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# Honeywell Precision Barometer



**HPB and HPA User's Manual  
RS-232 and RS-485 Output**

**Honeywell**

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# HPB\HPA User Manual

## 0 USER'S 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 HPB 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 HPB 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 HPB 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 HPB

It is suggested that the first-time user read the “Getting Started” section to be sure the necessary items are on hand. Be sure to connect a source of pressure that matches the transducer range.

## HPB/HPA User Manual

# 1 Introduction

## 1.1 PRODUCT OVERVIEW

The Honeywell Precision Barometer RS-232 and Honeywell Precision Barometer RS-485\* (HPB) provides high accuracy absolute pressure readings in digital form. The first-time user will be able to use the HPB within minutes, yet capability exists to configure the HPB for optimum performance in specific applications.

The heart of the HPB 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.

Any computer having a serial port and terminal emulation software can be connected to the HPB to allow the user to select baud rates, sample rates, readout resolution, units of pressure and other choices. RS-485 versions require an RS-485 to RS-232 converter or an RS-485 port on the computer. User selected functions are set through the digital interface. The selected functions may either be used temporarily, until the HPB is powered down, or may be stored in the internal EEPROM to automatically configure the HPB each time power is applied.

The HPB receives commands and sends data from either an RS-232 port or a multidrop RS-485 port. Using the RS-232 type HPB, up to 89 units can be connected in a ring configuration to a single serial port of a computer. The RS-485 type HPB allows up to 89 HPBs 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 HPBs to be addressed with a single command. Global (broadcast) addressing will send a command to all HPBs on the serial bus.

## 1.2 HARDWARE DESCRIPTION

See Sections 8 and 9.

\* For simplicity, references throughout this manual HPB-RS-232, HPB-RS-485, HPA-RS-232 & HPA-RS-485 have been shortened to HPB.

## 2 GETTING STARTED

### 2.1 OVERVIEW

The first-time user should approach the HPB 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 HPB is powered up. This tailors the personality of the HPB to meet the needs of a particular application.

### 2.2 EQUIPMENT NEEDED

**To prepare the HPB for operation, four 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 of the HPB.
- A computer, or host processor, having an RS-232 or RS-485 serial port and terminal program software such as HYPERTERMINAL . These programs are normally used to interface to a modem. The wiring diagram designates which HPB 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 HPB connections to that particular computer. A link to Honeywell demonstration software is available at [www.pressuresensing.com](http://www.pressuresensing.com).

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

### 2.4 INITIAL TURN-ON RESPONSE

Once the wiring connections and terminal program settings are complete, the HPB 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 HPB.

Typical Reply:

```
?01HPB__1200mBAR RS-232
?00HPB__1200mBAR RS-485
```

The "01" or "00" indicates a default address device called a "null address". This HPB has not yet been assigned an ID number so it assumes the null address.



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### 2.5 COMMAND FORMAT

Any command interaction with the HPB 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 commands are described in Section 5.

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

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

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

The following examples assume that the reader has followed them in order.

- **READ SINGLE PRESSURE**

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

<b>Type:</b>	<b>*00P1 &lt;cr&gt;</b>	<b>Response:</b>	<b>?01CP=15.458</b> (for RS-232)
			<b>?00CP=15.458</b> (for RS-485)

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

Note: The “?” indicates a response from a null address HPB – one which has not been assigned a device ID. A null address, 00, is coded into each HPB at the factory. When an RS-232 null address HPB 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.

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- **SET DEVICE ID**

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

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

**Type:** \*00ID=01 <cr> This sets the null addressed HPB 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 HPB response is from an address assigned unit.

where: \* indicates the start of a command  
00 is the null address of the HPB  
WE is the command to enable a configuration parameter change  
ID is the command to change the device address  
01 is the assigned HPB 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=11/15/02

(Actual response depends on production date of device being used.)

- **READ CONTINUOUS PRESSURE**

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

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

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

- **CHANGE TO A NEW SAMPLE RATE**

Enter the following command:

**Type:** \*01WE <cr> This enables the HPB 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 using the reading rate (**RR**) command in conjunction with the operating mode (**OP**) command. See Section 4 for description of these commands.

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- **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. Re-apply the power or send an **IN=RESET** command to revert to EEPROM default settings. Until an **SP=ALL** command is executed, no changes will be stored in the EEPROM.

### 2.7 COMMAND FUNCTIONAL GROUPS

- **PRESSURE DISPLAY UNITS** —*HPB reads out psi, in wc, mm Hg, etc.*

DU Set pressure units for output readings—any one of 13 common units (See Section 8)  
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  
ID 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 pressure reading...ASCII format  
P3 Single pressure reading...binary format  
T1 Single temperature reading...°C  
T3 Single temperature reading...°F

Continuous Readings Commands

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

Integration Time Commands —*Changes pressure reading response time*

DS Set deadband and sensitivity parameters  
I= Set pressure integration time, and sampling 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*

IC 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 and P4, are ASCII format readings.
    - OP Set operating mode...all readings or only changed readings
- **START-UP PARAMETERS**—*Sets the HPB configuration after power is applied*
  - WE Enable parameter writes to the RAM or EEPROM
  - SP Store RAM parameters to the EEPROM for startup
  - MO Specify the power-up message and operating mode
- **PRESSURE NOISE REDUCTION**—*Reduces pressure noise signals*
  - DS Set deadband and sensitivity parameters
- **DIAGNOSTIC AND RESET CONTROL**
  - IN Performs a software reset of microprocessor
  - RS Read status of error indicators
  - CK Performs and provides the result of EEPROM checksum
  - OP Use pressure reading checksum for binary format
- **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
  - MO Specify the startup header selection
- **HPB UNIT INFORMATION**
  - P= HPB production date
  - S= HPB serial number
  - V= HPB software version number
  - ID 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
  - X= Set the slope “m” parameter for user input mx+b control
  - Z= Set the offset “b” parameter for user input mx+b control

## 3 COMMANDS—QUICK REFERENCE

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		Example Input (1)	Example Response (2)
<b>A= Data String A</b> <i>(up to 8 characters, a &lt;cr&gt; indicates end-of-message. More than 8 characters is an invalid write) (Can store info. such as dates, readings, etc.)</i>	Write string A  Inquiry	*00 WE *00 A=2-8-95 *00 A=	?01 A=2-8-95
<b>BP Baud Rate and Parity Setting</b>	Set parameters <i>(no parity, 1200 baud)</i>	*99 WE *99 BP=N1200	
<b>B= Data String B</b> <i>(up to 8 characters, a &lt;cr&gt; indicates end-of-message, and more than 8 characters will not write to location) (Can store info. such as dates, readings, etc.)</i>	Write string B  Inquiry	*00 WE *00 B=123.4567 *00 B=	?01 B=123.4567
<b>CK Check EEPROM</b>	Inquiry	*00 CK	?01 CK=OK
<b>C= Data String C</b> <i>(up to 8 characters, a &lt;cr&gt; indicates end-of-message, and more than 8 characters will not write to location) The C and D string can be used for a watchdog or reset message (see MO command).</i>	Write string C  Inquiry	*00 WE *00 C=This_is_ *00 C=	?01 C=This_is_
<b>DO Default Operating Parameters</b>	Set DO parameters <i>(factory default setting)</i> Inquiry	*00 WE *00 DO=E *00 DO	?01 DO=E0N
<b>DS Deadband and Sensitivity Control</b>	Set DS parameters <i>(set deadband to 20 x 0.005% = 0.10%FS )</i> Inquiry	*00 WE *00 DS=20 *00 DS	?01 DS=00 S0
<b>DU Display Units Control</b>	Set DU parameters <i>(set units to in. Hg)</i> Inquiry	*00 WE *00 DU=INHG *00 DU	?01 DU=INHG
<b>D= Data String D</b> <i>(up to 8 characters, a &lt;cr&gt; indicates end-of-message, and more than 8 characters will not write to location) The C and D string can be used for a watchdog or reset message (see MO command).</i>	Write string D  Inquiry	*00 WE *00 D=A_HPBM!!! *00 D=	?01 D=A_HPBM!!!
<b>F= Custom Full Scale Range</b> Set F= parameter <i>(set custom FS range to 10.5psi)</i> Inquiry	*00WE *00F=10.5 *00F=	?01F=10.500	
<b>IC Idle Count Parameter</b>	Set IC parameter <i>(set idle count to 12 , so that 12 output samples are skipped)</i> Inquiry	*00 WE *00 IC=12 *00 IC	?01 IC=12

(1) A carriage return, <cr>, should follow each input. If the HPB 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 HPB. That is, an HPB that has not yet established unit identification (see ID command). If the HPB 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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		Example Input (1)	Example Response (2)
<b>ID Identification Number</b>	Set ID number	*00 WE	
	<i>(set device ID of first null addressed unit to 12)</i>	*00 ID=12	
	Confirmation of ID=12	*12 P1	#12CP= 14.32
	Set group number	*12 WE	
	[RS-232] <i>(set group ID of unit 12 to 95)</i>	*12 ID=95	
[RS-232] Group no. inquiry of device ID=12	*12 ID	#12ID=95	
[RS-485] <i>(set group ID of unit 12 to 95 with group sub-address of 01)</i>	*12 ID=9501		
[RS-485] Group no. inquiry of device ID=12	*12 ID	#12ID=9501	
<b>IN Initialize HPB Microprocessor</b>	Stop all current operations (does not affect RAM data)	*99 IN	
	Full reset of HPB processor	*99 IN=reset	
	Changes to RAM data are lost unless an SP=ALL command was previously issued. (Response is user message, if selected)	?01 Pressure tank 1	
<b>I= Integration time</b>	Set I parameter	*00 WE	
	<i>(set output rate to 50 readings/second)</i>	*00 I=R50	
	Inquiry	*00 I=	?01 I=R0 50
<b>MO Power Up Mode</b>	Set MO parameter	*00 WE	
		*00 MO=M1	
	Required to save in EEPROM for power-up	*00 WE	
		*00 SP=ALL	
	Inquiry	*00 MO	?01 MO=X2M1
<b>OP Operating Mode Parameters</b>	Set OP parameter	*00 WE	
	<i>(set to extended binary output mode)</i>	*00 OP=E	
	Inquiry	*00 OP	?01 OP=ANEW
<b>P1 Pressure, Single, ASCII Format</b>	Request compensated pressure	*00 P1	?01 CP= 14.45 0
			(repeated)
<b>P2 Pressure, Continuous, ASCII Format</b>	Request compensated pressure	*00 P2	?01 CP= 14.45 0
<b>P3 Pressure, Single, Binary Format</b>	Compensated pressure (null address)	*00 P3	^@PSA or
	Compensated pressure (assigned address)	*01 P3	{@PSA
	<i>(typical response is a ^ or { char plus 4 data bytes that are encoded for computer translation)</i>		
<b>P4 Pressure, Continuous, Binary Format</b>	Compensated pressure (null address)	*00 P4	^@P@@ or
	Compensated pressure (assigned address)	*01 P4	{@P@@
	<i>(typical response is a ^ or { char plus 4 data bytes that are encoded for computer translation)</i>		(repeated)
<b>P= Production Date</b>	(factory set date, mm/dd/yy) Inquiry	*00 P=	?01 P=06/13/02
<b>RR Reading Rate</b>	Set RR parameter	*00 WE	
	<i>(skip 5 x 100 = 500 readings if identical)</i>	*00 RR=5	
	Inquiry	*00 RR	?01 RR=5
<b>RS Read Status</b>	Inquiry	*00 RS	?01 RS=0000

**Note: See Section 5.10 for complete command descriptions.**

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		Example Input (1)	Example Response (2)
<b>S2 Speed Shift to 2X</b>	Set S2 parameter <i>(shift to double speed if pressure changes more than <math>12 * 0.01\%FS = 0.12\%FS</math>)</i>	*00 WE *00 S2=12	
	Inquiry	*00 S2	?01 S2=12
<b>S5 Speed Shift at 50msec Intervals</b>	Set S5 parameter <i>(Output reading if pressure changes more than <math>60 * 0.01\%FS = 0.6\%FS</math>)</i>	*00 WE *00 S5=60	
	Inquiry	*00 S5	?01 S5=60
<b>SI Synchronize Pressure Integration</b>	Synchronize Integration	*01 SI	
<b>SP Store Parameters in EEPROM</b>	Store parameter <i>(store all settings stored in RAM in EEPROM)</i>	*00 WE *00 SP=ALL	
<b>S= Serial Number</b>		Inquiry	*00 S= ?01 S=00032000
<b>T1 Temperature, Single, °C</b>	Request Celsius temperature	*00 T1	?01 CT= 24.5 or ?01CT= ..
<b>T2 Temperature, Continuous, °C</b>	Request Celsius temperature	*00 T2	?01 CT= 24.5 (repeated)
<b>T3 Temperature, Single, °F</b>	Request Fahrenheit temperature	*00 T3	?01 FT= 76.1 or ?01FT= ..
<b>T4 Temperature, Continuous, °F</b>	Request Fahrenheit temperature	*00 T4	?01 FT= 76.1 (repeated)
<b>TO Transceiver Operating Parameters</b>	Set RS-485 response delay to 2 character times	*01 WE *01 TO=2	
	Inquiry	*01 TO	#01TO=M2CN
<b>U= User Supplied Display Units</b>	Set display units <i>(set units to 5.1 x psi)</i> Activate user display units *00 DU=USER	*00 WE *00 U=5.100 *00 WE *00 DU=USER	
	Inquiry	*00 U=	?01 U=5.1000
<b>V= Version Number</b>		Inquiry	*00 V= ?01 V=02.3B6S2V
<b>WE Write Enable to EEPROM or RAM</b>	Write several RAM parameters <i>(example to set output units to cm water column (factory default setting) (Cancel continuous WE=RAM command)</i>	*01 WE=RAM *01 DU=CMWC *01 DO=D *01 WE=OFF	
	<i>Note: Any command changes in RAM will be lost when the HPB is powered down unless an SP command saves them to EEPROM.</i>		
<b>X= Slope- User Compensation Control</b>	Set X= parameter <i>(set user slope control to <math>0.005\% \times 17 = 0.085\%FS</math>)</i>	*00 WE *00 X=17	
	Inquiry	*00 X=	?01 X=17
	<i>Note: The input slope and offset control are for user supplied mx+b correction.</i>		
<b>Z= Offset - User Compensation Control</b>	Set Z= parameter <i>(set mx+b pressure offset to <math>20 \times 0.005\%FS = 0.1\%FS</math>) (null adjust output at zero pressure)</i>	*00 WE *00 Z=20 *00 Z=CAL	
	Inquiry	*00 Z=	?01 Z=20

**Note: See Section 5.10 for complete command descriptions.**

## 4 FUNCTIONAL OPERATION

### 4.1 OVERVIEW

The HPB 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 HPB has an accuracy of 0.03% 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.

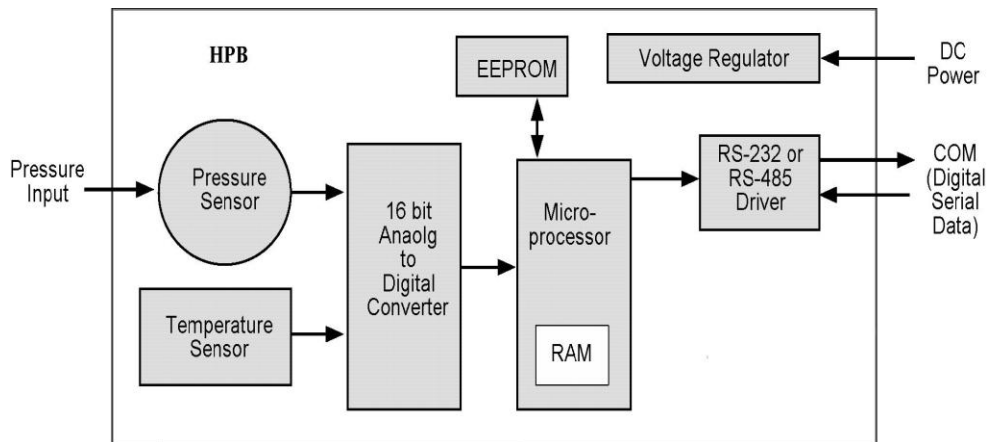


Figure 4.1—HPB Block Diagram

The HPB can be tailored to specific application requirements. Configuration information is sent to, or read from, the HPB 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 except baud rate or parity. 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 HPB RAM for immediate use until power is removed. These configuration changes are only made permanent in the EEPROM when the user executes the Write Enable (**WE**) command followed by the EEPROM Store Parameters (**SP**) command. Exceptions to this are the **A=**, **B=**, **C=**, and **D=** commands which are immediately stored to EEPROM if preceded by the WE command.

### 4.2 WHAT IS INTEGRATION?

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



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### 4.3 PRESSURE READING CONTROL

The HPB 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 4.5 and 4.6. 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 only output changed readings, or to skip from 100 to 1000 identical readings. The Operating Mode command (**OP**) can be set to output every reading or to only output readings when a pressure change occurs. 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.

# HPB Pressure Rate Conditioning

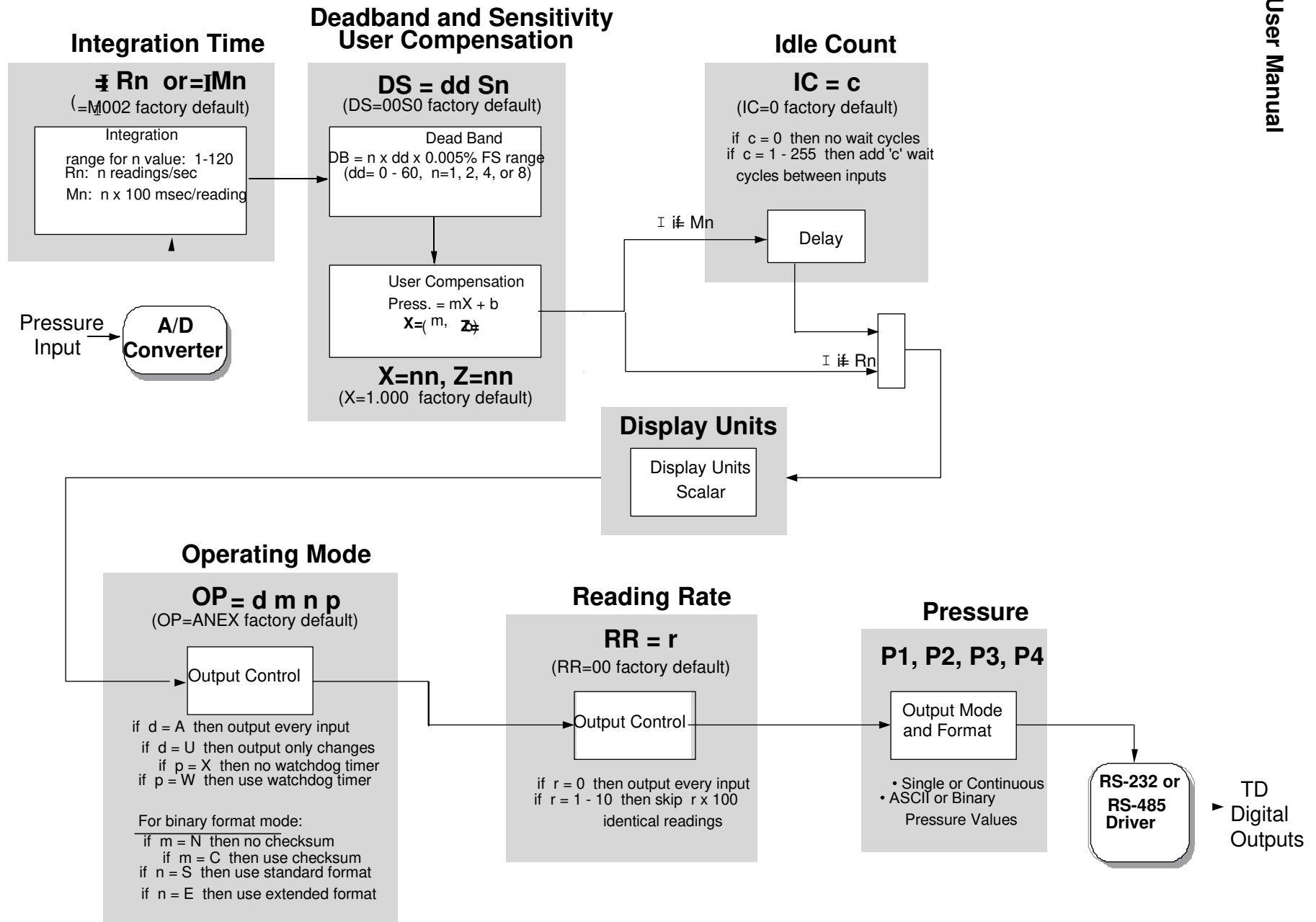


Figure 4.2—Pressure Reading Control  
 Shaded blocks represent command codes executed in the microprocessor

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### 4.4 CUSTOMIZED PRESSURE RANGE

The user can adjust the pressure vs. output value transfer curve using the X=, Z= and F= commands. The X= command adjusts the slope of the pressure output curve. The Z= command adjusts the offset of the pressure output curve. The range of adjustment for X= and Z= commands is  $\pm 0.6\%FS$  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 HPB temperature compensates the pressure reading according to the factory calibration. The user-supplied values (X=, Z=) are used as an  $mx+b$  correction. The X= command supplies the slope adjustment, or 'm', value and the Z= command supplies the offset adjustment, or 'b', value.

Figures 4.3 and 4.4 illustrate these commands.

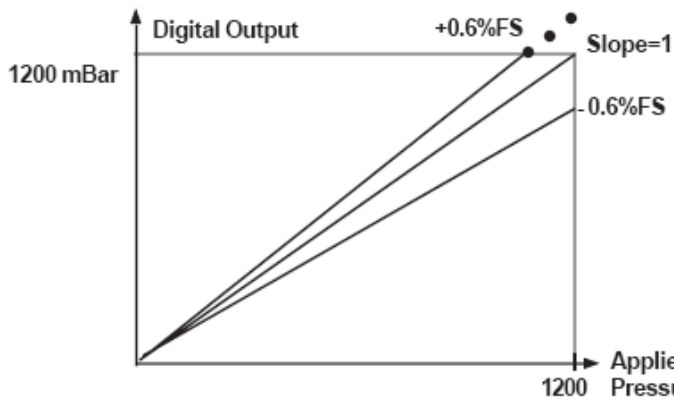


Figure 4.3—Custom Slope (X=) Options

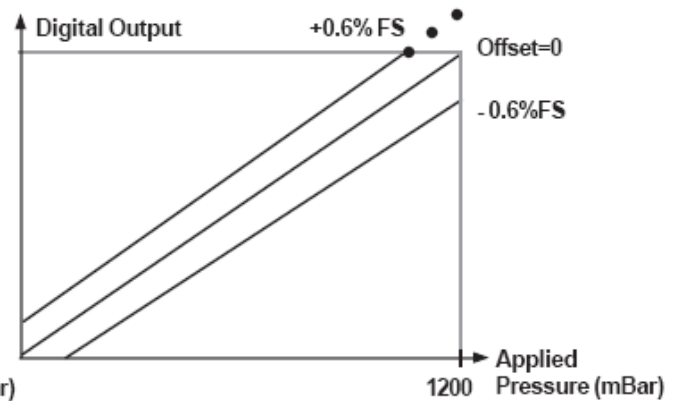


Figure 4.4—Custom Offset (Z=) Options

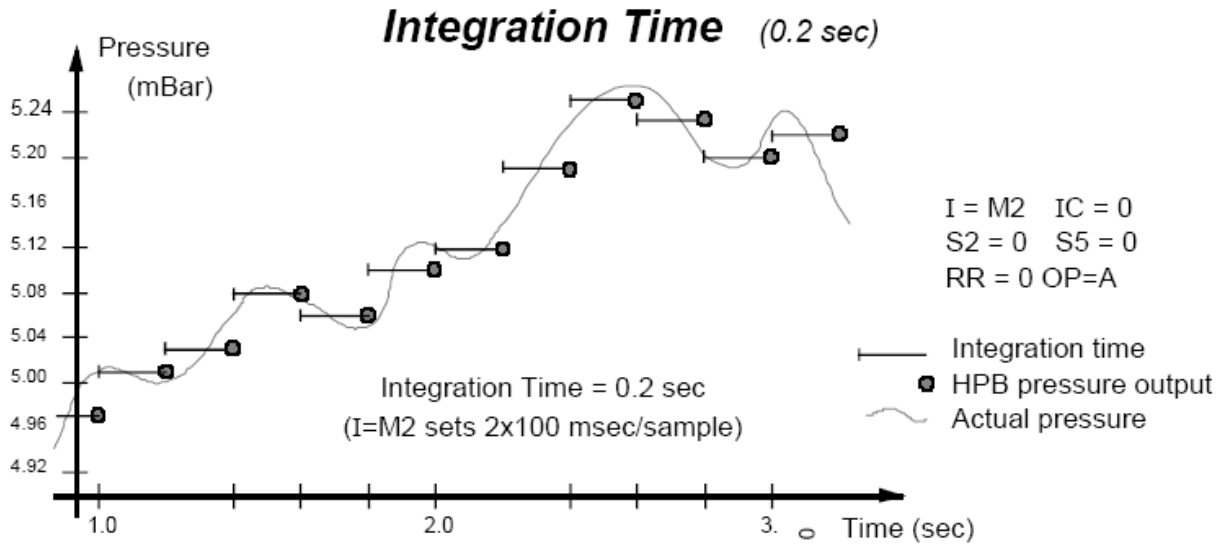
The user compensated pressure output can be expressed in terms of X= slope values 'm' where  $m=0$  to  $\pm 120$ . The offset value, Z=, can be expressed as 'b' where  $b=0$  to  $\pm 120$ .

$$\text{Pressure Output} = [(1 + m \times 0.00005) \times \text{Pressure Reading}] + [(b \times 0.00005) \times (\text{full scale})]$$

The F= command is used in conjunction with the X= and Z= command to customize the full scale range and user compensation of the HPB. The F= command allows the user to reduce the full scale range of the HPB 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 1200 mBar (900mm Mercury - mmhg) device to 800 mmhg, first select the desired display units using the DU command. Enter the command \*ddWE followed by a \*ddDU=mmhg. Then enter a \*ddWE followed by a \*ddF=800. The full scale pressure for this unit is now 800 mmhg.

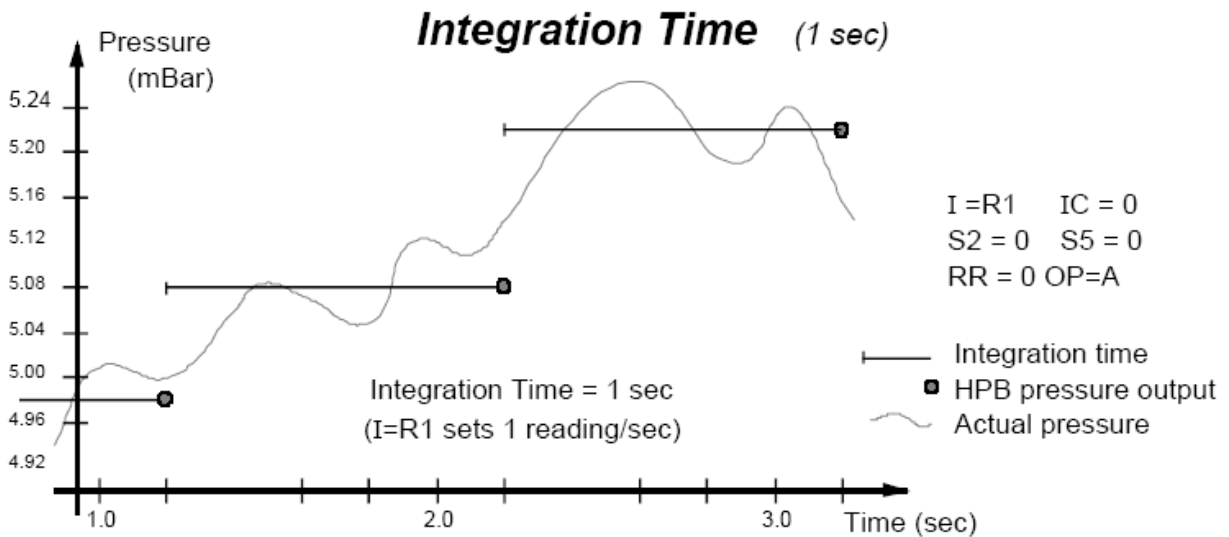
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**4.5 COMMAND ILLUSTRATIONS**

The figures below illustrate the commands that affect the pressure output rate. Figure 4.5 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 4.5—Integration (I=) Command, Example 1**

Figure 4.6 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 4.6—Integration (I=) Command, Example 2**

Figures 4.7 and 4.8 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 HPB 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 4.7—S2 Speed Shift

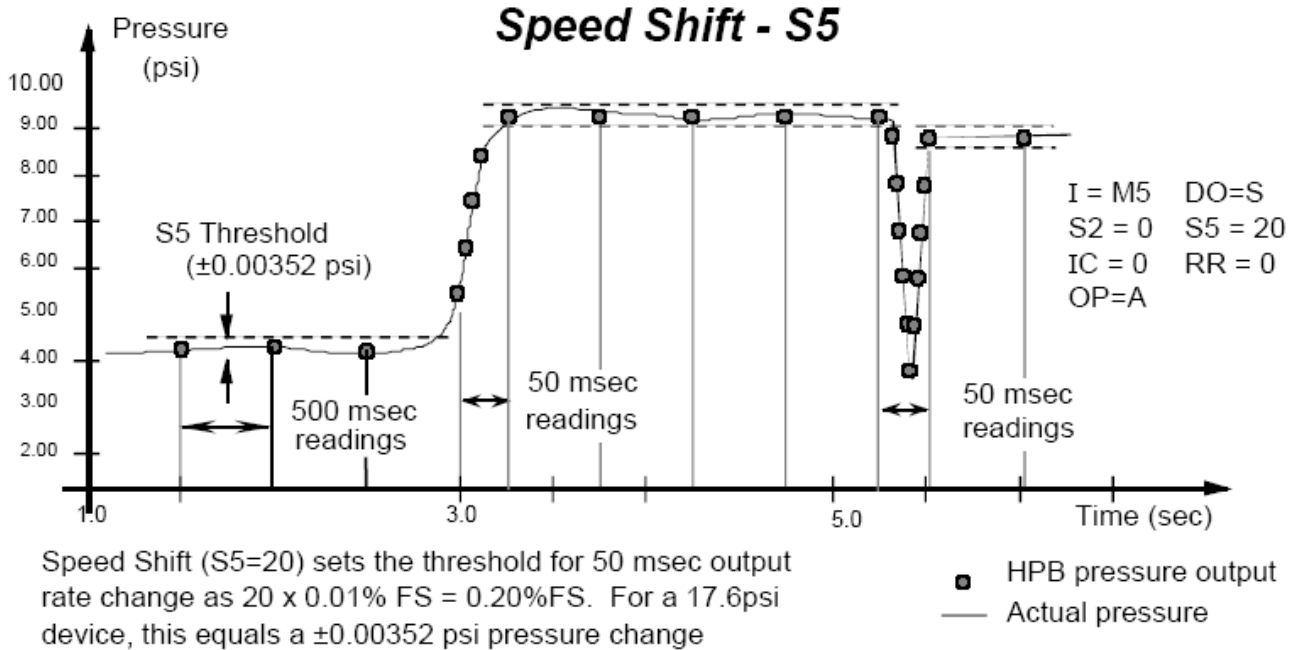
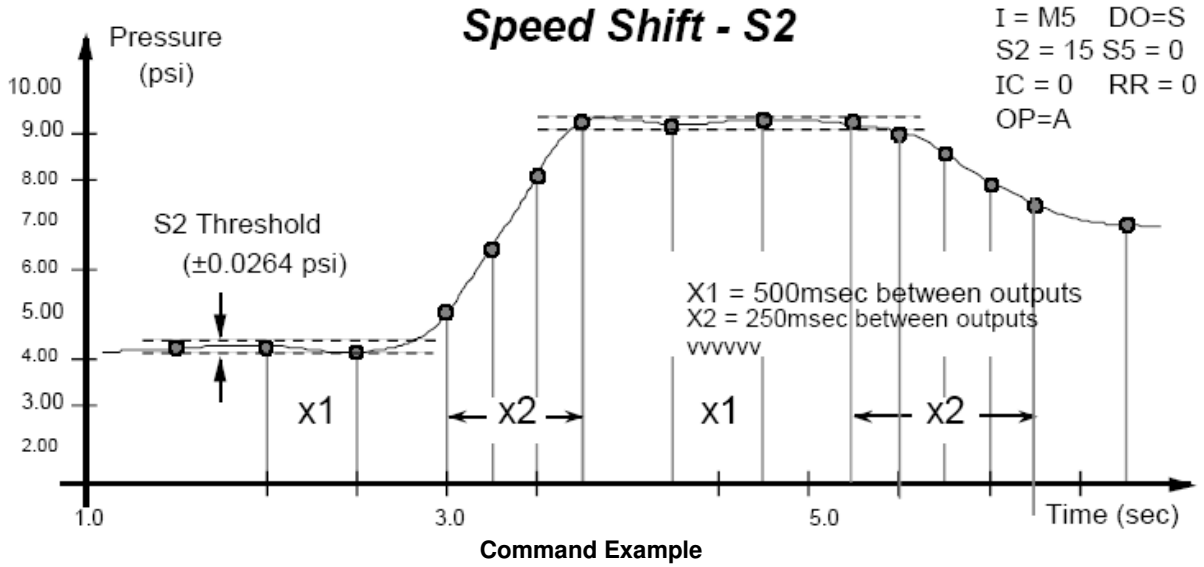


Figure 4.8—S5 Speed Shift Command Example

Figure 4.9 shows the effect of the deadband setting in the **DS** command. If a deadband of  $\pm 0.02\% \text{ FS}$  is selected, then the pressure output will not change reading as long as it is within this limit ( $\pm 0.00352$ psi for a 17.6 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 4.10 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 HPB 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 HPB units.

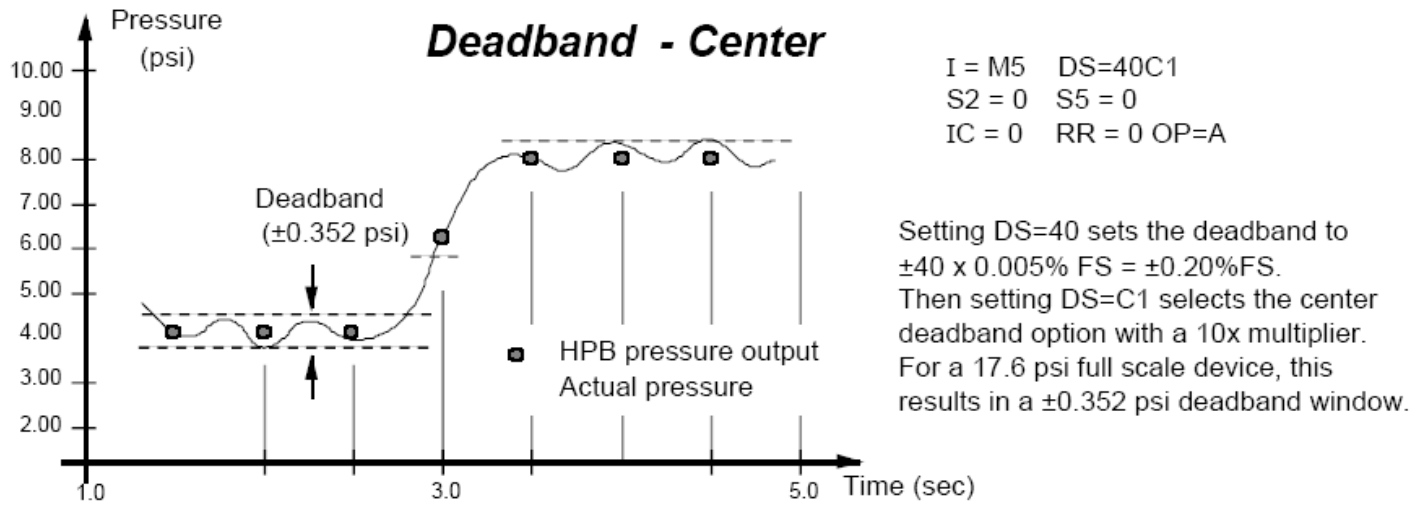


Figure 4.9a-Deadband and Sensitivity (DS) Command Examples

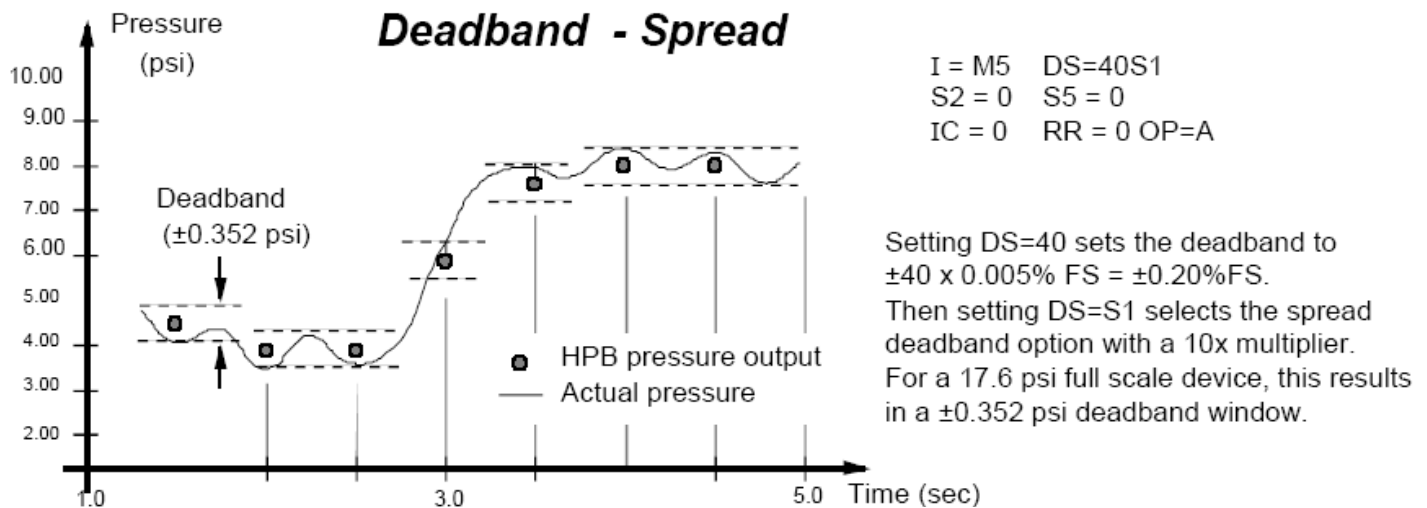


Figure 4.9b—Deadband and Sensitivity (DS) Command Examples

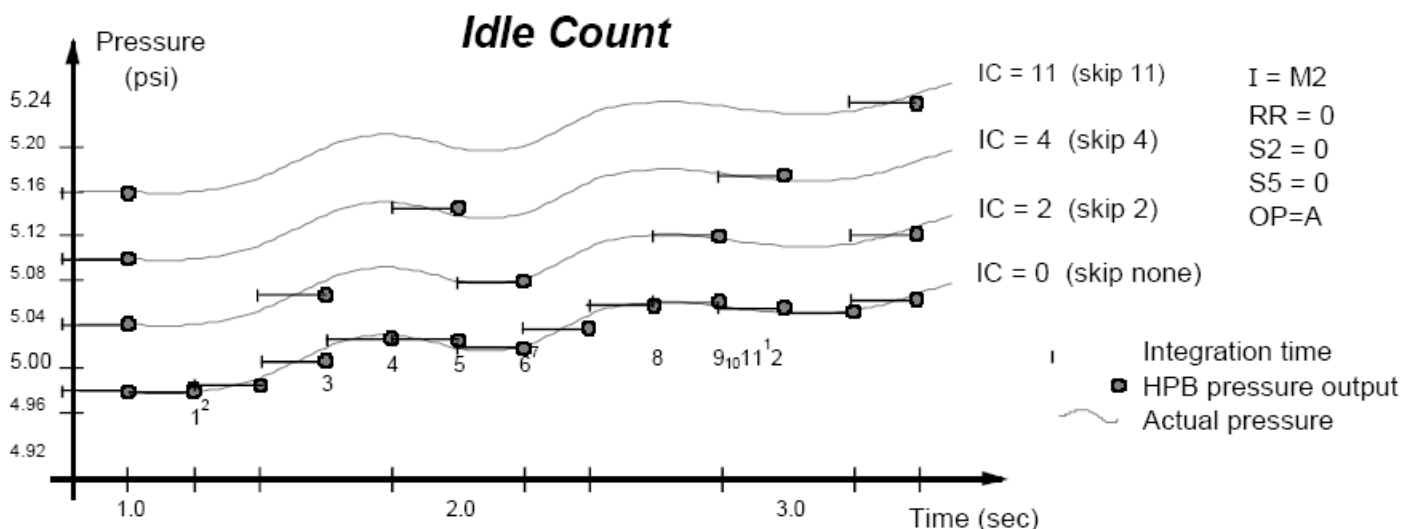
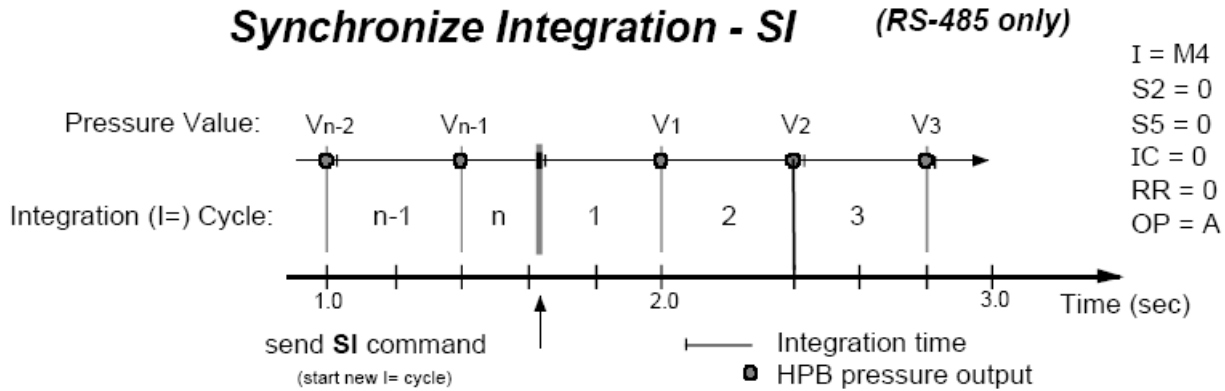


Figure 4.10—Idle Count (IC) Command Example

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Figure 4.11 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.



	*ddP1 Pressure Value Output during:				
TO Option	Cycle n-1	Cycle n	Cycle 1	Cycle 2	Cycle 3
TO=C (default)	$V_{n-2}$	$V_{n-1}$	$V_{n-1}$	$V_1$	$V_2$
TO=A	$V_{n-2}$	$V_{n-1}$	$V_{n-1}$	$V_1$	$V_2$
TO=S	$V_{n-2}$	$V_{n-1}$	<cr>	$V_1$	$V_2$
TO=H	$V_{n-2}$	$V_{n-1}$	<cr>	$V_1^*$	

\*  $V_1$  can be read once anytime after Cycle 1

Figure 4.11—Synchronize Integration Cycles (SI) Command Example

## 4.6 PRESSURE READING DECIMAL POSITION

Digital pressure readings are displayed with a sign and a decimal position. Table 4.1 shows the number of decimal place variations among the HPB pressure ranges; the number of digits to the right of the decimal place. This is important 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 (=0.XXXX). For pressure values greater than 1.0, (XX.XX), the first character will be a space or a number (= XX.XX or =XX.XX). For example, a 17.6 psia device set to KGCM units ( $17.6\text{psi} \times 0.070307 = 1.23740\text{ kg/cm}^2$ ) will read the full scale pressure as "#23CP=1.2374" kg/cm<sup>2</sup>. (The numerical limit for FS reading is 90,000.)

Units	Decimal Place	Units	Decimal Place
ATM	4	KPA	2
BAR	4	MBAR	1
CMWC	2	MMHG	1
FTWC	2	MPA	5
INHG	2	MWC	3
INWC	2	PFS	3
KGCM	4	PSI	3

Table 4.1—Decimal Place Locations for Pressure Readings  
(Extended format selected, OP=E)

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**4.7 HPB ADDRESSING**

The HPB 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 HPB. The next level is **group** address, which is separate from the device ID. All HPB 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 HPB's on the network. The device ID can be assigned by direct command or assigned automatically based on its position from the host processor in HPB network. The **null address** (00) is simply a default device ID that the HPB 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 HPB 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 HPB's. 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 5.5 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 ring networked units respond to global commands. Only multi-drop units with assigned addresses will respond to global commands. A multi-drop unit with a null address will not reply to any global command. The global address is not assigned but is built into the HPB.

**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 HPBs with assigned device IDs on a network is 89. An HPB ring network connection of six units is shown in Figure 4.12. 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 HPB units assigned.

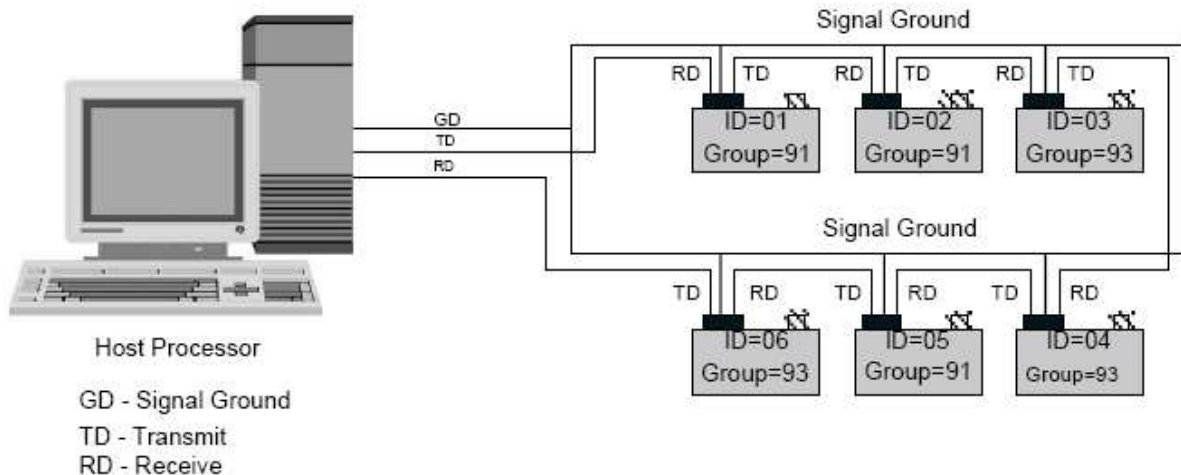


Figure 4.12-HPB RS-232 Ring Network



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Each HPB 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 HPB on a ring has a null address, and a 00 address command is transmitted by the host, only the first null address HPB will receive the command and the command is not passed on. This is the same for any address on a ring network.

Another advantage of the ring network is the ability to automatically assign device IDs to every HPB on the network. Since commands flow through every HPB on the ring, a single **\*99ID=01** command will assign ID=01 to the first unit, and each HPB 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 4.12, the command will read **\*99ID=07** when it returns to the host processor. The form of self-addressing will indicate the HPB position in the communication ring relative to the host processor.

*Every* unit in the ring network has an assigned group address. When the host processor sends a group addressed (**\*90** to **\*98**) command, that command cycles through every HPB 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 HPB replies before the group command while others pass the string of HPB replies after the group command. See Table 5.3 for specific sequential command types.

*Every* unit in the ring network responds to 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.

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### 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 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 HPBs on a network is 89.

An HPB multidrop network connection of six units is shown in Figure 4.13. 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.

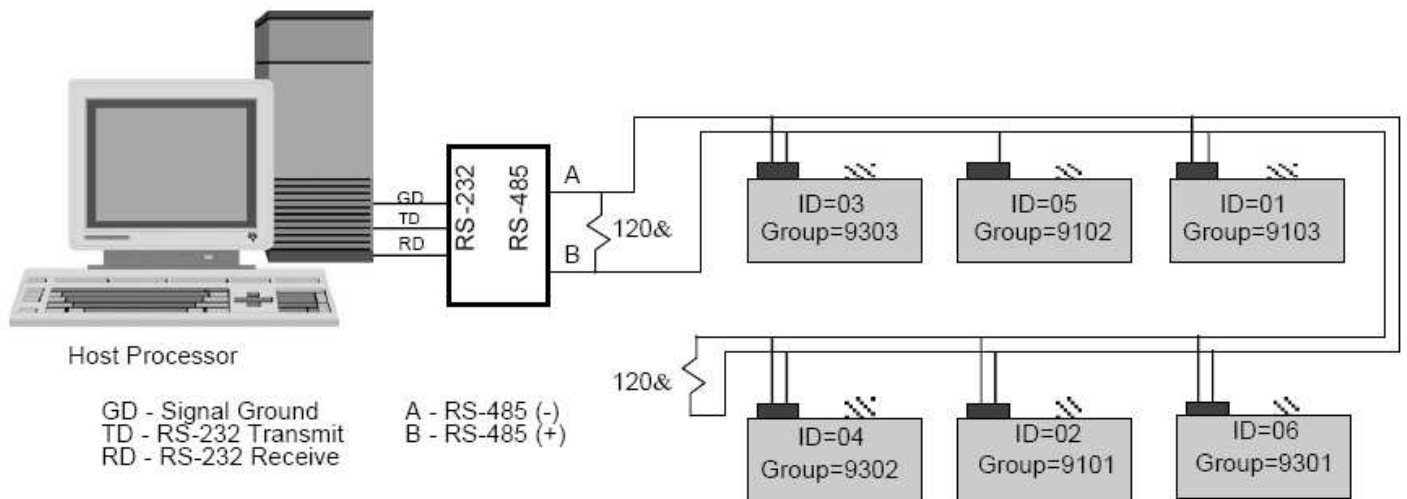


Figure 4.13—HPB RS-485 Multidrop Network

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

When an RS485 unit has a null address (unassigned), it will only respond to null addressed (\*00) commands. The command response will begin with the “?00” reply header. If two or more null addressed HPBs on a multidrop network receive a null addressed command, they will all respond together and cause a garbled message. Although all null addressed units will listen to group or globally addressed commands, and take the appropriate action, they will not send a response to a group or globally addressed command. 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 HPB 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 sub-address (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 4.13, there are two address groups, 91 and 93; each have 3 HPB units assigned.