



**TELEDYNE HASTINGS INSTRUMENTS**  
Everywhereyoulook™

# ***HVG-2020B***

## INSTRUCTION MANUAL



**TELEDYNE**  
HASTINGS INSTRUMENTS  
Everywhereyoulook™

**ISO 9001**

C E R T I F I E D

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# Manual Print History

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Visit [www.teledyne-hi.com](http://www.teledyne-hi.com) for WEEE disposal guidance.

## Description of Symbols and Messages used in this manual



**WARNING:** indicates a hazardous situation, which, if not avoided, could result in death or serious injury. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood.



**CAUTION:** indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.



**NOTICE:** calls attention to a procedure or practice that if not correctly performed or adhered to, could result in equipment damage, loss of data, or inaccurate data.



**NOTE:** is used for tips and other digressions.

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Hastings Instruments reserves the right to change or modify the design of its equipment without any obligation to provide notification of change or intent to change.

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# 1. General Information

The HVG-2020B is a small, low-cost electronics module which combines the outputs of a Pirani sensor and a piezo-resistive sensor to provide the user with accurate vacuum measurements over the range of  $1 \times 10^{-4}$  Torr to 1000 Torr. The piezo-resistive sensor produces an absolute pressure signal output that is proportional to pressure and independent of gas composition. The hot-wire Pirani sensor produces an absolute pressure signal dependent on the thermal conductivity of the surrounding gas remaining in the vacuum system.

The HVG-2020B is designed for quick, easy installation and will provide the user with long lasting, trouble free, reliable vacuum measurement. The electronics can be powered by a power supply capable of delivering any voltage between 12 VDC to 36 VDC.

The HVG-2020B instrument has a modular PCB design that allows for flexibility in available features and options for OEM applications. This includes analog output via a 9-pin D connector, additional 4 conductor 3.5 mm TRRS jack and USB virtual COM port for digital communication. The HVG-2020B VISION offers an additional color touch-panel display.

The two sensors exhibit excellent stability, and their outputs are characterized and digitally linearized to provide superior accuracy. The pressure signal is made available on the digital port and display. The signal is also converted to the desired analog signal (linear/logarithmic, voltage/current) and this signal is presented to the D connector.

Hastings vacuum instruments do not require any periodic maintenance under normal operating conditions with clean gases. No damage will occur from the use of moderate overpressures (< 25 psig).

The following sections contain the steps needed to get a new vacuum gauge operating as quickly and easily as possible. Please read the following thoroughly before attempting to install the instrument.



**NOTICE:** The instruments described in this manual may be available with multiple pinouts. Ensure that all electrical connections are correct.



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



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



**CAUTION:** There are no operator serviceable parts or adjustments inside the product.



**CAUTION:** If this equipment is used in a manner other than that specified, the protection provided by the equipment may be impaired.

## 1.1. Features

**COLOR DISPLAY WITH TOUCH PANEL.** The HVG-2020B has an optional integrated touch panel color LCD display. This gives the user easy configurability, stand-alone operation and local control over the instrument.

**SUPERIOR ACCURACY.** The output of the transducer is thermally compensated and linearized to provide accuracy of  $\pm$  (0.1% of reading + 0.3 Torr) between 1000 Torr and 10 Torr, better than  $\pm$  (5% of reading + 0.00025 Torr) between 10 Torr and 1 mTorr, and better than 10% of reading + 0.00025 mTorr less than 1 mTorr after zero adjustment.

**GAS CORRECTION.** The piezo-resistive sensor is media isolated and provides a direct pressure measurement that is gas species independent. There are internal corrections available for the Pirani sensor when used with other gases.

**NO ELASTOMERS.** The vacuum envelope of the HVG-2020B is entirely 300 series stainless steel with welded construction and glass-to-metal seals. Using metal seal vacuum connections eliminates the permeation, degradation and outgassing problems of elastomer O-rings.

**FLEXIBLE POWER REQUIREMENTS.** The HVG-2020B can operate with any power supply capable of providing 12 - 36 VDC via the 9-pin D connector or a 2 mm bayonet jack connection.

**DIGITAL COMMUNICATIONS.** The HVG-2020B is equipped with RS232/RS485 and USB for digital communications. The USB connector serves as a virtual COM port for serial communication, eliminating the need for a USB to Serial converter.

**ANALOG OUTPUTS.** The pressure is available in analog form as either a voltage or current signal on either a logarithmic or linear scale. The 0-20 mA or 4-20 mA current option gives the user the advantages of a current loop output to minimize environmental noise pickup and signal loss over long cable runs.

**TTL ALARMS.** Two alarm signals are provided with an open-drain configuration, one to indicate when pressure goes above a value and the other below a value.

**LED INDICATORS.** Two LEDs provide instrument status and system pressure information.

## 1.2. Specifications



**WARNING:** Do not operate instruments exceeding the specifications listed below. Failure to heed this warning could result in serious personal injury and/or damage to the equipment.

<b>Range:</b>	1x10 <sup>-4</sup> Torr to 1000 Torr
<b>Accuracy:</b>	± (0.1% of reading + 0.3 Torr) from 1000 to 20 Torr ± (5% of reading + 0.00025 Torr) from 20 to 0.001 Torr (Nitrogen) ± (10% of reading + 0.00025 Torr) from 0.001 to 0.0002 Torr (Nitrogen) at ambient operating temperature without temperature/humidity effects after 2 hours warm up followed by zero adjustment
<b>Warm up time:</b>	Within rated accuracy at atmosphere: 30 minutes (typical) For zero adjustment: 2 hours (typical)
<b>Installation orientation:</b>	any
<b>Internal volume:</b>	3.5 cc (1/4" stub tube, other connections will be larger)
<b>Maximum Pressure:</b>	Maximum operating: 1000 Torr Maximum overpressure: 2000 Torr / 25 psig (no change in performance) Burst pressure: 3000 Torr / 45 psig
<b>Operating Temperature:</b>	-20 °C to 70 °C



**WARNING:** Operation above 60 °C ambient may result in case temperatures capable of causing burns. Operation near the temperature extremes for more than 48 hours could result in display degradation.

<b>Humidity:</b>	30 to 90 %RH, non-condensing
<b>Thermal Zero Shift:</b>	< 3.5 mTorr (over -20 to 70 °C range)
<b>Thermal Span Shift:</b>	< 0.6% of reading above 10 Torr (over -20 to 70 °C range) < 5% of reading below 10 Torr (over -20 to 70 °C range)
<b>Leak Integrity:</b>	< 1x10 <sup>-9</sup> std. cc/s
<b>Analog Output:</b>	0-1 VDC, 0-5 VDC, 0-10 VDC (short-circuit protected, 1 kΩ min load) 0-20 mA, 4-20 mA (short-circuit protected, 1.2 kΩ max load)
<b>Power Requirements:</b>	With display: 2.1 watts max. / 12 to 36 VDC (1.5 W typ. @ 24 VDC) No display: 1.8 watts max. / 12 to 36 VDC (1.3 W typ. @ 24 VDC) Class 2 power 150 VA max fused



**NOTICE:** Use of an underpowered or under-voltage supply could result in equipment damage.



**WARNING:** Do not power with isolated drive circuits that are more than 36 volts above ground potential or could reach 36 volts in the event of a fault. Failure to heed this warning could result in serious personal injury and/or damage to the equipment.

Response Time:	< 100 ms
CE Mark	EN55011, EN61326, EN61010
RoHS Compliant	YES
Wetted Materials:	304 and 316 stainless steel, glass, nickel, gold plated tungsten
Weight (approx.):	0.6 lb. (0.27 kg) without fitting
Set points:	open-drain configuration (5 V / 5 mA max input)
Connectors:	2mm bayonet-style power jack (power) 9-pin "D" connector (power, analog signals, TTL serial) 3.5 mm TRRS jack (RS232/485 serial communications) USB micro-B (virtual COM port for serial communications)

## 1.3. Accessories

### 1.3.1. Power Supplies

A 24VDC switching power supply (P/N 12-01-169) is available to directly power the HVG-2020B through the 2mm bayonet jack.



### 1.3.2. Cables

The HVG-2020B instruments come with a 9 pin D-connector. A Hastings cable (Part # CB-AF-8-HVG9M) is available to interface with the standard 15 pin D-connector found on Hastings power supplies. Cables are available from Hastings in various lengths as well. A variable length cable with bare leads (Part # CB-LDS-XXX-HVG9M) is also available.

Serial communications cables are available from Hastings (Part # CB-RS232-TRRS). These cables connect from the 4-conductor 3.5 mm TRRS jack on top of the gauge to a standard 9-pin D connector used for serial communication on older computers and other adaptors.

A USB cable is available from Hastings (Part # CB-USB-MICRO-B) that will connect from the Type-A receptacle found on most computers to the Micro-B connector found on the HVG-2020B instruments. This cable is 6 feet in length and includes ferrites for increased RF immunity.

More information about the power supplies and cables can be found on the Hastings web site:

<http://www.teledyne-hi.com>

## 2. Installation and Setup

This section contains the necessary steps to assist in getting a new vacuum gauge into operation as quickly and easily as possible. Please read the following thoroughly before attempting to install the instrument.

### 2.1. Receiving Inspection

Prior to opening, inspect for obvious signs of damage to the shipment. Immediately advise the carrier who delivered the shipment if any damage is suspected. If the shipment has arrived intact, carefully unpack the gauge and any accessories that have been ordered. Check each component shipped with the packing list. Ensure that all parts are present (i.e. gauge, power supply, cables, etc.). Optional equipment or accessories will be listed separately on the packing list.

### 2.2. Mechanical Connections

#### 2.2.1. Mounting



**NOTICE:** The gauge should be installed in a clean and careful manner. Take care not to drop the product and avoid impacts to prevent damage.

The HVG-2020B gauge may be mounted in any position, though care should be taken to prevent objects, particles or condensate from dropping inside the gauge if mounted upside down.

Using bare hands to touching components that are exposed to the vacuum will result in increased desorption rate and can possibly interfere with proper sealing.

Contamination can impair the operation of the gauge. If your vacuum environment is highly contaminated or has unique fitting requirements, a Hastings filter or special adapter may be needed. Please contact the Hastings Instruments Sales Department for assistance in your system configuration.

Mount in such a way as to minimize vibration.



**WARNING:** If devices employing gaseous electrical discharges are present in the vacuum system, the discharge may couple dangerous high voltage through the gas in the chamber directly to ungrounded conductive surfaces or electrical conductors. Seriously injury or death can occur from contacting exposed ungrounded conductive surfaces/conductors at high potential.

Ensure that the vacuum port to which the gauge is mounted is electrically grounded. It is essential for personnel safety as well as proper operation that the envelope of the gauge be connected to a facility ground. Vacuum connections that use an O-ring for a seal such as a KF type flange or a quick connect fitting may electrically isolate the surfaces on the other side of the connection. This may also occur on an NPT fitting if PTFE tape is used on the sealing surfaces. In these conditions add a ground lug on a flange bolt to provide a ground path back to a protective earth terminal.



**WARNING:** If poisonous or injurious gases have been used in the vacuum system, ensure that all residues have been evacuated or flushed with inert gas before opening the system to install the gauge tube.

## 2.2.2. Plumbing

Mount the gauge as close as possible to the to the pressure area of interest. Long or restricted tubing will create a pressure difference between that area and the gauge. Mounting too close to gas sources can also affect pressure measurement.

The HVG-2020B can come with any of several vacuum connections, including: 1/8” NPT, ¼ VCR, ½” VCR, KF-16, KF-25, 1.33” CF, 2.75” CF and ½” smooth stub tube. The tube is configured with the vacuum fitting requested.



**NOTICE:** When installing the 1/8” NPT version, be certain to use the ½” wrench flats. Do not tighten using the aluminum housing as a grip or damage may result.



**WARNING:** Do not exceed the pressure rating of the instrument. If operating near the maximum operating pressure, ensure there is a pressure relief valve in the system.

## 2.3. Electrical Connections



**WARNING:** Care must be taken to avoid any high voltages that may be present when dealing with power supplies.

### 2.3.1. Connector

The HVG-2020B 9 pin “D” connector pin assignments are listed here.



**NOTICE:** The cable length must be less than 30 meters long (unless housed in a metal conduit) to meet CE Mark requirements.

Pin #	
1	High Setpoint
2	Low Setpoint
3	+ Power (12-36 VDC)
4	Power/Digital Common
5	Analog Output
6	Case Ground
7	Tx out (TTL)
8	Analog Common
9	Rx in (TTL)

### 2.3.2. Power Input

The HVG-2020B has its own internal switching power supply and requires between 12 and 36 VDC input voltage. The +VDC supply is pin 3 and the -VDC return is pin 4. Case ground is pin 6.



**NOTICE:** Either the base or pin 6 must be connected to ground for proper noise immunity and to meet CE Mark standards.

There is also a 2mm barrel connector available as a 24 VDC power jack. The center pin polarity is positive and is internally connected to pin 3 of the “D” connector. The sleeve is internally connected to pin 4 of the “D” connector.

The gauge requires a maximum of 2.1 watts for proper operation. Surge suppressors are recommended to prevent power spikes reaching the instrument. Hastings power supplies satisfy these power requirements.

### 2.3.3. Analog Output

The analog signal output is configurable via digital communications. See the instrument label to determine how the instrument was configured at the factory. In Hastings power supplies, the analog output is routed to the display and is also available at terminals on the rear panel. If a Hastings supply is not used, the output is available on pin 5 of the “D” connector.

The analog output is user selectable to be non-linear, linear, logarithmic or dual slope. Multiple voltage or current ranges are available: 0-1 VDC, 0-5 VDC, 0-10 VDC (short-circuit protected, 1 kΩ min load), 0-20 mA, 4-20 mA (short-circuit protected, 1.2 kΩ max load).

The standard output of the pressure meter is a 1 to 9 VDC signal logarithmically related to the pressure (9 VDC = 1000 Torr, 1 VDC/decade). Other full scale and slope values are selectable/settable via the display or serial communications. Predetermined linear and logarithmic selections are:

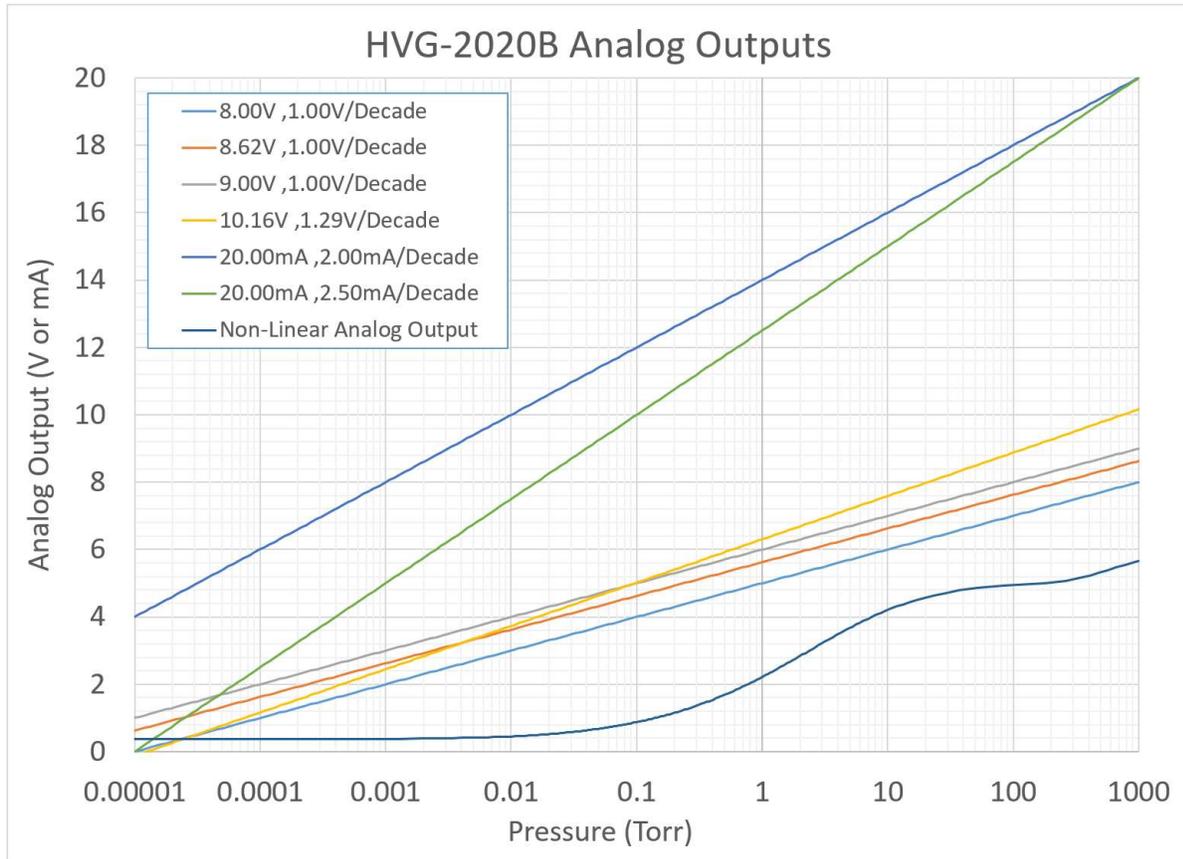
#### Options 1 to 11: Linear and Logarithmic Analog Outputs

Option	Slope	@ .0001 Torr	@ 1000 Torr	P(Torr) from V(volts) or I(mA)	V(volts) or I(mA) from P (Torr)
01: 0-1 V Linear	0.001 V/Torr	0.0000 V	1.0000 V	$P = 1000 * V$	$V = 0.001 * P$
02: 0-5 V Linear	0.005 V/Torr	0.0000 V	5.0000 V	$P = 200 * V$	$V = 0.005 * P$
03: 0-10 V Linear	0.010 V/Torr	0.0000 V	10.0000 V	$P = 100 * V$	$V = 0.01 * P$
04: 4-20mA Linear	0.016 mA/Torr	4.000 mA	20.000 mA	$P = 62.5 * I - 250$	$I = (P + 250)/62.5$
05: 0-20mA Linear	0.020 mA/Torr	0.000 mA	20.000 mA	$P = 50 * I$	$I = 0.02 * P$
06: 0-10V Log	1.00 V/dec	1.0000 V	8.0000 V	$P = 10^{(V-5)}$	$V = \log_{10} P + 5$
07: 0-10V Log	1.00 V/dec	1.6249 V	8.6249 V	$P = 10^{(V-5.6249)}$	$V = \log_{10} P + 5.6249$
08: 0-10V Log	1.00 V/dec	2.0000 V	9.0000 V	$P = 10^{(V-6)}$	$V = \log_{10} P + 6$
09: 0-10V Log	1.286 V/dec	1.1600 V	10.1620 V	$P = 10^{0.778(V-6.304)}$	$V = 1.286 \log_{10} P + 6.304$
10: 4-20mA Log	2.00 mA/dec	6.000 mA	20.000 mA	$P = 10^{0.5(I-14)}$	$I = 2 \log_{10} P + 14$
11: 0-20mA Log	2.50 mA/dec	2.500 mA	20.000 mA	$P = 10^{0.4(I-12.5)}$	$I = 2.5 \log_{10} P + 12.5$
12: Non-linear	n/a	0.3750 V	5.6590 V	See Option 12 below	
13: Dual Slope	n/a	0.0005 V	10.0000 V	See Option 13 below	

There is also a custom defined logarithmic output. All the user needs to do is input the desired volts per decade into S33 and the expected voltage at 1000 Torr into S32 (See Section 5.2.8). However, the analog output must be put into the custom mode (S31 = 0x06) before it will accept the inputs from the user.



**NOTICE:** Predetermined logarithmic voltage selections should be used in the 0-10 VDC mode, otherwise the output will be forced to fit that range; the slope and/or full-scale values will not be as listed. In 4-20 mA mode, the output current will not go below 3.7 mA.



There are two other analog output options that are available. One is a non-linear curve based on convection gauges. The other is a dual slope output. These are described below.

## Option 12: Non-Linear Analog Output (Convection Style Curve)

### Pressure to Voltage Conversion

p = 0.0001 Torr      p = 1000 Torr  
 v = 0.375 V          v = 5.659 V

Below 7.20 Torr      v=(a+cp+ep<sup>2</sup>+gp<sup>3</sup>)/(1+bp+dp<sup>2</sup>+fp<sup>3</sup>) volts  
 Above 7.20 Torr    v=(a+cp+ep<sup>2</sup>+gp<sup>3</sup>)/(1+bp+dp<sup>2</sup>+fp<sup>3</sup>+hp<sup>4</sup>) volts

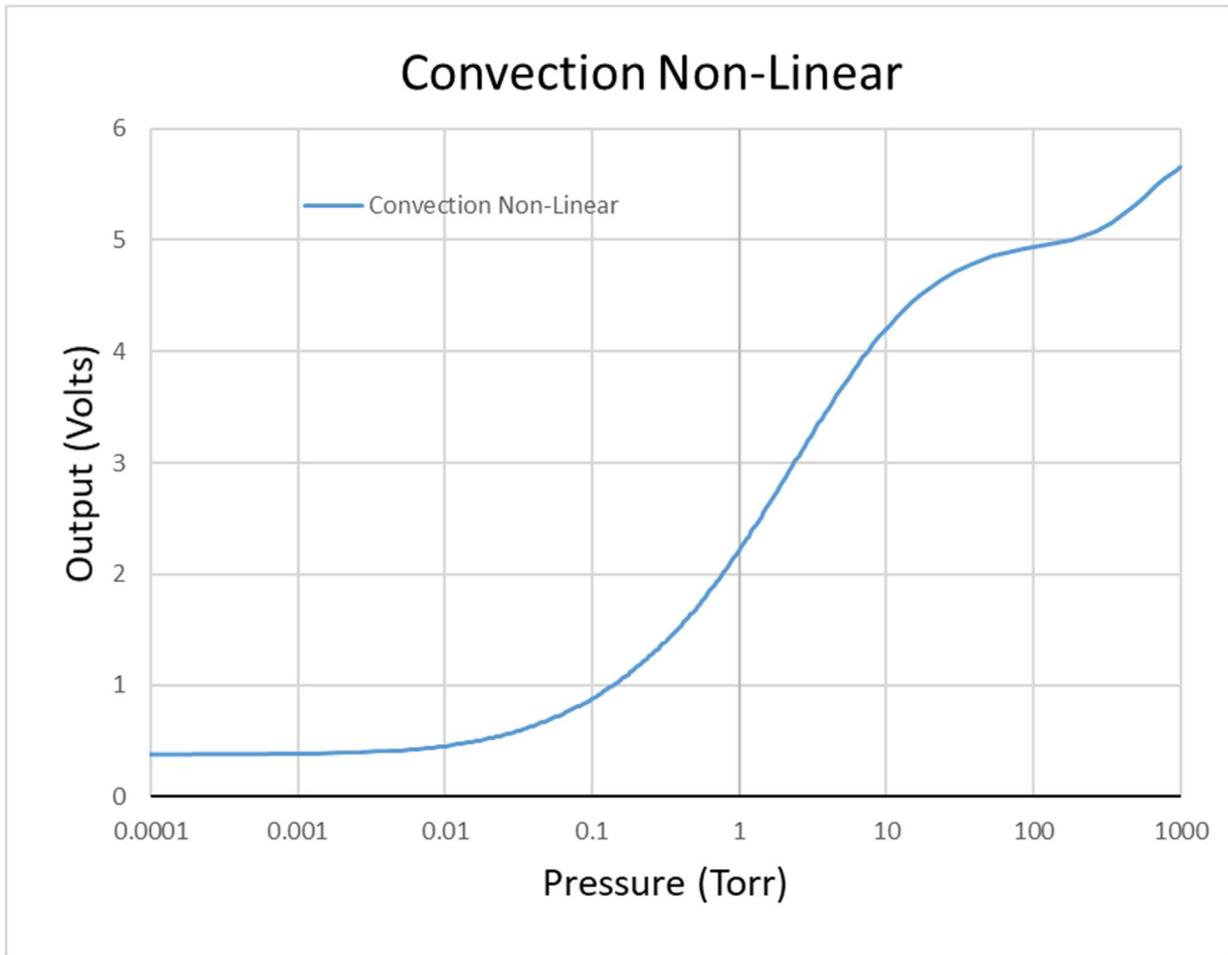
	<u>Below 7.2 Torr</u>	<u>Above 7.2 Torr</u>
a	0.375	1.485409798
b	15.31570974	0.307029664
c	14.4180837	1.566833148
d	24.2920447	-0.000228563
e	59.56106682	-0.001397165
f	5.507480905	1.36167E-06
g	27.91187899	7.85644E-06
h		-2.23911E-11

### Voltage to Pressure Conversion

v = 0.375 V          v = 5.659 V  
 p = 0.0001 Torr      p = 1000 Torr

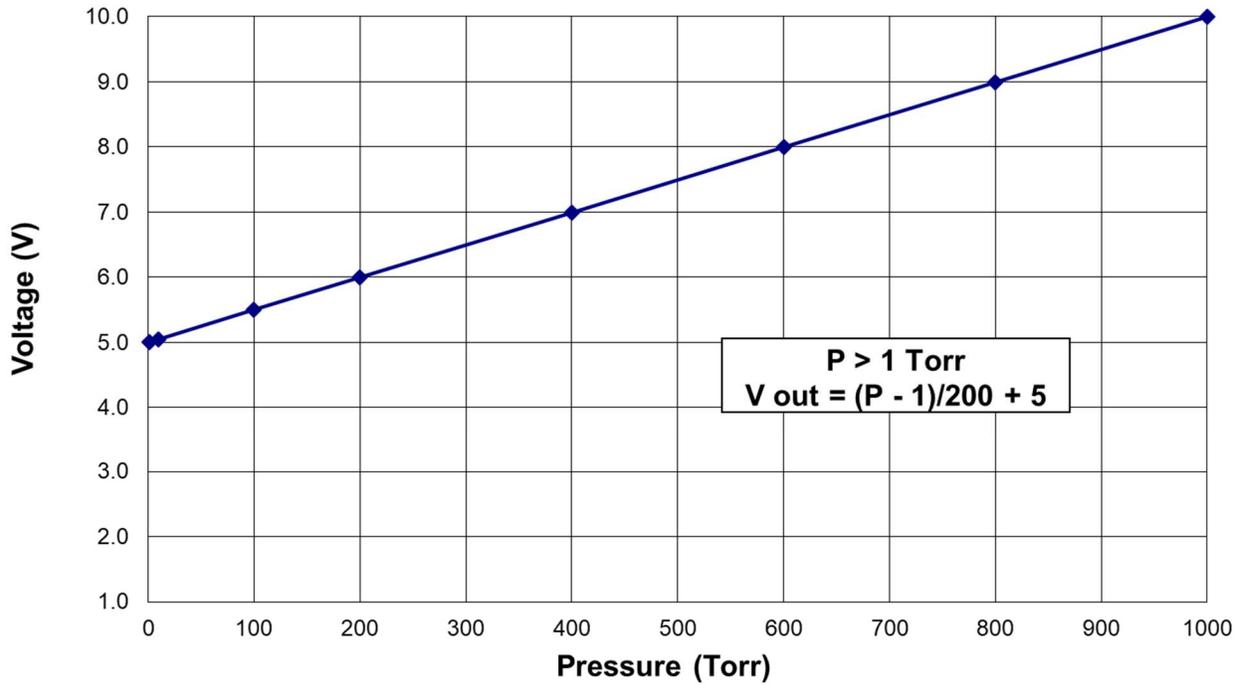
0.375 to 2.842 V    p=a+bv+cv<sup>2</sup>+dv<sup>3</sup>+ev<sup>4</sup>+fv<sup>5</sup> Torr  
 2.842 to 4.945 V    p=(a+cv+ev<sup>2</sup>)/(1+bv+dv<sup>2</sup>+fv<sup>3</sup>) Torr  
 4.945 to 5.659 V    p=(a+cv)/(1+bv+dv<sup>2</sup>) Torr

	<u>0.375 to 2.842 V</u>	<u>2.842 to 4.945 V</u>	<u>4.945 to 5.659 V</u>
a	-0.02585	0.1031	100.624
b	0.03767	-0.3986	-0.37679
c	0.04563	-0.02322	-20.5623
d	0.1151	0.07438	0.0348656
e	-0.04158	0.07229	
f	0.008738	-0.006866	

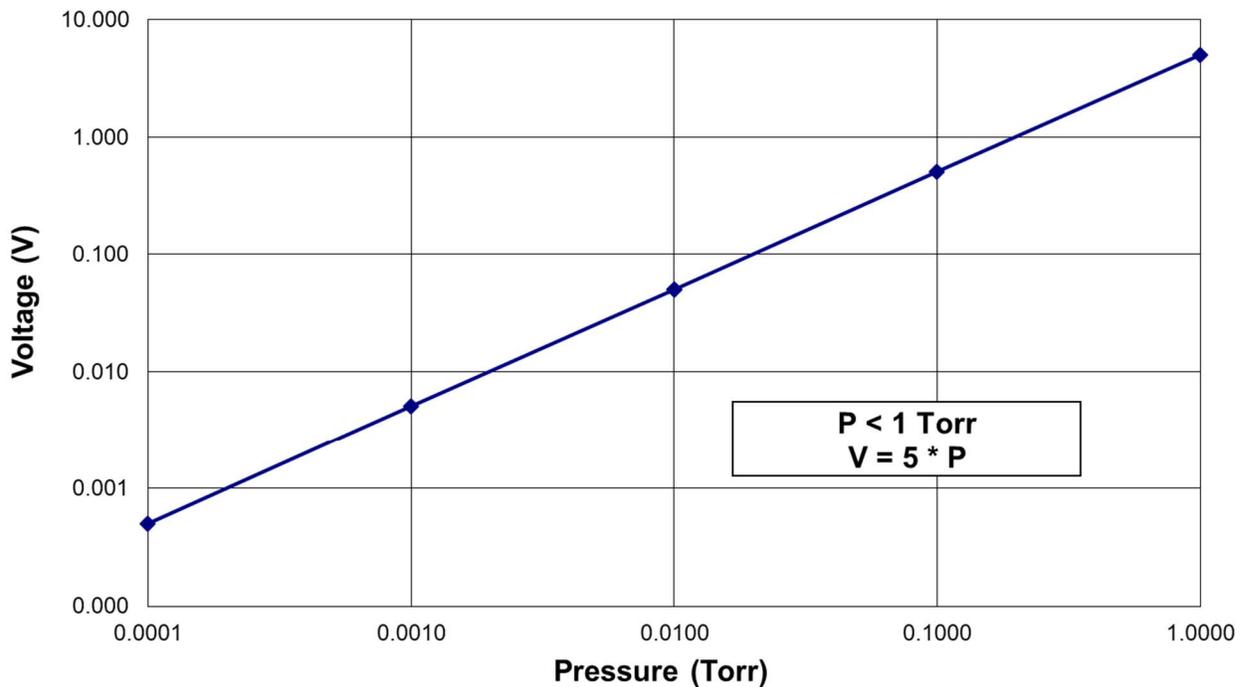


### Option 13: Dual Slope Analog Output

#### Dual Slope Analog Output Upper Range



#### Dual Slope Analog Output Lower Range



The analog output voltage is available on pin 5 and referenced to analog common on pin 8. The voltage output may be set to 1, 5 or 10 volts full scale. The standard value is 10 volts and will have been set as such unless another value was specified at time of order. The analog full-scale settings can be changed in the field with digital commands.



**NOTICE:** The load resistance must be no less than 1 kΩ for voltage output to maintain accurate readings.

Optional to the standard voltage output is the 0-20 mA or 4-20 mA current output that is proportional to pressure. The current loop output is useful for remote applications where pickup noise could substantially affect the stability of the voltage output. The current loop signal replaces the voltage output on pin 5 of the D” connector and is returned on pin 8.



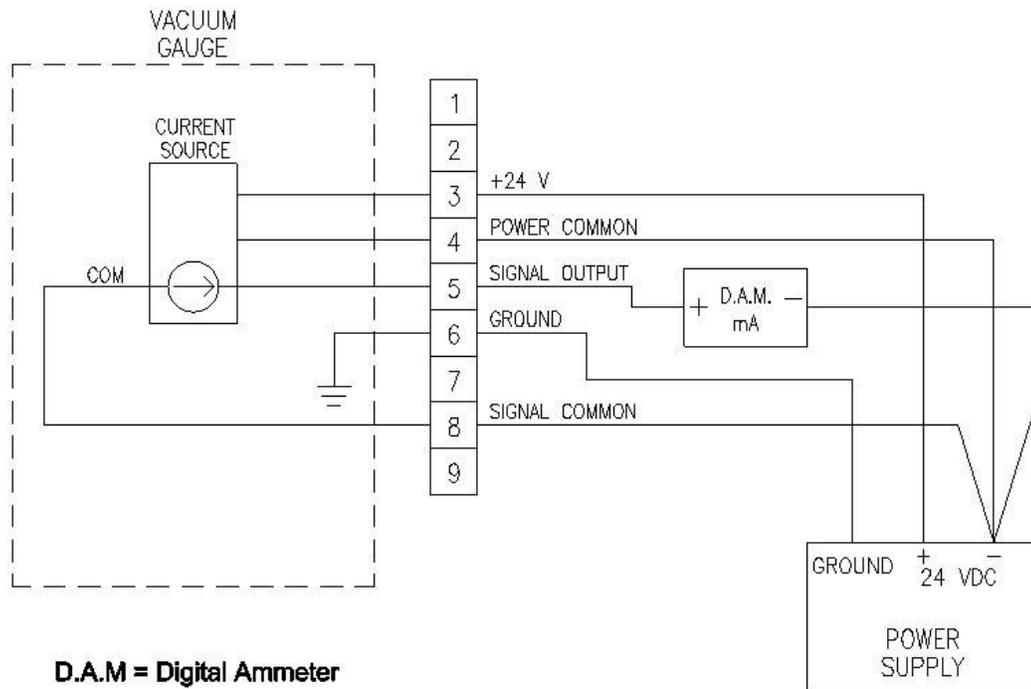
**NOTICE:** The loop load must be less than 1.2 kΩ. Failure to meet this condition will cause failure of the loop transmitter. Wiring diagrams for power and 4-20mA signals are shown below.



**NOTICE:** The power requirements are greater when using 0-20mA and 4-20mA output signals.



**NOTE:** 0-20mA cannot indicate a negative zero offset.



**D.A.M = Digital Ammeter**  
**Signal Output is sourced from 24V Supply**

4 - 20 mA wiring diagram w/ unipolar supply

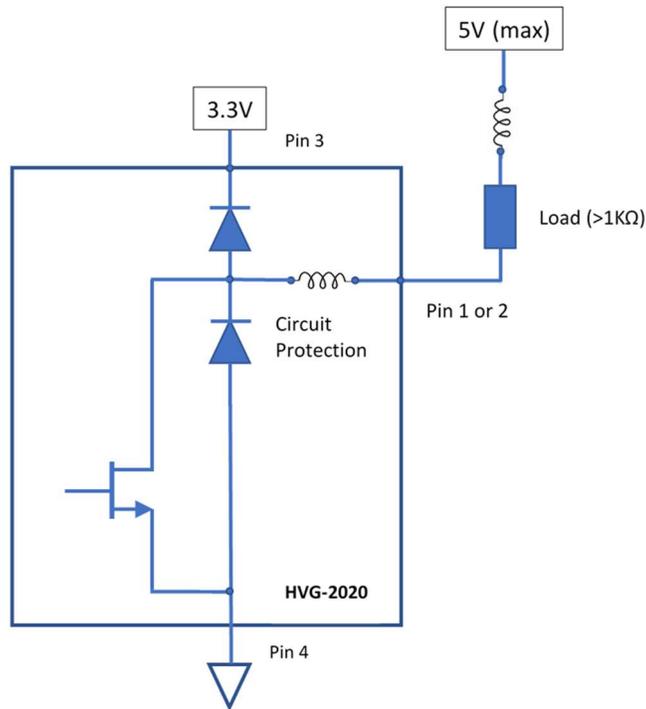
### 2.3.4. Setpoints

The HVG-2020B has two open-drain setpoints available on the 9 pin D connector. The Hi setpoint will be active when the pressure is above its set value and the Lo setpoint will be active when the pressure is below its set value. There is a small amount of hysteresis built into the settings. Once a setpoint is activated, the pressure must go 10% beyond that value in the opposite direction to deactivate when below 10 Torr. Above 10 Torr, the pressure must go 1 Torr beyond the setpoint value.

The set point values can be changed via the display (Setpoint View, Section 3.2) or serial communications (see S20 and S21 commands). The setpoints will also show on the Bar Graph View as up and down arrows.



**NOTICE:** To utilize the open drain setpoint pins, external pull-up resistors larger than 1 k $\Omega$  are required. Do not apply more than 5 volts to the setpoint pins.

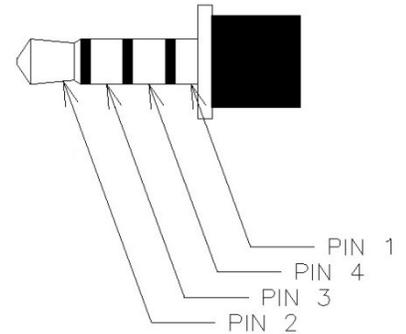


### 2.3.5. Serial Connection

The HVG-2020B has a 4-conductor TRRS 3.5 mm jack on the top of the instrument for digital communication. To daisy chain instruments on a RS485 bus, Y-splitters of the 4-conductor variety are available. The HVG-2020B can be configured to operate with either RS232 or RS485 signals via digital command or via the display.

Hastings uses a full duplex configuration. See the tables below for the standard pin-out.

COMMUNICATIONS CABLE PIN-OUT		
Pin#	RS232	RS485
1 (Sleeve)	Common	TX+ (TDB)
2 (Tip)	TX	TX- (TDA)
3 (Ring 1)	RX	RX- (RDA)
4 (Ring 2)	NC	RX+ (RDB)



If making up a cable to interface from the TRRS 3.5 mm jack connector to a standard PC 9-pin serial port (RS232), use the connections as listed here.



**NOTICE:** The serial cable length must be less than 30 meters long (unless housed in a metal conduit) to meet CE Mark requirements.

The HVG-2020B uses RS485 receivers that are protected from bus over-voltages and will not be damaged if connected to a bus without a driver or pull up resistors. The option to enable 120-ohm termination resistors is available via the display or digital command. They should be used if the instrument is the last one in a long cable length (prevents miscommunications due to reflections). This is not normally necessary for short cables. Do not have more than one instrument with these resistors enabled on any one cable run as this will load down the cable. Hastings ships RS485 instruments without the resistors enabled.

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

The default port set-up is 19.2K baud, 8 data bits, 1 stop bit, no parity and no flow control. A “carriage return” signals the end of command input. The end of a response message from the HVG-2020B is signaled by a “>” character. See Serial Communications section later in this manual for more information.

### 2.3.6. USB Connection

A USB micro-B connector is available that will implement a serial port interface. It will appear in the “Devices and Printers” list as “Teledyne Hastings Digital” along with its assigned COM port number. The serial port parameters are: 8 data bits, No Flow Control and 1 stop bit. The baud rate does not matter.

Only Windows 7 and 10 are supported. A device driver (THI\_D300.inf) is needed for Windows 7, but not for Windows 10.

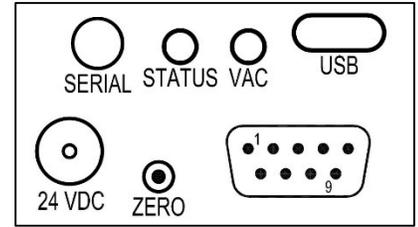
### 2.3.7. TTL Serial Connection

TTL Serial output is available on the 9-pin D connector pins 7 (Tx out) and 9 (Rx in). The voltage levels are near 3.3 V for logic high and near 0 V for logic low. To communicate using a computer serial port, a TTL-to-serial converter is required to raise the signal voltage levels to those required for RS232 communications.

## 2.4. Push-button Operation

On top of the HVG-2020B instrument, there is a push-button that serves to reset the zero by pressing and holding it for at least 3 seconds when the pressure is known to be well below 0.1 mTorr.

For HVG-2020B instruments without a display, the push-button has an additional function. To toggle RS232 and RS485 communications, press and hold the button before applying power, then apply power and continue holding button until both LEDs blink rapidly.



## 2.5. LED Operation

The HVG-2020B will go through an internal self-check upon power up and go into normal operation. The LEDs on top of the unit indicate the state of the device as follows:

System State	Status LED	Vacuum LED
<i>Pressure &gt; 1000 Torr</i>	Steady Green	Flash Yellow at 1 sec rate
<i>Pressure &gt; 800 Torr</i>	Steady Green	Steady Yellow
<i>Pressure near 760 Torr</i>	Steady Green	Steady Green
<i>Pressure &lt; 700 Torr</i>	Steady Green	Flash Green at 1 sec rate, Duty cycle proportional to pressure
<i>Pressure &lt; 1 Torr</i>	Steady Green	Short flash green at 1 sec rate
<i>Pressure &lt; 0.01 Torr</i>	Steady Green	Short flash green at 2 sec rate
<i>Main Board Comm Error</i>	Flash Red at 2 sec rate, Opposite of Vacuum LED	Flash Red at 2 sec rate, Opposite of Status LED
<i>Piezo Sensor Failure</i>	Steady Red	Steady Red
<i>Pirani Sensor Failure</i>	Steady Red	Flash Red at 2 sec rate
<i>Calibrate Mode</i>	Flash Green at 1 sec rate, In Synch with Vacuum LED	Flash Green at 1 sec rate, In Synch with Status LED
<i>Toggle RS-232/485</i>	Flash Green at 1/8 sec rate, Opposite of Vacuum LED	Flash Green at 1/8 sec rate, Opposite of Status LED
<i>Push-button Force zero</i>	Flash Green at 1/8 sec rate, In Synch with Vacuum LED	Flash Green at 1/8 sec rate, In Synch with Status LED
<i>Push-button Adjust Zero</i>	Steady Green	Flash Green at 1/8 sec rate

## 2.6. Quick Start

1. Unpack and inspect all items for any obvious signs of damage due to shipment. Immediately advise the carrier who delivered the shipment if any damage is suspected.
2. Wire the 9-pin “D” connector according to cable pinout using 24 AWG or other suitable wire.
3. Using a unipolar DC Power Supply, set the desired operating voltage within the range of 12 VDC to 36 VDC.
4. Transducer tube may be installed in any orientation. However, if condensation is likely to occur, then the tube port should be orientated downward.
5. When installing 1/8” NPT style transducer tube, use the ½” wrench flats.
6. Attach cable.
7. With the vacuum chamber at atmosphere, turn on the power supply. Gauge is now reading pressure.
8. For best accuracy, the gauge should now be zeroed. To do this, pump the vacuum system down to less than  $1 \times 10^{-4}$  Torr. Ideally the gauge should be powered for two hours before setting the zero.
9. To set the zero, press the menu icon, scroll to the **Set Zero** menu page and press the EDIT button. Alternatively, press and hold the Zero button until the LEDs flash.

## 3. Display Operation

### 3.1. General

The HVG-2020B has an optional color touch screen module that can be assembled with the internal I/O module to provide the user with local control over device operation. All operations done via the touch screen utilize the values associated with the digital lists and commands found in Section 4.

The resistive touch panel will allow items other than your finger to activate the touch, such as a stylus, pencil eraser, fingernail, gloved finger... etc. However, it can only detect one touch location at a time. The touch panel top layer is made of polyester, or polyethylene terephthalate (PET).

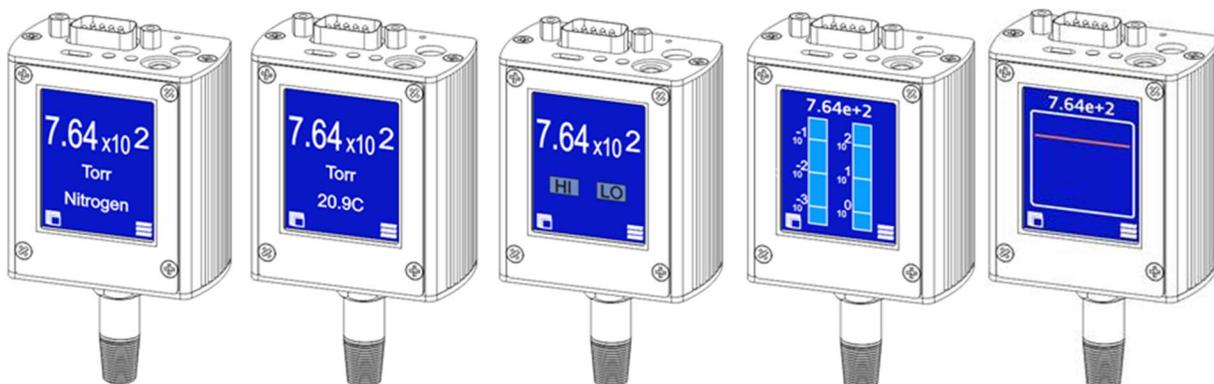


**NOTICE:** Do not apply excessive pressure, liquids or sharp objects to the touch screen to avoid damage. To clean the display, breathe on the surface and gently wipe it with a soft cotton or microfiber cloth.



### 3.2. VIEW Icon

The VIEW icon allows the user to cycle through five possible main screens (views). The VIEW and MENU icons remain visible in the bottom corners of the screen in all views. Some items displayed in the different Views allow the user to toggle or adjust them.

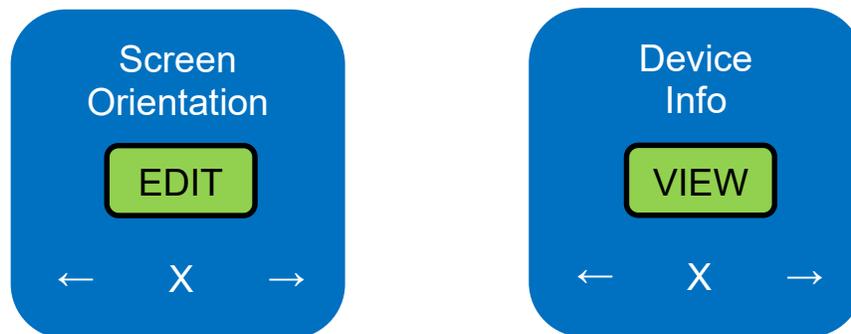


## Available Views:

1. **Pressure View:** gives the pressure and units. Touching the pressure reading will toggle between decimal notation and scientific notation. Touching the units will cycle through available units.
2. **Pressure and Temperature View:** The screen adds a temperature indication. It is only meant to be a visual aid indicating ambient temperature ( $\pm 1.5$  °C). Touching the temperature will toggle between °C and °F.
3. **Setpoint View:** Visual indicators of Hi and Lo setpoints. If the indicator is green the setpoint is active. The Hi setpoint is active when the pressure is above its setting and the Lo setpoint is active when the pressure is below its setting. The two settings may be different. Touching the Hi and Lo indicators will bring up a screen allowing the corresponding setpoint to be adjusted. Use the left/right arrows to select the digit and the up/down arrows to change the value of the digit.
4. **Bar Graph View:** A graphical indication of the current pressure on a log scale. The Hi setpoint is indicated with an upward arrow and Lo with a downward arrow. Green means the setpoint is active and red means inactive. If the set point values are made to be off scale, the arrows will not be displayed.
5. **History Graph View:** A graphical indication of the pressure over time. Touching the screen anywhere will bring up a screen allowing the user to adjust the time (in seconds) per sample (displayed point). Use the left/right arrows to select the digit and the up/down arrows to change the value of the digit.

### 3.3. MENU Button

In all Views except the History Graph View, the MENU icon opens a multipage ring of menu items that can be cycled using the arrow icons. The menu pages are: **Screen Orientation** → **Set Zero** → **Device Info** → **Analog Output** → **Gas Select** → **Serial Port** → **Restore Factory Defaults**. The menu ring cycles back around when continuing to press the arrow. To exit the menu ring, press the X icon. Press the EDIT or VIEW button on a menu page to change or view values pertaining to that menu item.



Within each menu page, there are sub-menus allowing the user to adjust an item.

Press the change symbol  to adjust a value or scroll through available values.

Press the arrow  to move to the next item in the sub-menu.

To accept the changes press the check mark 

To cancel the changes press the 

### 3.3.1. Screen Orientation

The top of the screen is indicated and will rotate 90° each time the screen is pressed.

### 3.3.2. Set Zero

The Set Zero menu will set the pressure reading to zero and should only be done if the actual pressure is known to be well below  $1 \times 10^{-4}$  Torr. If the pressure reading is too large, a warning screen will appear asking if the user is certain they want to do this operation.

### 3.3.3. Device Info

The user may view the serial number, analog output setting, calibration date, gauge type, the I/O and main board firmware revision levels, and current system errors.

### 3.3.4. Analog Output

The user may select non-linear, linear or logarithmic output. If logarithmic is selected, the user may select a given full scale/slope combination or a custom option. The custom selection must be set using serial communications.

The user may then select voltage or current output range: 0-1 V, 0-5 V, 0-10 V, 0-20 mA or 4-20 mA.

### 3.3.5. Gas Select

The user may select from the available gas options Refer to section 4.5 for specific values of the gas selections. The user may select a pre-defined gas or a custom gas. The custom selections must be set using serial communications.

The gases are as follows: Nitrogen, Air, Helium, Argon, Hydrogen, CF<sub>4</sub>, SF<sub>6</sub>, Custom 1, Custom 2

### 3.3.6. Serial Port

The user may select either RS232 or RS485 serial communications. After selecting the type, pressing the arrow icon will take the user to the baud rate selection There are 5 baud rates available: 9600, 19200, 38400, 57600 and 115200. If RS485 was selected, additional sub-menu screens will appear allowing the user to select the address and termination resistor state. At the end of the selection sub-menus, the user can accept or cancel the selections shown.

### 3.3.7. Restore Factory Defaults

This selection allows the user to reset the configuration of the gauge back to its original factory setup. A warning screen will appear asking if the user is certain they want to perform this operation.

## 4. General Operation

### 4.1. Operating Conditions



**NOTICE:** For proper operation, the combination of ambient temperature and process gas temperature must be such that the gauge temperature remains between -20 and 70°C. The most accurate measurement of pressure will be obtained if the gauge is zeroed at the operating temperature, as temperature shifts result in some zero offset.



**NOTICE:** The HVG-2020B is intended for use in non-condensing environments only. Condensate or any other liquids which enter the gauge may destroy its electronic components.

### 4.2. Zero Check

Turn the power supply on if not already energized. Typically allow at least 30 minutes for warm-up to be within rated accuracy. Typically allow at least 2 hours warm-up when adjusting the zero.

Reset the zero using the display menu, the ZERO command, or by pressing the zero-button for 3 seconds. This zero should be checked periodically during normal operation. Zero adjustment is required if there is a change in ambient temperature or humidity.

### 4.3. Piezo Sensor Auto-Zero

The HVG-2020B will periodically adjust the zero reading of the piezo sensor based on the Pirani reading. This may happen every 20 minutes given a certain set of circumstances: the Pirani pressure reads below 0.1 Torr, the piezo pressure reads less than 20 Torr, and the piezo pressure reads more than 0.5 Torr differently than its previous zero value.

### 4.4. Positive Pressure Operation



**WARNING:** The HVG-2020B does not have a high-pressure option and is only rated for a maximum operating pressure of 20 PSIA. Using the instrument above its rated maximum overpressure of 40 PSIA (25 PSIG), could result in damage to the instrument or alter its behavior.



**WARNING:** Do not install a weld stub terminated gauge in an O-ring sealed quick connect fitting if system pressure could exceed atmospheric pressure.

If pressure goes above 800 Torr, the VAC LED will turn yellow. If the pressure goes above 1000 Torr, it will begin to flash yellow.

A warning will also appear on the display if the instrument goes over 1000 Torr.

### 4.5. Temperature and Humidity Effects

As the temperature of the instrument changes from the calibration temperature, errors will be introduced into the output of the instrument. Large changes in humidity will also affect the pressure reading. The shift due to changes in temperature will affect the zero value and the span value by different amounts as described in the specification sheet. The effects to the zero reading are eliminated by re-zeroing the instrument at the new

temperature. The span error cannot be eliminated, but is typically less than 0.2 % of reading above 10 Torr and typically less than 2% of reading below 10 Torr over -20 to 70 °C.

## 4.6. Pirani and Gas Interactions

While the Piezo operates independently of any gas, the Pirani is affected by different gases. To allow for accurate measurement of vacuum in a specific gas, there are six pre-defined gases with the option for two custom gases. The values for the pre-defined gases are not variable, but the custom gas options can be changed using the R9 and R10 commands when a custom gas is selected. The custom gas values can also be used to perform a calibration in the actual gas as described in Section 4.7.

<i>Gas Name</i>	<i>Gas Factor</i>	<i>Gas Bend Factor</i>
Nitrogen	1	1
Air	0.999	1.052
Helium	1.089	-0.676
Argon	1.512	0.881
Hydrogen	0.656	-0.545
CF4	1.015	2.853
SF6	0.913	0.4327
Custom 1	1	1
Custom 2	1	1

## 4.7. Calibration Procedure



**NOTICE:** The HVG-2020B is calibrated in nitrogen at the factory and any attempt to adjust the values associated with it will void the calibration.

### Nitrogen Calibration

The HVG-2020B calibration requires digital communication. See Section 5.

1. Attach the HVG-2020B to a vacuum system and pump down below 0.0001 Torr
2. Make certain the instrument has been warmed up for 2 hours before proceeding.
3. Unlock the instrument by typing **FLOK=1234**
4. Set the temperature to ambient temperature near the gauge if necessary: **TEMPSET=##.#**
5. Zero the instrument by sending the **ZRO** command.
6. Backfill with nitrogen to between 0.1 and 1 Torr. Set the Pirani mid value equal to the value indicated by the pressure reference: **RMID = 0.###**
7. Backfill with nitrogen to between 20 and 50 Torr. Set the Pirani high value equal to the value indicated by the pressure reference: **RHIGH = ##.##**
8. Backfill with nitrogen to atmospheric pressure. Set the instrument span to equal the value indicated by the pressure reference: **SPAN=###.#**

### Calibration Using Actual Gas

The HVG-2020B can be calibrated using a specific gas to provide better accuracy.

1. Make sure the HVG-2020B has already been calibrated in nitrogen, but this adjustment will not affect the nitrogen calibration.
2. Change the selected gas (R8) to a custom gas: either **R8=7** or **R8=8**
3. Set the bend factor to the ratio of custom gas mass to nitrogen mass and subtract 0.6  
$$K_g = \left( \frac{M_g}{28.0134} \right) - 0.6, \text{ R10}=\#.###$$
4. Attach the unit to a vacuum system and pump down below 0.0001 Torr
5. Zero the instrument by sending the **ZRO** command.
6. Backfill with the custom gas until the pressure is between 0.1 and 1 Torr as indicated by the pressure reference.
7. Set the gas factor to the ratio between the indicated Pirani pressure and reference pressure ( $G_f = P/P_r$ ): **R9=#.###**
8. Backfill with the custom gas to between 2 and 12 Torr.
9. Adjust the bend factor by setting  $K_g$  to the reference pressure reading: **SETKG=##.##**. Using **SETKG** alone (without a value) uses the internal Piezo reading as the pressure reference.

## 5. Digital Operation

### 5.1. Instrument States

The HVG-2020B will be in one of the following states as reported by the SS command:

State 4	Operation
State 8	Calibration

After power up, the instrument will enter the Operation state (4); this is indicated by the Status LED being solid green

The Calibration state (8) is used to adjust the Analog Output hardware using the TDAO, TDAS, TDAZ and TOFF commands. This state is entered by sending the SS8 command and exited by sending the SS4 command.

### 5.2. Serial Communications

#### 5.2.1. General

The HVG-2020B provides three ports for serial communication: a 3.5mm TRRS jack, a USB micro-B port and a TTL serial port via the 9-pin D connector.

The TRRS jack can be configured for either RS232 or RS485. This is selected via the touch screen, the push-button (see Section 2.3.6) or the commands ENABLERS485 and DISABLERS485. The USB port is always available serving as a virtual COM port and utilizes the same RS232 command set. The TTL serial port will not recognize commands that deal with RS485. See section 2.3.7 for TTL connection information.

#### 5.2.2. Serial Communication Software

Serial Communication Software running on a host computer is required to access the serial port. All such programs need to be configured to communicate with the instrument; the required parameters are Baud Rate (Bits per second), the number of data bits (8), Parity (None), Number of Stop Bits (1), and Flow Control (None).

#### 5.2.3. The Sensor Lists

The HVG-2020B operational parameters are found in the Sensor Full List (SFL). To read all the parameters, send the command SFL. To read an individual item from the list (e.g. item #5 Device Address) send the letter/number combination of the line in the list (e.g. S5 reads the Device Address).

The Sensor List (SL) contains general information about the entire instrument as well as piezo sensor-specific information. The Pirani sensor list (RL) contains Pirani sensor-specific information.

#### 5.2.4. Command Prompt

The prompt character is a greater than symbol '>' (x3E); when this symbol is received, the HVG-2020B is ready to accept a new command. Software can use the prompt as an end of response indicator if this symbol is not used in any text fields (e.g. S54 Comment).

## 5.2.5. Command Format

The HVG-2020B expects a Carriage Return (0x0D) at the end of each command; Line Feeds (0x0A) are ignored. Commands can be aborted by sending the Escape character (0x1B) before the Carriage Return has been sent; the device will ignore all characters. A Backspace (0x08) erases the previous character, but some Serial Communication Software will need to be configured to erase from the display.

Spaces are ignored unless they are part of a text field, e.g. “S 5 4 = t e s t” will set the Comment field to “t e s t”, not “test”. Note that the leading spaces before the first t are ignored; the command is equivalent to S54=t e s t.

Commands can be entered in upper case, lower case, or mixed case, so s54 = S54 and sTaTuS = STATUS.

Some items can be changed by the user: for example, S20 Low Relay Setpoint. To change an item, enter the item to be changed followed by the equals sign ‘=’ followed by the new value, e.g. S20=60.

Some items which affect calibration cannot be changed by the user; “ACCESS DENIED” will be returned when trying to change these values.

Text Strings are limited to 63 characters.

## 5.2.6. RS232 / RS485 Mode

The active mode is determined by the touch screen, the push-button (see Section 2.4) or the commands ENABLERS485 and DISABLERS485. RS232 mode does not support addressing, so commands are entered as described in the command description.

In RS485 mode, multiple devices can be on the same bus; an address is required to select the device to which commands are directed. The HVG-2020B device address is stored in S5. The address is a two-digit hexadecimal value which can be in the range 0x01 to 0x98 and 0x9A to 0xFF; the factory default is x01.

The address is required at the beginning of every command and is entered in the format \*NN where NN is the two-digit hex address stored in S5 of the target device. As an example, if you want to read the Sensor List from the device with address 0x02, send the command \*02 SL. The HVG-2020B will accept a one-digit address, but this could cause problems; \*2 SL will work the same as \*02 SL, but \*2 A will be interpreted as \*2A which is addressing device 2A, not 2. (“A” returns the device address.) In this case, you must enter \*02 A because A is a valid hex digit. Note that \*02A works the same as \*02 A as discussed above.

Address 0x99 is used for broadcasting - all devices will process the command. For example, the command \*99 S14=3 will command all attached HVG-2020B gauges to display 3 decimal places.



**NOTE:** The \*99 address will not yield responses to query commands on the RS485 bus (except S5), because multiple instruments would try to respond simultaneously.

See the Digital Connection section 2.3.5 earlier in this manual for more information

## 5.2.7. Response Format

Responses may be set to either Cryptic or Verbose; this is controlled by using the S112 command (S112=1 for Verbose, S112=0 for Cryptic) or with the ENABLEVERBOSE and DISABLEVERBOSE commands.

Cryptic responses include only the requested item’s value.

Verbose responses include descriptive text along with the item’s value. If units are associated with the item, the units will also be displayed. The SL and SFL commands are always verbose.

### 5.2.7.1. Response Line Termination

The Response Line Termination character(s) is (are) appended to each line returned from the HVG-2020B; the default is a Carriage Return, but this can be changed via S65 to one of the following:

For carriage-return (default), enter “S65=x0D”.  
For line feed, enter “S65=x0A”.  
For carriage-return linefeed, enter “S65 =x0D0A”.

### 5.2.7.2. RS485 Mode Responses

In RS485 mode, all responses and error messages from commands sent using the broadcast address (0x99) will be suppressed. The S5 command is an exception to this rule; when the device is the only HVG-2020B on the bus, the command \*99 S5 can be used to get the device’s address.

Other than the above behavior, responses will be no different than responses in RS232 mode. There will be no address in responses.

## 5.2.8. Commands

### 5.2.8.1. Reporting Commands

#### **P** Pressure

Returns the current pressure in the units specified in S22.

#### **P1** Start Pressure Streaming

Causes pressure readings to be output every 1/2 second.

#### **P0** Stop Pressure Streaming

Stops the 1/2 second pressure reading output.

#### **R** Pirani Pressure

Returns the current Pirani sensor pressure in the units specified in S22.

#### **Z** Piezo Pressure

Returns the current piezo sensor pressure in the units specified in S22.

#### **X** Pirani Drive Data

Returns Pirani drive counts, voltages and operating temperature.

#### **XXP** Get Pressure and Temperature

Returns current pressure and temperature readings.

### 5.2.8.2. System Commands

#### **A** Device Address (Read/Write)

The RS485 address (also given in S5). For backward compatibility. The same as S5.

**BAUD=** (Write Only) Set the baud rate

Sets the baud rate and stores it in non-volatile memory. Valid options are: 9600, 19200, 38400, 57600 and 115200

**H** High Setpoint (Read/Write)

This is the value above which the high setpoint will become active. The same as S21.

**L** Low Setpoint (Read/Write)

This is the value below which the low setpoint will become active. The same as S20.

**U** Pressure Units (Read/Write)

Returns the current pressure unit name in text. The same as S22. To set the pressure unit that the gauge is displaying, a numeric value is used as follows:

- 1 = TORR
- 2 = MBAR
- 3 = KPA
- 4 = PSIA
- 5 = PSIG
- 6 = ATM
- 7 = BAR
- 8 = PA

**S112=** Verbose Replies (Write Only)

Enables (Non-Zero value) or disables (0) Verbose Replies.

**ENABLE VERBOSE** Display descriptive text and units. Same as S112=1.

**DISABLE VERBOSE** Display values only. Same as S112=0.

**ENABLE RS485** Configure the serial port for RS485 communication

**DISABLE RS485** Configure the serial port for RS232 communication

**IS485TERMINATED** Read whether termination resistors are engaged

**NOTERMINATERS485** Disable termination resistors on RS485 communications

**TERMINATERS485** Enable termination resistors on RS485 communications

**RESTOREFACTORYDEFAULTS** Reset variables to the values stored at the factory.

Reset values include: Product config (S64), Piezo calibration curve settings, Pirani calibration settings, Gas calibration settings, Temperature settings, Analog output settings

**GPV** Get Piezo Value

Gets the current Piezo Value in counts. Can be used in conjunction with S15= to zero the Piezo only.

**RHIGH=** Pirani High-range Cal (Factory Write Only)

Runs Pirani high-range calibration with provided pressure. RHIGH=30 performs Pirani curve fit calculations at the given pressure of 30 Torr. Should only be performed between 20 and 50 Torr.

**RMID=** Pirani Mid-range Cal (Factory Write Only)

Runs Pirani mid-range calibration with provided pressure. RMID = 0.1 performs Pirani curve fit calculations at the given pressure of 0.1 Torr. Should only be performed between 0.1 and 1.0 Torr.

**SETKG=** Pirani Gas Bend Factor Cal (Unlock Write Only)

Runs Pirani Gas Bend Factor calibration with provided pressure. SETKG=10.1 performs Pirani Gas Bend Factor calculations at the given pressure of 10.1 Torr. SETKG, without the “=” and number, performs the same calculation with the current Piezo reading. Should only be performed between 1.0 and 12.0 Torr. Can only be performed when R8 is set to 7 or 8 (custom gas).

**SPAN=** (Factory Write) Span the Piezo Sensor

Calibrates the Piezo sensor span based on the current pressure value given. Pressure value is stored in S28 also.

**TEMPSET=** (Factory Read/Write) Calibrate the Piezo Sensor Temperature

Calibrates the Piezo sensor temperature based on the current temperature value given.

**TDAO** DAC zero output (Unlock Write)

In calibration mode, generate output voltage equivalent to 0.00001 Torr on the DAC (value determined by S51).

**TDAS** DAC span output (Unlock Write)

In calibration mode, generate output voltage equivalent to full scale pressure on the DAC (value determined by S52).

**TDAZ** DAC zero count output

In calibration mode, generate output voltage equivalent to 0 counts on the DAC. This will typically be -0.23 V.

**TOFF** DAC adjust complete

In calibration mode, write the D/A converter values to memory.

**ZERO** Set Pressure Zero

Sets S15 (Piezo Zero Value) and R15 (Pirani Zero Value) to the current sensor counts. The effect of this is the current pressure reading becomes the zero-pressure point.

**ZRO** Alias for ZERO

For backward compatibility.

### 5.2.8.3. State Commands

#### **SS** System State (Read Only)

Returns the current system state which can be one of the following:  
4 = Normal Operation  
8 = Calibration Mode

#### **SS4** Enter Normal Operation mode (Unlock Write)

Returns the system from Calibration Mode (SS8) to Normal Operations (SS4).

#### **SS8** Enter Calibrate mode (Unlock Write)

Sets system state to Calibrate, allows calibration of the Analog I/O.

#### **STATUS** Current system error status

Returns the current System Status word; if in Verbose Output mode (S112=1), returns descriptions of the presently active errors.

0x0008 CONTROL\_BOARD\_COMM\_ERROR  
0x0800 PIEZO\_COMM\_ERROR  
0x1000 PIEZO\_STATUS\_ERROR  
0x2000 PIEZO\_OVER\_LIMIT

#### **ML** Status Alias

This is an alias for the STATUS command for backward compatibility.

#### **HISTORY** System Error Status History

Returns any Status errors that have occurred since system reset

#### **CLEAR HISTORY**

Clears the Status History

#### **FAIL CODES** System Fail codes

Returns all System Status Failure codes which have occurred since the device left the factory or since the last time the CLEAR FAIL CODES command was sent

0x0008 CONTROL\_BOARD\_COMM\_ERROR  
0x0800 PIEZO\_COMM\_ERROR  
0x1000 PIEZO\_STATUS\_ERROR  
0x2000 PIEZO\_OVER\_LIMIT

#### **CLEAR FAIL CODES** (Factory Function)

Clears the Fail Codes

#### **FLOK** Enable/Disable Factory-Level Access

Resets the Factory Access Code, allows only customer-level changes. Enables Factory-Level Access if the correct code is entered, allowing changes to everything.

## 5.2.8.4. Sensor List Commands

### **SL** Sensor List (Read Only)

Returns all items in the Sensor List

### **SFL** System Full List

Returns all system variables for use in problem determination.

### **S1** Model (Read Only)

Returns the Model and Software Version of the device.

### **S5** Device Address (Read/Write)

Address used for RS485 mode addressing. This is a hex number which accepts values from 0x01 to 0x98 and 0x9A to 0xFF; 0x99 is the BROADCAST ADDRESS - all devices process this message, but do not respond unless the command is S5.



**NOTE:** The command \*99S5 should be used with one single device attached to the RS485 bus. This allows discovery of the current address of a device when it is not known.

### **S14** Number of Decimal Places (Read/Write)

The number of decimal places displayed for floating point values. Valid values are 0 to 7. This setting is reflected in the lower 3 bits of S2.

### **S15** Piezo Zero Value (Read/Write)

The piezo sensor zero value in counts. Changing this value can be used to adjust the zero-pressure indication even when at higher pressures.

### **S16** Piezo Slope Value (Read Only)

The piezo sensor slope in Torr/count

### **S18** Sensor Temperature (Read Only)

The current sensor board temperature

### **S20** Low Relay Set Point (Read/Write)

This is the value below which the low setpoint will become active. Same as L command.

### **S21** High Relay Set Point (Read/Write)

This is the value above which the high setpoint will become active. Same as H command.

### **S22** Pressure units (Read/Write)

Returns the current pressure unit name in text. Same as the U command. To set the pressure unit that the gauge is displaying, a numeric value is used as follows:

1 = TORR	5 = PSIG
2 = MBAR	6 = ATM
3 = KPA	7 = BAR
4 = PSIA	8 = PA

### **S28** Piezo Span (Factory Read/Write)

The pressure at which the Piezo sensor span was set.

### **S31** Analog Output Type (Read/Write)

Change the type of analog output. It is a 2-digit hex number, with the first digit used for changing the type of analog output. The second digit is only used for logarithmic outputs. Options are as follows:

0x0X = Logarithmic

0x1X = Linear

0x2X = NonLinear

0x3X = Dual Slope

The “X” denotes that it does not matter what is put there. The logarithmic option has 7 predefined slope/span selections, and 1 custom option. The numbers for the custom option can be set with S32 and S33. The selections are as follows:

0x00 = Span:9V @1000Torr, Slope:1V/Dec

0x01 = Span:8V @1000Torr, Slope:1V/Dec

0x02 = Span:8.6249V @1000Torr, Slope:1V/Dec

0x03 = Span:10.1608V @1000Torr, Slope:1.286V/Dec

0x04 = Span:20mA @1000Torr, Slope:2mA/Dec

0x05 = Span:20mA @1000Torr, Slope:2.5mA/Dec

0x06 = Span: CUSTOM, Slope: CUSTOM

### **S32** Analog Log Span (Read/Write)

This sets the logarithmic span for the custom analog output (selection 6 only).

### **S33** Analog Log Slope (Read/Write)

This sets the logarithmic slope for the custom analog output (selection 6 only).

### **S36** Analog Output (Zero Pressure) (Read Only)

The Analog Output voltage or current value which is output when the pressure is at 0% of full scale. This is controlled by S64 Product Config.

### **S37** Analog Output (FS Pressure) (Read Only)

The Analog Output voltage or current value which is output when the pressure is at 100% of full scale. This is controlled by S64 Product Config.

### **S51** DAC Zero Code (Factory Read/Write)

The Analog Output D/A value used to represent 0.00001 Torr pressure. If in CALIBRATE state (SS8), writes value to RAM and Sets the Analog Output to the level representing 0 pressure; otherwise, writes value to RAM and FLASH

Range is 0 to 65535. Defaults are as follows:

0 to 5 V, 0 to 10 V	32764
1 to 5 V	35742
0 to 20 mA	0
4 to 20 mA	10950

**S52 DAC Full Scale Code (Factory Read/Write)**

The Analog Output D/A value used to represent full scale pressure. If in CALIBRATE state (S58), writes value to RAM and Sets the Analog Output to the level representing full scale pressure; otherwise, writes value to RAM and FLASH

Range is 0 to 65535. Defaults are as follows:

0 to 5 V, 1 to 5V	47654
0 to 10 V	62545
0 to 20 mA, 4 to 20mA	54670

**S53 Analog Output Full Scale (Factory Read/Write)**

The pressure at which the linear analog output will be at its full-scale value in Torr. If S53=1000, at 1000 Torr, the analog output will be 10 V for a 0-10V unit or 20mA for a 4-20mA unit. For different units, first set S22=1, then convert the desired full scale to Torr and input the result into S53. For example, a full scale at 1000 mbar would be at S53=750. Then set S22 to the final desired units. S53 will show in converted units. The value of S53 is ignored for logarithmic and non-linear outputs.

**S54 Comment (Read/Write)**

This allows the end user to add up to 63 characters of free-format text for their own use.



NOTE: do not use the greater-than sign '>' in any text field because it could affect automated command response processing since it is used as the end-of-response character.

**S62 Cal Date (Read/Factory Write)**

The date the device was calibrated at the factory. This is a text field which accepts a maximum of 63 characters.

**S63 Cal Temp (Read/Factory Write)**

The temperature at which the device was calibrated at the factory. This is a text field which accepts a maximum of 63 characters.

**S64 Product Config (Read/Factory Write)**

The product configuration word. Valid settings are as follows:

0x00 = 0 to 5 Volt Piezo gauge	0x01 = 0 to 5 Volt Combo gauge
0x02 = 0 to 10 Volt Piezo gauge	0x03 = 0 to 10 Volt Combo gauge
0x04 = 0 to 1 Volt Piezo gauge	0x05 = 0 to 1 Volt Combo gauge
0x14 = 0 to 20 mA Piezo gauge	0x15 = 0 to 20 mA Combo gauge
0x1C = 4 to 20 mA Piezo gauge	0x1D = 4 to 20 mA Combo gauge

When this command is executed, the system may automatically re-start.

**S65 NextLine (Read/Write)**

The Response Line Termination character(s) sent at the end of each line of a response.

- For carriage-return (default), enter "S65=x0D".
- For line feed, enter "S65=x0A".
- For carriage-return linefeed, enter "S65 =x0D0A".

**S68** Instrument ID (Read/Factory Write)

The Instrument's ID string. This is a text field which accepts a maximum of 63 characters.

**S75** Control Board Id (Factory Read Only)

The Hex ID and Software Version of the Control Board.

**PFS** Piezo Full Scale (Factory Read/Write)

The piezo sensor full-scale output used to normalize the pressure reading for curve fitting. The value should always be 1000 Torr.

**C1** Piezo Linearization Coefficient #1 (Factory Read/Write)

The linear term of the equation used to fit the calibration data to improve accuracy. If no curve fit was required, this term will be 1 and the others 0.

**C2** Piezo Linearization Coefficient #2 (Factory Read/Write)

The quadratic term of the equation used to fit the calibration data to improve accuracy.

**C3** Piezo Linearization Coefficient #3 (Factory Read/Write)

The third-order term of the equation used to fit the calibration data to improve accuracy.

**PSF** Piezo Span Factor (Factory Read/Write)

The factor used to scale the normalized curve fit. Used with PFS, C1, C2 and C3. Pressure = PFS/PSF. If no curve fit was required, this term will be 1.

**R4** Pirani R Zero (Read/Factory Write)

Pirani resistance

**R5** Pirani Alpha Coeff (Read/Factory Write)

Pirani Alpha coefficient

**R6** Pirani Scale Factor (Read/Factory Write)

Pirani scale factor. Determined using RMD command

**R7** Pirani B Coeff (Read/Factory Write)

Pirani B coefficient. Determined using RHIGH command.

**R8** Pirani Gas (Read/Write)

0 = Nitrogen	5 = CF4
1 = Air	6 = SF6
2 = Helium	7 = Custom Gas 1
3 = Argon	8 = Custom Gas 2
4 = Hydrogen	

**R9** Pirani Gas Factor (Read/Unlock Write)

Pirani gas conversion factor. Can only be written to when R8 is set to 7 or 8.

**R10** Pirani Gas Bend Factor (Read/Unlock Write)

Pirani gas bend factor. Can only be written to when R8 is set to 7 or 8. Determined using SETKG command.

**R15** Pirani Zero Value (Read/Write)

Pirani zero value in counts

**R23** Pirani Temperature Set Point (Read/Factory Write)

Pirani temperature set point for PID control

**R24** Pirani Proportional Control (Read/Factory Write)

Pirani drive proportional coefficient

**R25** Pirani Derivative Control (Read/ Factory Write)

Pirani drive differential coefficient

**R26** Pirani Integral Control (Read/Factory Write)

Pirani drive integral coefficient

**R27** Pirani Drive (Read/Factory Only)

Pirani drive counts

**R29** Pirani Control Bias (Factory Read/Write)

Lowest Pirani control drive in counts

## 6. Troubleshooting

### 6.1. Authorized Maintenance

With proper care in installation and use, the pressure gauge will require little or no maintenance. If maintenance does become necessary, it is best to consult the factory before doing so, since some procedures may require recalibration. Entry into the gauge or tampering with the printed circuit board will void the warranty.



**NOTICE:** Do not perform repairs on these assemblies while the unit is still under warranty. If there is a problem, check the listing below to rule out some of the straight-forward solutions that may exist.

### 6.2. Troubleshooting

#### 6.2.1. Instrument Lists and Codes

If a problem occurs and obvious solutions are not apparent, the internal instrument values can be accessed digitally. Using a terminal emulation program, type **SFL**. This command will return a long list of values. These values can then be sent to the factory to better determine what the problem may be.

Also, issues that may have occurred are recorded in memory and may be accessed using the commands **STATUS**, **HISTORY** and **FAIL CODES**. See Commands section above.

#### 6.2.2. Possible Problems and Solutions

**Symptom:** Not able to communicate digitally.

**Action:** Check settings as found in Serial Communications section above. Make certain baud rate and 232/485 operation are correct. If using RS485 with a long cable run, make certain termination resistors are enabled on the last instrument on the bus.

**Symptom:** Pressure gauge is out of calibration and/or non-linear.

**Action:** Check all fittings for leaks. Pump system down well below 0.1 mTorr and re-zero the gauge.

**Symptom:** The output is non-repeatable at zero or span (unit drifts).

**Action:** Make certain the instrument is properly warmed up. Pump system down well below 0.1 mTorr and re-zero the gauge.

**Symptom:** Intermittent, “jumpy” or “noisy” output from instrument.

**Action:** Determine if something could cause the actual pressure to fluctuate. Ensure that the instrument is well grounded and that all electrical connections are secure.

**Symptom:** LED indication is red.

**Action:** Cycle power. If symptom persists, check FAIL CODES and consult the factory.

## 7. Warranty

### 7.1. Warranty Policy

See the company website for warranty information at:

<http://www.teledyne-hi.com/terms&conditions.htm>

### 7.2. Return Policy

See the company website for return information at:

<http://www.teledyne-hi.com/terms&conditions.htm>

Any product returned for either warranty or non-warranty repair must have been issued a Return Material Authorization (RMA) form.

RMA Forms may be obtained from the Information section of the Hastings Instruments website:

<http://www.teledyne-hi.com/inforeq.htm>



**WARNING:** Contaminated parts can be detrimental to health and environment. Ensure instruments are free of hazardous contamination prior to shipment.

#### Company contact information

TELEDYNE HASTINGS INSTRUMENTS

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HAMPTON, VIRGINIA 23669 U.S.A.

ATTENTION: REPAIR DEPARTMENT

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1-800-950-2468

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# 8. Drawings

