

# MODEL PIM-3

DIGITAL INLINE AMPLIFIER



# SENSOTEC

2080 Arlingate Lane Columbus, Ohio 43228 • (614) 850-5000

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***MODEL PIM-3 Instruction Guide***  
**Sensotec Part Number: 008-0239-00**  
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# NOTES

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## **1.1 Introduction**

Inline Amplifiers are used in instrumentation systems to provide drive voltage to sensors and to amplify transducer outputs. Generally, the amplified output is applied to a data readout device such as a computer, in which the data are manipulated for display in some fashion. The primary difference between "ordinary" analog inline amplifiers and digital inline amplifiers is the fact that the output of the digital versions is a digital signal, usually coded in ASCII characters. Standards for serial data transmission such as RS-232 or RS-485 specify the signal transmission characteristics.

Because the digital inline amplifier is effectively a small computer, the usual functions of an inline amplifier (covered above) can be increased greatly. For example, averaging of many data points is possible. It is also possible to magnify a particular portion of the transducer's operating range, thereby making "turndown" possible.

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## 1.2 Organization

**Chapter 1**, "Introduction," offers general information about digital inline amplifiers versus analog amplifiers.

**Chapter 2**, "Specifications," lists the specifications and options available on the PIM-3.

**Chapter 3**, "Block Diagram," provides a block diagram of the PIM-3 to explain the versatility of the device and how it may be used.

**Chapter 4**, "Mounting and Wiring," shows all of the connectors on the case of the PIM-3 and what the functions are for each pin.

**Chapter 5**, "Getting Started with the PIM-3," describes how to quickly establish that a PIM-3 is connected and operating properly.

**Chapter 6**, "Command Format," describes the software protocol used by PIM-3 instruments, which is the same for both RS-232 and RS-485 equipped PIM-3's.

**Chapter 7**, "RS-232 Installation Notes," provides wiring examples and hardware information for those using RS-232-equipped PIM-3's.

**Chapter 8**, "RS-422/RS-485 Installation Notes," provides wiring examples and hardware information for those using RS-485-equipped PIM-3's.

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**Chapter 9**, "Applications Programs," includes the source code for simple communications programs for an IBM-PC compatible computer, which can be the start of your own program development. The source is given in both Turbo C and QuickBASIC languages. Also included are hints for communicating with a PIM-3 using Procomm Plus or the Microsoft Windows 3.1 Terminal.

**Chapter 10**, "System Commands," describes in detail the commands that affect the communications and limit setup of the PIM-3.

**Chapter 11**, "Amplifier Commands," describes in detail the commands that affect the operation of the transducer amplifier.

**Chapter 12**, "Understanding Limits," explains the setup and operation of the open-collector limits and gives several setup examples.

**Chapter 13**, "Calibration Examples," provides examples of calibrating the PIM-3 to the transducer using Shunt Calibration and Known-Load Calibration.

The **Appendix** includes warranty information and a quick reference chart which shows all of the available commands.



# Specifications

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SENSOTEC's PIM-3 Digital Inline Amplifier is a sophisticated microprocessor-based system with wide flexibility. The specifications are:

## **ABSOLUTE MAXIMUM SPECIFICATIONS**

Temperature, Storage: -20 to 200 deg F.  
Temperature, Operating: 0 to 150 deg F.

## **POWER REQUIREMENTS**

Power Supply Required: 12 to 28 VDC @  
150mA

## **TRANSDUCER INTERFACE SPECIFICATIONS**

Transducer Excitation: 5 or 10 VDC  
Inputs Accepted: 1 to 10 mV/V  
Transducer Drive, Max.: 30 mA.  
Input Gain Range: 20 to 200  
Remote Shunt Cal?: Yes  
Calibration Method: Shunt Resistor or  
Known Load  
Tare or Zero Balance: +/- 100%  
Noise and Ripple: -83 db  
Transducer Minimum Impedance: 350 ohms

---

### **AMPLIFIER CHARACTERISTICS**

|                           |                               |
|---------------------------|-------------------------------|
| Accuracy:                 | .01%                          |
| Frequency Response:       | 5 Hz.<br>(digitally filtered) |
| CMRR:                     | 120 db.                       |
| Short Circuit Protected?: | Yes                           |

### **DIGITAL SECTION CHARACTERISTICS**

|                                |                                     |
|--------------------------------|-------------------------------------|
| Output:                        | RS-232 or RS-485                    |
| Available Baud Rates:          | 300, 600, 1200, 2400,<br>4800, 9600 |
| No. of Characters Transmitted: | Up to 22 per message                |
| Scaling:                       | +/- 999,999 maximum                 |
| Eng. Units Transmitted?:       | Yes<br>(up to 10 characters)        |
| Polarity Indication?:          | Yes                                 |
| Decimal Point Selection?:      | Yes                                 |
| Overrange Indication:          | Overrange Message<br>Sent           |
| Resolution:                    | 1 part in +/-32,768                 |

### **SPECIAL FEATURES**

|                            |  |
|----------------------------|--|
| Limit Outputs:             | 4 Open-Collector<br>Outputs                    |
| Command Table:             | Over 35 Commands<br>including 14<br>universals |
| Analog Output:             | optional 0-5 VDC<br>or 4-20mA                  |
| Analog Output Update Rate: | 1Hz  |

# **Block Diagram**

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This chapter provides a block diagram of the PIM-3 in order to better explain the versatility of the device and how it may be used.

Figure 3-1 is the block diagram of the PIM-3. Each entity on this drawing is explained below.

1. AMP. The input amplifier increases the transducer's output signal in a precise ratio. Its gain is under the control of the microprocessor, operating through the GAIN CONTROL circuitry.
2. GAIN CONTROL. This circuit, under direction of the microprocessor, precisely controls the gain of the input amplifier.
3. A/D CONVERTER. The analog-to-digital converter circuit is a 16-bit delta-sigma converter. Its internal sample rate is much higher than the output data rate in order to increase accuracy. Sampling is controlled by the microprocessor. Output data are transferred to the DIGITAL FILTER.
4. DIGITAL FILTER. The digital filter circuitry is actually software in the operating program of the A/D Converter. This filter has the effect of filtering the frequency content of the converted data to a low-pass frequency of 5 Hertz. Noise is removed by this filtering. However, users with frequencies of interest higher than 5 Hz. will find that the PIM-3 is not a good choice for their application.

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5. RS-232 or RS-485 INTERFACE. Either RS-232 or RS-485 communications hardware will be included at the customer's option.

6. MICROPROCESSOR. The PIM-3 uses the Motorola MC68HC11 microprocessor. This device is an 8-bit microcontroller, featuring on-board EEPROM and RAM. Operating constants are stored in the EEPROM, so that they are not destroyed in the event of power failure. Thus, the setup made for a particular application remains safe until purposely changed. The microprocessor serves to control the entire processing of data and control of all functions in the PIM-3.

7. PROGRAM MEMORY. The program memory contains the entire software sequence to be performed by the microprocessor. Storage is 32,768 bytes.

8. LIMITS OUTPUTS. Open collector outputs are provided for limits, and up to four limits may be set. When the signal level exceeds a limit setting, the external circuit is completed through the open collector output. See Chapter 12, "Understanding Limits", for a discussion of limits terminology and application.

9. SHUNT CAL SWITCH. The shunt cal circuit will place a known value of resistance across one leg of a strain-gage transducer upon command, so that a precisely known output is obtained from the bridge. This should produce a known response in the PIM-3 circuit, and enable calibration of the transducer to the PIM-3.

---

This shunt cal switch can be software-activated upon user command, so that occasional calibrations may be performed.

10. EXCITATION SUPPLY. The excitation supply provides a well-regulated drive voltage to the transducer, under control of the microprocessor.

11. POWER SUPPLY. The power supply uses the input supply (12 to 28 VDC) to make voltages and currents for all circuits in the PIM-3.

12. ANALOG OUTPUT. An optional 0-5 VDC or 4-20mA analog output is available.

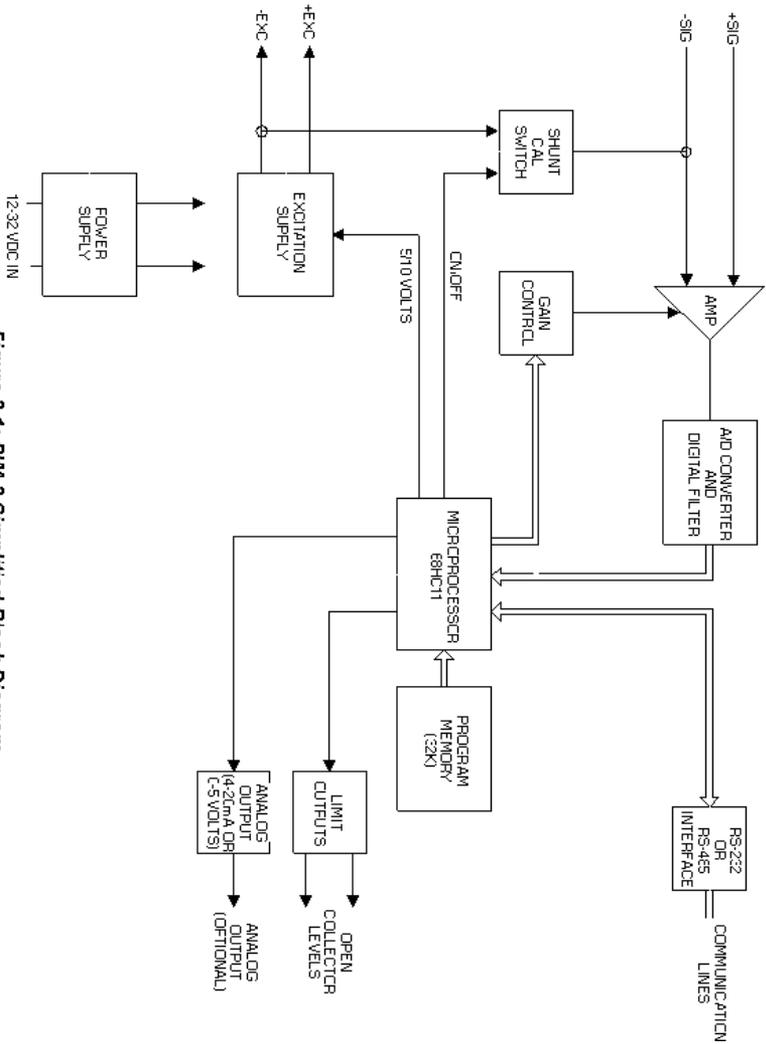


Figure 3-1: PIM-3 Simplified Block Diagram

# Mounting and Wiring

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## 4.1 Mounting

### Stand-alone metal case

The standard, stand-alone version of the PIM-3 is housed in a cast aluminum case. The cover and the body of this case are separated by an "O" ring gasket which may be seen when the case cover is removed. Two recessed mounting holes (outside the gasket area) may be seen in the case's base which do not extend through the lid. Holes may be drilled and tapped (#6-32) into the mounting surface and two screws used to mount the unit. Wood or sheet metal screws may also be used. Figure 4-1 is a template which may be used for hole location.

### Chassis-mounted plastic case

A version of the PIM-3 is also available in a plastic case which is designed to be plugged into a multi-channel backplane. Please note that Figure 4-1 only applies to the metal case, not the plastic case.

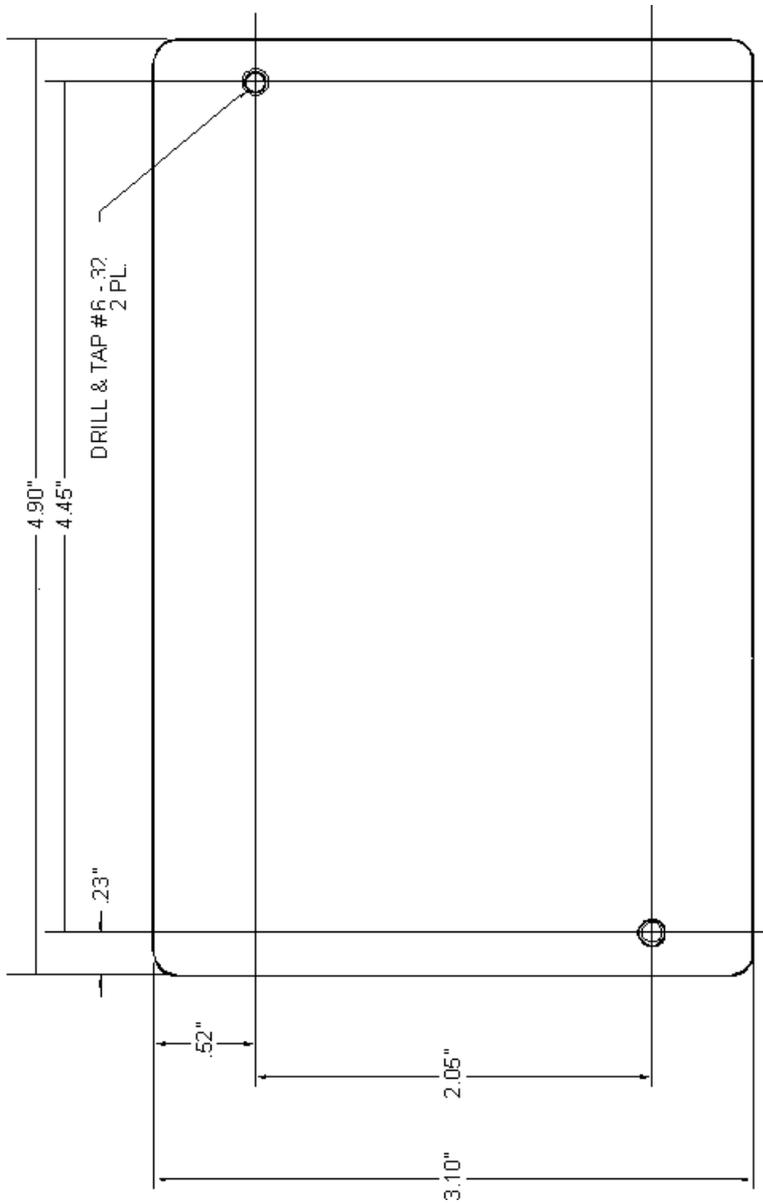
## 4.2 Wiring

### Stand-alone metal case

Four connectors bring signals to and from the PIM-3. Connector wiring is designated on drawing 001-0373-00. Terminology on this drawing is explained below to assist the user in connecting a PIM-3 into their system.

### Chassis-mount plastic case

A single, 20-pin, .1" OC socket connector is used to connect the PIM-3 to a multi-channel backplane. Connec-



**Figure 4-1: PIM-3 Mounting Template**

---

tor wiring is designated on drawing 001-0833-00.

### **A. Transducer Connections**

When two terminal designations are given (i.e. A + B), it is not necessary to connect to both. These are internally jumpered.

### **B. Communication Connections**

See Chapter 7, "RS-232 Installation Notes," for the definition of the Communication Connector pins for RS-232 equipped PIM-3s. See Chapter 8, "RS-485 Installation Notes," for the definition of the Communication Connector pins for RS-485-equipped PIM-3s.

### **C. Input Connections**

A. (+)SUPPLY is the positive (+) terminal of the power source (12 to 28 VDC).

B. SUPPLY RETURN is the negative (-) terminal of the power source.

C. (-)ANALOG OUTPUT is the negative (-) terminal of the optional analog output.

D. (+)ANALOG OUTPUT is the positive (+) terminal of the optional analog output.

E. DEFAULT pin. Suppose for a moment that the address of a PIM-3 has been forgotten, or the baud rate is not known. Without this information, communication with the unit is not possible. In the event that this happens, a default mode has been programmed into the PIM-3. By grounding the DEFAULT pin (connecting it to SUPPLY GROUND), then applying power to the unit, default conditions will be temporarily placed active in the PIM-3.

---

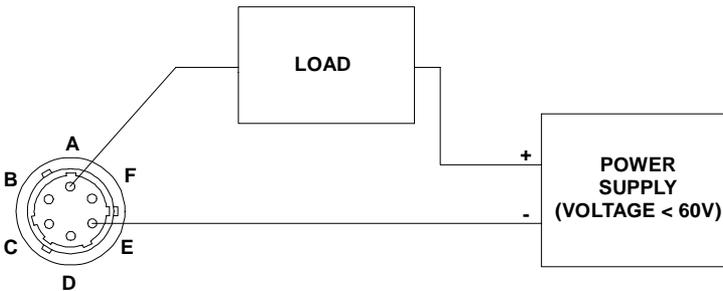
These default values are not written to non-volatile memory, but are active only when the DEFAULT pin is grounded. While the DEFAULT pin is grounded, you can still write data to the PIM-3's non-volatile memory. Powering up the unit again with the DEFAULT pin not grounded will allow the settings stored in non-volatile memory to then become active.

Default values are shown in Table 4-1.

### **D. Auxiliary Connections**

The Auxiliary Connections contain the four limit output control pins. When a limit is "on", the output terminal is effectively connected ("shorted") to the LIMIT RETURN terminal through a MOSFET transistor. The loads connected to the Limit output pins must be limited to 60 volts DC, at 0.5 amperes.

See Chapter 12, "Understanding Limits", for an explanation of how limits are used in the PIM-3. Figure 4-2 illustrates an example of wiring to the limits outputs.



**Figure 4-2: Limit Wiring**

---

**Table 4.2: DEFAULT VALUES**

| <u>Variable</u>     | <u>Default Value</u> |
|---------------------|----------------------|
| Character Length    | 8                    |
| Baud Rate           | 300                  |
| Auto Line Feed      | On                   |
| Echo                | Off                  |
| Address             | 00                   |
| Full-scale Units    | 20000                |
| mV/V                | 3                    |
| Limit 1 Setpoint    | 10000                |
| Limit 1 Hysteresis  | -100                 |
| Limit 2 Setpoint    | 500                  |
| Limit 2 Hysteresis  | 100                  |
| Limit 3 Hysteresis  | -100                 |
| Limit 4 Setpoint    | 500                  |
| Limit 4 Hysteresis  | 100                  |
| Tare                | Off                  |
| Excitation          | 10V                  |
| Shunt Cal Units     | 20000                |
| Continuous Transmit | Off                  |
| Engineering Units   | LBS                  |
| Auto Limit Report   | Off                  |

---

## 4.3 Shunt Cal Resistor

If a SENSOTEC transducer has been purchased and shipped with the PIM-3, the proper shunt calibration resistor has been installed. If not, SENSOTEC normally ships a 59,000 ohm 0.01% resistor installed in PIM-3. If the transducer used with PIM-3 requires another value of resistor, it may be necessary to remove the 59,000 ohm resistor and install another. To install another shunt cal resistor, proceed as follows:

1. Remove mating connectors from PIM-3, and remove the cover of the unit. The printed circuit boards will remain attached to the lid.
2. Locate the shunt calibration resistor. It is located on the analog circuit board (furthest from the lid), near the transducer connector location. The resistor is mounted in two pin jacks for easy removal. Using a pair of long-nose pliers, gently remove the resistor, and replace it with the proper value for your transducer.
3. Carefully replace the lid on PIM-3 and screw it in place.

001-0373-00

TRANSDUCER CONNECTOR

| PIN | DESIGNATION    |
|-----|----------------|
| A   | (+) EXCITATION |
| B   | (+) EXCITATION |
| C   | (-) EXCITATION |
| D   | (-) EXCITATION |
| E   | (-) SIGNAL     |
| F   | (+) SIGNAL     |

INPUT/OUTPUT CONNECTOR

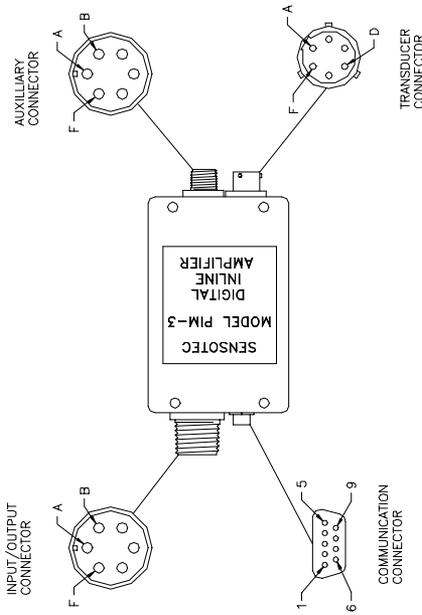
| PIN | DESIGNATION       |
|-----|-------------------|
| A   | (+) SUPPLY        |
| B   | SUPPLY RETURN     |
| C   | (-) ANALOG OUTPUT |
| D   | (+) ANALOG OUTPUT |
| E   | DEFAULT           |
| F   | N/C               |

AUXILIARY CONNECTOR

| PIN | DESIGNATION  |
|-----|--------------|
| A   | LIMIT 1      |
| B   | LIMIT 2      |
| C   | LIMIT 3      |
| D   | LIMIT 4      |
| E   | LIMIT RETURN |
| F   | N/C          |

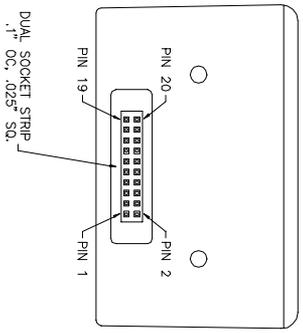
COMMUNICATION CONNECTOR

| PIN | DESIGNATION                              |
|-----|--|
| 1   | N/C                                      |
| 2   | RS-485 RXA (INPUT) / RS-232 TXD (INPUT)  |
| 3   | RS-485 RXB (INPUT) / RS-232 RXD (OUTPUT) |
| 4   | RS-485 TXA (OUTPUT) / N/C                |
| 5   | RS-485 TXB (OUTPUT) / N/C                |
| 6   | N/C                                      |
| 7   | N/C                                      |
| 8   | RS-232 GND                               |
| 9   | N/C                                      |



|  |                      |                 |          |
|--|----------------------|-----------------|----------|
| A  | REVISION PER ECR #14 | 11/25/97        | 17/6/97  |
| REV  | DESCRIPTION          | DATE            | BY       |
| 1  | NONE                 | 13 SEP 99       | 11/25/97 |
| 2  | REVISED FOR          | 11/25/97        | 17/6/97  |
| 3  | REVISED FOR          | 11/25/97        | 17/6/97  |
| <b>SENSOTEC INC.</b>                       |                      |                 |          |
| 3000 SHARPLETT AVE<br>COLUMBUS, OHIO 43228 |                      |                 |          |
| WIRING CODE                                |                      | MODEL PIM-3     |          |
| MODEL PIM-3                                |                      | DOCUMENT NUMBER |          |
| 63   |                      | 001-0373-00     |          |
| SHEET 1 OF 1                               |                      |                 |          |

| PIN | DESIGNATION                              |
|-----|--|
| 1   | (+) SIGNAL                               |
| 2   | (-) SIGNAL                               |
| 3   | (+) EXCITATION                           |
| 4   | (-) EXCITATION                           |
| 5   | (+) SUPPLY                               |
| 6   | (-) SUPPLY                               |
| 7   | RETURN RETURN, LIMIT RETURN, RS-232 GND  |
| 8   | DEFAULT                                  |
| 9   | N/C                                      |
| 10  | (+) ANALOG OUTPUT                        |
| 11  | LIMIT 1                                  |
| 12  | LIMIT 2                                  |
| 13  | LIMIT 3                                  |
| 14  | LIMIT 4                                  |
| 15  | N/C                                      |
| 16  | N/C                                      |
| 17  | RS-485 TXA (OUTPUT) / N/C                |
| 18  | RS-485 TXB (OUTPUT) / N/C                |
| 19  | RS-485 RXA (INPUT) / RS-232 RXD (OUTPUT) |
| 20  | RS-485 RXB (INPUT) / RS-232 TXD (INPUT)  |



|  |                 |          |
|--|-----------------|----------|
| INITIAL RELEASE TO PRODUCTION  | REVISION        | REVISION |
| DESCRIPTION  | DATE            | DATE     |
| SCALE  | SCALE           | SCALE    |
| NONE   | 11/9/97         | 11/9/97  |
| <b>SENSOTEC INC.</b><br>2000 ALBUQUERQUE BLVD<br>ALBUQUERQUE, NM 87105 |                 |          |
| WIRING CODE, MODEL, P/N, 3<br>RS-485 OR RS-232, PLASTIC CASE           |                 |          |
| DATE   | DOCUMENT NUMBER |          |
| 5/97   | 001-0833-00     |          |
| SHEET 1  | OF 1            |          |

## Getting Started with the PIM-3

---

It is assumed that the PIM-3 has been connected to its transducer, and the power is ready to be applied for the first time. All variables are shipped from the factory at their default settings unless a transducer has been purchased simultaneously. If this has happened, the PIM-3 will be shipped with the proper Full-Scale Units, Shunt Cal Units, and Engineering Units for the transducer stored into its memory.

It will not be necessary to ground the DEFAULT pin, since proper values (or defaults) have been loaded into the system when the instrument left the factory. Therefore, proceed as follows:

1. Set the communications terminal or computer software being used with the PIM-3 to 9600 baud, no parity bits, 8 data bits, and 1 stop bit.
2. Apply power to the PIM-3.
3. Select the desired address for the unit. This is a two-character code. For example, suppose the desired address is 19. Type the following to alter the module's address to 19:

#00W419 followed by the carriage return  
(ASCII code 13 decimal).

There will be no visible response to this command.

---

4. To verify that the unit is operating, it is suggested that the PIM-3 be placed in the "Continuous Transmit" mode, so that data are being constantly displayed. Type

#19WI1

followed by a carriage return.

Data should now be displayed continuously as PIM-3 transmits the signals it detects.

5. Since communication has now been established, the baud rate could be changed, and other operating parameters set up as desired. Remember to alter the baud rate of the terminal or the computer's serial output if you change the PIM-3's baud rate!

6. It is often desired that the PIM-3 be used to automatically detect the exceeding of a limit. Chapter 12, "Understanding Limits" describes limit setup and operation. Command `F6` will report limit status. Command `WJ` will enable any violation of a limit to cause a transmission of the violating variable. The `WJ` command will toggle this feature on or off.

# **Command Format**

---

One of two communications hardware interfaces are available, RS-232 or RS-485. Instruments equipped with the RS-485 two-wire interface can also be used in an RS-422 four-wire type setup; thus this interface is sometimes called RS-422/RS-485. Regardless of the type of hardware interface used, the PIM-3 uses the same software command set, the general format of which is described in this chapter.

## **6.1 Baud Rate, Bits and Parity**

PIM-3 Instruments always use 8 data bits, one start bit and one stop bit and no parity bits (often described as "N81") for serial communications. Baud rates of 300, 600, 1200, 2400, 4800, or 9600 baud are available. As shipped from the factory, PIM-3 Instruments are set to communicate at 9600 baud. The baud rate can be changed over the serial communications link using the `w1` system command. For details on changing the baud rate, see the "w1" command in Chapter 10, "System Commands."

The DEFAULT pin can be used to temporarily change a PIM-3's baud rate to 300 baud. See Chapter 4, "Mounting and Wiring" for more information.

---

## 6.2 Special Order Instruments

Special versions of the PIM-3 series instruments may use an expanded or reduced software command set. Additions or deletions to the commands described in this guide may be included with your instrument and supercede information found in this guide.

## 6.3 Two Types of Commands

Two types of commands are available to be sent to the PIM-3, *system* commands and *amplifier* commands. System commands are commands that apply to serial communications or limits.

Amplifier commands are those which affect the operation of the transducer amplifier circuit. For example, if the full scale range of a transducer amplifier is altered, an amplifier command is used.

## 6.4 Addressing

Every PIM-3 on the communications loop must have a unique two-character address. As shipped from the factory, every PIM-3 has an address of "00" (ASCII codes decimal 30, decimal 30). A PIM-3's address can be changed over the serial communications link using the "w4" command. For details on addressing, see Chapter 7, "RS-232 Installation Notes" or Chapter 8, "RS-422/RS-485 Installation Notes", depending on your application.

The DEFAULT pin can be used to temporarily change a PIM-3's address to "00." See Chapter 4, "Mounting and Wiring" for more information.

---

## 6.5 Command Format

An example command is shown below:

**#00WO1.2^**

where:

- #** *is called the "come alive" character, which alerts all PIM-3's that a command is being transmitted to them. This character is ASCII code decimal 35.*
  
- 00** *is the two-character address of the PIM-3 to be communicated with. Each character must be a number or an uppercase letter.*
  
- WO** *is the two-character command code to be executed. A list of the valid system command codes is given at the beginning of Chapter 10. A list of the valid amplifier command codes are given at the beginning of chapter 11.*
  
- 1.2** *is a value in the optional information field needed by commands that write data to the PIM-3.*
  
- ^** *represents the carriage return (ASCII code decimal 13) which indicates the end of the command.*

---

For example, the system command string "#00W12", followed by a carriage return, will cause the PIM-3 addressed as "00" to process the "W1" command with an information input of "2". The W1 system command changes the baud rate to the number represented by "2", which is 2400 baud.

An example of an amplifier command string is "#03F1". This command, followed by a carriage return, causes the PIM-3 addressed as "03" to process the "F1" command. The "F1" command activates the tare function, and thus this command string activates the tare function for the amplifier.

The first character of each two-character command code signifies if that command is a function command ("F"), a read operating parameter command ("R"), or a write operating parameter command ("W"). *Read* and *write* commands can be used to configure the operation of the instrument. *Function* commands are used to gather data from the instrument or to cause it to perform an operation.

All characters received before the pound sign are ignored. Therefore, one or more PIM-3 instruments can share a single communications link with other "foreign instruments" (within the physical limits of the RS-232 or RS-422/RS-485 interface, of course) as long as the host or the "foreign instruments" do not use the "#" character.

When the "#" character is sent to an PIM-3, the instrument enters its receive mode and will attempt to parse out the rest of the characters before the carriage return as a possible message.

---

If the PIM-3 then does not receive a carriage return within 10 seconds of receiving the "#" character, the PIM-3 leaves its receive mode. Likewise, if you believe that any stray or garbled characters have been sent to a PIM-3, sending the PIM-3 a carriage return will also cause the instrument to leave its receive mode.

## 6.6 Response Format

Some PIM-3 commands will give a response over the serial communications link, and others will not. There are three types of responses used by an PIM-3:

- \* ***"COMMAND ERROR", which is sent when an PIM-3 has been asked to perform an invalid command, or when invalid information is given with a write operating parameter ("W") command.***
- \* ***a floating point number as the result of a read operating parameter ("R") or function ("F") command.***
- \* ***other ASCII strings***

To signal the end of a response, the PIM-3 will send a carriage-return (ASCII code decimal 13) if the Auto-Linefeed function is off, or a linefeed/carriage-return (ASCII codes decimal 10, decimal 13) when the Auto-Linefeed is on. The Auto-Linefeed status can be changed over the serial communications link using the "W2" system command. For details on changing the Auto-Linefeed status, see the "W2" command in Chapter 10, "System Commands."

The DEFAULT pin can be used to temporarily change a PIM-3's Auto-Linefeed function to on. See Chapter 4, "Mounting and Wiring" for more information.



---

# **RS-232 INSTALLATION NOTES**

---

## **7.1 Introduction**

This chapter provides wiring examples and hardware information for RS-232 communication with the Model PIM-3. "DTE" (Data Terminal Equipment) will be used to refer to the personal computer, programmable controller, terminal, data acquisition system, etc. to which the PIM-3 is connected.

## **7.2 Function of Pins**

The table below lists the pins on the DB-9 connector that are used for RS-232 by the Model PIM-3.

| PIN | RS-232C<br>FUNCTION | DESCRIPTION                              |
|-----|---------------------|--|
| 2   | RXD                 | (output) Data from the PIM-3 to the DTE. |
| 3   | TXD                 | (input) Data to the PIM-3 from the DTE.  |
| 7   | GND                 | (ground) Reference pin.                  |

## **7.3 Operation Notes**

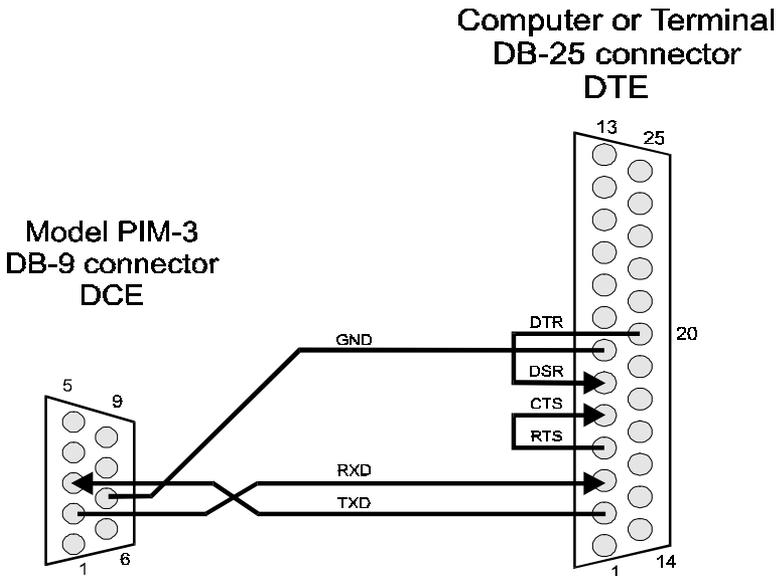
The DTE can send the PIM-3 a command string which starts with the '#' character and ends in a Carriage Return. If a '#' character is sent without a Carriage Return, the PIM-3 will wait 10 seconds for the Carriage Return before resetting its internal communications buffer.

If the address sent by the DTE matches the address of the PIM-3 and the command string is valid, then the PIM-3 will begin processing the command string. After the PIM-3 has finished processing the command string, the PIM-3 will send a response if necessary.

## 7.4 Typical Wiring Diagrams

Two example wiring diagrams are given in Figures 1 and 2 below. Figure 1 is used when the DTE has a 25-pin RS-232 serial port, and Figure 2 is used when the DTE has a 9-pin RS-232 serial port.

The RTS (Ready to Send) and CTS (Clear To Send) signals are not used by the PIM-3. Thus they are connected together in the communications cable in case the DTE (such as the IBM-PC) uses RTS/CTS-style hardware handshaking. Likewise, the DTR (Data Terminal Ready) and DSR (Data Set Ready) signals are not used by the PIM-3 and are connected together inside the cable.

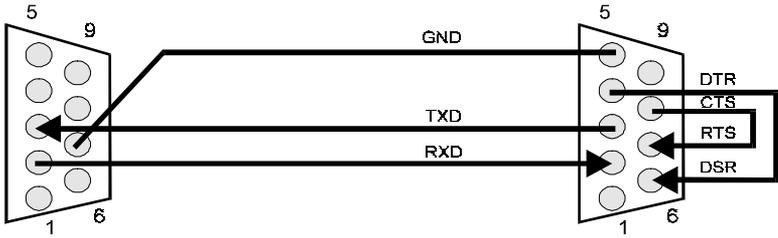


**Figure 7-1: Wiring to 25-pin DTE**

---

Model PIM-3  
DB-9 connector  
DCE

Computer or Terminal  
DB-9 connector  
IBM-AT/DTE



**Figure 7-2: Wiring to 9-pin DTE**



---

**RS-422/485 INSTALLATION NOTES**

---

**8.1 Introduction**

This chapter provides wiring examples and hardware information for RS-422/RS-485 communication with the Model PIM-3. "Bus master" will be used to refer to the personal computer, programmable controller, terminal, data acquisition system, etc. which is controlling PIM-3 instruments over the RS-422/RS-485 communications bus.

**8.2 Installation Overview**

Every PIM-3 on the communications bus must have a unique 2-character address. Before wiring multiple PIM-3's into an RS-422/RS-485 communications bus, it is recommended that you read this document thoroughly and then follow the sequence given below to avoid problems during installation.

- 1) Determine if the bus master has an RS-422 interface or a RS-485 interface. Wire up one, and only one, PIM-3 to the communications loop according to the wiring diagrams in the figures.
- 2) Use the DEFAULT pin to temporarily set this PIM-3's address and baud rate to the default values. This procedure is explained in the Chapter 4, "Mounting and Wiring".

- 
- 3) Use the values given in the “Default Values” table of Chapter 4 to establish communications with this PIM-3. For example, if the PIM-3's default address is "00", the command string "#00F0" followed by a carriage return will cause the PIM-3 to transmit a reading. If the PIM-3's response appears garbled, this may be caused by improper wiring, having two or more PIM-3's on the bus with identical addresses, or having the bus master's baud rate not match that of the PIM-3.
  - 4) Change this PIM-3's address to another unique value, such as "01", using the "W4" (Write Instrument Address) command as explained in the Chapter 6, “System Commands”. Verify communications with the PIM-3 to insure that it is operating with the new address.
  - 5) Change this PIM-3's baud rate to your desired value, such as 9600 baud, using the "W1" (Write Baud Rate) command as explained in the Chapter 6, “System Commands”. Verify communications with the PIM-3 to insure that it is operating with the new baud rate.
  - 6) Wire the next PIM-3 to the communications loop and repeat steps 2-6 until the last unit is on-line.

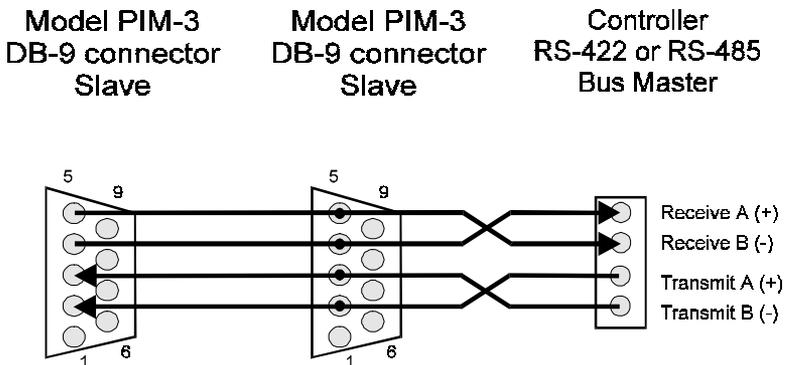
## 8.3 Function of Pins

The table below lists the pins on the DB-9 connector that are used for RS-422/RS-485 by the PIM-3.

| PIN | RS-422 FUNCTION | DESCRIPTION                                  |
|-----|-----------------|--|
| 4   | Transmit A      | (output+) Data from the PIM-3 to bus master. |
| 5   | Transmit B      | (output-) Data from the PIM-3 to bus master. |
| 2   | Receive A       | (input+) Data to the PIM-3 from bus master.  |
| 3   | Receive B       | (input-) Data to the PIM-3 from bus master.  |

## 8.4 RS-422 Wiring

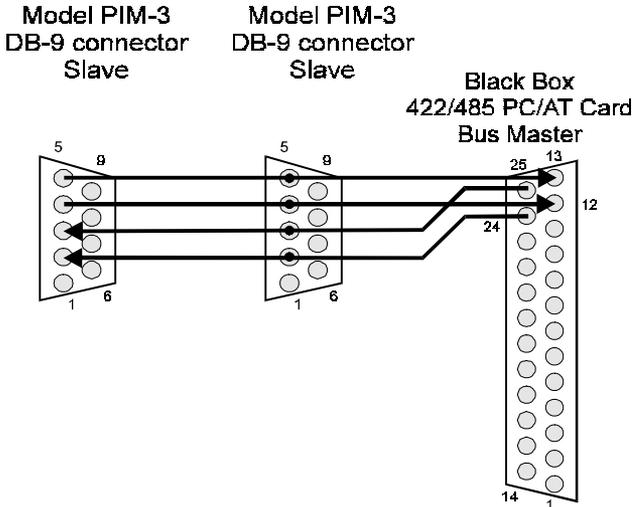
RS-422 uses two pairs of wires to communicate between one bus master and up to 10 slave devices. It is a full-duplex system, i.e. the bus master can transmit and receive data from the slaves at the same time. Use the wiring diagram in Figure 8-1 when connecting PIM-3 instruments to a RS-422 bus.



**Figure 8-1: RS-422 or 4-wire RS-485 Wiring**

## 8.5 Black Box PC/AT Card Wiring

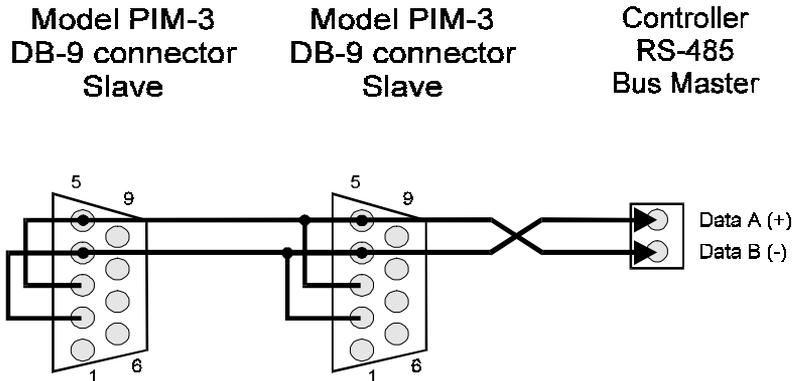
The instructions for Black Box products such as their "PC 422/485 Serial Interface Card" (part number IC030) includes a misleading connector pinout. The standard designators "A" and "B" for "positive" and "negative" have been reversed. Use the wiring diagram given in Figure 8-2 when connecting PIM-3 Instruments to this card. Many other distributors of industrial PC equipment provide PC/AT RS-422/RS-485 interface cards, and this does not constitute an endorsement by SENSOTEC of Black Box products.



**Figure 8-2: Black Box PC/AT Card Wiring**

## 8.6 RS-485 Wiring

An RS-485 balanced differential communications bus uses one or two pairs of wires to allow up to 32 devices to send and receive data. A two-wire RS-485 system is a half-duplex system, which means that no device can transmit and receive data at the same time, and that only one device can "drive" or "talk" on the bus at a time. A PIM-3 Instrument is configured as a two-wire RS-485 device when "Transmit A" (pin 4) is connected to "Receive A" (pin 2), and "Transmit B" (pin 5) and "Receive B" (pin 3) are connected together. Use the wiring diagram of Figure 8-1 for a four-wire RS-485 communications bus and use Figure 8-3 when connecting PIM-3 Instruments to a two-wire RS-485 communications bus.



**Figure 8-3: 2-wire RS-485 Wiring**

---

## 8.7 Operation Notes

The DTE can send the PIM-3 a command string which starts with the '#' character and ends in a Carriage Return. If a '#' character is sent without a Carriage Return, the PIM-3 will wait 10 seconds for the Carriage Return before resetting its internal communications buffer.

If the address sent by the DTE matches the address of the PIM-3 and the command string is valid, then the PIM-3 starts processing the command string. After the PIM-3 has finished processing the command string, the PIM-3 will send a response if necessary.

# **Application Programs**

---

## **9.1 Introduction**

Two program listings are included which implement a simple terminal program for communicating with Model PIM-3 instruments using an PC/AT computer. Both programs are written in BASIC. These programs are intended to be starting places for your own custom programs.

When the first program is run, it will simply send the characters that you type on the keyboard out of the serial port and display any characters that are received on the screen. Another BASIC program is provided which demonstrates how data can be read from a PIM-3 as often as possible by using the PIM-3's Continuous Transmit function.

Also included are hints for communicating with a PIM-3 using Procomm Plus or the Microsoft Windows 3.1 Terminal.

## **9.2 Sample QBasic Programs**

Below are sample terminal programs for Microsoft QBasic or QuickBasic. Microsoft includes a copy of QBasic with every version of MS-DOS after 5.0. Be sure to change the "OPEN" statement to match the COM port and the baud rate that you are using to communicate with the PIM-3. The QBasic communications routines will only work with COM1 or COM2.

---

The QBasic programs below cannot be used on an RS-485 two-wire bus. This is because QBasic does not assert and de-assert the RTS line between characters, and on most RS-422/RS-485 interface cards and converters the RTS line is used to control the output driver. The QBasic program can be used on a four-wire bus since having the PC continuously driving its Transmit lines will not prevent the PC from receiving characters on its Receive line.

Listing 1, the simple terminal program, reads characters from the computer's communications buffer one at a time.

```
REM          PIM3TERM.BAS
REM          Sample Microsoft QBasic or QuickBasic program to
REM          communicate to Sensotec Model PIM-3.
PRINT
PRINT      "PIM3TERM-Sample QBasic program for Sensotec PIM-3."
PRINT
REM          The "CS0" turns off the checking of CTS handshaking.
REM          The "DS0" turns off the checking of DSR handshaking.
OPEN       "COM1:9600,N,8,1,CS0,DS0,TB2048,RB2048" FOR RANDOM AS #1
PRINT     "Press <ESC> to exit..."
DO WHILE done=0
    IF LOC(1) > 0 THEN in$=INPUT$(1, #1): PRINT in$;
    out$=INKEY$: IF LEN(out$) <> 0 THEN PRINT #1,out$;
    IF out$=CHR$(27) THEN done=1
LOOP
CLOSE #1
PRINT "PIM3TERM: done."
END
```

### **Listing 1: Sample QBasic Terminal Program**

Listing 2 shows how data can be read as often as possible when the PIM-3 has its Continuous Transmit feature enabled. Because the BASIC "LINE INPUT #" statement will not work when it receives a Line-Feed/Carriage Return combination, the PIM-3's Automatic Line-Feed function must be disabled before using "LINE INPUT #".

---

```

REM          PIMCTRAN.BAS
REM          Sample Microsoft QBasic or QuickBASIC to demonstrate
REM          the use of the continuous transmit function to read
REM          data as quickly as possible from the Sensotec Model
REM          PIM-3.

PRINT "PIMCTRAN-Sample Microsoft QBasic program for Model PIM-3."

REM The "CS0" turns off the check for CTS handshaking
REM The "DS0" turns off the check for DSR handshaking
OPEN "COM2:9600,N,8,1,CS0,DS0,TB2048,RB2048" FOR RANDOM AS #1
PRINT "Press <ESC> to exit..."
PRINT #1, "#00W20" 'makes certain AUTO LINE_FEED function is off
PRINT #1, "#00W11" 'enable continuous transmit
DO WHILE done = 0
    LINE INPUT #1, in$ 'read response
    PRINT TIMES$, in$
    out$ = INKEY$
    IF out$ = CHR$(27) THEN done = 1
LOOP

CLOSE #1
PRINT "PIMCTRAN: done."
END

```

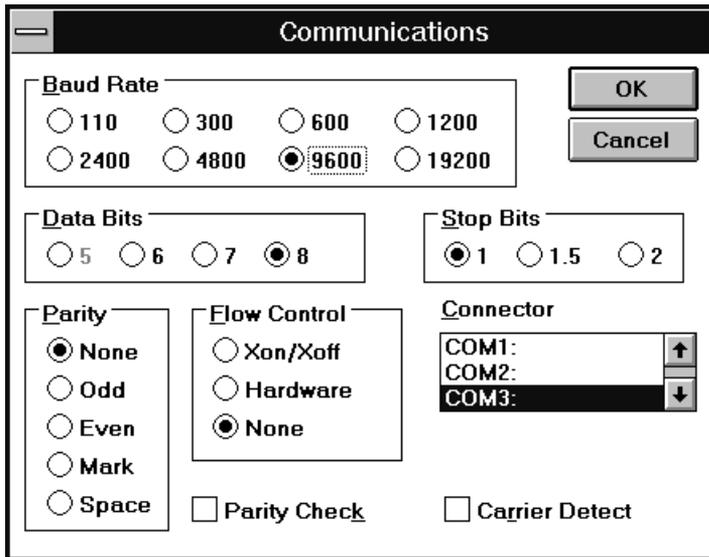
## **Listing 2: Sample QBasic Program for PIM-3 Continuous Transmit**

### **9.3 Hints for Procomm Plus for DOS**

Since PIM-3 series instruments do not use either "RTS/CTS" or "XON/XOFF" handshaking, you must change the standard Procomm Plus for DOS setup. To do this,; enter the "Procomm Plus Setup Utility" by pressing <ALT-S>, then select "Terminal Options." Change both the "Soft flow ctrl (XON/XOFF)" and the "Hard flow control (RTS/CTS)" options to OFF.

### **9.4 Hints for Windows 3.1 Terminal**

Since PIM-3 series instruments do not use either hardware or "XON/XOFF" flow control, you must change the communications settings of the Windows Terminal. To do this, select "Settings > Communications" and then change the screen to match the one shown below. Of course, the "Connector" and "Baud Rate" will change according your application.



*Figure 9-1: Windows 3.1 Terminal Communications Settings*

# System Commands

Below is a list of system commands for PIM-3 instruments. These commands only deal with the communication and limit setup parameters of the PIM-3.

| Function                              | Description                              | Universal command?             |     |
|---------------------------------------|--|--------------------------------|-----|
| F6                                    | Transmit Limit Status                    |                                |     |
| <b>Write      Read      Parameter</b> |  |                                |     |
| <b>Command</b>                        | <b>Command</b>                           |                                |     |
| W1                                    | Serial communications baud rate          | Yes                            |     |
| W2                                    | Serial communications Automatic linefeed | Yes                            |     |
| W3                                    | Serial communications Echo               |                                |     |
| W4                                    | Serial communications address            |                                |     |
| WA                                    | RA                                       | Limit 1 setpoint value         | Yes |
| WB                                    | RB                                       | Limit 1 hysteresis value       | Yes |
| WC                                    | RC                                       | Limit 2 setpoint value         | Yes |
| WD                                    | RD                                       | Limit 2 hysteresis value       | Yes |
| WE                                    | RE                                       | Limit 3 setpoint value         | Yes |
| WF                                    | RF                                       | Limit 3 hysteresis value       | Yes |
| WG                                    | RG                                       | Limit 4 setpoint value         | Yes |
| WH                                    | RH                                       | Limit 4 hysteresis value       | Yes |
| WI                                    |  | Continuous Transmit Setting    |     |
| WJ                                    |  | Automatic Limit Report Setting |     |
|                                       | RR                                       | Read Software Revision         |     |

Each command is described in this chapter.

---

## 10.1 F6 Transmit Limit Status

### **SYNOPSIS**

*F6 - Transmit Limit Status*

### **DESCRIPTION**

The F6 command transmits a message which indicates the status of the four open-collector limits. A limit status message looks something like this:

```
#AA L1 ON L2 ON L3 OFF L4 OFF
```

Where "AA" is the address of the PIM-3.

### **EXAMPLE**

```
#00F6
```

The above command, when followed by a carriage return, will cause the instrument addressed as "00" to transmit its limit status.

### **WHEN TO USE IT**

Use this command whenever you wish to know the status of the limits.

---

## 10.2 W1 Write Baud Rate

### SYNOPSIS

*w1{baud rate information from table below}*

### DESCRIPTION

The *w1* command changes the system baud rate used for serial communications according to the numeric value in the *information field*. After using this command, you would normally change the host's baud rate to match that of the instrument so that communications will be maintained. A list of the available baud rates and the corresponding value to be placed in the *information field* is given below.

| <b>information</b> | <b>baud rate</b> |
|--------------------|------------------|
| 0                  | 9600             |
| 1                  | 4800             |
| 2                  | 2400             |
| 3                  | 1200             |
| 4                  | 600              |
| 5                  | 300              |

The PIM-3 will not send a response after this command has been processed. If incorrect information is given, the PIM-3 will respond with "COMMAND ERROR."

To temporarily reset the baud rate to 300 baud, use the DEFAULT pin as described in Chapter 4, "Mounting and Wiring."

### EXAMPLE

```
#00w10
```

The above command, when followed by a carriage return, will cause the instrument addressed as "00" to use a baud rate of 9600 for all subsequent serial communications.

This command is a universal command. Sending this command for the special address of "FF" will cause all PIM-3's on the communications link to process the command.

### WHEN TO USE IT

As shipped from the factory, PIM-3 instruments are set to communicate at 9600 baud. If the communications cable is very long (>100 feet), or if the host will not support this baud rate, the baud rate used by the PIM-3 must be changed.

---

## 10.3 W2 Write Automatic Linefeed Setting

### **SYNOPSIS**

*w20 - Turns automatic linefeed off*

*w21 - Turns automatic linefeed on*

### **DESCRIPTION**

The `w2` command toggles the automatic linefeed on or off. If the first character in the *information field* is a `1`, the automatic linefeed function is turned on. An ASCII linefeed character (decimal 10) will then be transmitted just before the carriage return that signifies the end of the instrument's response.

If the first character in the *information field* is a `0`, the automatic linefeed function is turned off and messages from the instrument end with a carriage return. This is the default setting when the instrument is shipped from the factory.

The PIM-3 will not send a response after this command has been processed.

To temporarily set the automatic linefeed setting to "on" use the DEFAULT pin as described in Chapter 4, "Mounting and Wiring."

### **EXAMPLE**

```
#00W21
```

The above command, when followed by a carriage return, will turn on the automatic linefeed for the instrument addressed as "00."

### **WHEN TO USE IT**

If the PIM-3 is connected to a dumb terminal or to a printer, inserting a linefeed before the carriage return will make each message sent by the instrument appear on a separate line and thus be easier to read.

---

## 10.4 W3 Write Echo Setting

### **SYNOPSIS**

*w20 - Turns echo off*

*w21 - Turns echo on*

### **DESCRIPTION**

The *w2* command toggles the echo function on or off. If the first character in the *information field* is a 1, the echo function is turned on. Every character sent to the PIM-3 will be retransmitted out.

If the first character in the *information field* is a 0, the echo function is turned off. This is the default setting when the instrument is shipped from the factory.

The PIM-3 will not send a response after this command has been processed. If incorrect information is given, the PIM-3 will respond with "COMMAND ERROR."

To temporarily set the echo setting to "off" use the DEFAULT pin as described in Chapter 4, "Mounting and Wiring."

### **EXAMPLE**

```
#00W31
```

The above command, when followed by a carriage return, will turn on the echo for the instrument addressed as "00".

### **WHEN TO USE IT**

If the PIM-3 is connected to a dumb terminal or to a printer, the echo function will ease manual typing of commands. The echo feature is also useful when it is required to connect multiple PIM-3 units to a single RS-232 port. See Chapter 7, "RS-232 Installation Notes" for more information.

---

## 10.5 W4 Write Instrument Address

### **SYNOPSIS**

*w4{new two-character address}*

### **DESCRIPTION**

The *w4* command changes the two-character address which identifies the instrument during serial communications. The *information field* holds the new address. Lower case letters are converted to upper case letters. Using non-alphanumeric characters in the *information field* will cause the entire command to be ignored and the string "COMMAND ERROR" to be sent out on the serial port.

The default address for PIM-3 instrument's as they are shipped from the factory is "00" (ASCII codes decimal 30, decimal 30).

The PIM-3 will not send a response after this command has been processed.

To temporarily set the address to "00", use the DEFAULT pin as described in Chapter 4, "Mounting and Wiring."

### **EXAMPLE**

```
#00W4AA
```

The above command, when followed by a carriage return, will change the two-character address of the instrument addressed as "00" to "AA".

### **WHEN TO USE IT**

When using only a single instrument with a host, changing the address is not necessary. On an RS-485 communications bus with multiple PIM-3's, each PIM-3 instrument must have a unique address. As each PIM-3 is added one at a time to the communications bus, its address must be changed from the default of "00" to a unique address.

---

## 10.6 **WA , WC , WE , WG** Write Setpoints for Open-collector Limits **RA , RC , RE , RG** Read Setpoints for Open collector Limits

### **SYNOPSIS**

*WA{value}* - Change setpoint for limit 1 to {value}

*WC{value}* - Change setpoint for limit 2 to {value}

*WE{value}* - Change setpoint for limit 3 to {value}

*WG{value}* - Change setpoint for limit 4 to {value}

*RA* - Read setpoint for limit 1

*RC* - Read setpoint for limit 2

*RE* - Read setpoint for limit 3

*RG* - Read setpoint for limit 4

### **DESCRIPTION**

These commands changes the setpoints for each of the four open-collector limit outputs. The characters given in the *information field* are the value in the engineering units.

The hysteresis for each limit may be changed with the *WB , WD , WF , WH* command. For a complete explanation of limit parameters, please see Chapter 12, "Understanding Limits."

The PIM-3 will not send a response after this command has been processed. If incorrect information is given, the PIM-3 will respond with "COMMAND ERROR."

The *RA , RC , RE ,* and *RG* commands are used to read limit setpoints. This command is a universal command. Sending this command for the special address of "FF" will cause all PIM-3's on the communications link to process the command.

### **EXAMPLE**

```
#00WA325.2
```

The above command, when followed by a carriage return, will change the setpoint of open collector limit 1 to 325.2.

### **WHEN TO USE IT**

Limit parameters may be set at any time according to your particular application.

---

## 10.7 **WB , WD , WF , WH** Write Hysteresis value for Open-collector Limits **RB , RD , RF , RH** Read Hysteresis value for Open-collector Limits

### **SYNOPSIS**

*WB{value}* - Change Hysteresis value for limit 1 to {value}

*WD{value}* - Change Hysteresis value for limit 2 to {value}

*WF{value}* - Change Hysteresis value for limit 3 to {value}

*WH{value}* - Change Hysteresis value for limit 4 to {value}

*RB* - Read Hysteresis value for limit 1

*RD* - Read Hysteresis value for limit 2

*RF* - Read Hysteresis value for limit 3

*RH* - Read Hysteresis value for limit 4

### **DESCRIPTION**

These commands change the hysteresis values for each of the four open-collector limit outputs. The characters in the *information field* are the value in the engineering units.

The setpoint for each limit may be changed with the *WA*, *WC*, *WE*, and *WG* commands. For a complete explanation of limit parameters, please see Chapter 12, "Understanding Limits."

The PIM-3 will not send a response after this command has been processed. If incorrect information is given, the PIM-3 will respond with "COMMAND ERROR."

The *RB*, *RD*, *RF*, and *RH* commands are used to read the limit return point values. This command is a universal command. Sending this command for the special address of "FF" will cause all PIM-3's on the communications link to process the command.

### **EXAMPLE**

```
#00WH15.5
```

The above command, when followed by a carriage return, will change the hysteresis of open collector limit 4 to 15.5.

### **WHEN TO USE IT**

Limit parameters may be set at any time according to your particular application.

---

## 10.8 WJ Write Automatic Limit Report

### **SYNOPSIS**

*WJ0 - Turns off automatic limit reporting*

*WJ1 - Turns on automatic limit reporting*

### **DESCRIPTION**

The WJ command controls whether or not the PIM-3 will automatically transmit the status of the limits whenever any one of the limits has been switched from "off" to "on."

If the first character of the information field is a "1", then the PIM-3 will automatically transmit the limit status whenever any one of the limits has been switched from "off" to "on." A sample limit status message looks like this:

```
#AA L1 ON L2 OFF L3 OFF L4 OFF
```

Where "AA" is the address of the PIM-3.

### **EXAMPLE**

```
#00WJ1
```

The above command, when followed by a carriage return, will cause the instrument addressed as "00" to enable its automatic limit reporting function.

### **WHEN TO USE IT**

The automatic limit function can be used to signal that the transducer has tripped one of the limits.

This command should always be set to "off" when using multiple RS-485 PIM-3's on the same communications link.

---

## 10.9 WI Write Continous Transmit Setting

### **SYNOPSIS**

*wI0 - Turns off continous transmission*

*wI1 - Turns on continous transmission*

### **DESCRIPTION**

The **wI** command controls whether or not the PIM-3 will continuously transmit data.

If the first character in the *information field* is a "0", the PIM-3 will only transmit when requested. This is the default setting when the instrument is shipped from the factory.

If the first character in the *information field* is a "1", the PIM-3 will transmit the transducer reading as often as possible. This is equivalent to sending the system command "F0" repeatedly. The PIM-3 will still respond to other commands normally.

The PIM-3 will not send a response after this command has been processed. If incorrect information is given, the PIM-3 will respond with "COMMAND ERROR."

### **EXAMPLE**

```
#00wI1
```

The above command, when followed by a carriage return, will cause the instrument addressed as "00" to transmit data as quickly as possible, one reading after another.

### **WHEN TO USE IT**

If the PIM-3 is connected to a dumb terminal or to a printer, you can have the PIM-3 transmit data automatically.

This command is the easiest way to insure that you are obtaining data from the PIM-3 as quickly as possible.

The continous transmit setting should always be set to "off" when using multiple RS-485 PIM-3's on the same communications link.

---

## 10.10 RR Read Software Revision

### **SYNOPSIS**

*RR- Read software revision level*

### **DESCRIPTION**

The RR command reads the instrument's software part number and software revision level.

### **EXAMPLE**

The command "#00RR", when followed by a carriage return, produces a response similar to:

```
084-1003-00 2.4
```



# Amplifier Commands

Below is a list of standard amplifier commands for PIM-3 instruments. These commands affect the operation and calibration of the transducer amplifier.

| Function             |                     | Description                               | Universal Command? |
|----------------------|---------------------|---|--------------------|
| F0                   |                     | Transmit data                             |                    |
| F1                   |                     | Activate Tare                             | Yes                |
| F2                   |                     | Clear Tare                                | Yes                |
| F3                   |                     | Calibrate Analog-to-Digital Converter     | Yes                |
| F4                   |                     | Calibrate Amp using Shunt Cal method      | Yes                |
| F5                   |                     | Apply Shunt Resistor and Transmit Reading |                    |
| F7                   |                     | Transmit Average Value                    |                    |
| F8                   |                     | Calibrate Amp using Known Load method.    | Yes                |
| <b>Write Command</b> | <b>Read Command</b> | <b>Parameter</b>                          |                    |
| W5                   | R5                  | Full Scale Value                          | Yes                |
| W6                   | R6                  | Engineering Units                         | Yes                |
| W7                   | R7                  | Full Scale millivolt/Volt                 |                    |
| W8                   | R8                  | Shunt Calibration Value                   | Yes                |
| W9                   | R9                  | Excitation Setting                        | Yes                |
| WK                   | RK                  | Known Load Calibration Values             |                    |

Each command is described in this chapter.

---

## 11.1 F0 Transmit Data

### **SYNOPSIS**

*F0 - Transmits data*

### **DESCRIPTION**

The F0 function transmits one data point from the transducer amplifier. The amplifier channel is continuously reading the transducer and this function transmits the latest data point computed.

If the transducer signal is beyond the capability of the PIM-3 to measure, the PIM-3 will respond with "OVER" for overrange, and "UNDER" for underrange.

### **EXAMPLE**

#00F0

The above command, when followed by a carriage return, will cause the instrument addressed as "00" to transmit the data. For example,

5670.5 LBS

---

## 11.2 **F1** Activate Tare/Zero

### **SYNOPSIS**

***F1** - Activates Tare/Zero operation*

### **DESCRIPTION**

The Tare function forces the presently applied load on the transducer to be read as zero.

To deactivate the Tare/Zero function, you can send the **F2** command.

The PIM-3 will not send a response after this command has been processed.

This command is a universal command. Sending this command for the special address of "FF" will cause all PIM-3's on the communications link to process the command.

### **EXAMPLE**

```
#00F1
```

The above command, when followed by a carriage return, will cause the instrument addressed as "00" to activate the Tare/Zero function and force the data to read zero.

---

## 11.3 F2 Clear Tare/Zero

### **SYNOPSIS**

*F2 - Clears Tare/Zero operation*

### **DESCRIPTION**

Clearing the Tare/Zero function removes the offset which was applied to the data when the Tare operation was activated.

To activate the Tare function, you can send the F1 command.

The PIM-3 will not send a response after this command has been processed.

This command is a universal command. Sending this command for the special address of "FF" will cause all PIM-3's on the communications link to process the command.

### **EXAMPLE**

#00F2

The above command, when followed by a carriage return, will cause the instrument addressed as "00" to clear the Tare/Zero operation and remove the offset from the data.

---

## 11.4 F3 Calibrate Analog-to-Digital Converter

### **SYNOPSIS**

*F3 - Calibrates the analog-to-digital (A/D) converter*

### **DESCRIPTION**

The F3 function tells the analog-to-digital converter chip to perform its calibration. This removes the effects of temperature error on the analog-to-digital converter's readings.

After sending this command, you should wait 9 seconds before sending another command. This command does not send any response to indicate that calibration is complete.

The A/D converter chip is also calibrated when the PIM-3 instrument is powered up.

This command is a universal command. Sending this command for the special address of "FF" will cause all PIM-3's on the communications link to process the command.

### **EXAMPLE**

```
#00F3
```

The above command, when followed by a carriage return, will cause the instrument addressed as "00" to tell the analog-to-digital converter chip to perform a calibration.

### **WHEN TO USE IT**

The A/D converter chip is calibrated whenever the instrument is powered up. You would need to use this command if you know that the instrument experiences a large change in ambient temperature while the instrument is always powered up. Also, it is good practice to use this command before a recalibration.

---

## 11.5 **F4** Calibrate Amplifier using Shunt cal method

### **SYNOPSIS**

#### ***F4 - Calibrate amplifier using shunt cal method***

### **DESCRIPTION**

The **F4** command sets the “span” of the PIM-3’s transducer amplifier by applying the shunt calibration resistor across the -SIGNAL and -SENSE leads of the unloaded transducer. A reading is then taken from the transducer and used with the shunt calibration value entered with the **W8** command to calibrate the “span” of the amplifier to the transducer.

The proper data from the transducer’s calibration record (such as excitation voltage, full-scale mV/V value, shunt cal value, etc.) should be entered into the PIM-3 before calibrating. Also, the unit should be tared (“zeroed”) with the **F1** command before calibrating “span” with the **F4** command.

See Chapter 13, “Calibration Examples” for a detailed example of calibrating a PIM-3 to a transducer using the Shunt Calibration method.

### **EXAMPLE**

```
#00F4
```

The above command, when followed by a carriage return, will cause the instrument addressed as “00” to calibrate its amplifier to the unloaded transducer.

### **WHEN TO USE IT**

This command should be used to calibrate the PIM-3 amplifier to the transducer if a precision load is not available for use with the Known Load Calibration Method.

---

## 11.6 **F5** Apply Shunt Resistor and Transmit Reading

### **SYNOPSIS**

*F5 - Applies the Shunt Resistor and transmits the reading*

### **DESCRIPTION**

The F5 function applies the shunt resistor (usually 59,000 ohms for SENSOTEC transducers) on the amplifier channel to two transducer leads (usually -SIG and -SENSE for SENSOTEC transducers) and transmits the reading.

### **EXAMPLE**

#00F5

The above command, when followed by a carriage return, will cause the instrument addressed as "00" to apply the shunt resistor to the transducer and transmit the reading.

### **WHEN TO USE IT**

This can be used as quick check to verify that a strain gauge transducer is connected and operating properly.

---

## 11.7 **F7** Transmit and Reset Average

### **SYNOPSIS**

*F7 - Transmit and reset average of data*

### **DESCRIPTION**

The **F7** command transmits the average value of all of the data gathered since the last time the **F7** command was used. It also resets the average count and the average total.

After the first time the **F7** command is used after powerup, the PIM-3 will enable the processing of the average. Every 32.77ms thereafter, the PIM-3 takes data from the transducer, stores it into an average total, and increments an average counter. The next time the **F7** command is used, the average value is transmitted and both the average total and average value are reset. The PIM-3 then continues gathering data into the average total and counter.

The PIM-3 will gather average values for up to 35 minutes between instances of the **F7** command, after which the average total and counter are reset automatically.

### **EXAMPLE**

```
#00F7
```

The above command, when followed by a carriage return, will cause the instrument addressed as "00" to transmit the average values of all of the data gathered since the last instance of the **F7** command.

### **WHEN TO USE IT**

This command can be used to effectively "slow down" the data gathering speed of a PIM-3.

---

## 11.8 **F8** Calibrate amplifier using Known Load Method

### **SYNOPSIS**

*F8 - Calibrate amplifier using known load method*

### **DESCRIPTION**

The **F8** command sets the “span” of the PIM-3’s transducer amplifier by recording the reading taken when the known load entered with the **WK** command is applied to the transducer.

The proper data from the transducer’s calibration record (such as excitation voltage, full-scale mV/V value, known load value, etc.) should be entered into the PIM-3 prior to calibrating. Also, the unit should be tared (“zeroed”) with the **F1** command before calibrating “span” with the **F8** command.

See Chapter 13, “Calibration Examples” for a detailed example of calibrating a PIM-3 to a transducer using the Known Load Method.

### **EXAMPLE**

```
#00F8
```

The above command, when followed by a carriage return, will cause the instrument addressed as “00” to calibrate the “span” of its amplifier with the loaded transducer.

### **WHEN TO USE IT**

This command should be used to calibrate the PIM-3 amplifier to the transducer when a precision load is available to obtain maximum accuracy.

---

## 11.9 W5 Write Full Scale Value R5 Read Full Scale Value

### **SYNOPSIS**

*w5{value} - Change full scale of amplifier to {value} engineering units*

*R5- Read full scale value*

### **DESCRIPTION**

The w5 command changes the full scale value. The numeric value given in the *information field* is in engineering units. This command also sets the number of decimal places to be used in transmitting data.

The PIM-3 will not send a response after this command has been processed. If incorrect information is given, the PIM-3 will respond with "COMMAND ERROR."

This command is a universal command. Sending this command for the special address of "FF" will cause all PIM-3's on the communications link to process the command.

### **EXAMPLE**

The command below, when followed by a carriage return, will change the full scale value to 30.75 (with 2 decimal places).

```
#00W530.75
```

### **WHEN TO USE IT**

The full scale value is set if the instrument was purchased with a SENSOTEC transducer. This command is only needed if the instrument is being used with a transducer that was not purchased from SENSOTEC, or a SENSOTEC transducer was purchased separately.

---

## 11.10 **W6** Write Engineering Units

### **R6** Read Engineering Units

#### **SYNOPSIS**

*w6{text} - Change engineering units label to {text}*

*R6- Read engineering units label*

#### **DESCRIPTION**

The **w6** command changes the 10-character engineering units label. The text is transmitted out of the serial port when the **F0** command is used.

This command does not mathematically scale anything. If less than 10 characters are entered, the remaining characters are filled with spaces (ASCII code decimal 32).

The PIM-3 will not send a response after this command has been processed. If incorrect information is given, the PIM-3 will respond with "COMMAND ERROR."

This command is a universal command. Sending this command for the special address of "FF" will cause all PIM-3's on the communications link to process the command.

#### **EXAMPLE**

The command below, when followed by a carriage return, will change the text that is transmitted to "CATS".

```
#00W6CATS
```

#### **WHEN TO USE IT**

The engineering units text is set if the instrument was purchased with a SENSOTEC transducer. This command is only needed if the instrument is being used with a transducer that was not purchased from SENSOTEC, or a SENSOTEC transducer that was purchased separately from the PIM-3.

---

## 11.11 **W7** Write Full Scale mV/V Value

### **R7** Read Full Scale mV/V Value

#### **SYNOPSIS**

***w7{value} - Change full scale mV/V value to {value}***

***R7- Read full scale mV/V value***

#### **DESCRIPTION**

The **w7** command changes the full scale millivolt/volt value which changes the gain of the amplifier circuit. The numeric value given in the *information field* is in the units of millivolts/volt. This information is found on a transducer's calibration record as the "calibration factor."

The PIM-3 will not send a response after this command has been processed. If incorrect information is given, the PIM-3 will respond with "COMMAND ERROR."

#### **EXAMPLE**

The command below, when followed by a carriage return, will change the mV/V value to 3.75 mV/V.

```
#00W73.75
```

#### **WHEN TO USE IT**

The full scale millivolt/volt value is set if the instrument was purchased with a SENSOTEC transducer. This command is only needed if the instrument is being used with a transducer that was not purchased from SENSOTEC.

This command changes the gain of the amplifier circuit to always maintain at least 20,000 A/D counts between 0 mV/V input and the given full-scale mV/V input.

---

## 11.12 **W8** Write Shunt Calibration Value

### **R8** Read Shunt Calibration Value

#### **SYNOPSIS**

*w8{value} - Change shunt calibration value to {value} engineering units.*

*R8- Read Shunt Calibration Value.*

#### **DESCRIPTION**

The **W8** command changes the shunt calibration value. The numeric value given in the *information field* is in engineering units.

When the PIM-3 is calibrated to the transducer using the "Shunt Calibration Method", the internal shunt calibration resistor is connected across two transducer leads (-SIGNAL and -EXCITATION for SENSOTEC transducers) and the output of the transducer is scaled to this value.

The PIM-3 will not send a response after this command has been processed. If incorrect information is given, the PIM-3 will respond with "COMMAND ERROR."

This command is a universal command. Sending this command for the special address of "FF" will cause all PIM-3's on the communications link to process the command.

#### **EXAMPLE**

The command below, when followed by a carriage return, will change the shunt calibration value to 750.12.

```
#00W8750.12
```

#### **WHEN TO USE IT**

The shunt calibration value is set if the instrument was purchased with a SENSOTEC transducer. This command is only needed if the instrument is being used with a transducer that was not purchased from SENSOTEC.

This value is only used when calibrating with the "Shunt Calibration Method" via the **F4** command.

---

## 11.13 **W9** Write System Excitation

### **R9** Read System Excitation

#### **SYNOPSIS**

***w90 - Change excitation voltage to 5 VDC***

***w91 - Change excitation voltage to 10 VDC***

***r9 - Read excitation voltage***

#### **DESCRIPTION**

The **w9** command toggles the system excitation voltage between 5 and 10 volts DC. If the first character in the *information field* is a 0, the system excitation voltage is set to 5 volts DC. If the first character in the *information field* is a 1, the system excitation voltage is set to 10 volts DC.

The PIM-3 will not send a response after this command has been processed. The **r9** command will read the present excitation voltage.

This command is a universal command. Sending this command for the special address of "FF" will cause all PIM-3's on the communications link to process the command.

#### **EXAMPLE**

#00w91

The above command, when followed by a carriage return, will change the system excitation voltage to 10 volts DC.

#### **WHEN TO USE IT**

The system excitation voltage is set at the factory if the instrument was purchased with a SENSOTEC transducer. This command is only needed if the instrument is being used with a transducer that was not purchased from SENSOTEC.

---

## 11.14 **WK** Write Known Load Calibration Value **RK** Read Known Load Calibration Value

### **SYNOPSIS**

***WK{value} - Change Known load calibration value to {value}***

### **DESCRIPTION**

The **WK** command changes the known load calibration value. The numeric value given in the *information field* is in the engineering units for that amplifier channel.

When the PIM-3 is calibrated to the transducer using the "Known Load" this is the value that should be applied to the transducer during calibration.

The PIM-3 will acknowledge the write command by responding with "OK". The **RK** command is used to read the known load calibration value.

### **EXAMPLE**

The command below, when followed by a carriage return, will change the known load calibration value to 20000.

```
#00WK20000
```

### **WHEN TO USE IT**

The known load calibration value must be changed to match the precision load that you have available to calibrate your transducers. This value is only used when calibrating with the **F8** command.



# Understanding Limits

---

## 12.1 Introduction

The manner in which limits detectors operate can be confusing because terminology differs from manufacturer to manufacturer. This section will define what SENSO-TEC means when statements are made regarding limits.

## 12.2 Definitions

**LIMITS** -- Comparators which detect that a signal does or does not exceed a pre-established reference value.

**FAIL-SAFE** -- A configuration of limits such that normal operation never produces the same condition produced by power failure.

**LOW LIMIT** -- A limit configuration in which the limit is tripped when the signal is less than the limit reference setting.

**HIGH LIMIT** -- A limit configuration in which the limit is tripped when the signal is more than the limit reference setting.

**HYSTERESIS** -- A deadband in which a tripped limit will not deenergize. This makes the limit noise-resistant up to the amount of the hysteresis.

---

## 12.3 Configuring Limits

Two general rules exist that help in defining limit configurations:

1. Hysteresis always lies between the trip point and zero. Thus, a limit setting of 5000 with a hysteresis value of 100 would energize the limit at 5000, and deenergize it at 4900. Such a hysteresis value would be considered as negative, i.e. -100. See Figure 12-1
2. High limits always have negative hysteresis. Low limits always have positive hysteresis.

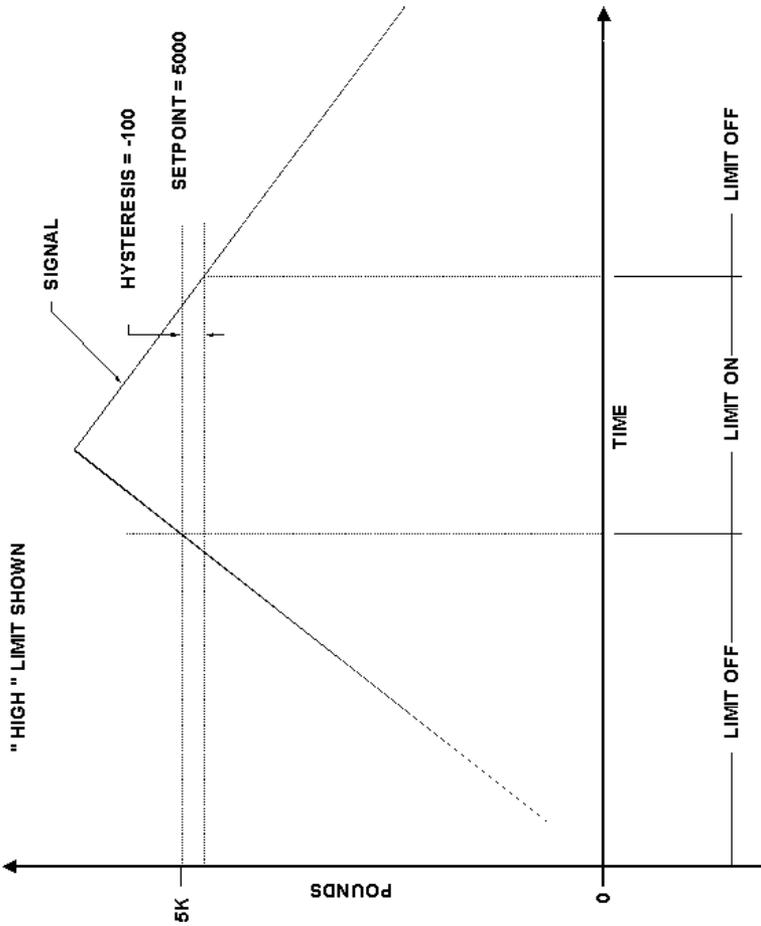


Figure 12-1: Illustration of "High" Limit

---

**Example 1.** When these two rules and the above definitions are applied, consider a pair of limits set so that they will indicate if a signal is too high or too low. As an example, let us say that a signal is ranged from 0 to 10000 pounds, and we wish a limit tripped if the signal gets outside the range of 2000 to 5000 pounds. A high limit will trip if the signal exceeds the setpoint, so the upper limit (5000 pounds) should be a high limit. A low limit will trip if the signal falls below the setpoint, so a low limit will work for the lower limit (2000 pounds). Suppose that it is decided that noise does not exceed 1% of the full-scale value, or  $0.01 \times 10000 = 100$  pounds. Since rule 2 must apply, the high limit hysteresis is a -100 pounds, and the low limit hysteresis is +100 pounds. Either limit may be designated as either value, since the sign of the hysteresis will tell the PIM-3 which type of limit we want. Arbitrarily, the high limit will be designated Limit 1, and the low limit as Limit 2. The setup will then be:

Limit 1 setpoint = 5000

Limit 1 hysteresis = -100

Limit 2 setpoint = 2000

Limit 2 Hysteresis = 100

Figure 12-2 shows these concepts graphically.

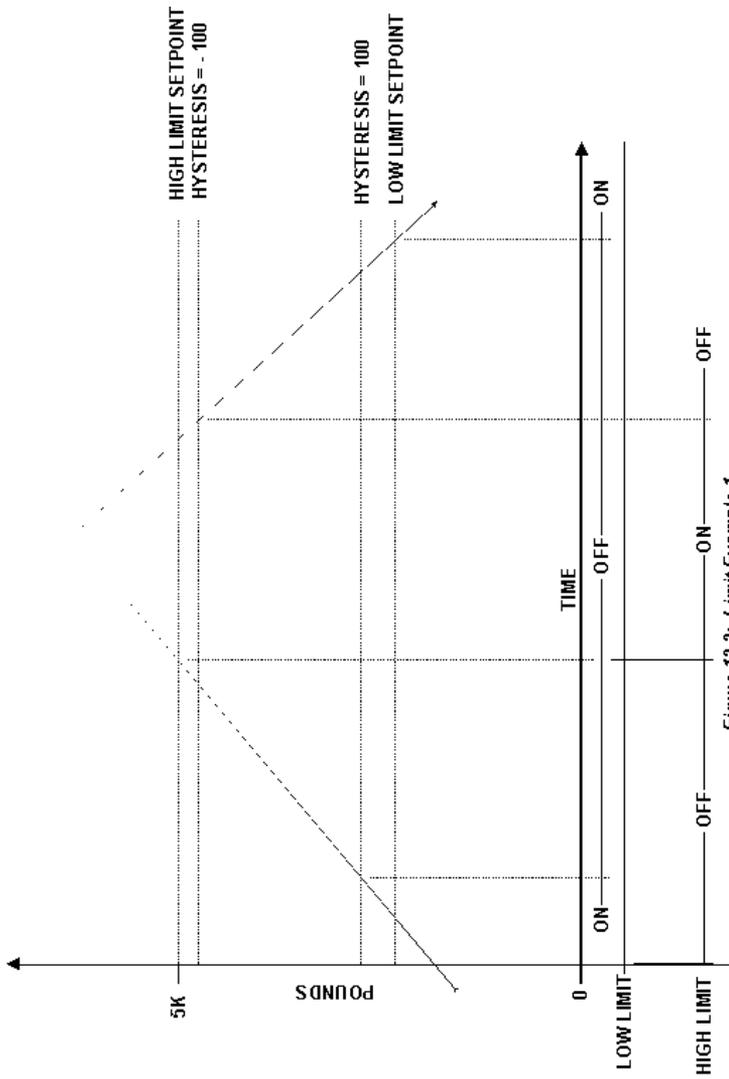


Figure 12-2: Limit Example 1

---

**Example 2.** Consider a case in which a tank is being pumped full of liquid. The tank is designed to hold 3000 gallons. When the tank level drops to the 500 gallon point, it is desired to fill it. If it should ever drop to 100 gallons, a dangerous condition could result, and the process must be shut down immediately. Further, when the tank has filled to the 2500 gallon point, the pump should quit. If the level should get to 2900 gallons, an alarm should warn the operator that the pump has not shut down properly and the tank could overflow. Because of slopping around of the tank liquid, a 2% noise limit ( $0.02 \times 3000 = 150$  gallons) is safe.

First, the 2900-gallon point is considered to be a danger point, and we want a limit to be fired if that level is exceeded. That means that the upper-upper limit is a high limit. We will call it Limit 1. Since it is a high limit, the hysteresis is negative.

$$\text{Limit 1 Setpoint} = 2900$$

$$\text{Limit 1 Hysteresis} = -150$$

Next, consider the shutdown that must occur if the level drops below 100 gallons. A low limit energizes below the setpoint, so this lower-lower limit must be a low limit. Therefore, hysteresis will be positive. In order to have the limits in order from most gallons to least gallons, call this Limit 4.

$$\text{Limit 4 Setpoint} = 100$$

$$\text{Limit 4 Hysteresis} = 150$$

---

Now, we want the pump to run when the level drops to 500 gallons, and to remain on until the level gets to 2500 gallons. If we can drive a relay to run the pump, we would like to energize the relay between 500 and 2500 gallons. Notice that this would work exactly backwards to a normal set of high-low limits, but we could drive the relay normally, and use the normally-closed contacts of the relay to drive the pump. Putting the two limits outputs in parallel as drivers to the relay would accomplish this. The 2500 gallon limit becomes a high limit (hysteresis is negative), and the 500 gallon limit becomes a low limit (hysteresis is positive).

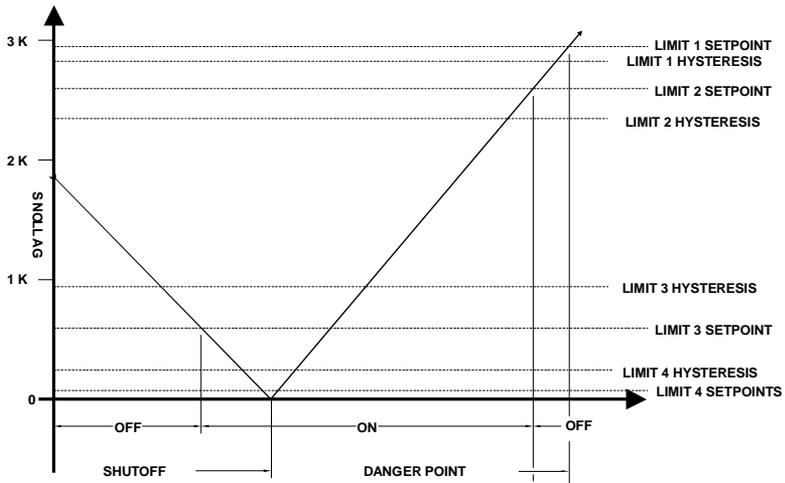
Limit 2 Setpoint = 2500

Limit 2 Hysteresis = -150

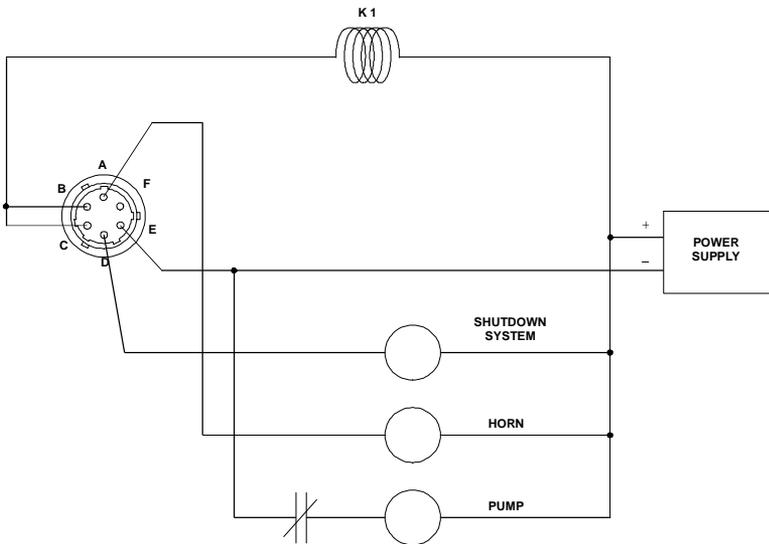
Limit 3 Setpoint = 500

Limit 3 Hysteresis = 150

Figure 12-3 illustrates the setup, and Figure 12-4 shows the required circuit.



**Figure 12-3: Limit Example 2 Setup**



**Figure 12-4: Limit Example 2 Circuit**

# Calibration Examples

---

## 13.1 Known-Load Calibration Example

### 13.1.1 Introduction

When calibrating a PIM-3 to a particular transducer, it is important that the command codes are sent in the proper order to obtain maximum system accuracy. This section will provide a detailed example of PIM-3 calibration by applying a known load to the transducer to which the PIM-3 is connected.

### 13.1.2 Requirements

The following equipment and information is required for proper calibration of a Model PIM-3 to a transducer:

- Model PIM-3 Digital Inline Amplifier.
- 12 - 28 volt DC power supply, to power the PIM-3.
- Communications terminal, or a personal computer running a terminal emulation program.
- Transducer to which the PIM-3 is to be calibrated.
- The full-scale millivolt per volt (mV/V) ("calibration factor") value, and the excitation voltage for the transducer must be known.
- A means of removing all load from the transducer, and of applying the desired full-scale load to the transducer.

### 13.1.3 Calibration Example

Assume that a Model PIM-3 has been properly wired to its power supply, transducer, and communications terminal. It is to be calibrated to a load cell such that the full scale output from the PIM-3 will read out at 150 pounds.

---

A 100 pound load will be used to calibrate the system. The full-scale mV/V value of the load cell, as obtained from its calibration record, is 2.997 mV/V at 10 volts excitation. The address of the PIM-3 has been previously set to "01" with the w4 command.

First, the proper setup values for the transducer must be entered into the PIM-3. Enter the following commands into the PIM-3, ending with a carriage return (ASCII code 13 decimal, shown here as <ret>):

```
#01W5150<ret>
#01W6pounds<ret>
#01W72.997<ret>
#01WK100<ret>
#01W91<ret>
```

Second, the analog to digital converter inside the PIM-3 is internally calibrated to minimize temperature errors. This may be done regardless of the load on the transducer.

```
#01F3<ret>
```

Next, the tare value will be entered into the PIM-3. All load must be removed from the transducer before this command is performed so that the PIM-3 will recognize this point as "zero".

```
#01F1<ret>
```

Finally, place a 100 pound load on the transducer, and calibrate the system.

```
#01F8<ret>
```

This completes the system calibration to a known load.

---

## 13.2 Shunt Resistor Calibration Example

### 13.2.1 Introduction

When calibrating a PIM-3 to a particular transducer, it is important that these command codes are sent in the proper order to obtain maximum system accuracy. This section will provide a detailed example of PIM-3 calibration by using the shunt calibration data for the transducer to which the PIM-3 is connected.

### 13.2.2 Requirements

The following equipment and information is required for proper shunt calibration of a Model PIM-3 to a transducer:

- Model PIM-3 Digital Inline Amplifier.
- 12 - 28 volt DC power supply, to power the PIM-3.
- Communications terminal, or a personal computer running a terminal emulation program.
- Transducer to which the PIM-3 is to be calibrated
- The full-scale millivolt per volt (mV/V) ("calibration factor") value, the excitation voltage, and the shunt calibration value for the transducer must be known.
- Precision shunt calibration resistor of the same value used to obtain the mV/V value for the transducer. For SENSOTEC transducers, 59.00K ohm resistors are used. Such a resistor is usually installed into PIM-3's at the factory.

---

### 13.2.3 Calibration Example

Assume that a Model PIM-3 has been properly wired to its power supply, transducer, and communications terminal. It is to be calibrated to a load cell such that the full scale output from the PIM-3 will read out at 150 pounds. The full-scale mV/V value ("calibration factor") of the load cell, as obtained from its calibration record, is 2.997 mV/V at 10 volts excitation. The shunt calibration value of the load cell using a 59K ohm resistor is 2.213 mV/V. These values were also found on the load cell's calibration record. The address of the PIM-3 has been previously set to "01" with the "w4" command.

Usually, PIM-3's are shipped with a 59.00K ohm precision shunt calibration resistor installed for calibrating transducers with the shunt calibration method. If the transducer used with the PIM-3 requires a different resistor value, it may be necessary to remove the 59.00K ohm resistor and install another. Please examine the Chapter 4, "Mounting and Wiring" for information on how to do this.

First, the shunt calibration value for this transducer must be converted from mV/V into pounds, based on the desired full-scale output of 150 pounds.

$$\begin{array}{r} 2.213 \text{ mv/V} \\ \text{-----} * 150 \text{ pounds} = 111.768 \text{ pounds} \\ 2.997 \text{ mV/V} \end{array}$$

Second, the proper setup values for the transducer must be entered into the PIM-3. Enter the following commands into the PIM-3, ending with a carriage return (ASCII code 13 decimal, shown here as <ret>):

---

```
#01W5150<ret>
#01W6pounds<ret>
#01W72.997<ret>
#01W8111.768<ret>
#01W91<ret>
```

Third, the analog to digital converter inside the PIM-3 is internally calibrated to minimize temperature errors. This may be done regardless of the load on the transducer.

```
#01F3<ret>
```

Next, the tare value will be entered into the PIM-3. All load must be removed from the transducer before this command is performed so that the PIM-3 will recognize this point as "zero".

```
#01F1<ret>
```

Then, calibrate the system using the shunt cal value. Make certain that there is still no load being applied to the transducer.

```
#01F4<ret>
```

This completes the system shunt calibration.

---

Finally, as an optional check, use the `F5` command to apply the shunt calibration resistor to the transducer and take a reading. When no load is applied to the transducer, this reading allows you to check the actual shunt calibration reading against the calculated shunt calibration reading entered with the `w8` command.

---

### 13.3 Using a Single Transducer with Multiple PIM-3's

It is possible to connect more than one PIM-3 instrument to a single transducer in order to allow each instrument to digitize the data over a different range. The transducer is driven by the excitation voltage of a single instrument, and the output of the transducer is connected in parallel to the signal inputs of all of the instruments.

For example, a single 500 pound load cell could have two PIM-3's connected to it. One instrument could be set up with its full scale as 500 pounds, and the second could be set up with its full scale at 100 pounds. When the load is less than 100 pounds the second instrument's output would offer greater resolution than the first instrument's output.

If this load cell's output is 5.000mV/V at full scale, the first instrument would be calibrated with the  $w7$  register set at 5.000 and the  $w5$  register set at 500. The second instrument would be calibrated with the  $w7$  register set at 1.000 and the  $w5$  register set at 100.

## A.1 Warranty and Repair Policy

### **Limited Warranty on Products**

Any of our products which, under normal operating conditions, proves defective in material or in workmanship within one year from the date of shipment by SENSOTEC, will be repaired or replaced free of charge provided that you obtain a return material authorization from SENSOTEC and send the defective product, transportation charges prepaid with notice of the defect, and establish that the product has been properly installed, maintained, and operated within the limits of rated and normal usage. Replacement or repaired product will be shipped F.O.B. our plant. The terms of this warranty do not extend to any product or part thereof which, under normal usage, has an inherently shorter useful life than one year. The replacement warranty detailed here is the buyer's exclusive remedy, and will satisfy all obligations of SENSOTEC whether based on contract, negligence, or otherwise. SENSOTEC is not responsible for any incidental or consequential loss or damage which might result from a failure of any SENSOTEC product. This express warranty is made in lieu of any and all other warranties, express or implied, including implied warranty of merchantability or fitness for particular purpose. Any unauthorized disassembly or attempt to repair voids this warranty.

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## **Obtaining Service Under Warranty**

Advance authorization is required prior to the return to SENSOTEC. Before returning the items, either write to the Customer Service Department, c/o SENSOTEC, Inc., 2080 Arlingate Lane, Columbus, Ohio 43228, or call (614) 850-5000 with: 1) a part number; 2) a serial number for the defective product; 3) a technical description (with information to assist us in understanding the application and the observed difficulty) of the defect; 4) a no-charge purchase order number (so products can be returned to you correctly); and 5) ship and bill addresses. At this time you will be issued a Return Material Authorization number (RMA#) on which to ship the unit(s) back to SENSOTEC. Shipment to SENSOTEC shall be at buyer's expense and repaired or replacement items will be shipped F.O.B. our plant in Columbus, Ohio. Non-verified problems or defects may be subject to an evaluation charge. Please return the original calibration data with the unit.

## **Obtaining Non-Warranty Service**

Advance authorization is required prior to the return to SENSOTEC. Before returning the item either write to the Customer Service Department, c/o SENSOTEC, Inc., 2080 Arlingate Lane, Columbus, Ohio 43228, or call (614) 850-5000 with: 1) a part number; 2) a serial number for the defective product; 3) a technical description (with information to assist us in understanding the application and the observed difficulty) of the defect; 4) a purchase order number to cover SENSOTEC's repair cost; and 5) ship and bill addresses. At this time you will be issued a Return Material Authorization number (RMA#) on which to ship the unit(s) back to SENSOTEC.

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After the product is evaluated by SENSOTEC, we will contact you to provide the estimated repair costs before proceeding. Shipment to SENSOTEC shall be at buyer's expense and repaired items will be shipped to you F.O.B. our plant in Columbus, Ohio. Please return the original calibration data with the unit.

**Repair Warranty**

All repairs of SENSOTEC products are warranted for a period of 90 days from date of shipment. This warranty applies only to those items which are found defective and repaired, and does not apply to products in which no defect was found and returned as is or merely recalibrated. Out-of-warranty products may not be capable of being returned to the exact original specifications or dimensions.

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## A.2 Command Listing

Below is a table of available commands in the PIM-3 which can be used as a quick reference.

### FUNCTION COMMAND LISTING

| CODE | FUNCTION   | UNIVERSAL COMMAND? |
|------|--|--------------------|
| F0   | Transmit data  |                    |
| F1   | Tare (Clear to 0)  | Yes                |
| F2   | Remove Tare  | Yes                |
| F3   | Calibrate A/D Converter (Used to minimize temperature error in the A/D converter. May be performed without regard to load on the transducer.)                                  | Yes                |
| F4   | Calibrate Amplifier using the Shunt Calibration Value entered with the W8 Command. (The transducer must not be loaded at this time.)   | Yes                |
| F5   | Check Shunt Calibration (Applies shunt calibration resistor to the transducer, allows time to stabilize, then transmits the reading.)  |                    |
| F6   | Request Limit Status   |                    |
| F7   | Request Average Value since last F7 Command (Average is updated each 32.77 milliseconds. Maximum time before auto reset of average is 35 seconds.)                             |                    |
| F8   | Calibrate Amplifier using the Known Load Calibration Value entered with the WK Command. (The load specified by the WK Command must be applied to the transducer at this time.) |                    |

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## READ COMMAND LISTING

| CODE | FUNCTION                                  |
|------|---|
| R5   | Reads PIM-3 Full-scale value              |
| R6   | Reads Engineering Units (lbs, psi, etc.)  |
| R7   | Reads Full-scale mV/V rating              |
| R8   | Reads Shunt Calibration Value             |
| R9   | Reads Excitation (5V = 0, 10V = 1)        |
| RA   | Read Limit 1 Setpoint                     |
| RB   | Read Limit 1 Hysteresis Setting           |
| RC   | Read Limit 2 Setpoint                     |
| RD   | Read Limit 2 Hysteresis Setting           |
| RE   | Read Limit 3 Setpoint                     |
| RF   | Read Limit 3 Hysteresis                   |
| RG   | Read Limit 4 Setpoint                     |
| RH   | Read Limit 4 Hysteresis                   |
| RJ   | Read Limit Automatic Limit Report Status  |
| RK   | Reads Known Load Calibration Value        |
| RR   | Reads Internal Revision Level of Software |

## WRITE COMMAND LISTING

| CODE | FUNCTION  | UNIVERSAL<br>COMMAND? |
|------|---|-----------------------|
| W0   | Reads Known Load Calibration Value  |                       |
| W1   | Set Baud Rate (9600 = 0, 4800 = 1, 2400 = 2, 1200 = 3, 600 = 4, 300 = 5)                      | Yes                   |
| W2   | Set Auto Line Feed (ON = 1, OFF = 0)  | Yes                   |
| W3   | Set Echo (ON = 1, OFF = 0) (Must be off for RS-485 with multiple units)                       |                       |
| W4   | Set this Unit's Address   |                       |
| W5   | Set Full-scale Magnitude (7 significant digits maximum, 3 decimals maximum XXXX.XXX,XXXXXXXX) | Yes                   |
| W6   | Set Engineering Units (10 character maximum)  | Yes                   |
| W7   | Set Full-scale mV/V (1 to 5 mV/V with 10 volts excitation; 5 to 10 mV/V)                      |                       |
| W8   | Set Shunt Calibration Value   | Yes                   |
| W9   | Set Excitation Voltage (0 = 5V, 1 = 10V)  | Yes                   |
| WA   | Set Limit 1 Setpoint (0 to +/- Full-scale, in engineering units, for all setpoints)           | Yes                   |
| WB   | Set Limit 1 Hysteresis (0 to +/- 100%, for all setpoints)                                     | Yes                   |
| WC   | Set Limit 2 Setpoint  | Yes                   |
| WD   | Set Limit 2 Hysteresis  | Yes                   |
| WE   | Set Limit 3 Setpoint  | Yes                   |
| WF   | Set Limit 3 Hysteresis  | Yes                   |
| WG   | Set Limit 4 Setpoint  | Yes                   |
| WH   | Set Limit 4 Hysteresis  | Yes                   |

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## WRITE COMMAND LISTING

| <b>CODE</b> | <b>FUNCTION</b>  | <b>UNIVERSAL COMMAND?</b> |
|-------------|--|---------------------------|
| WI          | Set continuous Transmit (ON = 1, OFF = 0) (Must be off for RS-485 with multiple units)           |                           |
| WJ          | Set Automatic Limit Report Output (ON = 1, OFF = 0) (Must be off for RS-485 with multiple units) |                           |
| WK          | Set Known Load Calibration Value   | Yes                       |

## SPECIAL COMMAND

| <b>CODE</b> | <b>FUNCTION</b>   |
|-------------|---|
| ZZ          | Initiates interactive command structure to set zero and span of analog output (either 4-20 mA or 0-5 volts). This command also has in-house testing features not normally required by the customer. |

