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Honeywell Precision Pressure Transducers

PPT and PPTR User's Manual

Honeywell

ADS-14052 Rev. 01/12

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0 USERS MANUAL CONTENT

This user's manual is divided into the following sections.

Section 1	**Introduction—**Product overview and hardware description.
Section 2	**Getting Started—**Lists equipment and procedures necessary to operate the PPT and provides a few simple command examples, which will get first-time users acquainted with the command structure.
Section 3	**Commands: Quick Reference—**A brief description of each command with typical PPT input and response examples.
Section 4	**Functional Operation**
Section 5	**Commands—**Contains a detailed description of the command structure, functional groupings and all user commands.
Section 6	**Electrical Connections—**Contains wiring diagrams for various PPT electrical connections.
Section 7	**Timing Diagrams—**Illustrates RS-232 serial port timing for command and reply interaction.
Section 8	**Specifications—**Contains electrical and environmental specifications.
Section 9	**Dimensions—**Contains a case outline of the PPT

It is suggested that the first-time user read the "Getting Started" section to be sure the necessary items are on hand. PPTs are available in various pressure ranges for absolute, gauge and differential modes of operation. Be sure to connect a source of pressure that matches the transducer range and mode.

1 INTRODUCTION

1.1 PRODUCT OVERVIEW

The Honeywell Model PPT and PPTR Precision Pressure Transducers (PPT) provide high accuracy pressure readings in both digital and analog form. The first-time user will be able to use the PPT within minutes, yet capability exists to configure the PPT for optimum performance in specific applications. Throughout this User's Manual, both the PPT and PPTR will be referred to as PPT (Precision Pressure Transducers) unless the specific model number is stated.

The heart of the PPT measuring system is a silicon piezoresistive sensor which contains both pressure and temperature-sensitive elements. Digital signals representing temperature and pressure are processed by a microprocessor to produce fully temperature compensated and calibrated pressure readings over the entire -40 to 85 °C temperature range. The output modes are shown in Table 1.1.

The PPT receives commands and sends data from either a RS-232 port or a multidrop RS-485 port. Using the RS-232 type PPT, up to 89 units can be connected in a ring configuration to a single serial port of a computer. The RS-485 type PPT allows up to 89 PPTs to be connected to a two-wire multidrop bus, when bus repeaters are used to satisfy the RS-485 bus electrical requirements. Group (multicast) addressing allows up to nine groups of PPTs to be addressed with a single command. Global (broadcast) addressing will send a command to all PPTs on the serial bus. Any computer having a serial port and terminal emulation software can be connected to the PPT to allow the user to select baud rates, sample rates, readout resolution, units of pressure and other choices.

Analog output from the 12-bit digital-to-analog converter may be obtained without a host computer. User selected functions may be set through the digital interface. The selected functions may either be used temporarily, until the PPT is powered down, or may be stored in the internal EEPROM to automatically configure the PPT each time power is applied.

Both the analog and digital outputs are corrected digitally over the full range of -40 to 85 °C. The PPT has a typical accuracy of 0.05% of full scale (FS) and the PPTR has a typical accuracy of 0.10% FS. Note that full scale for a 20 psig and a 20 psia is *20 psi*, but for a 20 psid it is *40 psi*. This is important to note when determining the accuracy allowance.

Digital Output	**Analog Output**
Single or Continuous Pressure Readings	Single Pressure Analog Voltage
Single or Continuous Temperature Readings	Tracking Pressure Analog Voltage
Single or Continuous Remote PPT Values	User Set Analog Voltage
	Remote PPT Controlled Voltage

Table 1.1—Various Digital and Analog Output Modes

1.2 HARDWARE DESCRIPTION

See Sections 8 and 9.

2 GETTING STARTED

2.1 OVERVIEW

The first-time user should approach the PPT in a manner analogous to using a word processor program; i.e., many features are available but one may begin by using those of interest at the moment. Section 2.7 of this manual lists command features by functional groups to assist in this selection. When shipped from the factory, the default settings provide a pressure transducer that will be usable for many applications. Once the user is familiar with the performance and command structure, changes may be made and stored using the 'Store Parameters' (SP) command. Once stored, the new default settings are activated each time the PPT is powered up. This tailors the personality of the PPT to meet the needs of a particular application.

2.2 EQUIPMENT NEEDED

To prepare the PPT for operation, three items are needed:

- A mating connector with proper wiring connections (see connector part number and wiring diagram in Section 6—Electrical Connections);
- A DC power supply;
- A source of pressure that is properly matched to the range and type of the PPT.

To operate the PPT in the analog output mode, one additional item is needed:

- *Voltage Output* - A five digit voltmeter with 0-5 volt range connected between Analog Out and Signal Common. A computer is not required when operating in this mode.

To operate the PPT in the digital output mode, one additional item is needed:

- A computer, or host processor, having an RS-232 or RS-485 serial port and terminal program software such as PROCOM™, VERSATERM™, TERMINAL (Windows® 3.x) or HYPERTERMINAL (Windows® 95). These programs are normally used to interface to a modem. The wiring diagram designates which PPT pins must connect to the computer "send", "receive" and "common" pins for proper communications. Some computers may not have an RS-232 or RS-485 serial port connection identical to the one shown in Section 6, making it necessary to adapt the PPT connections to that particular computer.

2.3 TERMINAL PROGRAM SETTINGS

- Enter the following settings in the terminal program:

  Baud Rate 9600
  Start Bits 1
  Data Bits 8
  Stop Bits 1
  Parity .... None

- Attach a line feed to the carriage return.
- Turn the local echo ON.

When shipped from the factory, the PPT is set to a baud rate of 9600, 1 start bit, 8 data bits with no parity and one stop bit. If the baud rate has been subsequently changed, and is unknown, it will be necessary to search all baud rate values to reestablish communication. See the BP command description in Section 5.10 of this manual for possible settings.

2.4 INITIAL TURN-ON RESPONSE

Analog Output

The analog output will provide a voltage (range 0-5V) which, when no pressure is applied to the PPT, reads:

Pressure Type	Voltage Output (@ zero applied pressure)
Gauge units	0 volt
Differential units	2.5 volts
Absolute units	A voltage representing atmospheric pressure

Digital Output

Once the wiring connections and terminal program settings are complete, the PPT will automatically send the following response (or similar to) when power is applied. This reply will be generated any time power is applied to the PPT.

Typical Reply:

RS-232 ?01PPT____10__psid

RS-485 ?00PPT____10__psid

The "**?01**" or "**?00**" indicates a default address device called a "null address". This PPT has not yet been assigned an ID number so it assumes the null address. The "**PPT____10__psid** " indicates a 10 psi differential device.

2.5 COMMAND FORMAT

Any command interaction with the PPT requires electrical connection to the RS-232 or RS-485 serial communications pins. There are two basic types of commands – action directing commands and information requesting commands. Theses are described in Commands – Section 5.

Typical PPT commands have the form ***ddcc = nnn** <cr>

Where:	*	is the command header character
	dd	is the decimal address of the PPT
	cc	is a command (refer to Commands – Section 5 for a complete description of commands)
	=	equal sign (required in some commands)
	nnn	additional characters (required in some commands)
	<cr>	carriage return is required to end all commands (do not type, press the ENTER/RETURN key)

2.6 STEP-BY-STEP EXAMPLES *(Only for single PPT connection)*

READ SINGLE PRESSURE

Once the PPT is powered up and connected to a computer, enter the following command:

Type: *00P1 <cr> **Response:** **?01CP=15.458** (for RS-232)
?00CP=15.458 (for RS-485)

where * indicates the start of a command
00 is the null address of the PPT (see note below)
P1 is the command to read the most current pressure

Note: The "?" indicates a response from a null address PPT – one which has not been assigned a device ID. A null address, 00, is coded into each PPT at the factory. When a RS-232 null address PPT responds, it adds one to its address, hence, the response '01'. Refer to the **ID** command in Appendix A for a description of addresses and responses.

In the reply, the "01" identifies the individual unit address (range 01-89). The "CP=15.458" indicates a compensated pressure of 15.458 psi. Your unit may not show this specific reading, depending on the applied pressure it is measuring.

SET DEVICE ID

To give the PPT an assigned address of 01 up to 89, enter the following commands:

Type: *00WE <cr> This enables the PPT to change a parameter in RAM

Type: *00ID=01 <cr> This sets the null addressed PPT to device ID=01.

Note: The device ID is now used in the command input

Type: *01S= <cr> **Response: #01S=00052036** (serial number test)

The "**#**" now replaces the "**?**" in the header and indicates the PPT response is from an address assigned unit.

where: * indicates the start of a command
00 is the null address of the PPT
W E is the command to enable a configuration parameter change
I D is the command to change the device address
01 is the assigned PPT address for this example
S= is the command to read the serial number

READ PRODUCTION DATE

To read the production date, enter the following command:

Type: *01P= <cr> **Response: #01P=04/13/95**

READ CONTINUOUS PRESSURE

For continuous pressure readings at the factory set default rate of 5 per second, enter the following command:

Type: *01P2 <cr> This enables a continuous stream of compensated pressure readings to flow into the terminal program.

Type: $*99IN <cr> This is the best way to stop the continuous pressure reading commands. The '$' character temporarily stops, or suspends, either the continuous pressure or temperature readings. The *99IN command stops the continuous pressure readings.

CHANGE TO A NEW SAMPLE RATE

Enter the following command:

Type: *01WE <cr> This enables the PPT RAM to accept a changed parameter.

Type: *01I=M20<cr> This sets the integration time to value 20, which corresponds to an output sample every 2 seconds.

The sample rate will change to one every 2 seconds. **I=** is an abbreviation for Integration time which determines how long to accumulate pressure samples between readings. Each integration period gathers the data for one pressure reading output (see Section 4.2 What is integration?). The range of integration times can be set by specifying readings per second (I=R45 for 45 readings/sec) or time delay in 100 millisecond intervals (I=M60 for 6 seconds). The factory set integration time is 5 samples per second (I=M2).

The output data rate can also be altered by use of the idle count (**IC**) command or by changing the reading rate (**RR**) command in conjunction with the operating mode (**OP**) command. See Section 4 for description of these commands.

REPEAT THE READ CONTINUOUS PRESSURE STEP ABOVE

Notice the slower output rate of one sample every 2 seconds.

TRY OTHER COMMANDS

Experiment with other commands to become familiar with the command structures. A short overview of each command with input and response examples is shown in Section 3 Commands – Quick Reference. See Section 5—Commands for complete command descriptions. Until an **SP=ALL** command is executed, no changes will be stored in the EEPROM. Re-apply the power or send an **IN=RESET** command to revert to EEPROM default settings.

2.7 COMMAND FUNCTIONAL GROUPS

PRESSURE DISPLAY UNITS *PPT reads out psi, in wc, mm Hg, etc.*

D U	Set pressure units for output readings—any one of 13 common units
U =	Specify a user supplied unit of measure

TEMPERATURE

T1	Single °C
T2	Continuous °C
T3	Single °F
T4	Continuous °F

RS-232/RS-485 BUS PARAMETERS

BP	Changes baud rate and parity
I D	Assign device ID and group addresses
M =	Select alternate message Headers [RS-485 only]
SI	Synchronize Integration cycles among units [RS-485 only]
TO	Set Transceiver Operating parameters

OUTPUT READING AND RATE *Speed up or slow down output rate*

Single Reading Commands

P1	Single RS-232 pressure reading...ASCII format
P3	Single RS-232 pressure reading...binary format
T1	Single RS-232 temperature reading...°C
T3	Single RS-232 temperature reading...°F

Continuous Readings Commands

P2	Continuous RS-232 pressure readings...ASCII format
P4	Continuous RS-232 pressure readings...binary format
T2	Continuous RS-232 temperature readings...°C
T4	Continuous RS-232 temperature readings...°F

Integration Time Commands —*Changes pressure reading response time*

DS	Set deadband and sensitivity parameters
I =	Set pressure integration time, and reading rate
S2	Set threshold level for 2X speed shift
S5	Set threshold level for output within any 50 msec period
SI	Synchronize pressure Integration cycles

Idle Count Command —*Changes pressure reading response time*

I C	Set number of idle integration cycles

Reading Response To Changes In Input Pressure—*Filters small changes*

S2	Set threshold level for 2X speed shift
S5	Set threshold level for output within any 50 msec period
RR	Set number of identical readings to skip
OP	Transmit all readings or only changed readings

FORMAT PRESSURE READINGS—*Changes data length into host processor*

Binary Format Commands

P3	Single RS-232 pressure...binary format
P4	Continuous RS-232 pressure...binary format
OP	Set operating mode...binary format checksum...set signed or extended binary output format

ASCII Format Commands

	All readings, except P3, P4 and ~, are ASCII format readings.
OP	Set operating mode...all readings or only changed readings

START-UP PARAMETERS—*Sets the PPT configuration after power is applied*

WE	Enable parameter writes to the RAM or EEPROM
SP	Store RAM parameters to the EEPROM for startup
M O	Specify the power-up message and operating mode

PRESSURE NOISE REDUCTION—*Reduces pressure noise signals*

DS	Set deadband and sensitivity parameters

ANALOG OUTPUT

D A	Enables PPT sensed pressure to control the analog output
N E	Enable host computer control of the analog output
N =	Supply an analog output value in ASCII format, by host computer
~	Supply an analog output value in binary format, by host computer
H =	Set the analog highest reading FS voltage
L =	Set the analog lowest reading voltage
O=	Set pressure window offset for minimum analog reading
W=	Set pressure window width for analog full scale span
A N	Turn on or off the customized H=, L=, O=, and W= analog scales

DIAGNOSTIC AND RESET CONTROL

I N	Performs a software reset of microprocessor
RS	Read status of error indicators
C K	Performs and provides the result of EEPROM checksum
OP	Use pressure reading checksum for binary format

OFFSET TARE CONTROL

T=	Allows user to install an offset in the output reading
TC	Turn on or off user controlled tare function

USER AND STARTUP MESSAGES

A=	Store 8 characters of user supplied data
B=	Store 8 characters of user supplied data
C=	Store 8 characters of user supplied data, which can be configured as a watchdog or reset message
D=	Store 8 characters of user supplied data, which can be configured as a watchdog or reset message
M O	Specify the startup header selection

PPT UNIT INFORMATION

P=	PPT production date
S=	PPT serial number
V=	PPT software version number
I D	Assign device ID and group addresses
M =	Read the maximum full scale pressure limit allowed

CUSTOMIZE PRESSURE WINDOW

F=	Customize the full scale pressure limit
O=	Set pressure window offset for minimum analog reading
W=	Set pressure window width for analog full scale span
X=	Set the slope “m” parameter for user input mx+b control
Y=	Same as X= but for negative slope in differential device
Z=	Set the offset “b” parameter for user input mx+b control

3 COMMANDSQUICK REFERENCE

			Example Input (1)	Example Response (2)
A N	**Analog Range Setting**			
		Turn analog customization on	*01WE *01AN=ON	
		Inquiry	*01AN	#01AN=ON
A=	**Data String A**			
		Write string A	*00WE	
	(up to 8 characters, a <cr> indicates end-of-message. More than 8 characters is an invalid write)		*00A=2-8-95	
	(Can store info. such as dates, readings, etc.)	Inquiry	*00A=	?01A=2-8-95
B P	**Baud Rate and Parity Setting**			
		Set parameters	*99WE	
		(no parity, 1200 baud)	*99BP=N1200	
B=	**Data String B**			
		Write string B	*00WE	
	(up to 8 characters, a <cr> indicates end-of-message, and more than 8 characters will not write to location)		*00B=123.4567	
	(Can store info. such as dates, readings, etc.)	Inquiry	*00B=	?01B=123.4567
C K	**Check EEPROM**			
		Inquiry	*00CK	?01CK=OK
C=	**Data String C**			
		Write string C	*00WE	
	(up to 8 characters, a <cr> indicates end-of-message, and more than 8 characters will not write to location)		*00C=This_is_	
	The C and D string can be used for a watchdog or reset message (see MO command).	Inquiry	*00C=	?01C=This_is_
D A	**Digital and Analog Control**			
			*00WE	
		Turn on analog output only	*00DA=A	
		Inquiry	*00DA	?01DA=A
D O	**Default Operating Parameters**			
		Set DO parameters	*00WE	
		(factory default setting)	*00DO=E	
		Inquiry	*00DO	?01DO=E0N
D S	**Deadband and Sensitivity Control**			
		Set DS parameters	*00WE	
		(set deadband to 20 x 0.005% = 0.10%FS)	*00DS=20	
		Inquiry	*00DS	?01DS=00S0
D U	**Display Units Control**			
		Set DU parameters	*00WE	
		(set units to in. Hg)	*00DU=INHG	
		Inquiry	*00DU	?01DU=INHG
D =	**Data String D**			
	(up to 8 characters, a <cr> indicates end-of-message,	Write string D	*00WE	
	and more than 8 characters will not write to location)		*00D=A_PPT!!!	
	The C and D string can be used for a watchdog or reset message (see MO command).	Inquiry	*00D=	?01D=A_PPT!!!
F =	**Custom Full Scale Range**			
		Set F= parameter	*00WE	
		(set custom FS range to 10.5psi)	*00F=10.5	
		Inquiry	*00F=	?01F=10.500
H =	**Highest Analog Output Voltage**			
		Set H parameter	*00WE	
		(set analog high value to 82% x 5V = 4.2V)	*00H=82	
		Inquiry	*00H=	?01H=82

Note: See Section 5.10 for complete command descriptions.

		Example Input (1)	Example Response (2)
I C	**Idle Count Parameter**		
	Set IC parameter	*00WE	
	(set idle count to 12 , so that 12 output samples are skipped)	*00IC=12	
	Inquiry	*00IC	?01IC=12
I D	**Identification Number**		
	Set ID number	*00WE	
	(set device ID of first null addressed unit to 12)	*00ID=12	
	Confirmation of ID=12	*12P1	#12CP= 14.32
	Set group number	*12WE	
	[RS-232] *(set group ID of unit 12 to 95)*	*12ID=95	
	[RS-232] Group no. inquiry of device ID=12	*12ID	#12ID=95
	[RS-485]*(set group ID of unit 12 to 95 with group sub-address of 01)*	*12ID=9501	
	[RS-485] Group no. inquiry of device ID=12	*12ID	#12ID=9501
I N	**Initialize PPT Microprocessor**		
	Stop all current operations (does not affect RAM data)	*99IN	
	Full reset of PPT processor	*99IN=reset	
	Changes to RAM data are lost unless an SP =ALL command was previously issued. (Response is user message, if selected)	?01Pressure_tank_1	
I =	**Integration time**		
	Set I parameter	*00WE	
	(set output rate to 50 readings/second)	*00I=R50	
	Inquiry	*00I=	?01I=R050
L =	**Lowest Analog Output Voltage**		
	Set L parameter	*00WE	
	(set analog low value to 28% x 5V = 1.4V)	*00L=28	
	Inquiry	*00L=	?01L=28
M =	**Maximum Full Scale Value Allowed**		
	(Factory set) Inquiry	*00M=	?01M=0010psid
M O	**Power Up Mode**		
	Set MO parameter	*00WE	
		*00MO=M1	
		*00WE	
	Required to save in EEPROM for power-up	*00SP=ALL	
	Inquiry	*00MO	?01MO=X2M1
N E	**Digital Input Enable to Analog (DAC) Output**		
	Set a DAC analog output voltage	*00NE	
	(example to set output of DAC to 2.5Volts)	*00N=2500	
	Set continuous PPT DAC parameters	*01NE=DAC	
	(set the PPT#01 DAC output to 2.5Volts)	*01N=2500	
	(set the PPT#01 DAC output to 1.25Volts)	*01N=1250	
	(set the PPT#01 DAC output to 0.1Volts)	*01N=100	
N =	**Send Number To DAC**		
	Set N= parameter	*00NE	
	(set analog output value to 4096mV = 4.096V)	*00N=4096	
	Inquiry	*00N=	?00N=4096.0
	See also the H=, L=, O=, and W= commands to control the analog output		
O=	**Offset Pressure Window For Analog Output**		
	Set O= parameter	*00WE	
	(set pressure offset window to 28% x 20 psi (FS) = 15.6 psi)	*00O=28	
	Inquiry	*00O=	?01O=28
		Example	**Example**

Note: See Section 5.10 for complete command descriptions.

		Input (1)	Response (2)
O P	**Operating Mode Parameters**		
	Set OP parameter	*00WE	
	(set to extended binary output mode)	*00OP=E	
	Inquiry	*00OP	?01OP=ANEW
P1	**Pressure, Single, ASCII Format**		
	Request compensated pressure	*00P1	?01CP= 14.450
P 2	**Pressure, Continuous, ASCII Format**		
	Request compensated pressure	*00P2	?01CP= 14.450 (repeated)
P 3	**Pressure, Single, Binary Format**		
	Compensated pressure (null address)	*00P3	^@PSA **or**
	Compensated pressure (assigned address)	*01P3	{@PSA
	(typical response is a ^ or { char plus 4 data bytes that are encoded for computer translation)		
P 4	**Pressure, Continuous, Binary Format**		
	Compensated pressure (null address)	*00P4	^@P@@**or**
	Compensated pressure (assigned address)	*01P4	{@P@@
	(typical response is a ^ or { char plus 4 data bytes that are encoded for computer translation)		(repeated)
P =	**Production Date**		
	(factory set date, mm/dd/yy) Inquiry	*00P=	?01P=04/13/95
R R	**Reading Rate**		
	Set RR parameter	*00WE	
	(skip 5 x 100 = 500 readings if identical)	*00RR=5	
	Inquiry	*00RR	?01RR=5
RS	**Read Status**		
	Inquiry	*00RS	?01RS=0000
S2	**Speed Shift to 2X**		
	Set S2 parameter	*00WE	
	(shift to double speed if pressure changes more than 12 0.01%FS = 0.12% FS)*	*00S2=12	
	Inquiry	*00S2	?01S2=12
S5	**Speed Shift at 50msec Intervals**		
	Set S5 parameter	*00WE	
	*(Output reading if pressure changes more than 60 * 0.01%FS = 0.6% FS)*	*00S5=60	
	Inquiry	*00S5	?01S5=60
S I	**Synchronize Pressure Integration**		
	Synchronize Integration	*01SI	
SP	**Store Parameters in EEPROM**		
	Store parameter	*00WE	
	(store all settings stored in RAM in EEPROM)	*00SP=ALL	
S=	**Serial Number**		
	Inquiry	*00S=	?01S=00005137
T1	**Temperature, Single, °C**		
	Request Celsius temperature	*00T1	?01CT= 24.5 or ?01CT= ..
T 2	**Temperature, Continuous, °C**		
	Request Celsius temperature	*00T2	?01CT= 24.5 (repeated)
T 3	**Temperature, Single, °F**		
	Request Fahrenheit temperature	*00T3	?01FT= 76.1 or ?01FT= ..
T 4	**Temperature, Continuous, °F**		
	Request Fahrenheit temperature	*00T4	?01FT= 76.1 (repeated)

Note: See Section 5.10 for complete command descriptions.

			Example Input (1)	Example Response (2)
T C	**Tare Control Switch**			
		Turn tare control on	*00WE *00TC=ON	
		Inquiry	*00TC	?01TC=ON
T O	**Transceiver Operating Parameters**			
		Set RS485 response delay to 2 character times	*01WE *01TO=2	
		Inquiry	*01TO	#01TO=M2CN
T =	**Set Tare Value**			
		Set tare value to current pressure reading	*00WE *00T=SET	
		Set tare value to a % of full scale pressure *(set tare to 10% of full scale; 10psi for a 100psi PPT)*	*00WE *00T=0.1	
		Inquiry	*00T=	?01T=0.1000
U =	**User Supplied Display Units**			
		Set display units *(set units to 5.1 x psi)* Activate user display units	*00WE *00U=5.100 *00WE *00DU=USER	
		Inquiry	*00U=	?01U=5.1000
V =	**Version Number**			
		Inquiry	*00V=	?01V=02.3B6S2V
W E	**Write Enable to EEPROM or RAM**			
		Write several RAM parameters *(example to set output units to cm water column)* *(factory default setting)* *(Cancel continuous WE=RAM command)*	*01WE=RAM *01DU=CMWC *01DO=D *01WE=OFF	
	Note: Any command changes in RAM will be lost when the PPT is powered down unless an SP command saves them to EEPROM.			
W=	**Set Width of Analog Pressure Window**			
		Set W= parameter *(set pressure window width to 40% x 20 psi (FS)= 8 psi)* *(set analog set point)*	*00WE *00W=40 *00W=S	
		Inquiry	*00W=	?01W=40
X=, Y=	**Slope - User Compensation Control**			
		Set X= parameter *(set user slope control to 0.005% x 17 = 0.085%FS)*	*00WE *00X=17	
		Inquiry	*00X=	?01X=17
	Note: The input slope and offset control are for user supplied mx+b correction. The Y= is for negative slope for differential units.			
Z=	**Offset - User Compensation Control**			
		Set Z= parameter *(set mx+b pressure offset to 20 x 0.005%FS = 0.1%FS)* *(null adjust output at zero pressure)*	*00WE *00Z=20 *00Z=CAL	
		Inquiry	*00Z=	?01Z=20
~	**Command Header for Binary DAC Values** *(Need to set DA=G, N, or R to receive, or O, S, or U to transmit)*			
		Then enable single RAM write for DAC *(example to set output of DAC to 2.5Volts)*	*00NE ~@#16	
	See also the H=, L=, O=, and W= commands to control the analog output			

(1) A carriage return, <cr>, should follow each input. If the PPT has an established address of 12, for instance, then begin the command with *12.. instead of *00...

(2) The responses shown here begin with ?01.. and are for a null address PPT. That is, a PPT that has not yet established unit identification (see ID command). If the PPT has an assigned address of 23, for instance, the response will begin with #23.. instead of ?01...

Note: See Section 5.10 for complete command descriptions.

4 FUNCTIONAL OPERATION

4.1 OVERVIEW

Honeywell's Precision Pressure Transducer (PPT) is based on a silicon piezoresistive sensor coupled with a microprocessor and other electronic circuitry. The piezoresistive sensor contains both pressure sensitive and temperature sensitive elements which, when modeled over a matrix of pressures and temperatures at the factory, provides a digitally compensated pressure reading. The PPT has a typical accuracy of 0.05% of full scale (FS) and the PPTR has a typical accuracy of 0.10% FS over a -40 to +85°C temperature range. This accuracy is achieved by compensation algorithms in the microprocessor. Because of the internal digital circuitry, having a digital output capability is straight forward. The digital readings are transmitted via RS-485 signals or RS-232 signals—which are commonly available on most personal computers. When connected to a computer, the user can modify the pressure reading rate, integration times, units of pressure, thresholds for deadbands and more.

In addition, a temperature compensated analog output is available. Analog output parameters can be modified by the user when the PPT digital communications port is connected to a computer, or host processor. For example, the factory set range of 0 to 5 VDC for the analog output voltage can be modified to 1 to 5 VDC operation or any voltage span within the 0 to 5 volt range in 1% increments. Those who choose to use the factory set defaults may use the analog output without ever connecting to a computer.

The analog output is driven by a 12-bit digital-to-analog converter (DAC). Because the PPT has an internal EEPROM (Electrically Erasable Programmable Read Only Memory) to store configuration settings, it can replace conventional analog transducers without connecting to a serial bus. Program your settings once and use it as a three-wire device—Power, Analog Out, Ground.

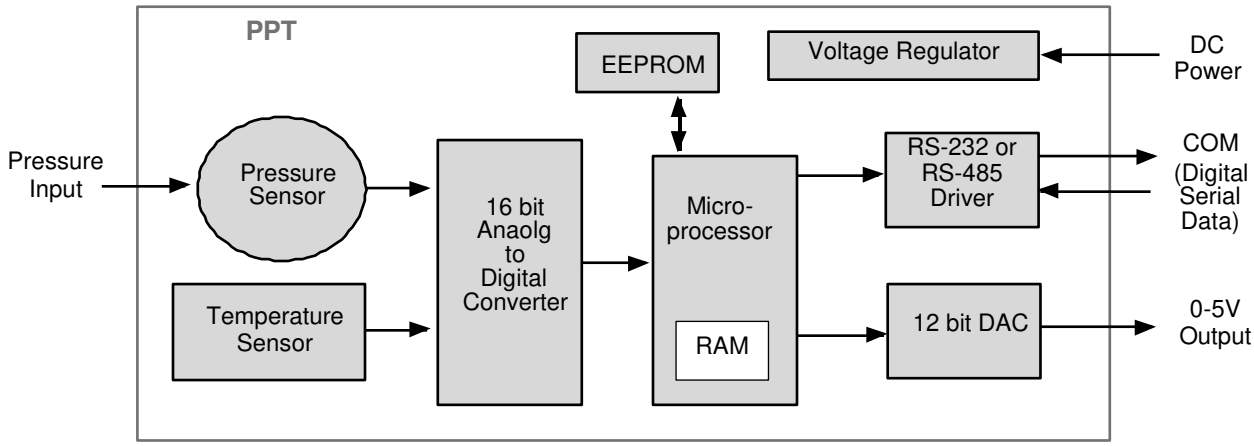

Figure 4.1—PPT Block Diagram

The PPT can be tailored to specific application requirements. Configuration information is sent to, or read from, the PPT by user command messages over the serial port. Any configuration parameter that can be changed by a command may be retrieved by use of that same command. Commands used to change parameters must be preceded by an enabling command (**WE** or **NE**), but commands used to retrieve information do not require an enable. All configuration changes are stored in the PPT RAM for immediate use until power is removed. These configuration changes are only made permanent in the EEPROM when the user executes the Write Enable (**WE**) command followed by the EEPROM Store Parameters (**SP**) command. Exceptions to this are the **A=**, **B=**, **C=**, and **D=** commands which are immediately stored to EEPROM if preceded by the WE command.

4.2 WHAT IS INTEGRATION?

The input pressure is converted to an analog electrical signal at the pressure sensor. This signal feeds into a delta-sigma analog-to-digital (A/D) converter where it is changed into a digital signal representing the pressure value. During the A/D conversion cycle, the signal is integrated over time. That is, the pressure reading is averaged (integrated) over the A/D conversion cycle so the resultant digital value is the summation of the average pressures observed during the cycle. This conversion cycle is controlled by the user with the Deadband and Sensitivity (DS), Synchronization Integration (SI), Idle Count (IC), and Integration (I=) commands.

4.3 PRESSURE READING CONTROL

The PPT commands allow considerable flexibility in tailoring pressure acquisition times, sample windows, thresholds, and output rates. These are controlled by 7 commands: Deadband and Sensitivity (**DS**), Integration (**I=**), Speed shift (**S2**), Speed shift at 50msec intervals (**S5**), Idle Count (**IC**), Reading Rate (**RR**), and OPerating mode (**OP**). Figure 4.2 illustrates how the user may control these attributes in three ways:

First, the internal analog-to-digital converter integration time may be controlled over a range of 1 sample every 12 seconds up to 120 samples per second. This is controlled using the 'Integration' **(I=**) command. The integration time is used to control the A/D integration cycle that allow noisy pressure inputs to be filtered, or averaged, over a selected period of time. See Figures 4.12and 4.13. The integration time can be set within a range of 1 to 120 samples/sec using the **I=Rn** form or a range of 100msec to 12 sec/sample using the **I=Mn** form. The values for 'n' range from 1 to 120 for both the rate (**Rn**) form and the millisecond (**Mn**) form.

The speed shift commands can only be enabled when the integration time is set using the **I=Mn** form. When enabled, the thresholds for pressure change can be set that cause the output rate to double (**S2**) or update at 50 msec intervals (**S5**). When the change of input pressure reaches or exceeds the threshold, the sample rate shifts to the higher rate.

Second, the integration cycles may be spaced with idle periods that cause pressure reading times to increase to as often as one every 51 minutes. The Idle Count (**IC**) command will insert, or skip, from 0 to 255 idle periods equal to the integration time. If the integration time is set to the maximum, 12 sec/sample, and an idle count of 255 is selected, then the time between samples = 12 sec. x 256 = 51.2 minutes.

Third, the reading rate may be controlled so pressure readings are obtained only when pressure changes occur. The Reading Rate (**RR**) command can be set to output only changed readings, or skip from 100 to 1000 identical readings. The Operating Mode command (**OP**) can be set to output every reading or to only output changes. The Deadband setting in the **DS** command can filter a small pressure change by not allowing the pressure reading to vary as long as it remains within the deadband limits. This controls the sensitivity to change of the **RR** and **OP** command modes when the 'output only when pressure changes' options are selected. If the pressure signal is stable within the deadband limit, then the pressure reading time can be increased up to 1000 times the integration time by using the **RR** command.

PPT Pressure Rate Conditioning

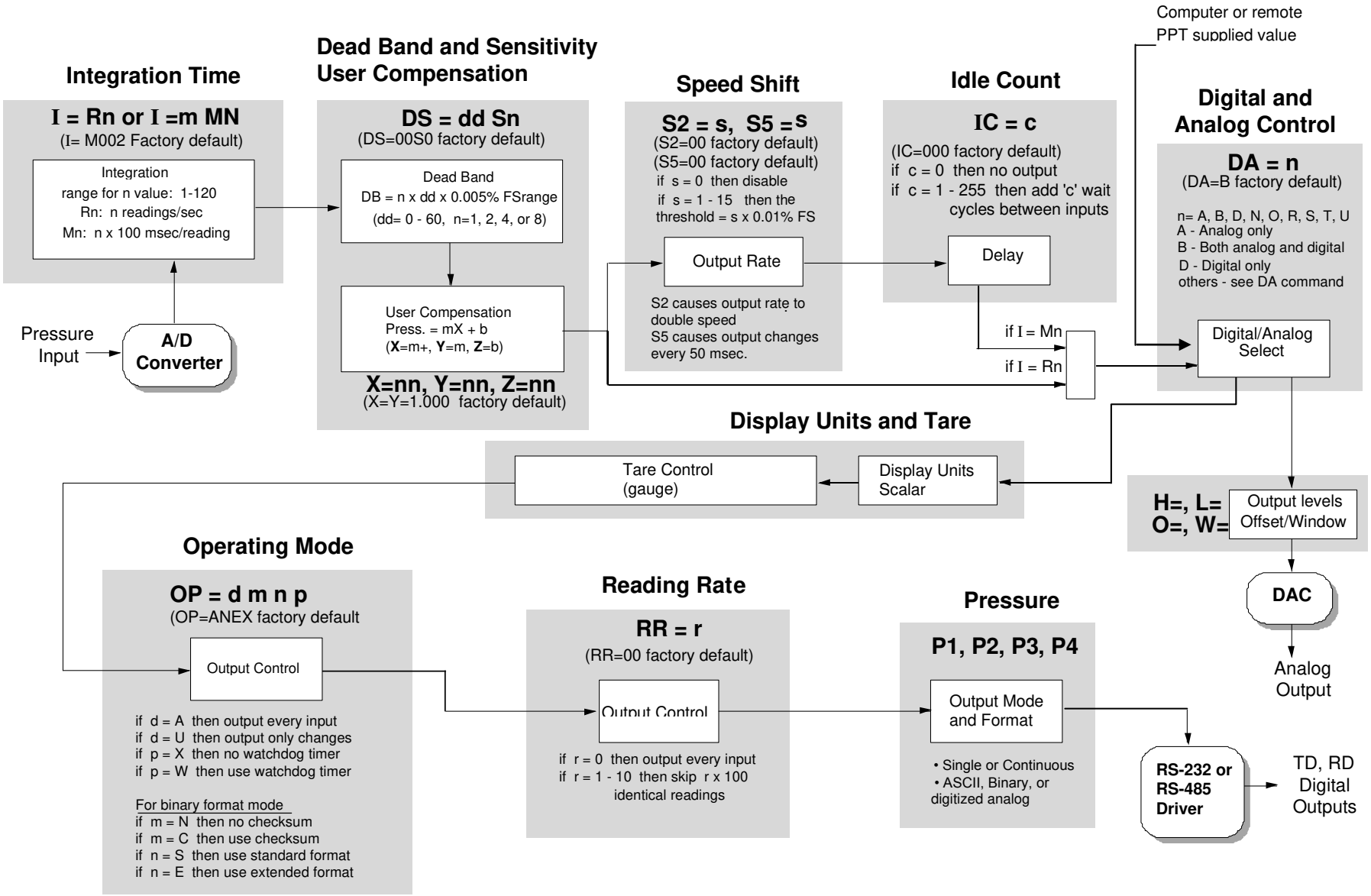

Figure 4.2—Pressure Reading Control

Shaded blocks represent command codes executed in the microprocessor

4.4 OUTPUT VOLTAGE CONTROL

A key feature of the PPT is the ability to configure the pressure range to a specific application by issuing commands from a PC or host computer. All configuration changes can be stored in the PPT so that it will power-up with those parameters set. This allows the user to set-and-forget any custom configuration changes and use the PPT in the analog output mode from then on. The pressure range and analog output parameters can be tailored to a specific application by using a simple set of PPT commands. These commands (**H=**, **L=**, **O=**, and **W=**) are described below.

The output analog voltages for the zero reading and full scale reading are set at the factory to zero and five volts. If the analog measuring device in the application has a low level input limit of 1 volt and a high limit of 4.85V, the PPT can be configured to accommodate this. The lower limit can be set to any value between 0 and 5 volts in 50 millivolt increments (1% FS steps). The **AN=ON** command must be set. For example, the low output limit can be changed from 0 volt to 1 volt by using the command ***ddL=20** (20% x 5V = 1V). Similarly, the high output limit can be changed from 5 volt to 4.850 volt by using the command ***ddH=97** (97% x 5V = 4.85V). Figure 4.3 shows the factory-set output levels and Figure 4.4 shows the user modified output levels configured from 1V to 4.85V range for a 20 psia unit.

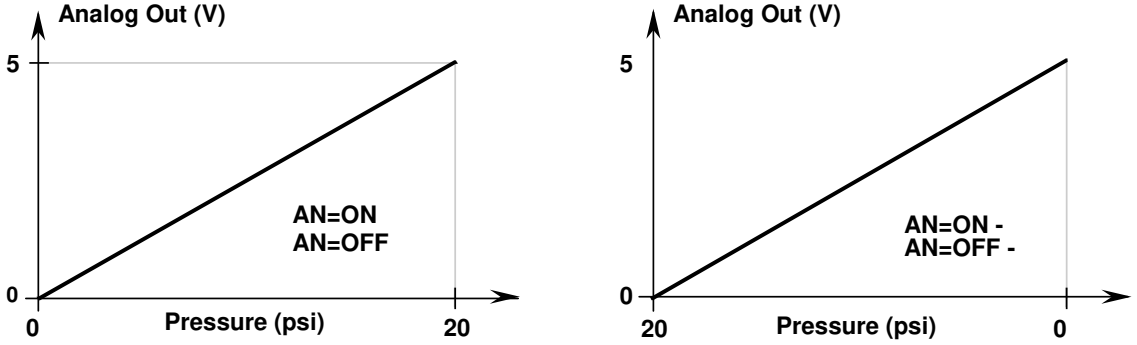

Figure 4.3—Factory Set Output Levels

The **AN** command has two options for reverse scale output: **AN=ON-** and **AN=OFF-**. When either option is selected, the lowest pressure will output the highest analog voltage (**H=**) and the highest pressure to output the lowest analog voltage (**L=**). Notice that the input pressure vs. output voltage curves in Fig. 4.3 look similar. But note that the pressure values along the pressure axis have been reversed. The curve on the right is how the analog range operates in the **AN=ON-** or **AN=OFF-** modes. When visualized in this manner, the offset (**O=**) command works similar for both curves. That is, the offset value moves the window (**W=**) from the origin (**O=0**) to the upper right (**O=99**).

4.5 PRESSURE WINDOW CONTROL

The pressure range, or span and offset, can be user customized to accommodate a specific application. The user can scale the PPT's pressure range over a smaller full scale span using the **W=** command. Compressing the pressure range this way increases the output resolution per change in pressure. The pressure range can be offset from the minimum pressure value by using the **O=** command. These commands can effectively increase the analog output resolution by spreading it over a smaller pressure range than full scale.

The O= command offsets the pressure window to reassign the minimum pressure value for the lowest analog output. This command sets a pressure offset value from 0 to 99% of full scale. The default is O=0%FS.

The W= command sets the width, or span, of the pressure window to a smaller range to fill the analog output limits. This command sets a pressure window value, or span, from 0 to 99% of full scale. A W=0 command will set the window to 100% and is the default value. For our example above,

a customized pressure span of 4 psi and offset of 12 psi can be configured from a 20 psia device by using the offset (**O=**) and window (**W=**) commands. First, set the window offset to **O=60** so that the lowest analog output would begin at 12 psi (60% of 20 psi). Then, set the window width to **W=20** so that the pressure span is 4 psi (20% of 20 psi). The pressure range vs. output level curve is shown in Figure 4.5.

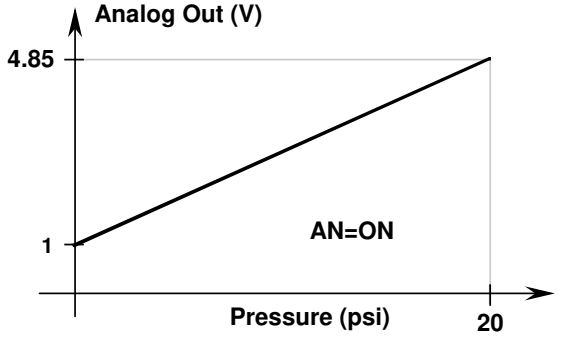

Figure 4.4—User Modified Output Levels

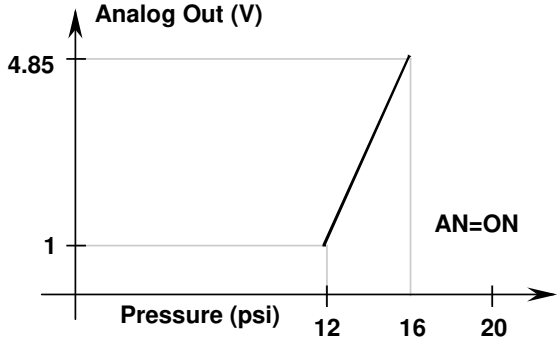

Figure 4.5—User Modified Pressure Span

Using the store parameters command (SP), the configuration changes can be saved in EEPROM so that the PPT will power up in that state ready to operate. This is particularly useful for applications that use the analog output signal. The PPT can be configured and stored in the lab and used in the field as an analog only instrument.

4.6 CUSTOMIZED PRESSURE RANGE

The user can adjust the pressure vs. output value transfer curve using the **X=**, **Y=**, **Z=** and **F=** commands. The **X=** command adjusts the slope of the pressure output curve for positive pressures. This applies to all absolute and gauge devices and modifies the positive full scale slope of PPTs. The **Y=** command adjusts the negative full scale slope of differential PPTs. The **Z=** command adjusts the offset of the pressure output curve. The range of adjustment for **X=, Y=** and **Z=** commands is ±0.6%FS in 0.005% increments. The **F=** command can change the full scale pressure span to any value between 50% and 100% of the factory specified range (**M=**).

The purpose of these commands is to allow the user to provide compensation for the pressure values specific to an application. This type of adjustment is made after the PPT temperature compensates the pressure reading according to the factory calibration. The user supplied values (**X=**, **Y=**, **Z=**) are used as an mx+b correction. The **X=** and **Y=** command supplies the slope adjustment, or 'm', value and the **Z=** command supplies the offset adjustment, or 'b', value. Figures 4.6 and 4.7 illustrate these commands.

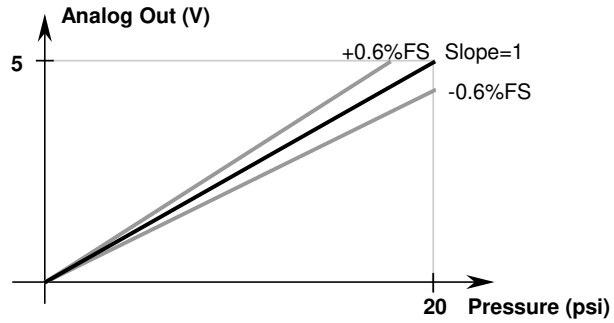

Figure 4.6—Custom Slope (X=) Options

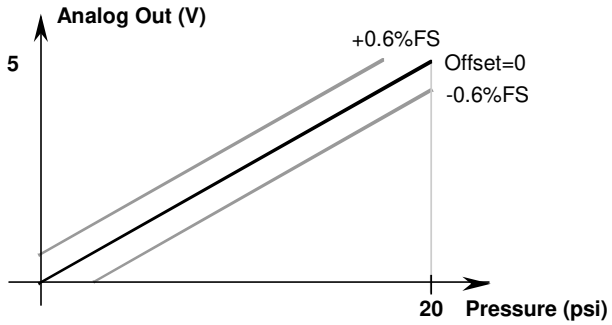

Figure 4.7—Custom Offset (Z=) Options

The user compensated pressure output can be expressed in terms of **X=** and **Y=** slope values 'm' where m=0 to ±120. The offset value, Z=, can be expressed as 'b' where b=0 to ±120.

Pressure Output = [(1 + **m** x 0.00005) x **Pressure Reading**] + [(**b** x 0.00005) x (full scale)]

The **F=** command is used in conjunction with the **X=**, **Y=**, and **Z=** command to customize the full scale range and user compensation of the PPT. The **F=** command allows the user to reduce the full scale range of the PPT as much as one-half the factory FS value. The **F=** command value can have up to 5 significant digits with a decimal point. Enter an **F=0** command to disable this function and return to the factory default (**M=**) full scale value. Using the **F=** command, the maximum allowable full scale pressure is the **M=** value and the minimum allowable FS pressure is (0.5 x the **M=** value). The new **F=** value becomes the standard FS number used for other commands and range calculations. Note that the accuracy specification is always referenced to the factory (**M**=) full scale value. For example, to customize the full scale range of a 20 psig (554 in. water column—inwc) device to 300 inwc, first select the desired display units using the **DU** command. Enter the command ***ddWE** followed by a ***ddDU=INWC**. Then enter a ***ddWE** followed by a ***ddF=300**. The full scale pressure for this unit is now 300 inwc.

4.7 SETTING ANALOG PRESSURE SET POINT

Another feature of the PPT is the ability to program an analog pressure set point that triggers the analog output from the low voltage setting (L=) to the high voltage setting (H=) using the W= and O= commands. These outputs can be used to activate alarms or lights based on pressure conditions. This feature can operate in an analog only mode once the set point has been configured and stored to EEPROM. The set point can be changed in the application through the digital RS-232 connection.

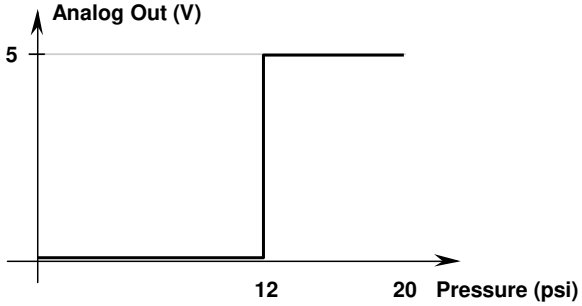

Figure 4.8—Pressure Set Point Set

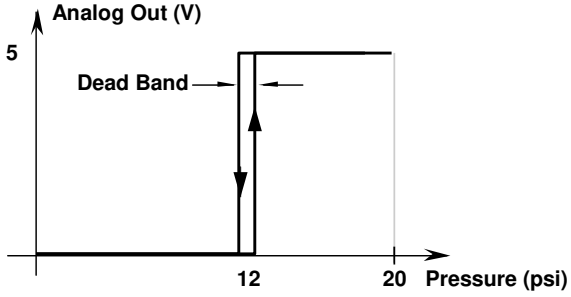

Figure 4.9—Deadband on Set Point

If a set point from a 20 psig unit was desired whenever the pressure equals, or exceeds 12 psi, then set **O=60** (12 psi = 60% of 20 psi FS) and **W=S** (for setpoint). Figure 4.8 illustrates the pressure vs. voltage response curve. The output will change to 5 volts at 12 psi. The output levels can be changed by using the L= and H= commands. If the unit was a 20 psid (differential), then the commands **O=80** (32 psi = 80% of 40 psi FS) and **W=S** are used. The difference is that the offset (**O=**) is referenced to the minimum pressure value, which is -20 psi for the differential unit. If the pressure signal has some noise in it, then a deadband should be added to the set point. For a 20psig unit, setting **DS=60** will put a ±0.06 psi deadband around the 12 psi set point. That is, the output will switch from 0 to 5V at 12.06 psi for increasing pressures and switch from 5 to 0V at 11.94 psi for decreasing pressures. The **I=** command can be used to filter, by increasing the integration time, any noise on the pressure signal.

4.8 PPT ANALOG OUTPUT CONFIGURATIONS

The PPT is truly a smart sensor device, but it can also be used to replace conventional analog pressure sensors straight from the box. A benefit of using the PPT in the analog mode is that there is no need for offset or span adjustments to achieve the specified accuracy across a -40 to 85°C (-40 to 185°F) temperature range.

When you receive a PPT, it is ready to output a calibrated analog voltage when power and a pressure line are connected. For example, a 20 psi (pounds per square inch) unit straight from the factory will have the characteristics shown in Figure 4.3. The voltage can be measured using a digital voltmeter (DVM) or an analog meter—see Figure 4.10.

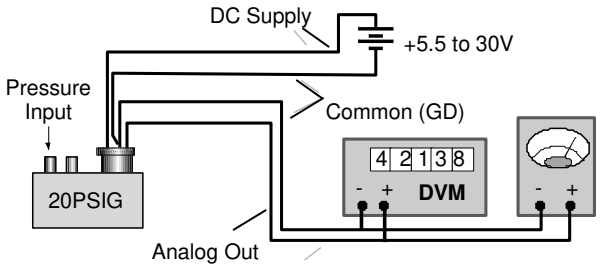

Figure 4.10—PPT Pressure to Analog Voltage

The PPT can be configured to transmit pressure in the digital mode and receive analog values, for the DAC output, to drive a voltage independent of pressure (see Figure 4.11). When operating in this mode (**DA=R, G** or **N**), the PPT will continue to provide calibrated pressure readings through the digital serial bus. In addition, the control processor can control the analog output voltage from the PPT independent of the pressure readings. This capability allows a single PPT unit to operate in a closed loop mode for systems requiring valve control.

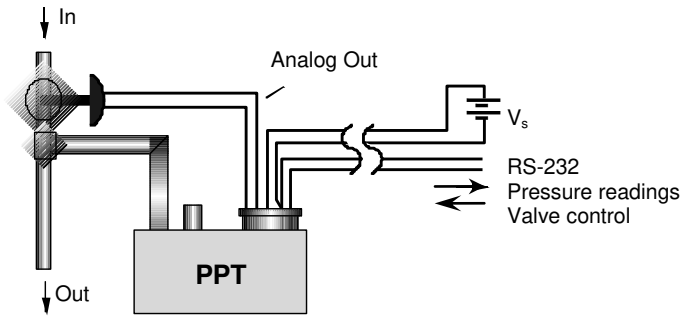

Figure 4.11—PPT Pressure Readings and Analog Voltage Control

Two PPTs can be used to sense pressure at one location and drive the analog pressure output at a remote location without a host processor. For example, a strip chart recorder or other analog input device, is being used to monitor a pressure point in a remote location. If the analog signal is run between locations, it will be subjected to electrical noise, line interference and connector electrical losses. The pressure signal would require shielding, single point ground connections and line filtering. A solution to eliminate the effects of line losses and noise sources would be to transmit the pressure information digitally to the strip chart recorder using two PPTs (see Figure 4.12).

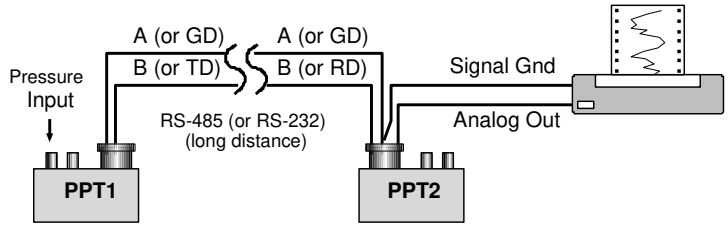

Figure 4.12—Sensing Remote Analog Pressure