HORNER
APG

User Manual for the
HE450RMU200,

Profibus Remote Message Unit

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PREFACE

This manual explains how to use the Horner APG's Profibus Remote Message Unit.

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To obtain warranty service, return the product to your distributor with a description of the problem, proof of purchase, post paid, insured and in a suitable package.

ABOUT PROGRAMMING EXAMPLES

Any example programs and program segments in this manual or provided on accompanying diskettes are included solely for illustrative purposes. Due to the many variables and requirements associated with any particular installation, Horner APG cannot assume responsibility or liability for actual use based on the examples and diagrams. It is the sole responsibility of the system designer utilizing the Profibus Remote Message Unit to appropriately design the end system, to appropriately integrate the Profibus Remote Message Unit and to make safety provisions for the end equipment as is usual and customary in industrial applications as defined in any codes or standards which apply.

Note: The programming examples shown in this manual are for illustrative purposes only. Proper machine operation is the sole responsibility of the system integrator.

Revisions to this Manual

This version (MAN0220-03) of the Profibus Remote Message Unit User Manual contains the following revisions, additions, and deletions:

a.   Made changes to **Figure 2.4** in section 2.4.1 on page 15.

b.   Made changes to **Figure 2.5** in section 2.4.1 on page 16.

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NOTES

CHAPTER 1: INTRODUCTION

1.1   Product Description

The Horner APG Profibus Remote Message Unit (HE450RMU200) is a remote terminal equipped with a keypad and display screen which functions as a slave device in a Profibus DP network. The Profibus DP application allows for the connection of I/O devices and simple field devices to an automation system via a Profibus network. Emphasis is on fast transmission of small data volumes.

Profibus uses a Master-Slave type of communication with master devices (such as the HE693PBM100/101) that are capable of controlling up to 64 slave devices. The HE693PBM100/101 communicates with slave devices such as input/ output devices, drives, valves, and measuring transmitters via a Profibus network (i.e., HE450RMU200).

As a slave device, the HE450RMU200 does not have bus access rights and can only acknowledge received messages or send messages to the master when requested to do so. Data from the HE450RMU200 can be read by any master. All connected slave devices (including the HE450RMU200) have the same priority.

1.2   Profibus Overview

Profibus, a token-passing network, supports one master controlling the network and writing to slave devices. Multiple masters, however, can read information simultaneously off the Profibus network. Master devices (HE693PBM100/101) are used to determine the data communication on the bus. Up to 32 devices (masters or slaves) can be connected in one segment without using repeaters or up to 64 devices can be connected using repeaters.

The HE693PBM100/101 master modules can be configured to access additional information pertaining to slave devices (such as the HE450RMU200) using the "Pseudo Slave" feature. (For information covering HE Master Modules, see the User Manuals for the HE693PBM100 and the HE693PBM101. For information covering HE Slave Modules, see the User Manuals for the HE693PBS105 and the HE693PBM106.)

For further information on the PROFIBUS Network, visit http:\\www.profibus.com.
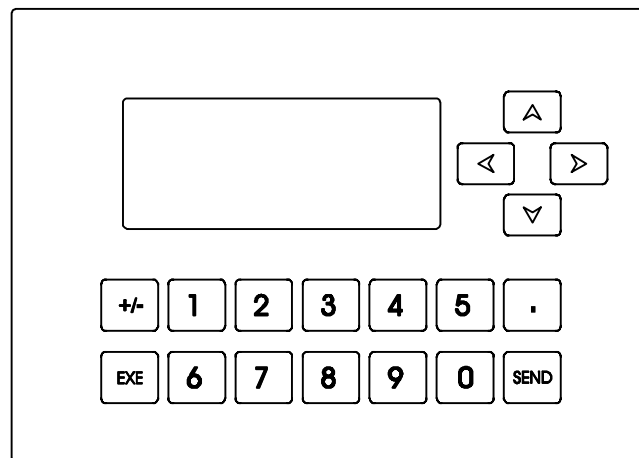
Figure 1.1 – HE450RMU200 Screen

1.3   Power Draw Specifications

The power draw specifications for the HE450RMU200 without Digital Board is 24VDC, Steady State 300mA, and inrush 2.3A for 6ms.

CHAPTER 2: INSTALLATION

2.1   Mounting Requirements of the HE450RMU200

Table 2.1 – Dimensions		
Height	6.5"	165.1 mm
Width	8.75"	222.25 mm
Depth	2.75	69.85 mm
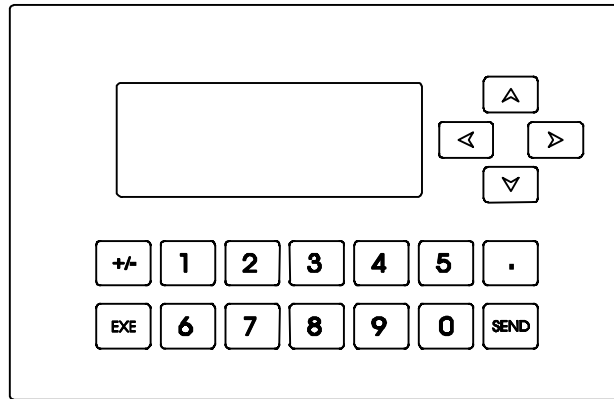
Figure 2.1 – HE450RMU200 Front View, Dimensions
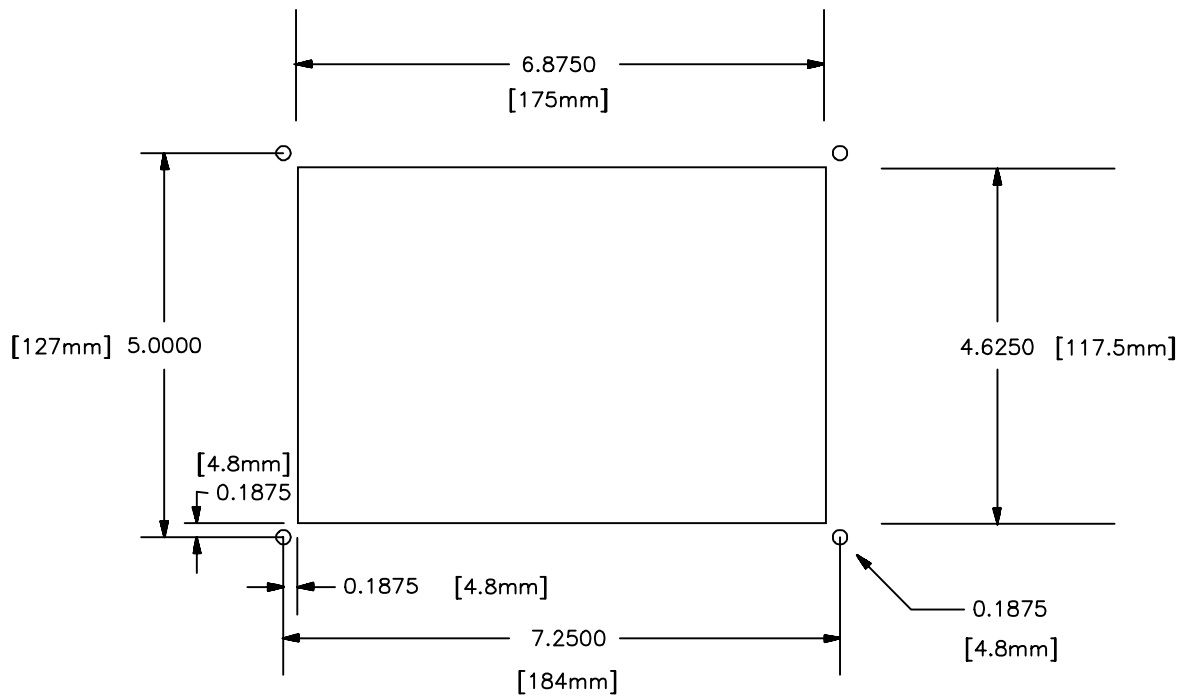
Figure 2.2 – Panel Cutout for the HE450RMU200

2.2   Hardware Connections

2.2.1   General

The HE450RMU200 is equipped with several connectors. Section 2.2 provides descriptions, pin-outs and electrical specifications for each connector.

IMPORTANT: For users with BETA hardware units (Rev 0 circuit board): The placement of the COM1 connector and the Profibus connector on the original hardware are SWAPPED with respect to the descriptions in this manual. On the prototype hardware, COM1 is on the right side and the Profibus connector is on the bottom of the unit.

It is the intention of Horner APG to replace any existing Rev 0 units with Rev 1 (or later) units.

2.2.2   Bottom Connector Layout

Most of the connectors are ported through the HE450RMU200 back cover on the bottom of the unit. The connector arrangement on the bottom of the unit is illustrated as follows:
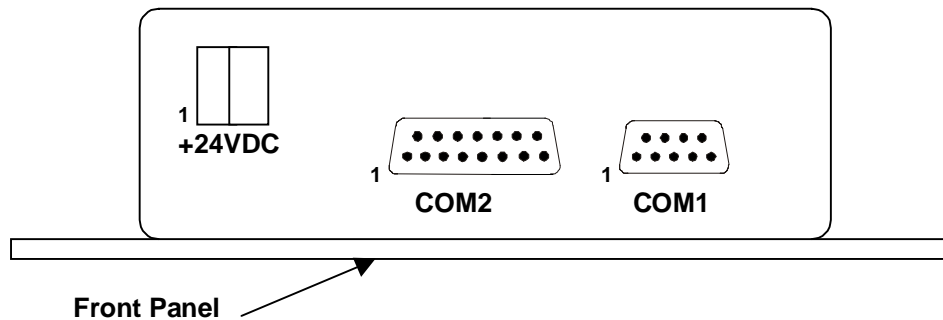
Figure 2.3 - Connector Placement, Bottom of Unit

2.2.3   The 24V Power Connector

The 24VDC power connector is a 2-pin, removable screw, contact connector. The pin-out for the connector is:

Table 2.2 – 24V Power Connector Pin-out	
Pin number	**Signal**
1	+8 to +28VDC
2	Return (Ground)

2.2.4   *The Profibus Connector*

On the right side of the HE450RMU200 (as viewed from the rear), there is one 9-pin D-connector accessible through the back cover. The Profibus connector is a standard 9-pin D-connector for use with prefabricated Profibus cables. The pin-out for the Profibus connector is:
(See Section 2.5 for more details on Profibus wiring.)

Table 2.3 – Profibus Connector Pin-out	
Pin number	**Signal**
1	No connection
2	No connection
3	RXTX+
4	RTS
5	Terminator GND
6	Terminator V+
7	No connection
8	RXTX-
9	No connection

2.2.5   The COM1 Connector

The connector, accessible at the bottom of the unit, is COM1, the primary RS-232 port. This port is also used as the firmware debug port, and the firmware upgrade port. However, when the HE450RMU200 is in its normal operating condition, COM1 is used for PowerMate serial communications.

COM1's pin-out is designed to be connected directly to a standard 9-pin port on a personal computer. The following table illustrates the COM1 pin-out:

Table 2.4 – COM1 Pin-out		
Pin number	**Signal**	**Direction**
1	DCD	Output from HE450RMU200
2	TXD	Output from HE450RMU200
3	RXD	Input to HE450RMU200
4	DTR	Input to HE450RMU200
5	GND	
6	DSR	Output from HE450RMU200
7	CTS	Input to HE450RMU200
8	RTS	Output from HE450RMU200
9	RI	Output from HE450RMU200

2.2.6   The COM2 connector

The HE450RMU200 is optionally equipped with an RS-485/RS-422 port at COM2. This is a 15-pin D- connector with the following signal pin-out:

Table 2.5 – COM2 Connector Pin-out
Pin number	**Signal**	**Direction**
1	Shield Ground	
2	No connection	
3	No connection	
4	RUN Indicator	Output from HE450RMU200
5	Switched +5VDC	Output from HE450RMU200
6	RTS-	Output from HE450RMU200
7	Signal GND	
8	CTS+	Input to HE450RMU200
9	Terminating resistor	Connect to pin 10 to install 120 ohm terminating resistor
10	RXD-	Input to HE450RMU200
11	RXD+	Input to HE450RMU200
12	TXD-	Output from HE450RMU200
13	TXD+	Output from HE450RMU200
14	RTS+	Output from HE450RMU200
15	CTS-	Input to HE450RMU200

To convert COM2 into a standard 9-pin RS-232 port, use Horner APG's SNP Adapter (HE693SNP232). When this device is used, COM2 must be configured for full-duplex operation, and the +5VDC must be switched ON. (See the DIP switch definitions in Table 2.8).

2.3   DIP Switches

On the left side of the HE450RMU200 (as viewed from the rear), there is an access hole in the back cover exposing a 6-position DIP-switch. Table 2.6 illustrates the meaning for each switch in this bank:

Switch number	Default Position	Meaning when OPEN (1)	Meaning when CLOSED (0)
		Table 2.6 - HE450RMU200 Dip Switch Definitions	
1	OPEN	Node Address and Firmware Memory Protected	Node Address and Firmware Memory Write Enabled
2	OPEN	BIOS Memory Protected	BIOS Memory Write Enabled (only if Switch #1 is also closed)
3	OPEN	Application RUN Mode	BIOS Upgrade Mode
4	OPEN	COM2: Full Duplex Mode	COM2: Half Duplex Mode
5	OPEN		
6	* OPEN	COM2: Disable +5VDC on Pin 5	COM2: Enable +5VDC on Pin 5

* Note that during normal operation, all of the switches should be in the OPEN position except switch #6.   Switch #6 should be CLOSED if COM2 is to be used with an HE693SNP232 adapter. If COM2 is not installed, or not used, switch #6 should be OPEN.

2.4   Profibus Wiring

2.4.1   Assembling the cable for use with the DP port on the HE693PBM101 and PBS105.

a.   The HE693PBM101 uses a 9-pin D-sub plug connector for its DP port.   The pin assignment of the plug connector and the wiring are shown below **(Figure 2.4)**.
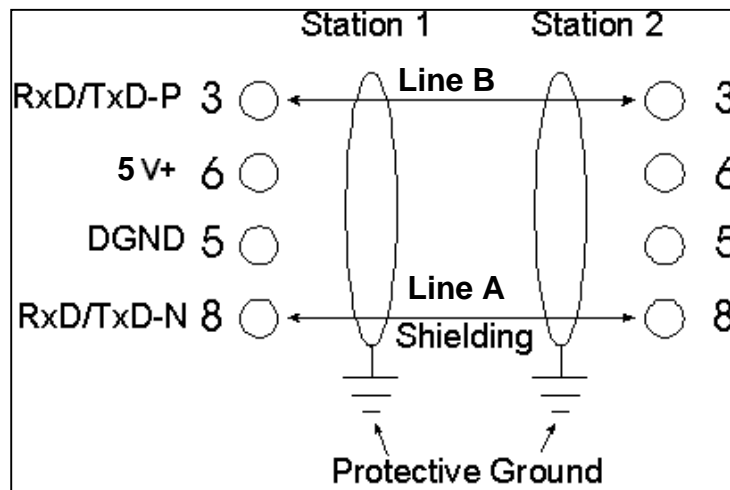
Figure 2.4

b.   It is necessary to terminate both ends of the network.   Both terminations must have power to them to insure proper operation of the network. The following diagram **(Figure 2.5)** illustrates the correct connection for the termination resistors.

Note: The wiring diagram (Fig. 2.5) is for illustrative purposes only. Cabling and connectors should be PTO approved to achieve the desired performance results. See Section 2.5.3 for recommended part numbers.
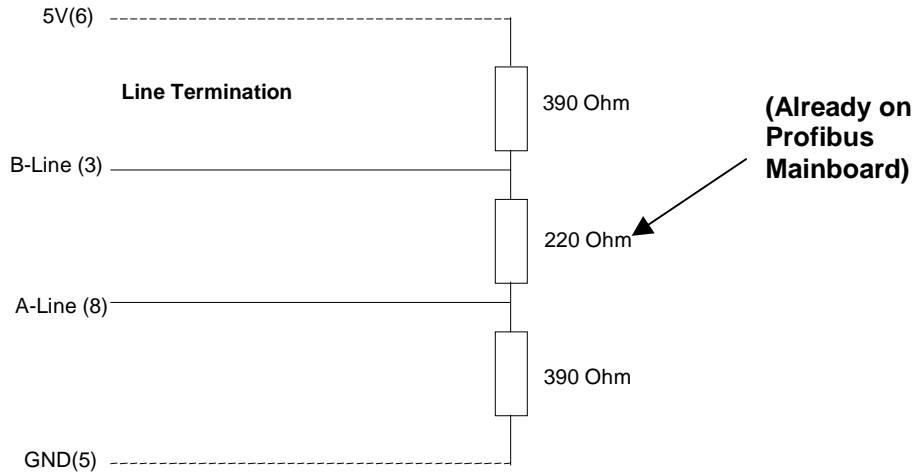
Figure 2.5

c.   The shield braiding and, if present, the shield foil should be connected to protective ground on both sides and with good conductivity via shield clamps covering as large an area as possible. In addition, it is recommended that the data lines be kept separate from all high-voltage cables.

2.4.2   Other Considerations when Wiring the Profibus network:

a.   In the Profibus network, up to 32 stations (master or slaves) can be connected per segment without the addition of repeaters. If more than 32 stations are desired repeaters must be used. The repeaters are used to connect individual bus segments together.

b.   The maximum cable length depends on the transmission speed. The specified cable length can be increased by the use of repeaters. However, the use of more than three repeaters in series is not recommended.

c.   The following cable length specifications are based on type-A cable with a 135 to 165 Ohm impedance, less than 30 pf/m capacity, a loop resistance of 110 Ohms/Km, a wire gauge of .64mm, and a conductor area of 0.34mm².

Table 2.7 - Baud/Distance Rates							
Baud Rate(bit/sec)	9.6K	19.2K	93.75K	187.5K	500K	1.5M	12M
Distance/Segment	1200m	1200m	1200m	600m	200m	200m	100m

d.   For data transmission speeds of greater than 500 kbit/sec, Stub lines (free hanging ends of the cable) should be avoided. There are plug connectors available on the market that permit data line A and data line B to be connected directly to the plug connector.

2.4.3   Recommended Part numbers:

It is highly recommended that the following cable and connectors be used for high-speed data transmissions. Both Cable and Connector part numbers are Siemens part numbers.

a.   Connectors: **Extra 9-pin DSUB for easy cable stacking.**

6ES7-972-0BB10-0XAO   6ES7-972-0BA10-0XAO

Figure 2.6 - Connectors

b.   **Cable: Part Number 6XV1-830-OAH10**

NOTES

CHAPTER 3: CONFIGURATION

3.1   HE450RMU Parameters for Configuring Profibus Master Device

In order for the Profibus master to communicate with the HE450RMU200, it is important that the master be configured with the correct HE450RMU200 parameters.

The HE450RMU200 is shipped with a GSD file that contains information for configuring the Profibus master with the HE450RMU200 parameters. The GSD file is named `HE085C.GSD`.

The Profibus identification numbers for the HE450RMU200 are 085C (in hexadecimal format) with 08 being the Ident High parameter and 5C being the Ident Low parameter.

There are eight modules in the master device that need to be configured in order to communicate with the HE450RMU200. A total of 88 output bytes and 28 input bytes are used for data exchange between the master and the HE450RMU200. The HE450RMU200 *receives* 88 bytes of Profibus data from the master and *sends* 28 bytes of data to the master. (The purpose of the outputs are described in Tables 4.1 and 4.2.)   Tables 3.1 and 3.2 indicate output and input parameters respectively needed for the master device to communicate with the HE450RMU200.

Table 3.1 – Input Parameters for the Master Device (to Communicate with the HE450RMU200)		
Module #	**Length Type**	**Data Length**
7	BYTE	16
8	BYTE	12
		Total: 28

Table 3.2 – Output Parameters for the Master Device (to Communicate with the HE450RMU200)		
Module #	**Length Type**	**Data Length**
1	BYTE	16
2	BYTE	16
3	BYTE	16
4	BYTE	16
5	BYTE	16
6	BYTE	8
		Total: 88

NOTE: Upon configuring the HE450RMU200, the slave address is the only configuration parameter that is set. All other parameters are predefined.

3.2   Local Mode of the HE450RMU200

In most instances, the HE450RMU200 is controlled by the Profibus master. It functions as a "dumb terminal" in that it displays data sent from the master and returns keypad information to the master. (See Chapter 4 for detailed information about the HE450RMU200's operation when controlled by the Profibus Master)

The HE450RMU200 must, however, be configured locally before the master can assume control. Also, the HE450RMU200 must be operated locally in order to perform self-tests. The four local modes of operation are:

Table 3.3 – Local Mode Summary		
Mode name	**Entered by**	**Exited by**
Self Test Mode	+/-, EXE, 2	SEND
Digital I/O Test Mode	+/-, EXE, 3	
Profibus Port Test Mode	+/-, EXE, 5	
Enter Node Address Mode	+/-, EXE, 8	

Note: Entry into any of these modes can be inhibited if the master sets the SLC bit (Suppress Local Control) of the master's handshake byte.

3.3   Local Control Functions and Configuration Procedures

3.3.1   Power Up

1.   When the HE450RMU200 is powered-up, it will display its sign-on message for at least 3 seconds. This message contains the model name, firmware revision number and assigned node address:

```
Horner Electric, Inc
     HE250RMU200
Remote Monitor Unit
Ver. 1.10  Node: 126
```

Figure 3.1 – HE450RMU200 Sign-On Screen

2.   Note that the sign-on message will remain on the display until the Profibus master begins exchanging data with the HE450RMU200 *and* sets the OLI bit in the master handshake byte to 1.

3.   Also, as shipped from the factory, the HE450RMU200 is configured as node address 126, which is an *invalid* node assignment. For this reason, the HE450RMU200 will automatically enter the "Enter node address" mode following the 3-second sign-on message, allowing the user to program the HE450RMU200's node address (described in detail in Section 3.2.4, item 4).

**Note: In order to set the node address, Dip Switch setting SW1 must be *closed*
or the HE450RMU200 will <u>not</u> accept the new setting.**

4.   After displaying this message for approximately 3 seconds, the HE450RMU200 will display the following message until Profibus communications is established with the master:

```
Horner Electric, Inc
     HE250RMU200
Waiting for master..
Ver. 1.10  Node: 126
```

Figure 3.2 – HE450RMU200

5.   This screen will remain on the display until the master sends updated display data.

3.3.2   Self Test Operation

1.   An important feature of the HE450RMU200 is the self-test. This provides the user with the ability to verify the functionality of all HE450RMU200 systems. By pressing the +/-, EXE and "2" keys simultaneously, the unit will automatically enter the self-test mode. During the self-test, the following "screen" is displayed:

```
ABCDEFGHIJKLMNOPQRST
KEYPAD: UP ARROW
COM1: OK
COM2: Not installed
```

Figure 3.3 – Self-Test Screen Format

2.   On line 1 of the display (the top line), the ASCII character set of the display will continuously "scroll" across the screen. This, along with the remaining test output, tests the functionality of the display.

3.   On line 2, the key name for the any key pressed will be displayed. This allows functional testing of the keypad.

4.   On lines 3 and 4, the results of the serial port tests are displayed. These tests require that a loopback connector be installed on each serial port that connects the RXD and TXD lines together, as well as the CTS and RTS lines. If any failures occur, the error is displayed.

5.   To exit the self-test mode, press and release the SEND key.

Note: Entry into any of these modes can be inhibited if the master sets the SLC bit (Suppress Local Control) of the master's handshake byte.

3.3.3   Configuring the Node Address

1.   As noted earlier, the factory-new HE450RMU200 is configured with a node address of 126. This is an invalid node address, and the HE450RMU200 will <u>not</u> attempt to communicate on the Profibus network while configured as such. When the new HE450RMU200 powers-up, it will display the sign-on message for three seconds, and then it will automatically enter this "Enter node address" dialog.

```
Enter node address:
(0-125, 126=disable)
SEND when done < 15>
 Node address:  ___
```

Figure 3.4 – Node Address Entry Screen

2.   Use the numeric keys to enter the desired node address (0 to 126). Note once again that the node address of 126 will disable the HE450RMU200 from all Profibus communications. During node address entry, the LEFT ARROW key (<) can be used to perform a backspace operation. Press the SEND key when entry is complete. The node address is stored in the HE450RMU200 and will remain as programmed until changed using this method.

3.   This mode can be entered to change the existing node address by pressing the +/-, EXE and "8" keys simultaneously.

Note: User entry into this mode can be inhibited if the master sets the SLC bit (Suppress Local Control) of the master's handshake byte.

4.   Also note that the node address is stored in a Flash EPROM device that must be "write enabled" prior to the attempt to update the node address. Switch #1 on the DIP switch bank, when CLOSED, enables writing to the node address. If switch #1 is OPEN during an attempt to set the node address, an error message will be displayed on the HE450RMU200 display. **Under normal operating conditions, switch #1 should be in the OPEN position.** If it is moved to the CLOSED position to change the node address, it should be placed in the OPEN position prior to placing the HE450RMU200 into long-term service.

3.3.4   Profibus Port Test Mode

1.   The HE450RMU200 is also capable of displaying an information message containing current Profibus statistics. This message also provides information regarding the current HE450RMU200 data width configuration. This message is displayed by pressing the +/-, EXE and "5" keys simultaneously.

```
Prf state:   Wait PRM
Prf baud:        1.5M
#In:  88   #Out:  28
 Press SEND to exit
```

Figure 3.5 – Profibus Port Test Message Format

2.   The Prf state parameter will indicate the connection state to the Profibus master. Possible values are:

Table 3.4 – Profibus State Definitions	
Displayed Value	**Meaning**
Wait PRM	Waiting for Profibus master communications - no connection
Wait CFG	Waiting for configuration file from Profibus master
Data EX	Configured and exchanging data with Profibus master
Error	HE450RMU200 has detected a communication error from the Profibus interface
Unknown	An unknown response code was returned from the Profibus interface

3.   The PRF baud parameter will indicate the connection baud rate (or the baud rate being attempted when int Wait PRM mode). Possible values are:

Table 3.5 – Profibus Baud Rate Definitions	
Displayed Value	**Meaning**
12.0M	12.0 Megabaud
6.0M	6.0 Megabaud
3.0M	3.0 Megabaud
1.5M	1.5 Megabaud
500K	500,000 baud
187.5K	187,500 baud
93.75K	93,750 baud
45.5K	45,500 baud
19200	19,200 baud
9600	9,600 baud
BAD	Invalid baud rate

4.   On the third line of the display, the HE450RMU200 will indicate the number of input bytes and the number of output bytes to be transferred to the Profibus master. The data direction displayed is with respect to the HE450RMU200 (#In reflects the data from the master to the HE450RMU200, #Out reflects the data from the HE450RMU200 to the master). This mode is exited by pressing the SEND key.

Note: User entry into this mode can be inhibited if the master sets the SLC bit (Suppress Local Control) of the master's handshake byte.

NOTES

CHAPTER 4: OPERATIONS

4.1   Protocol Overview

The HE450RMU200 is equipped with a Profibus™ communication port. From the Profibus master's point of view, the HE450RMU200 provides 88 bytes of data output (data from master to HE450RMU200), and 28 bytes of input (data from HE450RMU200 to master). **Chapter Three** describes the function of the data and assumes that the user is already familiar with Profibus networks. For termination and cabling information, see **Chapter 2, Section 2.5.**

4.2   Network Data Format

The HE450RMU200 receives 88 bytes of Profibus data from the master and sends 28 bytes of data to the master. Although the contents of the data are dependent on the commands and responses, the format will remain the same. The command "buffer" is organized as follows:

NOTE: Currently, only one option board is available. Boards 2 through 4 (see Table 2.9) are reserved for future use. *However, for programming purposes, it is important to set parameters for all boards (i.e., Command byte numbers 85-87) as indicated in various tables throughout this user manual.*

Table 4.1 – Data Format (Master to HE450RMU200)		
Command byte number	**Number of bytes**	**Meaning**
0	1	Master handshake byte
1-83	83	Command data
84-87	4	Future Expansion

The response buffer is organized as follows:

Table 4.2 – Data Format (HE450RMU200 to Master)		
Response byte number	**Number of bytes**	**Meaning**
0	1	Slave handshake byte
1-20	20	Response data
21-23	3	Bit-mapped keypad data
24-27	4	Future Expansion

4.3   Protocol Handshaking

The HE450RMU200 allocates the first byte of its receive command buffer and the first byte of its transmit response buffer as protocol handshaking bytes. Since each processor (master and HE450RMU200) must process data independently and asynchronously, the following method of data transfer handshaking guarantees data contiguity and integrity.

1.	The first byte of the command buffer (from the master) and the first byte of the response buffer (to the master) are identical in function. Each byte contains status reflecting the device from which it originates. The handshake bytes are defined as follows:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
				Table 4.3 – Handshake Byte Data			

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
OLI	MCH	SRH	SLC	Command / response code			
On Line Indicator Bit	Master Command Handshake Bit	Slave Response Handshake Bit	Suppress Local Control Bit	Function specific command or response code (0 to 15)			

a.	The On Line Indicator (OLI, bit 7) is used to perform initial network synchronization. The HE450RMU200 will not attempt to interpret any of the incoming data until it receives data from the master with this bit set to 1. When the HE450RMU200 detects the 0 to 1 transition of the OLI bit, it will copy the Master Command Handshake Bit (MCH, bit 6) and the Slave Response Handshake Bit (SRH, bit 5) to its own handshake output byte. The HE450RMU200 will then set its own On Line Indicator Bit (OLI).

2.	The handshaking process is described as follows:

a.	For data sent from the **master** to the **HE450RMU200**:

The master should first check to ensure that the MCH bits of **both the RX and TX handshake bytes** are equal. When both of the MCH bits are equal (either both '0', or both '1'), the HE450RMU200 is ready to accept a new command from the master, and the data buffer is "owned" by the master.

At this point, the master may manipulate the command buffer to prepare a message to send to the HE450RMU200. The HE450RMU200 will ignore this message until the master toggles its MCH bit. When the HE450RMU200 detects a difference in the state of the command buffer MCH bit and the response buffer MCH bit, it will process the data in its command buffer. It will then toggle the response buffer MCH bit to match that of the command buffer. At this point, the process may begin again.

b.	For data sent from the **HE450RMU200** to the **master**:

The process is identical for data sent from the HE450RMU200 to the master, except that in this case the SRH bits are used. When the HE450RMU200 detects that the SRH bits are equal in both the command buffer and the response buffer handshake bytes, it may manipulate the data in its response buffer, then toggle its SRH bit. When the master detects a difference in the SRH bits, it must retrieve the data from the HE450RMU200 and toggle its SRH output bit to let the HE450RMU200 know that it has finished with the response buffer.

3.   The following truth table illustrates the various states for the handshake bytes:

Table 4.4 – Handshake Bits Truth Table						
Master OLI	Master MCH	Master SRH	Slave OLI	Slave MCH	Slave SRH	State
0	X	X	X	X	X	Master is off-line, slave ignoring all other data
1	X	X	0	X	X	Master on-line and ready to access slave, slave is not yet ready to communicate
1	0	0	1	X	X	Master can manipulate command data, slave will not access command buffer
	1	1				
1	0	1	1	X	X	Master has placed a command into the command message buffer. Slave has not yet finished processing command
	1	0				
1	X	X	1	0	0	Slave can manipulate response data, master will not access response buffer
				1	1	
1	X	X	1	0	1	Slave has placed a response into the response message buffer. Master has not yet finished processing response
				1	0	

4.4   Local Control Suppression

The HE450RMU200 can normally be placed into one of five "modes" of operation from the local keypad (see Chapter 4, Configuration):

a.   Normal display mode (default power-up mode).
b.   Self-test mode
c.   I/O test mode
d.   Profibus status display mode
e.   Node address entry mode

At any time, the Profibus master can set the SLC (Suppress Local Control) bit in the handshake byte to prevent the local user from accessing the other modes. When the slave's SLC bit is set, this is an indication to the master that one of the local user modes is in effect.   When the slave exits one of the extended modes of operation, it will generate a 1-to-0 transition of its SLC bit, and will clear its display. When the 1-to-0 transition of the slave's SLC bit is detected by the master, it should completely update that slave's display with run-time data.

4.5   Real-time Data

The HE450RMU200 passes several bytes of data across the Profibus network continuously, irrespective of the message handshaking. This data is binary discrete and does not require synchronization with any other part of the system.

 The HE450RMU200 reports the current instantaneous state of the front-panel keypad. The bit map for these keys is as follows:

Byte 21							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
SEVEN	SIX	FIVE	FOUR	THREE	TWO	ONE	ZERO

Byte 22							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
EXE	SEND	RIGHT	LEFT	DOWN	UP	NINE	EIGHT

Byte 23							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Reserved (Always 0)						(.) DOT	(+/-)

4.6   Commands and Responses

4.6.1   General

The data transferred to and from the HE450RMU200 contains commands to be processed by the HE450RMU200, and responses sent from the HE450RMU200 to the master.   The following commands are supported by the HE450RMU200:

Table 4.5 – Command Table	
Command number (transferred in least significant 4 bits of handshake byte)	**Command description**
0	Soft reset of HE450RMU200 (clear display, cancel any pending commands)
1	Display data (optional cursor addressing and attributes)
2	Numeric Input mode
3	Serial port configuration (for PowerMate communications)
4	Serial port data transfer (to/from PowerMate)

The HE450RMU200 continuously reports the current binary state of keypad keys as real-time data. However, the HE450RMU200 only sends a response message to report an error condition or when completion of the Numeric string input command (Command #2) has been processed and entered by the operator.

Table 4.6 – Response Table	
Response number (transferred in least significant 4 bits of handshake byte)	**Response description**
2	Returned numeric string
4	Serial Status Reply

4.6.2   Soft Reset Command

The command is sent by the master to the HE450RMU200 to force the HE450RMU200 to clear the display and cancel any pending numeric input commands. The command format is:

NOTE: Currently, only one option board is available. Boards 2 through 4 (see Table 2.9) are reserved for future use. ***However, for programming purposes, it is important to set parameters for all boards (i.e., Command byte numbers 85-87) as indicated in various tables throughout this user manual.***

Table 4.7 – Reset Command Format			
Command byte number	**Number of bytes**	**Meaning**	**Value**
0	1	Master handshake byte	1 XXX 0000 Binary
1-83	83	Command data	Not used
84-87	4	Optional Digital Output Data	Binary

4.6.3   Display Data Command

This command is sent by the master to the HE450RMU200 to force the HE450RMU200 to display new data on the vacuum fluorescent display. The command format is:

NOTE: Currently, only one option board is available. Boards 2 through 4 (see Table 2.9) are reserved for future use. ***However, for programming purposes, it is important to set parameters for all boards (i.e., Command byte numbers 85-87) as indicated in various tables throughout this user manual.***

Table 4.8 – Display Data Command Format			
Command byte number	**Number of bytes**	**Meaning**	**Value**
0	1	Master handshake byte	1 XXX 0001 Binary
1	1	Starting cursor address	0 to 79
2	1	Attribute	See below
3-83	81	Command data	Display data
84-87	4	Optional Digital Output Data	Binary

The HE450RMU200 will interpret the fields for the Display Data Command as follows:

Starting Cursor Address: The HE450RMU200 will use this value (0 to 79) to determine at which display position to begin when sending the display data.

Attribute: If this value is zero, the command data is displayed normally. If this value is non-zero, the character value of the attribute byte is used to "blink" the characters. If the attribute byte contains a 20H (ASCII space), the characters sent to the display will flash (alternate between the display data and the space character). If the attribute byte contains a 5FH (underscore), the characters will alternate between underscore and the written display data.

Command data: This is the buffer for data to be sent to the display. Note that there is sufficient room in this buffer to update the entire display with a single command. Data from this buffer is sent to the display until a NULL character (ASCII 0) is encountered, or until 80 characters have been transferred.

4.6.4   Numeric Input Mode Command

The HE450RMU200 can be placed into a mode whereby it will record the operator's entry of a numeric sequence of keystrokes and automatically return the string to the master upon completion. The format for this command is:

Table 4.9- Numeric Input Mode Command Format			
Command byte number	Number of bytes	Meaning	Value
0	1	Master handshake byte	1 XXX 0010 Binary
1	1	Starting cursor address	0 to 79
2	1	Maximum field size	1 to 20
3	1	Attributes	See below
4-83	80	Extra command data	Not used
84-87	4	Optional Digital Output Data	Binary

The HE450RMU200 will interpret the fields for the Numeric Input Mode Command as follows:

Command length: This command always occupies 5 bytes.

Starting Cursor Address: The HE450RMU200 will use this value (0 to 79) to determine at which display position to begin echoing a numeric entry. If the value 0FFH is used here, the echo is suppressed.

Maximum field size: The maximum number of characters that will be recorded. If the operator enters more characters than specified by this parameter, the additional characters are simply ignored.

Attributes: The HE450RMU200 can be optionally configured to allow negative values, allow the decimal point, provide a cursor and suppress the echo. The attribute byte controls each of these features as follows:

Table 4.10 – Numeric Input Attribute Control							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SIGN	FLOAT		ECHO			CBLINK	CURTYPE

CURTYPE: Set to 1 for a block cursor, set to 0 for underscore cursor.

CURBLINK: Set to 1 for blinking cursor, set to 0 for solid cursor.

ECHO: Set to 1 to force HE450RMU200 to echo keystrokes to the display, set to 0 to suppress the echo.

SIGN: Set to 1 to allow negative values, set to 0 to force HE450RMU200 to ignore the +/- key.

FLOAT: Set to 1 to allow decimal point entry, set to 0 to force HE450RMU200 to ignore the decimal point.

During numeric entry, the operator may press the < key to perform a backspace operation. Pressing the SEND key causes the HE450RMU200 to send the Returned Numeric String response message discussed in Section 4.6.7.

4.6.5   Serial Port Configuration Command

The HE450RMU200 is equipped with two asynchronous serial ports. COM1 is an RS-232 port using a standard 9-pin D-connector. The pin-out of this connector is designed to connect directly to the standard 9-pin AT style COM ports on a personal computer. COM2 is an RS-485/RS-422 port using a 15-pin D- connector. The pin-outs for both ports are defined in Chapter 2.

Prior to using either of the serial ports for data communication, the port must be initialized and configured for communication with the desired parameters. This command allows the master to configure one of the ports.

NOTE: Currently, only one option board is available. Boards 2 through 4 (see Table 2.9) are reserved for future use. ***However, for programming purposes, it is important to set parameters for all boards (i.e., Command byte numbers 85-87) as indicated in various tables throughout this user manual.***

Table 4.11 – Serial Port Configuration Command Format			
Command byte number	**Number of bytes**	**Meaning**	**Value**
0	1	Master handshake byte	1 XXX 0011 Binary
1	1	Port Specifier	0 = COM1 1 = COM2
2	1	Baud Rate	0 = No change 1 = 300 baud 2 = 600 baud 3 = 1200 baud 4 = 2400 baud 5 = 4800 baud 6 = 9600 baud 7 = 14400 baud 8 = 19200 baud 9 = 38400 baud 10 = 57600 baud 11 = 115200 baud
3	1	Parity	0 = No change 1 = No parity 2 = Odd parity 3 = Even parity 4 = Mark parity 5 = Space parity
4	1	Data Bit Length	0 = No change 1 = 7 bits 2 = 8 bits
5	1	Stop Bit Length	0 = No change 1 = 1 stop bit 2 = 2 stop bits
6	1	Handshake Type	0 = No change 1 = No handshaking 2 = Software (XON/XOFF) 3 = Hardware (RTS/CTS) 4 = Multi-drop
7-83	77	Extra Command Data	Not used
84-87	4	Optional Digital Output Data	Binary

4.6.6   Serial Port Data Transfer Command

Once configured, the serial port(s) may be used to transfer data to and from a remote serial device. The protocol configuration largely dictates how the HE450RMU200 will handle this message:

NOTE: Currently, only one option board is available. Boards 2 through 4 (see Table 2.9) are reserved for future use. ***However, for programming purposes, it is important to set parameters for all boards (i.e., Command byte numbers 85-87) as indicated in various tables throughout this user manual.***

Command byte number	Number of bytes	Meaning	Value
0	1	Master handshake byte	1 XXX 0100 Binary
1	1	Port Specifier	0 = COM1 1 = COM2
2	1	Serial Command	0 = Flush 1 = Store data 2 = Send data 3 = Verify data 4 = Return status
3	1	Data Length	0 to 80
4-83	80	Serial Data or Checksum	
84-87	4	Optional Digital Output Data	Binary

<p style="text-align:center">**Table 4.12 – Serial Port Data Transfer Command Format**</p>

To be more specific (regarding the parameters for this command), the *Serial Command* byte (Byte 2) specifies how the *Serial Data* will be interpreted by the HE450RMU200.

Serial Command #0:   Flush Command - None of the serial data is used. This command forces the HE450RMU200 to flush its receive and transmit buffers, abort any transactions that are currently active, and clear the checksum.

Serial Command #1:   Store Data Command - All of the serial data is buffered in the receive buffer, but none is transmitted until a Send command is received.

Serial Command #2:   Send Data Command - The first two serial data bytes contain the checksum. This checksum is simply the sum of all of the data bytes truncated to 16 bits (low byte first). It is compared to the checksum calculated for the buffered data. If equal, all of the buffered serial data is transmitted to the PowerMate motion controller as soon as an XON character is received. If unequal, a checksum error is reported.

Serial Command #3:   Verify Data Command - The HE450RMU200 will request that the PowerMate return the data so that the HE450RMU200 can perform a read-back verification. Status for this operation is reported in the Serial Port Status Reply, which can be requested at any time by the master. If any errors occur, the Error Reply is returned to the master with the proper error code.

Serial Command #4:   Return Status Command - Forces the HE450RMU200 to return a Serial Port Status Reply message containing data regarding the status of the serial port (see Section 4.6.8).

4.6.7   Numeric Input Mode Reply

As described in section 4.6.4, the master can send a command to the HE450RMU200 to place the HE450RMU200 into the "numeric input" mode. When in this mode, the HE450RMU200 will return the following response message to the master (after the operator completes entry of a numeric string and presses the SEND key):

NOTE: Currently, only one option board is available. Boards 2 through 4 (see Table 2.9) are reserved for future use. ***However, for programming purposes, it is important to set parameters for all boards (i.e., Command byte numbers 85-87) as indicated in various tables throughout this user manual.***

Table 4.13 – Numeric Input Mode Reply Format			
Response byte number	**Number of bytes**	**Meaning**	**Value**
0	1	Slave handshake byte	1 XXX 0010 Binary
1-20	0 to 20	Returned numeric data	See below
21-23	3	Bit-mapped keypad data	Binary discrete
24-27	4	Optional Digital Input Data	Binary discrete

Returned numeric data: The HE450RMU200 will return the exact ASCII representation of the edited numeric entry. This data will either be NULL terminated or will be exactly 20 bytes in length.

4.6.8   Serial Port Status Reply

As described in Section 4.6.4, the master can send a command to the HE450RMU200 to place the HE450RMU200 into the "numeric input" mode. When in this mode, after the operator has completed entry of a numeric string and presses the SEND key, the HE450RMU200 will return the following response message to the master:

NOTE: Currently, only one option board is available. Boards 2 through 4 (see Table 2.9) are reserved for future use. ***However, for programming purposes, it is important to set parameters for all boards (i.e., Command byte numbers 85-87) as indicated in various tables throughout this user manual.***

Table 4.14 – Serial Port Status Reply Format			
Response byte number	**Number of bytes**	**Meaning**	**Value**
0	1	Slave handshake byte	1 XXX 0100 Binary
1	1	Status byte	See below
2-20	19	Not used	
21-23	3	Bit-mapped keypad data	Binary discrete
24-27	4	Optional Digital Input Data	Binary discrete

The Serial port status byte contains the bit-mapped serial port status flags;

Table 4.15 – Serial Status Byte							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Status code				RX Overrun Error	RX Framing Error	RX Parity Error	Port Number (0=COM1, 1=COM2)

The RX errors (overrun, framing and parity) are cleared following the transfer of this reply to the master, and indicate that the respective error(s) occurred at some point since the last status report.

| Table 4.16 – Serial Status Codes ||
Status Code	Meaning
00H	Idle, no errors
01H	Sending data to PowerMate
02H	Send complete
03H	Verifying data from PowerMate
80H	Specified port is not installed
81H	Checksum error
82H	Program verification error
83H	Program buffer overflow
84H	Parameter error
85H	Sequence error
88H	Unknown command

4.6.9   PowerMate Serial Data Transfer Procedure

To properly transfer motion program data to the PowerMate motion controller, the Profibus master must adhere to the following procedures:

1. Send the *Serial Port Configuration Command* to the HE450RMU200 to configure and initialize the desired serial port.

2. Send the *Serial Port Data Transfer Command* to the HE450RMU200, specifying Serial Command #0 *(Flush Command)*. This will prepare the HE450RMU200 for motion program reception.

3. Send the as many *Serial Port Data Transfer Commands* to the HE450RMU200, specifying Serial Command #1 *(Store Data Command)* as necessary to send the entire motion program to the HE450RMU200. The HE450RMU200 will buffer the data locally, while calculating the checksum.

4. Send the *Serial Port Data Transfer Command* to the HE450RMU200, specifying Serial Command #2 *(Send Data Command)*, send the 16-bit checksum as the data (low byte first). The HE450RMU200 will validate the checksum, and if correct, will send the stored data to the PowerMate. If the checksum does not match, the "Checksum Error" code is placed in the serial status byte. The HE450RMU200 will, after receipt of an XON character from the PowerMate, automatically send the buffered program data to the PowerMate.

5. Send the *Serial Port Data Transfer Command* to the HE450RMU200, specifying Serial Command #4 *(Report Status)*. The HE450RMU200 will respond by sending the *Serial Status Reply* message. The status code in the serial status byte will be "Sending data to PowerMate" until the data transfer is complete. Continue this process until either the transfer is complete, or until an error is reported. If an error is encountered, the entire operation should restarted at step 2.

6. Send the *Serial Port Data Transfer Command* to the HE450RMU200, specifying Serial Command #3 *(Verify Data Command)*.   The HE450RMU200 will read the motion program back from the PowerMate and will perform a local comparison on the data to verify its integrity.

7. Send the Serial Port Data Transfer Command to the HE450RMU200, specifying Serial Command #4 (Report Status). The HE450RMU200 will respond by sending the Serial Status Reply message. The status code in the serial status byte will reflect the current state of the motion program transfer to the PowerMate. Upon successful completion, the HE450RMU200 will place the "idle" code into the status code of the serial status byte.

NOTES