VIVISUN 5000
PROGRAMMABLE DISPLAY SYSTEM

Programmable Multifunction Pushbutton
And
Refresh Processor Unit

Interface and Software
Manual No. 5000-1-93-1 Rev. B
(RPU Serial Numbers 2000 and Above)

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INTRODUCTION

This manual provides complete information on interfacing and operating the VIVISUN SERIES 5000 programmable display system. The software coding instructions described herein are straightforward and easily implemented in software development. The manual also describes the electrical parameters required to provide electrical power and communications between the host computer and the VIVISUN SERIES 5000.

The VIVISUN SERIES 5000 is a complete, ready to use system that is comprised of three major components (see Figure A):

1. One to four (1-4) Programmable Multifunction Pushbuttons (PMP) switches.
2. One Refresh Processor Unit (RPU).
3. Four cables which connect each PMP to the RPU.

All that is required to display legends is power and serial data input/output from a personal computer. Legends can be formed on the PMP switch displays by sending characters from the computer's serial output port as those characters are typed from the keyboard. This user-friendly feature can be an immense aid in system software development.

PMP FUNCTION

The PMP serves as an interactive interface between the operator and the host computer. Legends from the host computer can be displayed on the PMP display's face. The PMP can also be depressed to inform the host computer that it has been actuated. On a systems level the PMP can perform multiple functions, serving different purposes at different times, with the legends changing accordingly.

The PMP switch display is an LED dot matrix consisting of 16 rows by 35 columns for a total of 560 LED pixels. The PMP also contains the LED drive electronics and a hermetically sealed solid state Hall-Effect switch that signals the RPU when the PMP face is depressed. A mechanism within the PMP provides a positive tactile feedback when the pushbutton is actuated.

RPU FUNCTION

The RPU acts as an intelligent interface between the host computer and the PMPs. All of the electronics necessary to control the four PMP switches and to communicate with the host computer are contained within the RPU. The RPU also performs high-speed refreshing of the LED displays completely independent of the host computer. Other functions performed include:

1. Verification of messages received from the host computer.
2. Conversion of ASCII characters into pixel patterns.
3. Controlling the blinking and luminance of the PMP displays.
4. Transmitting PMP actuations to the host computer.
5. Acknowledging command execution.
6. Self-testing of its microprocessor.

INTERACTIVE COMMUNICATIONS

The VIVISUN SERIES 5000 system provides interactive communications between the operator and the host computer resulting in the interactive control necessary in complex systems. Information is imparted to the operator by legends appearing on the PMP switch displays. These legends are formed from coded messages transmitted to the RPUs from the host computer. The operator acts on these legends by actuating the PMP switch displaying the appropriate selection. This actuation results in the RPU transmitting a code back to the host computer informing it as to which PMP switch was actuated. The host computer performs the appropriate task according to its programming and then presents new information to the operator. This interaction involving continuously changing information is the basis for interactive communications.

The protocol for information exchange between the host computer and the RPU is command oriented with message validation. Messages transmitted to the RPU are coded with the destination PMP, the command and legend information. The RPU (1) echoes the message back to the host computer for message validation, (2) responds to each message with a response code transmitted back to the host computer notifying it of the message status. The RPU also transmits a unique switch identification code back to the host computer each time a switch is actuated.

The messages are made up of variable length strings of standard ASCII characters. The ASCII characters are the instruction codes that control the message command, the legend information and the destination PMP. Nothing will appear on the PMP switch displays unless the RPU has received a valid message. These messages are stored in the host computer's memory and are called up by system software and transmitted to the RPU to meet the system program requirements. In the event of a momentary power disruption, the RPU incorporates advanced features that will attempt to maintain any existing legend information (see RPU DISPLAY MEMORY RETENTION section).

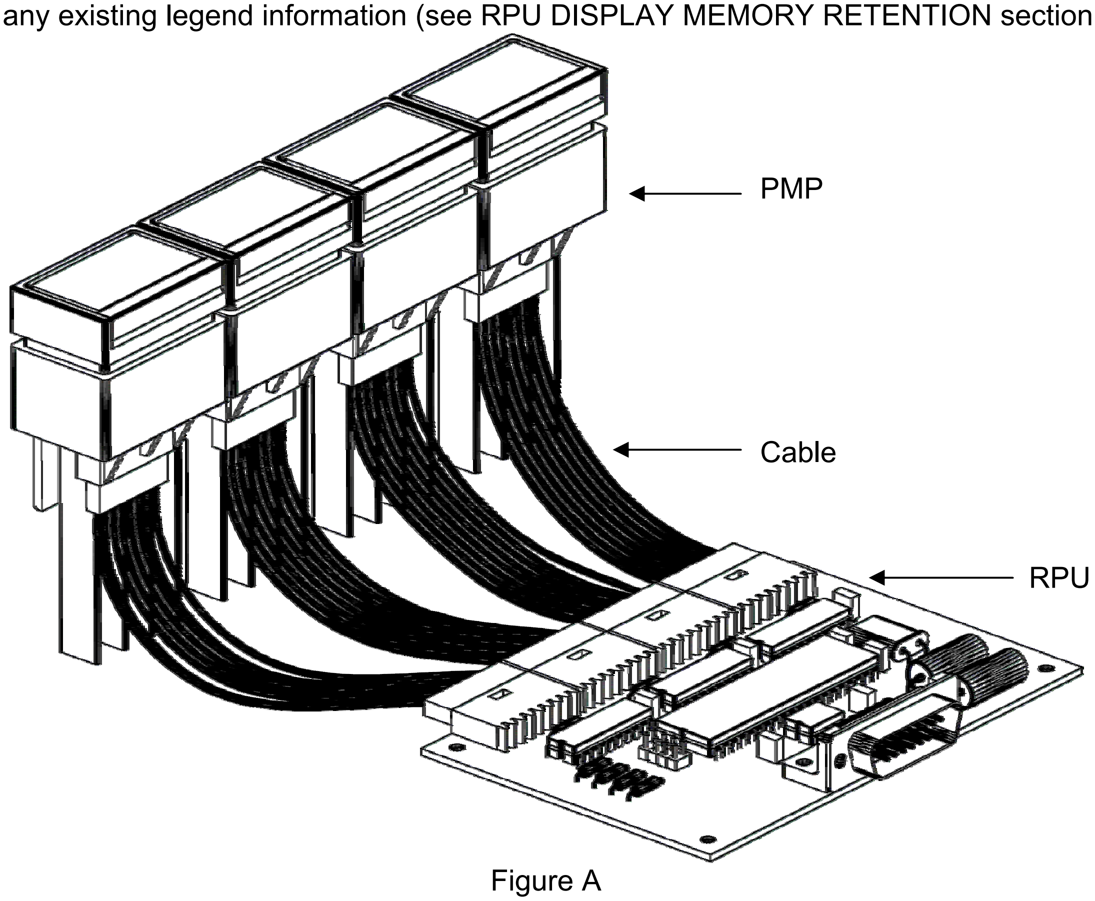


Figure A

LOOP NETWORK OPERATION

Multiple RPUs can be connected together to form a Loop Network. Loop Networking allows the host computer to control as many as four RPUs and sixteen PMPs from a single serial port. From one to four RPUs may be used in any single Loop Network. Figure 1 shows the message flow in a Loop Network. The serial output from the host computer is connected to the serial input of the first RPU. The serial output from each consecutive RPU is connected to the serial input of the next RPU. The serial output from the fourth RPU is connected to the serial input of the host computer.

The Loop Network operates because each RPU within the network echoes all messages that it receives to the next RPU in the loop, eventually returning back to the host computer. This feature allows the host computer to compare the echoed message with the intended message providing validation that the RPU acted upon the correct data.

Loop Network Operation

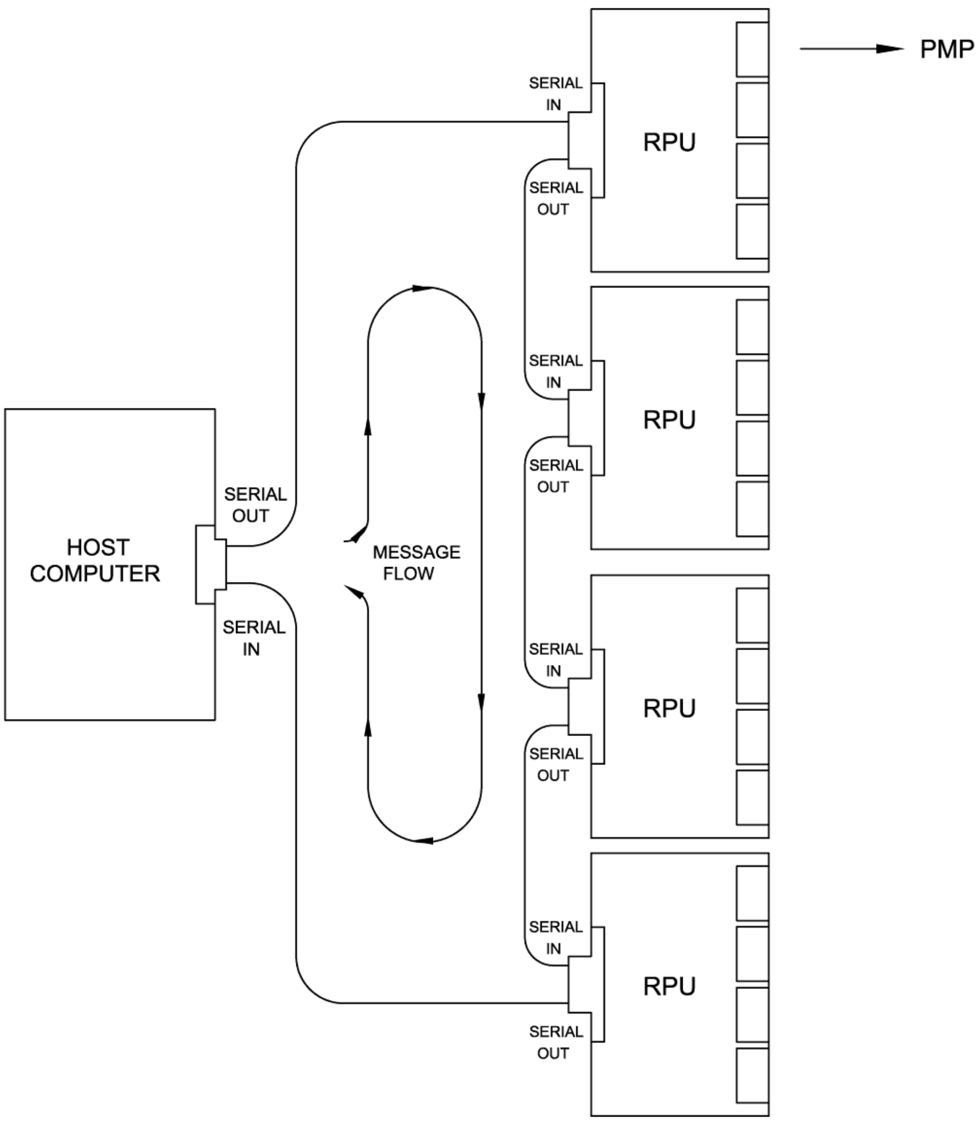


Figure 1

RPU Jumpers

Since all messages are received and echoed by each RPU in the Loop Network, each RPU in the network must have its own unique address. All RPU hardware is identical, but there are four pairs of pins that must be configured using jumpers that Characterize the RPU. The jumper pins are arranged and identified as shown in Figure 2. The user must set these jumpers to assign the baud rate and Loop Network address characteristics for each RPU. The RPU jumper pin pairs can be left open meaning no connection between the pair or closed meaning that a jumper is used to connect the pair together.

RPU Jumpers
72 73 74 75

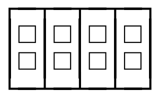


Figure 2

Baud Rate Jumper Settings

The serial communications rate between the RPU and the host computer is configured on pin pairs 72 and 73. Figure 3 shows the jumper settings for 2400, 4800, 9600, 19200 baud. All RPUs within a loop network must be jumper configured with the same baud rate.

The RPU baud rate is set only at power up. If the jumpers are changed while power is applied, the change will not be applied until the power has been removed and then applied again.

Baud Rate Jumper Settings

Baud Rate	Jumpers 72	73	
2400	C	C	O = Open
4800	O	C	C = Closed
9600	C	O	
19200	O	O	

Figure 3

RPU Address Jumper Settings

Each RPU in a Loop Network must be assigned its own unique address. The RPU address is configured on pin pairs 74 and 75. Each RPU can be assigned one of four possible addresses (0, 1, 2 or 3) by the jumper settings shown in Figure 4. Once the jumpers have been configured the RPU will be Characterized during power-up with the address number corresponding to its jumper settings.

No two RPUs within a Loop Network may have the same address configuration. Any RPUs with identical address configurations will respond to messages identically. If the jumpers are changed while power is applied, the change will not be applied until the power has been removed and then applied again.

RPU Address Jumper Settings

RPU Address	Jumpers 74	75	
0	C	C	O = Open
1	O	C	C = Closed
2	C	O	
3	O	O	

Figure 4

Characterized RPUs in a Loop Network

Figure 5 shows four RPUs that have been Characterized by configuring their jumper settings and have been arranged in a Loop Network. The baud rate jumper pin pairs 72 and 73 are both open for all four RPUs that Characterizes them to receive and transmit asynchronous serial data at 19200 baud. The address jumper pin pairs are both closed for the first RPU Characterizing it as address 0. The second RPU has jumper pin pair 74 open and 75 closed Characterizing it as address 1. The third RPU has jumper pin pair 74 closed and 75 open Characterizing it as address 2. The fourth RPU has both jumper pin pairs 74 and 75 open Characterizing it as address 3.

In Figure 5 all four RPUs have the same baud rate configuration but no two have the same address configuration as is required for Loop Network operation. Once an RPU is Characterized by configuring the jumper settings, it will respond the same way regardless of its physical location in the network.

Characterized RPUs within a Loop Network

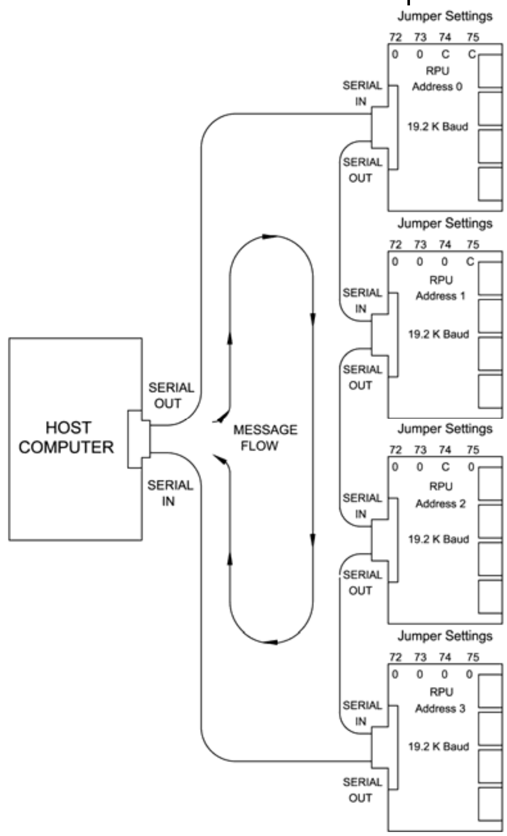


Figure 5

COMMUNICATIONS PROTOCOL

Messages transmitted from the host computer are coded for the destination RPU address within the network and these messages are echoed by each RPU within the network and then back to the host computer for validation. As the message is being echoed, each RPU within the Loop Network compares the message address coding with its address configuration and the RPU that is Characterized to respond to the message coding will execute the message. The RPUs that execute the message transmit a response code back to the host computer informing it that the message has been received and executed.

Each time that a PMP switch is actuated, a signal is sent from the PMP to the RPU. The RPU then transmits a unique response code back to the host computer identifying the PMP switch that was actuated.

During VIVISUN 5000 RPU power-up, the host computer should wait a minimum of 50 milliseconds before transmitting message data to allow the RPU time to complete internal diagnostics (see RPU POWER-DOWN AND RPU POWER-UP section).

For effect communications with the Vivisun 5000, the host computer software must have the following features:

1. A delay of 50 milliseconds on power-up to allow RPU internal diagnostics tests to complete.
2. Message transmission to the RPU that includes correctly formatted address and data coding.
3. Echoed message reception from the RPU for message comparison and validation.
4. Reception of RPU and PMP Response codes for host program control.

RPU Message Response Codes

The RPU that is sent a message first checks the message for validity, executes the message and finally transmits an Acknowledge code back to the host computer. If the RPU declares the message invalid for any reason, the message is ignored and a Retry code is transmitted back to the host computer. The RPU Acknowledge and Retry codes are different for each RPU address and provide the host computer with RPU identity, message status and that the RPU is ready for the next message.

Figure 6 shows the Acknowledge and Retry response codes transmitted from each RPU address in response to messages directed to those addresses. The host computer must wait for the message response code from an RPU before transmitting a second message to that RPU to insure that the second message is not lost.

Since it is possible for a message to be corrupted yet still contain valid data, it is mandatory that the host computer system not only check for a valid RPU Response code but also compare the echoed message to what was transmitted to be sure that the RPU acted upon the correct data.

Acknowledge and Retry Response Codes

RPU Address	Acknowledge	Retry
0	q	r
1	u	v
2	y	z
3	}	~

Figure 6

Specific PMP Address Codes

Each RPU has four PMP connectors in locations numbered 79, 80, 81 and 82. In a Loop Network arrangement the specific PMP Address code is determined by the RPU address jumper settings and the RPU to PMP connector number of the RPU where the PMP is connected. The specific PMP Address codes for the sixteen PMPs connected in a four RPU Loop Network are shown in Figure 7. The PMPs have no individual configurations and can be connected to any connector on any RPU.

The RPU address (0, 1, 2 or 3) is not used for the message Address code. Messages directed to an RPU use any one of the four PMP Addresses controlled by that RPU. Messages directed to a specific PMP use that PMPs specific Address code. Figure 8 shows the specific PMP Address codes and the response codes for four RPUs connected in a Loop Network arrangement.

Specific PMP Address Codes

RPU Address Jumper Settings 74	75	RPU Address	RPU to PMP Connector	Specific PMP Address Code
C	C	0	79	@
C	C	0	80	A
C	C	0	81	B
C	C	0	82	C
O	C	1	79	D
O	C	1	80	E
O	C	1	81	F
O	C	1	82	G
C	O	2	79	H
C	O	2	80	I
C	O	2	81	J
C	O	2	82	K
O	O	3	79	L
O	O	3	80	M
O	O	3	81	N
O	O	3	82	O

Figure 7

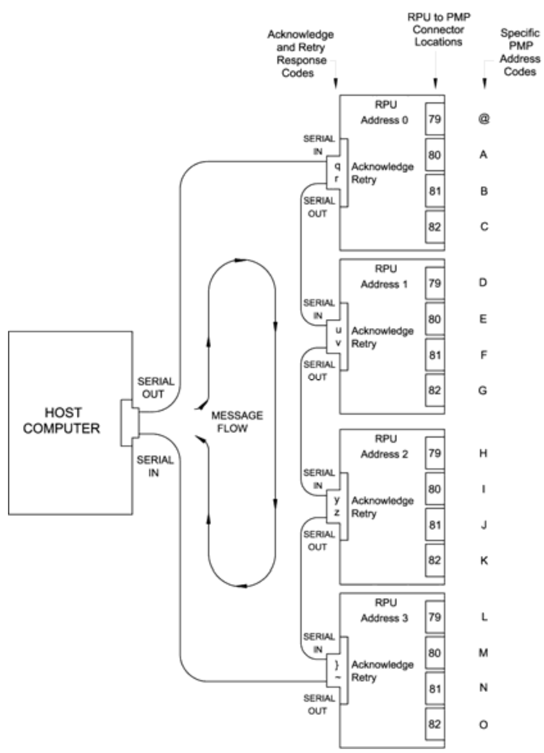


Figure 8

PMP Actuated Switch Codes

When any one of the sixteen PMPs connected in a network is actuated, the Hall-Effect switch within that PMP signals the RPU that an actuation has occurred. The RPU then transmits an Actuated Switch response code to the host computer. The transmitted Actuated Switch Response code depends on the specific Address code of the PMP that was actuated and identifies the actuated PMP to the host computer.

Figure 9 shows the Actuated Switch Response codes for each of the sixteen PMP Address codes. The PMPs have no individual coding and can be connected to any connector on any RPU. Each time a switch is actuated a single Actuated Switch Response code is transmitted by the RPU. Figure 10 shows the Actuated Switch Response codes for each of the specific PMP Address codes and the Acknowledge and Retry Response codes for four RPUs connected in a network.

PMP Actuated Switch Codes

RPU Address	Specific PMP Address Code	PMP Actuated Switch Response Code
0	@	`
0	A	a
0	B	b
0	C	c
1	D	d
1	E	e
1	F	f
1	G	g
2	H	h
2	I	i
2	J	j
2	K	k
3	L	l
3	M	m
3	N	n
3	O	o

Figure 9

PMP Actuated Switch Responses

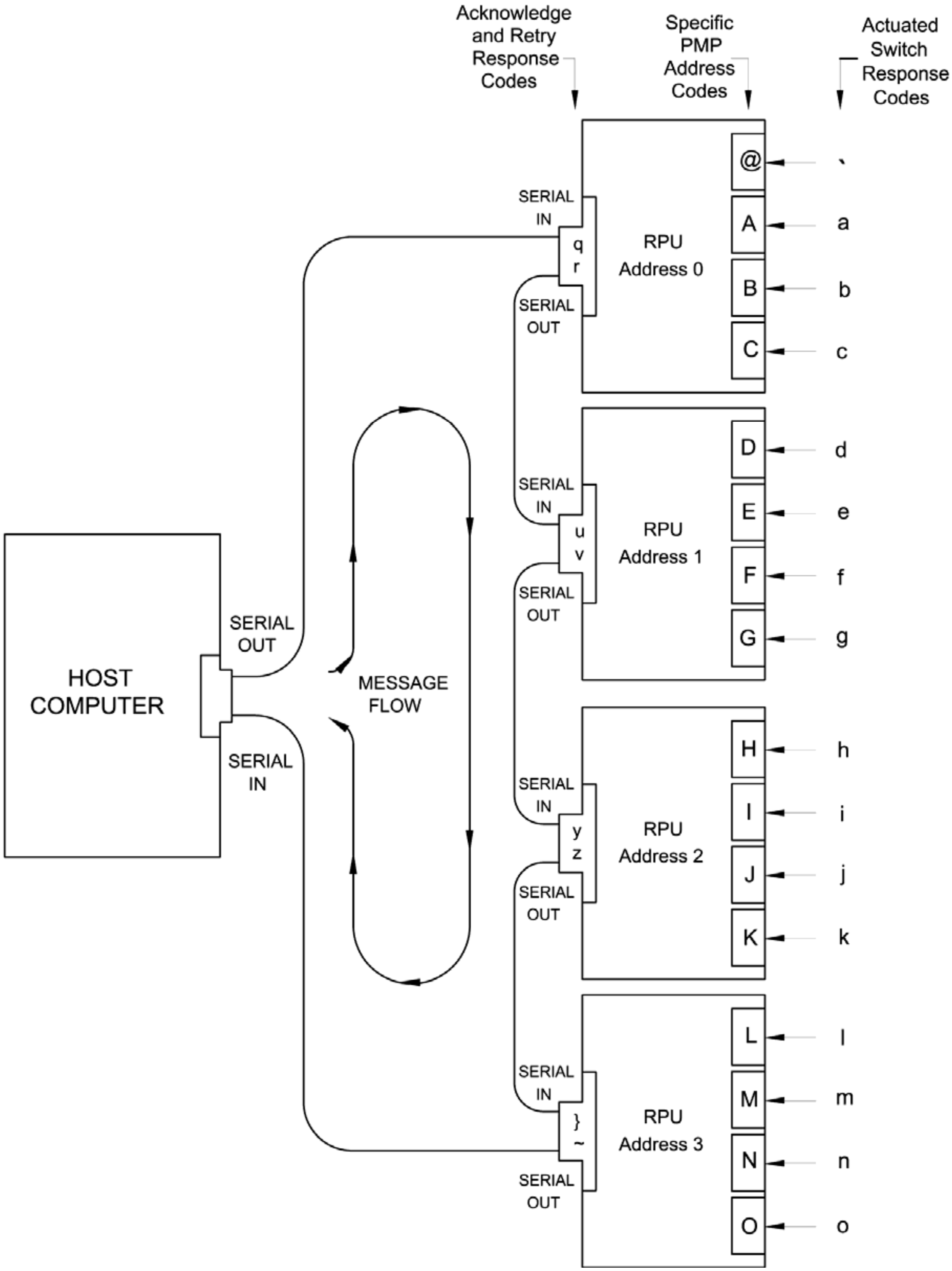


Figure 10

Summary of RPU Characteristics

Each RPU is Characterized for baud rate and Loop Network address by configuring the pin pairs at 72, 73, 74 and 75. The baud rate is determined by the configuration of the pin pairs at 72 and 73. The RPU jumper configuration at 72 and 73 determine:

1) The RPU address number.
2) The specific PMP Address Codes for each of the four RPU to PMP connectors.
3) The Acknowledge and Retry RPU Response codes.
4) The Actuated Switch RPU Response codes.

Figure 11 is a listing of the RPU address jumper configurations and the resulting Characterized RPU address, the specific PMP Address codes, the Acknowledge and Retry RPU Response codes and the Actuated Switch Response codes.

Summary of RPU Characteristics

RPU Address Jumper Settings		RPU Network Address	RPU to PMP Connector	Specific PMP Address Code	RPU Response Codes		
74	75				Acknowledge	Retry	Actuated Switch
C	C	0	79	@	q	r	`
C	C	0	80	A	q	r	a
C	C	0	81	B	q	r	b
C	C	0	82	C	q	r	c
O	C	1	79	D	u	v	d
O	C	1	80	E	u	v	e
O	C	1	81	F	u	v	f
O	C	1	82	G	u	v	g
C	O	2	79	H	y	z	h
C	O	2	80	I	y	z	i
C	O	2	81	J	y	z	j
C	O	2	82	K	y	z	k
O	O	3	79	L	}	~	l
O	O	3	80	M	}	~	m
O	O	3	81	N	}	~	n
O	O	3	82	O	}	~	o

Figure 11

SERIAL COMMUNICATIONS

All communications between the host computer and the RPU whether RS-422 or RS-232C are performed using asynchronous serial data. The ASCII communications characters consist of 1 start bit, 7 data bits, 1 odd parity bit, and 1 stop bit, for a total of 10 bits per character. Parity is used by both the RPU and (through message echoing) the host computer to check message and response code validity. All RPU communications are performed in a full duplex mode with the host computer.

In asynchronous communications, the proper reception and framing of ASCII characters is dependent upon being able to determine the timing of the initial start bit of each character. It is for this reason that the RPU incorporates data buffering and management features that ensure that at least one bit time is inserted between echoed ASCII characters.

THE ASCII CHARACTER SET

All characters used to communicate with the RPU are within the ASCII character set. Figure 12 lists the industry standard ASCII characters and their corresponding hexadecimal values.

Characters transmitted from the host computer to the RPU are restricted to the range of 00 hex to 5F hex and are echoed back by the RPU.

Response codes transmitted from the RPU to the host computer are restricted to the range of 60 hex to 7F hex. If the host computer transmits a character in this range, it will be echoed back to the host computer by the RPU but otherwise ignored.

The ASCII Character Set

Hexadecimal MSB

Hexadecimal LSB	0	1	2	3	4	5	6	7
0	NUL	DLE	SP	0	@	P	`	p
1	ctrl-A	DC1	!	1	A	Q	a	q
2	ctrl-B	DC2	"	2	B	R	b	r
3	ETX	DC3	#	3	C	S	c	s
4	EOT	DC4	$	4	D	T	d	t
5	ENQ	NAK	%	5	E	U	e	u
6	ACK	SYN	&	6	F	V	f	v
7	BEL	ETB	'	7	G	W	g	W
8	BS	CAN	(	8	H	X	h	x
9	HT	EM	)	9	I	Y	i	y
A	LF	SUB	*	:	J	Z	j	z
B	VT	ESC	+	;	K	[	k	{
C	FF	FS	,	<	L	\	l	|
D	cr	GS	-	=	M	]	m	}
E	SO	RS	.	>	N	^	n	~
F	SI	US	/	?	O	_	o	del

Figure 12

MESSAGE STRUCTURE

Messages are formed by strings of ASCII characters. The message structure requires that all messages transmitted by the host computer must begin with a message Preamble character and end with a Carriage Return. The Preamble character informs the RPU of the category of message that is being transmitted and the Carriage Return informs the RPU that message transmission is complete. The characters between the Preamble and the Carriage Return depend upon the message type and may include Address codes, Command codes and legend data characters.

MESSAGE CATEGORIES

There are two message categories, Global and Specific, defined by the message Preamble character. Global messages are executed by all RPUs regardless of RPU address configuration and Specific messages are directed to a single RPU with a specific address configuration. Specific category messages can affect all or any one of the PMP switches controlled by the addressed RPU. The Preamble character used for Global category messages is Control-A (01 hex) while the Preamble character used for Specific category messages is Control-B (02 hex).

Global category messages are executed by all RPUs regardless of address configuration and require no addressing information within the message. Specific messages that are to be executed by a single RPU board require an Address code. The character immediately following the Preamble in Specific messages is the PMP Address code.

Following the Address code in Specific category messages and following the Preamble code in Global category messages is the Command code. The Command code informs the RPU of the desired operation to be performed. Some commands are control oriented and require no additional data. Others that create legends require additional data necessary to supply the RPU with detailed information about the legend that is to be displayed.

Once all data required by the Command code has been transmitted to the RPU, a Carriage Return character (0D hex) must be transmitted in order to complete the message. No action will be taken by the RPU until a Carriage Return character is received. Once a valid Carriage Return is received, the RPU will check the message for validity, execute the command and transmit a response code. When a Global category message is transmitted, all RPUs within the network check the message for validity, execute the command and transmit a response code. When a Specific category message is transmitted, only the RPU controlling the addressed PMP will check the message for validity, execute the command and transmit a response code.

In the following message examples, abbreviations will be used to represent certain ASCII characters. The character Control-A will be abbreviated ctrl-A, Control-B as ctrl-B, Space as §, Carriage Return as cr and Delete as del.

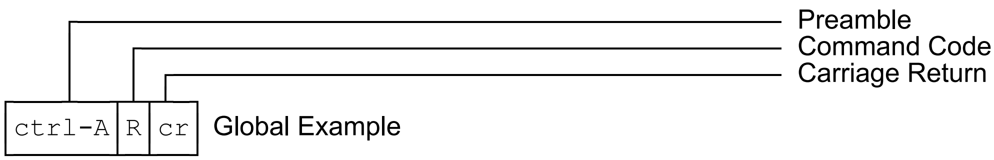
GENERAL MESSAGES

General messages may be transmitted as either a Global or Specific message. When transmitted as a Global, the message will be executed by all RPUs within the network. When transmitted as a Specific, only the addressed RPU will execute the message. When transmitting a General message as a Specific, any one of the PMP address codes controlled by that RPU may be used.

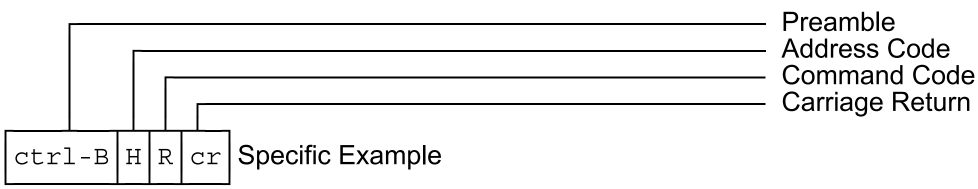
Command
Code

R- Restart Blink Timer

This Command synchronizes the blink timers on all RPUs in a network. This insures that all PMP switch displays within the network blink in unison.



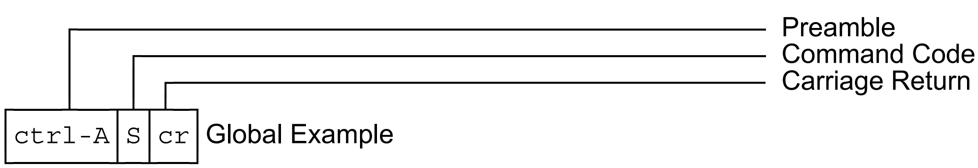
This message restarts the blink timers on all RPUs in the network.



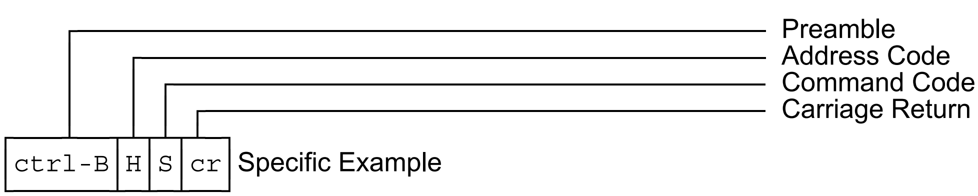
This message restarts the blink timer on RPU address 2 only.

S- Switch Status Request

This Command requests that RPUs with PMP switches held depressed report this condition to the host computer. The RPUs will respond with the Actuated Switch codes of any PMP held depressed. An Acknowledge code will be transmitted by the RPU upon completion of the command.



This message requests switch status from all network RPUs.

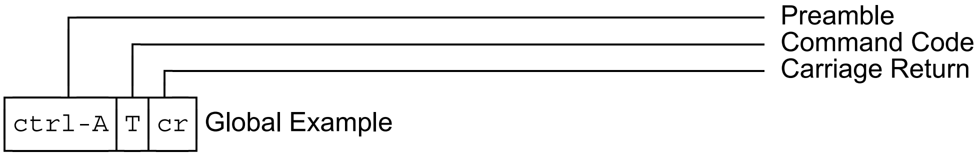


This message requests switch status from RPU address 2 only.

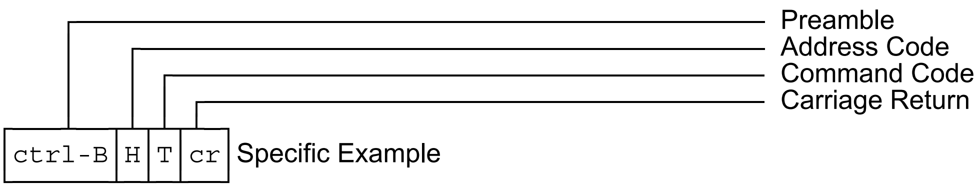
Command Code

T- Enable All Displays

This Command activates all PMP switch displays restoring the PMP legends, Luminance Control values and Blinking conditions from the RPU legend memory. It is used after transmitting an Inhibit Display or an Inhibit All Displays Command. All PMP switch displays are Enabled after power up.



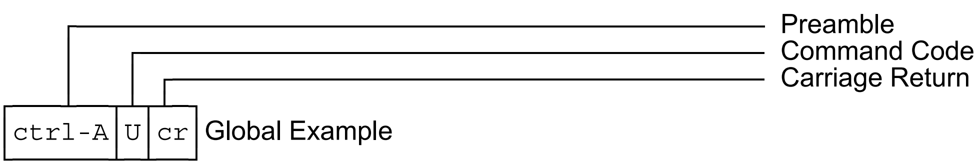
This message enables all displays in the network.



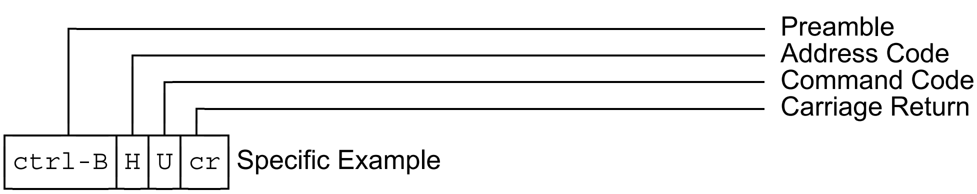
This message enables all displays on RPU address 2 only.

U- Inhibit All Displays

This Command blanks all PMP switch displays without destroying the legend information in the RPU legend memory. The PMP legends, Luminance Control values and Blinking conditions remain unchanged within the RPU legend memory. An Enable Display or Enable All Displays Command is used to restore the legend information on the PMP switch displays.



This message inhibits all displays in the network.

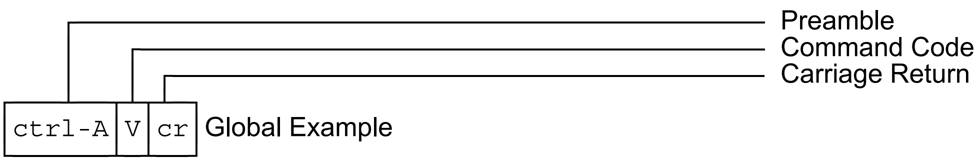


This message inhibits all displays on RPU address 2 only.

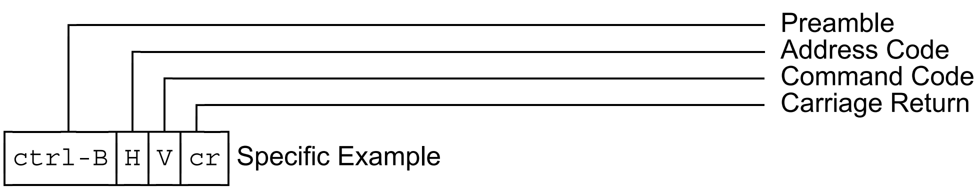
Command
Code

V- Communications Check

This Command requests an Acknowledge response code from the RPU and is used to verify the integrity of the serial communications link.



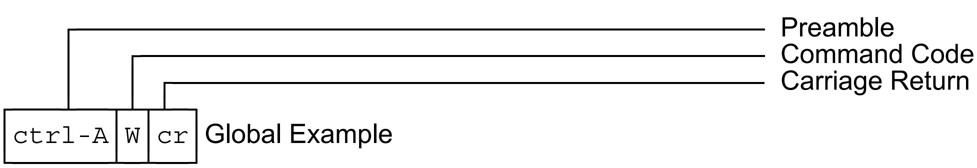
This message requests an Acknowledge response code from all network RPUs.



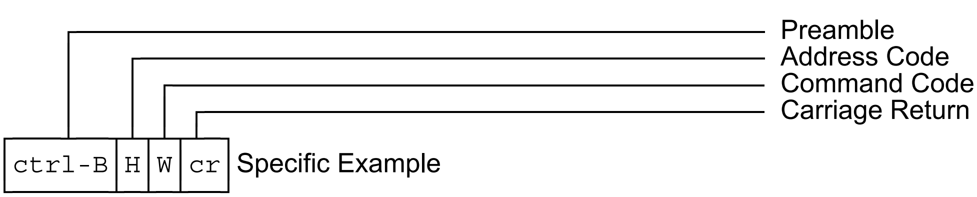
This message requests an Acknowledge response code from RPU address 2 only.

W- Clear All Displays

This Command erases the legend information of all four PMP switch displays controlled by an RPU. All blinking PMP switch displays will be returned to the non-blinking condition. The previously transmitted Luminance Control value will be unaffected.



This message erases all legend information on all network PMP switch displays.



This message erases all legend information on the four PMP switch displays controlled by RPU address 2.

Command
Code

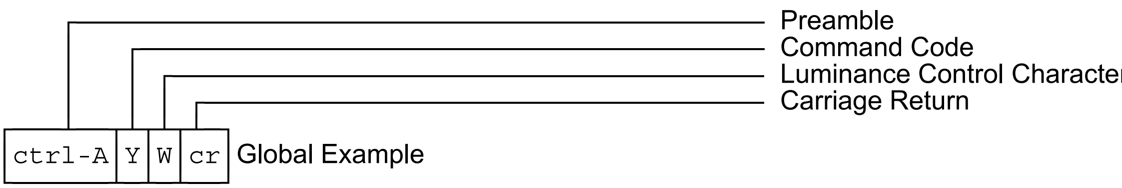
Y- Luminance Control

This Command controls the legend luminance on all four PMP switch displays controlled by an RPU. The Luminance Control value can be set to any one of 35 levels. The Luminance Control Character is transmitted immediately after the Command code and is described in Figure 13. After RPU power up, the Luminance Control value is automatically preset to the maximum value of Y.

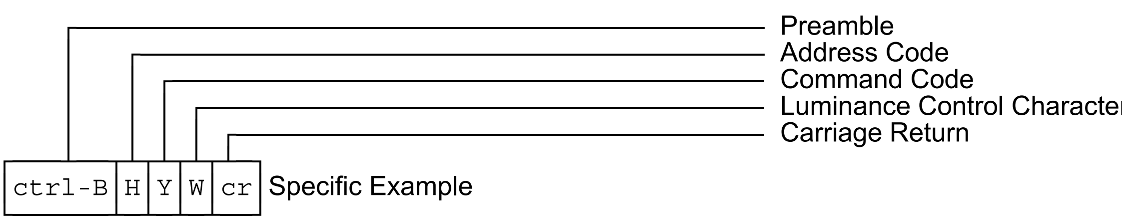
Luminance Control Character

```
0 1 2 3 4 5 6 7 8 9 A B C D E F G H I J K L M N O P Q R S T U V W X Y
|                                                                    |
└──Minimum Display Luminance           Maximum Display Luminance─────┘
```

Figure 13



This message sets the luminance of all PMP switch displays within the network to luminance level 33.



This message sets the luminance of all four PMP switch displays controlled by RPU address 2 to luminance level 33.

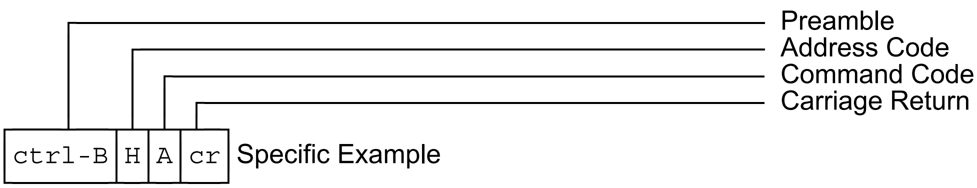
CONTROL MESSAGES

All Control Messages are Specific and addressed to a single PMP switch. Each Control Message must contain the PMP Address code immediately following the Preamble. None of the Control Messages require any data characters following the Command code.

<u>Command</u>
<u>Code</u>

A- All Pixels On

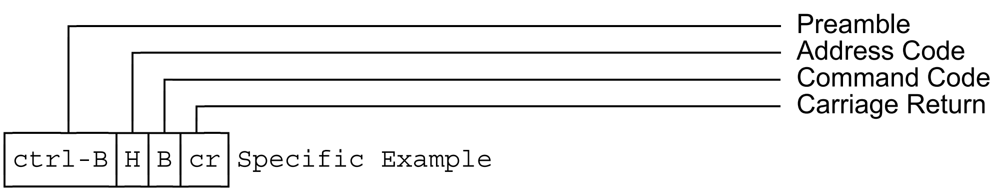
This Command energizes all pixels in the display of the Addressed PMP switch display for use as an LED test pattern.



This message energizes all pixels on the PMP switch display attached to connector 79 on RPU address 2.

B- Blink Display

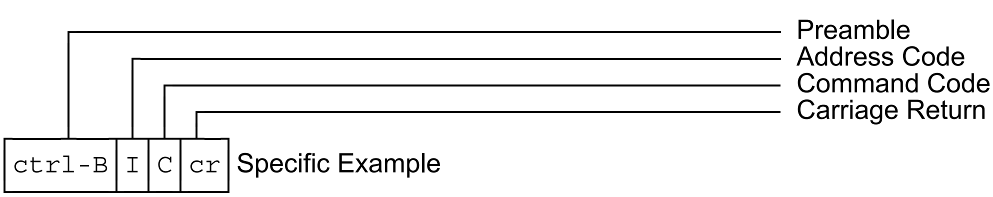
This Command causes the addressed PMP switch display to begin blinking at a rate of 1.5 Hertz. When commanded to blink, a PMP switch display will remain blinking until a Stop Blink Display, Clear Display, Clear All Displays or Self Test message is transmitted by the host computer. The blink timers on network RPUs may be synchronized using the Global message Restart Blink Timers.



This message causes the PMP switch display attached to connector 79 on RPU address 2 to begin blinking.

C- Clear Display

This Command erases the legend information on the Addressed PMP switch display. If the Addressed PMP switch display is blinking, it will be returned to non-blinking. The legend information on all other PMP switches is unchanged. The luminance value will be unaffected.

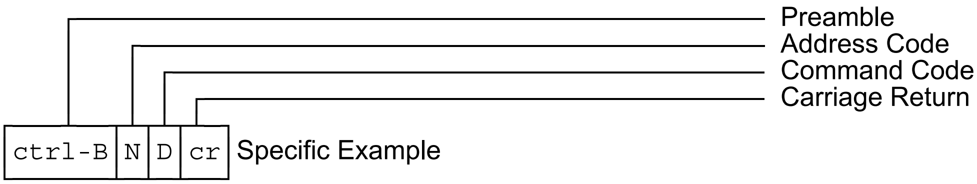


This message clears the legend information on the PMP switch attached to connector 80 on RPU address 2.

Command
Code

D- Inhibit Display

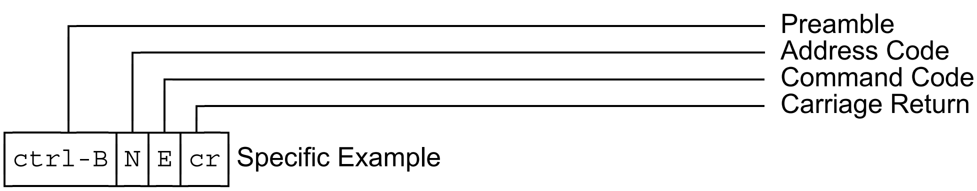
This Command deactivates the Addressed PMP switch display without destroying the legend information in the RPU legend memory. The PMP legend, luminance value and blinking condition remain unchanged within the RPU legend memory. An Enable Display or Enable All Displays Command is used to restore the legend information on the PMP switch display.



This message inhibits the PMP switch display attached to connector 81 on RPU address 3.

E- Enable Display

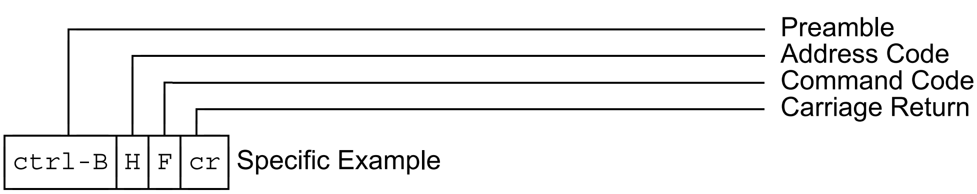
This Command activates the Addressed PMP switch display restoring the PMP legend, luminance value and blinking condition from the RPU legend memory. It is used after transmitting an Inhibit Display or an Inhibit All Displays Command. All PMP switch displays are enabled after power up.



This message enables the PMP switch display attached to connector 81 on RPU address 3.

F- Stop Blink Display

This Command will return the Addressed PMP switch display to a non-blinking condition if it had been previously commanded to blink by the Blink Display command. No previously transmitted legend information is lost.



This message returns the blinking PMP switch display attached to connector 79 on RPU address 2 to a non-blinking state.

DISPLAY COORDINATES

The display matrix consists of 560 LED pixels arranged into an array of 16 horizontal rows by 35 vertical columns. Each LED has a unique X (horizontal) and Y (vertical) Coordinate. Legend information may be placed anywhere within this array. To inform the RPU of the desired legend position, coordinates must be transmitted within the message by the host computer.

These X and Y legend Coordinates are always transmitted to the RPU immediately following the Command code. To improve message efficiency, a single character Coordinate code has been assigned to represent each X and Y coordinate. These X and Y Coordinate codes and locations are shown in Figure 14.

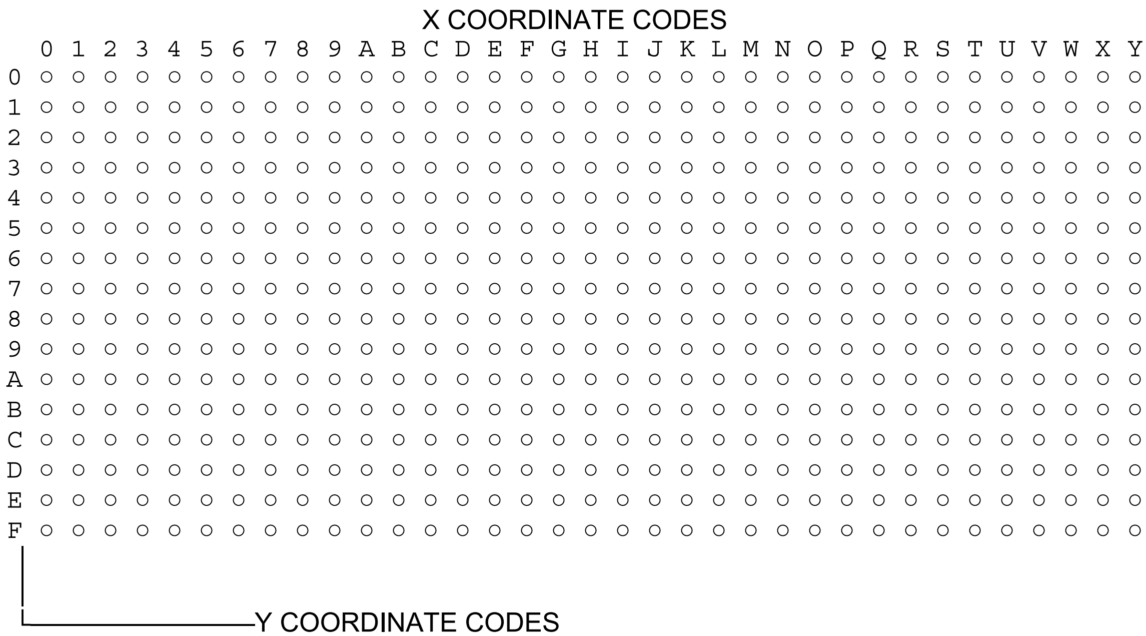


Figure 14

TEXT MESSAGES

Text messages are used to display one or more alphanumeric characters in a single line on a PMP switch display. Any of the 64 ASCII characters in the range of 20 hex to 5F hex may be displayed. Conversion of the ASCII characters to their equivalent pixel patterns is performed by the RPU. Text messages are Specific and always transmitted to a single PMP switch. A PMP Address code must be included in Text messages immediately following the preamble.

Two character formats are available with Text messages and are specified by the Command code that immediately follows the PMP Address code. The two available formats are 5x7 and 10x14. Either one line of 3 characters in the 10x14 format or two lines of 6 characters in the 5x7 format can be displayed on the PMP switch display at one time. Two separate messages are required to produce two lines of characters on the display.

The two characters that immediately follow the Command code are the horizontal (X) and vertical (Y) Coordinate codes to specify the location on the PMP display where the text data characters are to be placed. The text data characters are then transmitted to the RPU following the X and Y Coordinate codes. The first text data character is placed on the PMP display with the upper left corner of the 5x7 or 10x14 character area at the specified location. The pixel pattern of the first text data character is written to the right of the specified X and Y Coordinate codes. All other text data characters within the message are placed in a line to the right of the first character. A Carriage Return follows the last text data character to be written on the PMP switch display.

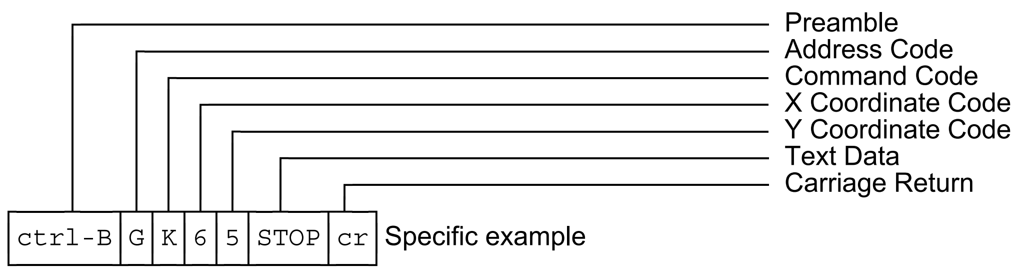
When text data characters are placed on the PMP switch display, a gap is automatically inserted between consecutive characters by the RPU. In the 5x7 format, the gap between consecutive characters is one pixel in width and is inserted to the right of the Text data character. In the 10x14 format, the gap is two pixels in width and both are inserted to the right of the Text data character. The total text data character area, including the gap between consecutive characters is 6 pixels in width by 7 pixels in height for the 5x7 format; and 12 pixels in width and 14 pixels in height for the 10x14 format. Any pixel patterns previously transmitted to the display that are within the text data character area will be replaced with the new character pattern. Only the previously transmitted pixel patterns within the total text data character pattern area will be affected. When complete replacement of the existing pixel pattern on the PMP display is desired, a Clear Display Command should precede the text message. This will insure that all previously transmitted legend information is removed from the PMP switch display.

Command
Code

K- 5x7 Text

This Command places from 1 to 6 ASCII characters in the 5x7 Text format in a single line on the addressed PMP switch display. A one pixel wide gap is automatically inserted by the RPU between consecutive characters placed on the display. Each character replaces any existing legend information that may be in the same 6x7 pixel area.

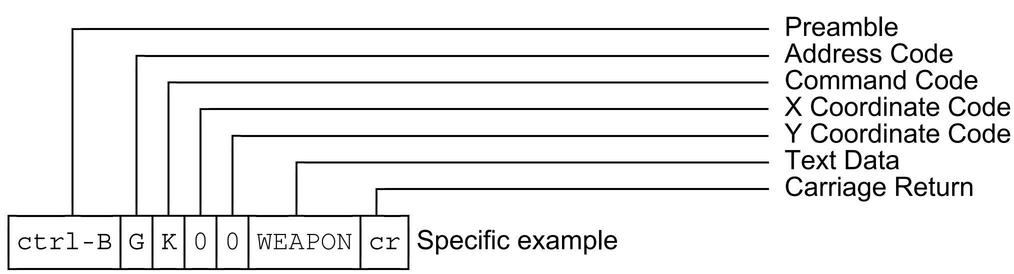
One Line 5x7 Text Example



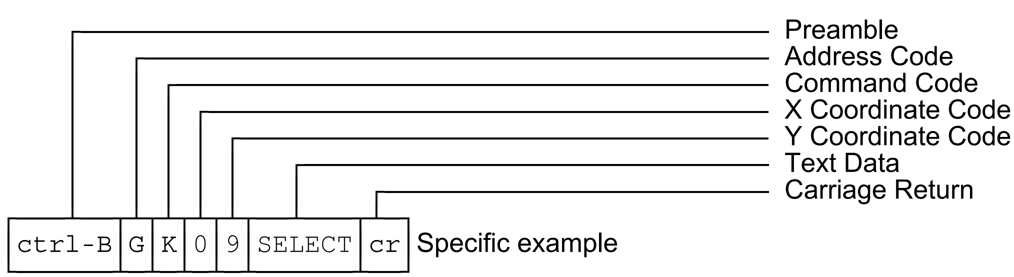
This message places the single line 5x7 text legend "STOP" at the coordinates X=6 and Y=5 on the PMP attached to connector 82 on RPU address 1.

Two Line 5x7 Text Example

Two separate Text messages are needed to produce two lines of characters on the same display. Up to twelve 5x7 Text characters may be placed on a PMP switch display. In the following example, the legend "WEAPON" is to be placed above the legend "SELECT" on the PMP switch display attached to connector 82 on RPU address 1.



This message places the 5x7 text message "WEAPON" on the top half of the display.

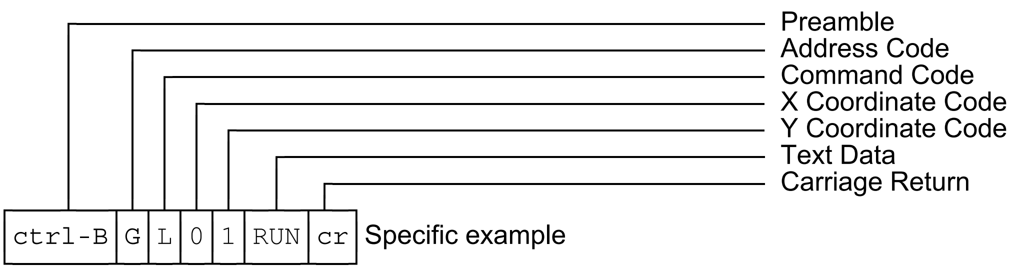


This message places the 5x7 text message "SELECT" on the lower half of the display.

Command Code

L- 10x14 Text

This Command places from 1 to 3 ASCII characters in the 10x14 Text format in a single line on the addressed PMP switch display. A two pixel wide gap is automatically inserted by the RPU between consecutive characters placed on the display. Each character replaces any existing legend information that may be in the same 12x14 pixel area.



This message places the single line 10x14 text "RUN" at coordinates X=0 and Y=1 on the PMP attached to connector 82 on RPU address 1.

LINE MESSAGES

Line Messages are Specific messages that are used to draw horizontal or vertical lines on the Addressed PMP display. The message begins with the Preamble, the PMP Address code and the Command code that specifies the line type, horizontal or vertical. Following the Command code is the Line Length code that can specify line lengths from 1 to 35 pixels as shown in Figure 15. Lines specified to extend beyond the edge of the display stop at the display edge without error.

From 1 to 15 identical length lines can be drawn with a single message. Following the Length code is the X and Y coordinate pair for the starting point of the first line to be drawn. The following Coordinate pairs specify the starting point for each of the following lines. The Coordinate pair specifies the top most point for vertical lines and the left most point for horizontal lines. Vertical lines are drawn from top to bottom and horizontal lines are drawn from left to right. Only the pixels within the lines to be drawn will be affected on the display. A Carriage Return follows the Coordinate pair of the last line to be drawn.

Line Length Codes

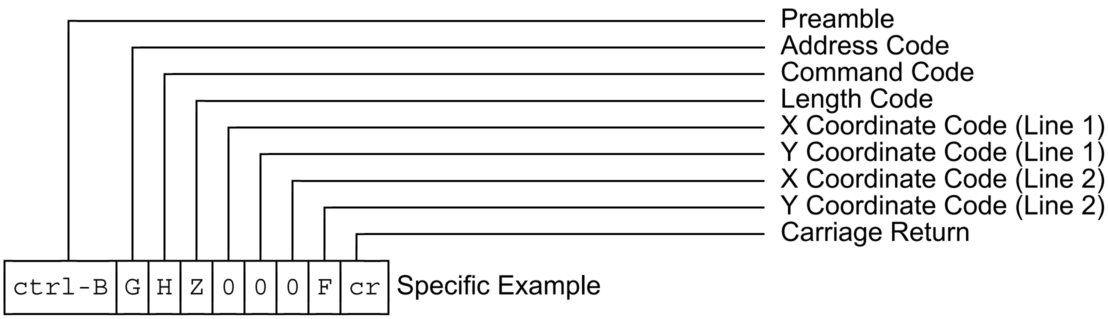
Length	Code	Length	Code	Length	Code	Length	Code	Length	Code
1	1	8	8	15	F	22	M	29	T
2	2	9	9	16	G	23	N	30	U
3	3	10	A	17	H	24	O	31	V
4	4	11	B	18	I	25	P	32	W
5	5	12	C	19	J	26	Q	33	X
6	6	13	D	20	K	27	R	34	Y
7	7	14	E	21	L	28	S	35	Z

Figure 15

Command
Code

H- Horizontal Line

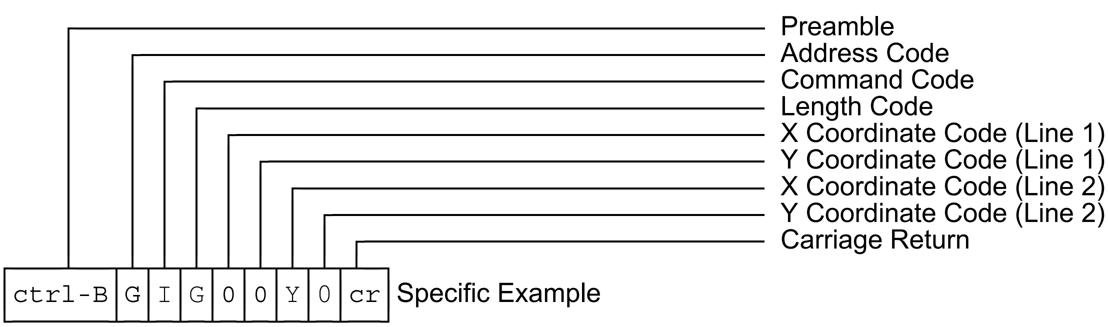
This command draws horizontal lines on the Addressed PMP switch display. Up to 15 horizontal lines of identical length may be drawn anywhere on the PMP switch display with a single message. Only the display pixels within the lines to be drawn will be affected. No other pixels previously energized will be affected.



This message draws two horizontal lines of 35 pixels in length each on the PMP switch display attached to connector 82 on RPU address 1. The first line is drawn across the top row (row 0) of the display and the second line is drawn across the bottom row (row F) of the display.

I- Vertical Line

This command draws vertical lines on the Addressed PMP switch display. Up to 15 identical length vertical lines can be drawn anywhere on the display surface with a single message. Only the display pixels within the lines to be drawn will be affected. No other pixels previously energized will be affected.



This message draws 2 vertical lines of 16 pixels in length each on the PMP switch display attached to connector 82 on RPU address 1. The first line is drawn down the left side (column 0) of the display and the second is drawn down the right side (column Y).

GRAPHICS MESSAGES

Graphics messages allow independent on/off control of each pixel in the Addressed PMP display. Any graphics pattern that can be drawn within the 16x35 LED array is possible.

Graphics Data Characters

Within the Graphics message, Data characters are used to instruct the RPU as to which pixels are to be turned on and which pixels are to be turned off. A single Data character controls the on/off status of six sequential pixels at a time. These six pixels are numbered 1 to 6 from left to right.

```
○ ○ ○ ○ ○ ○
1 2 3 4 5 6
```

The on/off pattern of these six pixels is determined by the Data character code. All possible on/off pixel patterns and their corresponding character codes are shown in Figure 16 where the "on pixels" are represented as darkened circles ● and the "off pixels" by an empty circle ○. For example, to turn on pixels 1 and 6 the pattern is ●○○○○● and the Data character from Figure 16 is A. To turn on pixels 1,3 and 5 the pattern is ●○●○●○ and the Data character from Figure 16 is 5. To turn off all six pixels the pattern is ○○○○○○ and the Data character from Figure 16 is a space character designated as §. All the data characters are restricted to the 64 ASCII characters with hexadecimal values ranging from 20 through 5F.

The 560 LED pixels in the PMP display are arranged in 16 rows with 35 pixels in each row. A single row of 35 pixels can be divided into 6 groups, the first group containing 5 pixels and the next 5 groups containing 6 pixels each.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
○○○○○	○○○○○○	○○○○○○	○○○○○○	○○○○○○	○○○○○○

The 6 pixels in Groups 2 through 6 are numbered 1 to 6 from left to right. The 5 pixels in Group 1 are numbered 2 through 6 from left to right. Group 1 does not have a pixel at location 1 and is so denoted by an X at that location. The pixel pattern of each group is controlled by the patterns specified in Figure 16.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
X○○○○○	○○○○○○	○○○○○○	○○○○○○	○○○○○○	○○○○○○
123456	123456	123456	123456	123456	123456
Data Char1	Data Char2	Data Char3	Data Char4	Data Char5	Data Char6

Six Data characters are required to control the pixel pattern of one entire row of 35 pixels. For example, to turn on pixel 6 in Group 1, pixels 5 and 6 in Group 2, pixels 4, 5 and 6 in Group 3, pixels 3, 4, 5 and 6 in Group 4, pixels 2, 3, 4, 5 and 6 in Group 5 and pixels 1, 2, 3, 4, 5 and 6 in Group 6 the pixel pattern and the Data character codes from Figure 16 are as follows:

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
X○○○○●	○○○○●●	○○○●●●	○○●●●●	○●●●●●	●●●●●●
123456	123456	123456	123456	123456	123456
Data Char1	Data Char2	Data Char3	Data Char4	Data Char5	Data Char6
@	P	X	\	^	_

Data character codes: @PX\^_

The X in Group 1 is used as a place holder and can always be considered as an off pixel when determining the pixel pattern and the corresponding Data Character code from Figure 16.

Graphics Message Structure

Complex pixel patterns can be displayed using Graphics messages. These messages are Specific category messages and begin with the Control-B Preamble followed by the PMP Address code and the message Command code. The character immediately following the Command code is the Graphics Row code from Figure 17 specifying the beginning row number for the pixel pattern. The following characters are the Data character codes that determine the actual pixel patterns.

The pixel pattern is specified sequentially row by row from the top of the display to the bottom. The pixel patterns for the 35 pixels in each row are designated by six consecutive Data character codes from Figure 16. The Data characters must be in multiples of six, up to 54 characters maximum, for a single message specifying nine consecutive rows of pixels. A Carriage Return character follows the Data characters to terminate the message. Two messages are required to display graphics patterns exceeding nine consecutive rows of pixels.

Data Character Codes

Pattern	Code	Pattern	Code	Pattern	Code	Pattern	Code
○○○○○○	§	○○○○●○	0	○○○○○●	@	○○○○●●	P
●○○○○○	!	●○○○●○	1	●○○○○●	A	●○○○●●	Q
○●○○○○	"	○●○○●○	2	○●○○○●	B	○●○○●●	R
●●○○○○	#	●●○○●○	3	●●○○○●	C	●●○○●●	S
○○●○○○	$	○○●○●○	4	○○●○○●	D	○○●○●●	T
●○●○○○	%	●○●○●○	5	●○●○○●	E	●○●○●●	U
○●●○○○	&	○●●○●○	6	○●●○○●	F	○●●○●●	V
●●●○○○	'	●●●○●○	7	●●●○○●	G	●●●○●●	W
○○○●○○	(	○○○●●○	8	○○○●○●	H	○○○●●●	X
●○○●○○	)	●○○●●○	9	●○○●○●	I	●○○●●●	Y
○●○●○○	*	○●○●●○	:	○●○●○●	J	○●○●●●	Z
●●○●○○	+	●●○●●○	;	●●○●○●	K	●●○●●●	[
○○●●○○	,	○○●●●○	<	○○●●○●	L	○○●●●●	\
●○●●○○	-	●○●●●○	=	●○●●○●	M	●○●●●●	]
○●●●○○	.	○●●●●○	>	○●●●○●	N	○●●●●●	^
●●●●○○	/	●●●●●○	?	●●●●○●	O	●●●●●●	_

Figure 16

Graphics Message Coding

The graphics message coding required to generate an actual pixel pattern can be derived using the following five steps:

Step 1- Make a diagram of the pixel pattern on the Graphics Template in Figure 17 showing the "on" pixels as filled in circles ● and the off pixels as empty circles ○. This template has been divided into the six groups necessary for coding the pixel pattern.

Step 2- Place an asterisk beside the Graphics Row code on the Graphics Template in which the first "on" pixel occurs. This row number is the starting Graphics Row code for the message and precedes the Data character codes.

Step 3- Fill in the Data Template in Figure 18 with the Data character codes from Figure 16 corresponding to the pixel patterns on the Graphics Template. The X's are place holders and interpreted as empty circles ○ when determining the Data character codes.

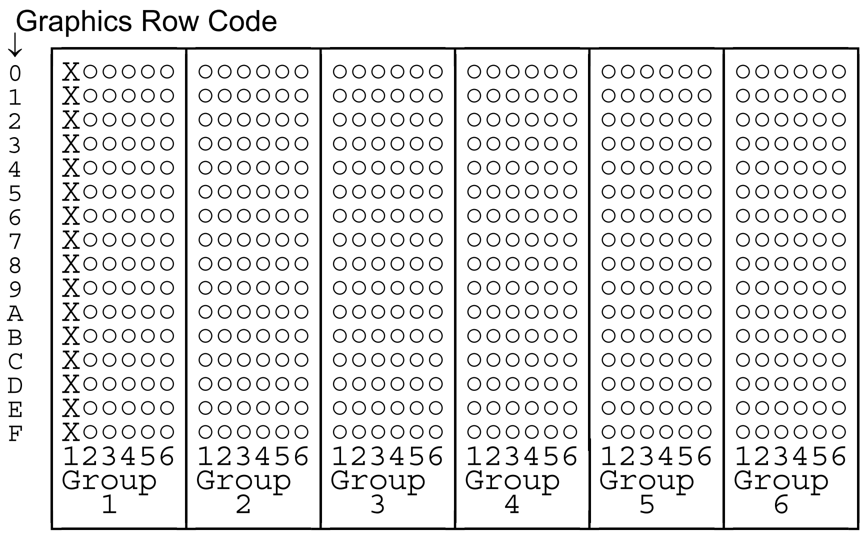
Step 4A- Beginning with the starting row number, list the Data character codes interpreted from the Data Template in a single line in sequence from left to right and top to bottom. This list will terminate at the end of the last row where pixels are "on" or at the end of nine consecutive rows.

Step 4B- If more than nine rows are involved, a second message is required. On the Graphics Template, place an asterisk beside the Graphics Row code number of the row following the last row coded in the first message. This is the Graphics Row code for the second message. List the Data character codes for this second message beginning with the Data character codes for the second row number with an asterisk and terminating at the end of the last row where pixels are "on".

Step 5A- Form the Graphics message by listing the Control-B Preamble, PMP Address code, Graphics Command code, Graphics Row code for the first message, the list of Data character codes for the first message from Step 4A and Carriage Return to terminate the message.

Step 5B- If a second Graphics message is required, it is formed in the same manner except the Graphics Row code and the list of Data character codes used are those that were determined in Step 4B for the second message.

Graphics Template



<u>Note:</u> Pixel position 1 of Group 1 is ignored by the RPU.

Figure 17

Data Template

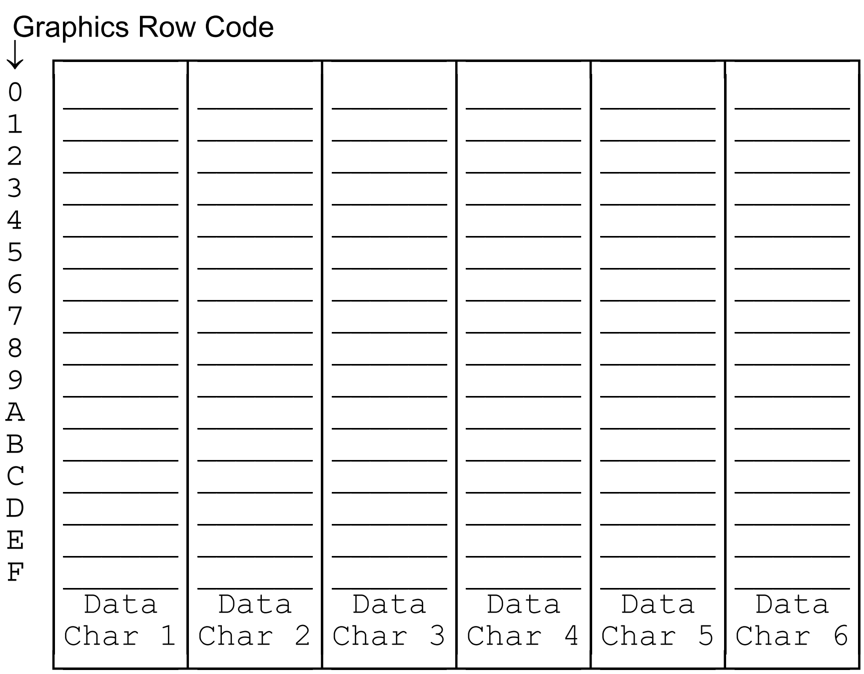


Figure 18

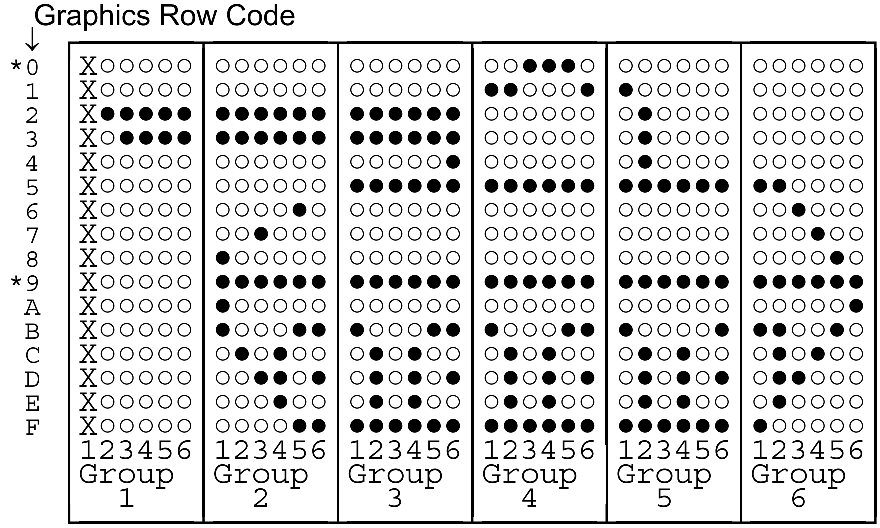
Command
Code

M- Graphics

This command allows independent on/off control of each pixel in the Addressed PMP switch display. The following example illustrates each of the five steps in creating a Graphics message.

Step 1- Draw the desired pixel pattern on the Graphics Template as in Figure 19.

Step 2- Place an asterisk beside the starting Graphics Row code as in Figure 19.



Note: Pixel position 1 of Group 1 is ignored by the RPU.
Figure 19

Step 3- Enter the Data Character codes corresponding to the Graphics Template pixel patterns in the Data Template as in Figure 20. Figure 21 is identical to Figure 16 and shows all of the Graphics pixel patterns and their corresponding Data Character codes.

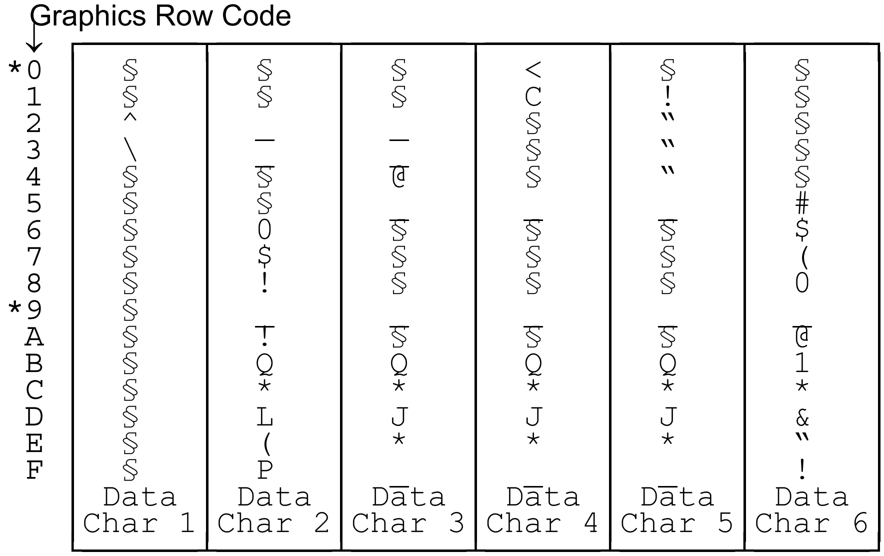


Figure 20

Data Character Codes

Pattern	Code	Pattern	Code	Pattern	Code	Pattern	Code
○○○○○○	§	○○○○●○	0	○○○○○●	@	○○○○●●	P
●○○○○○	!	●○○○●○	1	●○○○○●	A	●○○○●●	Q
○●○○○○	"	○●○○●○	2	○●○○○●	B	○●○○●●	R
●●○○○○	#	●●○○●○	3	●●○○○●	C	●●○○●●	S
○○●○○○	$	○○●○●○	4	○○●○○●	D	○○●○●●	T
●○●○○○	%	●○●○●○	5	●○●○○●	E	●○●○●●	U
○●●○○○	&	○●●○●○	6	○●●○○●	F	○●●○●●	V
●●●○○○	'	●●●○●○	7	●●●○○●	G	●●●○●●	W
○○○●○○	(	○○○●●○	8	○○○●○●	H	○○○●●●	X
●○○●○○	)	●○○●●○	9	●○○●○●	I	●○○●●●	Y
○●○●○○	*	○●○●●○	:	○●○●○●	J	○●○●●●	Z
●●○●○○	+	●●○●●○	;	●●○●○●	K	●●○●●●	[
○○●●○○	,	○○●●●○	<	○○●●○●	L	○○●●●●	\
●○●●○○	-	●○●●●○	=	●○●●○●	M	●○●●●●	]
○●●●○○	.	○●●●●○	>	○●●●○●	N	○●●●●●	^
●●●●○○	/	●●●●●○	?	●●●●○●	O	●●●●●●	_

Figure 21

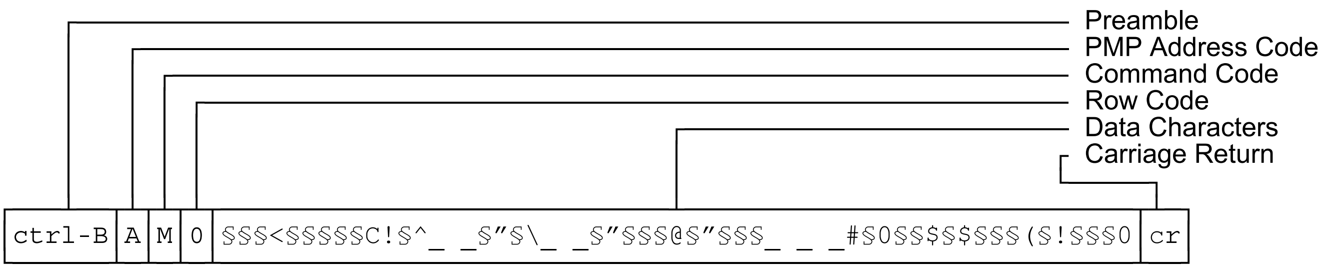
Step 4A- Make a list of the 54 Data Character codes for the first Graphics message:

§§§<§§§§§C!§^_ _§”§_ _§”§§§@§”§§§_ _ _#§0§§$§$§§§(§!§§§0

Step 4B- Make a list of the 42 Data Character codes for the second Graphics message:

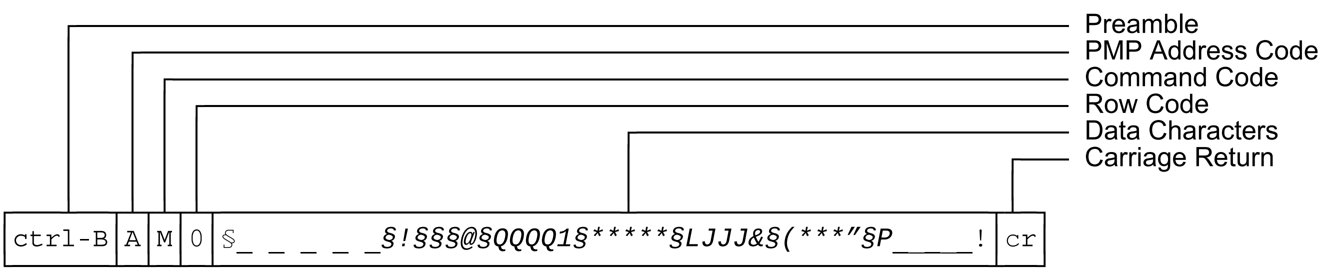
§_ _ _ _ _§!§§§@§QQQ1§*****§LJJJ&§(***”§P _ _ _!

Step 5A- Form the first Graphics message to be transmitted to the RPU:



This message places graphics pixel patterns on Row 0 through Row 8 on the PMP switch display attached to connector 80 on RPU address 1.

Step 5B- Form the second Graphics message to be transmitted to the RPU:



This message places graphics pixel patterns on Row 9 through Row F on the PMP switch display attached to connector 80 on RPU address 1.

SELF-TEST

On command from the host computer, the RPU can perform a Self-Test to verify that the microprocessor is operating properly. A Self-Test Response code (codes are shown in Figure 22) followed by an acknowledge code will be transmitted from the RPU to the host computer once the Self-Test is completed. During power up a Self-Test is performed by each RPU in the network; however only RPUs that fail the Self-Test will send a response back to the host computer. If the RPUs pass the power up Self-Test no response is transmitted back to the host computer.

Self-Test Response codes

RPU Address	Pass	Fail
0	p	s
1	t	w
2	x	{
3	|	del

Figure 22

Self-Test Response-Passed

A Self-Test Passed RPU response code informs the host computer that the RPU microprocessor is operating properly. This provides assurance that the RPU is capable of properly interpreting and displaying host computer messages.

Self-Test Response-Failed

A Self-Test Failed RPU Response code indicates that the RPU microprocessor is not working properly. When a failure is detected, the RPU will continue to echo characters as long as possible to allow communications with other RPUs within the network.

Self-Test Effects on Legend Information

During Self-Test all PMP legend information will be destroyed, clearing all 4 PMP displays. Any of the 4 PMPs that were inhibited will be enabled and any of the 4 PMPs that were blinking will be returned to the non-blinking condition. The previous luminance setting for the PMP switches will remain unchanged. The effects on legend information resulting from a Self-Test on the RPU are identical to a Clear All Displays command.

Self-Test Message

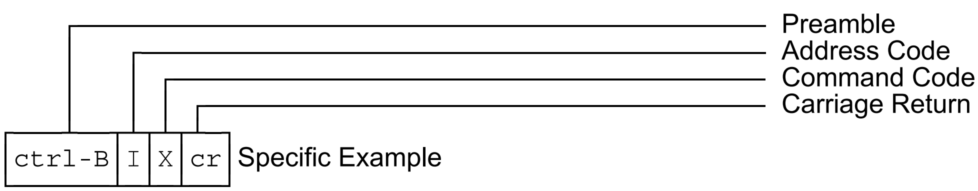
The Self-Test message is a Specific category message that requests the addressed RPU to perform internal diagnostics tests on the microprocessor and respond back to the host computer. The Address code used within the message may be any of the Address codes of the PMP switches controlled by that RPU. A Self-Test message consists of a Control-B Preamble, Address code, Command code and Carriage Return. The addressed RPU will respond back to the host computer with the results of the Self-Test. The Self Test response codes for each RPU address are listed in Figure 22. Self-Test is also performed automatically by each RPU after power up. During a power up Self-Test, only the RPUs that fail Self-Test will respond back to the host computer. If the RPUs pass the power up Self-Test, no response is transmitted to the host computer.

During VIVISUN 5000 RPU power-up, the host computer should wait a minimum of 50 milliseconds before transmitting message data to allow the RPU time to complete internal diagnostics (see RPU POWER-DOWN AND RPU POWER-UP section).

Command
Code

X- Self-Test

This Command instructs the addressed RPU to perform an internal diagnostics test on the microprocessor circuitry. The RPU will transmit a Self-Test Response code to the host computer upon completion of testing. These response codes are described in Figure 22. The Self-Test Address code can be any PMP Address code controlled by the RPU. During Self-Test all legend information is destroyed, all inhibited displays are enabled and all blinking displays are returned to the non-blinking condition. The previous luminance setting for the PMP switches will remain unchanged.



This message requests RPU address 2 to perform a Self-Test and transmit the Self-Test Response code back to the host computer.

MIXED DISPLAY LEGENDS

The RPU allows multiple character formats, lines and graphics to be displayed simultaneously on the same PMP switch display. It is important that certain precautions be observed so that one legend will not overwrite the next legend. The order of messages producing mixed display legends should be transmitted to the RPU as follows:

1. Clear Display
2. 5x7 or 10x14 format text messages.
3. Graphics messages.
4. Horizontal or Vertical Line messages.

Before placing any new legend information on the PMP switch display, a Clear Display Command should be transmitted. This will prevent any old legend information from remaining on the display surface. Text messages should be transmitted next. The 5x7 format text message overwrites a 6x7 pixel area per character and the 10x14 format text message overwrites a 12x14 pixel area. Graphics messages overwrite an entire line of pixels and should be transmitted next. Line messages affect only the display pixels within the line to be drawn and should be transmitted last. The following examples illustrate multiple text formats, text with lines and text with graphics.

Mixed Format Text Messages

The following example utilizes two messages to display a combination of 10x14 format text and 5x7 format text. The legend that will be displayed is the chemical symbol for water, H_2O. The "H" and "O" will be displayed in the 10x14 format and the subscript "2" in the 5x7 format.

1. 10x14 Text Message

ctrl-B	F	L	0	0	H§O	cr	Specific Example

This message places the single line 10x14 format text message "H§O" on the PMP switch display attached to connector 81 on RPU address 1. Placing a space character between the "H" and the "O" allows room on the display for the subscript "2" to be transmitted in the next message.

2. 5x7 Text Message

ctrl-B	F	K	E	9	2	cr	Specific Example

This message places the single 5x7 format text character "2" as a subscript between the previously transmitted 10x14 format "H" and "O". The legend is placed on the PMP switch display attached to connector 81 on RPU address 1.

Text Messages and Line Messages

The following example utilizes three messages to display a combination of 5x7 text and lines. The final appearance of the display will be the text legend "STOP" surrounded by a box.

1. 5x7 Text Message

ctrl-B	G	K	6	5	STOP	cr	Specific Example

This message places the 5x7 format text legend "STOP" centered on the PMP switch display attached to connector 82 on RPU address 1.

2. Horizontal Line message

ctrl-B	G	H	Z	0	0	0	F	cr	Specific Example

This message draws two horizontal lines of 35 pixels in length each on the PMP switch display attached to connector 82 on RPU address 1. The first line is drawn across the top row (row 0) of the display and the second line is drawn across the bottom row (row F) of the display.

3. Vertical Line Message

ctrl-B	G	I	G	0	0	Y	0	cr	Specific Example

This message draws two vertical lines of 16 pixels in length each on the PMP switch display attached to connector 82 on RPU address 1. The first line is drawn down the left side (column 0) of the display and the second line is drawn down the right side (column Y).

Text Messages and Graphics Messages

The following example utilizes two messages to display a combination of 5x7 format text information and Graphics. The final appearance of the display will be the 5x7 format text legend "STOP" centered on the display with two rows of graphics information across the top of the display.

1. 5x7 Text Message

ctrl-B	G	K	6	5	STOP	cr	Specific Example

This message places the 5x7 format text legend "STOP" centered on the PMP switch display attached to connector 82 on RPU address 1.

2. Graphics Message

ctrl-B	G	M	0	nXP@/P"'/?P/	cr	Specific Example

This message places the graphics pattern shown below on rows 0 and 1 of the PMP attached to connector 82 on RPU address 1.

○●●●●	○○○●●●	○○○○●●	○○○○○●	●●●●○○	○○○○●●
●○○○○	●●●○○○	●●●●○○	●●●●●○	○○○○●●	●●●●○○

INVALID MESSAGES

If the message transmitted from the host computer to the RPU is declared invalid for any reason, the RPU will transmit a Retry response code back to the host computer. Errors detected within the structure of a message will result in the Retry code being transmitted by the RPU immediately upon detection of the error. Any of the following conditions will result in a Retry response code:

1. A parity error within the message.
2. An invalid Command code.
3. An invalid X Coordinate code.
4. An invalid Y Coordinate code.
5. A Line Length code specification of zero.
6. An invalid Graphics Row code.
7. An invalid character imbedded within a message.
8. A message that is too long.

No other action will be taken by the RPU in response to an invalid message, and no legend information will be lost from any of the PMP switch displays. The entire message must be retransmitted from the host computer upon receipt of the Retry response code.

Since it is possible for a message to be corrupted yet still contain valid data, it is mandatory that the host computer system not only check for a valid RPU Response code but also compare the echoed message to what was transmitted to be sure that the RPU acted upon the correct data.

RPU POWER-DOWN AND POWER-UP

When an impending power loss is detected, the RPU performs the following procedure:

1. At 4.375 ±.125 VDC, all displays are shut-down and refresh operation halted.
2. At 4.125 ±.125 VDC, the microprocessor is reset and goes to a low power mode.

This power-down sequence is designed to reduce the RPU and PMP power consumption so that the power supply voltage will be retained for as long as possible (see “RPU DISPLAY MEMORY RETENTION” section below for details on display memory retention). Upon the restoration of power above approximately 4.5 VDC, the RPU performs the following initialization procedure before accepting any commands or data from the host computer:

1. The baud rate is initialized according to the configuration of jumpers 72 and 73.
2. The Loop Network address is initialized according to the configuration of jumpers 74 and 75.
3. A Self-Test of the microprocessor is performed.
4. The display memory is tested to determine if valid data exists. If valid display data is detected, no operation is performed that would alter this data.
5. All 4 PMP switch displays are set in the non-blinking condition.
6. All 4 PMP switch displays are enabled.
7. The display luminance is set to maximum.

No response code is transmitted to the host computer after power up unless there is a failure condition detected during Self-Test. A failure of Self-Test will result in the transmission of a Self-Test Fail Response code to the host computer. To allow sufficient time for the proper initialization of the RPU, the host computer must wait at least 50 milliseconds after power is applied to the RPU before transmitting any messages.

RPU DISPLAY MEMORY RETENTION

The RPU incorporates advanced features that are designed to retain display information as long as possible should there be a momentary interruption in power. These features enable the display memory to be retained indefinitely with applied voltages at or above 2.0 VDC. As voltage falls below 2.0 VDC, the display memory may be lost.

If the retention of display memory is not desired, a Clear All Displays command should be transmitted to the RPU following the 50 millisecond power-up delay. Alternately, a Clear All Displays command can be transmitted to the RPU during power-down as long as the RPU receives and acknowledges the message prior to an applied voltage of 4.375 ±.125 VDC.

USING SWITCH STATUS REQUEST

The Switch Status Request message is used to determine if any PMP switches are being held depressed. The actuated switch response codes of any PMP switches held depressed will be transmitted by the RPU to the host computer in response to the Switch Status Request. There are several conditions that can result in the transmission of an actuated switch response code by the RPU when using the Switch Status Request message:

1. The PMP switch is being held depressed.
2. The PMP switch is mechanically damaged.
3. The PMP Hall-Effect switch is defective.
4. The PMP to RPU Cable Assembly has become damaged.

Any PMP switch that is found to be continually depressed should be suspect of being defective or damaged. A damaged PMP LED display will not result in a continually depressed switch unless the failure has caused mechanical or electrical damage to the Hall-Effect switch circuitry or mechanism.

RS-422 AND RS-232

The RPU is available with an RS-422 or optionally an RS-232 serial communications interface. A comparison of these interfaces based upon Electronic Industries Association (EIA) standards is shown in Figure 23.

RPU Interface Comparison

Parameter	RS-232	RS-422
Mode of Operation	Single Ended	Differential
Maximum Cable Length	50 Feet	4000 Feet
Maximum RPU Baud Rate	19200 Baud	19200 Baud
Driver Impedance	3K to 7K Ohms	100 Ohms

Figure 23

The RS-422 interface is designed for use with 100 ohm impedance twisted pair cables terminated in a 100 Ohm resistive load at the host computer. The twisted pair data lines operate in a differential mode of operation that is magnetically canceling, reducing message transmission EMI and greatly improving susceptibility to EMI induced data errors in electrically noisy environments. This interface is ideal for aircraft and military applications.

The RS-232 interface allows RPU messages to be easily transmitted from portable data terminals and personal computers. The cable length should be limited to 50 feet and shielded data cables should be used in electrically noisy environments and applications where cable radiated EMI during message transmission may be unacceptable. For these reasons, RS-232 is not recommended for airborne, military or other demanding applications.

CONNECTOR PINOUTS AND POWER SUPPLY REQUIREMENTS

The RPU to host interface connector is a Cannon type DAP-15PAA. The power requirements and pinouts for the RS-422 RPU are shown in Figure 24 and the RS-232 RPU in Figure 25.

RS-422 Pinout

Pin	Function
1	-Serial Input to RPU
2	+Serial Input to RPU
3 and 4	No Connection
5	+Serial Output From RPU
6	-Serial Output From RPU
7 and 8	No Connection
9,10,11	Power Ground
12 and 13	+5VDC (±0.25V), 0.1A typical RPU Logic Power Input
14 and 15	+5VDC (±0.25V), 3.0A max. (4 PMPs) Display Power Input

Figure 24

RS-232 Pinout

Pin	Function
1	Serial Input to RPU
2,3,4,5	No Connection
6	Serial Output From RPU
7 and 8	No Connection
9,10,11	Power and Signal Ground
12 and 13	+5VDC (±0.25V), 0.1A typical RPU Power Input
14 and 15	+5VDC (±0.25V), 3.0A max. (4 PMPs) Display Power Input

Figure 25

MESSAGE TRANSMITTAL AND COMMAND EXECUTION TIME

The total time required to transmit a message from the host computer and to receive the RPU Acknowledge response code back from the RPU is important. The host computer must wait for the Acknowledge response code from the RPU before transmitting the next message. The total time required to display a legend is dependent upon the message type, the message complexity and the communications baud rate.

Selecting the maximum baud rate of 19200 baud will result in the lowest possible message transmittal time. Typical times for message transmittal and Acknowledgement at 19200 baud for several example messages are as follows:

```
One 6 character 5x7 Text message------------- 17 ms.
One 54 character Graphics message------------ 41 ms.
```

Typical times for message transmittal and Acknowledgement at 19200 baud for four RPUs in a Loop Network are as follows:

```
32   6 character 5x7 Text messages----------- 550 ms.
16  54 character Graphics messages----------  650 ms.
32  48 character Graphics messages---------- 1210 ms.
```

PMP MOUNTING INSTRUCTIONS

1. The panel mounting cutout shall be as shown in Figure 26.

2. The panel thickness shall be between .062 and .125 inches.

3. Remove the mounting sleeve from the PMP switch.

4. Insert the PMP switch into the panel mounting cutout with the rubber sealing gasket in place.

5. Install the mounting sleeve onto the PMP switch and tighten the mounting screws to 3.0 inch-pounds maximum.

PMP Panel Mounting Cutouts

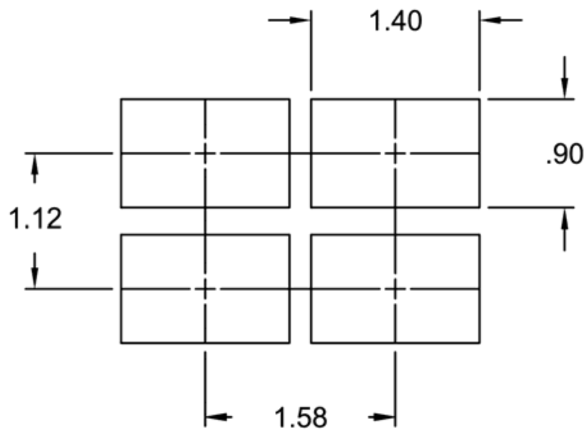


Figure 26

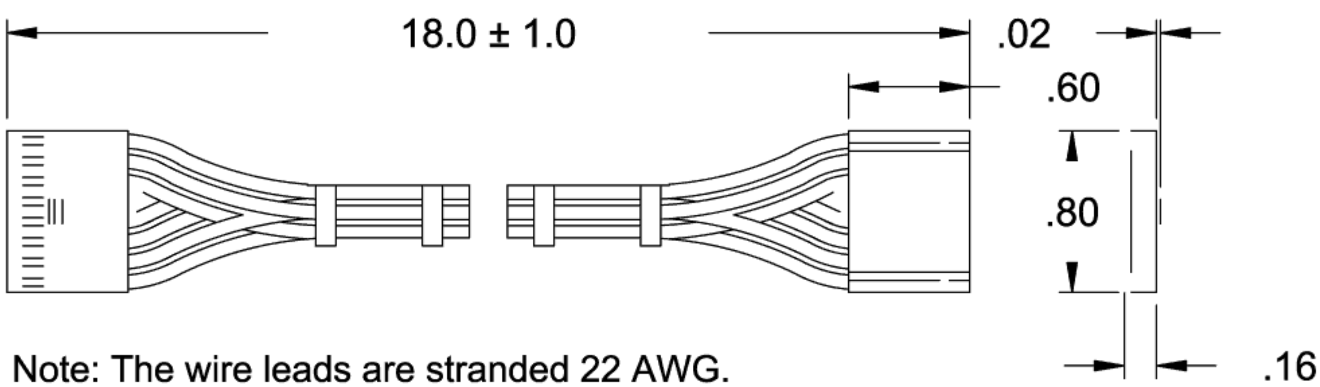


Figure 27

PMP AND RPU DIMENSIONS

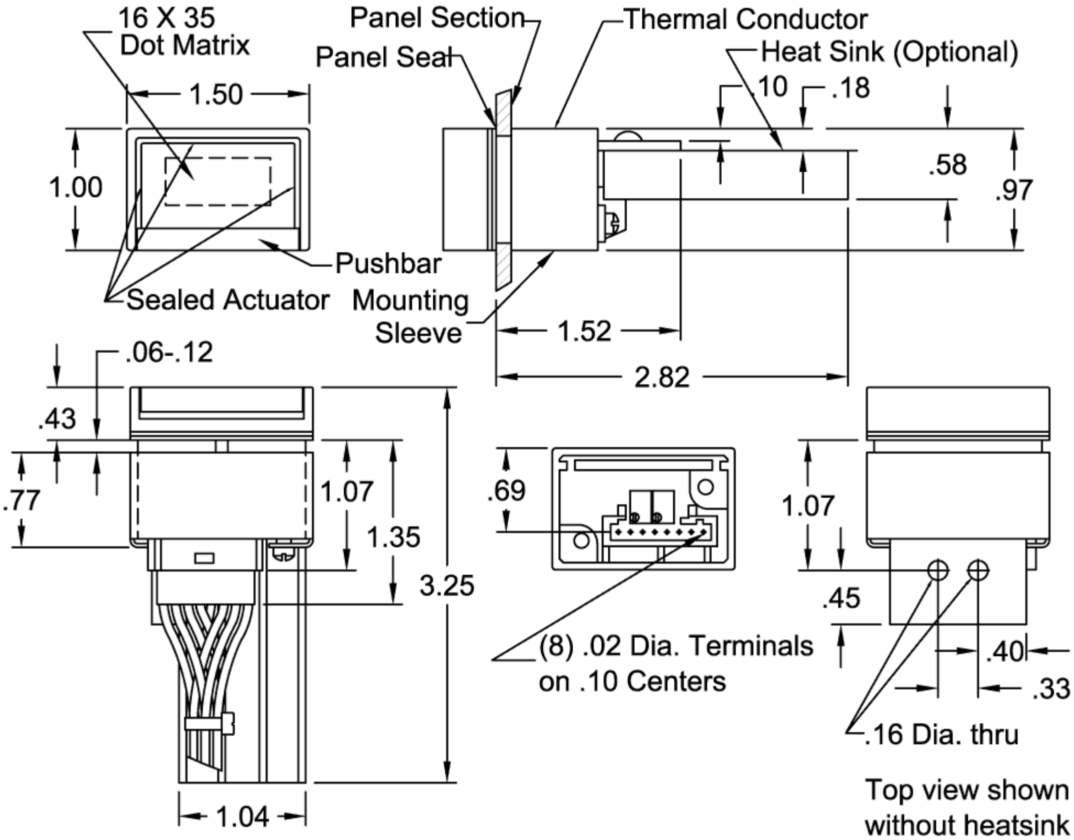


Figure 28

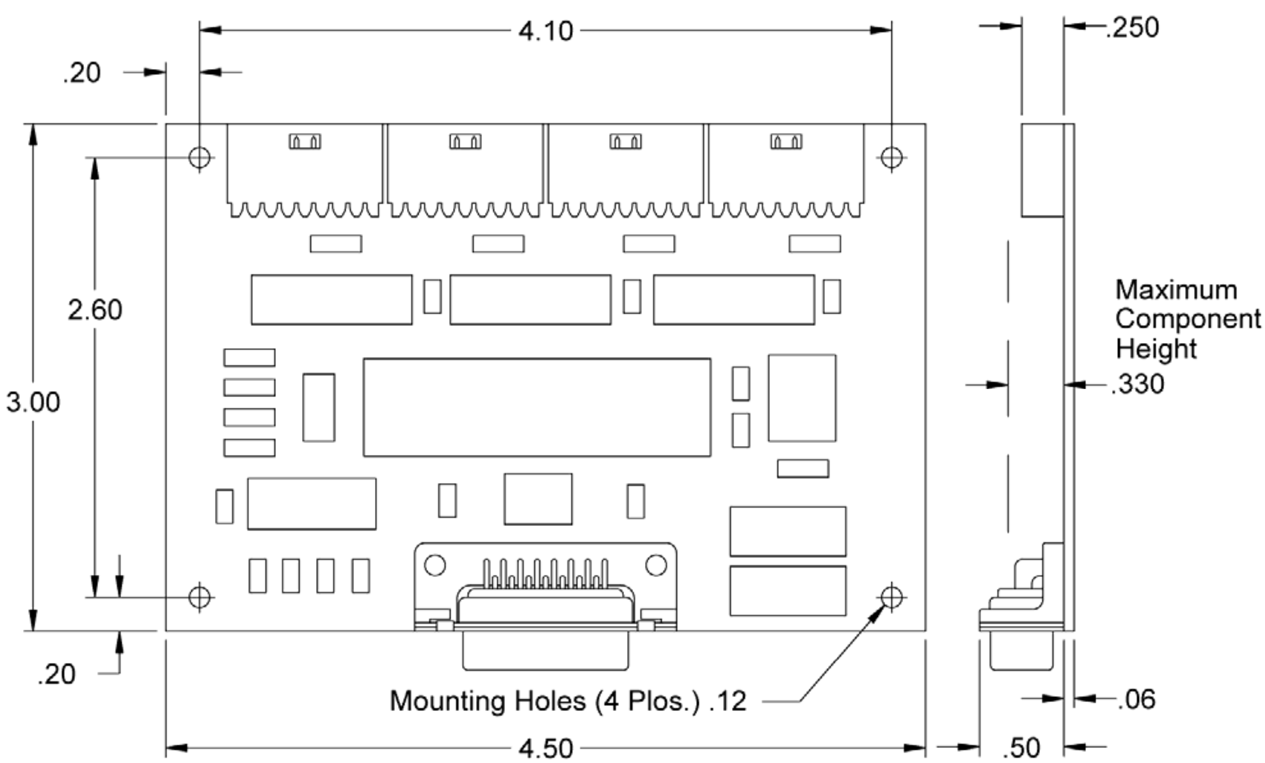


Figure 29

SUMMARY OF COMMAND CODES

Command Code	Command Description	Message Type	Command Category
A	All Pixels On	Control	Specific
B	Blink Display	Control	Specific
C	Clear Display	Control	Specific
D	Inhibit Display	Control	Specific
E	Enable Display	Control	Specific
F	Stop Blink Display	Control	Specific
H	Horizontal Line	Line	Specific
I	Vertical Line	Line	Specific
K	5x7 Text	Text	Specific
L	10x14 Text	Text	Specific
M	Graphics	Graphics	Specific
R	Restart Blink Timer	General	Global
S	Switch Status Request	General	Global
T	Enable All Displays	General	Global
U	Inhibit All Displays	General	Global
V	Communications Check	General	Global
W	Clear All Displays	General	Global
X	Self-Test	Self-Test	Specific
Y	Luminance Control	General	Global

Figure 30

SUMMARY OF PROTOCOL CODES

<table>
<tr><th colspan="2">RPU Address Pin Pairs</th><th rowspan="2">RPU Network Address</th><th rowspan="2">RPU to PMP Connector</th><th rowspan="2">PMP Address Code</th><th colspan="3">RPU Response Codes</th><th colspan="2">Self-Test</th></tr>
<tr><th>74</th><th>75</th><th>Acknowledge</th><th>Retry</th><th>Actuated Switch</th><th>Pass</th><th>Fail</th></tr>
<tr><td>C</td><td>C</td><td>0</td><td>79</td><td>@</td><td>q</td><td>r</td><td>`</td><td>p</td><td>s</td></tr>
<tr><td>C</td><td>C</td><td>0</td><td>80</td><td>A</td><td>q</td><td>r</td><td>a</td><td>p</td><td>s</td></tr>
<tr><td>C</td><td>C</td><td>0</td><td>81</td><td>B</td><td>q</td><td>r</td><td>b</td><td>p</td><td>s</td></tr>
<tr><td>C</td><td>C</td><td>0</td><td>82</td><td>C</td><td>q</td><td>r</td><td>c</td><td>p</td><td>s</td></tr>
<tr><td>O</td><td>C</td><td>1</td><td>79</td><td>D</td><td>u</td><td>v</td><td>d</td><td>t</td><td>w</td></tr>
<tr><td>O</td><td>C</td><td>1</td><td>80</td><td>E</td><td>u</td><td>v</td><td>e</td><td>t</td><td>w</td></tr>
<tr><td>O</td><td>C</td><td>1</td><td>81</td><td>F</td><td>u</td><td>v</td><td>f</td><td>t</td><td>w</td></tr>
<tr><td>O</td><td>C</td><td>1</td><td>82</td><td>G</td><td>u</td><td>v</td><td>g</td><td>t</td><td>w</td></tr>
<tr><td>C</td><td>O</td><td>2</td><td>79</td><td>H</td><td>y</td><td>z</td><td>h</td><td>x</td><td>{</td></tr>
<tr><td>C</td><td>O</td><td>2</td><td>80</td><td>I</td><td>y</td><td>z</td><td>i</td><td>x</td><td>{</td></tr>
<tr><td>C</td><td>O</td><td>2</td><td>81</td><td>J</td><td>y</td><td>z</td><td>j</td><td>x</td><td>{</td></tr>
<tr><td>C</td><td>O</td><td>2</td><td>82</td><td>K</td><td>y</td><td>z</td><td>k</td><td>x</td><td>{</td></tr>
<tr><td>O</td><td>O</td><td>3</td><td>79</td><td>L</td><td>}</td><td>~</td><td>l</td><td>|</td><td>del</td></tr>
<tr><td>O</td><td>O</td><td>3</td><td>80</td><td>M</td><td>}</td><td>~</td><td>m</td><td>|</td><td>del</td></tr>
<tr><td>O</td><td>O</td><td>3</td><td>81</td><td>N</td><td>}</td><td>~</td><td>n</td><td>|</td><td>del</td></tr>
<tr><td>O</td><td>O</td><td>3</td><td>82</td><td>O</td><td>}</td><td>~</td><td>o</td><td>|</td><td>del</td></tr>
</table>

Figure 31