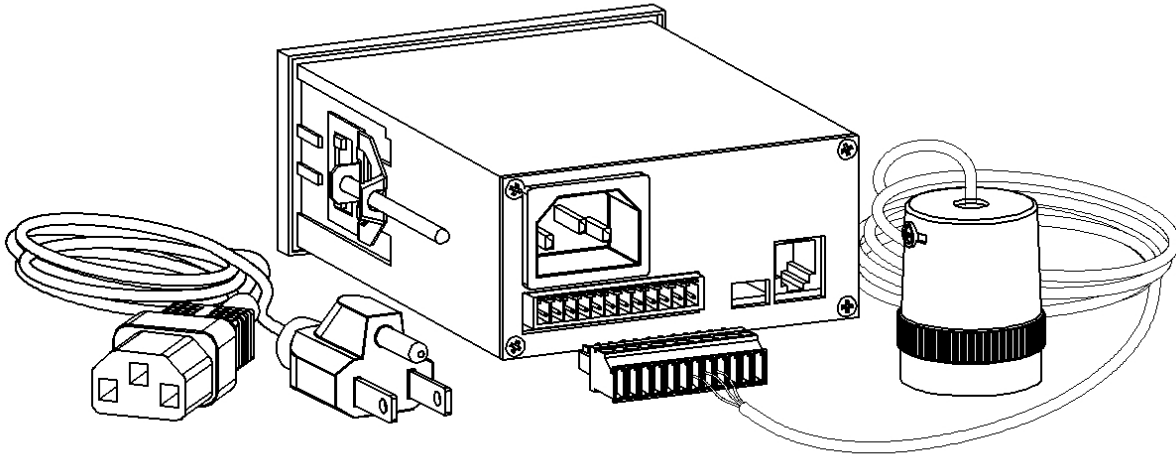|		
55-3	OM-8-OFV	8 Ft Extension Cable
55-22	OM-12-OFV	12 Ft Extension Cable
65-53	OM-25-OFV	25 Ft Extension Cable
65-102	OM-50-OFV	50 Ft Extension Cable
55-142	OM-100-OFV	100 Ft Extension Cable

2. Installation

2.1. DIGITAL CVT, OUTLINE DIMENSIONS
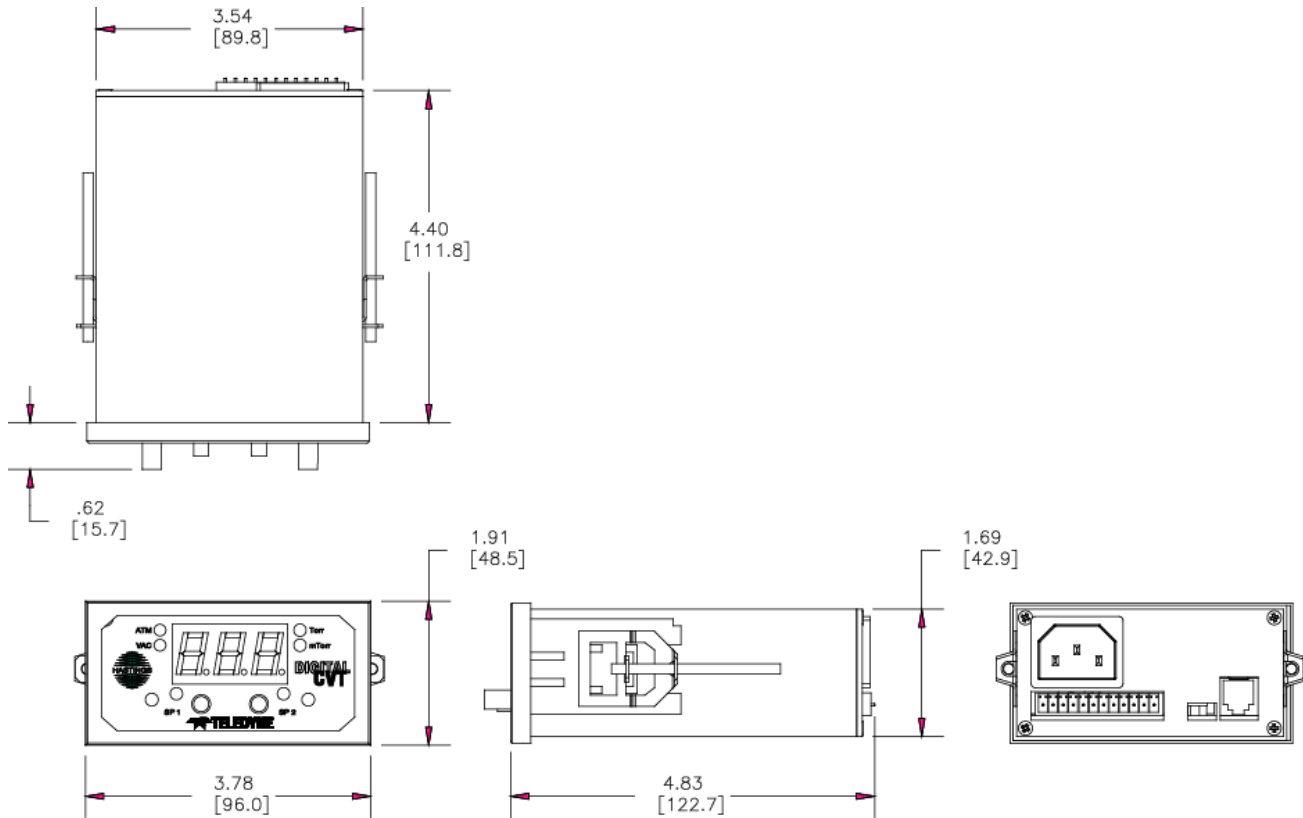
## 2.2. DIGITAL CVT, FRONT PANEL

## 2.3.DIGITAL CVT, BACK PANEL

2.4.PANEL MOUNTING

Shut-off power to the panel. Install the Digital CVT through the panel cutout as shown in the illustration below. Attach brackets to the side of the case and tighten until the front of the case is snug against the instrument panel. Use the power cord supplied with the unit and follow local codes when connecting power source to the unit.
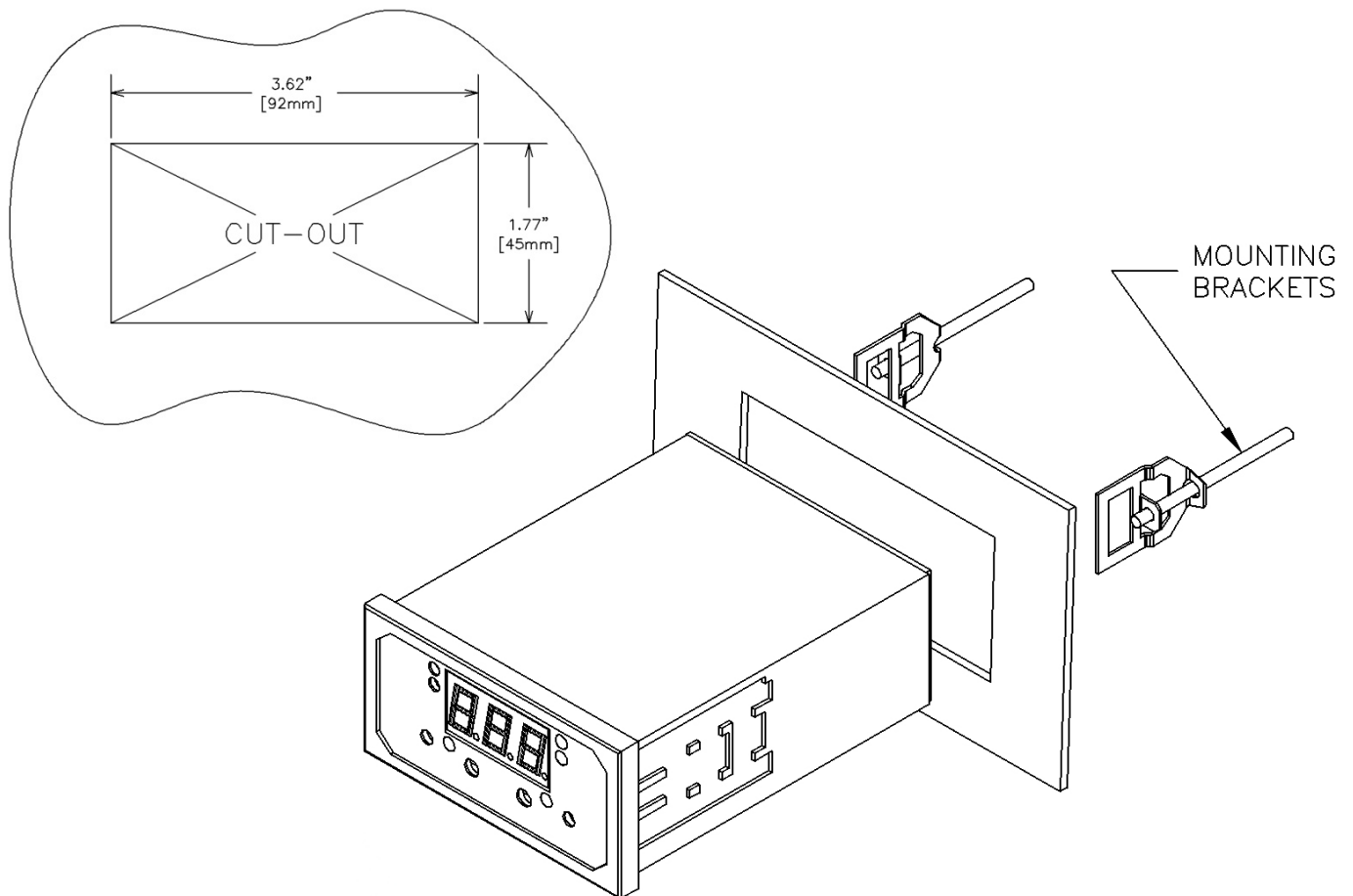
2.5.DIGITAL CVT-33D, OUTLINE DIMENSIONS
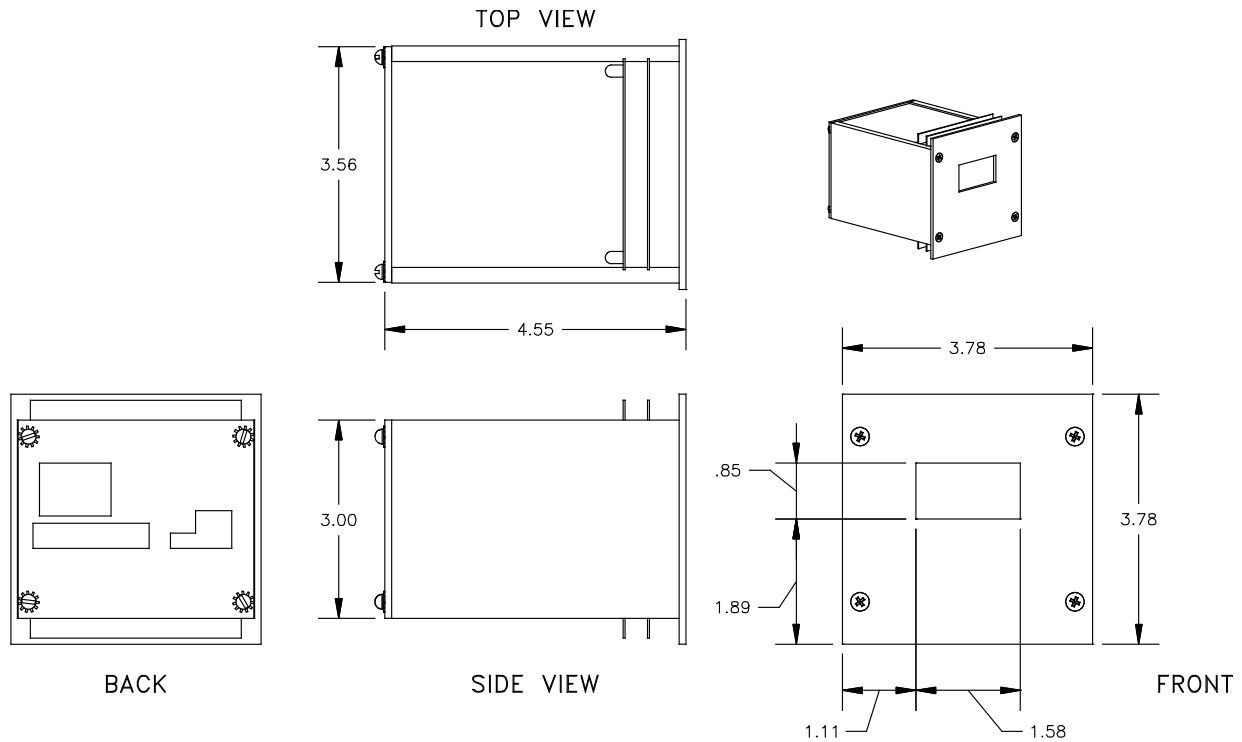
2.6.TERMINAL BLOCK

Terminal Block

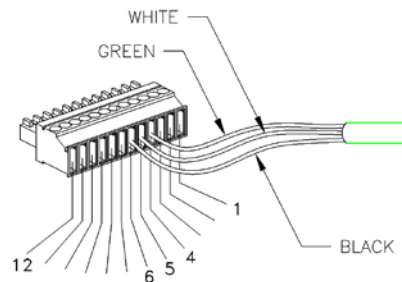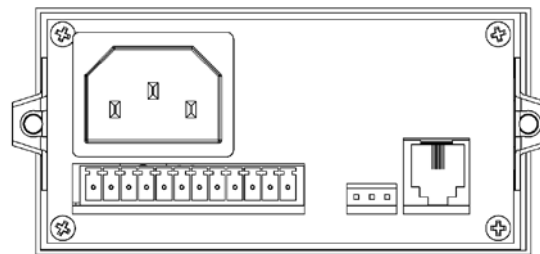| Pin#	Description
1	Analog Out
2	Common
3	24 VDC
4	Tube – Green
5	Tube – White
6	Tube – Black
7	Relay1 – NC
8	Relay1 – Common
9	Relay1 – NO
10	Relay2 – NC
11	Relay2 – Common
12	Relay2 - NO
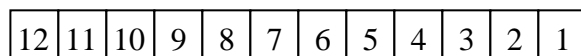
Figure 1

2.7. RELAY CONNECTION

There are two relays installed in the Digital CVT. Each relay can be set to trigger independently. Both relays are setup to be de-energized at high pressure and to energize when the indicated pressure is below the setpoint. Normally-open (NO), common and normally-closed (NC) terminals are available for each relay on the rear terminal block. The normally-open contact for Relay1 (terminal 9) will connect to the common terminal for Relay1 (terminal 8) when the indicated pressure is less than the setpoint. The normally-closed contact for Relay1 (terminal 7) will be connected to the common terminal for Relay1 whenever the pressure is greater than the setpoint or when power is lost. The contacts for Relay2 operate similarly.

These connections can be used to start/stop pumps, ion gauges or to open/close system valves at selected pressures. The specifications for the switching capability can be found in Specifications section of this manual.

2.8. DIGITAL CONNECTION

The Digital CVT uses an RJ12 modular connector (6P6C).

See the table below for the standard pin-out:

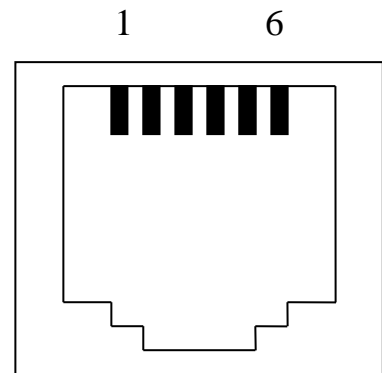| Pin#	RS232
1	
2	TX
3	Ground
4	Ground
5	RX
6	

Figure 2

The pins are numbered looking into the female connector with the pins on the top from left to right. Note that the TX pin is defined as signals being transmitted from the Digital CVT to the bus master while the RX pin is defined as signals being received by the Digital CVT Series from the buss master.

Teledyne Hastings offers a preassembled cable that will interface between a Digital CVT and a standard 9 pin computer serial port (#CB-RS232-RJ12). If making up a cable to interface to the standard PC 9 pin serial port use the following connections:

RJ12	D9 Female
NC	1
2	2
5	3
NC	4
4	5
NC	6
NC	7
NC	8
NC	9

The default port set-up is 19.2K baud, 8 data bits, no parity, and no flow control. If the instrument receives a Ctrl-Z (hex 1A, decimal 26) character it will automatically set itself to the baud rate of the port. The <ctrl-z> is entered by holding down the "Ctrl" key while pressing the "z" key when using terminal emulator program.

2.9. ANALOG OUTPUT CONNECTION

The Digital CVT may be configured to have one of several types of analog outputs available on pins 1 and 2 of the terminal block. One type is a 0 – 1 volt signal, which is equal to an amplified tube millivolt

signal. This signal will NOT be linearly proportional to the indicated pressure. 1 volt will correspond to a system pressure that is less than 1 mTorr. Increasing pressure will be indicated by a decreasing voltage. The load resistance connected to these terminals must be kept above 2 K ohms. See Section 3.11 "ANALOG OUTPUT INTERPRETATION" for more information.

The Digital CVT can also be configured for one of the following linear analog outputs: 0-1v, 0-5v, 0-10v, 0-20mA and 4-20mA. See Sections 3.6, 3.10 and 3.14.4. These voltage and current outputs will increase linearly with increasing system pressure.

The current loop output is useful for remote applications where pickup noise could substantially affect the stability of the voltage output or long cable runs where cable resistance would cause a voltage signal to decay. The current loop signal replaces the voltage output on pin 1 of the terminal block. The current loop is sourced internally and must be returned to common on pin 2 after passing through the monitoring circuitry to complete the loop. The load must be between 0 and 1200 Ohm.

If the instrument is being powered through the 24 VDC pin on the rear terminal board instead of with AC power, the analog output may have an offset of 63 millivolts due to the voltage drop created by the supply current.

CURRENT LOOP WIRING
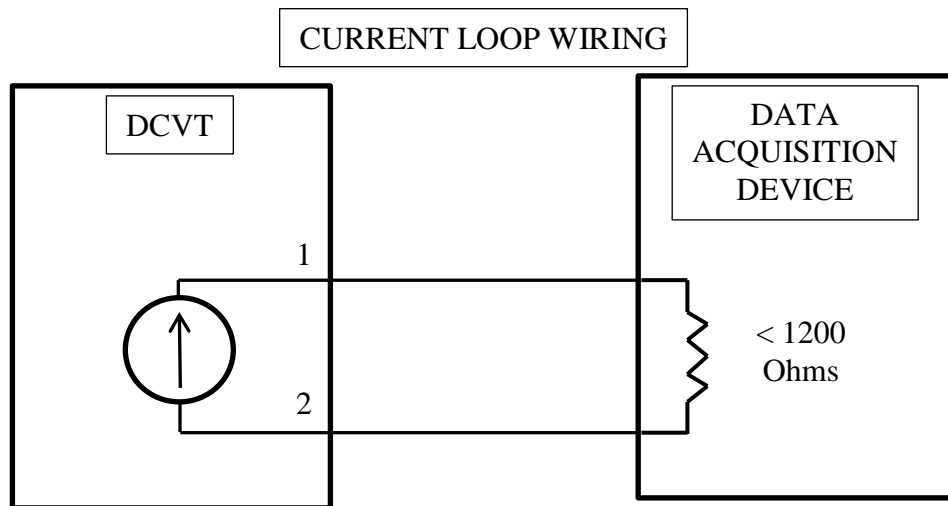
3.Vacuum Gauge Operation

All Teledyne Hastings gauge tubes are shipped with a protective cap or cover at the evacuation port to reduce contamination and prevent damage to the internal thermopile elements. Once the protective cap or cover is removed, a tube can be installed in any convenient position in the vacuum system without adversely affecting calibration or performance. The recommended orientation is with the tube vertical and its stem down. This will aide in preventing condensable materials from remaining in the gauge tube.

3.1.AC INPUT POWER

⚠️ The Digital CVT Power Supply input is rated as consuming 0.05 Amps @ 120VAC (< 0.12 Amps at 90 VAC).

The Digital CVT uses an IEC-320 power cable. To operate the Digital CVT, plug the power cable into the connector located in the rear of the Digital CVT. Connect the plug of the power supply into a single phase 90 - 250 VAC. 50/60 Hz power source

3.2.QUICK START

1. Shut-off power to the instrument panel

2. If desired, install the Digital CVT into the instrument panel as detailed in section 2.4.

3. Plug the Gauge Tube Cable into the connector on the rear panel of the Digital CVT.

4. Connect the Octal Socket cable assembly that is attached to the rear of the Digital CVT to a DV4, DV5 or DV6 gauge tube.

5. Plug Digital CVT power cable into a 90 - 250 VAC. 50/60 Hz outlet source. Energize the instrument panel.

6. The CPU will do a self check/initialization. The digital display should count up and stop momentarily at FFF. (Note: If the digital display shows a "- - -", this means the instrument is out of range or gauge tube is unplugged.)

7. The Torr and mTorr LED's should also momentarily illuminate.

8. After the CPU is operating, and the self-check/initialization is complete, the display will indicate the output of the DV4, DV5 or DV6 tube.

9. For a more accurate reading from the DV4, DV5 or DV6 tubes, refer to Section 3.7 and perform a calibration of unit.

3.3.PRESSURE MEASURMENT

Connect the gauge tube cable's octal socket onto the octal base of a gauge tube installed in vacuum system. The gauge will display the system pressure on the Digital CVT. To check the accuracy of the gauge, perform the required operations as specified in section 3.8.

3.4.OPERATION AND PERFORMANCE

The Digital CVT will be calibrated at the factory. Recalibration is not required. For maximum accuracy refer to section 3.8 "CALIBRATION PROCEDURE".

The simplest and quickest way of checking the operation and performance of a gauge and/or gauge tube, is to keep a new, or known-good gauge tube on hand for use as a Reference.

To check operation, install both a reference vacuum gauge and unit under test gauge tubes in a common vacuum system (locate the gauge tubes as close as possible to each other), then evacuate the system until a stable base pressure is obtained. Alternately connect the vacuum gauge to each gauge tube and

record its pressure readings. If the gauge tube-under-test produces a higher pressure reading than the Reference gauge tube then a calibration shift has occurred, usually as the result of contamination (particulate, oil, or other chemical deposits). You can try to restore calibration of the contaminated gauge tube by cleaning it internally with an appropriate solvent such as high-purity isopropyl alcohol (flood the interior cavity of gauge tube gently with solvent and allow it to stand and soak for about 15 to 30-minutes). Drain the contaminated solvent and let gauge tube dry in ambient air until all of the cleaning solvent has evaporated. To prevent mechanical damage to the thermopile elements, do not use forced air to dry the gauge tube. Gauge tubes that remain out of calibration after cleaning should be replaced.

3.5. GAUGE TUBE OPERATING PRINCIPLE

Operation of the Teledyne Hastings gauge tube is based on a low voltage AC bridge that heats a noble metal thermopile. A change in pressure in the gauge tube changes the molecular collision rate and therefore the thermal conduction of the gas or gas mixture surrounding the thermopile. This results in a temperature shift in the AC heated thermocouples A and B (Fig. 3). The resultant temperature shift causes a change in the DC output from couples A and B inversely with pressure changes. When installed, the DC thermocouple C is in series with the circuit load. Thermocouple C provides compensation for transient changes in ambient temperature.
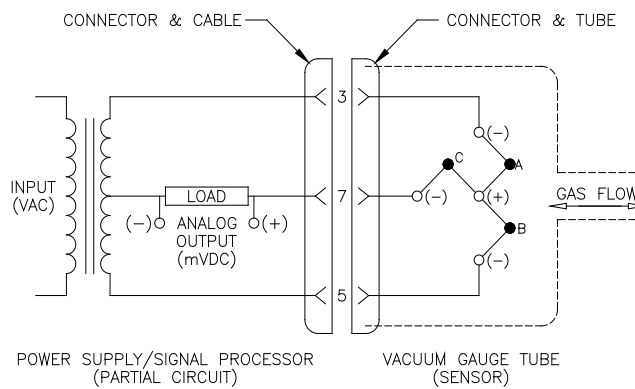

Figure 3

3.6. LINEAR OUTPUT SELECTION

The Digital CVT will be set for linear or non-linear analog output at the factory. The customer may change the Digital CVT unit from its current linear or non-linear configuration by rearranging the jumper settings of J24, located internally next to Pins 1 & 2 of the Terminal Block, to match Figure 4 for the desired analog output.
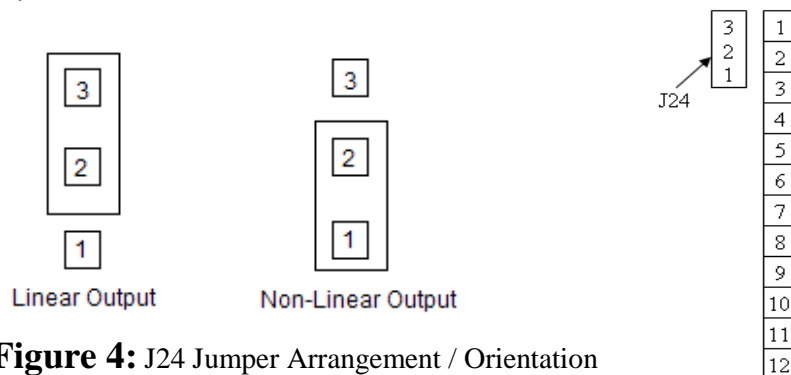

Figure 4: J24 Jumper Arrangement / Orientation

During linear output configuration, the customer may change the output voltage to 0-10v, 0-5v, 0-1v, 0-20ma, or 4-20ma linear full scale. Refer to sections 3.10 "LINEAR OUTPUT CALIBRATION" and 3.14.4 "LINEAR COMMANDS" for linear output calibration and commands.

3.7. TUBE SELECTION

The Digital CVT can be setup to operate with a Hastings DV4, DV5, DV6 or DV33D vacuum gauge tube. There is a jumper located on the rear panel, which will select the desired tube if using a DV4 or DV6 tube. This jumper has no effect if the instrument is configured for a DV5 or DV33D tube.

Normally the Digital CVT will arrive from the factory configured for the tube type specified by the customer order. However if the system pressure range changes, and a different tube type will now be used, the tube type can be changed by moving the jumper position. The tube calibration procedure in section 3.8 must be performed after changing the tube type.

Note: Complete removal of the jumper will be interpreted by the internal processor as the DV4 configuration. Both the Digital CVT-5 and Digital CVT-33 instruments will read properly in the DV-4 or DV-6 jumper configuration, therefore, no jumper arrangement is needed for the Digital CVT-5 or Digital CVT-33. Also, while in field, it is not possible to change a DV-4 or DV-6 to a DV-5.
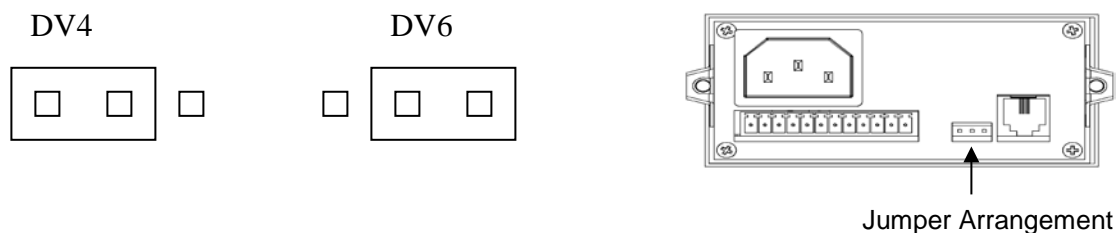

Figure 5: Rear Panel Jumper Arrangement

3.8. CALIBRATION PROCEDURE

3.8.1. PREPARATION

1. Plug in DV-4, DV-5, DV-6 or DV-33 gauge tube. Leave tube at atmospheric pressure.

2. Plug the Digital CVT power supply into an outlet providing 90 -250 VAC, 50/60 Hz.

3. CLEAR out any previously entered calibration data.

   a. Using a pointed object, such as a ballpoint pen, press and hold the "ATM" push button located on the front panel until "CLR" appears on the digital display. The "ATM" button must be held in the pressed position approximately 5 seconds before data is cleared and "CLR" is displayed.

4. Once "CLR" is displayed any previously entered data has been deleted.

3.8.2. SET HIGH END

NOTE: TUBE MUST BE AT ATMOSPHERE TO PROPERLY SET THE HIGH END.

A. Press "ATM" push button until "Set" appears. The high-end is now set.

3.8.3. SET LOW END WITH A VACUUM SYSTEM

NOTE: The LOW END can be adjusted by either bringing the system to a known vacuum or by using a TELEDYNE HASTINGS REFERENCE TUBE.

A. Set system to known vacuum.

B. Turn the "VAC" pot on the front panel until the known vacuum is displayed on the digital display. (IF KNOWN VACUUM IS BELOW 1 mTorr FOR DV-4 DV-6 AND DV-33 OR 0.1 mTorr, FOR DV-5, SET DISPLAY TO ZERO).

C. The low end is now adjusted.

3.8.4. **SET LOW END WITH A REFERENCE TUBE**

A. Connect a TELEDYNE HASTINGS reference tube.

B. Turn the "VAC" pot until the value printed on TELEDYNE HASTINGS reference tube is displayed on digital Display.

C. THE LOW END is now adjusted.

NOTE: If re-calibration is required you must first repeat step 3.8.2.

IF SEVERAL TUBES ARE TO BE READ AND RE-CALIBRATION FOR EACH TUBE IS NOT DESIRED, YOU MAY CLEAR THE CALIBRATION DATA (STEP 2) AND ONLY ADJUST THE LOW END SETTING ONCE. HOWEVER A LOSS OF ACCURACY WILL BE NOTICED ON THE HIGH END.

Note: The following table specifies the TELEDYNE HASTINGS reference tube to be used in the calibration of a gauge based upon the type of gauge tube being used.

Ref. Tube	Gauge Tube
DB-16D	DV-4
DB-18	DV-5
DB-20	DV-6

NOTE: ONCE CALIBRATION IS COMPLETE THE CALIBRATION DATA IS PERMANENTLY STORED IN NONVOLATILE MEMORY. A LOSS OF POWER WILL NOT ERASE THE CALIBRATION DATA.

3.9. **SET RELAY TRIGGER POINTS**

The Digital CVT provides 2 relays for process control. Each relay has a normally-open, a common and a normally-closed contact available through the terminal block on the rear of the instrument. The pin-out is shown in Figure 1 of section 2.7. Each relay operates independently from each other. Each relay will be energized whenever the pressure measured by the vacuum tube is less than the value that has been set for each relay. Upon loss of power the Digital CVT relays will indicate a high pressure condition.

There is a small amount of hysteresis present in the relay trigger point in order to prevent excessive relay switching if the system operating pressure is close to a setpoint. The relay will energize exactly on the setpoint but it will de-energize ≈ 1% of reading above the setpoint.

The relays can be read or changed by locally using front panel controls or remotely through the serial port. To view and change the set point for relay #1 using the front panel controls, press the switch next to the SP1 designator. The display will indicate the pressure value that is currently set on the potentiometer next to the SP1 designator (if the setpoint had been set remotely via the serial port the display will not indicate this remotely set value and the local value will now over-ride the previous value). While holding the switch, adjust the potentiometer knob until the desired pressure is indicated on the display. When the switch is released, this pressure value will be stored as the setpoint for relay #1 and the instrument will return to normal pressure indication.

Relay #2 can be set similarly using the controls next to the SP2 designator. While the instrument is in the setpoint adjust mode it cannot monitor the pressure at the vacuum tube and relays will not be set/reset if the pressure changes until the switch is released. The setpoints can be read and changed remotely through the serial port. **[Whenever the appropriate setpoint switch is pressed and released the current setpoint will be changed to the value currently set by the potentiometer regardless of the any changes made remotely.]** Rotating the potentiometer while the switch is not pressed will not affect the setpoint however the next time the switch is pressed the setpoint will change to the rotated value.

The relay switching can be prevented by setting the setpoint above or below the pressure range of the vacuum tube. Setting the setpoint to a negative value will keep the relay de-energized and setting the setpoint to high value will keep the relay energized at all times.

3.10. LINEAR OUTPUT CALIBRATION

The Digital CVT linear output voltage will be set and calibrated at the factory per the customer's requested configuration. However, the customer may change the output voltage to 0-1v, 0-5v, 0-10v, 0-20ma, or 4-20ma linear full scale.

Setup:

1. Connect the Digital CVT to HyperTerminal using the Teledyne Hastings preassembled RS232 cable that will interface between a Digital CVT and a standard 9 pin computer serial port (#CB-RS232-RJ12). Refer to section 2.8 "DIGITAL CONNECTION".

2. Ensure pins 2 & 3 of the analog output jumper J24 are as shown in Figure 4 located in section 3.6 for Linear Output.

3. Connect a multimeter to pins 1 & 2 of the Terminal Block of Figure 1 located in section 2.6 "TERMINAL BLOCK".

Note: Step 3 will allow the user to change the desired output voltage configuration and adjust the appropriate HyperTerminal command until the adequate full scale values have been reached.

Procedure: (Refer to section 3.14.4 "LINEAR COMMANDS")

1. Send the command via Hyper Terminal for the desired voltage full scale range. (Ex. D1 for 1 volt Range)

2. Set the Zero value first by sending the "DAZ" command, then "DZ" command to check the current value for zero. The user should see a value given in scientific notation.

3. Use the "DZ=" command to adjust the zero value until the multimeter displays "0.000v" for 1v, 10v, and 5v ranges, and "4mA" for 4-20ma. The zero adjustment value should be between "32000" and "33000".

4. Once the desired zero value is reached, use the "DZW" command to set this value.

5. Repeat procedures 1-4 to set the span value, using the respective span commands listed in section 3.14.4 "LINEAR COMMANDS".

Note: When adjusting the span value using the "DS=" command, the starting adjustment value should begin around "6000-7000" for 1v range, "32000-33000" for 10v and 5v ranges, and "22000-23000" for the 0-20ma and 4-20ma range.

3.11. ANALOG OUTPUT INTERPRETTION

3.11.1. NON-LINEAR ANALOG OUTPUT INTERPRETATION

The Digital CVT has a 0 – 1 volt analog output signal available on pins 1 and 2 of the terminal block. This signal is equal to an amplified tube millivolt signal. The following signal is NOT linearly proportional to the indicated pressure. 1 volt will correspond to a system pressure that is less than 1 mTorr. Increasing pressure will be indicated by a decreasing voltage.

The voltage signal can be mapped to a pressure value by using the following equation.
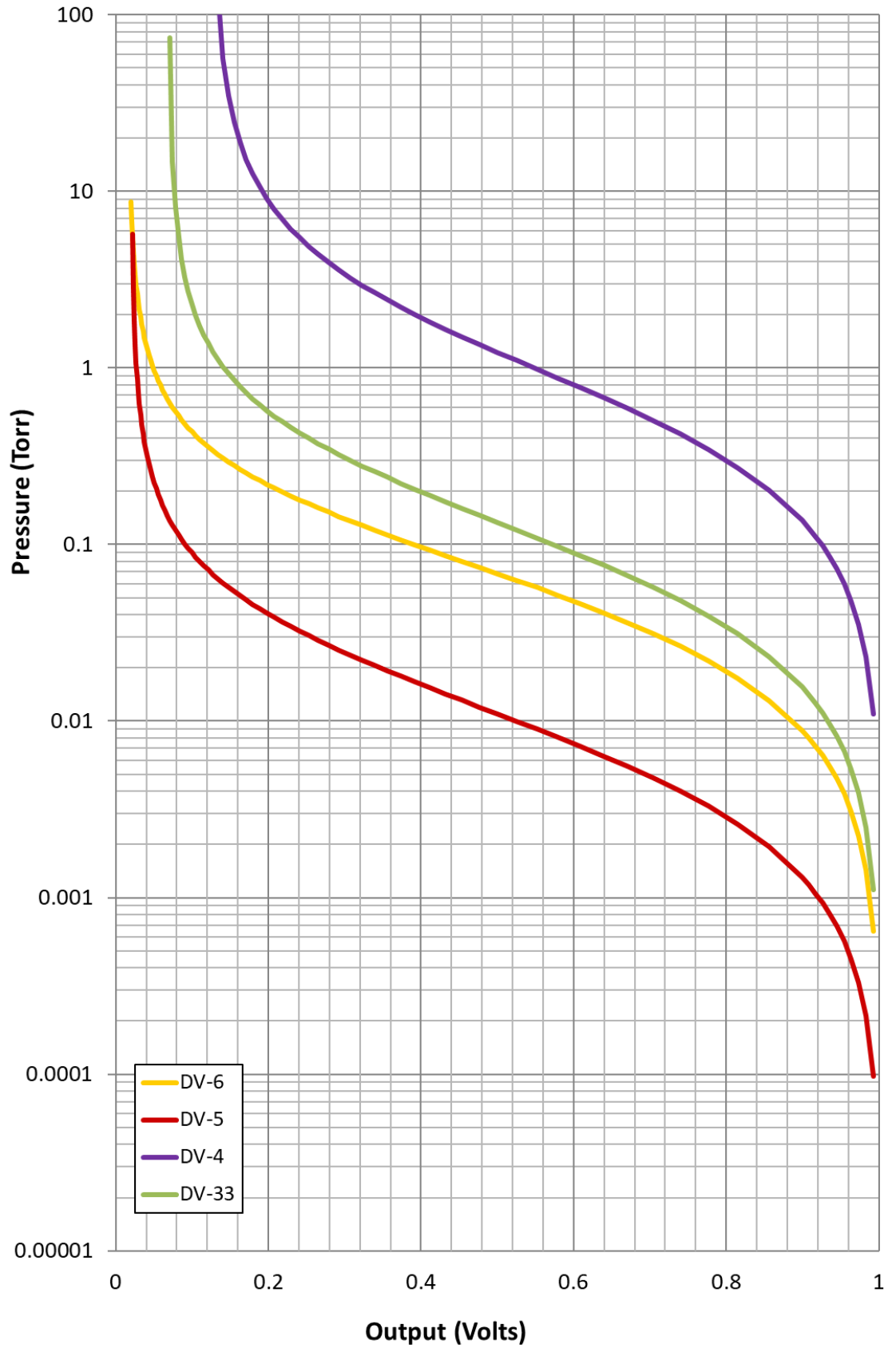
$$P = \frac{a + cV + eV^2}{1 + bV + dV^2}$$

Parameters	DV6	DV4	DV5	DV-33
a	-1623.22	-5.10184	-0.25948	-0.687519
b	-58.0442	-6.91233	-42.23869	-10.54539
c	-11732.2	-4.4943	-2.92598	-7.22733
d	-130.397	-6.30995	-256.9951	-52.55145
e	13338.17	9.563177	3.18016	7.905523

Where:

V = Voltage

P = pressure in Torr for DV4, DV-6 and DV-33, and in mTorr for DV6

Non-Linear Analog Output vs Pressure

3.11.2. **LINEAR ANALOG OUTPUT INTERPRETATION**

The Linear Digital CVT provides voltage span values of 0 – 1v, 0 – 5v, 0 – 10v, 0-20ma, and 4ma - 20ma. These analog output signals are available on pins 1 and 2 of the terminal block. This signal is equal to an amplified tube millivolt signal. The following signals are linearly proportional to their indicated voltages. Increasing pressure will be indicated by an increasing voltage.

The pressure value can be mapped to a voltage signal by using the following equation.
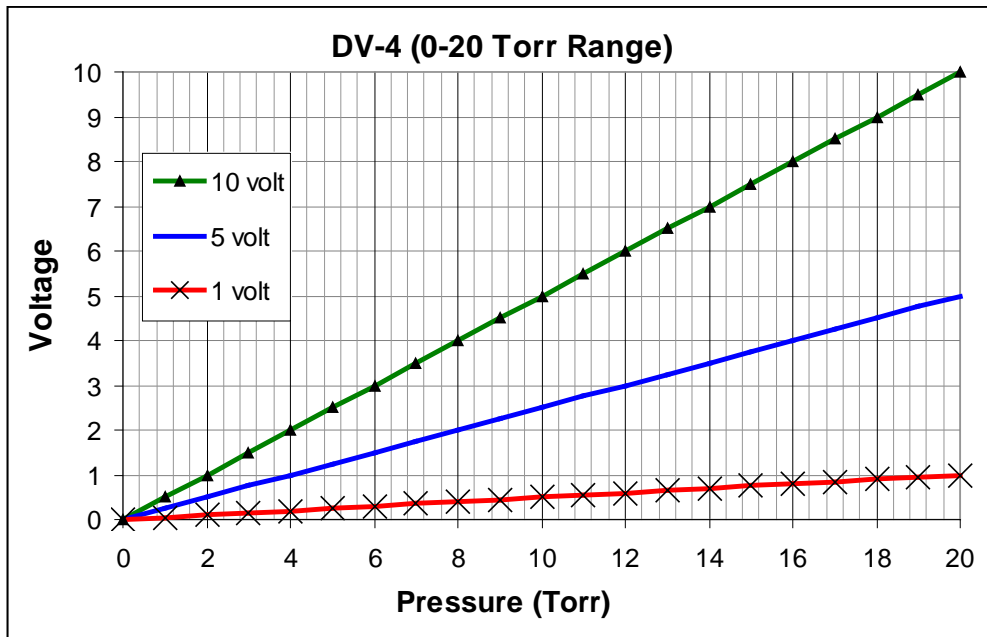
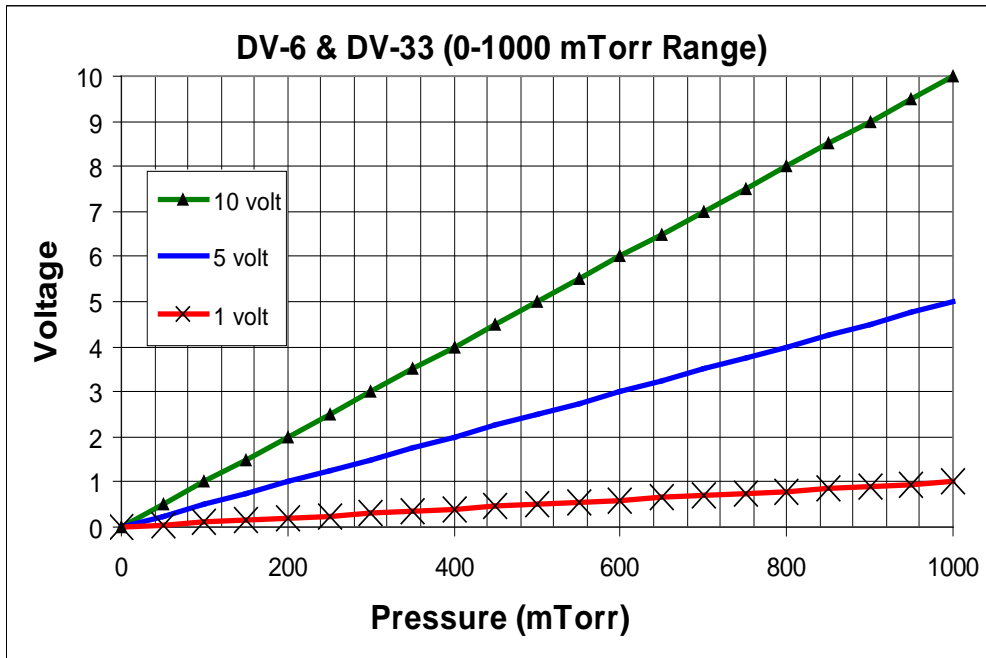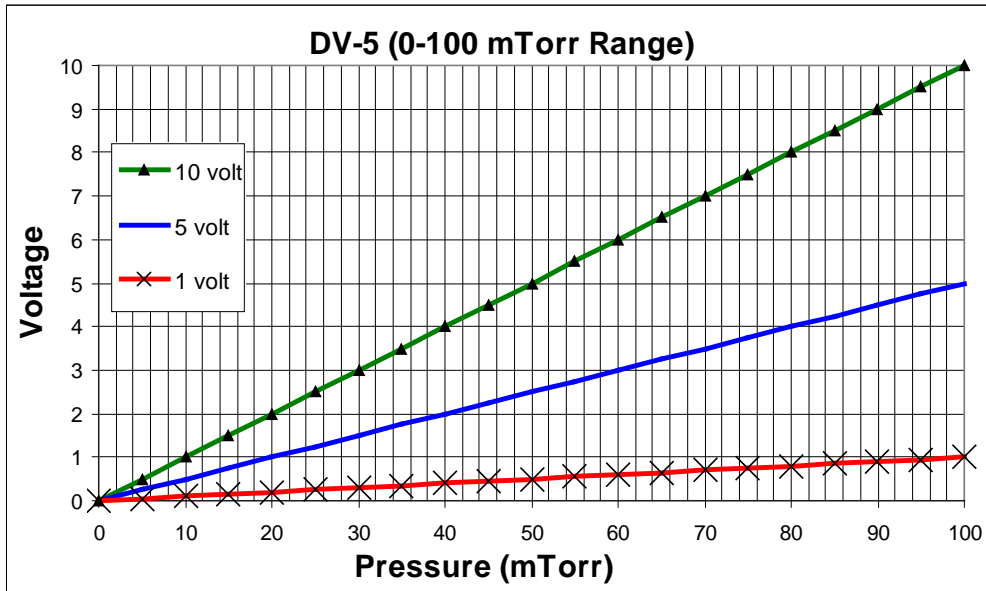$$V = \left(\frac{P}{Mp} \right) \times vsp$$

Where:

V = Voltage

P = pressure in Torr for DV-4, and in mTorr for DV-5, DV-6, and DV-33

Mp = Max pressure range (20 Torr, 100 mTorr, 1000 mTorr)

vsp = Voltage Span Value (example: 5 for 0-5v)

Note: The 4-20ma was calculated with the range of 0ma-16ma, and 4ma is added to the final value in order to obtain a 4-20ma range.

DV-4 (0-20 Torr Range)

DV-5 (0-100 mTorr Range)

Voltage vs Pressure (mTorr), with curves for 10 volt, 5 volt, and 1 volt.

DV-6 & DV-33 (0-1000 mTorr Range)

Voltage vs Pressure (mTorr), with curves for 10 volt, 5 volt, and 1 volt.

The 4-20ma value can be mapped to a milliamp signal by using the following equation.

$$I(mA) = \left(\left(\frac{P}{Mp} \right) \times vsp \right) + 4$$

DV-4 (4ma - 20ma & 0ma - 20ma)

DV-5 (4ma - 20ma & 0ma - 20ma)

DV-6 & DV-33 (4ma - 20ma & 0ma - 20ma)
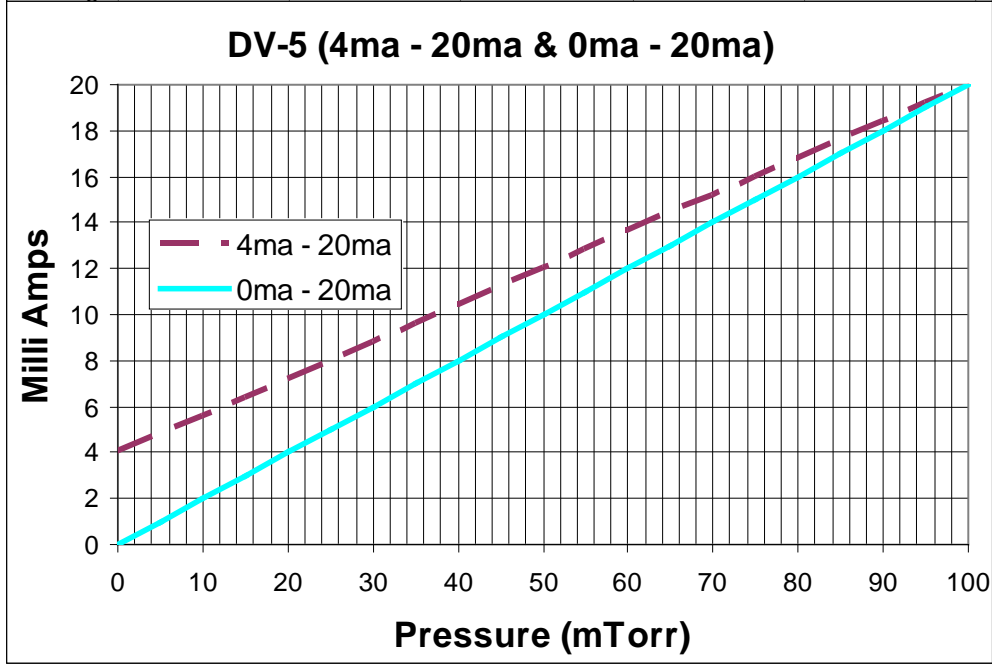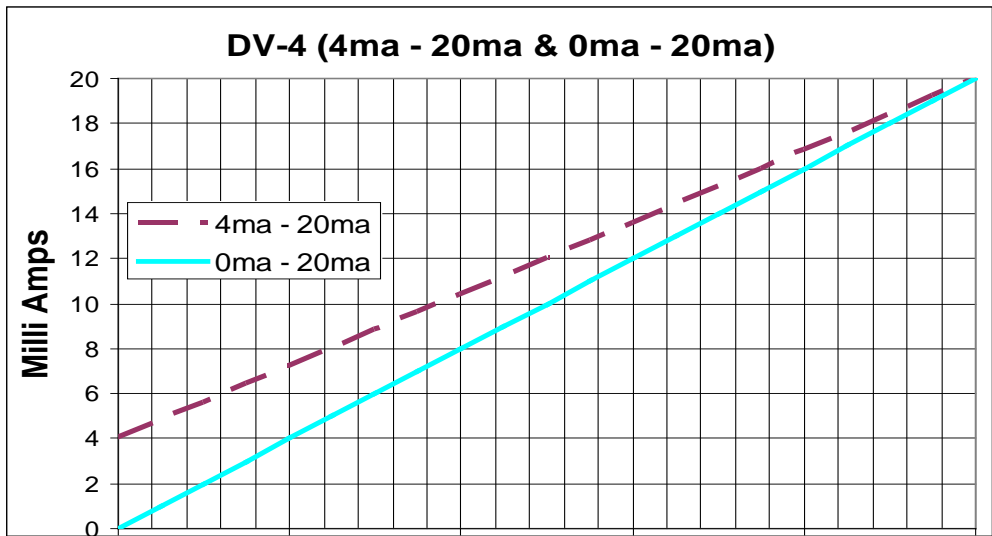
3.12. PRESSURE UNITS

The Digital CVT will arrive configured per customer order for one of these 3 possible pressure unit settings: Torr, mbar, Pascal. When setup at the factory the front panel overlay will indica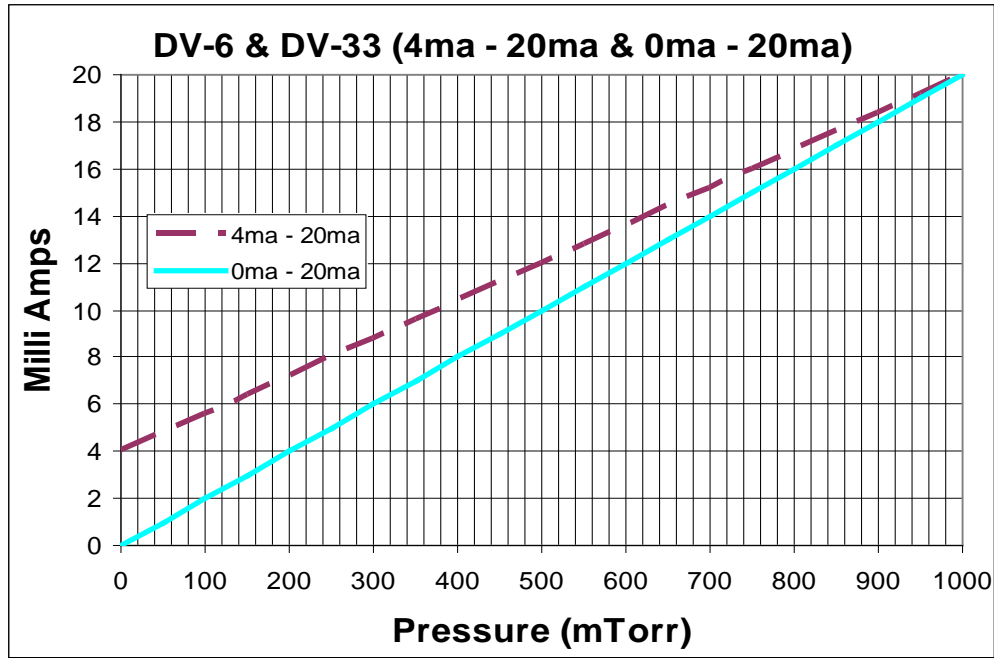te the proper units. However it can be changed in the field with a digital command over the serial interface. If changed in the field, the units shown on the overlay will not match the units of the displayed pressure. The pressure indication received serially will always report in the base of the selected units using scientific notation.

Since the DV4, DV5, and DV6 tube have a different pressure range, a different multiplier of each pressure unit is required to be able to display both tube types on the same 3 digit display. The top LED will light when in the DV4 mode and it will indicate that the larger version of the base pressure unit is active. When a DV-5 or DV-6 tube is being used, the bottom LED will light and indicate that the smaller version of the pressure unit is presently active as shown in the table below.

Instrument	Pressure Units	Base Multiplier	RS232
DV4	Torr	1	U1
	hPascal	100	
	mbar	1	
DV5	Torr	0.001	U2
	hPascal	0.1	
	mbar	0.001	
DV6	Torr	0.001	U3
	hPascal	0.1	
	mbar	0.001	

To convert the value given by the LED display to the given base unit, multiply the displayed value by the appropriate base multiplier. As an example, if a DCVT-6 version of a Digital CVT is configured for Pascal and is displaying 543 then the current pressure is 543 x 0.1 = 54.3 Pascal. In this case the serial port would report the pressure as "Pa: 5.43000e+1 Pascal<CR>".

If a DCVT-6 is configured for mbar and is displaying 543, the current pressure is 543 x 0.001 = 0.543 mbar. In this case, the serial port would report the pressure as "Pa: 5.43000e-1 mbar<CR>". To convert mbar to bar multiply by 0.001. (Ex. 0.543 x 0.001 = 0.000543 bar)

3.13. THERMAL COEFFICIENT

The Digital CVT generates an AC heating voltage using an internal transformer. This heating voltage is supplied to the vacuum tube to warm up the thermocouples in order to measure the pressure.   As the ambient temperature increases or decreases, the internal resistance of the copper winding in the transformer also changes. This resistance change will change the AC heating voltage that the vacuum tube receives. It will also change the pressure reading slightly. The typical rate of change for both tube types is given below:

DV6   0.06 mTorr/°C + 0.09% of reading/°C

DV4   0.9 mTorr/°C + 0.03% of reading/°C

Increasing the temperature will cause the pressure readings to increase, while decreasing temperature will cause the pressure readings to decrease. The instruments are initially adjusted at an ambient temperature of approximately 22°C. This effect can be corrected by adjusting the low pressure reading at the operating ambient temperature. The specified rate of change does not include any changes due to thermal effects on the vacuum tube or actual changes in pressure that occur in a vacuum system during temperature excursions.

3.14. DIGITAL COMMUNICATIONS

Communication with the serial interface of the Digital CVT is via an ASCII data string. The command message consists only of a command string and the terminator. If all components of the ASCII data string are valid, the command will be accepted and executed.

3.14.1. COMMAND SYNTAX

In the following examples of syntax codes, the special characters are explained:

The characters in square brackets [ ] represent a command string, either upper or lower case command characters accepted. All characters must follow each other in the string with no spaces or other characters.

The characters within wavy brackets { } contain choices for the appropriate command.

The characters within the symbols < > are the common abbreviations for the one digit ASCII control codes which they represent, (e.g. <CR> represents carriage return).

When entering more than one command in the same data string, they must be separated by a comma.

All command strings must be followed by the terminator character (carriage return <CR>, also known as ENTER).

When a lower case character is present in an example it represents an option.

Character	Description	Valid Inputs:
m	Most Significant Digit of Mantissa	1 - 9
d	Decimal Digit	0 - 9
e	Exponent	0 - 5

| | <CR> | Command Terminator (carriage return) | N/A |

3.14.2. INTERROGATION COMMANDS

Command Description	Format	Sample Response
Get Current Pressure	P<CR>	Pa: 1.23456e+0 Torr<CR>
Get Output Voltage	U<CR>	Vavg: 1.23456e-1 Volts<CR>
Get Relay #1 Setpoint	S1<CR>	SP1: 1.0240e-2 mbar<CR>
Get Relay #1 Setpoint	S2<CR>	SP2: 4.3639e-2 Pascal<CR>
Get Relay Status	RS<CR>	0,R1:OFF,R2:OFF<CR>
Get Device ID	ID<CR>	Digital CVT<CR>
Get Sensor Type	ST<CR>	DV-6<CR>
Get Software Version #	V<CR>	Digital CVT 1.1.0 <CR>
Get Serial Number	SN<CR>	1023400012<CR>
Get User Data	UD<CR>	Text String<CR>

3.14.3. PARAMETER MODIFICATION COMMANDS

Command Description	Format	Valid Range:
Set unit to Torr	U1<CR>	All subsequent values in Torr
Set unit to Pascal	U2<CR>	All subsequent values in Pascal
Set unit to Mbar	U3<CR>	All subsequent values in mbar
Modify User Data	UD=Text String<CR>	10 character maximum
Modify Relay#1 Setpoint	S1= {m.dd} E {+e} <CR>	1.00000e-9 to 9.99999e+9
Modify Relay#2 Setpoint	S2 {m.dd} E {-e} <CR>	1.00000e-9 to 9.99999e+9

Notes:

The "User Data" is a 10 digit text area reserved for the use by the customer for identification purposes. For example, "User Data" could be set to reply "Foreline #1".

The setpoints may also be entered as a decimal number, e.g. [S1=0.760<CR>] will be same as entering [H=7.60E-1<CR>].

When inputting setpoint data, it should be entered in the same Units of Pressure as the presently selected Units of Measurement (i.e. Torr, mbar or Pascal). The data is only checked to be a valid number with a one digit exponent before being accepted. There are no limit checks on the data; the user is free to choose any value appropriate to his use of the instrument.

If the command syntax is not met or if the number is out or range, the Digital CVT will respond with the ASCII codes for <bell>?<CR>, and the command will be ignored.

3.14.4. LINEAR COMMANDS

After switching to linear output operation, some instrument calibration may be required. Refer to section 3.10 "LINEAR OUTPUT CALIBRATION" for calibration setup and procedure.

Command Description	Command	Notes:
1 Volt Range	D1	Selects 1 Volt DAC Range
5 Volt Range	D5	Selects +/-5 Volt DAC Range
10 Volt Range	D10	Selects +/-10 Volt DAC Range
0-20 mA Range	D0	Selects 0-20 mA DAC Range
4-20 mA Range	D4	Selects 4-20 mA DAC Range
Read Zero Value	DZ	Read the DAC Zero Value
Set Zero Value	DZ=	Set the DAC Zero Value
Store Zero Value	DZW	Store the DAC Zero Value
Read Span Value	DS	Read the DAC Span Value
Set Span Value	DS=	Set the DAC Span Value
Store Span Value	DSW	Store the DAC Span Value
Output Zero Value to DAC	DAZ	Output Zero Value to DAC
Output Span Value to DAC	DAS	Output Span Value to DAC
Output Pressure Value to DAC	DAP	Output Pressure Value to DAC

3.14.5. LINEAR STATUS OUTPUT

The Digital CVT will arrive configured per customer order for one of the 5 possible linear output ranges: 0-1v, 0-5v, 0-10v, 0-20ma, or 4-20ma. The "ST" command provides the customer the ability to view the currently selected DV-Tube and linear output range. The following table provides the RS232 communication output of each DV-Tube and linear output.

Refer to section 3.14.2 "INTEROGATION COMMANDS" for general "ST" command description, format, and sample response.

Instrument	Linear Output	"ST" Command Response
DV-x	0-1Volt	DV-x 0-1Volt
	0-5Volt	DV-x 0-5Volt
	0-10Volt	DV-x 0-10Volt
	0-20ma	DV-x 0-20 mA
	4-20ma	DV-x 4-20 mA

Where x = 4, 5, 6 or 33 depending upon DV-Tube being used.

Note: When the Digital CVT unit is set to non-linear configuration per Figure 4 in section 3.6 "LINEAR OUTPUT SELECTION", only the DV-Tube type (DV-x) of the "ST" command response is valid.

3.14.6. RESET / INITIALIZE COMMANDS

Command Description	Format	Notes:
Software Reset	/<CR>	Reset instrument
Autobaud	<ctrl-z><CR>	Match baud rate currently in use

The <ctrl-z> is entered by holding down the "Ctrl" key while pressing the "z" key when using terminal emulator program. This character has an ASCII code of 26 (decimal) and 1A (hexadecimal).

3.14.7. DEVICE STATUS

When requested to transmit the relay status, the Digital CVT responds with a 3 part text string which is explained in the following:

0, R1: OFF, R2: OFF
1st part (before 1st comma) binary representation of the state of both relays
0 = 0 + 0 = both relays off

1 = 0 + 1 = relay 2 – off, relay 1 – on

2 = 2 + 0 = relay 2 – on, relay 1 – off

3 = 2 + 1 = both relays on

2nd part and 3rd part describe textually the status of each relay.
R1: OFF = Relay 1 is de-energized; pressure is above the setpoint for Relay1.

R1: ON = Relay 1 is energized; pressure is below the setpoint for Relay1.

R2: OFF = Relay 2 is de-energized; pressure is above the setpoint for Relay2.

R2: ON = Relay 2 is energized; pressure is below the setpoint for Relay2.

4. Warranty and Repair

4.1. WARRANTY REPAIR POLICY

Teledyne Hastings Instruments warrants this product for a period of one year from the date of shipment to be free from defects in material and workmanship. This warranty does not apply to defects or failures resulting from unauthorized modification, misuse or mishandling of the product. This warranty does not apply to batteries or other expendable parts, nor to damage caused by leaking batteries or any similar occurrence. This warranty does not apply to any instrument which has had a tamper seal removed or broken.

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty as to fitness for a particular use. Teledyne Hastings Instruments shall not be liable for any indirect or consequential damages.

Teledyne Hastings Instruments, will, at its option, repair, replace or refund the selling price of the product if Teledyne Hastings Instruments determines, in good faith, that it is defective in materials or workmanship during the warranty period. Defective instruments should be returned to Teledyne Hastings Instruments, **shipment prepaid**, together with a written statement of the problem and a Return Material Authorization (RMA) number. Please consult the factory for your RMA number before returning any product for repair. Collect freight will not be accepted.

4.2. NON-WARRANTY REPAIR POLICY

Any product returned for a non-warranty repair must be accompanied by a purchase order, RMA form and a written description of the problem with the instrument. If the repair cost is higher, you will be contacted for authorization before we proceed with any repairs. If you then choose not to have the product repaired, a minimum will be charged to cover the processing and inspection. Please consult the factory for your RMA number before returning any product repair.

TELEDYNE HASTINGS INSTRUMENTS

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ATTENTION: REPAIR DEPARTMENT

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INTERNET ADDRESS	http://www.teledyne-hi.com/

Repair Forms may be obtained from the "Information Request" section of the Teledyne Hastings Instruments web site.