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Honeywell Precision Pressure Transducers



PPT User's Manual

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PPT User's Manual

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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.

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1 INTRODUCTION

1.1 PRODUCT OVERVIEW

The Honeywell Model PPT 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.

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.

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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-to-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 EZTerminal or Honeywell demonstration software available at the product web page.

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.

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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 Volt
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. These 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)

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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=04/13/18**

READ CONTINUOUS PRESSURE

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

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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.

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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

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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

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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

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3 COMMAND QUICK 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 *(no parity, 1200 baud)*	*99WE *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 *(factory default setting)*	*00WE *00DO=E	
		Inquiry	*00DO	?01DO=E0N
D S	**Deadband and Sensitivity Control**			
		Set DS parameters *(set deadband to 20 x 0.005% = 0.10%FS)*	*00WE *00DS=20	
		Inquiry	*00DS	?01DS=00S0
D U	**Display Units Control**			
		Set DU parameters *(set units to in. Hg)*	*00WE *00DU=INHG	
		Inquiry	*00DU	?01DU=INHG
D =	**Data String D**			
	(up to 8 characters, a <cr> indicates end-of-message, and more than 8 characters will not write to location)	Write string D	*00WE *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 *(set custom FS range to 10.5psi)*	*00WE *00F=10.5	
		Inquiry	*00F=	?01F=10.500
H =	**Highest Analog Output Voltage**			
		Set H parameter *(set analog high value to 82% x 5V = 4.2V)*	*00WE *00H=82	
		Inquiry	*00H=	?01H=82

Note: See Section 5.10 for complete command descriptions.

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		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.

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		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.

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		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)* *See also the H=, L=, O=, and W= commands to control the analog output*	*00NE ~@#16	

(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.

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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) 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.

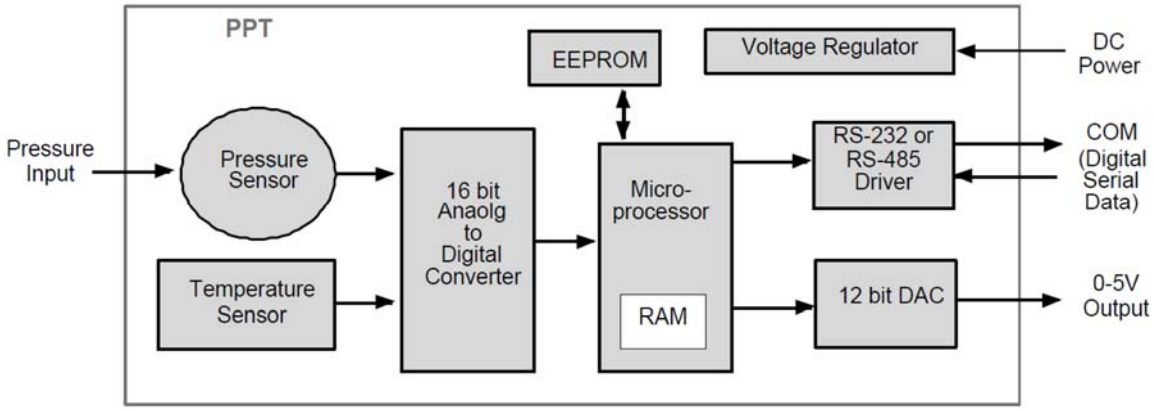


Figure 4.1 – PPT Block Diagram

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

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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.

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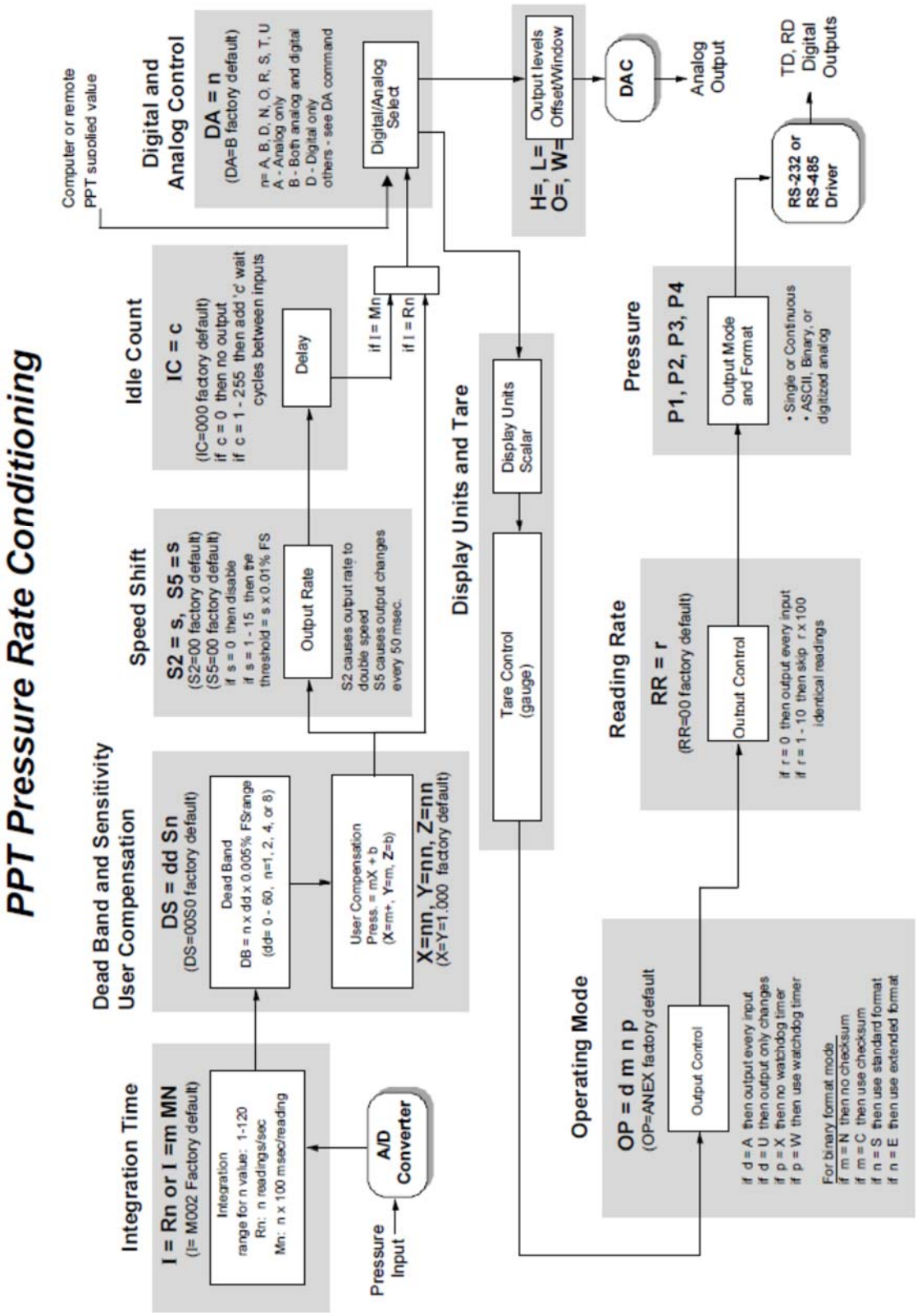


Figure 4.2 - Pressure Reading Control

Shaded blocks represent command codes executed in the microprocessor

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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.

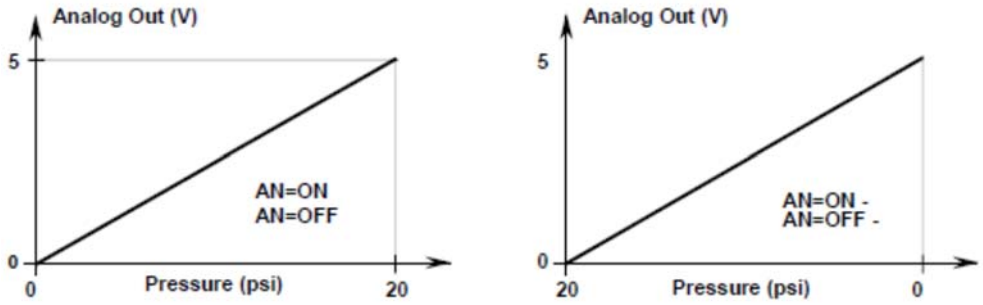


Figure 4.3 – Factory Set Output Levels

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

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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

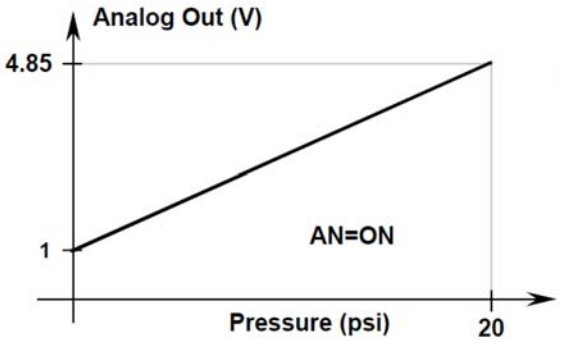


Figure 4.4 – User Modified Output Levels

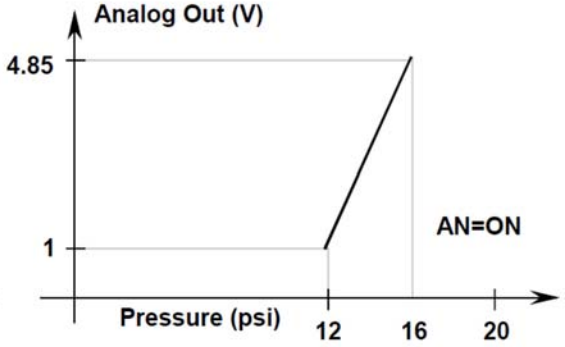


Figure 4.5 – User Modified Pressure Span

curve is shown in Figure 4.5.

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.

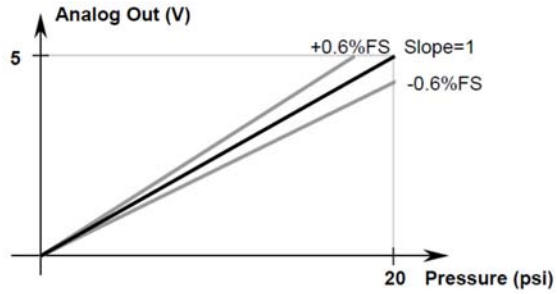


Figure 4.4 – Custom Slope (X=) Options

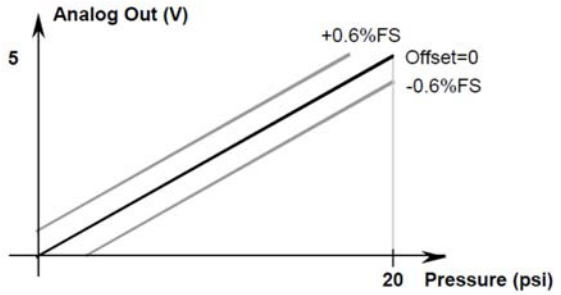


Figure 4.5 – Custom Offset (Z=) Options

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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.

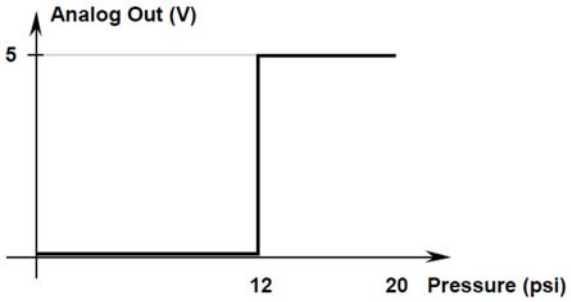


Figure 4.8 – Pressure Set Point Set

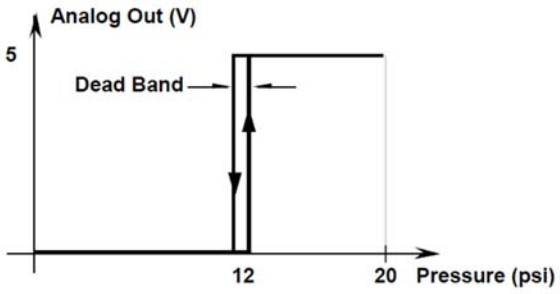


Figure 4.9 – Deadband on Set Point

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.

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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.

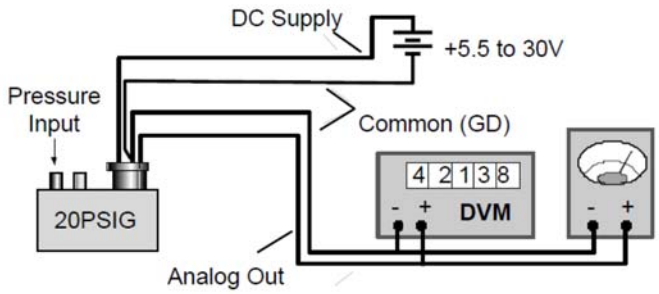


Figure 4.6 — PPT Pressure to Analog Voltage

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 his 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.

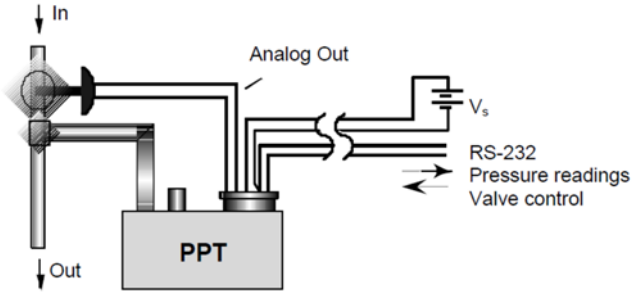


Figure 4.7 — PPT Pressure Readings and Analog Voltage Control

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).

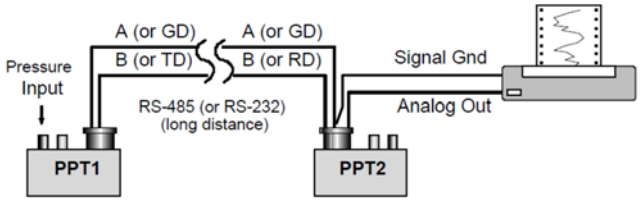


Figure 4.8 — Sensing Remote Analog Pressure

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This can easily be accomplished using two PPT units, one at the pressure point and one by the chart recorder. A two-wire digital interface would transmit 1st PPT pressure information to the 2nd PPT recorder point. The digital RS-232, or RS-485, line is more tolerant of noisy environments and connector losses than an analog signal. Commercially available RS-232, or RS-485, drivers and repeaters are available to extend the distance between the two PPT units, up to several miles if necessary. The 2nd PPT unit can be placed close to the chart recorder with very little, if any, noise on the analog output. When the RS-232, or RS-485, baud rate is set to 28,800 baud, the reading delay imposed by the digital transmission is 2 msec. The benefit of using two PPTs this way is that it is quick and easy to implement and that no software development is required. Using this technique, the RS-232 connections can be configured as a single two-wire bus that accommodates up to nine pairs of PPT units simultaneously sensing remote pressures. In order to avoid bus collisions on a RS-485 bus only one pair of PPTs may be operated in this mode.

The PPT units should be configured as follows so that they will begin transmitting and outputting analog readings when power is applied (see Table 4.1). To connect additional PPT pairs to the RS-232 bus, configure each pair with a unique group number. Nine groups are available from number 90 through 98. The example shown in Table 4.1 assumes both PPT units are in the same group – factory default group is 90.

Commands to setup 1st PPT		**Commands to setup 2nd PPT**	
Input	*Comment*	*Input*	*Comment*
*01WE=RAM	Write enable	*02WE	Write enable
*01DA=U	Pressure to '~' format	*02DA=R	Digital to analog output
*01MO=P4	Power up mode	*02NE=DAC	Enable write to DAC
*01WE	Enable EEPROM write	*02WE	Enable EEPROM write
*01SP=ALL	Store all to EEPROM	*02SP=ALL	Store all to EEPROM

Table 4.1 – PPT to PPT Remote Sensing Setup Commands

4.9 COMMAND ILLUSTRATIONS

The figures below illustrate the commands that affect the pressure output rate. Figure 4.13 shows a varying pressure signal having a reading integration time of 200 msec. If the small variations on the pressure signal are considered noise and are undesirable, increase the integration time to time-average the pressure signal, and filter out the noise.

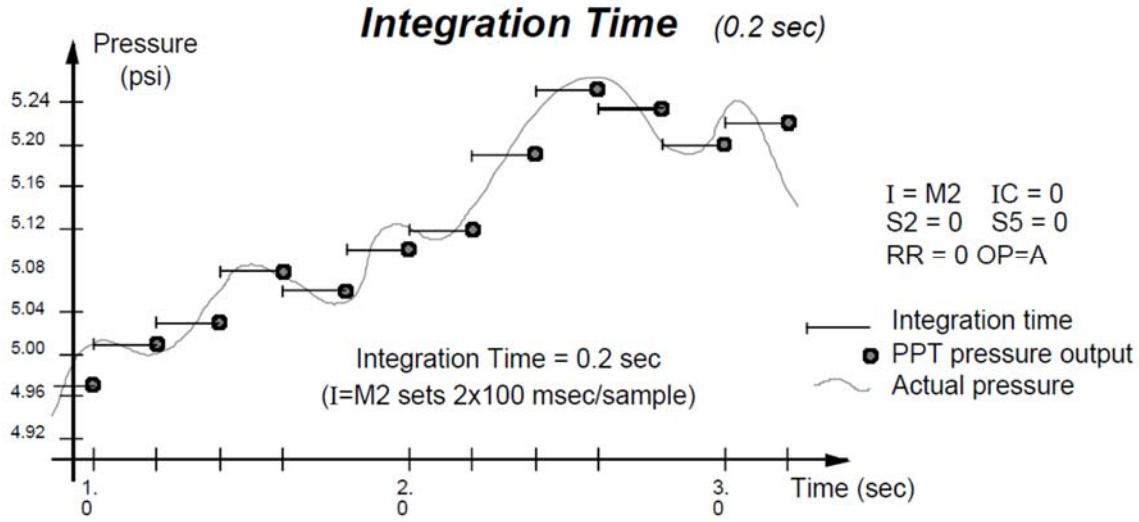


Figure 4.9 - Integration (I=) Command, Example 1

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Figure 4.14 shows the same pressure signal with a 1 second integration time reducing the noise variations on the output readings. Of course, the penalty for doing this is reducing the response time to rapidly changing pressures that are not considered noise.

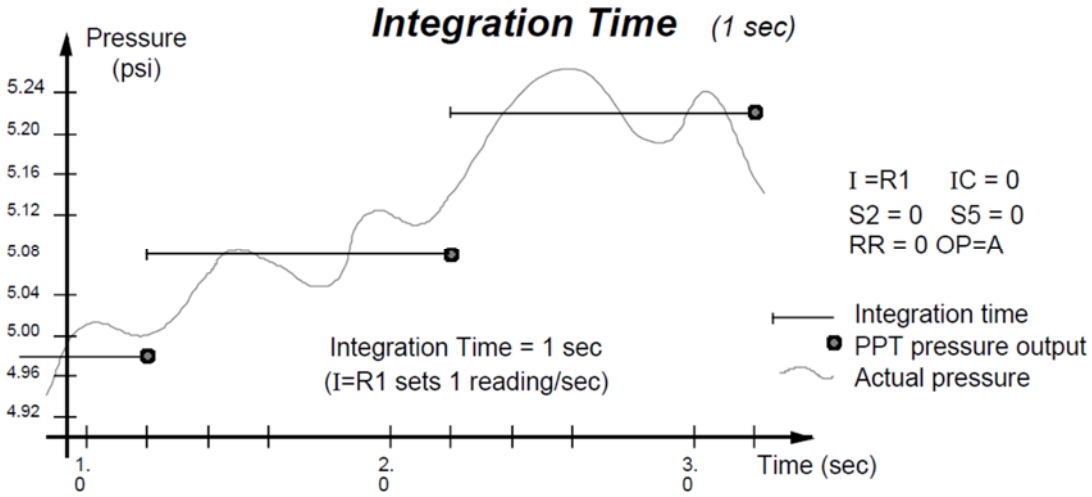


Figure 4.10 - Integration (I=) Command, Example 2

Figures 4.15 and 4.16 illustrate rapid pressure changes using the **S2** and **S5** commands. The Speed Shift commands (**S2**, **S5**) allow the tracking of rapid changes while sampling less often when pressures are slowly changing. A threshold is set independently for the **S2** and **S5** commands that tell the PPT when to begin outputting samples at the higher rate. The **S2** command causes the output rate to double. The **S5** command causes the readings to be output at 50 msec intervals synchronous with the normal reading rates.

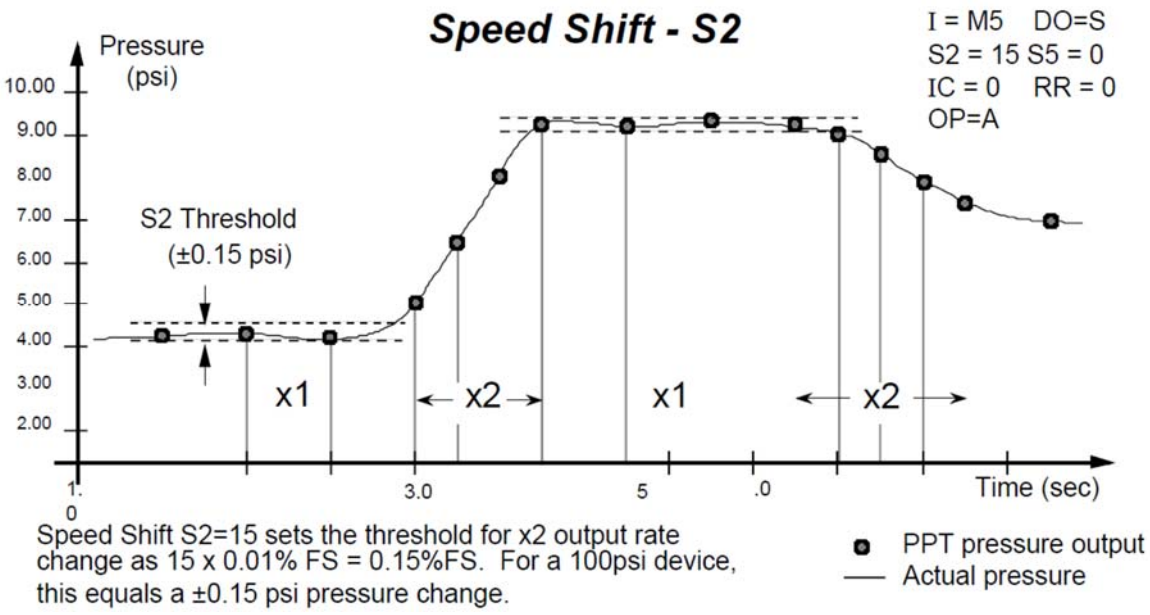


Figure 4.11 – S2 Speed Shift Command Example

REF: ECN-6046312

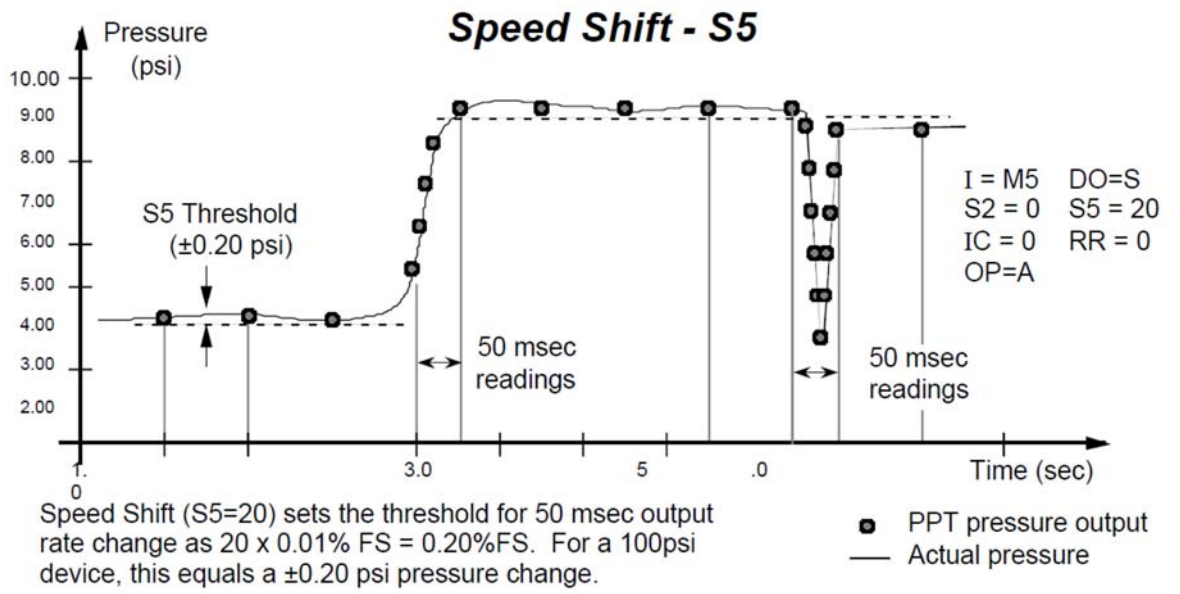


Figure 4.12 – S5 Speed Shift Command Example

Figures 4.17 and 4.18 show the effect of the deadband setting in the **DS** command. If a deadband of ±0.02% FS is selected, then the pressure output will not change reading as long as it is within this limit (±0.02psi for a 100 psi unit). If the pressure exceeds or falls below this threshold, the pressure reading will track the actual pressure value. It will continue to track the pressure value until there is no change again within the threshold limit.

Figure 4.19 illustrates the effect of the Idle Count (**IC**) command for four different pressure curves. The **IC** command does nothing more than skip over a set number of readings. If the idle count were set to **IC=4**, then after a pressure output reading, the PPT would not output the next 4 readings and the fifth one would become the next output reading. This feature allows the reading rate to be established different from the integration time. This feature is useful for minimizing the communications traffic on a network of many PPT units.

Figure 4.20 illustrates the Synchronize Integration cycle (**SI**) command as well as the Transceiver Operating parameters (**TO)** options that affect it. This is for RS-485 units only.

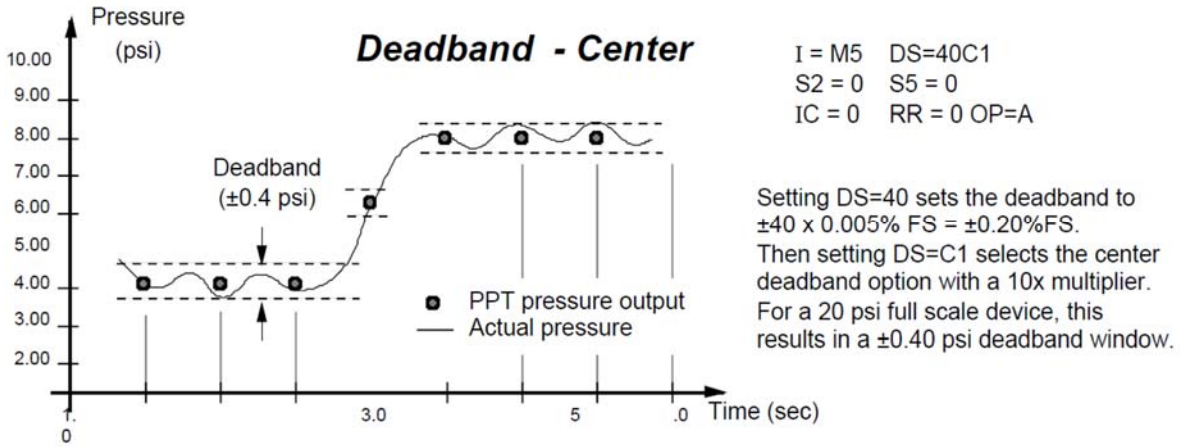


Figure 4.13 – Deadband and Sensitivity (DS) Command Examples

REF: ECN-6046312

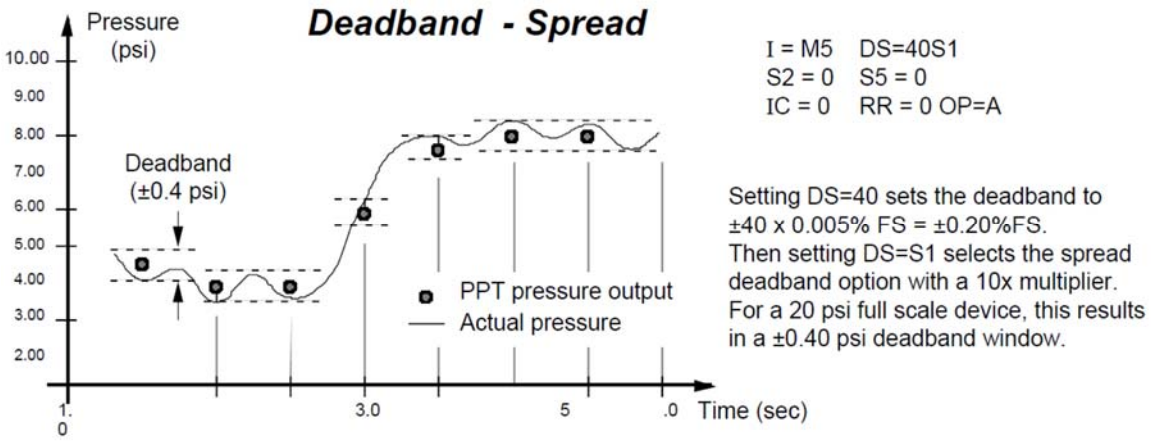


Figure 4.14 – Deadband and Sensitivity (DS) Command Examples

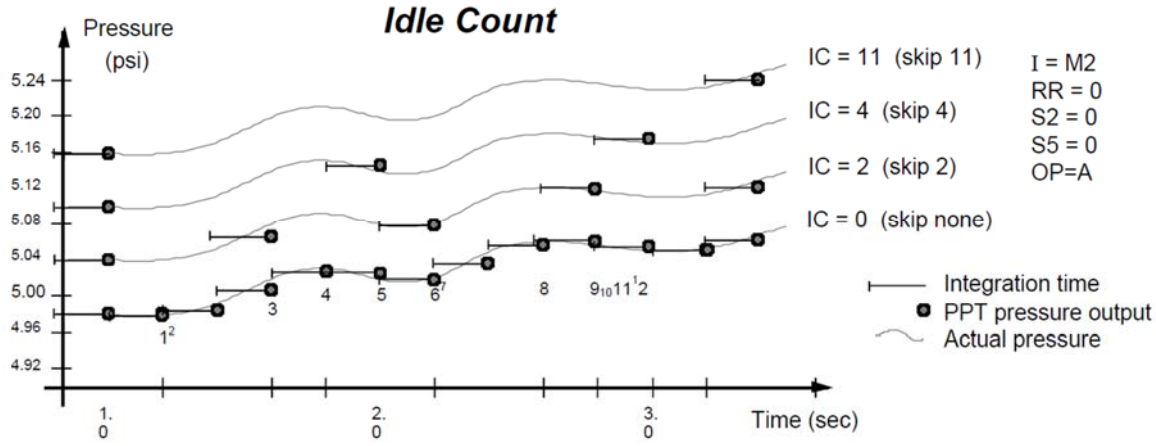
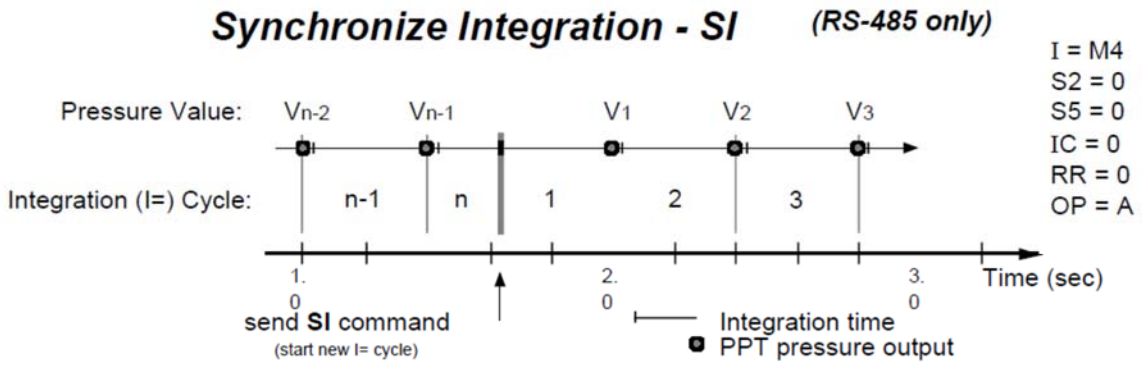


Figure 4.15 – Idle Count (IC) Command Examples

REF: ECN-6046312



	*ddP1 Pressure Value Output during:				
TO Option	Cycle n-1	Cycle n	Cycle 1	Cycle 2	Cycle 3
TO=C (default)	Vn-2	Vn-1	Vn-1	V1	V2
TO=A	Vn-2	Vn-1	Vn-1	V1	V2
TO=S	Vn-2	Vn-1	<cr>	V1	V2
TO=H	Vn-2	Vn-1	<cr>	V1*	

* V1 can be read once anytime after Cycle 1

Figure 4.16 – Synchronize Integration Cycles (SI) Command Example

4.10 PRESSURE READING DECIMAL POSITION

Digital pressure readings are displayed with a sign and a decimal position. Table 4.2 shows the number of decimal place variations among the PPT pressure ranges; the number of digits to the right of the decimal place. This is valuable when converting a binary format number so that decimal position can be determined. For pressure values less than 1.0, (.XXXX), the first character of the pressure reading will be a zero if positive (=0.XXXX), or a minus sign if negative (=-.XXXX). For pressure values, XX.XX, greater than 1.0, the first character will be a space or a number if positive (= XX.XX or =XX.XX), or a minus sign if negative (=-XX.XX). For example, a 20psig device set to KGCM units (20psi x 0.070307= 1.40614 kg/cm$_2$) will read the full scale pressure as "**#23CP=1.4061**" kg/cm$_2$. (The numerical limit for FS reading is 90,000.)

Units	1 psi	20 psi	100 psi	500 psi
ATM	6	4	4	3
BAR	6	4	4	3
CMWC	3	2	1	0
FTWC	4	2	2	1
INHG	4	2	2	1
INWC	3	2	1	0
KGCM	6	4	4	3
KPA	4	2	2	1
MBAR	3	1	1	0
MMHG	3	1	1	0
MPA	7	5	5	4
MWC	5	3	3	2
PSI	4	3	2	2

Table 4.2 – Decimal Place Locations for Pressure Readings
(Extended format selected, OP=E)

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4.11 PPT ADDRESSING

The PPT provides three levels of addressing. The lowest level of address is the individual unit address, or **device ID**. This address level is used to address any single PPT. The next level is **group address**, which is separate from the device ID. All PPT units with the same group address will respond to a command sent to this level address. The last is a **global address,** which is read by all PPTs on the network. The device ID can be assigned by direct command or assigned automatically based on its position from the host processor in PPT network. The **null address** (00) is simply a default device ID that the PPT automatically assumes until one is assigned. That is, upon power-up, if there is no ID assigned, and an ID has not been stored in the EEPROM, then the PPT will assign itself the "00" null address.

The individual unit address, or **device ID**, has an assigned range from 01-89. The null address 00 is the factory default address for unassigned PPTs. A unit with the null address, replies with a 'null address' header. The null address header characters are '?' for ASCII format or '^, &, |, or %' for binary format (see Section 5.4 for these format types). A unique device ID allows the host processor to send commands to specific units on a bus.

The second level of addressing is a multicast, or **group**, address in the range of 90-98. Each unit can be assigned a group address by the ID command. A unit responds to its group address in the same manner as it does to its global address described below. The group addressing allows the host processor to send commands to several units having the same group address. The factory default group address is 90.

The highest level of addressing is the broadcast, or **global**, address 99. All units receive global addressed commands. All RS-232 units respond to global commands. Only RS-485 units with assigned addresses will respond to global commands. An RS-485 unit with a null address will not reply to any global command. Global addresses are not assigned but are built into the PPT.

RS-232 Ring Network

The RS-232 network consists of a three-wire bus (TD, RD, and GD) that begins and ends at the host processor. The RS-232 electrical standard requires that the distance *between* units not exceed 60 feet (18 meters). An advantage of the RS-232 network is that it interfaces directly to the serial COM port of most personal computers. The maximum number of PPTs with assigned device IDs on a network is 89.

A PPT ring network connection of six units is shown in Figure 4.21. In this example, the Device IDs are sequential, starting from 01, from the transmit port of the host processor around the loop. There are two address groups, 91 and 93; each have 3 PPT units assigned.

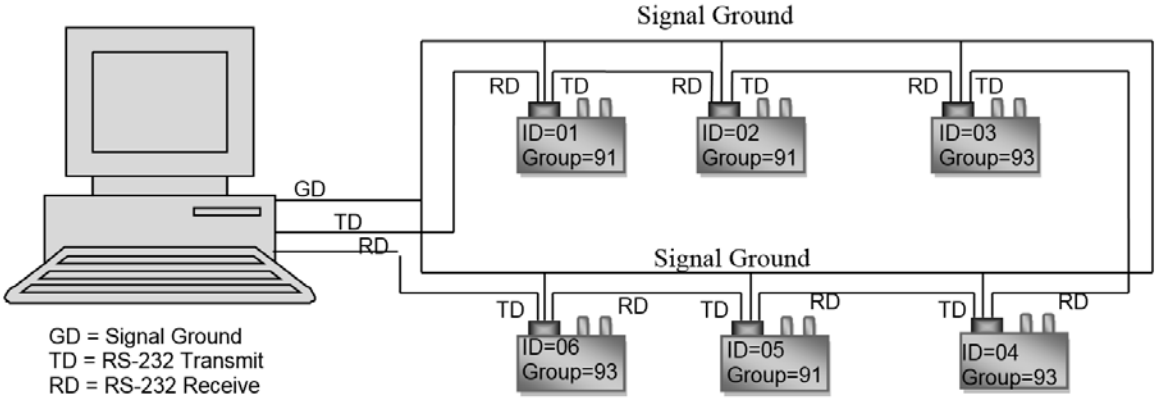


Figure 4.17 – RS-232 PPT Ring Network

REF: ECN-6046312

Each PPT on a communication ring must have a unique address in order to *individually* receive commands from the host processor. For example, if more than one PPT on a ring has a null address, and a 00 address command is transmitted by the host, only the first null address PPT will receive the command and the command is not passed on. This is the same for any address on an RS-232 ring network.

Another advantage of the RS-232 ring network is the ability to automatically assign device IDs to every PPT on the network. Since commands flow through every PPT on the ring, a single ***99ID=01** command will assign ID=01 to the first unit, and each in the ring will assign itself the next number. As the command is passed along, each unit adds one to the ID command. For the example shown in Figure 4.21, the command will read ***99ID=07** when it returns to the host processor. The form of self-addressing will indicate the PPT position in the communication ring relative to the host processor.

Every unit in the RS-232 ring network has an assigned group address. When the host processor sends a group addressed (***90** to ***98**) command, that command cycles through every PPT and is passed to the next one in the loop. Those units having that group address read the command, then pass the command and reply to the next unit in the ring. This is called a **sequential response**. Some sequential responses pass the string of PPT replies before the group command while others pass the string of PPT replies after the group command. See Table 5.3 for specific sequential command types.

Every unit in the RS-232 ring network receives a global addressed (***99**) command. All units read the command and pass the command and their response to the next unit in the ring. The sequential response is the same as for the group command described above. See Table 5.3 for sequential command types.

RS-485 Multidrop Network

The RS-485 network consists of a two-wire bus (A and B) that begins at the host processor and ends at the far end from the processor. A star network configuration can also be used where each unit is connected directly to the A and B terminals at the host processor. An advantage of the RS- 485 network is that it can extend up to 4,000 feet (1,220 meters) and units can be added and removed without breaking the network connection. A requirement of the RS-485 electrical standard is that the bus is terminated at both ends by a [3]120 ohm resistor. Also, the standard allows a maximum of 32 units on a single two-wire bus. To accommodate more than this, some of the 32 units can be repeaters. Each repeater can add an additional 32 units. The maximum number of addressable PPTs on a network is 89.

A PPT multidrop network connection of six units is shown in Figure 4.22. In this network, the device IDs are not in order from one end of the network to the other. Looking at all the units on the bus, the device IDs are sequential beginning with ID=01 and without duplication. This is an important setup condition if global commands (*99) are desired.

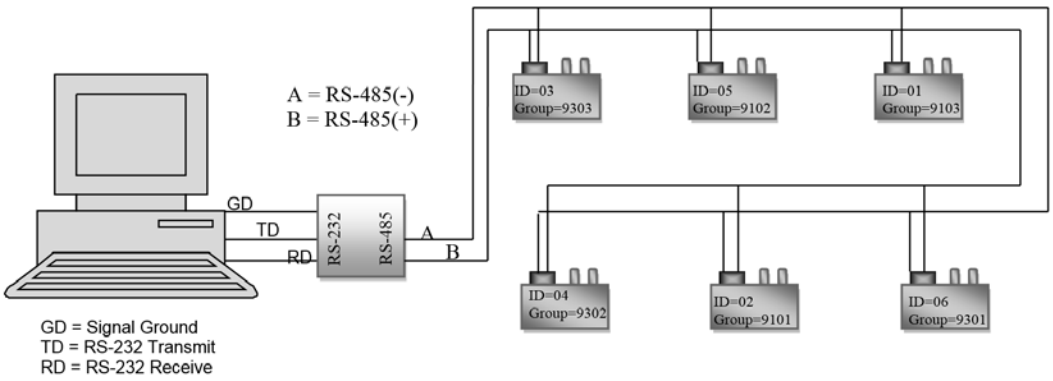


Figure 4.18 – RS-485 PPT Multidrop Network

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This gives the units on a multidrop bus a preassigned order to follow when they are responding to a global (*99) command. Each PPT on the communication bus must have a unique address in order to individually receive commands from the host processor.

To assign device IDs when the PPTs are on a multidrop network takes a bit more record keeping than for a RS-232 ring. When a RS-485 unit has a null address (unassigned), it will only respond to null addressed (*00) commands with a "?00" reply header. All null addressed units will listen to a group or global addressed command and take action, if required. If there are two or more PPTs on the bus with null addresses, then they will both respond together and may cause a garbled message. Null addressed units will still receive global (*99) commands but will not answer. It is important to assign each unit a unique and sequential device ID to begin any useful communication.

Assign Device IDs: Start with a list of all the units serial numbers. For example, send the global commands ***99WE** and ***99S=00001234**. This will prepare the PPT with serial #00001234 to assign itself the number from the next global ID command. Send ***99WE**, ***99ID=02**, ***02WE**, and ***02SP=ALL** to complete the device ID assignment. Repeat this for each unit on the RS-485 network. Other methods for device ID assignments are described in the **ID** command description.

Assign Group Numbers: Once the device IDs are set the group IDs can be assigned. Each unit in the same group must have a sequential sub-address - beginning with 01. The sub-address tells each unit what order it should respond in a group addressed command. To set the group (91) and subaddress (01) for device ID=02, send the following commands: ***02WE**, ***02ID=9101**, ***02WE**, ***02SP=ALL**. Now when a command is sent to group 91, device ID=02 will be the first one to reply. In Figure 4.22, there are two address groups, 91 and 93; each have 3 PPT units assigned.

Every PPT in the network receives all commands. If the command has a group or global address requiring a response, the PPTs addressed will wait until the unit with the next lower address responds before sending its response. If the command had a global address (*99), then the PPTs will respond in the order of the assigned device IDs. If the command had a group address (*90 to *98), then the PPTs will respond in the order of the assigned group sub-address. If a number in the sequence of device IDs or group sub-addresses is missing, then the responses will stop and the command will be finished (see **ID** command).

When a RS-485 multidrop network has all device IDs properly assigned (Figure 4.22), then global addressed commands can seek replies from all units without conflict. The **TO=N** and **TO=P** commands instruct the units how to reply in this situation. When **TO=N** command is set, each PPT will respond in sequence beginning with ID=01, one right after another. It is important that during this response sequence the host processor, or user, not transmit on the bus until the last unit has finished its message. A carriage return (<cr>) sent during the response sequence will cause the next unit ID to send its response even though the previous unit ID is still transmitting.

If the **TO=P** command is set, then a <cr> prompt from the host processor is required for the first response and each successive response.. The ID=02 response will not transmit until 1) the previous unit's message has finished and 2) an additional <cr> has been sent on the bus. This <cr> can be sent manually by the user or systematically by the host processor. Each additional unit on the bus will require the above two conditions be completed before sending its message.

Another option in the RS-485 multidrop network is the use of alternate headers. That is, the leading symbol (*, #, etc.) in command and response communications on the bus. The **M=ALT** command is used to select the alternate message headers of non-printing characters. This option is useful when there is a conflict between the standard PPT message headers and the message characters used by some other components that share the RS-485 bus.

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5 COMMANDS

5.1 COMMAND FORMAT

Communication between the host or control processor and a PPT is accomplished by message transfers, or commands and replies. Communications initiated by the host processor to one or more PPTs are called **commands** and must begin with an '*' or a '~' **header character**. All commands must be terminated by a <cr> (carriage return or ENTER key). Communications initiated by a PPT to the host are called responses or **replies,** and begin with one of ten unique header characters (2 for ASCII, 8 for binary).

Commands may either *request information* from one or more PPTs such as read pressure, or *direct action* to one or more PPTs such as change a configuration value or operating mode.

Typical PPT command format: *ddcc = nnn <cr>

Where: *	is the command header character (a '~' in one case)
dd	is the decimal address of the command message (00-99)
cc	is the command code. The command code characters can be one letter, two letters, or a letter and a number. The letters are not case sensitive; i.e., either an upper case or lower case may be used. The PPT will convert the character to upper case.
=	equal sign (required in some commands)
nnn	additional characters (required in some commands)
<cr>	carriage return (do not type, press the ENTER key)

Note: For RS-485 mode, alternate headers are available. (see **MO** command)

For RS-232 mode, when manually applying commands to one or more PPTs which are in the continuous send mode **(P2, P4, T2, T4),** the special header character '$' should be used to suspend all PPT transmissions while the command message is being typed. The '$' is immediately followed by the normal command format.

Also for RS-232 mode, if an erroneous command is sent to the PPT, it is echoed back to the host in the same form it was sent. The only exception to this is when a group or global address command (ID = 90 to 99) is sent such as *99S2=15<cr>. These addresses will always echo the command back to the host processor after being read by all PPTs.

Commands are not executed until the carriage return is applied; therefore, any command message may be re-entered at any time prior to the carriage return. To do this, type a '*' followed by the command, or press a carriage return and retype the command.

Only the minimum number of characters is required for command inputs to distinguish between various command options. For example, **DU=MB**, **DU=MBAR**, or **DU=MBXYZ** will all set the display units to millibar, since only the first two characters (MB) are needed. Also, when a parameter value is entered that exceeds the stated range for that value, the parameter will be set to the maximum value for that range.

A special binary format command that controls the DAC analog output, uses a '~' (tilde) header character instead of an '*' (asterisk). This command is sent in binary form, as opposed to ASCII, and is a more efficient alternate to the standard command requiring less data to be transmitted (see Section 5.4 for binary and ASCII descriptions). For this command, the '~' has the same header functional characteristics as the '*' described above.

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5.2 INFORMATION REQUEST COMMANDS

Information request commands retrieve information from the PPT as an inquiry. One example would be a speed shift command inquiry. The command ***00S2** would request the x2 speed shift threshold value. The response may be **?01S2=12**, assuming the unit had not been assigned a device ID. A characteristic of the information request command is that the '**=nnn**' portion of the command format is dropped.

Most commands that set parameters may be used in this form to inquire about that parameter's value. For commands that have a single letter command code (**cc**), use that letter followed by an '=' equal sign to form an inquiry. For instance, to set the tare control use ***00T=SET**. To inquire about the tare control, use ***00T=** as an information request.

5.3 ACTION DIRECTING COMMANDS

Action directing commands can 1) change the PPT configuration, 2) set specific parameter values, 3) activate or deactivate controls, or 4) store information in EEPROM.

Examples of action directing commands are:

1) *00MO=P2M2	Continuous pressure readings and user message at power-up
2) *00IC=9	Set the idle count value to 9
3) *00TC=ON	Turn on the tare control switch
4) *00B=02-12-95	Set B string in EEPROM to "02-12-95"

A characteristic of most action directing commands is that they are preceded by a RAM, or EEPROM, write enable (**WE**) command or an analog control enable (**NE**) command. This signals the PPT to write the action directing parameter(s) and is provided as a safeguard to prevent inadvertent changes. The only exception to this is the initialization (**IN**) command which is activated upon receipt.

5.4 COMMAND REPLIES - GENERAL

Replies are transmitted from the PPT in response to an information request inquiry or due to a power applied condition. All replies end with a <cr> carriage return character, which can be used as a delimiter, to distinguish between sequential responses. Replies have two forms: the **ASCII format** – which consists of standard keyboard alphanumeric characters (see Section 5.5), and the **binary format** – which require fewer data bytes that are encoded for computer translation (see Section 5.6).

The binary format replies are for pressure readings using the **P3** and **P4** commands. The replies are more compact, require less data transmission, and more than double the RS-232, or RS-485, data transfer capacity. However, the binary format is difficult for people to translate and is best left for a computer to interpret.

The ASCII format characters have readable output values and do not require user interpretation. However, the binary format will transmit a pressure reading in 6 bytes where it may take up to 16 bytes in the ASCII format. (See the Binary Format Replies description below for a detailed explanation of the address and pressure encoding.) There is a mode (**OP=R**) that can transmit ASCII format in 8 bytes.

When an information request command is sent to a PPT or group of PPTs the reply will take on different forms based on the state of the PPT, the address of the PPT, or the out-of-range condition for that parameter.

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A pressure-over-range error condition will occur when the applied pressure is greater than or equal to 1% of full scale (FS) above the FS limit. For example, if the pressure applied to a 20 psi unit is •20.200 psi, then an over range error condition is set (see **RS** command). Similarly, an under range condition occurs when the applied pressure is greater than or equal to 1%FS below the minimum limit. To indicate an out-of-range condition (greater than ±1% FS), the equal '=' sign will be replaced by an exclamation point '!' in the pressure reading reply. This indicator will disappear when the applied pressure is in range, but the **RS** command error flag will continue to be set until it is cleared by an inquiry.

The maximum reading will flatten out between 1% and 5% beyond the FS limit with increasing pressure. This limit varies from device to device but will continue to display the out-of-range indicator ("!" in place of "=") until the pressure drops below 1% over FS limit.

5.5 ASCII FORMAT REPLIES

Most commands use the ASCII format reply and may be identified by the header character (ASCII – American Standard for Coded Information Interchange). The ASCII format consists of standard keyboard alpha-numeric characters and symbols. The **header character** is the first character in the reply from the PPT. The ASCII format information request reply uses the following header characters:

#	ASCII format reply from an assigned address PPT.
?	ASCII format reply from a null address PPT.

Example replies to command code (cc) are: (where xx = the parameter value)

#ddcc=xx	reply from unit with an assigned address (dd).
#ddcc!xx	reply from unit with an assigned address (dd) when 1) pressure or temperature reading is out-of-range (over/under limit = ±1%FS) or, 2) an EEPROM parity error has occurred (pressure reading will output zero).
#ddcc=..	reply from unit with an assigned address (dd) when data is not available yet from the PPT or the output was disabled (see **DA** command). Request again.
?ddcc=xx	reply from a null address unit (dd).
?ddcc!xx	reply from a null address unit (dd) when 1) pressure or temperature reading is out-of-range (over/under limit = ±1%FS) or, 2) an EEPROM parity error has occurred (pressure reading will output zero).
?ddcc=..	reply from a null address unit (dd) when data is not available yet from the PPT or the output was disabled (see **DA** command). Request again.

Note: For multidrop bus mode alternate header descriptions see **MO** command description.

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ASCII format command and reply messages contain only the set of printable ASCII characters as described in the following list of legal characters:

*	Asterisk
~	Tilde
-	Minus
+	Plus
.	Period
=	Equal
>	Greater than
<	Less than
0-9	Numbers zero through nine
a-z	Letters ‘a’ through ‘z’ (not sent in replies)
A-Z	Letters ‘A’ through ‘Z’
#	Pound sign
?	Question mark
{	Left brace
!	Exclamation mark
^	Circumflex
|	Bar
}	Right brace
@	At/each
&	And/ampersand
%	Percent
$	Dollar sign (used before a command to stop, or suspend, continuous PPT transmissions while manually typing commands
‘ ‘	Space, or Blank

5.6 BINARY FORMAT REPLIES

The binary format reply is only used for the pressure reading commands **P3** and **P4**. It consists of a 1 byte header character, 4 bytes data, an optional 1 byte cyclic check sum, and 1 byte <cr> character. For the binary format replies, the address type, error condition and data sign are encoded into the single header character as shown in Table 5.1 below.

Header Characters	Assigned Address	Error Condition	Data Sign Hdr.	Alternate RS-485 only (1)
{	Yes	No	+	DC1 (ctrl Q)
}	Yes	No	-	DC2 (ctrl R)
!	Yes	Yes	+	DC3 (ctrl S)
@	Yes	Yes	-	DC4 (ctrl T)
^	Null	No	+	none
&	Null	No	-	none
|	Null	Yes	+	none
%	Null	Yes	-	none

(1) See **M=** command and Table 9.2 for ASCII hex value

Table 5.1 – Header Description for Binary Format Pressure Readings

REF: ECN-6046312

Example **P3**, **P4** command replies in binary format: (where hhhh = the 4 byte data value)

{hhhh<cr>	reply from unit with an assigned address, no errors, (+) data sign.
@hhhh<cr>	reply from unit with an assigned address, error condition exists, (-) data.
^hhhh<cr>	reply from a null address unit, no errors, (+) data sign.
&hhhh<cr>	reply from a null address unit, no errors, (-) data sign.
{nnnn<cr>	where nnnn pressure value is (FFFF)Hex, all ones.

The binary format reply: xx??? or xx_?? indicates that data is not yet available from the PPT or the output was disabled, see **DA** command. The 'xx' is the header character and the 6 most significant bits of the address.

Note: A PPT can be configured (using **DA=O, S, T**, or **U**) to provide a '**~**' response to a **P3** or **P4** request. In this case, the header is a '**~**', the address is the group address, no error conditions are indicated and the sign is always positive.

The 4 byte data value hhhh contains the device address and the pressure reading. The most significant bit of each 'h' character is a parity bit. The next most significant bit of each 'h' character is either a 1 or 0 required to make the resultant byte a printable character. The 6 least significant bits are used for the device address and pressure reading.

The device ID and the pressure reading can be read by combining the 6 least significant bits of each of the four 'h' characters, which result in 24 bits of information. The first 7 bits represent the device address in binary form (00 through 89 decimal). The next 17 bits represent the pressure reading and can be configured in the signed form or the extended form by using the OP command. The 24 bit binary forms are:

Extended:	7 bit binary device address	17 bit binary pressure data
Signed:	7 bit binary device address	sign bit + 16 bit binary pressure data

Example binary reply: {@#16<cr>

Refer to Table 5.1 for the header character '{' definition. The sign of this pressure value is determined by the header character. The next 4 characters, '@#16', contain the encoded device address and the temperature compensated pressure reading. For this example, the extended form is used so that the pressure data is represented as a 17 bit binary value. Using the binary format character codes found in Table 5.2, convert each of the 4 byte characters into the binary value equivalent. The highlighted portion of each character below represents the 6 least significant bits. (Parity is off, OP=N)

@=01 **000000** #=00 **100011** 1=00 **110001** 6=00 **110110**

Using the least significant (LS) 6 bits of each of the 4 data bytes, regroup the binary numbers into the 7 bit binary device address and 17 bit binary pressure data, which produces the 24 bit string:

000000 100011 110001 110110 = @#16 least significant 6 bits of each byte
0000001 00011110001110110 = (device ID=01) and (pressure = 15,478)

The binary format reply indicates the device address is **ID=01** and the pressure reading is 15,478. Now, the decimal point position for the pressure reading must be determined. The decimal place is in the same position as when it reads a P1 pressure command (see Table 4.2). So, if this is a 20 psig device reading in inches water column (DU=INWC) then there are 2 decimal places. The final reading from the binary format will be **154.78 inH2O**. The header character for this binary reply was '{' which indicates a positive pressure value.

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Binary Format Character	Decimal Value	Hex Value	Binary Value	Least 6 Significant Bits
@	64	40	0100 0000	000000
A	65	41	0100 0001	000001
B	66	42	0100 0010	000010
C	67	43	0100 0011	000011
D	68	44	0100 0100	000100
E	69	45	0100 0101	000101
F	70	46	0100 0110	000110
G	71	47	0100 0111	000111
H	72	48	0100 1000	001000
I	73	49	0100 1001	001001
J	74	4A	0100 1010	001010
K	75	4B	0100 1011	001011
L	76	4C	0100 1100	001100
M	77	4D	0100 1101	001101
N	78	4E	0100 1110	001110
O	79	4F	0100 1111	001111
P	80	50	0101 0000	010000
Q	81	51	0101 0001	010001
R	82	52	0101 0010	010010
S	83	53	0101 0011	010011
T	84	54	0101 0100	010100
U	85	55	0101 0101	010101
V	86	56	0101 0110	010110
W	87	57	0101 0111	010111
X	88	58	0101 1000	011000
Y	89	59	0101 1001	011001
Z	90	5A	0101 1010	011010
[	91	5B	0101 1011	011011
\	92	5C	0101 1100	011100
]	93	5D	0101 1101	011101
^	94	5E	0101 1110	011110
_	95	5F	0101 1111	011111

Binary Format Character	Decimal Value	Hex Value	Binary Value	Least 6 Significant Bits
` (1)	96	60	0110 0000	100000
!	33	21	0010 0001	100001
"	34	22	0010 0010	100010
#	35	23	0010 0011	100011
$	36	24	0010 0100	100100
%	37	25	0010 0101	100101
&	38	26	0010 0110	100110
'	39	27	0010 0111	100111
(	40	28	0010 1000	101000
)	41	29	0010 1001	101001
j (2)	106	6A	0110 1010	101010
+	43	2B	0010 1011	101011
,	44	2C	0010 1100	101100
-	45	2D	0010 1101	101101
.	46	2E	0010 1110	101110
/	47	2F	0010 1111	101111
0	48	30	0011 0000	110000
1	49	31	0011 0001	110001
2	50	32	0011 0010	110010
3	51	33	0011 0011	110011
4	52	34	0011 0100	110100
5	53	35	0011 0101	110101
6	54	36	0011 0110	110110
7	55	37	0011 0111	110111
8	56	38	0011 1000	111000
9	57	39	0011 1001	111001
:	58	3A	0011 1010	111010
;	59	3B	0011 1011	111011
<	60	3C	0011 1100	111100
=	61	3D	0011 1101	111101
>	62	3E	0011 1110	111110
?	63	3F	0011 1111	111111

(1) The grave accent character is used instead of a space to provide printable characters for debug and verification purposes.

(2) The lower case 'j' is used instead of the '*' because the '*' is interpreted as a message header character.

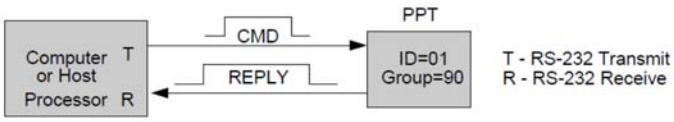
Table 5.2 – Binary Format Character Codes

REF: ECN-6046312

5.7 COMMAND AND REPLY SEQUENCING

When the PPT is operated in the digital output mode, it may be connected to a host processor, or computer, via RS-232, or RS-485, connection. See Section 6 for various electrical connections. In this mode, the host processor sends a command and the PPT responds with a reply. The reply and timing of the reply are dependent on the command and PPT network configuration.

Typical command and reply messages are shown in Figure 5.1 for a single PPT connected to a host processor. The **CMD** waveform represents the command sent from the host to the PPT. It is actually a sequence of RS-232 level ASCII characters sent at the correct baud rate and parity type (see **BP** command). The **REPLY** is the corresponding response from the PPT to the CMD command. Note that the command input is case insensitive, that is, either upper case or lower case letters may be used. For global and group commands, the PPT reply is always in upper case letters. The reply format is ASCII and the device is initially unassigned, or null address.



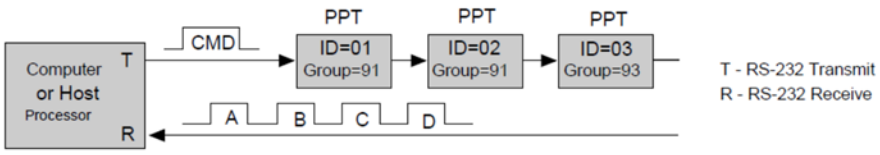
COMMAND	REPLY	COMMENT
Power-on	?01PPT____20_psia	factory set power-on message
*01S=	?01S=00036714	Read factory set serial number
*99we	*99WE	RAM or EEPROM write enable (global)
*99id=01	*99ID=02	Set device IDs (global)
*01P1	#01CP=12.345	Read pressure from device ID=01
*01ID	#01ID=90	Read group number

Figure 5.1 – Single PPT Command and Reply

When several PPT units are serially connected as a network, the reply sequence now depends on the type of address (individual, group, or global) and command type (sequential response or not). Refer to Table 5.3 — Command Summary Table, for the sequential response type of each command.

Different types of command and reply messages are shown in Figure 5.2 for a three-PPT network connected to a host processor. The commands are sent to individual units, groups and global addresses. Note that for group and global addressed commands, the command is sent around the network and returns to the host processor. If the host processor sends a sequential response command to a group or global address, then the reply(ies) may return before or after the command, depending on the command type. Examples of the different types of sequential response commands are also shown. The reply format is ASCII.

REF: ECN-6046312



Command (1)	Reply A	Reply B	Reply C	Reply D
*01T1	#01CT=25.4	–	–	–
*02WE	–	–	–	–
*02DU=mmhg	–	–	–	–
*02DU	#02DU=MMHG	–	–	–
*92DU	#02DU=MMHG	*92DU	–	–
*91P1	#01CP=1.024	#03CP=15.25	*91P1	–
*91CK	*91CK	#01CK=OK	#03CK=OK	–
*99we	*99WE	–	–	–
*99bp=n19200	*99BP=N19200	–	–	–
*99RS= =	#01RS=0000	#02RS=010+	#03RS=000-	*99RS= =
*99WE	*99WE	–	–	–
*99sp=all	*99SP=ALL	–	–	–
*99P1	#01CP=1.274	#02CP=12.498	#03CP=-.00004	*99P1

(1) See Table 5.3 for types of sequential response commands.
– Indicates there is no reply for this timing location

Figure 5.2 – Multiple PPT Network Command and Replies

5.8 COMMAND ERRORS

For RS-232 ring configuration, if the host processor receives a PPT reply with a '*' header character, this indicates one of three conditions.

1. If the reply is exactly the same as the command sent, and the command was not sent to a group or global address (90 to 99), then the command has been rejected due to an incorrect header, address number, command code or action character.

   This error is common if an incorrect command code format was used or if the command should have been preceded by a write enable (WE, NE) command and was not.

   If the command was rejected because of an incorrect command code or action character, an error indicator is set which can be read and cleared with the Read Status (RS) command.

2. If the command was a group or global command, then the reply should contain the *90.. to *99.. command sent. (The command should contain a 9 as the first digit of the group or global address.) This reply indicates to the host processor the command has been delivered to all addressed units in the network. This indicates an error only if the reply does not contain the command sent.

3. The command stream has been aborted by the sending host processor.

NOTE: A **R**ead **S**tatus command is used to determine the error condition and clear the error status. (See Read Status command description for error conditions.)

REF: ECN-6046312

5.9 COMMAND SUMMARY TABLE

The PPT command set is summarized in Table 5.3—Command List. A more detailed description of each command can be found in Section 5.10—Command Descriptions.

Table heading explanations for Table 5.3—Command List:

Command Code: Two-character code (cc) in the command format. The command code characters can be one letter followed by an '=' equal sign, two letters, a letter and a number, or a '~' tilde. The letters are not case sensitive; i.e. either upper case or lower case may be used. The PPT will convert the characters to upper case.

Action Directing Command: Does this command change the PPT configuration? **Yes**—The command changes the PPT configuration as an action directing command. **No**—The command is only an information request command.

Sequential Response with Group or Global Address: Commands that begin with a group or global address (ID=90-99), are passed through the PPT network from one device to the next and eventually end up back at the host processor. The PPT response is sent with the command through the network. **Before**—The PPT response is sent before the group or global command. This is a sequential response. **After**—The PPT response is sent after the group or global command. **No**—The PPT just passes the command through the network with no response.

Input or Output: Is information input to the PPT or output from the PPT? **In**—Command is only used to input (action direct command) to the PPT. **Out**— Command is only used to output (request information inquiry) from the PPT. **Both**—Command can be used for either IN or OUT purposes.

Requires Write Enable: Is a WE command required before for this command? **Yes**—When sent as an action directed command, it must be preceded by a WE command. **No**—Never requires a WE command beforehand. These are request information commands only.

Terminates Continuous Commands: Will this command stop the PPT flow? **Yes**—This command will end the continuous flow of the P2, P4, T2, T4 commands. **No**—Command will not stop the continuous flow commands.

Write to EEPROM: Can this command have parameters stored in EEPROM? **Yes**—Parameter values associated with this command may be stored in EEPROM. **No**—Can not store anything from this command in EEPROM. **All**—Cause all parameters to be store in EEPROM.

Write to DAC: Can this command be written to the DAC? **Yes**—Command may be directed to the DAC. **No**—Command has nothing to do with the DAC

REF: ECN-6046312

Command Code	Action Directing Command	Sequential Response with (90-99) Addresses	Input or Output Type	Requires Write Enable	Terminates Continuous Commands	Can Write to EEPROM	Can Write to DAC	Command Description
A=	No	After (4)	Both	Yes	No	Yes (10)	No	Data string A - up to 8 characters
AN	Yes	Before	Both	Yes (6)	No	No (11)	No	Customize Anolog Range
B=	No	After (4)	Both	Yes	No	Yes (10)	No	Data string B - up to 8 characters
BP	Yes	No	In	Yes	Yes	No (11)	No	Set baud rate and parity
C=	No (1)	After (4)	Both	Yes	No	Yes (10)	No	Data string C - up to 8 characters
CK	No	After (4)	Out	No	No	No	No	Check for EEPROM checksum error
D=	No (1)	After (4)	Both	Yes	No	Yes (10)	No	Data string D - up to 8 characters
DA	Yes	Before	Both	Yes (6)	No	No (11)	Yes (12)	Switches analog updates to output
DO	Yes	Before	Both	Yes (6)	No	No (11)	No	Set default operating parameters
DS	Yes	Before	Both	Yes (6)	No	No (11)	No	Set deadband and sensitivity values
DU	Yes	Before	Both	Yes (6)	No	No (11)	No	Set pressure output display unit
F=	Yes	After (4)	Both	Yes (6)	No	No (11)	No	Set custom full scale pressure range
H=	Yes	After (4)	Both	Yes (6)	No	No (11)	Yes (13)	Set custom analog high limit (DAC)
I=	Yes	After (4)	Both	Yes (6)	No	No (11)	No	Set integration time, Rn and Mn forms
IC	Yes	Before	Both	Yes (6)	No	No (11)	No	Set idle count (data output rate)
ID	Yes	Before	Both	Yes (6)	No	No (11)	No	Set PPT device ID or group number
IN	No (2)	No	In	No	Yes	No	No	Initialize or reset PPT processoer
L=	Yes	After (4)	Both	Yes (6)	No	No (11)	Yes (13)	Set custom analog low limit (DAC)
M=	Yes	After (4)	Out	No	No	No	No	Reads maximum full scale setting
MO	Yes	Before	Both	Yes (6)	No	No (11)	No	Set power-up mode parameters
N=	No (3)	After (4)	Both	No (7)	No	No	Yes (13)	Set analog (DAC) output level
NE	No	No	In	No	No	No	No	Analog output (DAC) write enable
O=	Yes	After (4)	Both	Yes (6)	No	No (11)	Yes (13)	Offset a custom analog output range
OP	Yes	Before	Both	Yes (6)	No	No (11)	No	Set operating mode parameters
P=	No	After (4)	Out	No	No	No	No	Read PPT production date
P1	No	Before (5)	Out	No	No	No	No	Single pressure reading (ASCII)
P2	No (3)	After	Out	No	Yes (9)	No	No	Continuous pressure reading (ASCII)
P3	No	Before (5)	Out	No	No	No	No	Single pressure reading (binary)
P4	No (3)	After	Out	No	Yes (9)	No	No	Continuous pressure reading (binary)
RR	Yes	Before	Both	Yes (6)	No	No (11)	No	Set reading rate for identical data
RS	No	Before (5)	Out	No	No	No	No	Read status of error conditions
S=	No	After (4)	Out	No	No	No	No	Read PPT factory serial number
S2	Yes	Before	Both	Yes (6)	No	No (11)	No	Set 2x speed shift threshold
S5	Yes	Before	Both	Yes (6)	No	No (11)	No	Set 50 msec interval threshold
SI	Yes	No	In	No	No	No	No	Synchronize Pressure Integration
SP	Yes	No	In	Yes	No	All	No	Store RAM parameters in EEPROM
T=	Yes	After (4)	Both	Yes (6)	No	No (11)	No	Set tare value (gage only)
T1	No	Before (5)	Out	No	No	No	No	Single temperature reading (°C)
T2	No (3)	After	Out	No	Yes (9)	No	No	Continuous temperature reading (°C)
T3	No	Before (5)	Out	No	No	No	No	Single temperature reading (°F)
T4	No (3)	After	Out	No	Yes (9)	No	No	Continuous temperature reading (°F)
TC	Yes	Before	Both	Yes (6)	No	No (11)	No	Turn On/Off tare control
TO	Yes	Before	Both	Yes (6)	No	No (11)	No	Set transceiver operating mode
U=	Yes	After (4)	Both	Yes (6)	No	No (11)	No	Set user supplied pressure units
V=	No	After (4)	Out	No	No	No	No	Read PPT software code version
W=	Yes	After (4)	Both	Yes (6)	No	No (11)	Yes (13)	Set custom width of analog output
WE	Yes	No	In	No	No	No (11)	No	Write enable for RAM/EEPROM
X=	Yes	After (4)	Both	Yes (6)	No	No (11)	No	Set "m" of user mx+b control
Y=	Yes	After (4)	Both	Yes (6)	No	No (11)	No	Set "m" of user mx+b control, diff. only
Z=	Yes	After (4)	Both	Yes (6)	No	No (11)	No	Set "b" of user mx+b control
~	No (3)	No	In	No (8)	No	No	Yes	Set DAC analog output (binary)

Table 5.3 – Command List

See previous page for descriptions of the table headings.

REF: ECN-6046312

Table 5.3—Command List Notes

(1) The **C=** and **D=** commands do not change the mode of operation but do provide a user supplied power-up message if configured using the **MO** command.

(2) The **IN** command does not change the operating parameters stored in RAM, but it does stop continuous readings (**P2**, **P4**, **T2**, **T4** commands). If the **IN=RESET** command is sent, then any parameters that were stored in RAM, and were not stored in the EEPROM with a **SP** command, will default to the last stored EEPROM value. This may cause a change in the operational parameters as well as a configuration change.

(3) The **P2, P4, T2,** and **T4** commands do not change the operating parameters, only activate continuous readings. The **N=** and '**~**' commands do not change any operating parameter values only the DAC analog output voltage.

(4) When an information request command is sent to a group or global address, the PPTs do not respond sequentially. That is, the command is returned to the host processor before the replies from the PPTs. Also, these commands require more time for execution, often requiring EEPROM reads and/or writes, so responses from more than one PPT are not received in any guaranteed order. During the execution of one of these commands, if another command is received that is an "After" type, whether globally, group, or individually addressed, the received command is rejected and the command read status error (see **RS** command) is set.

(5) These commands may cause sequential responses from any, all or none of the addressed units. A sequential response is when the PPT reply is sent before the global or group command through the network. See the individual command descriptions for detailed information.

(6) These commands only require a write enable (**WE**) when used in the action directing form. For these commands the **WE** command provides a single occurrence write enable for RAM update. That is, only the next instruction is written to RAM. The **WE=RAM** command provides continuous write enables for RAM for multiple command updates. The continuous RAM enable is active until a **WE** is sent.

(7) The **N=** command requires an **NE** command enable when used to send information. The **NE** command provides single occurrence write enable for analog control. The **NE=DAC** command can be used to provide continuous write enable for analog control.

(8) The '**~**' command requires an **NE** command enable. The **NE** command form provides single occurrence write enable and the **NE=DAC** command form provides continuous write enable. The **NE=CKS** command form provides continuous write enable and requires that the '**~**' command contain a cyclic checksum.

(9) These commands terminate an active continuous reading command (**P2**, **P4**, **T2**, **T4**) and initiate the new one.

(10) These commands automatically write to the EEPROM when they are used in the action directing form, which must be preceded by a WE command.

(11) These commands can be used to change RAM contents which can then be written to the EEPROM using the **SP=ALL** command.

(12) The **DA** command does not write to the DAC but it does allow the DAC to be controlled by the PPT input pressure value or by a digital value applied by the **N=** command.

(13) These commands only write to the DAC when used in the action directing form.

REF: ECN-6046312

5.10 COMMAND DESCRIPTIONS

In the command descriptions, the definitions and conventions below apply. For an example of each command and associated reply, see Section 3 Commands – Quick Reference. The factory default values are shown in Table 5.4.

Inquiry:	**Information requesting command**
Action:	Action directing command(s)
EEPROM Store:	Command(s) to permanently store value or condition into EEPROM
Bold	Words that appear in boldface should be typed as shown
Italics	Words that appear in italics are place holders for information you supply
{Either |Or}	Words that appear in braces with a vertical line between indicate a mandatory choice between two or more items.

Typical PPT command format: *ddcc = nnn <cr>

Where: *	is the command header character (a '~' in one case)
dd	is the decimal address of the command message (00-99)
cc	is the command code. The command code characters may be one letter, two letters, or a letter and a number. The letters are not case sensitive; i.e. either upper case or lower case may be used. The PPT will convert the character to upper case.
=	equal sign (required in some commands)
nnn	additional characters (required in some commands)
<cr>	carriage return (ENTER key) **must** follow every command.

Commands are not executed until the carriage return is applied; therefore, any command message may be re-entered at any time prior to the carriage return. To do this, just type an '*' followed by the remainder of the command.

Command	Factory Default
A=	(empty)
A N	ON
B=	(empty)
B P	N (9600)
C=	(empty)
D =	(empty)
D A	B
D O	E0N
D S	00S0
D U	PSI
F =	0
H =	100

Command	Factory Default	
I =	M 2	
I C	0	
I D	90	RS-232
I D	9000	RS-485
L =	0	
M =	(psi range)	
M O	X2M1	
O=	0	
O P	ANEX	
P =	(date)	
R R	0	
S=	(ser.#)	

Command	Factory Default	
S2	0	
S5	0	
T =	0.0000	
T C	OFF	
T O	R0CN	RS-232
T O	M1CN	RS-485
U =	1.000	
V =	(ver.#)	
W=	100	
X=	0	
Y=	0	
Z=	0	

Table 5.4 – Command Factory Default List

REF: ECN-6046312

A= Data String A

The **A=** data string command can be used to store and retrieve up to eight characters in the EEPROM. This command must have 1 to 8 characters immediately following the '=' character. The message is terminated with the <cr> (ENTER key) character. The data string is automatically stored in EEPROM with this action command. Since this string is stored in EEPROM, it will remain in the PPT even after the power is turned off. Examples include dates for maintenance checks, over/under range pressure or temperature values, or key pressure readings specific to application. If the response has an '!' character instead of '=', there was an EEPROM parity error.

Note: This command will not work when a ***ddWE=RAM** continuous write enable is active. It must be preceded by a singular write enable (***ddWE**).

Inquiry: *dd**A=**

Action: *dd**WE**
*ddA=*Your_msg*

Your_msg must have 1 to 8 characters immediately following the '=' character. The message is terminated with the <cr> character. The legal characters for *Your_msg* include all characters between the 'space' (SP) and lower case 'z' inclusive, except the '*', in standard ASCII (see last page of manual).

A N Analog Range Setting

The **AN** command turns on and off the custom **AN**alog output setting of the DAC. The analog range setting is established with the **H=** and **L=** commands. Analog window settings are established with the **O=** and **W=** commands. When **AN** is **ON**, the customized settings are activated; when **OFF**, the factory default range of 0V to 5V is active. When custom **H=** and **L=** range settings are used, the resolution of the analog signal will be reduced. For example, the full 5 volt range has a 12 bit resolution. A range reduction to 2.5 volts will result in an 11 bit resolution. Ranges between these two values would result in a resolution between 11 and 12 bits. The use of analog window limits **O=** and **W=** can increase the resolution of the analog signal. See Section 4.5 for an example. (Default: **AN=ON**)

Inquiry: *dd**AN**

Action: *dd**WE**
*dd**AN={ON|OFF|ON-|OFF-}**

EEPROM Store: *dd**WE**
*dd**SP=ALL**

ON The analog output will adjust to the high and low limits (**H=**, **L=**) and the offset and window limits (**O=**, **W=**). The highest pressure produces the high (**H=**) output voltage and the lowest pressure produces the low (**L=**) voltage.

OFF The analog output will set to 5 volts for the FS pressure (**F=**) and to 0 volts for zero pressure - or negative FS pressure for differential.

ON- Same function as **ON**, but output scale is reversed. i.e. The highest pressure produces the low (**L=**) output voltage and the lowest pressure produces the high (**H=**) voltage.

OFF- The analog output will set to 0 volts for the FS pressure (**F=**) and to 5 volts for zero pressure - or negative FS pressure for differential.

REF: ECN-6046312

B= Data String B

The **B=** data string command can be used to store and retrieve up to eight characters in the EEPROM. This command must have 1 to 8 characters immediately following the '=' character. The message is terminated with the <cr> (ENTER key) character. The data string is automatically stored in EEPROM with this action command. Since this string is stored in EEPROM, it will remain in the PPT even after the power is turned off. Examples include dates for maintenance checks, over/under range pressure or temperature values, or key pressure readings specific to application. If the response has an '!' character instead of '=', there was an EEPROM parity error.

Note: This command will not work when a ***ddWE=RAM** continuous write enable is active. It must be preceded by a singular write enable (***ddWE**).¡

Inquiry: *dd**B=**

Action: *dd**WE**
*dd**B**=*Your_msg*

Your_msg must have 1 to 8 characters immediately following the '=' character. The message is terminated with the <cr> character. The legal characters for *Your_msg* include all characters between the 'space' (SP) and lower case 'z' inclusive, except the '*', in standard ASCII (see last page of manual).

B P Baud Rate and Parity Setting

The **B**aud rate and **P**arity command is used to change the baud rate and parity type. Both the write enable (**WE**) and **BP** command **must** be sent as a global address (e.g. *99); otherwise, the command is rejected and sets the read status (**RS**) command error.

For this command only the first one or two baud rate characters need to be used. This command causes the new baud rate and parity setting to be changed and the command to be retransmitted to the next PPT. When the command transmission is complete, the new baud rate and parity are activated, but are not permanently stored in the EEPROM until an **SP=All** command is executed. The new baud rate *must* be selected before executing the **SP=ALL** command. (Default: **BP=N9600**)

Note: When shipped from the factory, the PPT is set to a baud rate of 9600, 1 start bit, 8 data bits, no parity, and 1 stop bit. If the baud rate has been changed to an unknown value, it will be necessary to search all the baud rate values to reestablish communication.

Inquiry: *dd**BP** EEPROM Store: ***99WE**
***99SP=ALL**

Response: #dd**BP=N** *or* #dd**BP=E** *or* #dd**BP=O**

Note: A *99WE and *99BP=.. global address *must* be used to change the baud rate.

Action: ***99WE**
***99BP=** {**N**|**E**|**O**} {**12**00 |**24** 00|**4**800|**9**600|**14**400|**19** 200|**28**800}

N No parity
E Even parity
O Odd parity

1200**,...28**800 Baud rate (bits/sec)

REF: ECN-6046312

C= Data String C

The **C=** data string command can be used to store and retrieve up to eight characters in the EEPROM. This command must have 1 to 8 characters immediately following the '=' character. The message is terminated with the <cr> (ENTER key) character. The data string is automatically stored in EEPROM with this action command. Since this string is stored in EEPROM, it will remain in the PPT even after the power is turned off. Examples include dates for maintenance checks, over/under range pressure or temperature values, or key pressure readings specific to application. If the response has an '!' character instead of '=', there was an EEPROM parity error.

Note: This command will not work when a ***ddWE=RAM** continuous write enable is active. It must be preceded by a singular write enable (***ddWE**).

Note: This data can be used to provide the first eight characters of a user provided start-up message (see the **MO** command). When used as a start-up message, any space character in the **C=** message will terminate the message. Use an underscore (_) character for spaces.

Inquiry: *dd **C=**

Action: *dd**WE**
*dd**C=***Your_msg***

Your_msg must have 1 to 8 characters immediately following the '=' character. The message is terminated with the <cr> character. The legal characters for *Your_msg* include all characters between the 'space' (SP) and lower case 'z' inclusive, except the '*', in standard ASCII (see last page of manual).

C K Check EEPROM

The **C**hec**K** EEPROM command performs a checksum on both the characterization area and the configuration area of the EEPROM. This check typically takes 180 msec.

Inquiry: *dd**CK**

There are four possible responses for this command.

#(or ?)ddCK=**OK**	Indicates no checksum errors
#(or ?)ddCK=**ERR1**	Indicates a characterization area checksum error
#(or ?)ddCK=**ERR2**	Indicates a configuration area checksum error
#(or ?)ddCK=**ERR3**	Indicates both checksum errors

REF: ECN-6046312

D = Data String D

The **D=** data string command can be used to store and retrieve up to eight characters in the EEPROM. This command must have 1 to 8 characters immediately following the '=' character. The message is terminated with the <cr> (ENTER key) character. The data string is automatically stored in EEPROM with this action command. Since this string is stored in EEPROM, it will remain in the PPT even after the power is turned off. Examples include dates for maintenance checks, over/under range pressure or temperature values, or key pressure readings specific to application. If the response has an '!' character instead of '=', there was an EEPROM parity error.

Note: This command will not work when a ***ddWE=RAM** continuous write enable is active. It must be preceded by a singular write enable (***ddWE**).

Note: This data can be used to provide the last eight characters of a user provided start-up message (see the **MO** command). When used as a start-up message, any space character in the **D=** message will terminate the message. Use an underscore (_) character for spaces.

Inquiry: *dd**D=**

Action: *dd**WE**
*dd**D=***Your_msg***

Your_msg must have 1 to 8 characters immediately following the '=' character. The message is terminated with the <cr> character. The legal characters for *Your_msg* include all characters between the 'space' (SP) and lower case 'z' inclusive, except the '*', in standard ASCII (see last page of manual).

REF: ECN-6046312

DA Digital and Analog Control

The **D**igital and **A**nalog control command determines which signals connect to the digital output and which to the analog DAC output. The analog output can be disabled (**C**, **D**, **M**, **O**, **T**), set to track the input pressure (**A**, **B**, **E**, **F**, **S**, **U**), or set to track the digital input in the '**~**' form (**G, N, R**). When the analog output is not changing, the voltage output remains at its last setting. When tracking pressure, the digital output can be set to binary format, ASCII format, or '**~**' DAC values. When using the **P1** or **P2** commands, the digital output can be disabled (**A, C, F, G, N, O, S**), or set to track the pressure input using the ASCII format (**B**, **D**, **E**, **M, R**, **T**, **U**). When using the **P3** or **P4** commands, the digital output can track the pressure input using the binary format (**B, C**, **D**, **F, G**, **R**), or track the pressure input using the DAC value '~' format (**O**, **S**, **T**, **U**).

When using the **DA=N**, **G**, or **R** commands to drive the analog voltage using the '**~**' DAC value format, a ***ddNE=DAC** command must be issued to the receiving unit. This allows continuous tracking of the analog voltage during a **P4** command readings. See **AN**, **H=** , **L=**, **O=**, and **W=** commands for customizing the analog output range. See the **NE**, **N=** and '**~**' commands for optional host processor control of the analog output. (Default: **DA=B**)

Inquiry: *dd**DA**

Action: *dd**WE** EEPROM Store: *dd**WE**
* d d **D A =** { **A** | **B** | **C** | **D** | **E** | **F** | **G** | **M** | **N** | **O** | **R** | **S** | **T** | **U** } *dd**SP**=**ALL**

	Digital Output Commands P1, P2	Digital Output Commands P3, P4	DAC Analog Output Voltage
A	Disabled (1)	Disabled (2)	Tracks Pressure
B (5)	ASCII Format	Binary Format	Tracks Pressure
C	Disabled (1)	Binary Format	Last Value (3)
D (5)	ASCII Format	Binary Format	Last Value (3)
E (5)	ASCII Format	Disabled (2)	Tracks Pressure
F (5)	Disabled (1)	Binary Format	Tracks Pressure
G (5)	Disabled (1)	Binary Format	Tracks '~' or 'N=' Input
M	ASCII Format	Disabled (2)	Last Value (3)
N	Disabled (1)	Disabled (2)	Tracks '~' or 'N=' Input
O	Disabled (1)	'~' DAC Value	Last Value (3)
R (5)	ASCII Format	Binary Format	Tracks '~' or 'N=' Input
S (5)	Disabled (1)	'~' DAC Value	Tracks Pressure
T (5)	ASCII Format	'~' DAC Value	Last Value (3)
U	ASCII Format	'~' DAC Value	Tracks Pressure

(1) Output response to P1 command will be #ddCP=.. or ?ddCP=.. to indicate disabled.

(2) Output response to P3 command will be xx??? or xx_?? to indicate disabled. The 'xx' is the header character and the 6 most significant bits of the address.

(3) Output will remain at last value until a different DA mode is selected.

(4) Analog output will track the '~' DAC value inputs only if they are "down stream" from the transmitting PPT with the same group address, or the analog output tracks the '~' or N= values transmitted by a control processor

(5) These selections may cause PPT microprocessor bandwidth warnings, RS=xxxB, when used with pressure reading rates over 100/sec (see I= Rn) dependent on the baud rate selected. Bandwidth warnings may also occur if there is a lot of bus traffic. These warnings do not indicate incorrect pressure readings but they do indicate the requested update rate may not be satisfied in all cases.

REF: ECN-6046312

DO Default Operating Parameters

The **D**efault **O**perating command affects four modes of operation - 1) how the PPT handles a command when a parity error occurs, 2) a value that represents the number of PPTs on the RS-232 bus, and 3) noise protection when running in the continuous pressure (**P4**) mode. (Default: **DO=E0N**)

Inquiry:	*dd **DO**			
Action:	*dd**WE**		EEPROM Store:	*dd**WE**
	*dd**DO=**{**E**|**R**}	or		*dd**SP=ALL**
	*dd**DO=***numPPTs*	or		
	*dd**DO=**{**N** |**P**}			

E Execute the command in the event of a parity error.

R Reject the command in the event of a parity error.

numPPTs *RS-232 configuration only* A decimal number from 0 to 9. The number 0 should be used if a single PPT is connected. When 2 or more PPTs are on the bus, the correct number is calculated by dividing the number of PPTs by 10 and rounding up to the next whole number.

N Normal operation.

P Noise protection when running in the **P4** continuous mode. This option reduces the chance that noise will cause transmission to stop during continuous **P4** pressure readings. In this mode, the PPT will respond normally to computer sent commands that are transmitted as a contiguous character string, but ignores commands that are typed in manually. In this mode, the **P4** command can only be interrupted manually by rapidly entering 3 suspend characters ($) *and* an asterisk (*). Once the pressure readings have stopped, the desired command can be entered within a 5 second period. Otherwise, the continuous pressure readings will resume.

Note: To run **P4** for a RS-485 unit, the **TO=C** option must be set.

REF: ECN-6046312

DS Deadband and Sensitivity Control

The **Deadband** and **S**ensitivity control command allows the user to adjust the threshold value that causes a change in pressure reading. There are two option for this, **C** and **S**.

The **C** option sets the deadband to around the center of the pressure reading that moved it last. When the deadband is first set, the deadband will be split half above and half below the current reading. When the pressure exceeds either limit, the new pressure value becomes centered in the deadband limits.

The **S** option sets the deadband based on the peaks and valleys of the pressure level. For instance, when a small peak pressure is sensed, the top edge of the deadband will move to that pressure and have the entire deadband range below this value. The output reading will be one-half the deadband below the pressure (see Figure 4.18). As long as the pressure stays within the new deadband range the output will not change. If a pressure is sensed below this range, the deadband will move so that the bottom edge will be at that pressure and the entire deadband will be above this value.

Note: For both the **C** and **S** options, there are instances when the transmitted pressure value can be inside the deadband limits. This is due to the integration of the pressure value where multiple pressure samples are used to determine a single pressure reading. If one of the samples falls outside the deadband limits and the average of all the samples falls inside the limits then the transmitted reading will be inside the limits. To avoid this effect, set the integration time to **I=R61**, or greater. Now the transmitted pressure output will be based on a single sample.

When the **W=S** command is used to establish an analog set point. The deadband (**DS**) controls the set point null span (set point hysteresis). Also, the **S2** and **S5** speed shift thresholds can be used to create higher reading rates when pressure is changing, and lower reading rates when pressure is stable within the deadband limits. To eliminate repetitive readings of the same pressure within the deadband set the **OP=U** command. See Figures 4.9 and 4.17 for command illustrations. (Default: **DS = 00S0**)

Inquiry:	*dd**DS**			
Action:	*dd**WE**	EEPROM Store:	*dd**WE**	
	*dd**DS=** *deadband*	or		*dd**SP=ALL**
	*dd**DS= C***n* or			
	*dd**DS= S***n*			

deadband
- 0 provides no deadband
- 1-60 provides *deadband* x 0.005% of full scale deadband limits

Note: The full scale for a 20 psig and a 20 psia is 20 psi, but for a 20 psid it is 40 psi, for example.

C Center deadband around each new pressure output change.
S Deadband **S**pread varies with the peaks and valleys of pressure changes.
n 0 or 1 – provides a deadband multiplier to allow the user to specify a wider set point null span where:

- 0 provides a 1x multiplier (deadband x 0.005% FS)
- 1 provides a 10x multiplier (deadband x 0.05% FS)

REF: ECN-6046312

D U Display Units Control

Set the **D**isplay **U**nits for compensated pressure replies. A **USER** defined display unit can be set with this command that causes the pressure output to equal the value input by the **U=** command multiplied by the actual pressure in psi units. (Default: **DU=PSI**)

Inquiry: *dd **DU**

EEPROM Store: *dd**WE**
*dd**SP=ALL**

Action: *dd**WE**
*dd**DU=** {**ATM** |**BAR**|**CMWC** |**FTWC**|**INHG**|**INWC**|**KGCM**|**KPA**|**MBAR**|**MMHG**|**MPA**|**MWC**|**PSI**|**USER**|**LCOM**|**PFS**}

Display Unit	**PSI Multiplier** (1)	**Units Description**
AT M	0.068046	ambient atmosphere at sea level
BAR	0.068948	bar (105 newtons/meter2)
CMWC	70.304	centimeters of water column (4 °C)
FTWC	2.3065	feet of water column (4 °C)
I N H G	2.0360	inches of mercury (0 °C)
INWC	27.679	inches of water column (4 °C)
KGCM	0.070307	kilograms/centimeter2
KPA	6.8948	kilopascal
MBAR	68.948	millibar (1 hectopascal)
M M H G	51.714	millimeters of mercury (0 °C) or torr
MPA	0.0068948	megapascal
MWC	0.70304	meters of water column (4 °C)
PSI	1.0000	pounds per square inch
USER	0.0010000-999.99	user supplied (see also **U=** command)
LCOM	FS=60000	logic common value (2)
PFS	FS=100.000	percent of full scale in 0.001% increments

Table 5.5 — Display Units Options

(1) From the *CRC Handbook Of Tables For Applied Engineering Science*

(2) The **LCOM** display unit (logic common) automatically switches the digital pressure output to a scale which has 60000 as the full scale output (±60000 for differential devices). The output will have a decimal point in the same position that it is in with the original psi scale. For example, when a 10psia device is switched to **DU=LCOM**, the full scale digital pressure output will be 60.000, instead of 10.000. Also, a 500psi device will output full scale at 600.00 instead of 500.00. If the pressure reading was at zero, then no output change will be seen since zero is the same for any display unit. **LCOM** provides the highest reading resolution available when using the standard output format (**OP=S**).

REF: ECN-6046312

F= Customized Full Scale Range

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 by at least one-half the FS value (**M=**). Some units may allow more than 2x reduction of the full scale 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. (Default: **F=0** , factory set FS)

Note: The accuracy specification is always referenced to the factory (**M**=) full scale value.

Note: After the **F=** command is changed, make sure all parameters are stored in EEPROM **(SP=ALL**) then enter a reset command (**IN=RESET**) or cycle the power off and on.

Inquiry: *dd**F=**

Note: The **F=** inquiry will always send the full scale value in the display units (**DU**) that were set when the **F=** command was executed. To insure the pressure units of an **F=** inquiry, follow the **F=** command with the **DU** inquiry.

Action:	*dd**WE** *dd**F=***FSnum***	EEPROM Store:	*dd**WE** *dd**SP=ALL**

FSnum This value can have up to 5 significant digits with a decimal point. First, select the display units desired (except for **LCOM**, **USER**, or **PFS**) using the **DU** command.

H= Highest Analog Voltage

Set the DAC **H**igh analog output voltage full scale (FS) reading. The input is a value from 0 to 99% of 5 volts, or 50 millivolts per count. An **H=** inquiry reads the value in 50 millivolt counts. This command is used in conjunction with the **L=**, and **AN** commands to customize the range of the PPT analog voltage output. If there is an input error, then the command error flag in the **RS** command will be set and no change will occur. See Figure 4.4 for command illustration. (Default: **H=100**)

Note: See the **L=** command for setting the low analog output voltage. See the **AN** command for enabling and disabling the **H=** and **L=** settings and for the effect on analog resolution. If **H=** value - **L=** value, then no change will occur and an **RS** command error will result.

Inquiry: *dd**H=**

Action:	*dd**WE** *dd**H=***pp***	EEPROM Store:	*dd**WE** *dd**SP=ALL**

pp **0 - 100** (%) This number sets the full scale (FS) analog voltage as an integer percent of 5.00 volts. An **H=0** setting will set the high level to 100% (5 volts). It can also be thought of as a multiplier in 50 millivolt increments. As an example, H=85 corresponds to a FS voltage of 4.25 volt (85 x 50mV or 85% of 5.00V). For **H=0**, the FS voltage is set to 100%, or 5.00 volts. A **H=** entry greater than 100 will set **H=**100.

REF: ECN-6046312

I= Integration Time

The **I**ntegration time command allows the user to adjust the analog-to-digital converter integration time over a range of 1 sample every 12 seconds up to 120 samples per second. The integration time can be used to filter noisy pressure inputs by averaging, or smoothing, the readings over a selected period of time. See Figures 4.13 and 4.14.

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 0 to 120 for the rate (**Rn**) and millisecond (**Mn**) form. For **I=R0**, or **I=M0**, the last stored setting in EEPROM will be restored. If there is an input error, then the command error flag in the **RS** command will be set and no change will occur.

(Default: **I = M2** [200msec = 5 readings/sec])

Inquiry: *dd**I=**

Action: *dd**WE** EEPROM Store: *dd**WE**
*dd**I= R***n* or **M***n* *dd **SP=ALL**

R *n* where n = 0 - 120. This form sets the output **R**ate to integer values between 1 and 120 readings per second. When using the Rn form, the sample rates do not utilize the S2, S5, and IC commands. I=R0 will restore the last setting saved in EEPROM.

M *n* where n = 0 - 120. This form sets the output sample time in 100 **M**illisecond increments (0.1 seconds). This allows output rates from 10 readings per second up to 1 reading every 12 seconds. I=M0 will restore the last setting saved in EEPROM.

IC Idle Count Parameter

The **I**dle **C**ount parameter specifies the number of pressure integration times that the microprocessor skips between output values (see Fig. 4.18). This command is only operational for the **I=Mn** form of the Integration Time (**I=**) command. (See the **I=** command for setting integration times.) This parameter can be used to reduce the average PPT power requirement by as much as 50% when increased response time is acceptable. This parameter is also used to reduce the reply message traffic on the network bus from PPTs whose response time is not critical. The **S2** and **S5** parameters are operational with this parameter to allow integration speed shifting. (Default: **IC=0**)

Note: If the **OP=W** (watchdog timer) command is set, then the **IC** command will not work (other than IC=0) and cause a **RS** command error condition.

Inquiry: *dd**IC**

Action: *dd**WE** EEPROM Store: *dd**WE**
*dd**IC=** *ICcount* *dd **SP=ALL**

ICcount 0 to 255

where: 0 causes all integration cycles to be used.
1 causes 1 of 2 integration cycles to be used.
2 causes 1 of 3 integration cycles to be used.
3 causes 1 of 4 integration cycles to be used.
255 causes 1 of 256 integration cycles to be used.

REF: ECN-6046312

I D Identification Number

Set the device **ID**entification number. This command is used to set a unique PPT address and/or a group address. Two sections describe this command based on the RS-232 or RS-485 type of unit. (Default: device **ID=00**, **group address=90**)

RS-232 type only

To unassign all device IDs, send a ***99WE** and a ***99ID=00** command. In this case, all the PPT units in the network will set their device IDs to address '00', the null address.

To sequentially assign device IDs to a RS-232 ring network, send a ***99ID=01** to the first unit. That unit will number itself **ID**=01, increment the command and automatically send a ***99ID=02** to the next PPT in line. This will continue down the ring until all of the PPTs have sequentially numbered themselves. The host processor will receive: ***99ID=nn**, where nn= the number of PPT units in the network plus 1. For example, if 6 PPTs are connected in a network, then a ***99ID=01** command will sequentially assign device IDs to all six units and return a ***99ID=07** to the host processor. Note that ID=01 must be entered and not just ID=1. The PPTs will now be sequentially assigned device IDs from 01 to 06.

Inquiry: *dd**ID** (reply is group number)

Action:	*dd**WE** *dd**ID=***newNumber*	EEPROM Store:	*dd**WE** *dd**SP=ALL**

newNumber	00 – 99 (must enter a **TWO** digit decimal number)
where: 00	Unit numbers itself '00' (null address) and transmits the message unchanged. A ***99ID=00** will change all PPTs in network to null address (see **Note** above).
01-88	Unit numbers itself with device ID *newNumber*, increments the number by 1, and transmits the message. This will sequentially number all PPTs in a network, starting from unit dd, with ID=*newNumber* (see **Note** above).
89	Unit numbers itself with device ID '89', changes the number to '99', and transmits the message.
90-98	Unit assigns itself group address *newNumber*, and transmits the message unchanged.
99	Unit does not change its address, changes *newNumber* to 'ER' and transmits the message.
ER	Unit does not change its address and transmits the message unchanged.

RS-485 type only

If a RS-485 unit has the factory default identification address of 00, the PPT cannot respond to group or global commands until it is assigned a valid address. This can be accomplished by one of three methods:

1) An identification address can be assigned off-line by connecting the PPT to an RS-485 compatible serial port. The command sequence to assign address 01 is:

***00WE**
***00ID=01**
***01WE**
***01SP=ALL**

REF: ECN-6046312

If global addressing is to be used for PPT responses, then all PPT's that are to respond to global requests must be addressed sequentially starting with address 01. See the **TO** command description for further information on RS-485 global addressing.

If group addressing is to be used for PPT responses, then all PPT's within a single group must have a group sub-addresses assigned sequentially starting with address 01. The command sequence to assign group address 91 and sub-address 01 to a PPT with identification address 03 is:

***03WE**
***03ID=9101**
***03WE**
***03SP=ALL**

See the **TO** command description for further information on RS-485 global addressing.

2) If the PPTs to receive ID addresses have null addresses, they can be installed on the RS-485 bus *one at a time*. After each PPT is connected, its ID address can be assigned by using the above procedure.

3) Any number of null addressed, or unknown addressed, PPTs can be connected to a RS-485 bus and have ID individually assigned by using their serial numbers as unique identifiers. The command sequence to assign the address 02 to a PPT with serial number 3175 is:

***99WE**
***99S=00003175** (must use all 8 numbers)
***99WE**
***99ID=02**
***02WE**
***02SP=ALL**

When the identification address has been assigned, group address and sub-address can be assigned in the same manner as in **1)** above.

Note: For RS-485 units, all ***9xID=** commands are ignored unless the command has been preceded by a serial number command (***99S=**ssssssss) with the serial number that matches that unit. The next ***9xID** command will set that unit's device ID number.

I N Initialize PPT Microprocessor

This command **IN**itializes the PPT microprocessor. When this command is sent with the RESET option, it performs the same start-up function as removing and re-applying power to the PPT (exceptions to this are described in the **MO** command).

Action: * dd**IN**

This stops a continuous read operation but does not perform a power-on reset. All RAM stored parameters are retained.

Action: *dd**IN=RESET**

This stops any current operation and then performs a power-on reset. If the command has a group or global address (90-99), the message is re-transmitted before the power-on reset is activated. All RAM parameters are replaced with EEPROM stored parameters. See **MO** command for reset options

REF: ECN-6046312

L = Lowest Analog Output Voltage

Set the DAC **L**ow analog output voltage zero reading for absolute and gauge units and most negative reading for differential units. The input is a value from 0 to 99% of 5 volts, or 50 millivolts per count. An **L=** inquiry reads the value in 50 millivolt counts. This command is used in conjunction with the **H=**, and **AN** commands to customize the range of the PPT analog voltage output –see Figure 4.4. If there is an input error, then the command error flag in the **RS** command will be set and no change will occur. (Default: **L=0**)

Note: See the **H=** command for setting the high, full scale, analog output voltage. See the **AN** command for enabling and disabling the **H=** and **L=** settings. If **L=** value • **H=** value, then no change will occur and an **RS** command error will result.

Inquiry: *dd**L=**

Action: *dd**WE** EEPROM Store: *dd**WE**
*dd**L=***pp*** *dd**SP=ALL**

pp **0 - 99** This number sets the zero reading for absolute and gauge units and the FS negative reading for differential units as an integer percentage of 5.00 volts. It can also be thought of as a multiplier in 50 millivolt increments. As an example, L=15 corresponds to a zero reading voltage of 0.75 volts (15 x 50mV or 15% of 5.00V). For **L=0**, the low voltage will be 0V. For **L>99**, the low voltage will be 4.95V.

M = Maximum Customized Full Scale

This command identifies the **M**aximum full scale pressure, in psi units, that can be user customized (see **F=** command). This value is fixed at the factory and corresponds to the full scale reference value for accuracy and error determination. If the response has an '!' character instead of '=', there was an EEPROM parity error.

Inquiry: * d d **M**

RS-485 type only
This command is used to select the PPT alternate message header set of non-printing characters. This can be used when there is a conflict between the standard PPT message headers and the message characters used by some other components that share the bus.

To change from standard to alternate headers:

Action: *dd**WE** EEPROM Store: (ctrl \) dd**WE**
*dd **M=ALT** (ctrl \) dd**SP=ALL**

To change from alternate to standard headers:

Action: (ctrl \) dd**WE** EEPROM Store: *dd**WE**
(ctrl \) dd**M=ALT** *dd**SP=ALL**

Standard Header		Alternate Header	ASCII Name (1)
*	becomes	ctrl \	FS
$	becomes	ctrl]	GS
~	becomes	ctrl ^	RS
#	becomes	ctrl _	US
{	becomes	ctrl Q	DC1
}	becomes	ctrl R	DC2
!	becomes	ctrl S	DC3
@	becomes	ctrl T	DC4

Note: For example, the designator (ctrl \) indicates that the control key, "ctrl", is held down while the backslash key, "\", is typed. (1) See Table 9.2 for ASCII values.

REF: ECN-6046312

M O Power-Up Mode

Sets the power-up **MO**de for the PPT. This command does not produce any immediate operational change but, when stored in the EEPROM with the **SP** command, causes the specified option(s) to be applied at power-up, at an IN=RESET command, or a watchdog timer timeout (if activated). (Default: **MO=X2M1**)

Note: User provided messages may be up to 16 characters long and may contain any information desired by the user. The message is stored in the EEPROM with the **C=** and **D=** commands. When an **M2** or **M3** power-up option is selected, a message is transmitted starting with the left most character of the **C=** string to the right most character of the **D=** string, or until a space character is encountered. Use the underscore (_) character in the **C=** or **D=** message if a space is desired.

Inquiry: *dd**M O**

Action: *dd**WE** EEPROM Store: *dd**WE**
*dd**MO=**{**X2**|**P2**| **P4**| **T2**| **T4**} or *dd**SP=ALL**
*dd**MO=**{**M0**|**M1**| **M2**| **M3** |**N0** |**N1**| **N2**| **N3**}

X2 No continuous readings.
P 2 Continuous pressure readings in ASCII format.
P 4 Continuous pressure readings in binary format.
T 2 Continuous Celsius temperature readings.
T 4 Continuous Fahrenheit temperature readings.

Note: To use the **P2**, **P4**, **T2**, or **T4** commands on RS-485 units, the **TO=C** command must be set, and only for *one* unit on the bus.

	Power - Up			IN=RESET or watchdog timeout	
	Message (1)	EEPROM checksum (2)		Message (1)	EEPROM checksum (2)
M0	None	No		None	No
M1 (3)	Factory	Yes		Factory	No
M2 (3)	User	No		User	Yes
M3 (3)	Factory	Yes		User	Yes
N0 (4)	None	No		None	No
N1	None	Yes		None	No
N2	None	No		None	Yes
N3	None	Yes		None	Yes

(1) See Section 2.4 for factory message. See **C=, D=** for user message
(2) This checksum can take up to 170ms to complete. See **CK** command.
(3) For RS-485 mode, only *one* unit should have **M1, M2, or M3** active.
(4) Same as **M0**.

REF: ECN-6046312

N = Send Number to DAC

The analog **N**umber command is used to apply an ASCII decimal format value to the DAC for direct host processor control of the analog output. Before executing this command the digital and analog control must be set to **DA=G, N**, or **R** and the analog write enable must be activated - ***ddNE**, or ***ddNE=DAC**. The '**~**' command performs the same function using the binary format. If there is an input error, then the command error flag in the **RS** command will be set and no change will occur.

Note: This command may be used to read the digital input value at the DAC at any time, without requiring an enable and regardless of the state of the **DA** command.

Inquiry: *dd**N=**

Action: *dd**NE**
*dd**N=** *dddd*

dddd Decimal digits in the range 0 to 5000.0 which controls the DAC analog voltage. The first 5 digits, or until the first digit past the decimal point, are input to the *dddd* value. This value can be expressed in millivolts (N=4000 for 4.000 volts) or in millivolts to the tenths of millivolts digit (N=4234.1 for 4.2341 volts). The value *dddd* will be modified by the **O=**, **W=**, **H=**, or **L=** commands if they are activated.

N E Analog Output Enable

The a**N**alog **E**nable command allows the host processor to control the DAC analog output. This command is used to enable the **N=** command and the binary form '**~**' command for direct DAC control.

Action: *dd **NE**

This enables the next command to write to the DAC analog output.

Action: *dd**NE=DAC** EEPROM Store: *dd**WE**
*dd**SP=ALL**

This provides a permanent analog write enable for the binary format '**~**' command or the ASCII format **N=** command. This enable remains active until a ***ddNE**, ***ddNE=OFF**, or ***ddNE=CKS** command is sent. This condition can be stored in EEPROM for a power up DAC enable.

Action: *dd **NE=CKS** EEPROM Store: *dd**WE**
*dd**SP=ALL**

This provides a permanent analog write enable for the binary format '**~**' command using a cyclic checksum. This enable remains active until a ***ddNE**, ***ddNE=OFF**, or ***ddNE=DAC** command is sent.

Action: *dd **NE=OFF**
This turns off any active analog output enable, ***ddNE** , ***ddNE=DAC,** or ***ddNE=CKS** .

REF: ECN-6046312

O= Offset Pressure Window

Offset the analog 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. An **O=** inquiry reads the value in percent of full scale (**F=** value). This command is used with the **W=**, **L=**, and **H=** commands to customize the size of the PPT analog output window and analog output voltage. This command has no effect on the digital readings. This command is enabled by the **AN** command. If there is an input error, then the command error flag in the **RS** command will be set and no change will occur. (Default: **O=0**)

For example, when L=0 and H=0, if a 20 psia (or 20 psig) unit had the offset window set to **O=20**, then the analog 0V output would begin at 4 psi (20% of 20 psi) and be rescaled to 5V at 20 psi. Use the **W=** command (**W=80**) to adjust the span if only a portion of the remaining range is of interest. If the range of 4psi to 16psi is desired to be windowed onto the 0 to 5 volt scale then a W=60 would be used (60% of 20=12 psi) + 4 psi = 16 psi FS.

If a 20 psid unit had the offset pressure window set to **O=20**, then the offset pressure would be 8 psi (20% of 40 psi). The analog 0V output would begin at -12 psi, cross 2.5V at 4 psi, and output 5V at 20 psi. If the W= value was > 80, then it is automatically set to 80.

Note: Setting a window offset (O=) value that causes the maximum output pressure to exceed 5V will automatically scale the pressure window (W=) value to maintain the 5V limit.

Inquiry: *dd **O=**

Action:	*dd**WE** *dd**O=***pp***	EEPROM Store:	*dd**WE** *dd**SP=ALL**

pp **0 - 99** This number is a percent multiplier (%) of the full scale pressure that sets the minimum pressure value corresponding to the lowest analog output. It can also be thought of as an offset, or sliding, of the pressure window. For **O=0**, the offset is zero pressure and the original pressure value for 0V (or **L=** value) output is used. For **O>99**, the pressure offset window will be 99%FS.

REF: ECN-6046312

O P Operating Mode Parameters

Sets the **OP**erating mode parameters for the number of decimal places, checksum usage, and sequential read control for pressure readings. It also controls the built-in watchdog timer feature. If enabled, the watchdog timer will perform an automatic system reset, similar to an IN=RESET command, if the PPT becomes interrupted due to external influences. This option is useful in applications that are subject to electrical noise, power glitches, electrostatic discharges, etc., or where high reliability is required.
(Default: **OP=ANEX**)

Inquiry: *dd**OP**
Action: *dd**WE** EEPROM Store: *dd**WE**
*dd**OP=**{**A**|**U**} or *dd**OP=**{**N**|**C**} or *dd**SP=ALL**
*dd**OP=**{**E**|**F**|**R**|**S** } or *dd**OP=**{**X**|**W**}

A Transmit all readings for sequential requests and continuous mode.
U Transmit only changed pressure readings for sequential requests and continuous mode. **Note**: See **DS** command for controlling the amount of pressure deviation that is detected as a change. See **RR** command to skip identical readings. Upon receipt of a **P2** or **P4** command, the PPT will send one reading and then wait for a pressure change before sending another.

N **N**o checksum.
C Apply an integrity **C**hecksum to the binary format readings. When all of the characters in the message, including the header and this character, are added together (with carries) the least significant 6 bits of the resultant sum will be zero. Do not include the <cr>; that is, if you add the 6 least significant bits of the—header, 4 data, and checksum—characters, with carries, the 6 least significant bits of the result will be zeroes (see Table 5.2 for the list of characters to be used.)

E **E**xtended form for the commands (P3, P4, '~') using the binary format. This yields a 7 bit binary device address and a 17 bit magnitude for the pressure reading. The pressure sign is encoded in the header character. This allows up to 90,000 counts in the pressure A/D conversion cycle, and allows digital readings (**P1**, **P2**) up to a full scale value of 90,000 to use five significant digits.
F **F**ixed sign position provides the same function as **E** option above but forces a sign position for the **P1** and **P2** readings. With this option the pressure readings do not shift positions when the sign changes from + to - on gauge and differential PPTs.
R **R**emove header characters from **P1** and **P2** pressure readings. Provides the same function as **E** and **F** options above. The first transmitted byte will be the pressure sign character followed by the pressure value and a <cr>. In this mode, there is no device ID number or indication of out-of-range pressure condition in the **P1** and **P2** modes.
S **S**igned form for the commands (P3, P4, '~') using the binary format. This yields a 7 bit binary device address and a sign + 16 bit magnitude for data. This allows up to 60,000 counts in the pressure A/D conversion cycle. If the FS value is set above 60,000 counts, then only four significant digits will be displayed instead of five.

X No watchdog timer enabled.
W Watchdog timer enabled to reset the PPT if it should stop for ³50 msec. See above for application uses.

Note: If the **IC** command is set to any value other than **IC=0**, then the **OP=W** command will not set and cause a **RS** command error condition.

REF: ECN-6046312

P= Production Date

The **P**roduction date command reads the factory set PPT manufactured date with format mm/dd/yy. If the response has an '!' character instead of '=', there was an EEPROM parity error.

Inquiry: *dd**P=**

P1 Pressure, Single, ASCII Format

The **P1** command requests a temperature compensated pressure (CP) reading in ASCII format. Refer to Table 4.2 for default decimal placement and significant digits. When this command has a group or global address (***9d**), it is a sequential request command and the **OP=A** or **U** 'all or changes only' parameter controls the output. If this command is executed while a **P2**, **P4**, **T2**, or **T4** command is executing, then one ASCII pressure reading is transmitted and the continuous command resumes operation.

Note: If a group or global **P1** or **P3** command is sent and the pressure reading for that integration cycle has been read before, then the PPT will not send any pressure value.

Note: The PPT continuously integrates and calculates pressure and temperature readings. When this command is received, the latest available reading is transmitted if there is sufficient RS-232 output buffer space. A group or global address command echo of ***9dP1!** indicates that RS-232 buffer space was not available for one of the addressed PPTs.

Inquiry: *dd**P1**

A response of **#ddCP!0.0000** either indicates the pressure is at zero and a temperature over/under range occurred *or* there is an EEPROM parity error. Check **RS** for specific error. If a parity error occurred, then send a ***ddIN=RESET** command or cycle the power off and on.

A response of **#01CP=..** indicates that no pressure reading is available yet. Try again. This response can be a result of a **P1** request after a **DU**, **BP** (parity change), or **ID** action command or during the power-up cycle before valid data is available. Or, it can result from a reading where the ASCII output has been disabled using the **DA** command.

P2 Pressure, Continuous, ASCII Format

The **P2** command requests continuous temperature compensated pressure readings in ASCII format. The reading rate is controlled by the **IC**, **S2**, **S5** , **OP** and **RR** command settings. See the **DO=P** or **N** commands for the suspend readings options. For RS-485 mode, the **TO=C** command must be set to transmit continuous readings. See the two response descriptions at the bottom of the **P1** command description.

Inquiry: *dd**P2**

Type:	**$*ddIN** or ***ddIN**	To stop a single PPT from continuous pressure reading.
Type:	**$*99IN** or ***99IN**	To stop the continuous readings for all PPTs on the bus.

Note: For RS-485 units, when the continuous transmit parameter is **NOT** active (is not set to **TO=C**), the **P2** command sends only *one* reading.

Note: For RS-232 units, type a **$*ddIN** to stop this command. The '$' character suspends the pressure readings while the ***ddIN** command disables the continuous output function. For RS-485 units when **TO=C**, type a ***ddIN** to stop this command.

REF: ECN-6046312

P3 Pressure, Single, Binary Format

The **P3** command produces a single temperature compensated pressure reading in a 6 byte binary format; a 1 byte header character, 4 bytes encoded address and pressure data, and a1 byte <cr> character (see Section 5.6—Binary Format Replies). Refer to Table 4.2 for default decimal placement and significant digits.

When this command has a group or global address (dd=90-99), it is a sequential request command. When this command has a group or global address (***9d**), it is a sequential request command and the **OP=A** or **U** 'all or changes only' parameter controls the output. If this command is executed while a **P2**, **P4**, **T2**, or **T4** command is executing, then one ASCII pressure reading is transmitted and the continuous command resumes operation. When **DA**={**O**|**S**|**T**|**U**}, this command transmits the analog reading value with a tilde '**~**' header - see '**~**' command at the end of this section.

The **OP** command also controls whether an integrity checksum is to be inserted between the last data byte and the <cr> character. See **OP** command for checksum calculation.

Note: See the two notes in **P1** command

Inquiry: *dd**P3**

Typical reply: {@#16	Binary format compensated pressure reading from device **ID**=01 is 15.478 inH_2O; refer to Table 5.1 and 5.2
If reply is xx??? or xx_??	(Binary format compensated pressure reading not available yet, request again, or it has been disabled. The 'xx' is the header character and the 6 most significant bits of the address.

P 4 Pressure, Continuous, Binary Format

The **P4** command produces a continuous stream of temperature compensated pressure readings in a 6 byte binary format; a 1 byte header character, 4 bytes encoded address and pressure data, and a <cr> character (see Section 5.6—Binary Format Replies). See **P3** for typical reply. See the **DO=P** or **N** commands for suspend readings from a **P4** command.

When **DA**={**O**|**S**|**T**|**U**}, this command transmits the analog reading value with a tilde '~' header - see '**~**' command at end of command section. For RS-485 mode, the **TO=C** command must be set to transmit continuous readings.

The **OP** command also controls whether an integrity checksum is to be inserted between the last data byte and the <cr> character. See **OP** command for checksum calculation.

Inquiry: *dd**P4**

Type:	**$*ddIN** or ***ddIN**	To stop a single PPT from continuous pressure reading.
Type:	**$*99IN** or ***99IN**	To stop the continuous readings for all PPTs on the bus.

Note: For RS-485 units, when the continuous transmit parameter is **NOT** active (is not set to **TO=C**), the **P4** command sends only *one* reading.

Note: For RS-232 units, type a **$*ddIN** to stop this command. The '$' character suspends the pressure readings while the ***ddIN** command disables the continuous output function. For RS-485 units when **TO=C**, type a ***ddIN** to stop this command.

REF: ECN-6046312

R R Reading Rate

The **R**eading **R**ate command specifies the number of identical readings to skip after a pressure reading has been transmitted before making another reading available. The **TO=C** command option must be set. The sensitivity to pressure changes and deadband is controlled by the **DS** command. (Default: **RR=0**)

Note: This command is only operational when **OP=U** is used.

Inquiry:	*dd **RR**		
Action:	*dd**WE**	EEPROM Store:	*dd**WE**
	*dd**RR=***readRate*		*dd**SP=ALL**

readRate 0 to 10

where: 0 Transmit every reading.

1-10 Requests that *readRate x100* identical readings be skipped after each transmission. When this number has been reached, the current pressure reading is transmitted, to provide an “I am still here” confirmation.

REF: ECN-6046312

RS Read Status

The **R**ead **S**tatus command is used to determine if an error, or warning, condition has been detected by the PPT. The act of reading the **RS** command clears the error, or warning, indicators, except for EEPROM checksum errors, which require two **RS** commands to clear.

If a sequential **RS** command is issued with the form: ***9dRS**, only addressed PPTs with one or more error indications in the status register will respond; e.g., if the ***9dRS** command is returned with no response, then no errors exist.

If a sequential **RS** command is issued with the form: ***9dRS= =**, then all addressed PPT's respond in connected sequential order, whether an error exists or not. This form can be used to get a sequential "I am here and OK" response from all PPTs. An ***9dRS!** or ***9dRS!=** echo response indicates one or more addressed PPTs had status data to transmit but did not have sufficient buffer space due to bus traffic. The **RS** command should be re-executed.

Inquiry: *dd**RS** **or** *dd**RS= =**

Replies: **?ddRS=pqrs** (null address) **#ddRS=pqrs** (assigned address)

Where:

P = 0	No EEPROM error
p = 1	EEPROM characterization table checksum error
p = 2	EEPROM control checksum error
p = 3	EEPROM characterization/control checksum error
p = 4	EEPROM parity error
p = 5	EEPROM parity/characterization checksum error
p = 6	EEPROM parity/control checksum error
p = 7	EEPROM parity/characterization/control error
p = 8	EEPROM parity error for **A=**, **B=**, **C=**, **D=**, **M=**, **P=**, **S=**, and start-up header response.
q = 0	No DAC write checksum error or command error
q = 1	Command error
q = 2	DAC write checksum error
q = 3	Both DAC write checksum error and command error
r = 1	RS-232 framing error
r = 2	RS-232 parity error
r = 3	Both RS-232 framing and parity errors
s = 0	No temperature or pressure range errors
s = >	Over temperature condition
s = <	Under temperature condition
s = +	Over pressure condition (>1% over FS)
s = -	Under pressure condition (>1% under lower limit)
s = B	Microprocessor bandwith warning
s = G	Internal signal noise detected, which indicates a grounding problem
s = W	Watchdog timer interrupt occured or an **IN=RESET** was executed

A pressure-over-range error condition will occur when the applied pressure is greater than or equal to 1% of full scale (FS) above the FS limit. For example, if the pressure applied to a 20 psi unit is •20.200 psi, then an over range error condition is set. Similarly, an under-range condition occurs when the applied pressure is greater than or equal to 1% FS below the minimum limit. If the temperature exceeds the limit values (-40 and 85 °C), then the over/under temperature error flag is set. The temperature output reading will remain at the limits. If there had been an over- **and** an under-range condition, then the first **RS** inquiry reply will be "000+", the second will be "000-" and the third will be "0000".

REF: ECN-6046312

The maximum pressure reading is 105 percent of FS. This limit varies slightly from device to device but will continue to display the out-of-range indicator ("!" in place of "=") until the pressure drops below 101 percent of FS.
Note: In the unlikely event of EEPROM checksum errors, the temperature and pressure integration cycles stop. This can be overridden by executing two **RS** commands consecutively, which clears the error indications. Pressure, temperature and DAC readings can then be taken; however, the readings may not be correct. Also the fourth error indicator is prioritized in the order shown. When the **RS** command is issued with a group or global address (sequential mode), only PPTs which have at least one error condition will respond. Replies are in sequential RS-232 bus loop connection order, followed by the return of the **RS** command.

Out-of-range temperature has display precedence over out-of-range pressure, which in turn has precedence over microprocessor bandwith warning, which is followed in precedence by noisy signal ground warning. The indication is cleared only if the condition no longer exists. If temperature outof- range, pressure out-of-range, and microprocessor bandwidth warning all existed, then with successive **RS** commands, the first command would show the temperature condition, the second command would show the pressure condition, the third command would show the bandwidth warning, and the fourth command would show no error.

REF: ECN-6046312

S= Serial Number

The **S**erial number command reads the factory set PPT serial number. If the response has an '!' character instead of '=', there was an EEPROM parity error.

Inquiry: *dd**S=**

RS-485 type only
In multidrop bus configuration only this command must be used to identify a PPT for address assignment. Command *99**S=**ssssssss, where ssssssss is the 8 character serial number of the PPT (in this case the leading zeros of the serial number must be used because the identification match is made on all 8 ASCII characters—not the decimal value of the serial number), identifies the PPT for identification address assignment. The address assignment is then performed by a *99**ID**nn command, where nn is the address.

Note: If two PPT units on a RS-485 bus have the same ID then you can use the sequence below to re-assign ID numbers

Action: ***99WE**
99S=ssssssss* (this allows the PPT to accept the next *99ID command)
***99WE**
***99ID**=nn (this assigns the PPT #ssssssss the ID number 'nn')

Where: *ssssssss* is the PPT serial number with sufficient leading zeros to provide 8 characters.

REF: ECN-6046312

S2 Speed Shift x2

The **S**peed shift x**2** command specifies the threshold at which the pressure integration speed doubles; e.g., the integration time is halved. When the pressure change rate falls below the threshold, the PPT resumes transmission at its configured output rate. This command is only operational when the **I=Mn** form of the Integration command is used. See Figure 4.15 for command illustration. (Default: **S2=0**)

Inquiry: *dd**S2**

Action:	*dd**WE**	EEPROM Store:	*dd**WE**
	*dd**S2=***thresholdS2***		*dd**SP=ALL**

thresholdS2 0 to 15
where: 0 Disable the x2 speed shift function.
1-15 Sets the speed shift threshold for double speed at *thresholdS2*x 0.01% FS reading times (threshold = 0.01%FS x *thresholdS2*).

S5 Speed Shift at 50msec Intervals

The **S**peed shift S5 command specifies the threshold at which the pressure integration speed changes to outputting every 50 milliseconds. When the pressure change rate falls below the threshold, the PPT resumes transmission at its configured output rate. The 50 msec interval is synchronous with the configured output rate. This command is only operational when the **I=Mn** form of the Integration command is used. See Figure 4.16 for command illustration. (Default: **S5=0**)

Inquiry: *dd**S5**

Action:	*dd**WE**	EEPROM Store:	*dd**WE**
	*dd**S5=***thresholdS5***		*dd**SP=ALL**

thresholdS5 0 to 15
where: 0 Disable the S5 speed shift function.
1-15 Sets the speed shift threshold for 50 msec intervals at *thresholdS5 x* 0.01% FS reading times (threshold = 0.01%FS x *thresholdS5*).

SI Synchronize Integration Cycles

RS-485 type only
The **S**ynchronize **I**ntegration command is used to control the start of a PPT's pressure integration cycle. When used with group or global addressing on an RS-485 bus, this command simultaneously starts the pressure integration cycles of all addressed PPTs on the bus. The results of pressure integration cycles completed *prior* to the execution of this command are either preserved for reading or discarded, depending on the operational configuration specified by the **TO=C, A, S, or H** command. The new integration cycle (**I=**) begins immediately following the carriage return (<cr>) entry of the **SI** command. See Figure 4.20 for command illustration.

Action: *dd**SI**

Setting:	When an **SI** command is sent:
TO=C, or **A**	Restart **I=** cycle
TO=S	Restart **I=** cycle, Clear previous **I=** value
T O = H	Restart **I=** cycle, Clear previous **I=** value, Stop after 1 **I=** cycle

REF: ECN-6046312

SP Store Parameters in EEPROM

The **S**tore **P**arameters command causes all control parameter(s) to be stored in the EEPROM so they are available when power is applied. Only changes are updated, and if an update is made, the control parameter EEPROM checksum is automatically recalculated.

Note: This command will not work when a ***ddWE=RAM** continuous write enable is active. It must have a singular write enable (***ddWE**) command preceding it.

Action: *dd**WE**
*dd**SP= All** Writes all parameters to EEPROM.

T = Set Tare Value (gauge units only)

The **T**are command allows the user to input a tare (zero offset) value, and is applicable only to gauge PPT types. This command has two forms. 1) Use the currently applied pressure to zero the PPT (**SET**), or 2) The user may supply a zero set point value (*TareValue*) in terms of a %FS pressure range. If there is an input value limit error, the command error flag in the **RS** command will be set and no change will occur. A pressure over or under range error will be set (see **RS**) and the "**!**" will appear in the reading if the applied pressure exceeds the FS range, or falls below zero, by 1%FS. (Default:**T=0.0000**)

What is a tare? Setting the tare is similar to setting an offset pressure. An example would be going to the delicatessen and weighing the empty container before filling it. A tare is set to offset the weight of the container so that it is not included in the final weight.

Note: Tare does not affect the analog outputs—see Figure 4.2.

Inquiry: *dd**T=**

Action: *dd**WE** EEPROM Store: *dd**WE**
*dd**T=**{**SET**|*TareValue*} *dd **SP=ALL**

S E T Set tare value to current pressure present at the PPT pressure port.

TareValue -2 to 102 (%FS)
TareValue must be a decimal number between 1.02 and -0.02. This corresponds to a tare value that is between 2% above FS and 2% below zero. Up to four digits may be supplied following the decimal point. For example, to tare a 100 psig PPT to 1/1000 psi (=0.01%) below its untared zero point, the command ***ddT=-0.01** or ***ddT=-.01** would be used. It is advisable to confirm the setting by executing a ***ddT=** command after the setting is established. The confirmation reply is always in terms of a percentage of full range (10%FS = 0.1000). If an attempt is made to establish a tare value outside of the allowed range, the tare update will not occur and a command error (see **RS**) will occur. When the **T=** command is legally executed, it turns the tare control to **ON**. See the **TC** command for subsequent disabling and enabling of the user supplied tare.

REF: ECN-6046312

T 1 Temperature, Single, °C

The **T1** command requests a single temperature reading in degrees Celsius. The reading resolution is 0.1 degrees C. When this command has a group or global address, it is a sequential request command. (Factory default is °C, after that, the default will be the last reading type, °C or °F, which is stored in EEPROM during a SP=ALL command.)

A response of **#01CT=..** indicates that no temperature reading is available or the last reading was in Fahrenheit. If the last reading was in Fahrenheit, then it will take two inquiries to get the first reading. Successive readings in Celsius only take one inquiry.

A group or global address command echo of ***9dT1!** indicates that RS-232 buffer space was not available for one or more of the addressed PPTs.

Note: The PPT continuously integrates and calculates pressure and temperature readings. When this command is received, the latest available reading is transmitted if there is sufficient output buffer space.

Inquiry: *dd**T1**

T 2 Temperature, Continuous, °C

The **T2** command requests continuous temperature readings in degrees Celsius. Reading rate is controlled by the **IC** command setting. The reading resolution is 0.1 degrees C. (Default - see T1 command)

Inquiry: *dd**T2**

Type: **$*99IN** To stop the continuous temperature reading command.

Note: For RS-485 units, when the continuous transmit parameter is **NOT** active (is not set to **TO=C**), the **T2** command sends only *one* reading.

Note: For RS-232 units, type a **$*99IN** to stop this command. The '**$**' character suspends the temperature readings while the ***99IN** command disables the continuous output.

T 3 Temperature, Single, °F

The **T3** command requests a single temperature reading in degrees Fahrenheit. The reading resolution is 0.1 degrees F. (Factory default is °C, after that, the default will be the last reading type, °C or °F, which is stored in EEPROM during a SP=ALL command.)

A response of **#01FT=..** indicates that no temperature reading is available or the last reading was in Celsius. If the last reading was in Celsius, then it will take two inquiries to get the first reading. Successive readings in Fahrenheit will only take one inquiry.

A group or global address command echo of ***9dT1!** indicates that RS-232 buffer space was not available for one or more of the addressed PPTs.

Note: The PPT continuously integrates and calculates pressure and temperature readings. When this command is received, the latest available reading is transmitted if there is sufficient output buffer space.

Inquiry: *dd**T3**

REF: ECN-6046312

T 4 Temperature, Continuous, °F

The **T4** command requests continuous temperature readings in degrees Fahrenheit. RS-232 reading rate is controlled by the IC command setting. The reading resolution is 0.1 degrees F. (Default - see T1 command)

Inquiry: *dd**T4**

Type: **$*ddIN** or ***ddIN** To stop a single PPT from continuous temperature reading.

Type: **$*99IN** or ***99IN** Stops the continuous pressure reading for all PPTs on the bus.

Note: For RS-485 units, when the continuous transmit parameter is **NOT** active (is not set to **TO=C**), the **T4** command sends only *one* reading.

Note: For RS-232 units, type a **$*99IN** to stop this command. The '**$**' character suspends the temperature readings while the ***99IN** command disables the continuous output.

T C Tare Control Switch

The **T**are **C**ontrol command turns on or off the user controlled tare (zero offset) function. When **ON**, the setting established by the **T=** command is used to set the zero reading of the PPT. When **OFF**, the factory supplied zero setting is used. (Default: **TC=OFF**)

Inquiry: *dd **TC**

Action:		EEPROM Store:	
	*dd**WE**		*dd**WE**
	*dd **TC=**{ **ON**|**OFF**}		*dd**SP=ALL**

O N Tare control set to **T=** command value
O F F Tare control set to factory zero setting

REF: ECN-6046312

T O Transceiver Operating Parameters

Sets the **T**ransceiver **O**perating parameters for the RS-232, or RS-485, transceiver interface protocol. The **TO=R** or **M** commands can select either a ring *or* multidrop configuration for RS-232 type PPTs, or a multidrop configuration *only* for RS-485 type PPTs. All other command parameters apply only to the multidrop RS-485 configuration. See Figure 4.20 for **TO=A**, **S**, and **H** command illustrations.

(Default: **TO=R0CN** for RS-232 type or **TO=M1CN** for RS-485 type)

Inquiry: *dd**TO**

Action: *dd**WE**
*dd**TO=**{**R**|**M**} or *dd**TO=**{**0-3**} or
*dd**TO=** {**C**|**A**|**S**|**H**} or *dd **TO=**{**N**|**P**}

EEPROM Store: *dd**WE**
*dd**SP=ALL**

R **R**ing protocol for RS-232 units. This parameter option *cannot* be selected for the RS-485 type.

M **M**ultidrop protocol for RS-485 units. This option *can* be selected for RS-232 unit, but requires an external RS-232 to RS-485 converter. If an RS-232 unit has **TO=M** selected, then all the options labeled "*RS-485 only*" apply.

0-3 Controls the minimum command response delay, RS-485 bus turn around time. For baud rate of 9600 and below, each count (0-3) represents about 1 millisecond. For baud rates above 9600, each count represents one character transmission time. This feature has no effect on RS-232 units.

Baud	1200	2400	4800	9600	14400	19200	28800
time/count	1 ms	1 ms	1 ms	1 ms	0.7 ms	0.5 ms	0.3 ms

C Allows a RS-485 unit to transmit **C**ontinuous pressure readings (**P2** or **P4**) when the device ID is used. This parameter has no effect on RS-232 units.

A **RS-485 only:** Causes the **SI** command to start a pressure integration cycle and *not* clear the result of the previous cycle so it can be read with a **P2** or **P4** command if the result has not been previously read. When the synchronized cycle completes a new cycle is immediately started.

S **RS-485 only:** Causes the **SI** command to start a pressure integration cycle and clear the result of the previous cycle so that a **P2** or **P4** command produces a "pressure reading not available" indication (<cr> only) if a **P2** or **P4** read attempt is made before the new integration cycle completes. When the synchronized cycle completes, a new cycle is immediately started. If the pressure reading produced by the synchronized cycle is to be read it must be read before the next integration cycle completes

H **RS-485 only:** Causes the **SI** command to start a pressure integration cycle and clear the result of the previous cycle so that a **P2** or **P4** command produces a "pressure reading not available indication" (<cr> only) if a **P2** or **P4** read attempt is made before the new integration cycle completes. When the synchronized cycle completes, the pressure reading is **H**eld until it is read or until a new **SI** command is issued.

Setting:	When an **SI** command is sent:
TO=C, or **A**	Restart **I=** cycle
TO=S	Restart **I=** cycle, Clear previous **I=** value
T O = H	Restart **I=** cycle, Clear previous **I=** value, Stop after 1 **I=** cycle

REF: ECN-6046312

N **N**ormal read operation response. This parameter has no effect on RS-232 units. In RS- 485 mode, each PPT will respond to a group or global read operation after the unit with the next lower device ID (for global) or next lower sub-address (for group) has responded. Device ID, and group sub-addresses, must be sequential beginning with number 01.

P **RS-485 only: P**rompted read operation response. In RS-485 mode, after the lower addressed PPT responds to a group or global read operation, this PPT will not respond until it is prompted by a <cr> from the bus system host. The <cr> may also be manually entered by the user to get each successive response. To receive data from each prompt, the device ID, or group sub-addresses, must be sequential beginning with number 01.

Note: If an RS-485 unit receives a group or global addressed (***9x**) command and fails to respond, the command terminates at that point until additional carriage returns are received. Usually, the reason for failure to respond is that the device IDs or group subaddresses were not sequential beginning with number 01.

U = User Supplied Display Units

The **U**ser supplied display units command allows the user to enter units of measure for the PPT. The value entered for this command is multiplied by the actual pressure in psi to get the user defined units. For example, if ***ddU=15.0**<cr>, then the compensated pressure output values will be 15 times the actual psi value. This function (multiplier) is activated by executing the ***ddDU=USER**<cr> command. If there is an input error, then the command error flag in the **RS** command will be set and no change will occur.

Inquiry: *dd**U=**

Action:	*dd**WE** *dd**U=***UserValue***	EEPROM Store:	*dd**WE** *dd**SP=ALL**

UserValue Must be a value between 0.0010000 and 999.99. It is advisable to confirm the setting by executing a ***ddU=**<cr> command after the **U=** setting is established. The user supplied display function is activated by executing the ***ddDU=USER**<cr> command.

V = Version Number

This **V**ersion number command transmits the factory set software version number.

Inquiry: *dd**V=**

Reply: #01**V=**02.4C4S2V

02.4C4	Software version number		
S	PPT Type	**S**: PPT	
2 or **4**	Digital Output	**2**: RS-232	**4**: RS-485
V	Analog Output	**V**: 0-5 volt	

REF: ECN-6046312

W= Width of Pressure Window

Set the width, or span, of the pressure window to a smaller range to fill the analog output voltage limits. This command sets a pressure window value, or span, from 0 to 99% of full scale. An **W=** inquiry reads the value in percent of full scale (**F=** value). This command is used with the **O=**, **L=**, and **H=** commands to customize the size of the PPT analog pressure window and analog output voltage. If there is an input error, then the command error flag in the **RS** command will be set and no change will occur. This command is enabled by the **AN** command. See Figure 4.5 for command illustration. (Default: **W=100**)

For example when L=0 and H=0, if a 20 psia, psig, or psid unit has the pressure window width set to **W=60**, then the 0 to 5 volt analog output span would correspond to 0 to 12 psi (60% of 20 psi). Use the **O=** command (**O=20**) to offset the pressure window by 4 psi. Now the analog output values range from 0 volt=4 psi up to 5 volt=16 psi.

If a 20 psid unit has the pressure window width set to **W=60**, then the pressure window would be 24 psi (60% of 40 psi). The analog 0V output would begin at -20 psi, cross 2.5V at -8 psi, and output 5V at 4 psi. If a window offset of **O=20** was set, then the analog 0V output would begin at -12 psi, cross 2.5V at 0 psi, and output 5V at 12 psi. If an **O=** value is set > 40, then it is automatically set to 40.

Note: Setting a pressure window (W=) value that causes the maximum output pressure to exceed 5V will automatically scale to window offset (**O=**) value to maintain the 5V limit.

Inquiry: *dd**W=**

Action: *dd**WE**
*dd**W=***pp** |**S**

EEPROM Store: *dd**WE**
*dd**SP=ALL**

pp **0 - 100** (%) This number is a percent multiplier (%) of the full scale pressure that sets the pressure span across the analog output range. It can also be thought of as scaling, or shrinking, the pressure window to fill the output voltage range. A **W=0** setting will set the pressure window is 100%, full span. A **W=** entry greater than 100 will set **W=**100.

S This enables the analog output setpoint. The setpoint trip voltage is controlled by the **O=** command. The setpoint null, or hysteresis, is controlled by the **DS** command. The setpoint off voltage is controlled by the **L=** command and the on voltage is controlled by the **H=** command. See Figure 4.8 for command illustration.

REF: ECN-6046312

W E Write Enable to EEPROM or RAM

The **W**rite **E**nable command enables an EEPROM write or a RAM write operation. It is used as a safeguard to prevent erroneous command sequences from changing the PPT configuration. A ***ddWE** command must immediately precede the **SP**, **A**=, **B**=, **C**= or **D**= commands when storing information in the EEPROM. The ***ddWE** command must also immediately precede any command that changes the configuration parameters in the RAM. When manually making multiple configuration changes, ***ddWE=RAM** command form may be used to permanently enable RAM updates until the next ***ddWE** or ***ddWE=OFF** command is executed.

Note: The ***ddWE** command remains active until the next '***'** followed by a <cr> is received, or a '***9..***<cr>' passes through from a group or global addressed command.

Action: *dd**WE**
This enables the next command to write to the RAM or EEPROM, and also disables the ***ddWE=RAM** condition after the next command is received.

Action: *dd**WE=RAM**
This provides a permanent RAM write enable. All commands following a *dd**WE=RAM** will be stored in RAM. A ***ddWE** command will disabled, or deactivate, this permanent RAM write enable. The *dd**WE=RAM** command will not allow the **SP** command to write to EEPROM.

Action: *dd**WE=OFF**
This immediately disables the ***ddWE=RAM** condition.

X= Slope 1—User Compensation Control

The user can adjust the pressure vs. output curve using the **X=**, **Y=**, and **Z=** 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 compound PPTs. The range of adjustment is ±0.6%FS in 0.005% increments. Use the modified full scale value if the **F=** command is set. For differential units, use one-half the range (FS=10 for a 10psid). If there is an input error, then the command error flag in the **RS** command will be set and no change will occur. See Figure 4.6 for command illustration. (Default: **X=0**)

Inquiry: *dd**X=**

Action: *dd**WE** EEPROM Store: *dd**WE**
*dd**X=***pp*** *dd **SP=ALL**

pp **0 to ±120** This number adjusts the pressure reading by multiplying it by 0.005% and scaling the slope of the pressure reading before output.

Pressure Output = [1 + (pp x 0.00005)] x Pressure Reading

REF: ECN-6046312

Y= Slope 2—User Compensation Control

The user can adjust the pressure vs. output curve using the **X=**, **Y=**, and **Z=** commands. The **Y=** command adjusts the slope of the pressure output curve for negative pressures. This modifies the negative full scale slope. The range of adjustment is ±0.6%FS in 0.005% increments. Use the modified full scale value if the **F=** command is set. For differential units use one-half the range (FS=10 for a 10psid). If there is an input error, then the command error flag in the **RS** command will be set and no change will occur. See Figure 4.6 for command illustration. (Default: **Y=0**)

Inquiry:	*dd**Y=**		
Action:	*dd**WE**	EEPROM Store:	*dd**WE**
	*dd**Y=***pp***		*dd**SP=ALL**

pp **0 to ±120** (see **X=** for definition)

Z= Offset—User Compensation Control

The user can adjust the pressure vs. output curve using the **X=**, **Y=**, and **Z=** commands. The **Z=** command adjusts the offset of the pressure output curve. This applies to all PPTs. The range of adjustment is ±0.6%FS in 0.005% increments. For differential units use one-half the range (FS=10 for a 10psid). Use the customized full scale value (**F=**) as a multiplier.

For gauge type units, a zero offset null may be set by removing pressure and executing a **Z=CAL** command. For a differential unit, a zero offset null can be set by applying equal pressure to both ports and execute a **Z=CAL** command.

If there is an input error, then the command error flag in the **RS** command will be set and no change will occur. See Figure 4.7 for command illustration. (Default: **Z=0**)

Inquiry:	*dd**Z=**		
Action:	*dd**WE**	EEPROM Store:	*dd**WE**
	* d d**Z =** *pp*		*dd**SP=ALL**

pp **0 to ±120** This number adjusts the pressure reading by adding (pp x 0.005% FS) to the reading before outputting.

Pressure Output = [(pp x 0.00005) x (**M=** full scale)] + Pressure Reading

$ Suspend Continuous Readings

This is not actually a command but a special command header character. During a continuous pressure reading command, **P2** or **P4** in RS-232 ring configuration or when the bus noise protection parameter is used (**DO** command) in multidrop configuration, a '**$**' by itself will temporarily stop, or suspend, transmission. Pressure readings will continue to be taken at the configured rate but will not be transmitted on the RS-232 outputs. This allows for manual entry of a command when continuous readings are filling the display. Pressure reading transmission will resume when the <cr> carriage return (ENTER key) is pressed.

Note: Under some conditions it is possible to enter a command that will not cause continuous readings to resume after entering the <cr> character, in which case a second <cr> will cause the continuous readings to resume.

Example:	*dd **P2**	*(Start continuous pressure readings)*
	$*dd**V=**	*(Suspend continuous pressure readings to read version number)*
		*(Resume continuous pressure reading after the **V=** reply)*

REF: ECN-6046312

~ Command Header for Binary DAC Values

The '**~**' (tilde) command is actually a command header and is used to apply a binary format value to the DAC input. This allows the host processor or a remote PPT to control the DAC analog output. This command provides up to 40% reduction in analog control message length, compared to the **N=** command, and allows the use of a cyclic checksum. Before executing this command, the digital/ analog control must be set to **DA=G**, **N**, or **R** and the analog write must be enabled (see the **NE** command).

The data format consists of six bytes: 1 byte header character (~), 4 bytes data, and 1 byte <cr> character. The 4 byte data value bbbb contains the device address and the analog output value. The most significant bit of each 'b' character is a parity bit. The next most significant bit of each 'b' character is either a 1 or 0, in order to make the resultant byte a printable character. The 6 least significant bits of each character are used for the device address and analog output value.

The device address and the analog output value can be encoded by first defining the 7 bit binary address and the 17 bit binary analog value and then, separating them into four 6 bit groups. The analog value is expressed in tenths of millivolts so that 2.5V = 25,000. As an example, for device ID=1 and analog value = 4.25 volts (42,500 count), the following binary strings are formed: 0000001 01010011000000100. Grouping this string into four 6 bit groups gives: 000000 101010 011000 000100. Converting these to printable characters using Table 5.2 give the four byte string: @jXD. Therefore, the command ~@jXD<cr> will set the DAC output to 4.2500 volts when **DA=G**, **N**, or **R** and the **NE=DAC** is enabled.

Note: The PPT transmits '~' command data when **DA=O**, **S**, **T**, or **U** and a **P3** or **P4** is activated. The address of the transmitted '~' command is the group address of the PPT.

Note: This mode can be used to run a closed loop system. That is, the host processor can be monitoring a line pressure using the digital pressure readings. Then, the host processor can drive an analog signal back to a valve control based on the digital readings.

Action: *dd**NE** *(must precede each '~' command)*
~bbbb or *~bbbb***s**

Action: *dd**NE=DAC** *(only required one time)*
~bbbb or *~bbbb***s**

Action: *dd**NE=CKS** *(only required one time)*
*~bbbb***s**

bbbb Four ASCII characters whose least significant six bits provide the device address and analog output value. The first 7 bits represent a binary address (0-99). The last 17 bits contains a binary output value expressed in tenths of millivolts. A zero to five volt range is coded as 0 to 50,000 counts. See binary format, Section 5.6, and Table 5.2 for the list of ASCII characters.

s Cyclic checksum character. When all of the characters in the message, including the header and this character, are added together (without carries), the least significant six bits of the resultant sum will be zero. Do not include the <cr>. See Table 5.2 for the list of characters to be used.

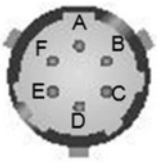
REF: ECN-6046312

6 ELECTRICAL CONNECTIONS

PPT (Plastic Connector)	PPT (Metal Connector)	Signal Name
1	A	RS-232 (TD) or RS-485 (B)
2	B	RS-232 (RD) or RS-485 (A)
3	C	Case Ground
4	D	Common Ground (GND)
5	E	DC Power In (+)
6	F	Voltage Output



PPT (plastic connector) (pins – top view)



PPT (metal connector) (pins – top view)

PPT, Plastic Mating Connector
Conxall P/N 6-282-6SG-522 Newark Stock no. 89F4115
PPT, Metal Mating Connector
ITT Cannon P/N MS3116F10-6S Newark Stock no. 93F3377

Figure 6.1 – PPT – Plastic and Metal Electrical Connector Pin Assignment

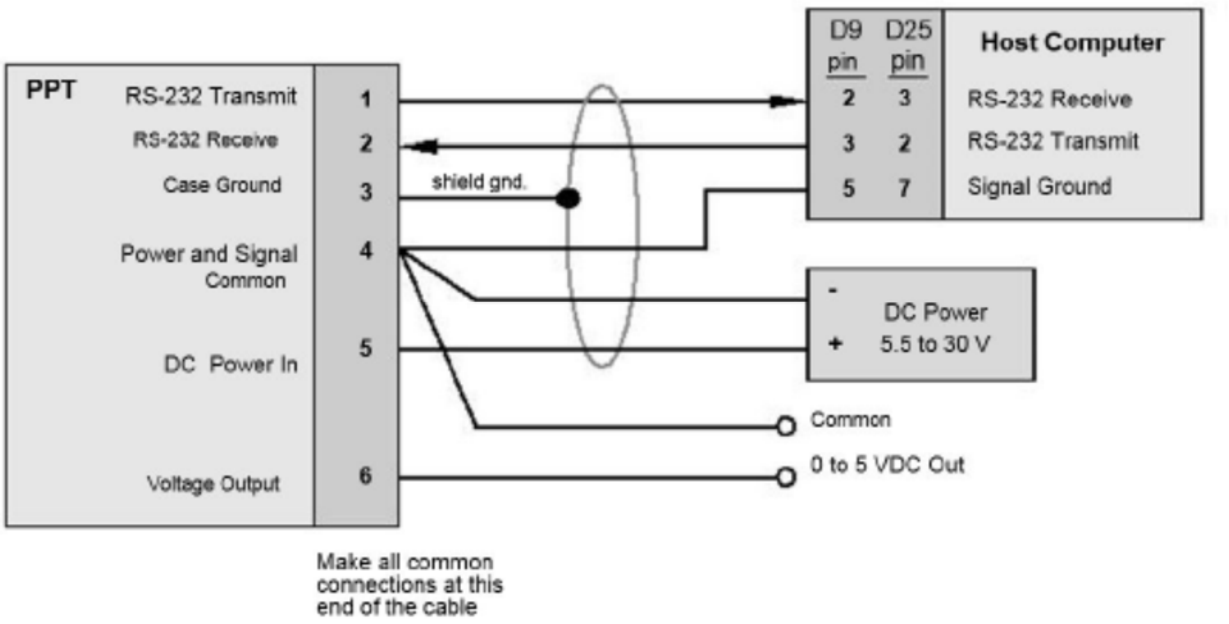


Figure 6.2 – Connection for RS-232 Operation and Analog Output

REF: ECN-6046312

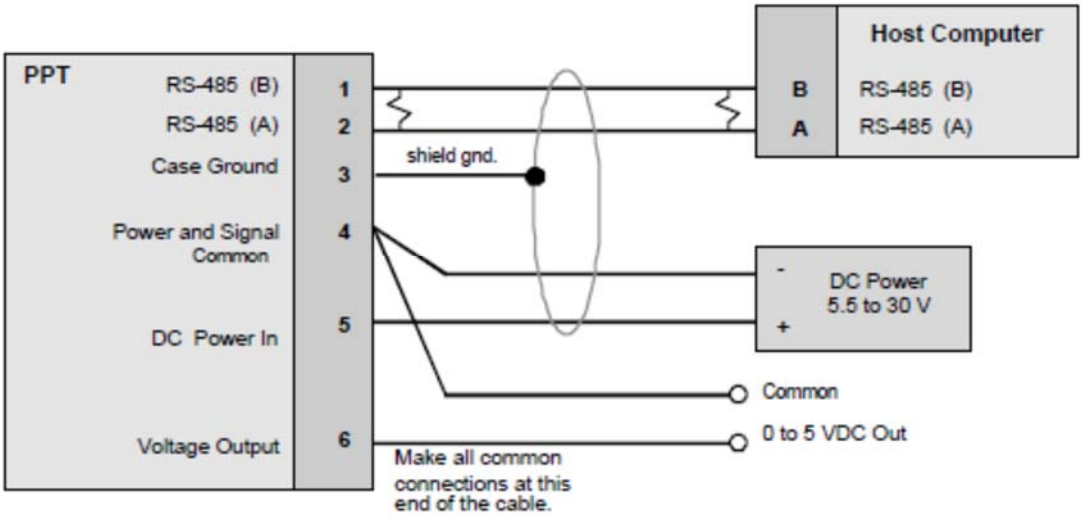


Figure 6.3 – Connection for RS-485 Operation and Analog Output

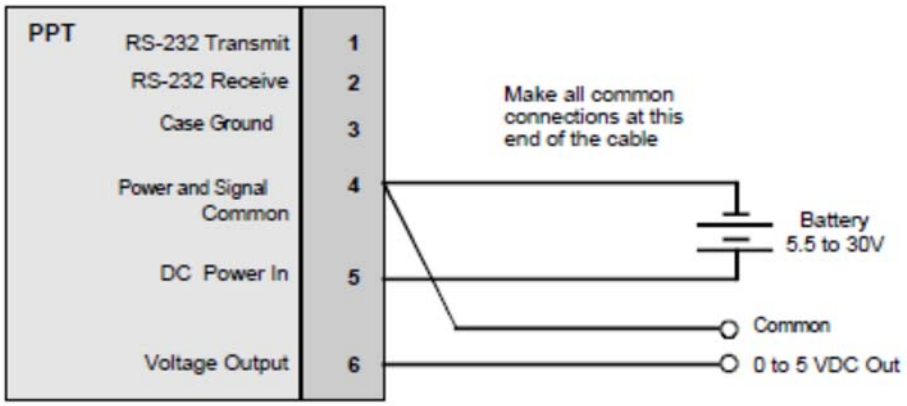


Figure 6.4 – Connection for Analog Output and Battery Operation

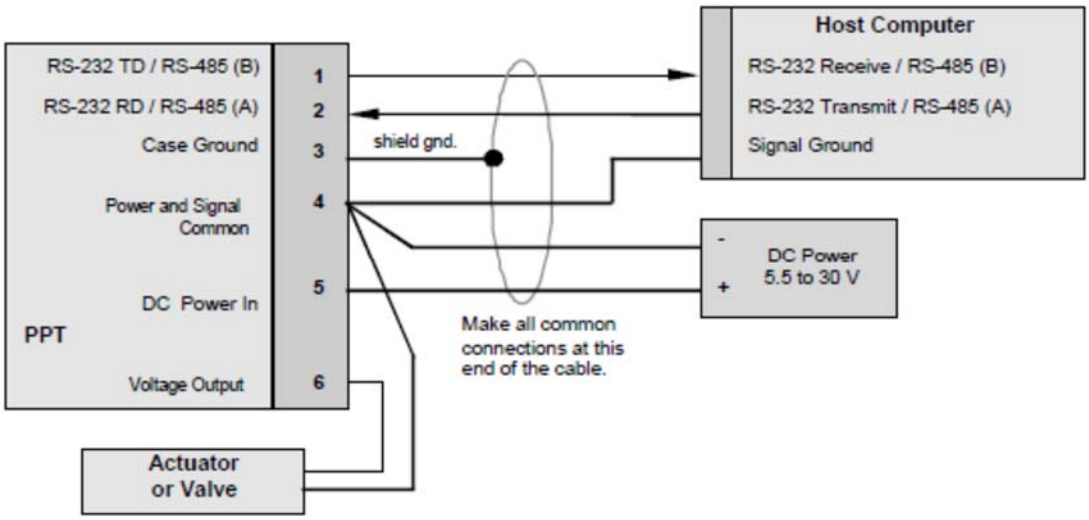


Figure 6.5 – Connection for Computer Operation and User Controlled Analog Voltage Output

REF: ECN-6046312

7 TIMING DIAGRAMS

For the factory default settings, the PPT will respond to a **P1** or **P3** pressure reading with an integration time of 200 msec at 9600 baud data output. The timing for this is shown Figure 7.1. The RS-232 command input time, **Y**, is the transmission time for the command message. This is equal to the number of command characters plus the <cr> character, times the baud transmission time per byte (***01P1**<cr> = 6 x (byte times)). The integration and calculation times are internal PPT times. The integration time is user controlled with the **DI** command. The RS-232 pressure reading output time, **X**, is the reply transmission time. Character, byte or transmission times for different baud rates are listed in Table 7.1. Reply character lengths, **X**, are listed in Table 7.2.

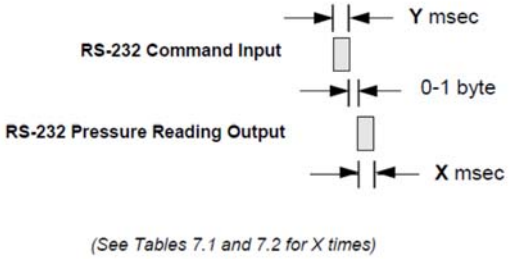


Figure 7.1 – Default Single Pressure Reading Timing Diagram

When I=Mn mode or I=R30 (or less) mode:

For continuous pressure reading commands (**P2** and **P4**), the PPT internal times and the output timing are shown Figure 7.2.

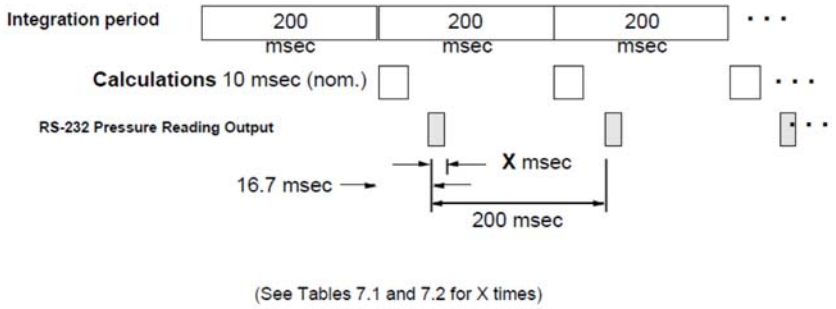


Figure 7.2 – Default Continuous Pressure Reading Timing Diagram

For continuous pressure reading commands (**P2** and **P4**) and an **IC**=1 setting, the PPT internal times and the output timing are shown Figure 7.3.

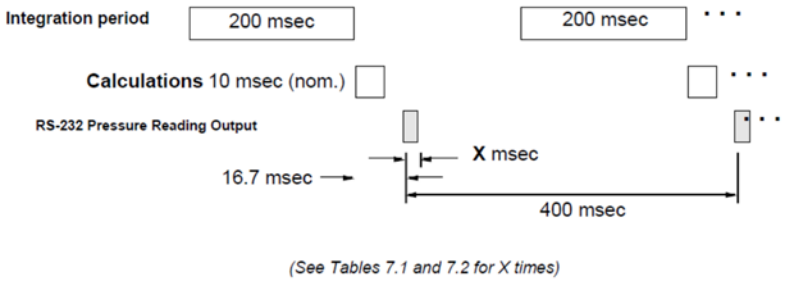


Figure 7.3 – Continuous Pressure (with IC = 1) Timing Diagram

Shown below in Figures 7.4 to 7.6 are the timing diagrams for faster pressure output rates - up to 120 readings/second. These rates are achieved by setting the integration time (**I=**) command. For the continuous reading commands P2 and P4, three pressure output timing figures are shown below.

REF: ECN-6046312

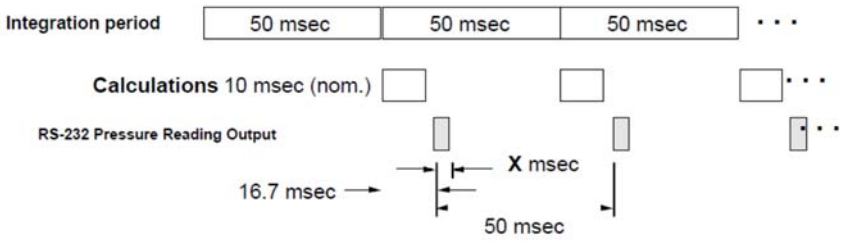


Figure 7.4 – Timing Diagram for 20 Readings per Second

When I=R31 (or more) mode:

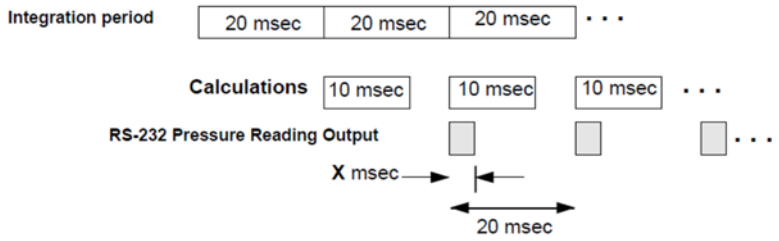


Figure 7.6 – Timing Diagram for 50 Readings per Second

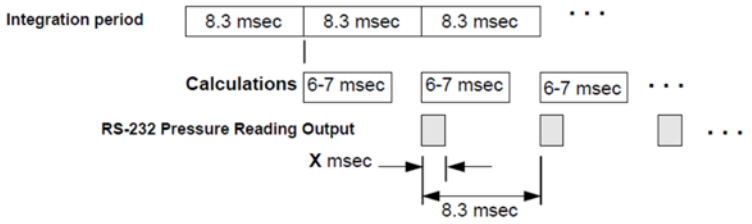


Figure 7.5 – Timing Diagram for 120 Readings per Second

REF: ECN-6046312

Baud Rate (bps)	Time/Character (msec) (1)
1200	8.33
2400	4.17
4800	2.08
9600	1.04
14400	0.694
19200	0.521
28800	0.347

(1) Time is same for No, Even, or Odd parity selection

Table 7.1 — Transmission Times at Selected Baud Rate

Reply from:	# of Characters (1)	Format
P3, P4 no checksum	6	Binary
P3, P4 with checksum	7	Binary
P1, P2 min. length	12	ASCII
P1, P2 max. length	16	ASCII
T1, T2, T3, T4	12	ASCII
Other Replies	11	ASCII

(1) Includes <cr> character

Table 7.2 — Number of Bytes in Various Replies

Two command examples for calculating the digital transmission times are shown below. These examples are for 9600 baud selection.

	Message	# of Characters	Transmission Time
ASCII			
Inquiry:	*23P1<cr>	6	6.24 msec
Reply:	#23CP=-16.437<cr>	14	16.64 msec
Binary			
Inquiry:	*23P3<cr>	6	6.24 msec
Reply:	^@PSA	6	6.24 msec

REF: ECN-6046312

8 SPECIFICATIONS

PERFORMANCE	
Total Error Band [1] Digital	 ±0.10%FS Max for Pressure Ranges above 5 psi ±(0.10%FS + 0.04% Abs. Reading) Max for Pressure Ranges 5 psid/g and below ±(0.20%FS + 0.04% Abs. Reading) Max for 1 psig units
Analog	±0.12%FS Max for Pressure Ranges above 5 psi ±(0.12%FS + 0.04% Abs. Reading) Max for Pressure Ranges 5 psid/g and below ±(0.24%FS + 0.04% Abs. Reading) Max for 1 psig units
Temperature Range	Operating: -40 to 85ºC Storage: -55 to 90°C
Sample Rate [3]	8.33 ms to 51.2 min; minimum response delay 17 ms
Resolution	Digital: Up to 0.001% FS, Analog: 1.22 mV steps (12 bits)
Long Term Stability	0.025%FS per year typical
MECHANICAL	
Pressure Units [3]	atm, bar, cmwc, ftwc, hPa, inHg, inwc, kg/cm2, KPa, mBar, mmHg, MPa, mwc, psi, user, lcom, pfs
Media Compatibility	Suitable for non-condensing, non-corrosive, and non-combustible gases
Weight	Approx. 5 oz. (142 gm) without fittings
ELECTRICAL	
Output [3][4]	RS-232 Digital with 0-5V Analog, RS-485 Digital with 0-5V Analog
Power	Supply Voltage: 5.5 to 30 VDC, Operating Current: 35 mA maximum
Baud Rate [3]	User configurable between 1200 and 28800 bits/sec
Bus Addressing [3]	Address up to 89 units
Connector	MIL-C-26482, Shell Size #10, 6-pin, #20 size
ENVIRONMENTAL	
Mechanical Shock	1500G, 0.5 ms half sine; per MIL-STD-883D, M2002.3, Cond. B
Thermal Shock	24 1-hr cycles, -40 to 85°C
Vibration	0.5 in or 20G, 20-2000 Hz; per MIL-STD-883D, M2007.2, Cond. A
Overpressure [2]	3X FS, maximum 600psi
Burst Pressure [2]	3X FS, maximum 700psi
EMC Directives	Compliant, Metal Connector Model Only
RoHS Directive	Non-Compliant

(1) Total Error is the sum of worst case linearity, repeatability, hysteresis, thermal effects and calibration errors over the operating temperature range. Full scale for differential ranges is the sum of + and – ranges. Calibration is traceable to NIST. (2) Exposure to overpressure will not permanently affect calibration or accuracy of unit. Burst pressure is the sum of the measured pressure plus the static pressure and exceeding it may result in media escape. (3) User configurable. (4) Recommended load impedance of 100 k-ohm or greater.

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Digital Output: *(RS-232 or RS-485)*

Baud Rates:	1200, 2400, 4800, **9600**, 14400, 19200, 28800
Data Framing:	1 start bit, 8 data bits, 1 stop bit
Parity:	**No parity**, even parity or odd parity
Handshaking:	Not supported
Addressing:	89 individual (self-numbering, or user assigned) 9 group addresses (multicast) 1 global address (broadcast) 1 null address (address not assigned)
Bus Operating Modes:	Response to a designated unit request. Sequential response to selected units request. Sequential response by all units to a single request. Continuous response by any (or all for RS-232) units.

Pressure Units:

Analog or Digital:

psi, mbar, bar, kPa, MPa, in. Hg, mm Hg, (torr), in. wc, ft. wc, mwc, cm wc, kg/cm2, atm, LCOM, %FS, or user defined; (wc=water column @ 4°C, Hg @ 0°C).

REF: ECN-6046312

9 DIMENSIONS

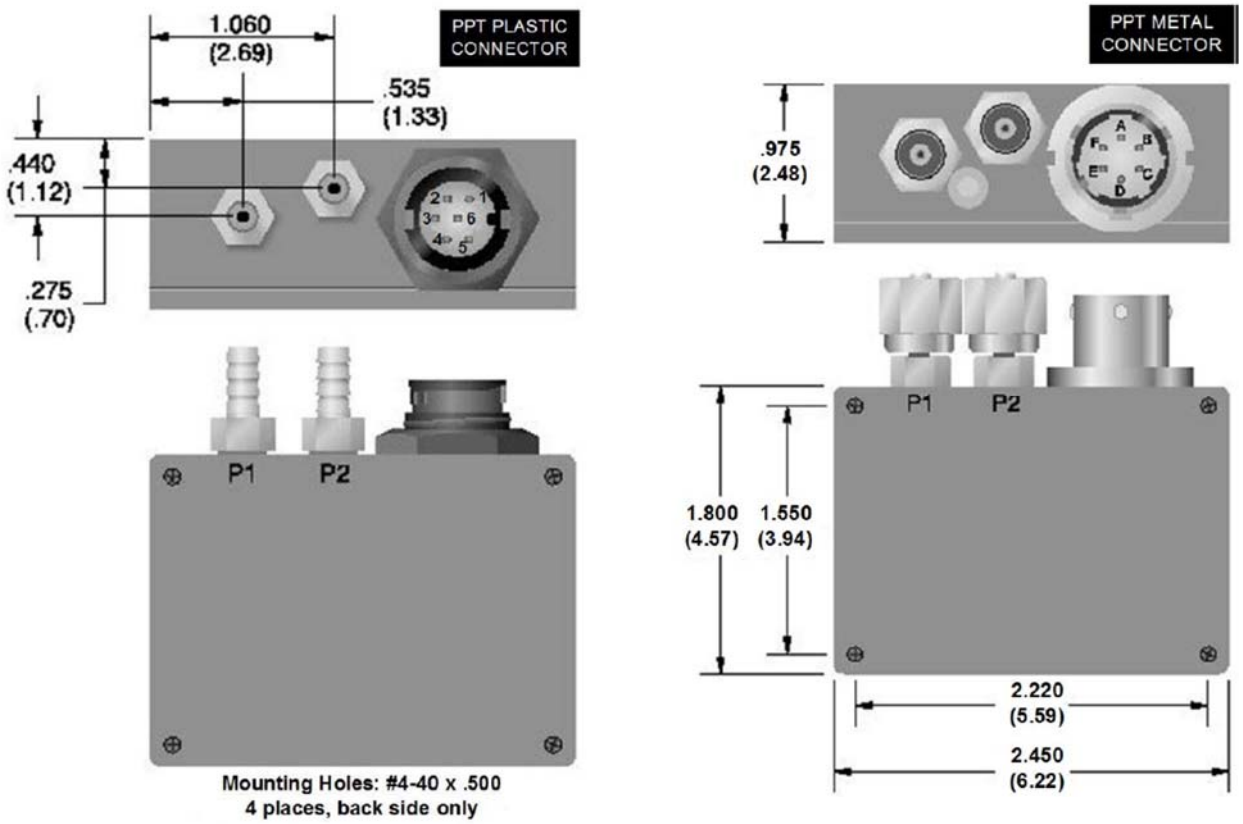


Figure 9.1 – PPT Case Outline

PPT (Plastic Connector)	PPT (Metal Connector)	Signal Name
1	A	RS-232 (TD) or RS-485 (B)
2	B	RS-232 (RD) or RS-485 (A)
3	C	Case Ground
4	D	Common Ground (GND)
5	E	DC Power In (+)
6	F	Voltage Output

Figure 9.2 - Electrical Connector

REF: ECN-6046312

DEC	HEX	ASCII	KEY	DEC	HEX	ASCII	DEC	HEX	ASCII	DEC	HEX	ASCII
0	00	NUL	ctrl @	32	20	SP	64	40	@	96	60	'
1	01	SOH	ctrl A	33	21	!	65	41	A	97	61	a
2	02	STX	ctrl B	34	22	"	66	42	B	98	62	b
3	03	ETX	ctrl C	35	23	#	67	43	C	99	63	c
4	04	EOT	ctrl D	36	24	$	68	44	D	100	64	d
5	05	ENQ	ctrl E	37	25	%	69	45	E	101	65	e
6	06	ACK	ctrl F	38	26	&	70	46	F	102	66	f
7	07	BEL	ctrl G	39	27	'	71	47	G	103	67	g
8	08	BS	ctrl H	40	28	(	72	48	H	104	68	h
9	09	HT	ctrl I	41	29	)	73	49	I	105	69	i
10	0A	LF	ctrl J	42	2A	*	74	4A	J	106	6A	j
11	0B	VT	ctrl K	43	2B	+	75	4B	K	107	6B	k
12	0C	FF	ctrl L	44	2C	,	76	4C	L	108	6C	l
13	0D	<cr>	ctrl M	45	2D	-	77	4D	M	109	6D	m
14	0E	SO	ctrl N	46	2E	.	78	4E	N	110	6E	n
15	0F	SI	ctrl O	47	2F	/	79	4F	O	111	6F	o
16	10	DLE	ctrl P	48	30	0	80	50	P	112	70	p
17	11	DC1	ctrl Q	49	31	1	81	51	Q	113	71	q
18	12	DC2	ctrl R	50	32	2	82	52	R	114	72	r
19	13	DC3	ctrl S	51	33	3	83	53	S	115	73	s
20	14	DC4	ctrl T	52	34	4	84	54	T	116	74	t
21	15	NAK	ctrl U	53	35	5	85	55	U	117	75	u
22	16	SYN	ctrl V	54	36	6	86	56	V	118	76	v
23	17	ETB	ctrl W	55	37	7	87	57	W	119	77	w
24	18	CAN	ctrl X	56	38	8	88	58	X	120	78	x
25	19	EM	ctrl Y	57	39	9	89	59	Y	121	79	y
26	1A	SUB	ctrl Z	58	3A	:	90	5A	Z	122	7A	z
27	1B	ESC	ctrl [	59	3B	;	91	5B	[	123	7B	{
28	1C	FS	ctrl \	60	3C	<	92	5C	\	124	7C	|
29	1D	GS	ctrl]	61	3D	=	93	5D	]	125	7D	}
30	1E	RS	ctrl ^	62	3E	>	94	5E	^	126	7E	~
31	1F	US	ctrl _	63	3F	?	95	5F	_	127	7F	DEL

*ASCII – American Standard for Coded Information Interchange

Table 9.1 – ASCI Conversion Table, Decimal to Hexadecimal

EIA-2323-E Or RS-232	Pin # DB-25	Pin # DB-9
Shield	1	
Transmit Data (TD)	2	3
Receive Data (RD)	3	2
Request to Send (RTS)	4	7
Clear to Send (CTS)	5	8
DCE Ready (DSR)	6	6
Signal Ground (SG)	7	5
Received Line Signal Detector (DCD)	8	1
DTE Ready (DTR)	02	4
Ring Indicator	22	9

Signal State	Threshold Voltages	
	Signal With Respect to SG	Signal A With Respect to Signal B
"0", Asserted, ON, Space, Active	+3 to +25 VDC	+1.5 to +6 VDC (Transmitter) +0.2 to +12 VDC (Receiver)
"1", Disasserted, OFF, Mark, Inactive	-3 to -25 VDC	-1.5 to -6 VDC (Transmitter) -0.2 to -7 VDC (Receiver)

Note: Some RS-485 equipment uses "+" and "-" descriptors. The "-" corresponds to "A" and the "+" corresponds to "B".

Table 9.3 – Signal Levels

Table 9.2 – RS-232 Standard Pin Connections

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