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Honeywell Precision Pressure Transducer 2

PPT2 User's Manual

Honeywell

ADS-14221 Rev. 10/16

For more information, visit us online at www.pressuresensing.com
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1.0 Product Overview

The Honeywell Model PPT2 Precision Pressure Transducers provide high accuracy pressure readings in both digital and analog form. The first-time user will be able to use the PPT2 within minutes, yet capability exists to configure the PPT2 to optimize performance in the User's specific applications. Throughout this User's Manual, the PPT2 may be referred to as Precision Pressure Transducer.

The heart of the PPT2 measuring system is a silicon piezoresistive sensor which contains both pressure and temperature-sensitive elements. Digital signals representing temperature and pressure are processed by the PPT2 microprocessor to produce calibrated, temperature-compensated pressure readings over the entire operating temperature and pressure range.

Both the analog and digital outputs are internally corrected over the full operating range. The PPT2 has a digital accuracy of 0.075% of full scale (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, the sum of + Full scale and – Full Scale. This is important to note when determining the accuracy allowance.

The PPT2 receives commands and sends digital data using either an RS-232 serial port or a multi-drop RS-485 serial port of a computer. (Note: many newer computers will have only USB ports, no RS-232 or RS-485 ports. A USB converter can be used to provide the required RS-232 or RS-485 port.)

Using the RS-232 type PPT2, up to 89 units can be connected in a ring configuration to a single serial port of a computer. The RS-485 type PPT2 allows up to 89 PPT2's to be connected to a two-wire multi-drop bus. Group (multicast) addressing allows up to nine groups of PPT2's to be addressed with a single command. Global (broadcast) addressing will send a command to all PPT2's on the serial bus.

Any computer having a serial port and terminal emulation software can be connected to the PPT2 to allow the user to set baud rates, reading rates, reading resolution, units of pressure and other choices. (User modified functions must be set through the digital interface, using a computer with a serial port). The user-modified functions may either be used temporarily, until the PPT2 is powered down, or may be stored in the PPT2 internal EEPROM to automatically configure the PPT2 each time power is applied.

Analog output from the PPT2 16-bit digital-to-analog converter may be obtained without a host computer.

2.0 Getting Started

2.1 OVERVIEW

The first-time user should approach the PPT2 in a manner analogous to using a word processor program; i.e., many features are available but one may begin by using only those of interest at the moment.

As 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 user-defined settings are activated each time the PPT2 is powered up. This tailors the performance of the PPT2 to meet the needs of a particular application.

2.2 EQUIPMENT NEEDED

To prepare the PPT2 for operation, three items are needed:

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

To operate the PPT2 in the analog output mode, one additional item is needed:

• *Voltage Output* - A five digit voltmeter with 0-5 volt range connected between Analog Out and Signal Common. A computer is not required to read the Analog output.

To operate the PPT2 in the digital output mode, one additional item is needed:

• A computer, or host processor, having an RS-232 or RS-485 serial port (or suitable USB adapter) and terminal emulation program.
The wiring diagram designates which PPT2 pins must connect to the computer "send", "receive" and "common" pins for proper communications.

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 PPT2 is set to a baud rate of 9600, 1 start bit, 8 data bits with no parity and 1 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 of this manual for possible settings.

2.4 INITIAL TURN-ON RESPONSE

Analog Output

The factory default analog output will provide a voltage (range 0-5V) which, when ambient pressure is applied to the PPT2,reads:

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

Digital Output

Once the wiring connections and terminal program settings are complete, the PPT2 will automatically send the following response (or similar to) when power is applied. This reply will be generated any time power to the PPT2 is cycled off and on.

Typical Reply:

?00PPT2___10__psid

The “?00” indicates a default address device called a “null address”. This PPT2 has not yet been assigned an ID number by the user, so it assumes the null address. The “PPT2___10__psid ” indicates a 10 psi differential device.

2.5 COMMAND FORMAT

Any command interaction with the PPT2 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 PPT2 commands have the form *ddcc = nnn <cr>

Where:

* is the command header character

dd is the integer address of the PPT (00 – 89)

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 “<cr>”, press the ENTER/RETURN key)

2.6 STEP-BY-STEP EXAMPLES (For a single PPT2 connection, default 00 address)

READ A SINGLE PRESSURE

Once the PPT2 is powered up and connected to a computer, enter the following command: (do not type “<cr>”, press the ENTER/RETURN key)

User Types on the keyboard:

*00P1 <cr>

PPT2 Response:

?00CP=14.4582

Where

*	indicates the start of a command
00	is the null address of the PPT2 (see note below)
P1	is the command to read the most current pressure

Note: The “?” indicates the response from a null addressed PPT2– one which has not been assigned a device ID. A null address, 00, is coded into each PPT2 at the factory. Refer to the ID command in Section 5 for a description of addresses and responses.

The “CP=14.4582” indicates a compensated pressure of 14.4582 psi. (Your unit may not show this specific reading, depending on the applied pressure it is measuring.)

SET DEVICE ID

To give the PPT2 an assigned address of 01 up to 89, enter the following commands:

*00WE<cr> This enables the PPT2 to change a parameter in RAM

*00ID=01<cr> This sets the null addressed PPT2 to device ID=01.

Note: *The new device ID is now used in subsequent commands*

*01S=<cr>

Response: #01S=00052036 (serial number)

The “#” now replaces the “?” in the header and indicates the PPT2 response is from an address-assigned unit.

READ PRODUCTION DATE

To read the production date, enter the following command:

*01P=<cr>

Response: #01P=04/13/11

READ CONTINUOUS PRESSURE

For continuous pressure readings (factory default rate = 5 per second) enter the following command:

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

$*99IN<cr> This is the best way to stop the continuous pressure reading commands. The '$' character temporarily stops, or suspends, the digital output of the PPT2. The *99IN command stops the continuous pressure or temperature readings.

CHANGE TO A NEW READING RATE

Enter the following command:

*01WE <cr> This enables the PPT2 RAM to accept a changed parameter.

*01I=M200<cr> This sets the integration time to value M200, which corresponds to an output reading every 2 seconds.

The reading rate will change to one every 2 seconds. I= is an abbreviation for Integration time, which determines how long to accumulate corrected pressure values 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=R50 for 50 readings/sec) or in 10 millisecond intervals (I=M600 for 6 seconds). The factory-set integration time is 200 milliseconds or 5 readings per second (I=M20).

The output data rate can also be altered by use of the idle count (IC) command or by changing the operating mode (OP) command. See Section 5 for description of these commands.

REPEAT THE READ CONTINUOUS PRESSURE STEP ABOVE

Notice the slower output rate of one reading 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 Command Summary. See Section 5— Commands for complete command descriptions. Until an SP=ALL command is executed, no changes will be stored in the PPT2 EEPROM. Re-apply the power or send an IN=RESET command to revert to the settings last saved in EEPROM.

3.0 PPT2 Command Summary

The PPT2 command set is summarized in Table 1.0 – Command List. A more detailed description of each command can be found in the subsequent command descriptions in Section 5.

Table heading explanations for Table 1.0 – Command List:

Command Code: Two-character code (cc) in the command format (see Section 2.5). The command code characters may be one letter followed by an '=' equal sign, 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 PPT2 internally converts all lower case characters to upper case.)

Action Directing Command: Does this command change the PPT2 configuration?

Yes – The command changes the PPT2 configuration as an action directing command.

No – The command is only an Information Request Command.

Information Request Command: The command initiates a response (output) from the PPT2, with the output content being specific to that particular PPT2.

Sequential Response with Group or Global Address:

Commands that begin with a group or global address (ID=90-99), are passed through the PPT2 ring configuration network from one device to the next and eventually end up back at the host computer. The PPT2 response is sent with the command through the network.

Before – The PPT2 response is sent before the group or global command is repeated.

After – The PPT2 response is sent after the group or global command is repeated.

No – The PPT2 just passes the command through the network with no response.

Input or Output: Is information input to the PPT2 or output from the PPT2?

In – Command is only used to input (action direct command) to the PPT2.

Out – Command is only used to request output (Information Request Command) from the PPT2.

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 Information Request Commands.

Terminates Continuous Commands:

Will this command stop the PPT2 digital output flow?

Yes – This command will end the continuous flow of the P2, P4, or T2 replies.

No – Command will not stop the continuous digital output flow.

Write to EEPROM: Can this command have parameters stored in EEPROM?

Yes – Parameter values associated with this command may be stored in EEPROM.

No – Cannot store anything from this command in EEPROM.

All – Cause all parameters to be stored in EEPROM.

Write to DAC: Can this command be written to the DAC?

Yes – Command may be directed to the DAC.

No – Command is not associated with the DAC.

Table 1.0 – Command List, Grouped by Function

See previous page for descriptions of the table headings.

Command Code	Action Directing Command	Sequence of 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
Pressure Readings								
P1	No	Before (5)	Out	No	No	No	No	Pressure, Single, ASCII Format
P2	No (3)	After	Out	No	Yes (8)	No	No	Pressure, Continuous, ASCII Format
P3	No	Before (5)	Out	No	No	No	No	Pressure, Single, Binary Format
P4	No (3)	After	Out	No	Yes (8)	No	No	Pressure, Continuous, Binary Format
Pressure Units								
DU	Yes	Before	Both	Yes (6)	No	Yes (9)	No	Display Units Control
U=	Yes	After (4)	Both	Yes (6)	No	Yes (9)	No	User Supplied Display Units
Pressure Sensor Temperature Readings								
T1	No	Before (5)	Out	No	No	No	No	Sensor Temperature, Single, °C
T2	No (3)	After	Out	No	Yes (8)	No	No	Sensor Temperature, Continuous, °C
Transducer Information								
ID	Yes	Before	Both	Yes (6)	No	Yes (9)	No	Identification Number
M=	Yes	After (4)	Out	No	No	No	No	Maximum Full Scale Pressure
P=	No	After (4)	Out	No	No	No	No	Production Date
S=	No	After (4)	Out	No	No	No	No	PPT2 serial number
V=	No	After (4)	Out	No	No	No	No	PPT2 Firmware Version
Pressure Reading Modifiers								
I=	Yes	After (4)	Both	Yes (6)	No	Yes (9)	No	Integration Time
IC	Yes	Before	Both	Yes (6)	No	Yes (9)	No	Idle Count Parameter
CM	Yes	Before	Both	Yes (6)	No	Yes (9	No	Compatibility Mode (new command)
DS	Yes	Before	Both	Yes (6)	No	Yes (9)	No	Deadband and Sensitivity Control
Pressure Window Customization, Calibration, and Control								
F=	Yes	After (4)	Both	Yes (6)	No	Yes (9)	No	Customized Full Scale Pressure Range
T=	Yes	After (4)	Both	Yes (6)	No	Yes (9)	No	Set Tare Value
TC	Yes	Before	Both	Yes (6)	No	Yes (9)	No	Tare Control Switch
X=	Yes	After (4)	Both	Yes (6)	No	Yes (9)	No	Slope 1, User Compensation Control
Y=	Yes	After (4)	Both	Yes (6)	No	Yes (9)	No	Slope 2, User Compensation Control
Z=	Yes	After (4)	Both	Yes (6)	No	Yes (9)	No	Offset, User Compensation Control
Analog Customization, Calibration, and Control								
AN	Yes	Before	Both	Yes (6)	No	Yes (9)	No	Analog Range Setting
DX	Yes	After (4)	Both	Yes (6)	No	Yes (9)	No	DAC Slope Compensation Control (new command)
DZ	Yes	After (4)	Both	Yes (6)	No	Yes (9)	No	DAC Offset Compensation Control (new command)
H=	Yes	After (4)	Both	Yes (6)	No	Yes (9)	Yes (11)	Highest Analog Voltage

L=	Yes	After (4)	Both	Yes (6)	No	Yes (9)	Yes (11)	Lowest Analog Voltage
O=	Yes	After (4)	Both	Yes (6)	No	Yes (9)	Yes (11)	Offset Pressure Window (analog output)
W=	Yes	After (4)	Both	Yes (6)	No	Yes (9)	Yes (11)	Width of Analog Window
N=	No (3)	After (4)	Both	No (7)	No	No	Yes (11)	Send Number to DAC (force analog output)

Diagnostic and Reset Control

CK	No	After (4)	Out	No	No	No	No	Check Memory
IN	No (2)	No	In	No	Yes	No	No	Initialize PPT2 Microprocessor
RS	No	Before (5)	Out	No	No	No	No	Read Status

Operating Parameters

BP	Yes	After (4)	In	Yes	Yes	Yes (9)	No	Baud Rate and Parity Setting
DA	Yes	Before	Both	Yes (6)	No (12)	Yes (9)	Yes (10)	Digital and Analog Control
DO	Yes	Before	Both	Yes (6)	No	Yes (9)	No	Default Operating Parameters
MO	Yes	Before	Both	Yes (6)	No	Yes (9)	No	Power-up Mode
OP	Yes	Before	Both	Yes (6)	No	Yes (9)	No	Operating Mode Parameters
TO	Yes	Before	Both	Yes (6)	No	Yes (9)	No	Transceiver Operating Parameters

Utility

A=	No	After (4)	Both	Yes	No	Yes (9)	No	Data string A
B=	No	After (4)	Both	Yes	No	Yes (9)	No	Data string B
C=	No (1)	After (4)	Both	Yes				
D=	No (1)	After (4)	Both	Yes	No	Yes (9)	No	Data string D
FD	Yes	No	In	Yes	No	No	No	Restore Factory Defaults (new command)
NE	No	No	In	No	No	Yes (9)	Yes	Analog Output Enable
SP	Yes	No	In	Yes	No	All	No	Store RAM parameters in EEPROM
WE	Yes	No	In	No	No	No	No	Write enable for RAM/EEPROM
$								Suspend Continuous Readings

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** 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,** and **T2** commands do not change the operating parameters, only activate continuous readings. The **N=** command does not change any operating parameter values only the DAC analog output voltage.

(4) When this information request command is sent to a group or global address, the PPT2s do not immediately respond with their output. The command is repeated from PPT2 to PPT2 in a ring configuration network , and eventually returned to the host processor. Each PPT2 appends its own response as it forwards the command. Also, this command requires more time for execution, of EEPROM reads , so responses from more than one PPT2 are not received in any guaranteed order. During the execution of one of this command, 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 PPT2 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) These commands terminate an active continuous reading command (**P2**, **P4**, **T2**) and initiate the new one.

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

(10) The **DA** command does not write to the DAC but it does allow the DAC to be controlled by the PPT2 input pressure value or by a digital value applied by the **N=** command.

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

(12) A P2 mode will be cancelled when a DA= A, C, F, G or N parameter is selected. A P4 mode can be cancelled when a DA=A, E, M or N parameter is selected.

COMMAND FORMAT

Communication between the host or control processor and a PPT2 is accomplished by message transfers, or commands and replies. Communications initiated by the host processor to one or more PPT2s are called commands and must begin with an '*' header character. (For RS-485 PPT2s, alternate header characters are available, using the **MO** command.) All commands must be terminated by a <cr> (carriage return or ENTER key). Communications initiated by a PPT2 to the host are called responses or replies, and begin with one of ten unique header characters (2 for ASCII responses, 8 for binary format responses).

Commands may request information from one or more PPT2s such as read pressure, or direct action to one or more PPT2s such as change a command value or operating mode.

Typical PPT2 command format: *ddcc = nnn <cr>

Where:	*	is the command header character
	dd	is the decimal address of the command message (00-99)
	cc	is the command code. Command code characters sent to the PPT2 are not case sensitive; i.e., either an upper case or lower case may be used. Responses from the PPT2 will have capitalized command code characters. Example: #01CP=14.2426
	=	equal sign (required in some commands)
	nnn	additional characters (required in some commands)
	<cr>	carriage return (the ENTER key on a standard keyboard)

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

In an RS-232 network, when manually applying commands to one or more PPT2s which are in the continuous send mode (**P2, P4, T2,**), the special header character '$' should be used to suspend all PPT2 transmissions while the command message is being typed. The '$' is immediately followed by the normal command format.

In the case of an RS-232 network, if an erroneous command is sent to the PPT2, it is echoed back to the host as soon as the PPT2 recognizes it as an invalid command. For example, if the user tries to enter *01S2=15 (S2 is not a valid command for the PPT2), *01S2 would immediately be echoed back. The other instance of an echoed command is when a group or global address command (ID = 90 to 99) is sent, such as *99I=R15<cr>. Group/global addresses will always echo the command back to the host processor after being read by all PPT2s in the network.

PRESSURE READING DECIMAL POSITION

The table below shows the number of decimal place variations with respect to PPT2 full scale - the number of digits to the right and left of the decimal place. This is valuable when converting a binary format number so that the proper decimal position can be determined.

If CM=ON (PPT Compatibility Mode), subtract 1 from the “Digits to Right“ column of the table below.

Full Scale * (current Display Units)	Digits to Left	Digits to Right	Digit to Left if -1< reading < 1	Negative Values
≥ 9,000,000	8	1	0, padded w/ leading spaces	“-“ inserted after “=”
≥ 900,000 and < 9,000,000	7	1	0, padded w/ leading spaces	“-“ inserted after “=”
≥ 90,000 and < 900,000	6	1	0, padded w/ leadings spaces	“-“ inserted after “=”
≥ 9,000 and < 90,000	5	1	0, padded w/ leading spaces	“-“ inserted after “=”
≥ 900 and < 9000	4	2	0, padded w/ leading spaces	“-“ inserted after “=”
≥ 90 and < 900	3	3	0, padded w/ leading spaces	“-“ inserted after “=”
≥ 9 and < 90	2	4	0, padded w/ leading space	“-“ inserted after “=”
≥ 0.9 and < 9	1	5	0	“-“ inserted after “=”
≥ 0.09 and < 0.9	1	6	0 or “-“	Leading zero replaced with “-“
≥ 0.009 and < 0.09	1	7	0 or “-“	Leading zero replaced with “-“
≥ 0.0009 and < 0.009	1	8	0 or “-“	Leading zero replaced with “-“
< 0.0009	1	9	0 or “-“	Leading zero replaced with “-“

* For differential units, when determining decimal point position the Full Scale is the maximum positive pressure (5 psid = 5, 20 psid = 20, etc)

Whether OP=E (extended) or OP=F (fixed) also has an impact upon how the data is displayed.

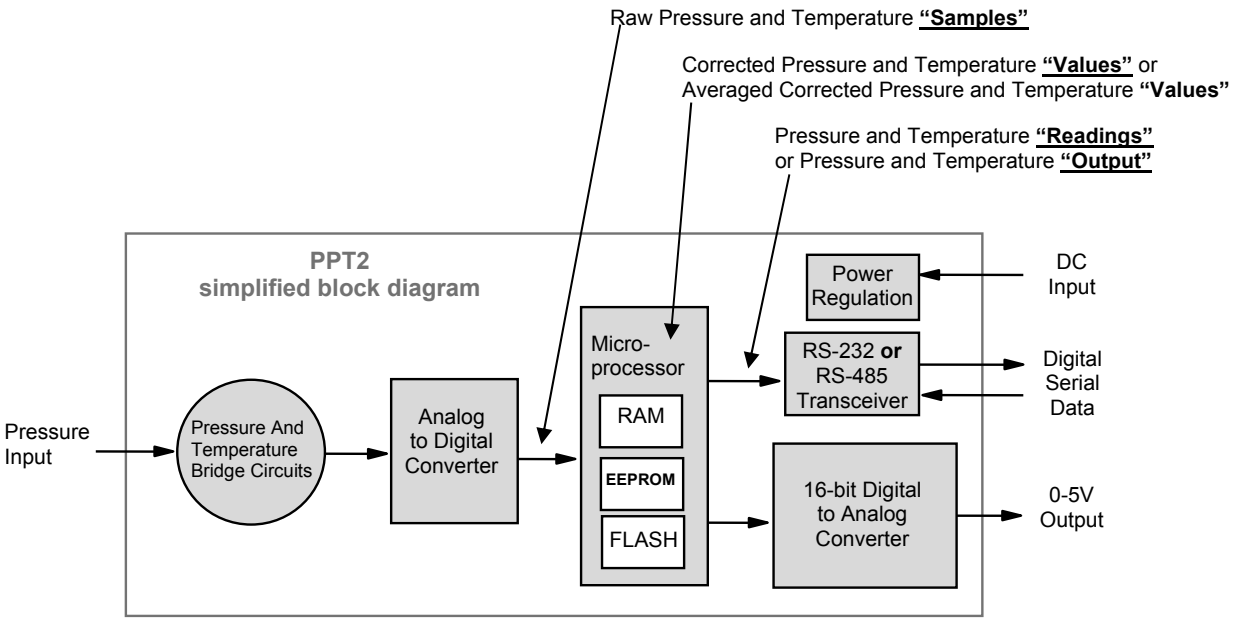
Example readings:

```
5 psid, OP=E, F=0 (5 psi)

?00CP=-0.00141                (negative reading > -1)
?00CP=0.02373                 (positive reading < 1)
?00CP=-3.00537                (negative reading < -1)
?00CP=2.36973                 (positive reading > 1)

5 psid, OP=F, F=0 (5 psi)

?00CP=-0.01442                (negative reading < -1)
?00CP= 0.00454                (positive reading < 1)
?00CP=-4.37939                (negative reading < -1)
?00CP= 3.80066                (positive reading > 1)

5 psid, OP=E, F=0.8 psi

?00CP=-.551017                (negative reading)
?00CP=0.804965                (positive reading)

5 psid, OP=F, F=0.8 psi

?00CP=-.779264                (negative reading)
?00CP=0.733452                (positive reading)
```

PPT Commands/Parameters Not Implemented in PPT2

DA={O|S|T|U}	**Digital and Analog Control**
DO=N|P	**Noise Protection in P4 mode**
NE=ZER[O,V]	**NE Command Extension**
RR	**Reading Rate**
S2	**Speed Shift x2**
S5	**Speed Shift at 50msec Intervals**
SI	**Synchronize Integration Cycles**
T3	**Temperature, Single, °F**
T4	**Temperature, Continuous, °F**
TO=R|M	**Special Ring and Multi-drop protocol functionality**
TO=C|A|S|H	**Synchronization functionality**
TO=N|P	**Normal and Prompted RS-485 group/global read operations**
~	**Command Header for Binary DAC Values**

4.0 Terminology



4.1 WHAT IS INTEGRATION?

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

4.2 PRESSURE READING CONTROL

The PPT2 commands allow considerable flexibility in tailoring pressure acquisition times, reading windows, thresholds, and output rates. These are controlled by 4 commands: Deadband and Sensitivity (**DS**), Integration (**I=**), Idle Count (**IC**), and OPerating mode (**OP**). The user may control these attributes in three ways:

First, the internal integration time may be controlled over a range of 1 reading every 10 seconds up to 1000 readings per second. This is controlled using the 'Integration' (I=) command. Pressure values are calculated every millisecond. The integration time is used to control the amount of averaging of these pressure values to create each pressure value. The integration time can be set within a range of 1 to 1000 readings/sec using the **I=Rn** form, or a range of 10 msec to 10 sec/reading using the **I=Mn** form. The values for 'n' range from 1 to 1000 for both the rate (**Rn**) form and the millisecond (**Mn**) form.

Second, the integration cycles may be spaced with idle periods that cause pressure reading times to increase to as long as one every 42.67 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, 10 sec/reading, and an idle count of 255 is selected, then the time between readings = 10 sec. x 256 = 42 minutes, 40 seconds.

Third, the reading rate may be controlled so pressure readings are obtained only when pressure changes occur. The OPerating mode command (**OP**) can be set to output every reading (**OP=A**) or to only output changes (**OP=U**). The Deadband setting in the **DS** command can filter a small pressure change by not allowing the pressure output reading to vary as long as it remains within the

deadband limits. This controls the **OP** command mode's sensitivity to pressure change when the 'output only when pressure changes' (**OP=U**) option is selected.

4.3 PPT2 ADDRESSING

The PPT2 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 PPT2. The next level is **group address**, which is separate from the device ID. All PPT2 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 PPT2s on a network. The device ID can be assigned by direct command or assigned automatically based on its position from the host processor in PPT2 network. The **null address** (00) is simply a default device ID that the PPT2 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 PPT2 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 PPT2s. A unit with the null address, replies with a 'null address' header. The null address header characters are '?' for ASCII format (standard keyboard alphanumeric characters) or '^, &, |, or %' for binary format (fewer data bytes that are encoded for computer translation.) A unique device ID allows the host processor to send commands to specific units on a bus.

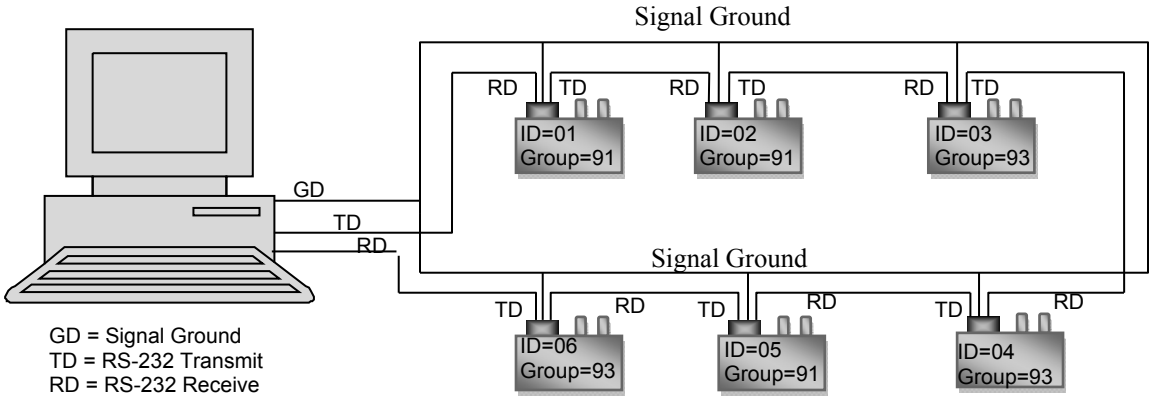
The second level of addressing is a multicast, or **group**, address in the range of 90-98. Each unit can be assigned a group address by the ID command. A unit responds to its group address in the same manner as it does to its global address described below. The group addressing allows the host processor 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 PPT2.

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. In general, 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 (or USB to serial adaptor). The maximum number of PPT2s with assigned device IDs on a network is 89.

A PPT2 ring network connection of six units is shown below. 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 PPT2 units assigned.



Each PPT2 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 PPT2 on a ring has a null address, and a 00 address command is transmitted by the host, only the first null address PPT2 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 PPT2 on the network. Since commands flow through every PPT2 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 network shown above, the command will read ***99ID=07** when it returns to the host processor. The form of self-addressing will indicate the PPT2 position in the communication ring relative to the host processor.

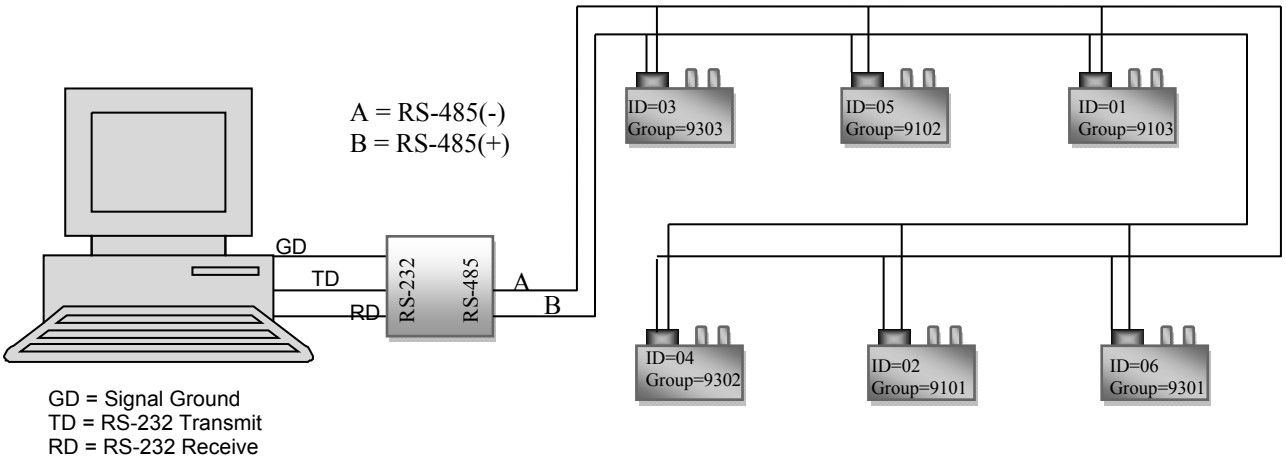
Every unit in the RS-232 ring network has an assigned group address. When the host processor sends a group addressed (***90** to ***98**) command, that command cycles through every PPT2 and is passed to the next one in the loop. Those units having that group address read the command, then pass the command and reply to the next unit in the ring. Some responses pass the string of PPT2 replies before the group command while others pass the string of PPT2 replies after the group command. See Table 1.0 for specific command types and the order of repeating the group command.

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.

RS-485 Multi-drop 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. The maximum number of addressable PPT2's on a network is 89.

A PPT2 multi-drop network connection of six units is shown below. 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 command operation (*99) is desired.



5.0 Command Descriptions (alphabetical order)

COMMAND CODE		COMMAND DESCRIPTION				
A=		**Data String A**				
Action Directing	Sequential Response with (90-99) address	Input or Output Type	Requires Write Enable	Terminates Continuous Commands	Can Write to EEPROM	Can Write to DAC
No	**After (4)**	**Both**	**Yes**	**No**	**Yes (9)**	**No**

DETAILS:
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. If this string is stored in EEPROM with the SP=ALL command, it will remain in the PPT2 even after the power is turned off. Example uses include dates for maintenance checks, over/under range pressure or temperature values, or key pressure readings specific to application. (Default: **A=**<empty>)

NOTE:

EXAMPLES:

Inquiry: *dd**A=**

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

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

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. Other characters outside this range are replaced with the "space" character. (see Appendix B for the ASCII table)

DIFFERENCES FROM LEGACY PPT:
The A= command will now work with a *ddWE=RAM continuous write enable is active. The SP=ALL command is now required before the value is written to EEPROM.
The PPT stored a parity bit for each pair of ASCII characters stored in the 8 character A= register. This is not required for the PPT2.
The PPT response is always 8 characters with trailing spaces if required. The PPT2 responds only with the characters stored.

COMMAND CODE		COMMAND DESCRIPTION				
AN		**Analog Range Setting**				
Action Directing	Sequential Response with (90-99) address	Input or Output Type	Requires Write Enable	Terminates Continuous Commands	Can Write to EEPROM	Can Write to DAC
Yes	**Before**	**Both**	**Yes (6)**	**No**	**Yes (9)**	**Yes**

DETAILS:
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 15+ bit resolution. A range reduction to 2.5 volts will result in a 7+ bit resolution. Ranges between these two values would result in a resolution between 7+ and 15+ bits. The use of analog window limits **O=** and **W=** can increase the volts/pressure resolution of the analog signal.
(Default: **AN=ON**)

NOTE:
Regardless of **AN** setting, **DX** and **DZ** settings are always active. **AN** command settings affect the analog output only when **DA=A|B|C|D|E|F|G|M|M|R**. When **DA=V** the analog output is disabled (floating).

EXAMPLES:

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.

DIFFERENCES FROM LEGACY PPT:
No difference from PPT implementation.

COMMAND CODE		COMMAND DESCRIPTION				
B=		**Data String B**				
Action Directing	Sequential Response with (90-99) address	Input or Output Type	Requires Write Enable	Terminates Continuous Commands	Can Write to EEPROM	Can Write to DAC
No	**After (4)**	**Both**	**Yes**	**No**	**Yes (9)**	**No**

DETAILS:
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. If this string is stored in EEPROM with the SP=ALL command,, it will remain in the PPT2 even after the power is turned off. Example uses include dates for maintenance checks, over/under range pressure or temperature values, or key pressure readings specific to application. (Default: **B=**<empty>)

NOTE:

EXAMPLES:

Inquiry: *dd**B=**

Action: *dd**WE**
*ddB=*Your_msg*

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

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. Other characters outside this range are replaced with the "space" character. (see Appendix B for the ASCII table)

DIFFERENCES FROM LEGACY PPT:
The B= command will work with a *ddWE=RAM continuous write enable is active. The SP=ALL command is now required before the value is written to EEPROM.
The PPT also implemented parity with the B= contents. This will not be required for the PPT2.
The PPT response is always 8 characters with trailing spaces if required. The PPT2 responds only with the characters stored.

COMMAND CODE		COMMAND DESCRIPTION				
BP		**Baud Rate and Parity Setting**				
Action Directing	Sequential Response with (90-99) address	Input or Output Type	Requires Write Enable	Terminates Continuous Commands	Can Write to EEPROM	Can Write to DAC
Yes	**After (4)**	**In**	**Yes**	**Yes**	**Yes (9)**	**No**

DETAILS:
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 a read status (**RS**) command error bit is set.

For this command, only the first two baud rate characters, that uniquely identify the baud rate, need to be used. Values beyond the first two valid baud rate characters will be ignored. Example: ***99BP=N48**X1will cause the baud rate to be set to 4800. If the first two baud rate characters are invalid, the command will be rejected and the command error flag set in the **RS** command response.
For networked RS-232 devices, this command causes the new baud rate and parity setting to be changed and the command to be retransmitted to the next PPT2. For multi-drop networked RS-485 devices all units receive the command at the same time. 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. A corresponding new communication port baud rate *must* be selected before executing the **SP=ALL** command. (Default **BP=N96**00)

NOTE:
As shipped, the PPT2 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.
When setting the baud rate, all continuous transmission commands (**P2, P4 and T4**) will be terminated.

EXAMPLES:

Inquiry: *dd**BP**

EEPROM Store: ***99WE**
***99SP=ALL**

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

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

Action: ***99WE**

***99BP=** {**N**|**E**|**O**} {**12**00|**24**00|**48**00|**96**00|**14**400|**19**200|**28**800|**38**400|**57**600|**11**5200}

N No parity
E Even parity
O Odd parity

1200**,...115,2**00 Baud rate (bits/sec)

DIFFERENCES FROM LEGACY PPT:
The PPT2 adds three new baud rates: 38400, 57600, and 115200.

COMMAND CODE		COMMAND DESCRIPTION				
C=		**Data String C**				
Action Directing	Sequential Response with (90-99) address	Input or Output Type	Requires Write Enable	Terminates Continuous Commands	Can Write to EEPROM	Can Write to DAC
No (1)	**After (4)**	**Both**	**Yes**	**No**	**Yes (9)**	**No**

DETAILS:
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. If this string is stored in EEPROM using the SP=ALL command, it will remain in the PPT2 even after the power is turned off. Example uses include dates for maintenance checks, over/under range pressure or temperature values, or key pressure readings specific to application. (Default: **C=**<empty>)

NOTE:
When MO=M2 or M3, the contents of the C= data string are used as the first 8 characters of the user startup message.

EXAMPLES:

Inquiry: *dd**C=**

Action: *dd**WE**
*ddC=*Your_msg*

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

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. Other characters outside this range are replaced with the "space" character. (see Appendix B for the ASCII table)

DIFFERENCES FROM LEGACY PPT:
The C= command will work with a *ddWE=RAM continuous write enable is active. The SP=ALL command is now required before the value is written to EEPROM.
The PPT also implemented parity with the C= contents. This will not be required for the PPT2.
The PPT response is always 8 characters with trailing spaces if required. The PPT2 responds only with the characters stored.