PM500 User's Manual

Part Number: 990-005700 REV F

Electro-Sensors, Inc.
6111 BLUE CIRCLE DRIVE
MINNETONKA, MN 55343–9108

www.electro-sensors.com

sales@electro-sensors.com
tech@electro-sensors.com

Local:	952.930.0100
Toll-Free:	800.328.6170
Fax:	952.930.0130

Table of Contents

List of Figures

List of Tables

Introduction to this Manual

What is in this manual?

This installation and operation manual provides detailed technical information about the PM500 Programmable Process Ratemeter. It should serve as your technical resource to install, set up, operate, and test the PM500.

Who should use this manual *(audience)*

Keep in mind that the function of the PM500 installed in a mechanical process is to monitor position, capacity, speed, etc; therefore, it must be installed by qualified personnel only. This manual is designed for persons who have the primary responsibility to install, set up, operate, and test the PM500.
The secondary audience would be those persons seeking technical information about the electrical concepts and operation of the PM500.

Knowledge level

Persons installing, setting up, and operating the PM500 should have good knowledge and understanding of electrical and mechanical concepts and principles pertaining to Programmable Process Ratemeters. Again, the PM500 should be installed by qualified personnel only.

Notices

Introduction to this Product

The PM500 is a stand-alone display device that accepts up to two 4–20 mA DC analog input signals.

- The display has four 7-segment LED digits with decimal points.
- The PM500 can be programmed to display any value of user units from ’00.00’ to ‘9999’ and from ‘-0.00 to -999’.
- The PM500 has either two SPDT relay outputs or four SPDT with programmable functions (UNUSED, UNDER and OVER).
- The PM500 has an option for 2 16 bit 4 to 20 mA output signals, which are isolated from the 4 to 20 mA input signals.
- The PM500 display has 5 status LED’s so you can determine which input you are viewing, as well as for indicating when the PM500 is in the programming, or diagnostics modes. It also signals the user when there is a sensor failure.
- The PM500 has 2 regulated +24 VDC outputs that can each supply 50 mA maximum. (This supply can be used to power sensors, etc.).

The User Interface

The user interface consists of a keypad, the four character display, five discrete LEDs, several user variables, and three menus—the user variable menu, the security menu, and the diagnostic menu. The three menus are each accessed by a menu key; the VAR key accesses the user variable menu, the DECIMAL POINT key accesses the security menu, and the DIAG key accesses the diagnostic menu. In each of these menus there is an intermediate level (level 2) enabling you to select a menu item and a final level (level 3) enabling you to change or edit the selected menu item.

The method for selecting which menu item to edit depends on what menu you are in. In the VAR menu use the up, down, left, and right arrow keys to edit the two digits of the user variable number. In the security menu and in the DIAG menu use the up and down arrow keys to scroll through menu item prompts.
Once a menu item has been chosen, press the ENTER key to move to the final level (level 3) to edit the variable value or perform the diagnostic action.

To edit a user variable value, use the left and right arrow keys to move the cursor (the flashing digit) to the digit whose value you want to change, then use the up and down arrow keys to change the value of the digit. Press the ENTER key to accept the value or press the 'abort' key to throw away the changes that you have made. (The 'abort' key depends on which menu you are in, i.e. the VAR key enters the user variable menu and the VAR key aborts the user variable menu.)

For example, to change a user variable value, press the VAR key to go to level 2—select user variable number. While in level 2, edit the display so that it shows the user variable number whose value that you want to change. Then, press the ENTER key to accept the user variable number and go to level 3—change user variable value. While in level 3, edit the display so that it shows the new user variable value. Then, press the ENTER key to accept that value and return to level 1—the user units display level. When the user accepts a value the PM500 will test it and will not allow an out-of-range or illegal value. If at any time you don't like the changes that you have made while you are in a particular level, press the abort key to discard the changes and go back to level 1—the user units display level.

The SECR menu works in a similar way to allow you to change the security variable values. The diagnostic menu will allow you to perform a diagnostic test, to perform calibration actions, or to observe the state of the system, thereby enabling you to set up your system or to troubleshoot your system installation.

The five front panel LEDs are used to indicate which menu you are in or to indicate status information about the PM500. There are five LEDs: Sensor Error, PROG, INPUT A, INPUT B, and KEY ERR. When a menu key is pressed the LED associated with that menu turns on to indicate which menu you are in.

Key	LED	Menu
Decimal Point key	PROG LED on & Disp reads " SEC"	Change Security Variable
VAR key	PROG LED & Disp reads "Prxx"	Change User Variable
DIAG key	PROG LED & disp reads "dIAG"	Perform Diagnostic Action

Table 1; Associations Between Keys, LEDs, and Menus

The Input "A" LED is associated with input channel A. The Input "B" LED is associated with input channel B. The Input LED that is illuminated shows the user which input channel is being displayed.l

The KEY ERR LED is used to indicate an invalid key press, an invalid user variable number, or an invalid user variable value. It shuts off after a timeout period of 500 ms.

The PROG LED is 'OFF' when the display is showing a real-time value selected by the display function variable.

The User Interface Tables

(DIAG Menu) How to Perform the Diagnostic Functions

1. Press the **DIAG** key
2. Use the arrow keys to select desired variable and press **ENTER**
   a. When finished hit **DIAG** key to exit menu
3. Press **DIAG** key one more time to exit the DIAG Menu

Note: See table on next page for Diagnostics description

(SECR Menu) How to Change the Security Settings

1. Select the Security menu by pressing the **Decimal Point Key.**
2. Use up and down arrows to select the desired variable
   a. Press Enter
   b. Change variable and accept by pressing **Enter Key** or aborting change by hitting **Decimal Point Key**
3. Press **Decimal Point Key** to exit Security Menu

(VAR Menu) How to Change a User Variable

1. Press the VAR key
2. Use the **Arrow** Keys to navigate to desired parameter
   a. Press **enter key** to select or abort by hitting **Var Key**
   b. Change variable using arrow keys and press **ENTER** key to accept or **Var Key** to abort
3. Press **Var Key** to exit Variable Menu.

Note: Access to the VAR menu is still permitted during an LRC error in the PM500's non-volatile memory

Diagnostics Neumonics

Diagnostic	Display Value	Function
dIAG Diagnostics	dIAG	You have Entered Diagnostic Mode
Anou Analog Output	Output percent "0XXX".	Verify your analog out by scrolling from 0 to 100% 0 = 4 mA 100 = 20mA
SIn Switch Input	Read current Switch state	Read current switch state
rELY Relay Test	"0000" (When relays are off, 1 value denotes on)	Relay states. "XXXX" Relay one–1's. Relay two–10's. Relay one–100's. Relay two–1000's.
HeyP Keypad Test	VAR key–"1111.". Up arrow key–"222.2". REV key–"33.33". Left arrow key–"4.444". ENTER key–"5555.". Right arrow key–"666.6". Decimal point key–"77.77". Down arrow key–"8.888".	Tests individual buttons on keypad
UEr Firmware Version	"XX.XX"	Displays Firmware Version
rESE Reset Unit	"dOnE"	Resets Unit to Factory Defaults
OFFS ADC Offset Calibration		ADC value in hexadecimal of the actively displayed ADC input.
SPAN ADC Span Calibration		ADC value in hexadecimal of the actively displayed ADC input.

Table 2; How to perform diagnostic functions

(SECR Menu) The Security Variables

The SECURITY menu is accessed by pressing the DECIMAL POINT key.

In the security menu the user has access to three variables. The input password variable (PIn), the password definition variable (PdEF), and the security definition variable (SdEF).

The security features defined by the security definition variable ‘SdEF’ are enabled anytime the input password ‘PIn’ is different from the password definition ‘PdEF’.
In other words, in order to access locked-out functions the user has to enter an input password that matches the password definition (PIn = PdEF).
In order to lock out unauthorized changes to user variables the user must enter a password definition that is unknown to unauthorized users (PIn ≠ PdEF). Any attempt to access the password definition by an unauthorized user will result in a display of “HIdn” (hidden).

The following table indicates how menu access is controlled by the digits of the security definition variable.

<table>
<tr><th>Display Digits</th><th>Digit Function</th><th>Function Codes</th></tr>
<tr><td>Digit 1</td><td>VAR Menu

When this menu is locked the user variables can be viewed but not changed.</td><td rowspan="4">0–Menu Unlocked
1–Menu Locked</td></tr>
<tr><td>Digit 2</td><td>DIAG Menu

When this menu is locked, access to the diagnostic functions are denied.</td></tr>
<tr><td>Digit 3</td><td>Not used</td></tr>
<tr><td>Digit 4</td><td>Not used</td></tr>
</table>

Table 3; Security Variable “SdEF”, Security Definition

User Variable Descriptions and Formats

(Var 01 to Var 04) Relay Output Setpoints

User Variable 01— **Variable 04** These variables contains the trip point levels for relays. It is a value entered as user units. They can have decimal places and be positive or negative.

(Var 07) Relay ADC Select

User Variable 07—Relay ADC select.
Var07 allows the user to select the ADC input that is assigned to the given relay output. The user can choose from three function codes (one is unused). The following table gives the relay output function codes and shows which Var07 digit corresponds to which relay output.

Display Digits	Digit Function	Function Codes
Digit 1	Relay Output 1	0–Unused 1–Analog input A 2–Analog input B
Digit 2	Relay Output 2	
Digit 3	Relay Output 3	
Digit 4	Relay Output 4	

Table 4; Var 07, ADC select Variable

(Var 08) Relay Output Function

Var08 allows the user to select the relay output function. The user can choose from five function codes (one option is unused). The following table gives the relay output function codes and shows which Var08 digit corresponds to an individual relay output. Some of the function codes refer to range hysteresis or setpoint hysteresis in their description. For some user operations such as monitoring a slide gate or reading a temperature, using a constant percentage hysteresis (i.e. 5% of the total range) that is independent of the setpoint value usually works best. When using range hysteresis, the hysteresis value is the same magnitude whether the set point is near 0 or 100 percent. For speed monitoring a hysteresis value that is a percentage of the setpoint usually works best (setpoint hysteresis). The hysteresis magnitude changes with the setpoint, but the percentage stays the same. The lower the speed the lower the hysteresis is in RPMs.

Display Digits	Digit Function	Function Codes
Digit 1	Relay Output 1	0–Unused 1–Under setpoint (range hysteresis) 2–Over setpoint (range hysteresis) 3–Keypad control 4- Under setpoint (setpoint hysteresis) 5- Over setpoint (setpoint hysteresis)
Digit 2	Relay Output 2	
Digit 3	Relay Output 3	
Digit 4	Relay Output 4	

Table 5; Var 08, Relay Output Function Codes

Output	Key assignment for keypad control	Relay state
Relay 1	Up key	Only 1 relay programmed for Keypad control can be active at a time. It is the relay that is associated with the currently pressed key.
Relay 2	Down key	
Relay 3	Left key	
Relay 4	Right key	

Figure 1; key assignments for Keypad control of the relay outputs

The **unused** function keeps the respective relay permanently dropped-out.

The **Under setpoint** function pulls-in the relay when the 4/20 mA input signal rises to the trip point level, and drops-out the relay when the 4/20 mA input signal falls below the trip point level by 2%.

The **Over setpoint** function pulls-in the relay when the 4/20 mA input signal falls to the trip point level, and drops-out the relay when the 4/20 mA input signal rises above the trip-point level by 2%.

The **Keypad control** function pulls-in the relay when the associated key is depressed, and drops-out the relay when the associated key is not depressed. Only one of all the relays under keypad control can be active at a time.

Note: The relay hysteresis is fixed at 2% of the “Maximum Rate in User Units” value.

(Var 09) Switch Input Function

This is not implemented at this time

(Var 10 & Var 12) Analog Input A& B User Units at Lower Calibration Point

User Variable 10—Analog Input A User Units at lower calibration point (typically at 4 mA input).
User Variable 12—Analog Input B User Units at lower calibration point (typically at 4 mA input).

This variable (a.k.a. "Minimum Rate in User Units") is used to scale a 4 mA signal into a displayed maximum value in user units. The value entered into Var 10 & 12 is the number of user defined units (position, capacity, speed, etc,) processed by the system when the analog input signal is at its lowest calibration point. The lowest calibration point is usually at 4 mA, but that is not a requirement.

Notes:

1. When used with TT420's this value would typically be -40.
2. When used with ST420's this would be the min value in RPM's the ST420 was programed for.
3. When used as a percentage meter the value in Var 10 and Var 12 should be 0.

(Var 11 & Var 13) Analog Input A & B User Units at Upper Calibration Point

User Variable 11—Analog Input A User Units at upper calibration point (typically at 20 mA input).
User Variable 13—Analog Input B User Units at upper calibration point (typically at 20 mA input).

This variable (a.k.a. "Maximum Rate in User Units") is used to scale a 20 mA signal into a displayed maximum value in user units.
The values entered into Var 11& 13 is the number of user defined units (position, capacity, speed, etc,) processed by the system when the analog input signal is at its upper calibration point. The upper calibration point is usually set to 20mA, but that is not a requirement.

Notes:

1. When used with TT420's this value would typically be 248.
2. When used with ST420's this would be the max value in RPM's the ST420 was programmed for.
3. When used as percentage meter the value in Variable 11 and 13 should be 100.

(Var 14) ADC Averaging

Is not implemented at this time.

(Var 15) Analog Input Enable

Analog enable is used to enable or disable inputs individually. The outputs can be disabled to prevent a sensor error signal when only one sensor is being monitored.

Var 15 selections are:

- "0000" disables both inputs.
- "0001" enables input 'A'.
- "0010" enables input 'B'
- "0011" enables both the 'A' & 'B' inputs.

The default is "0001".

(Var 16) Factory Calibration Selection

When factory calibration select is set to "0001", it makes the ADC inputs use factory calibrated ADC values, not the default/user calibration value. These value are not cleared when resetting the unit. They can however be set using the 485 communications. When cleared variable 16 is resets to "0000" and the unit uses the default values/user set values.

(Var 17) Display Function Select

Controls which real-time value is displayed by the user interface. The default function code is 0 (display in User Units). The following table gives the display function codes and a description of their meanings. If both inputs are enabled pressing the rate key will toggle between the inputs. So pressing the rate key will toggle the rate code between 0 and 1. It also will allow toggling between rate code 2 and 3. .

Function Code	Function Description	Display Units	Modbus Address
0	ADC A Process position, capacity, speed, etc.	User Units[1]	31000
1	ADC B Process position, capacity, speed, etc.	User Units[2]	31010
2	ADC A current value	ADC 1 Bits, 0 to FFFF	31020
3	ADC B current value	ADC 2 Bits, 0 to FFFF	31030
4	Analog A output DAC value	0-FFFF (0-65535)	31040
5	Analog B output DAC value	0-FFFF (0-65535)	31050
6	Relay Status	Boolean State (0 or 1) see Table 7 for more detail	31060
7	Switch Inputs	00XX	31070

Table 6; Var 17, Display Function Codes

Display Digits	Digit Function	Status Code
Digit 1	Relay Output 1	0–Dropped Out 1–Pulled In
Digit 2	Relay Output 2	
Digit 3	Relay Output 3	
Digit 4	Relay Output 4	

Table 7; Var 17, Display Function Code 4, Relay Output Status

[1] Var11 “Maximum Rate in User Units” scales the 4/20 mA analog input signal into user units for display function 0.
[2] Var13 “Maximum Rate in User Units” scales the 4/20 mA analog input signal into user units for display function 1.

(Var 20 & 22) Analog Output Minimum Rate in User Units

Analog Output Minimum Rate in User Units: (4 mA output setpoint).
Var20 is used to set the point where the PM500 will output 4 mA on channel "A" when the display is at this value.
Var22 is used to set the point where the PM500 will output 4 mA on channel "B" when the display is at this value

(Var 21 & 23) Analog Output Maximum Rate in User Units

Analog Output Maximum Rate in User Units: (20 mA output setpoint).
Var21 is used to set the point where the PM500 will output 20 mA on channel "A" when the display is at this value.
Var23 is used to set the point where the PM500 will output 20 mA on channel "B" when the display is at this value

(Var 24) Analog Selection

When analog selection is set to (0001), it makes the analog output user units track the analog input user units. You will not set variables 20-23, as they are ignored. When variable 24 is cleared (0000) 20-23 again have authority over analog outputs.

(Var 25) Analog Output Response

Sets the analog output response time. This is the time it takes to change from 10-90% out. Time is listed below in seconds. This can be used to smooth the output or to filter out slight deviations.

1 = 0.00	7 = 1.3
2 = 0.020	8 = 2.5
3 = 0.040	9 = 4.8
4 = 0.080	10 = 9.5
5 = 1.7	11 = 20.0
6 = 0.57	

(Var 30) Modbus Node Address

Modbus Node Address sets the address for Modbus communications values 1 to 247 are valid..

(Var 31) Modbus Baud Rate

Modbus baud rate sets the baud rate for Modbus communications values 0-4 are valid.

0 - 1200 BAUD
1 - 2400 BAUD
2 - 4800 BAUD
3 - 9600 BAUD
4 - 19200 BAUD

(Var 32) Modbus Parity

Modbus Parity: sets the parity for Modbus communications values 0-2 are valid.

0 – No Parity, 2 stop bits (default)
1 – Odd Parity, 1 stop bit
2 – Even Parity, 1 stop bit

(Var 33) Modbus Data Type

Modbus data type: the slave must use the same data type as the master. Different slaves can use different data types, as long as the data type of the slave's response is the same as the data type of the master's query. Values 0 to 5 are valid.

0 - Float High Low	32 bit	Transmit Most Significant word **First**
1 - Float Low High	32 bit	Transmit Most Significant word **Last**
2 - Long High Low	32 bit	Transmit Most Significant word **First**
3 - Long Low High	32 bit	Transmit Most Significant word **Last**
4 - Signed Integer (default)	16 bit	
5 - Unsigned Integer	16 bit	

(Var 34) Modbus Integer Encoding

Modbus integer encoding: sets how the integer is returned. Values 0-2 are valid.

0. Integer only output (default)
1. Entire display output.
2. Decimal encoded.

Option zero (0) only shows the integer portion of the number and cannot show the sign value if using unsigned type. This applies to all variables.

Option one (1) will show all significant digits. The sign value will be absent for unsigned type. This applies to all variables.

Option (2) shows all significant digits and encodes the decimal in the 10K positon. For negative unsigned types it also encodes the sign. Compare in the tables below. Encoding only occurs on user units. All other values are untouched and come out as is. Reading certain values in 16 bit signed integers may result in reading errant numbers which are positive (greater than 32768) but show up as negative. Using 5 digits for display values allows for easier visual understanding of the encoding. Break your number down with the tables below and encoding becomes apparent. This applies to all variables with user units, see variable logs tables 11-13.

S code (sign of display)	Signed type	Unsigned type
- Negative number	-00000	30000
+ positive number	00000	00000

Table 8; S codes (sign)

Display value with decimal	1234 (0 DP)	123.4 (1 DP)	12.34 (2 DP)
D Code	00000	10000	20000

Table 9; D codes (decimal weight)

Display value	-12.3		9876		-65.0		99.99	
Type of integer	signed	unsigned	signed	unsigned	signed	unsigned	signed	unsigned
Sign S Code	-00000	30000	00000	00000	-00000	30000	00000	00000
D code	10000	10000	00000	00000	10000	10000	20000	20000
Display use 5 digits	00123	00123	09876	09876	00650	00650	09999	09999
Encoded value (sum)	-10123	40123	09876	09876	-10650	40650	29999	29999

Table 10; Integer encoding for Var 43 option (2) using various values

(Var 35 & Var 36) Modbus Faulted Sensor Value

Modbus Faulted sensor value: sets the value the PLC or other Modbus device gets when the sensor reads out of range. Var 35 is for input A and Var 36 is for input B. All user unit values are valid. Values used would typically be an alarm value.

Modbus Wiring Diagram

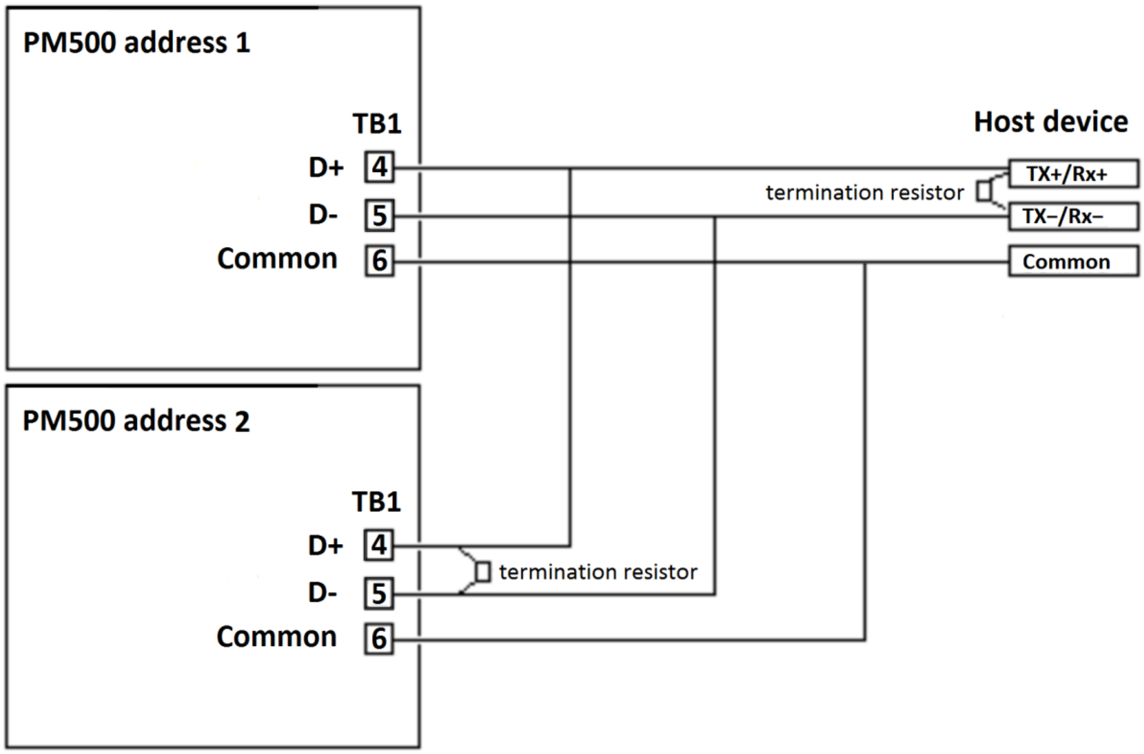


Figure 2; PM500 Modbus wiring diagram

Programming the Analog Inputs

The ways to get the display and analog output you desire from the PM500 are presented below:

1. Input is calibrated. (default is typically accurate enough for temp probes, otherwise you will need to go to diagnostics and perform the offset and scale calibrations)
2. Verify Input is properly programmed.
    a. If channel A is used: Variables 10 & 11 must be programmed (lower and upper setpoints).
    b. If channel B is used: Variables 12 & 13 must be programmed (lower and upper setpoints).
    c. Variable 15 must be set appropriately for your input configuration.
3. Verify output is programmed.

Programming the Relay Outputs

In order for the relays to operate you must do the following:

1. Enter the setpoints for the relays by setting the variables 1 through 4.
2. Set the relays to trigger on the right input by using variable 7.
3. Turn on the relay to over or under setpoint tripping.in variable 8.

Programming the Analog Outputs

There are several aspects to getting the display and analog output you desire from the PM500. They are as follows:

1. Calibrate inputs. (Default is typically accurate enough for temp probes, otherwise you will need to go to diagnostics and preform the offset and scale calibrations)
2. Verify input is properly programmed.
3. Verify Program output is properly programmed.
    a. If channel A is used: Variables 20 & 21 must be programmed (lower and upper setpoints).
    b. If channel B is used: Variables 22 & 23 must be programmed (lower and upper setpoints).
    c. If you want to use the input setpoints to also be the output setpoints, set variable 24 (analog selection) to 0001. This is an easy way to make sure any changes to the inputs will always be reflected in the outputs (mirror), otherwise leave variable 24 to 0000 and set your outputs independent of the inputs.

The LRC Non-volatile Memory Check Feature

The LRC feature is a self-check the PM500 performs on its non-volatile memory upon power-up. User variables are stored in the non-volatile memory.

If upon a power-up, the new LRC sum matches the previous LRC sum from the non-volatile memory, then the LRC self-check passes. But, if the new LRC sum does not match the previous LRC sum, then the LRC self-check flags an error. An LRC error means the values of at least one variable have been corrupted in the non-volatile memory (i.e., they don't contain all the user's previous values).

During an LRC error the PM500 goes into a 'fail-safe' mode. It does not show the real-time display, but rather shows the message "LrC". Also for an LRC error the relay outputs drop-out and the 4-20 mA analog output holds at 4.00 mA due to the corruption of the user variables. To prevent the PM500 from performing abnormally, the PM500 essentially stops performing (because any inadvertent change to the user variables may have changed its performance). The user then obviously knows something is wrong with the PM500's user variables.

Note: *It is important the user fills in their application's values in the 'User Variable Log' near the back of this PM500 User Manual. Because if an LRC error does occur, then there will be a correct list of variable values to compare to, when attempting to fix a corrupted variable situation.*

During a LRC error:

- Access to the Diagnostic Menu is allowed.
- Access and changes to the Security Menu are allowed (having no effect on the LRC error).
- Access to the Var Menu is allowed for read only. Changes to the Var Menu are not allowed.
- The unit can be reset to factory defaults.
- 485 communications will continue to work.

(DIAG Menu) The Diagnostic Functions

The DIAGNOSTIC menu is accessed by pressing the DIAG key. Once inside the Diagnostics Menu, press the UP and DOWN arrow keys to scroll through the list of diagnostic functions. Each of the diagnostic functions is explained below.

(Anou) How to Check the Analog Output

At this time the 4-20 mA outputs are a fixed calibration. This diagnostic allows you to force the outputs to a given % out.
This can be useful for trouble shooting..

(SIn) How to Check the Switched Inputs

Select " SIn" from the diagnostics menu. The display will show the status of the switch inputs.

- The right most digit represents the first switch input (000X).
- The digit that is the second most right represents the second switch input (00X0).
- The DIAG key exits the "SIn" switch input test.

(rELY) How to Test the Relay Outputs

Select " rELY" from the diagnostics menu. The display will show the status of the relay outputs.

- The right arrow key pulls-in relay output 1 & 3, and sets the corresponding digit of the display to a 1.
- The left arrow key pulls-in relay output 2 & 4, sets the corresponding digit of the display to a 1.
- The ENTER key drops-out all relays, clears the corresponding digits of the display to 0.
- The DIAG key exits the "rELY" Relay Output test.

(HEyP) How to Verify that the Keypad is Working

Select "HEyP" from the diagnostics menu.
Each key corresponds to a unique display. Press each key to test its response.
The DIAG key exits the test.

(UEr) How to Find out the Firmware Version Number

Select " Uer" from the diagnostics menu. The firmware version and revision are displayed in "XX.XX" format.
The two digits before the decimal point reflect the version number.
The two digits after the decimal point reflect the revision number.
The DIAG key exits the test.

(rESE) How to Reset the User Variables to their Factory Default Values

1. Select "rESE" from the diagnostics menu. Then press the ENTER key. This does not reset the processor, it only resets the user variables Var01 through Var08 in both the RAM memory and the non-volatile FRAM memory. When the display shows "done", press the DIAG key to exit.
2. Or, hold down the DIAG key on power-up. When the display shows "rESE" then release the DIAG key. This does everything the "rESE" diagnostic does, but also resets the processor.

Note: After doing a "reset-to-factory-defaults", the analog inputs may need recalibration.

(OFFS)How to Calibrate the Analog Input Offset

This procedure calibrates the analog input (via calibrating the A/D converter's low end-point).

- The 4 mA low-end is initially factory calibrated via defaults, which for temperature probes should be more than adequate. When necessary follow the steps below.

Calibrating the 4/20 mA analog input.

1. Set the display to read the input you want to calibrate. The diagnostic will calibrate whichever input is active. The front panel LED's will tell you which input is active for calibration.
2. Press the 'Diag' key.
3. Scroll to 'OFFS'.
4. Set your sensor to its minimum value.
5. Press the enter key and the display will start reading the ADC. It will display it in Hexadecimal. The 1's digit will vary +/- 1 or 2 ADC bits. If it varies more wait until the sensor has settled.
6. Press enter to save the value or diag to back out without updating the ADC input.
7. Calibration is done for that channel now you should verify that variable 10 and 12 reflect the point you calibrated. This step can be done after calibrating both channels upper and lower ADC points.
8. You are done.

(SCAL) How to Calibrate the Analog Input Scale

This procedure calibrates the analog input (via calibrating the A/D converter's high end-point).

- The 20 mA high end calibration is initially factory calibrated via defaults, This should be more than adequate for temperature probes. When necessary recalibration of the analog input is possible, to do so follow the instructions below.

Calibrating the 4/20 mA analog input.

1. Set the display to read the input you want to calibrate. The diagnostic will calibrate whichever input is active. The front panel LED's will tell you which input is active for calibration.
2. Press the 'Diag' key.
3. Scroll to 'SCAL' and press enter.
4. Set your sensor to its Maximum value (20mA point) or a known operating value.
5. Press the enter key and the display will start reading the ADC. It will display it in Hexadecimal. The 1's digit will vary +/- 1 or 2 ADC bits. If it is varying more wait until the sensor has settled.
6. Press enter to save the value or diag to back out without updating the ADC input.
7. Calibration is done for that channel now you should verify that Variable 11 and 13 reflects the point you calibrated.
8. You are done.

Application Examples

A plant engineer is using an Electro-Sensors, Inc. SG1000x SlideGate Monitor to sense the position of a slide gate controlling the amount of grain flowing out of a hopper storage bin.

The Electro-Sensors' SG1000x SlideGate Monitor is programmed to output a 4 mA DC signal when the gate is in the fully-closed position, and output a 20 mA DC signal when the gate is in the fully-open position. Any gate position between the fully-closed and fully-open positions, will be represented by the SG1000x output signal being proportionally between 4 mA and 20 mA.

Typically in such an application, the fully-closed slide gate position is referred to as being "0% open". Likewise, the fully-open slide gate position is referred to as being "100% open".

In this example, an Electro-Sensors' PM500 can be used to read the 4/20 mA signal coming from the SG1000x. The PM500 can be programmed to display the slide gate position as a percentage, from 0% open to 100% open. The user simply then has to view the PM500 displayed value to know the position of the slide gate at the bottom of the hopper storage bin.

In this example using Input 'A' the PM500's variables are set as follows below.

- ADC select Var 05 is set to xx11, relay 1 and 2 are programmed to use ADC input 'A'.
- User units for ADC 'A' are programmed. Var 10 is set to 0 and Var11 is set to 100 (to read 0-100% when the analog input is 4 to 20 mA).

The plant engineer also wants the PM500 to signal an Under alarm when the gate is in the 2% open position, and a Over alarm when the gate is in the 98% open position.
To accomplish this he programs the PM500's Relays as follows below.

- Relay Actuation: Var06 to XX21 (Relay Output 1 as a Under alarm, Relay Output 2 as a Over alarm).
- Relay Setpoint: Var01 is programmed at 0002 (to trip at 2% display value), and Var02 is programmed at 0098 (to trip at 98% display value).

The plant engineer tests the final system by closing the slide gate beneath the hopper bin, and verifies that the PM500 reads 0 (i.e., 0% for the 4 mA signal coming from the SG1000x).
When he runs the slide gate wide open, the PM500 shows 100 (i.e., 100% for the 20 mA signal coming from the SG1000x).

He notices that when the slide gate was fully-closed relay 1 was off, and remained so until the slide gate opened up to 4% (2% setpoint and 2% hysteresis).

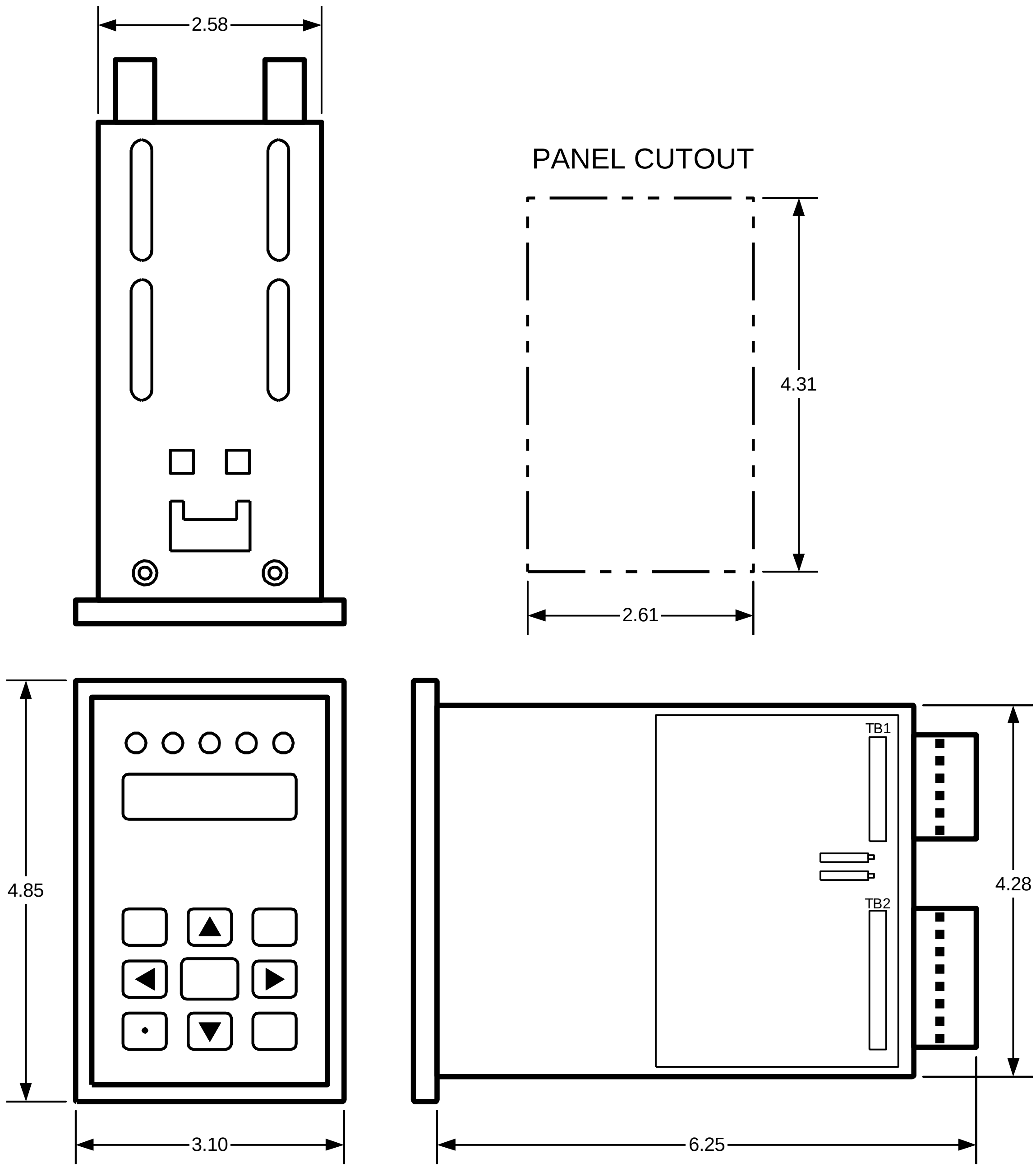
He also noticed that the PM500's relay 2 was on the entire time the slide gate was near the fully-closed position, and remained 'ON' until the slide gate opened-up to the 98% open position, then relay 2 turned 'OFF'. This is the over setpoint alarm he wanted.

Appendix A—Panel Cutout Dimensions

To install the PM500 into an instrument panel:

- Remove the mounting brackets.
- Slide the PM500 into the panel cutout.
- Replace the mounting brackets and tighten the bracket screws (do not over tighten the bracket screws).

Allow a minimum of 1.5 inches clearance on all sides of the PM500.



Wiring Practices for Industrial Equipment

1. **All control signals must be shielded cable**. The shield must be tied to common or earth ground at the receiving end only. In some environments earth ground may contain excessive electrical noise. If you have problems using earth ground as a shield tie point, switch the shields to signal common. All connections to the controller are considered signal unless they carry AC power.

2. **Never use a shielded cable with unused conductors**. The unused conductors act as antennas. Attempting to tie the unused conductors to ground or other signals just creates different antenna configurations. In many cases unshielded wire would have received less electrical noise. Always insure that a shielded cable with the correct number of conductors is pulled.

3. **All control signals must be separated from power wiring**. Power wiring includes any AC or DC voltages with a current potential of greater than 1Amp or a voltage greater than 24 V. This includes, but is not limited to, 115 VAC, 230 VAC, and 460 VAC. Do not bundle shielded cables and power wiring together.

4. **Do not run signal cables along high magnetic or electrostatic generators**. This includes, but is not limited to, motors, fans, contactors, igniters, etc. Aluminum shielded cable does not stop magnetically induced noise, braided shielded cable only partially reduces magnetically induced noise.

5. **An earth ground wire must be installed on microprocessor based controllers when it is specified**. Do not rely on enclosure contact with the panel for earth ground. Earth ground is often used in noise rejection circuitry and is not just a safety factor.

6. Contactors, solenoids, and relay coils on the same AC power or in the same enclosure (panel) as the controller must be suppressed with a capacitor-resistor filter across the coil. These can be made with a 1 kV capacitor and a ¼ watt resistor in series, or they can be purchased in a pre-made package. Use a capacitance value of 0.1 μF or larger and a resistance value of 500 ohms or less.

7. When power is stepped down from a higher AC voltage for controllers, a capacitor-resistor network or other filter should be placed across the secondary.

Appendix B—Wiring the PM500

AC Input Power Supply (TB1-1, TB1-2)

The standard PM500 uses 115 VAC power. 230 VAC. Internal fusing is provided within the unit. The recommended fuse size is a TR5 100 mA Slow-Blow for 115 VAC, TR5 50 mA Slow-Blow for 230 VAC.

485 communications (TB1-4 to TB1-6)

A two conductor shielded cable should be used for this connection. The shield should be tied to the PM500 common, not earth ground.

Switch inputs (T1-7 to TB1-9)

The switches are contact closure and require only 2 or 3 wires depending on number of switches used. Use of signal wire and shielding is advised but is not mandatory.

4/20 mA Analog Input (TB2-10 to TB2-15)

A two conductor shielded cable should be used for this connection. The shield should be tied to the PM500 common, not earth ground.

4/20 mA Analog Output (TB1-16 to TB1-18)

A two/three conductor shielded cable should be used for this connection, depending on the number of outputs used. The shield is not counted as a conductor. The shield is tied to the PM500's common.

Relay Outputs (TB3-1 to TB3-18)

Relay wiring is dependent on user needs.

Wiring Diagrams

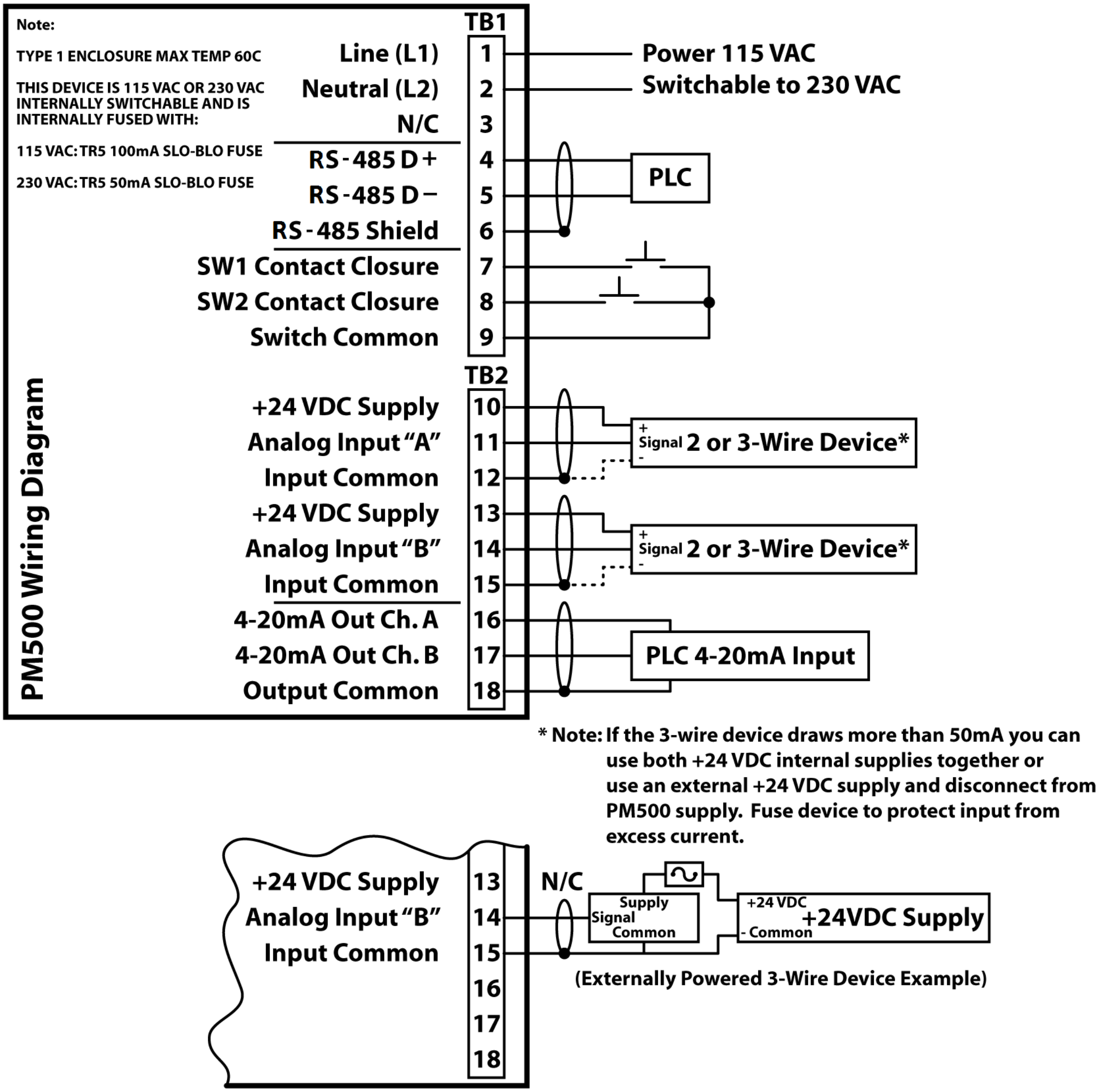


Figure 3; PM500 Wiring diagram

Wiring Diagrams continued.

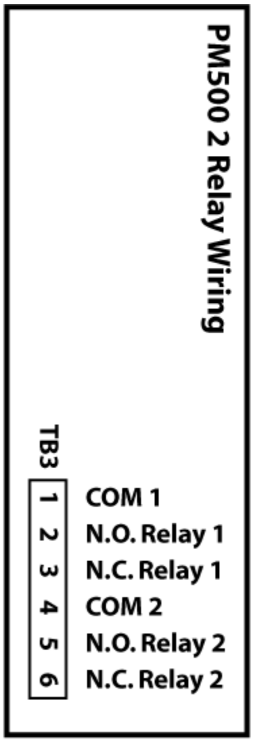


Figure 4; 2 Relay outputs wiring diagram

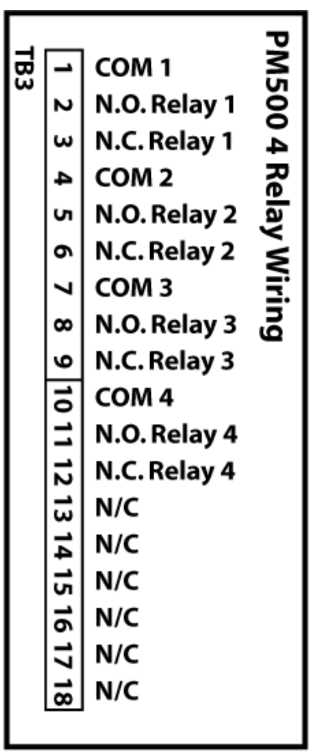


Figure 5; 6 Relay outputs wiring diagram

Appendix C—PM500 Specifications

Power	Description
Input power	**Standard**: 115 VAC 50/60 Hz, 9 VA **Switchable:** 230 VAC 50/60 Hz, 9 VA
Fusing (internal)	100mA TR5 Slow-Blow recommended for 115 VAC 50mA TR5 Slow-Blow recommended for 230 VAC

Sensor Supply	Description
Transducer Power Supply	+24 VDC regulated , 50 mA max, 2 channels
Fusing	Internal, resettable (power down, remove short and wait 1 min)

Control I/O	Description
Standard Inputs	2 Switch inputs (contact closure).
Standard Outputs	2 standard or 4 optional SPDT (form C) fully programmable relays, • 250 VAC, 5 A, Resistive Load • 30 VDC, 5 A, Resistive Load
Relay update rate	100mS
Relay setpoint hysteresis	5 %

Analog Inputs	Description
Quantity	2 channels
Type	4-20mA Input
Resolution	16 bit ADC (15½ bits of usable range)
Accuracy	0.02 % uncalibrated @ 25C typical 0.15 % uncalibrated @ 25C max. 0.25 % uncalibrated for full temperature range max.
ADC update rate	50mS

Analog outputs	Description
Quantity	2 channels
Type	4-20mA outputs (one associated with each input)
Resolution	16 bit DAC
Accuracy	0.1 % uncalibrated, @ 25C maximum. 0.15 % uncalibrated, full temperature range maximum.
DAC update rate	25mS
Input to Output isolation	1000 VAC isolation Analog input to Analog output

Mechanical	Description
Enclosure	ABS Plastic 94V-0
Keypad	Polycarbonate Tactile Switch Pad, Chemical Resistant, Splash Proof
Operating temperature	0–50° C (32–122° F)
Humidity	0–90% Non-Condensing

Operational Specifications	Description
Display	4 digits, 0.3”, seven-segment LED, 5 Status LEDs
Display update rate	500mS.

Variable Logs

User Variables Log

Variable Number	Variable Name	Default Value	User Value	Range of Values	DP move enabled	Modbus Address	Page Ref.
01	Set Point 1	0005		User units limitation	Yes	41010	5
02	Set Point 2	0095		User units limitation	Yes	41020	5
03	Set Point 3	0005		User units limitation	Yes	41030	5
04	Set Point 4	0095		User units limitation	Yes	41040	5
05	reserved	0000		User units limitation	Yes	41050	
06	reserved	0000		User units limitation	Yes	41060	
07	Relay ADC select	0021		XXXX X = 0, 1 or 2	No	41070	5
08	Relay function	0021		XXXX X = 0-3	No	41080	5
09	Switched input function	0000			No	41090	7
10	Analog input A Min Value	0000		User units limitation	Yes	41100	8
11	Analog input A Max Value	0100		User units limitation	Yes	41110	8
12	Analog input B Min Value	0000		User units limitation	Yes	41120	8
13	Analog input B Max Value	0100		User units limitation	Yes	41130	8
14	ADC Averaging	0000			No	41140	8
15	Analog Input Enable	0001		00XX X = 0 or 1	No	41150	8
16	ADC Factory Calibration select	0000		000X X = 0-1	No	41160	8
17	Display options	0000		000X X = 0-8	No	41070	9
18-19	Reserved						
20	Channel A 4mA set-point	0000		User units limitation	Yes	41200	10
21	Channel B 20mA set-point	0100		User units limitation	Yes	41210	10
22	Channel B 4mA setpoint	0000		User units limitation	Yes	41220	10
23	Channel B 20mA setpoint	0100		User units limitation	Yes	41230	10
24	Analog Select					41240	10
25	Analog output Response	0000		000X X = 0-1	No	41250	10
26-30	reserved						

Table 11; User Variable Log

Communication Variables Log

Variable Number	Variable Name	Default Value	User Value	Range of Values	DP move enabled	Modbus Address	Page Ref.
30	Modbus Node	0001		000XX X = 1-247	No	41300	10
31	Modbus Baud	0003		000X X = 0-4	No	41310	10
32	Modbus Parity	0000		000X X = 0-2	No	41320	10
33	Modbus Data type	0005		000X X = 0-5	No	41330	10
34	Modbus Integer encoding	0000		0000-0002	No	41340	9
35	Faulty sensor A Modbus value	0000		User units limitation	Yes	41350	9
36	Faulty sensor B Modbus value	0000		User units limitation	Yes	41360	9

Table 12; Communications Variables Log

Calibration Variables Log

Variable Number	Variable Name	Default Value	User Value	Range of Values	DP move enabled	Modbus Address	Page Ref
40	User ADC 1 offset cal	10465		0000–FFFF	No	41400	
41	User ADC 1 span cal	52323		0000–FFFF	No	41410	
42	User ADC 2 offset cal	10465		0000–FFFF	No	41420	
43	User ADC 2 span cal	52323		0000–FFFF	No	41430	
44	Factory ADC 1 offset cal	*		0000–FFFF	No	41440	
45	Factory ADC 1 span cal	*		0000–FFFF	No	41450	
46	Factory ADC 2 offset cal	*		0000–FFFF	No	41460	
47	Factory ADC 2 span cal	*		0000–FFFF	No	41470	
48	Reserved			0000–FFFF	No	41480	
49	Reserved			0000–FFFF	No	41490	
50	Reserved			0000–FFFF	No	41500	
51	Reserved			0000–FFFF	No	41510	

Table 13; Calibration Variables Log

Security Variable Log

Variable Number	Variable Name	Default Value	User Value	Range of Values	DP move enabled	Modbus Address	Page Ref.
PdEF	Password Definition	0500		0001–9999	None	41520	4
Pin	Password Input	0500		0001–9999	None	41530	4
SdEF	Security Definition	1001		X00X (X is 0 or 1)	None	41540	4

Table 14; Security Variables Log

Index

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NOTES

PM500 User's Manual Back Cover

Part Number: 990-005700 REV F

Electro-Sensors, Inc.

6111 BLUE CIRCLE DRIVE
MINNETONKA, MN 55343–9108

www.electro-sensors.com

sales@electro-sensors.com
tech@electro-sensors.com

Local:	952.930.0100
Toll-Free:	800.328.6170
Fax:	952.930.0130