

HVG-PR

INSTRUCTION MANUAL



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Manual Print History

The print history shown below lists the printing dates of all revisions created for this manual. The revision level letter increases alphabetically as the manual undergoes subsequent updates. 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.

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.

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-PR is a small, low-cost electronics module with a Pirani sensor to provide the user with accurate vacuum measurements over the range of 1×10^{-4} Torr to 1000 Torr. The hot-wire Pirani sensor produces an absolute pressure signal dependent on the thermal conductivity of the surrounding gas remaining in the vacuum system. There are internal gas conversions available when used with gases other than nitrogen.

The vacuum envelope of the HVG-PR 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.

The HVG-PR 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-PR instrument has a modular PCB design that allows for flexibility in available features and options for OEM applications. This includes analog voltage output and digital RS485 communication via an 8-pin RJ-45 connector. A two-color LED provides instrument status and system pressure information as well.

The sensor exhibits excellent stability, and its output is characterized and digitally linearized to provide excellent accuracy. The pressure signal is made available digitally and is also converted to a logarithmic voltage signal.

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. 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.

Range:	1x10 ⁻⁴ Torr to 1000 Torr
Accuracy:	± (50% of reading) from 1000 to 100 Torr (Nitrogen) ± (15% of reading) from 100 to 0.001 Torr (Nitrogen) ± (50% of reading + .0001 Torr) from 0.001 to 0.0001 Torr (Nitrogen) at ambient operating temperature without temperature/humidity effects after 2 hours warm up followed by zero adjustment
Warm up time:	Within rated accuracy: 15 minutes (typical) For zero adjustment: 1 hour (typical)
Installation orientation:	any: no effect at vacuum, ±10% shift (typical) near atmosphere
Internal volume:	< 3.0 cc
Maximum Pressure:	Maximum operating: 1000 Torr Maximum overpressure: 2000 Torr / 25 psig (no change in performance)
Operating Temperature:	-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 degradation.

Humidity:	30 to 90 %RH, non-condensing
Thermal Zero Shift:	< 3.5 mTorr (over -20 to 70 °C range)
Thermal Span Shift:	0.4% of reading/ °C (typical) above 10 Torr (over 0 to 40 °C range) 1.0% of reading/ °C (typical) above 10 Torr (over 0 to 65 °C range) < 5% of reading (max) below 10 Torr (over -20 to 70 °C range) 6.5%/ °C (typical) between 200 and 300 Torr (beyond 0 to 40 °C)
Leak Integrity:	< 1x10 ⁻⁹ std. cc/s
Analog Output:	0-10 VDC (short-circuit protected, 1 kΩ min load)
Power Requirements:	0.41 watts max. / 12 to 36 VDC (0.36 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:	< 0.3 seconds (rapid evacuation), < 0.6 seconds (rapid vent)
CE Mark / KC Mark	EN55011, EN61326 / KSC9811, KSC9610
RoHS Compliant	YES
Wetted Materials:	304 and 316 stainless steel, glass, nickel, gold plated tungsten
Weight (approx.):	0.25 lb. (0.11 kg)
Connectors:	8-pin RJ-45 connector (power, analog signal, RS-485 serial)

1.2. Accessories

The HVG-PR instruments come with an 8-pin RJ-45 connector. A variable length cable with bare leads (Part # CB-HVGPR-LEADS-XXX) is available to interface with the HVG-PR.

Special cabling for power and RS-485 communications can be made available upon request.

Cabling for use with the THCD-101 power supply providing a remote display method can be made available upon request.

Special fixturing to assist with daisy-chaining units on an RS485 bus can be made available upon request.

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-PR 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 touch 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. Serious 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 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-PR comes with one of two vacuum connections: 1/8" NPT or KF-16.



NOTICE: When installing the 1/8" NPT version, be certain to use the 1/2" wrench flats. Do not tighten by gripping the housing as 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-PR 8-pin RJ-45 connector pin assignments are listed here.



NOTICE: This is **NOT** an Ethernet connection. Connecting to a powered Ethernet cable will cause equipment damage.

Pin #	
1	+ Power (12-36 VDC)
2	Power/Digital Common
3	Analog Output
4	Gauge ID resistor
5	Analog Common
6	RS-485+ (B)
7	Remote Calibration
8	RS-485- (A)



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

2.3.2. Power Input

The HVG-PR has its own internal switching power supply and requires between 12 and 36 VDC input voltage. The +VDC supply is pin 1 and the -VDC return is pin 2.



NOTICE: The base must be connected to ground for proper noise immunity and to meet CE Mark standards.

The gauge requires a maximum of 0.41 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 or by using the push-button (See Section 2.4). The analog output voltage is available on pin 3 and referenced to analog common on pin 5.

The analog output is user selectable to be one of two logarithmic voltage options (0 - 11 VDC full range, short-circuit protected, 1 kΩ min load). The standard output of the pressure meter is a 2 to 9 VDC signal logarithmically related to the pressure (9 VDC = 1000 Torr, 1 VDC/decade). The other is a 1.16 to 10.16 VDC signal (10 VDC = 1000 mbar, 1.286 VDC/decade).

Logarithmic Analog Outputs

Option	Slope	@ .0001 Torr	@ 1000 Torr	P(Torr) from V(volts)	V(volts) from P (Torr)
0-10V Log, 9V FS	1.00 V/dec	2.0000 V	9.0000 V	$P = 10^{(V-6)}$	$V = \log_{10} P + 6$
0-10V Log, 10V FS	1.286 V/dec	1.1600 V	10.1620 V	$P = 10^{0.778(V-6.304)}$	$V = 1.286 \log_{10} P + 6.304$



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

2.3.4. Serial Connection

The HVG-PR uses pins 6 and 8 of the RJ-45 jack on the top of the instrument for 2-wire RS485 digital communication. These pins are typically wired as part of a twisted pair channel.



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

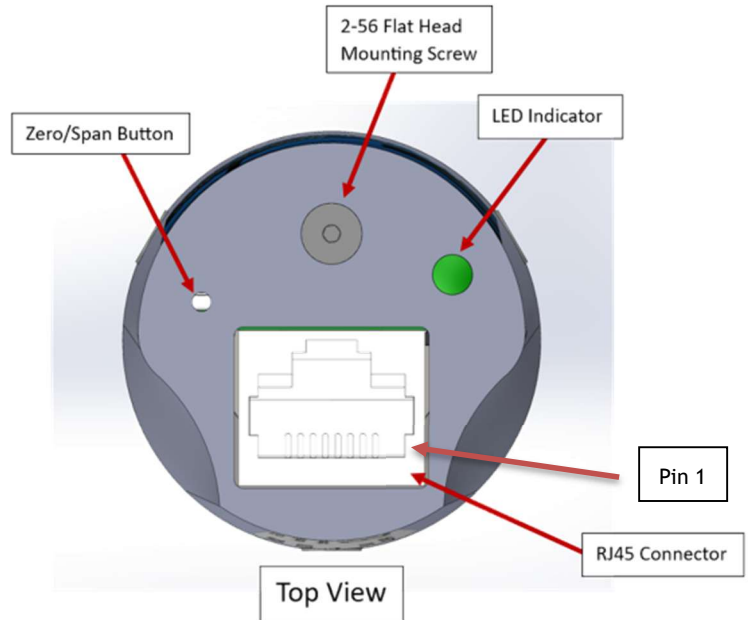
The HVG-PR uses RS485 receivers that are protected from bus over-voltages and will not be damaged if connected to a bus without a driver or pull up resistors. The HVG-PR does not provide bus termination. External termination of the RS485 bus using a 120 resistor may be required for some configurations. This is not normally necessary for short cables.

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-PR is signaled by a “>” character. See Serial Communications section later in this manual for more information.

2.4. Push-button Operation

On top of the HVG-PR instrument, there is a push-button that serves to reset the zero or atmosphere settings by pressing and holding it for at least 3 seconds. When the Pirani power is sensed to be below .003 W (approx. 1 Torr), the unit will rezero. When the Pirani power is sensed to be above .02 W (approx. 100 Torr), the unit will reset atmosphere. *The user must ensure that the pressure is indeed at hard vacuum or atmosphere for proper adjustment.*

The push-button has an additional function to toggle between the two analog output settings. Press and hold the button before applying power, then apply power and continue holding button until the LED blinks.



2.5. LED Operation

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

System State	LED Indication
Pressure > 1000 Torr	Steady Orange
Pressure 700 to 1000 Torr	Steady Green
Pressure < 700 Torr	Flash Green at 1 second rate, Duty cycle proportional to log of pressure
Pressure < 1 Torr	Short flash green at 1 second rate
Pressure < 0.01 Torr	Short flash green at 2 second rate
Pirani Sensor Failure	Steady Red
Analog Calibrate Mode	Flash Green at 1/2 second rate
Push-button Adjust	Flash Green at 1/2 second rate, 5 times
Power-Up 9.0 V Scale	Flash Green at 1/2 second rate, 3 times
Power-Up 10.16 V Scale	Flash Green at 1/2 second rate, 6 times

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 8-pin RJ-45 connector according to cable pinout. This is **NOT** an Ethernet connection.
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 1/2" 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 1×10^{-4} Torr. Ideally the gauge should be powered for two hours before setting the zero.
9. To set the zero, press and hold the push-button until the LED flashes.

3. General Operation

3.1. 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-PR is intended for use in non-condensing environments only. Condensate or any other liquids which enter the gauge may destroy its electronic components.

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

3.3. Positive Pressure Operation



WARNING: The HVG-PR 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 an NPT terminated gauge in an O-ring sealed quick connect fitting if system pressure could exceed atmospheric pressure.

If pressure goes above 1000 Torr, the LED indicator will turn orange.

3.4. 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. 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 can be determined.

3.5. Pirani and Gas Interactions

The Pirani sensor output is affected by use of different gases. To allow for accurate measurement of vacuum in a specific gas, there are eight pre-defined 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 3.6.

<i>Gas Name</i>	<i>Gas Factor</i>	<i>Gas Bend Factor</i>	<i>High Range Factor</i>
Nitrogen	1	1	1
Air	0.999	1.052	1
Helium	1.089	-0.676	NA
Argon	1.512	0.881	1.45
Hydrogen	0.656	-0.545	NA
CF ₄	1.015	2.853	1.30
SF ₆	0.913	0.4327	1.35
CH ₄	0.65	1.1	0.70

3.6. Calibration Procedure



NOTICE: The HVG-PR 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-PR calibration requires digital communication. See Section 4.

1. Attach the HVG-PR 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 low value equal to the value indicated by the pressure reference: **RLOW= 0.###**
7. Backfill with nitrogen to between 20 and 50 Torr. Set the Pirani mid value equal to the value indicated by the pressure reference: **RMID= ##.##**
8. Backfill with nitrogen to between 250 and 300 Torr. Set the Pirani high value equal to the value indicated by the pressure reference: **RHIGH= ###.#**
9. 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-PR can be calibrated using a specific gas to provide better accuracy.

1. Make sure the HVG-PR 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=#.#.#.**

4. Digital Operation

4.1. Instrument States

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

State 4	Operation
State 8	Calibration

After power up, the LED will first flash to indicate the analog output type, then the instrument will enter the Operation state (4).

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

4.2. Serial Communications

4.2.1. General

The HVG-PR provides 2-wire RS485 serial communication via an 8-pin RJ-45 jack.

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).

4.2.2. The Sensor Lists

The HVG-PR 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. The Pirani sensor list (RL) contains Pirani sensor-specific information.

4.2.3. Command Prompt

The prompt character is a greater than symbol '>' (x3E); when this symbol is received, the HVG-PR 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).

4.2.4. Command Format

The HVG-PR 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, S14 Number of Decimal Places. To change an item, enter the item to be changed followed by the equals sign '=' followed by the new value, e.g. S14=5.

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.

4.2.5. RS485 Mode

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-PR 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-PR 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-PR 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 2.3.4 earlier in this manual for more information

4.2.6. 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.

4.2.6.1. Response Line Termination

The Response Line Termination character(s) is (are) appended to each line returned from the HVG-PR; 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".

4.2.6.2. 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-PR 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.

4.2.7. Commands

4.2.7.1. Reporting Commands

P Pressure

Returns the current pressure in the units specified in S22.

M Reset Device

Software reset - similar to power on reset

R Pirani Pressure

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

X Pirani Drive Data

Returns Pirani drive voltage (V), current (mA), and wire temperature (°C), and control error (°C).

XXP Get Pressure and Temperature

Returns current pressure and board temperature readings.

CE Control Data (Factory Read only)

Returns Pirani control data for engineering diagnostics.

4.2.7.2. System Commands

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

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.

ENABLEVERBOSE Display descriptive text and units. Same as S112=1.

DISABLEVERBOSE Display values only. Same as S112=0.

RESTOREFACTORYDEFAULTS Reset variables to the values stored at the factory.

Reset values include: Product configuration, Pirani calibration settings, Gas calibration settings, Temperature settings, Analog output settings

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

Runs Pirani high-range calibration with provided pressure. RHIGH=250 performs Pirani curve fit calculations at the given pressure of 250 Torr. Should only be performed between 200 and 300 Torr.

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

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

RLOW= Pirani Low-range Cal (Factory Write Only)

Runs Pirani low-range calibration with provided pressure. RLOW = 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. 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 Pirani Sensor

Calibrates the Pirani sensor span based on the current pressure value given. Pressure and power values are stored in R11 and R12.

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

Calibrates the instrument temperature based on the current temperature value given.

TDAO DAC zero output (Unlock Write)

In calibration mode, programs the DAC to output 1.0 V assuming nominal amplifier gains. The analog output voltage measured under this condition is used to set the S51 value for calibrating the analog output response. (This forms the first point in a two-point line fit calibration)

TDAS DAC span output (Unlock Write)

In calibration mode, programs the DAC to output 9.0V assuming nominal amplifier gains. The voltage measured under this condition is used to set the S52 value for calibrating the analog output response. (This forms the second point in a two-point line fit calibration).

TOFF DAC adjust complete (Unlock Write)

Turns off calibration mode (equivalent to SS4)

OL Open loop drive enable/disable (Factory Read/Write)

Enable (1)/ Disable (0) Pirani drive open loop control. When enabled the Pirani wire drive output is directly set by the OD command instead of being controlled by the temperature setpoint.

OD Open loop drive (Factory Read/Write)

The open loop value for the Pirani wire drive. 0.0-1.0 when open loop mode is enabled. CAUTION - setting OL too high under vacuum conditions below 10 Torr can result in destruction of the Pirani wire due to overheating.

AO Analog output (Unlock Read/Write)

When in calibration mode, this can be used to set the analog output to an arbitrary voltage level between 0 and -11V. This can be used to verify the calibration

ZERO Set Pressure Zero

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

ZRO Alias for ZERO

For backward compatibility.

4.2.7.3. 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.

0x0001 PIRANI_DRIVE_ERROR
0x0002 PIRANI_PRESSURE_INVALID
0x6000 PIRNIN_OVER_LIMIT
0x8000 PIRANI_WIRE_ERROR

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

CLEARHISTORY

Clears the Status History

FAILCODES 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

0x0001 PIRANI_DRIVE_ERROR
0x0002 PIRANI_PRESSURE_INVALID
0x6000 PIRNIN_OVER_LIMIT
0x8000 PIRANI_WIRE_ERROR

CLEARFAILCODES (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.

4.2.7.4. 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.

S18 Sensor Temperature (Read Only)

The current sensor board temperature

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

S31 Analog Output Type (Read/Write)

0 = Span:9V @1000Torr, Slope:1V/Dec
1 = Span:10.162V @1000Torr, Slope:1.286V/Dec

S32 Analog Log Span (Read only)

This sets the logarithmic span for the custom analog output.

S33 Analog Log Slope (Read only)

This sets the logarithmic slope for the analog output.

S36 Analog Output (Zero Pressure) (Read Only)

The Analog Output voltage value which is output when the pressure is at 0% of full scale.

S37 Analog Output (FS Pressure) (Read Only)

The Analog Output voltage which is output when the pressure is at 100% of full scale.

S51 Analog Output Low Calibration Voltage (Factory Read/Write)

Voltage generated at the analog output when DAC is set to nominal 1.0 V output.

S52 Analog Output High Calibration Voltage (Factory Read/Write)

Voltage generated at the analog output when DAC is set to nominal 9.0V output

S53 Analog Output Full Scale (Factory Read/Write)

The pressure at which the analog output will be at its full-scale value in Torr. If S53=1000, at 1000 Torr, the analog output will be 9V or 10.162V depending on the selected output scale.

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.

S65 New Line (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.

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 RLOW command

R7 Pirani B Coeff (Read/Factory Write)

Pirani B coefficient. Determined using RMID command.

R8 Pirani Gas (Read/Write)

0 = Nitrogen	5 = CF4
1 = Air	6 = SF6
2 = Helium	7 = CH4
3 = Argon	8 = Custom Gas 1
4 = Hydrogen	9 = Custom Gas 2

R9 Pirani Gas Factor (Read/Unlock Write)

Pirani gas conversion factor. Can only be written to when R8 is set to a custom gas selection

R10 Pirani Gas Bend Factor (Read/Unlock Write)

Pirani gas bend factor. Can only be written to when R8 set to a custom gas selection. Determined by gas selection or using SETKG= command.

R11 Pirani Span Power (Factory Read/Write)

Pirani power at the span calibration point.

R12 Pirani Span Pressure (Factory Read/Write)

Pressure at the span calibration point.

R13 Pirani High Power (Factory Read/Write)

Pirani power at the high calibration point (250 to 300 Torr).

R14 Pirani High Pressure (Factory Read/Write)

Pressure at the high calibration point (250 to 300 Torr).

R15 Pirani Zero Value (Read/Write)

Pirani zero value in counts

R16 Pirani High Calibration Slope (Factory Read/Write)

High calibration slope (Torr/W) calculated with SPAN=.

R17 Pirani High Calibration Offset (Factory Read/Write)

High calibration offset value, calculated with RHIGH=.

R18 Pirani Low Power (Factory Read/Write)

Pirani power at the low calibration point (0.1 to 1 Torr).

R19 Pirani Low Pressure (Factory Read/Write)

Pressure at the low calibration point (0.1 to 1 Torr).

R20 Pirani Normalized Power (Read only)

Normalized Pirani power

R23 Pirani Temperature Set Point (Read/Factory Write)

Pirani temperature set point for PID control

R24 Pirani Proportional Control Low Pressure (Read/Factory Write)

Pirani drive proportional coefficient for low pressure ranges

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 0-1 (Fraction of full scale of the DAC)

R29 Pirani Control Bias (Factory Read/Write)

Lowest Pirani control drive in fraction of full scale 0-1.

R30 Pirani Proportional Control High Pressure (Read/Factory Write)

Pirani drive proportional coefficient for high pressure ranges

R31 Pirani Proportional Control Power Knee (Read/Factory Write)

The normalized power knee of the s-curve for scaling the proportional factor between the min and max. The PID proportional factor is computed based on the normalized power w of the Pirani wire. This is needed because temperature response of the wire changes with pressure.

$$P = 10^{\log\left(\frac{P_{max}}{P_{min}}\right) \frac{1}{1+e^{-2\log\left(\frac{w}{w_0}\right)}} + \log(P_{min})}$$

R32 Pirani Gas Factor High Pressure (Read/Unlock Write)

Pirani gas conversion factor for upper pressure range. Can only be written to when R8 is set to a custom gas selection

5. Troubleshooting

5.1. 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.

5.2. Troubleshooting

5.2.1. 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.

5.2.2. 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 2-wire RS485 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 FAILCODES and consult the factory.

6. Warranty

6.1. Warranty Policy

See the company website for warranty information at:

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

6.2. Return Policy

See the company website for return information at:

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

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 Calibration and Repair section of the Hastings Instruments website:

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



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

804 NEWCOMBE AVENUE

HAMPTON, VIRGINIA 23669 U.S.A.

ATTENTION: RMA # that has been issued for return

TELEPHONE (757) 723-6531
1-800-950-2468

FAX (757) 723-3925

E MAIL mailto:hastings_service@teledyne.com

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

7. Drawings

