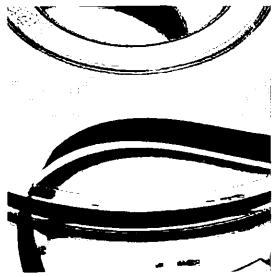
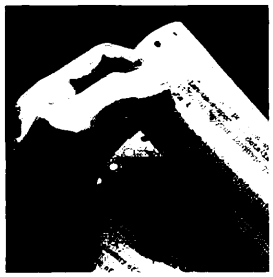
Prime Computer, Inc.

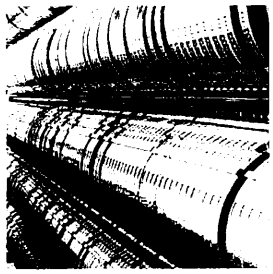
DOC8719-2LA

PT200 Graphics Option Programmer's Reference Guide










PT200 Graphics Option Programmer's Reference Guide

Second Edition

by

Karen Howe

Updated by Muriel Chase

This guide documents the use and operation of PT200 graphics firmware as implemented at graphics firmware Revision B.

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PRINTING HISTORY

PT200 Graphics Option Programmer's Reference Guide

Edition	Date	Number	Firmware Release
First Edition	March 1985	DOC8719-1LA	A
Second Edition	September 1985	DOC8719-2LA	B

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Contents

About This Book

This book explains how to program graphics with the PT200™ Graphics Option. This book is written for people who are:

- Familiar with how the PT200 terminal works.
- Experienced as graphics programmers.
- Knowledgeable in using the PRIMOS™ operating system and one of Prime's text editors (EMACS or EDITOR).

ORGANIZATION OF THIS BOOK

This book is divided into three chapters.

Chapter 1 describes the features of the Graphics Option. It gives an overview of the organization of graphics operations, describes terminal features that are affected by graphics operation, and explains graphics command syntax.

Chapter 2 explains and gives examples of how to program graphics with the PT200 Graphics Option.

Chapter 3 is an alphabetical graphics command reference.

The seven appendixes provide information on the differences between the graphics option features available with the PT200 terminal and the Tektronix 4014™ terminal, a description of Graphics Option hardware, tables of Tektronix Graphics and Native Graphics commands, valid keys

and control codes, an ASCII code conversion chart, and coordinate conversion charts.

OTHER BOOKS THAT MAY BE USEFUL

The PT200 Terminal Primer (DOC8620-2LA) contains basic information about the features and uses of the PT200 terminal.

The PT200 Graphics Option Installation Instructions (IDR8717-1XA) describe how to install and test the Graphics Option board.

The PT200 Graphics Option Primer (DOC8718-1LA) explains how to run Tektronix 4014-compatible and PT200 graphics application programs on the PT200 terminal.

The PT200 Programmer's Reference Guide (DOC8621-2LA) explains how to program the PT200 terminal.

Refer to the Guide to Prime User Documents (DOC6138-3PA) for a comprehensive list of Prime publications.

CONVENTIONS USED IN THIS BOOK

The following list summarizes the conventions used in this book.

Item	Convention
ESC	ESC refers to the escape character or the ESC key.
Spaces in Escape Sequences	In this documentation, spaces are separate characters for visual clarity only. For example, the Select Memory Bank command is written: ESC [Ps z Do not enter the spaces as part of the sequence in a program or at the keyboard, or you will receive an error message.

1

PT200 Graphics Option Features

When the PT200™ Graphics Option is installed in the PT200 terminal, the terminal can perform a wide range of graphics functions. The terminal emulates a Tektronix™ 4014 Computer Display Terminal; thus, it can run Tektronix-compatible software packages, such as PLOT-10 and TELL-A-GRAPH. Tektronix 4014 emulation includes Tektronix 4010 capability as a subset. If the Graphics Option is installed in a PT200 with a color monitor, a subset of Tektronix 4105 functions is available. With these commands you can create in color business and scientific graphics, such as bar charts, X-Y graphs, and pie charts.

The Graphics Option not only emulates a Tektronix 4014 terminal and provides some 4105 functions, it also has PT200 Native Graphics commands that can be applied with Tektronix commands in user-written programs. The Native Graphics commands provide features such as memory dumps, memory loads, four visual (intensity) levels, and blanking levels, none of which are supported by the Tektronix 4014.

The Graphics Option has two operating modes:

- Tektronix Graphics with standard Tektronix commands
- Native Graphics with the new PT200 Native Graphics commands

Although Tektronix Graphics and Native Graphics are separate operating modes, they are used in conjunction with each other.

This chapter describes briefly these two operating modes. Some terminal features in Graphics Operation, such as cursors, are different from those in standard operation. Command syntax is explained for

Tektronix and Native Graphics commands, and instructions are provided for entering graphics commands in source programs or at the keyboard.

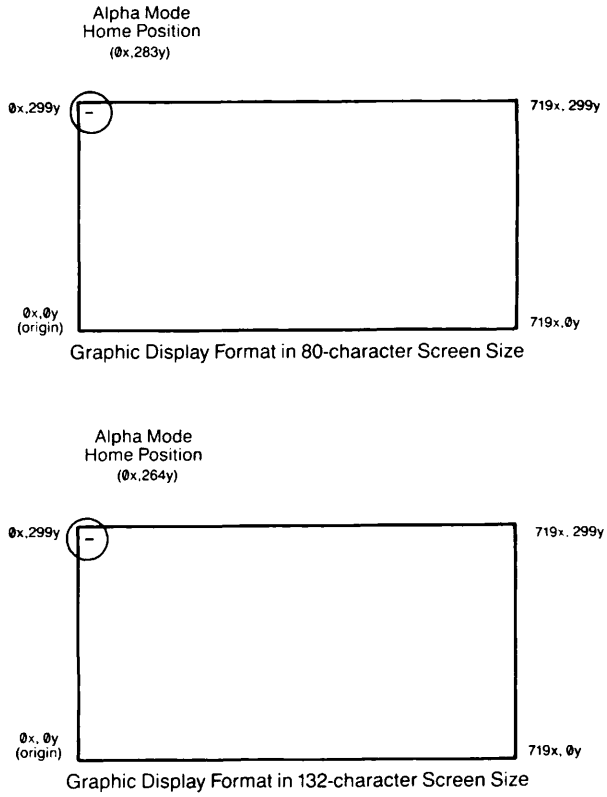
TEKTRONIX 4014 GRAPHICS

This section describes Tektronix 4014 features that are used in graphics operation, but not in standard operation. These include screen margins and graphic cursors. The differences between the PT200 terminal and the Tektronix 4014 terminal graphics operation also are discussed.

The Display Screen

The PT200 terminal's graphics display screen has a different number of pixels than the Tektronix 4014. In Tektronix Graphics on the PT200, the number of pixels per screen is automatically scaled down. The Tektronix graphics format of 780 x 1024 pixels/screen becomes the PT200 graphics display format of 300 x 720 pixels/screen. The PT200 graphics display format is shown in Figure 1-1.

In Tektronix Graphics, the origin (0,0) is at the lower left-hand corner of the screen in all modes except Alpha mode. The Alpha mode origin is shown in Figure 1-1. The Y-to-X aspect ratio is 1.881/1 in 80-character mode and 2.015/1 in 132-character mode.

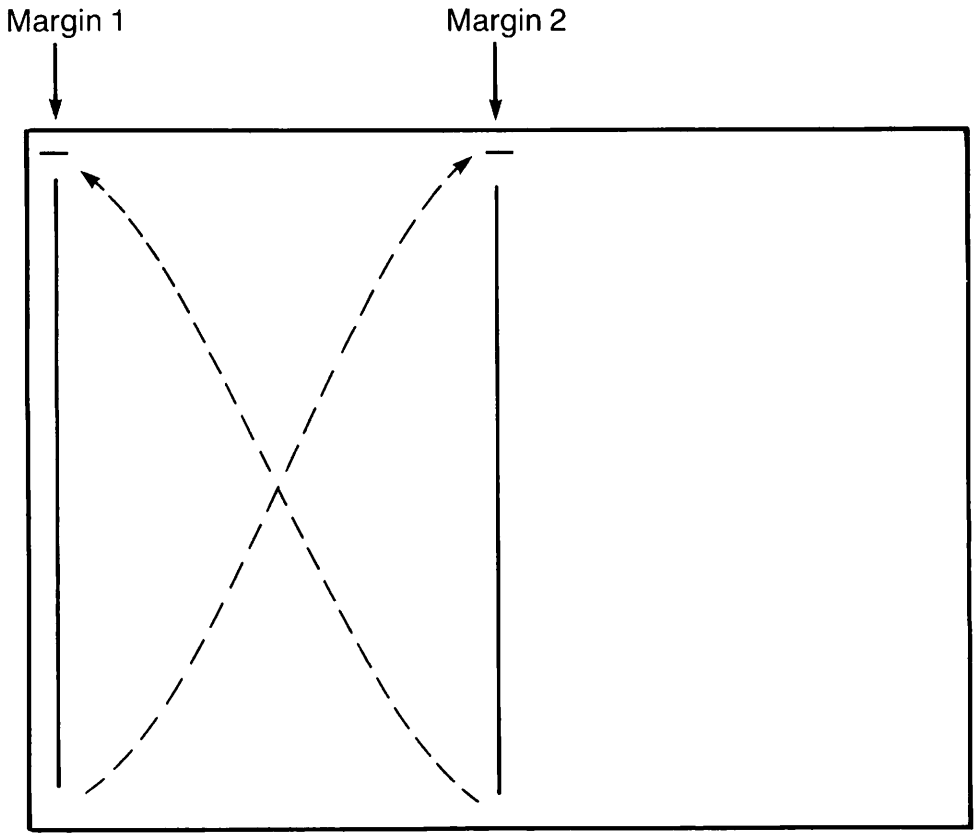


PT200 Graphics Display Formats
Figure 1-1

Tektronix Screen Margins

The PT200 uses Tektronix screen margins in Tektronix 4014 Graphics. Margin 1 (default) is column 1 of the screen, and Margin 2 is the center column of the screen, as shown in Figure 1-2.

When you line feed past the last line of text in Margin 1, the margin switches to Margin 2. When you line feed past the last available line of text in Margin 2, the margin switches back to Margin 1. When the margin switches, the cursor remains in the same position relative to the margin.



Tektronix Screen Margins
Figure 1-2

Graphics Cursors

The PT200 cursors are different in Tektronix 4014 Graphics than in standard operation. The Alpha mode cursor is a non-storing underline that indicates the next-character writing position. The Graphic cursor is a non-storing crosshair cursor. It can be moved around the screen with the arrow keys.

Tektronix 4014 Graphics Operating Modes

There are five 4014 Tektronix Graphics modes: Alpha, Vector, Point Plot, Incremental Plot, and Graphic Cursor. The five graphics operating modes are used to write characters, draw vectors, plot single points or series of points, or position the Graphic cursor. Control characters can be executed in all modes. The functions of the Tektronix Graphics modes follow:

Graphic Mode	Function
Alpha	Data sent to the terminal is interpreted as writing characters or as control codes. You can display writing characters on the screen at the same time as vectors and points, so that you can put labels or titles on graphs. The terminal executes control characters.
Vector	The terminal draws vectors from given coordinate values. Five vector types are available: solid, dotted, dot-dashed, short-dashed, and long-dashed.
Point Plot	The terminal plots the end point of a vector. The points are specified by coordinate screen values.
Incremental Plot	This mode plots points in one-point increments in any one of eight directions from the current position.
Graphic Cursor	The terminal displays the Graphic cursor (crosshair) at maximum intensity. You can move the cursor around the display with the arrow keys.

At power-up, Alpha mode is assumed as the default state. After power-up, whenever you enter graphics operation, the terminal assumes whichever mode was selected prior to exiting the graphics operation.

Tektronix 4014 Graphics Command Syntax

Tektronix 4014 Graphics commands follow Tektronix syntax. They have three possible forms: ESC followed by a control code, ESC followed by a non-control code, or a control code alone. The following Tektronix Graphics commands are examples of the three forms:

Command Forms	Command	Command Name
ESC control code	ESC SUB	Graphic Cursor mode
ESC non-control code	ESC $?	Exit Graphics Operation
Control code	LF	Move One Line Down

TEKTRONIX 4105 COLOR GRAPHICS

Tektronix 4105 Color Graphics commands are an enhancement to the Tektronix 4014 graphics operation. They provide a full-color display on a PT200 with a color monitor. Two of the commands, Begin Panel Boundary and End Panel, can be used on a monochrome terminal.

Tektronix 4105 Color Graphics Operating Modes

Tektronix 4105 Color Graphics commands can be executed from all five of the operating modes utilized by Tektronix 4014 Graphics, except for the Begin Panel Boundary command which is issued from Vector mode. Control characters can be executed in all modes, as with Tektronix 4014 Graphics.

Tektronix 4105 Color Graphics Command Syntax

Tektronix 4105 Color Graphics commands used with the PT200 are a subset of Tektronix 4105 commands. They follow Tektronix syntax and all begin with ESC. Two of the commands, Begin Panel Boundary and End Panel, can be issued in monochrome or color operation. Other 4105 commands are full-color commands. Chapter 2 includes a color graphics example in its graphics instruction sessions. Chapter 3 provides full set of 4105 color graphics commands.

NATIVE GRAPHICS

Native Graphics commands have been incorporated in the Graphics Option to enhance the functions of Tektronix Graphics. With Native Graphics, you can perform memory dumps and loads, select plane blanking levels, and choose visual levels. Native Graphics is not divided into separate operating modes.

Native Graphics Command Syntax

Native Graphics commands have PT200 syntax as follows:

- All commands begin with ESC.
- If a command has more than two characters, its second character is either a dollar sign ($), a begin bracket ([), a greater-than sign (>), or the number seven (7).
- If the second character is a dollar sign ($), only one more character follows.
- If the second character is a begin bracket ([), the command's length and the number of arguments can vary. If there is more than one argument, each is separated by a semicolon.
- If the second character is a greater-than sign (>) or a seven (7), the command has nonstandard syntax. For example, the Memory Load command is ESC 7 <x>;<y>..* and the Memory Dump command is ESC > <row>; (count); (page) #.

The term Ps indicates that a parameter can be inserted in the command to select one of the several subfunctions that the command can carry out.

Here are a few examples of Native Graphics commands which illustrate most of the possible escape command formats:

Command	Command Name
ESC $ 1	Select Tektronix Graphics
ESC [Ps x	Clear Graphic Display
ESC > <row>;(count);(page)#	Memory Dump

ENTERING ESCAPE CHARACTERS IN SOURCE PROGRAMS

The way you enter escape characters into source programs depends upon the program editor you are using.

If you use EDITOR to enter source code, enter a caret (^) and the octal value for Escape, which is 233. Here is what the Incremental Plot Mode command would look like:

```
^233RSPA
```

In EMACS, you must precede the escape character with the Ctrl/Q (^q_quote_command) command. This command tells EMACS to "quote" the character following it instead of interpreting that character as an EMACS command. The escape character is displayed on the screen as a delete character ▒ . You can also use the Ctrl/X Q (quote) command because it is identical to Ctrl/Q.

The Incremental Plot Mode command would look like this in EMACS:

```
▒RSPA
```

ENTERING GRAPHICS COMMANDS AT THE KEYBOARD

This book primarily explains how to enter graphics commands in programs. You can enter most graphics commands at the keyboard as well. When you enter commands at the keyboard, you must enter the keyboard equivalent of the ASCII characters. They are listed in Appendix E, NUMERICAL EQUIVALENTS IN ASCII FORMAT. When you enter a command at the keyboard, do not hold down the ESC key while you press the keys following it.

2

Using the Graphics Option

This chapter is an overview of graphics functions that are available with the Graphics Option. It gives instructions for entering and exiting graphics operation and selecting graphics modes. Each graphics mode is described, and graphics examples are included. This chapter does not give detailed instructions for all graphics commands. For descriptions of individual commands, see Chapter 3, GRAPHICS COMMAND REFERENCE.

ENTERING GRAPHICS OPERATION

In graphics operation, characters are sent to the Graphics Option board where they are interpreted as alphanumeric data, standard PT200 control codes, Tektronix 4014 terminal functions, Tektronix 4105 terminal functions, or Native Graphics escape sequences. All standard operation PT200 escape sequences produce errors when used in graphics operation. The following command enters you into graphics operation:

Enter Graphics Operation ESC $ 6

Alpha mode is the default graphics mode at power-up. After power-up, when you enter graphics operation, the following things happen:

- The previously selected mode is assumed.
- The Status Line disappears from the bottom of the screen.

- All Graphics Option board parameters remain in their previously selected state.
- The screen does not clear.
- The character set is the standard ANSI set.
- The total number of pixels on the screen depends on the screen size that was selected in standard operation.
- The Tektronix 4014 with its 780 x 1024 pixel display is automatically scaled down to the Graphics Option board 300 x 720 pixel display.
- The graphics board powers up in monochrome operation with the currently selected monochrome color.

To enter Native Graphics, you must be in Graphics Operation mode, then use the Select Native Graphics command as follows:

Select Native Graphics ESC $ 0

When you enter this command, any cursor disappears from the display screen.

Standard operating modes cannot be set or reset in Graphics Operation. In Tektronix 4014 Graphics, Tektronix 4105 Graphics, and Native Graphics, the terminal assumes the following standard PT200 mode states and functions:

Standard Mode	State	Function
Character/Block	Reset	Each character entered at the keyboard is either transmitted directly to the host or causes a sequence of characters to be sent to the host.
Numeric/PF Keypad	Set	The numeric keypad generates numbers and other symbols printed on the faces of the keys.
Host Notification	Reset	The host is not notified when a Clear Screen or Reset to Initial State command has been completed.

During graphics operation, the terminal checks the state of some other standard PT200 modes. To change a mode state you must exit to standard operation. For more information about standard PT200 operating modes, see the PT200 Programmer's Reference Guide. The terminal checks the following standard PT200 modes and ignores all other standard operating modes during graphics operation:

Standard Mode	State	Function
Function Termination	Set	If you press a function key, the PT200 appends a carriage return to the escape sequence.
	Reset (Default)	No carriage return is appended to the escape sequence.
Online/Local	Online	Data entered is sent to the host.
	Local	Data entered is sent to the graphics board.
Send/Receive	Reset	Each graphics input is displayed on the screen when typed.
	Set	Local input is logically disconnected from the output. Only data sent in a data stream to the terminal are displayed. There is no local echo. The default is determined by the Non-Volatile Ram (NVR) setting on the terminal at power-up. If the terminal is online, a character is also sent to the host regardless of the mode setting.
Transparent Data	Set (Default)	The XON (Ctrl/Q), XOFF, (Ctrl/S), and Ctrl/P codes from keyboard are treated as normal characters. They are not sent immediately, but are put into transmit buffers.

Standard Mode	State	Function
	Reset	Characters have their usual PRIMOS meanings and are sent immediately. The PT200 always responds to host-generated XON, XOFF, and Ctrl/P codes as flow control, regardless of the mode setting.

The terminal checks 80/132 Screen Size. This is not a mode but an operating state controlled by the Set Display Size command in standard operation.

The terminal also checks to see whether it will default to monochrome operation or function in user-selected full color operation.

EXITING GRAPHICS OPERATION

The Exit Graphics Operation command is used to exit from either Tektronix or Native Graphics and to return to standard operation. It is executed as follows:

Exit Graphics Operation ESC $?

When you enter this command, the following things happen:

- The status line is restored to the screen.
- The screen does not clear.
- The standard operation cursor is restored to the screen.

CLEARING THE SCREEN

Whatever is written in standard operation can only be cleared in standard operation, and anything written in graphics operation can only be cleared in graphics operation. If you have anything on the standard PT200 screen when you enter graphics operation, you cannot clear it. Therefore, clear the standard PT200 screen before entering graphics operation.

Likewise, you should clear the graphics screen before exiting graphics operation. You can clear the screen with the following commands:

Operating Mode	Command or Key
Standard Operation	Ctrl/Clear Key
Tektronix Graphics	ESC Ctrl/L (Erase Display and Move Cursor Home), or Clear Key
Native Graphics	ESC [Ps x (Clear Graphics Display)

When you clear the screen in Tektronix Graphics, you enter Alpha mode.

SELECTING GRAPHICS MODES

When you enter graphics operation, Tektronix Alpha mode is assumed. In graphics operation, there are five Tektronix graphics modes (Alpha, Vector, Graphic Cursor, Incremental Plot, Point Plot) and one Native Graphic mode. The commands used to select modes are:

Command Name	Mode	Command Sequence
Move to Current Margin	Alpha	CR
Erase Display and Move Cursor Home	Alpha	ESC FF
Move to Current Vector/Point Position	Alpha	US or ESC US, US
Graphic Cursor Mode	Graphic Cursor	ESC SUB
Incremental Plot Mode	Incremental Plot	ESC RS, RS
Point Plot Mode	Point Plot	FS
Vector Mode	Vector	ESC GS, GS
Select Tektronix Graphics	Alpha	ESC $ 1
Select Native Graphics	Native Graphics	ESC $ 0

The first three commands select Alpha mode and position the Alpha cursor to different places on the display screen. You enter Alpha mode when you select Tektronix Graphics from Native Graphics. You cannot move freely from mode to mode. For example, in Native Graphics you cannot select any Tektronix Graphics mode except Alpha mode. Once in Alpha mode, you can select any other Tektronix or Native Graphics mode. Table 2-1 shows when modes can be selected.

Table 2-1
Selecting Graphics Modes

Command	Alpha Mode	Vector Mode	Point Plot Mode	Incremental Plot Mode	Graphic Cursor Mode	Native Graphics Mode
Move to Current Margin (Alpha mode)	V	V	V	V	V	-
Erase Display and Move Cursor Home (Alpha mode)	V	V	V	V	V	-
Move to Current Vector/Point Position (Alpha mode)	-	V	V	V	-	-
Graphic Cursor Mode	V	V	V	V	-	-
Incremental Plot Mode	V	V	V	V	-	-
Point Plot Mode	V	V	V	-	-	-
Select Native Graphics	V	V	V	V	V	-
Select Tektronix Graphics	-	-	-	-	-	V
Vector Mode	V	V	V	V	-	-

Key

V Valid command in this mode
- Invalid command in this mode

TEKTRONIX 4014 GRAPHICS

This section explains the operations that can be performed in each mode of Tektronix 4014 Graphics.

Alpha Mode

Alpha mode is used to write text, such as labels for graphs. The Alpha cursor (underline) shows the location of the next character. You can move the Alpha cursor to any point on the screen with a number of commands and can change the number of alphanumeric characters on the screen by changing character size, as described below.

Positioning the Cursor: The Alpha cursor can be positioned on the display screen with the following commands:

Command Name	Command
Erase Display and Move Cursor Home	ESC FF
Move to Current Margin	CR
Move to Current Vector/Point Position	ESC US, US
Move One Line Down	LF
Move One Line Up	ESC VT, VT
Move One Space Left	ESC BS, BS
Move One Space Right	ESC HT, HT

The first three commands select Alpha mode and position the Alpha cursor. They perform no action when issued in Alpha mode. The last four commands are used within Alpha mode to move the cursor around the screen.

Choosing Character Size: Alpha mode has four character sizes. Large characters are the default size. The commands used to select character size are listed on the next page.

Character Size Commands	Command
Select Large Characters	ESC 8
Select Size 2 Characters	ESC 9
Select Size 3 Characters	ESC :
Select Small Characters	ESC ;

Using Alternate Characters: The standard U.S. ASCII character set is used in graphics operation. If you want to use alternate characters, you must either draw them with vectors or exit from graphics operation and use the alternate character set in standard operation.

Vector Mode

In Vector mode you can draw visible and invisible vectors (lines) of any length within the graphics grid. Five vector types are available

in Vector mode. The vector end points are addressed by 4-byte vector endpoint coordinate values, which you must enter in programs in ASCII format, as explained below.

Vector Types: The five available vector types are shown below:

Solid ————————

Dotted ·····

Dot-Dashed -·-·-·-·-·-

Short-Dashed - - - - - -

Long-Dashed — — — — —

When writing dot-dashed vectors, the vector always begins with a dash.

Addressing Screen Coordinates: Vector coordinate end points are specified by the X and Y address of the point on the graphics grid. You enter end-point addresses in programs by sending the terminal the binary equivalent of the X and Y address of the point. The X and Y binary equivalents are each divided into two bytes, so a complete address contains four data bytes: High X, Low X, High Y, and Low Y. To enter an address at the keyboard, you must enter the ASCII equivalent of the decimal address. The procedure for converting the vector coordinates to ASCII equivalents is explained in Appendix F, COORDINATE CONVERSION CHARTS.

When you enter the address bytes in Vector mode, the beam moves to the specified position. Memory retains the first three bytes of the last executable address, so you do not have to enter address points unless they change. The points do not have to be reloaded when the terminal is reset to Alpha or Graphic Cursor mode.

Graphic Cursor Mode

Graphic Cursor mode displays a Graphic (cross-hair) cursor at maximum intensity on the screen. You can move the cursor around the display screen with the arrow keys. If you press any key that generates an ASCII code, the ASCII code is sent to the host along with the graphic cursor coordinates and the trailer code. You should not execute any control characters from the keyboard while in this mode. The purpose of this mode is to send the host the following information:

- Any character typed on the keyboard
- Terminal mode status

- Graphic cursor or Alpha cursor address or the last vector end point
- Carriage return (CR)
- End of transmission (EOT)

This information is sent when the terminal is online and the host sends a Status Inquiry (ESC ENQ) request. After the terminal transmits the information, it returns to Alpha mode. You must enter a bypass-clearing command before you can write anything in Alpha mode.

Point Plot Mode

This mode allows you to write single points instead of drawing a line. Points are addressed by coordinate values in the same format as for vector drawing. Each coordinate sent is displayed on the screen.

Incremental Plot Mode

Incremental Plot mode plots points in one-point increments in any one of eight directions from the current position. In this mode you can execute unwritten points; this allows you to make breaks in vectors or to move the beam without drawing a vector.

Setting the Bypass

In Graphics Operation you can set a bypass so that the terminal does not respond to echoed data. You can enter the bypass condition with the Set Bypass (ESC CAN) command. The condition is automatically set when the terminal responds to Status Inquiry (ESC ENQ) or when you perform any operation in Graphic Cursor mode. The following commands clear the bypass: Ring Bell (ESC BEL), Move to Current Margin (CR), Move One Line Down (LF), Move to Current Vector/Point Position (ESC US), Make Copy (ESC ETB), Erase Display and Move Cursor Home (ESC FF). You can also clear the bypass with the SI control code, by writing a vector, or by pressing the Prt Scn, Clear, or Ctrl/Clear keys.

Alternate Forms of Tektronix 4014 Graphics Commands

Many Tektronix Graphics commands have more than one form that produce the same function. The following table lists the commands that have alternate forms.

Command Name	Command	Function
Ring Bell	ESC BEL	Same as BEL
Move One Space Left	ESC BS	Same as BS
Escape Sequence Introducer	ESC CR	Same as ESC
Vector Mode	ESC GS	Same as GS
Move One Space Right	ESC HT	Same as HT
Move One Line Down	ESC LF	Same as ESC
Escape Sequence Introducer	ESC NUL	Same as ESC
Incremental Plot Mode	ESC RS	Same as RS
Move to Current Vector/Point Position	ESC US, US	Same as US
Move One Line Up	ESC VT	Same as VT

TEKTRONIX 4105 COLOR GRAPHICS

The following operations can be performed with Tektronix 4105 Color Graphics commands:

Command Name	Command	Function
Set Surface Color Map	ESC T G <s> <n> <i:c>	Sets up color table
Set Text Index	ESC M T <i>	Specifies color of text
Set Line Index	M L <i>	Determines color of lines
Begin Panel Boundary	ESC L P <c> <b>	Begins polygon boundary
End Panel	ESC L E	Closes and fills polygons
Select Fill Pattern	ESC M P <n>	Chooses polygon fill color

Tektronix 4105 Color Graphics are an enhancement of Tektronix 4014 Graphics. Thus, all the functions of Tektronix 4014 remain intact, but they are executed in color with 4105 Color Graphics.

Tektronix 4105 Color Graphics commands work in all five modes of Tektronix 4014 Graphics, except for the Begin Panel Boundary command which works in Vector mode only. Chapter 3 provides full information.

NATIVE GRAPHICS

Native Graphics commands enhance Tektronix Graphics. Most Native Graphic commands are used to control graphics memory. You cannot draw vectors or write characters in Native Graphics. Therefore, Native Graphics commands are used in conjunction with Tektronix Graphics commands.

In Native Graphics you can perform memory dumps and memory loads to the host. This allows you to save a graphics display for future use. You can blank screen planes either separately or simultaneously, and you

can select visual levels that control screen intensity on a per pixel or per character basis. Thus you can shade portions of the graphics screen.

PRINTING GRAPHICS

You can make hard copies of the graphics display screen in any Tektronix Graphics mode with the Make Copy (ESC ETB) command or in Native Graphics with the Print Graphic Display (ESC $ 2) command. You can use the Prt Scn key to make hard copies of the screen in either Tektronix or Native Graphics. When making hard copies, you must use an Epson FX-80 compatible printer.

GRAPHICS PROGRAMMING EXAMPLES

The following examples show how to use features of Tektronix 4014 Graphics, Tektronix 4105 Color Graphics, and Native Graphics. You can do these examples either in a program by entering the ASCII format of the commands or at the keyboard by entering the keyboard equivalents of commands. Keyboard equivalents for graphics commands are listed in Appendix E, NUMERICAL EQUIVALENTS IN ASCII FORMAT. Instructions for encoding color indexes are in Appendix F.

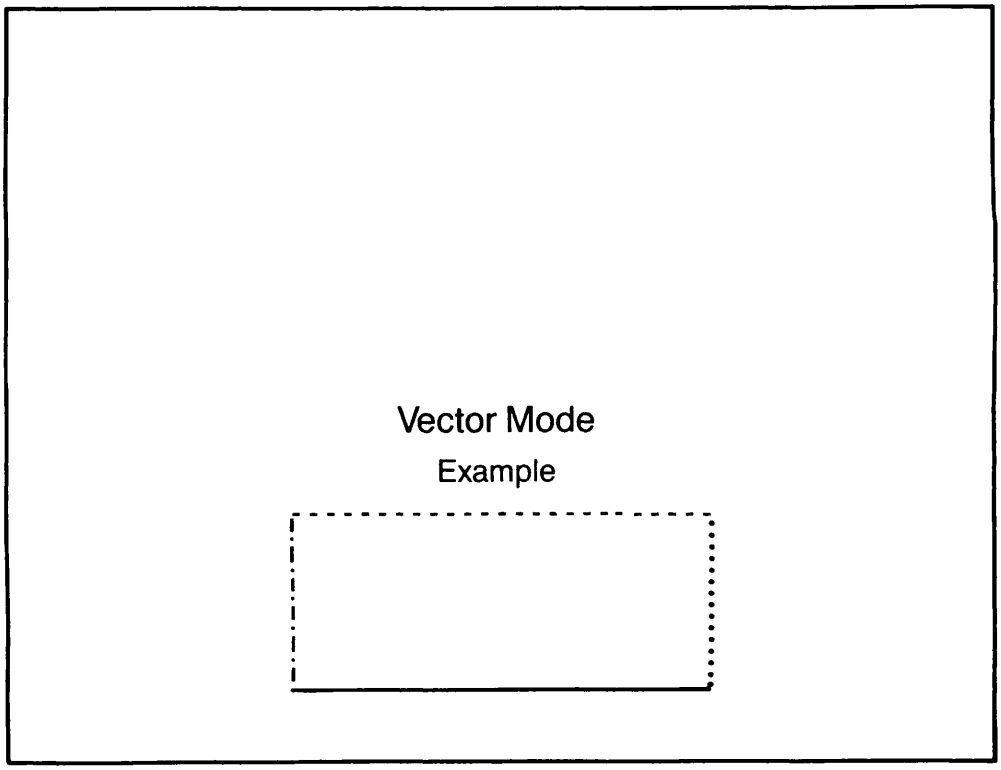
Each example is self-contained — it begins and ends in standard operation with the screen size set at 80 characters. You can perform the examples consecutively by skipping the Exit Graphics Operation and Enter Graphics Operation commands at the end and beginning of each example. Some of the examples include printing the graphics display screen. To do this, you must have an Epson-compatible printer attached to the system. If you do not have a suitable printer, skip the printing steps.

The examples are formatted in three columns. The Command column lists the command name or action to perform. If you want to execute the examples within a program, use the command sequences from the Character column. To execute the examples at the keyboard, enter the commands listed in the Keyboard Equivalent column at the keyboard. For additional information about any command, see the command description in Chapter 3, GRAPHICS COMMAND REFERENCE.

Keyboard equivalents must be entered exactly as shown in the example. Uppercase letters must be entered as such or you will get different results than expected. A slash (/) indicates keys that must be pressed simultaneously.

Vector Mode Example

In this example you will draw a box in Vector mode and label it in Alpha mode. You will use four vector types and will learn how to move around the screen in Alpha mode and how to print the graphic display when it is completed. Figure 2-1 shows the completed, labeled box, and Table 2-2 lists the commands to enter.



Vector Mode Example
Figure 2-1

Table 2-2
Commands for Vector Mode Example

Directions With Command Names	Command Characters	Keyboard Equivalent
Clear display screen.		Ctrl/Clear
Enter Graphics Operation.	ESC $ 6	ESC $ 6
Vector Mode.	GS	Ctrl/]
Select Solid Vector.	ESC `	ESC `
Enter vector starting point. Nothing is drawn.	100Y,235X	#d'K
Enter the first vector endpoint using a shortened address. A solid vector is drawn.	100Y,470X	d.V
Select Dotted Vector.	ESC a	ESC a
Enter the second vector endpoint. A dotted vector is drawn.	200Y,470X	&h.V
Select Long-dashed Vector.	ESC d	ESC d
Enter the next vector endpoint. A long-dashed vector is drawn.	200Y,235X	h'K
Select Dot-dashed Vector.	ESC b	ESC b
Enter the next vector endpoint. A dot-dashed vector is drawn.	100Y,235X	#dK
Move to Current Vector/Point Position. This command enters Alpha mode.	ESC US	Ctrl/_
Move One Line Up. (Five times)	ESC VT	Ctrl/K
Move One Space Right. (Six times)	HT	Ctrl/I
Select Size 2 Characters.	ESC 9	ESC 9

Table 2-2 (continued)
Commands for Vector Mode Example

Directions With Command Names	Command Characters	Keyboard Equivalent
Write "Example" in Size 2 characters.	"Example"	"Example"
Move One Space Left. (Nine times)	ESC BS	Ctrl/H
Move One Line Up.	ESC VT	Ctrl/K
Select Large Characters.	ESC 8	ESC 8
Write "Vector mode".	"Vector mode"	"Vector mode"
Make Copy.	ESC ETB	ESC Ctrl/W
Erase Display and Move Cursor Home.	ESC FF	ESC Ctrl/L
Exit Graphics Operation.	ESC $?	ESC $?

Incremental Plot Mode

In this example you will use Incremental Plot mode to plot visible and invisible points. Incremental Plot mode plots points one at a time in one of eight directions. You can plot a series of points by holding down the key which specifies the direction. The possible directions and the corresponding keys are shown in the Incremental Plot Mode command description in Chapter 3. Directions for this example are listed in Table 2-3.

Table 2-3
Commands for Incremental Plot Example

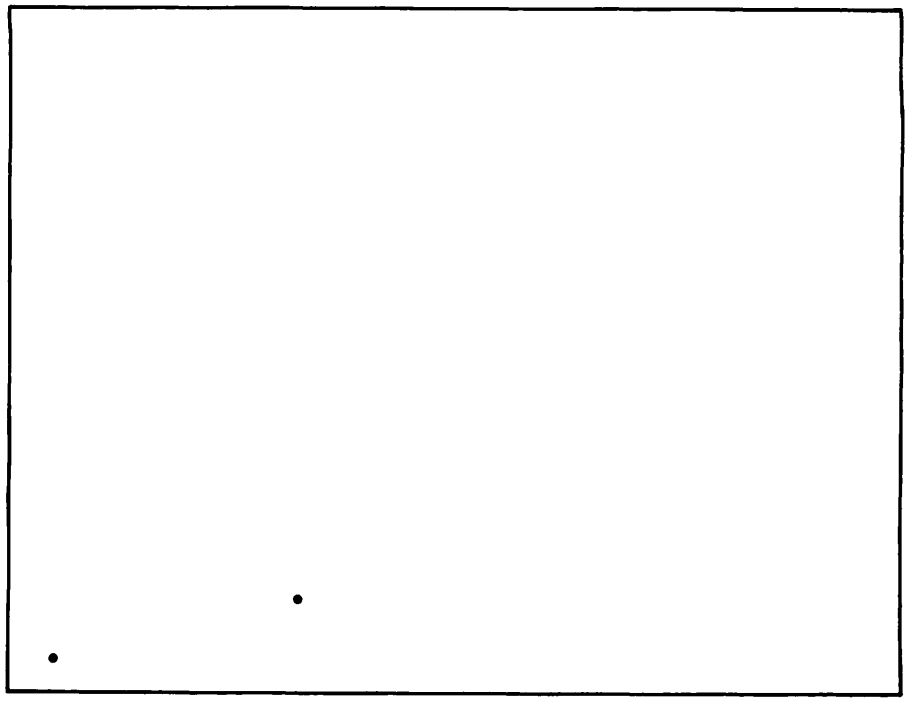
Directions With Command Names	Command Characters	Keyboard Equivalent
Enter Graphics Operation.	ESC $ 6	ESC $ 6
Erase Display and Move Cursor Home.	ESC FF	ESC Ctrl/L

Table 2-3 (continued)
Commands for Incremental Plot Example

Directions With Command Names	Command Characters	Keyboard Equivalent
Incremental Plot Mode.	RS	Ctrl/^
Enter P, the code to draw a visible point or points.	P	P
Hold down the H key to draw a series of points in a southerly direction from the current position.	H	H
Hold down I to plot points in a southeasterly direction. If you approach the edge of the screen, change direction. Points will not plot past a screen edge.	I	I
Enter SP (space bar), the the code to draw an invisible point or points.	Space	Space
Hold down A and note that no points are plotted.	A	A
Enter P to draw a visible point or points.	P	P
Hold down D and note that points are plotted beginning at a point away from the last plotted points.	D	D
Exit Graphics Operation.	ESC $?	ESC $?

Point Plot Mode

In the example in Table 2-4, you will enter Point Plot mode and plot a few isolated points. An illustration of the results is shown in Figure 2-2 and directions for this example are listed in Table 2-4 .



Point Plot Mode Example
Figure 2-2

Table 2-4
Commands for Point Plot Example

Directions With Command Names	Command Characters	Keyboard Equivalent
Clear the display screen.		Ctrl/Clear
Enter Graphics Operation.	ESC $ 6	ESC $ 6
Point Plot mode.	FS	Ctrl/\
Plot a point at the origin (0,0).	0,0	space`space@
Plot another point at 50Y,300X.	50Y,300X	!r)L
Plot another point at 350Y,350X.	350Y,350X	*~*^
Erase Display and Move Cursor Home.	ESC FF	Ctrl/L
Exit Graphics Operation.	ESC $?	ESC $?

Graphic Cursor Mode

In the example in Table 2-5 you will enter Graphic Cursor mode, move the Graphic cursor around the display screen, and send the cursor coordinates and an alphanumeric key code to the host. The Graphic Cursor command ESC SUB will work if the terminal is online and the command is sent from the host. To do the example at the keyboard, the terminal must be in Local mode. You can select Local mode from the SET UP menu in either graphics or standard operation.

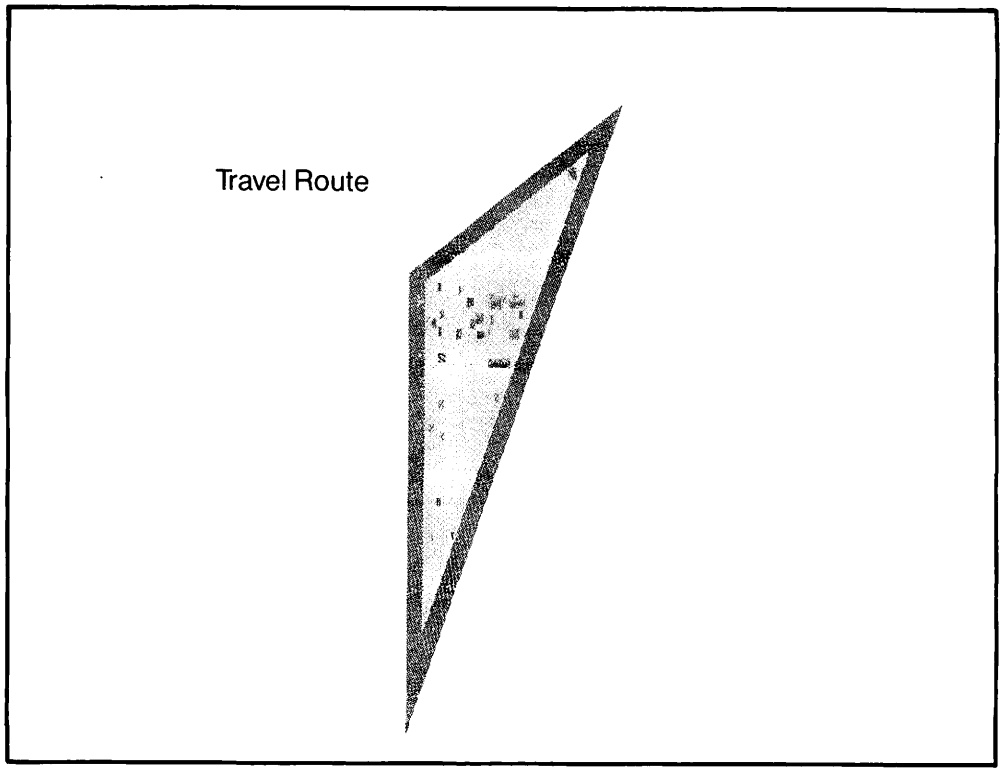
Table 2-5
Commands for Graphic Cursor Mode Example

Directions With Command Names	Command Characters	Keyboard Equivalent
Clear display screen.		Ctrl/Clear
Enter Graphics Operation.	ESC $ 6	ESC $ 6
Graphic Cursor mode.	ESC SUB	ESC Ctrl/Z
Move the Graphic cursor around the display screen with the arrow keys.		Any arrow key
Press any alphanumeric key. This sends the intersection point of the Graphic cursor and the key code to the host. Pressing an alphanumeric key makes the Graphic cursor disappear, enters Alpha mode, and sets the bypass.		Any alpha-numeric key
Ring Bell to remove the bypass.	BEL	Ctrl/G
Exit Graphics Operation.	ESC $?	ESC $?

Color Graphics

In the example in Table 2-6 you will use Vector mode to plot a dark magenta triangle and fill it in with light green. You will then use Alpha mode to label the points of the triangle with dark blue. The background color will be black. An illustration of the results is shown in Figure 2-3.

To perform this exercise, you must have a PT200 color terminal with a color graphics option board installed.



Color Graphics Example
Figure 2-3

Table 2-6
Commands for Color Graphics Example

Directions With Command Names	Command Characters	Keyboard Equivalent
Clear the display screen.		Ctrl/Clear
Enter color operation.	ESC [8 {	ESC [8 {
Enter graphics operation.	ESC $ 6	ESC $ 6
STEP 1		
Select four colors for the session with the Set Surface Color Map command: ESC T G <s><n><i:c>		
<s> is the surface number (always "1")	ESC T G 1	ESC T G 1
<n> is the number of color indexes defined (0 - 3 = "4")	A0	A0
<i is the specific index number		
:c> are the color definition decimals for hue, brightness, and saturation encoded in ASCII*		
Index — Decimals — ASCII		
0 = black — 0, 0, 0 — 000	0 000	0 000
1 = dark magenta — 31, 0,100 — A?0F4	1 A?0F4	1 A?0F4
2 = dark blue — 331, 0,100 — T;0F4	2 T;0F4	2 T;0F4
3 = light green — 211,50,100 — M3C2F4	3 M3C2F4	3 M3C2F4
STEP 2		
Set the color ot drawing lines with the Set Line Index command: ESC M L <i>	ESC M L 1	ESC M L 1
STEP 3		
Enter Vector mode to plot the triangle.	GS	Ctrl
Begin the panel boundary.	ESC L P	ESC L P
Plot the first point at 100Y, 300X.	100Y, 300X	#d#D
Display boundary in line index color.	1	1
Plot the second point at 300Y, 400X.	300Y, 400X	)1,P
Plot the third point at 390Y, 512X.	390Y, 512X	,fO@

Table 2-6 (continued)
Commands for Color Graphics Example

Directions With Command Names	Command Characters	Keyboard Equivalent
STEP 4		
Select a color to fill the triangle with the Select Fill Pattern command: ESC M P <n>	ESC M P 3	ESC M P 3
Decimal numbers representing the fill pattern color definition "<n>" bear a negative sign.*		
End panel.	ESC L E	ESC L E
STEP 5		
Set color of text and cursor with the Set Text Index command: ESC M T <i>	ESC M T 2	ESC M T 2
STEP 6		
Label graphics in Alpha mode. Set Alpha mode with this command: ESC US, US	ESC US, US	Ctrl _
Move the cursor for placing a label with Cursor Motion Commands:		
Move One Line Down	LF	CONTROL J
Move One Line Up	ESC VT, VT	CONTROL K
Move One Space Left	ESC BS, BS	CONTROL H
Move One Space Right	ESC HT, HT	CONTROL I
Type any label you like.		

Native Graphics

In the example in Table 2-7 you will use some of the features of Native Graphics in conjunction with Tektronix Graphics. In Native Graphics you will select low-intensity visual Level. Then in Tektronix Graphics you will draw a low-intensity vector. The commands to perform this example are listed in the table.

Table 2-7
Commands for Native Graphics Example

Directions With Command Names	Command Characters	Keyboard Equivalent
Clear display screen.		Ctrl/Clear
Enter Graphics Operation.	ESC $ 6	ESC $ 6
Write any characters.		
Select Native Graphics.	ESC $ 0	ESC $ 0
Clear Graphic Display.	ESC [2 x	ESC [2 x
Select Visual Level. Enter a parameter of 1 to select low intensity vector.	ESC [1 s	ESC [1 s
Select Tektronix Graphics.	ESC $ 1	ESC $ 1
Vector Mode.	GS	Ctrl/]
Select Dotted Vector.	ESC a	ESC a
Draw a low intensity vector from 100,100 to 290Y,700X.	100Y,100X 290Y,700X	#d#D)b5\
Make Copy.	ESC ETB	ESC Ctrl/W
Erase Display and Move Cursor Home.	ESC FF	ESC Ctrl/L
Select Native Graphics.	ESC $ 0	ESC $ 0
Select Visual Level.	ESC [3 s	ESC[3 s
Clear Graphic Display.	ESC [2 x	ESC [2 x
Exit Graphics Operation.	ESC $?	ESC $?

3
Graphics Command Reference

This chapter has three sections. The first describes Tektronix 4014 Graphics commands emulated by the PT200. The second describes the Tektronix 4105 Color Graphics commands which enhance 4014 Graphics. The third describes Native Graphics commands available on the PT200.

TEKTRONIX 4014 GRAPHICS COMMANDS

The commands listed in this section are valid in Tektronix Graphics. Most of the commands in the section perform Tektronix 4014 functions. Two new commands, Exit Graphics Operation and Select Native Graphics, have been added to PT200 Tektronix capability. Even though they do not perform Tektronix 4014 functions, they are included in this section because they are valid in Tektronix Graphics.

Most Tektronix 4014 Graphics commands are only valid in certain modes. For example, you can only use commands that position the Alpha cursor in Alpha mode. Table 3-1 lists all Tektronix 4014 graphics commands and the modes in which they are valid.

Table 3-1
Tektronix Graphics Commands

Command	Alpha Mode	Vector Mode	Point Plot Mode	Incremental Plot Mode	Graphic Cursor Mode
Erase Display and Move Cursor Home	V	V	V	V	V
Exit Graphics Operation	V	V	V	V	V
Graphic Cursor Mode	V	V	V	V	-
Incremental Plot Mode	V	V	V	V	-
Make Copy	V	V	V	V	V
Move One Line Down	V	-	-	-	-
Move One Line Up	V	-	-	-	-
Move One Space Left	V	-	-	-	-
Move One Space Right	V	-	-	-	-
Move to Current Margin	V	V	V	V	V
Move to Current Vector/Point Position	-	V	V	V	-
Point Plot Mode	V	V	V	-	-
Ring Bell	V	V	V	V	V
Select Dot-Dashed Vector	-	V	-	-	-
Select Dotted Vector	-	V	-	-	-

Key

V Valid in this mode
- Invalid or performs no action in this mode

Table 3-1 (continued)
Tektronix Graphics Commands

Command	Alpha Mode	Vector Mode	Point Plot Mode	Incremental Plot Mode	Graphic Cursor Mode
Select Large Characters	V	-	-	-	-
Select Long-Dashed Vector	-	V	-	-	-
Select Native Graphics	V	V	V	V	V
Select Short-Dashed Vector	-	V	-	-	-
Select Size 2 Characters	V	-	-	-	-
Select Size 3 Characters	V	-	-	-	-
Select Small Characters	V	-	-	-	-
Select Solid Vector	-	V	-	-	-
Set Bypass	V	V	V	V	V
Status Inquiry	V	V	V	V	V
Vector Mode	V	V	V	V	V

Key

V Valid in this mode
- Invalid or performs no action in this mode

▶ ERASE DISPLAY AND MOVE CURSOR HOME — ESC FF

This command sets Alpha mode, erases the graphics display, moves the Alpha cursor to home position, sets Margin 1, and clears the bypass. When you select full color operation, the display is cleared to the currently defined background color and the alpha cursor is displayed in the current text index. The default text index is 1 (white).

▶ EXIT GRAPHICS OPERATION — ESC $?

This command exits you from graphics operation to standard operation. All characters sent after this command are sent to the PT200 controller board. When you enter Exit Graphics Operation, the graphics display does not clear, but the status line and standard PT200 cursor are restored to the screen. This sequence is valid in both Tektronix Graphics and Native Graphics.

▶ GRAPHIC CURSOR MODE — ESC SUB

This command enters Graphic Cursor mode and displays the Graphic cursor (cross hair) at maximum intensity. You can move the Graphic cursor around the display screen with the arrow keys. When you press an arrow key, the cursor moves one position at the current repeat rate. When you release the arrow key, the cursor stops.

In full color operation, the graphic cursor is displayed in the current line index. The default line index is 1 (white).

If you press any key that produces an ASCII code, the ASCII code is transmitted to the host. The ASCII code is followed by the graphic cursor coordinates and the trailer code of the form shown in Figure 3-2. No graphics status byte is sent. When the terminal receives a control code other than ESC ENQ, it does not transmit anything to the host. After data transmission to the host is complete, the terminal exits to Alpha mode and ignores subsequent characters until you enter a command that clears the bypass. If you enter Graphic Cursor mode when the terminal is in Local mode, only the arrow keys are applicable and no transmission is performed.

You can exit from Graphic Cursor mode while the graphic cursor is displayed without sending anything to the host. This is done by having the host send the terminal CR, ESC FF, or ESC ENQ.

▶ INCREMENTAL PLOT MODE — ESC RS

This mode plots points in one-point increments in any one of eight directions from the current position. The RS code is followed by a Visible or Invisible code (which is equivalent on a plotter to pen

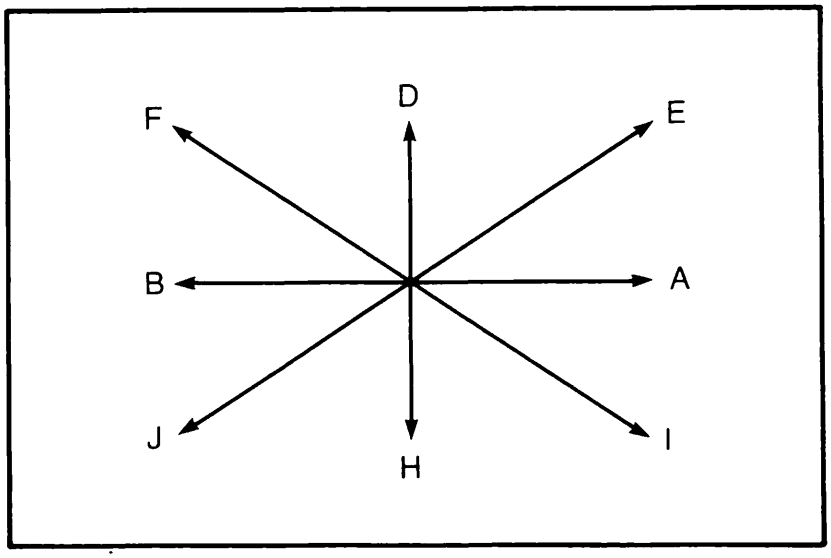
down and pen up, respectively) then by a directional character. The Invisible code is used when you want to start a new vector at a point away from the current position.

The Visible/Invisible codes are:

ASCII Character	Action
SP (space)	Invisible
P	Visible

The directional characters correspond to the eight positions listed below and shown in Figure 3-1.

ASCII Character	Direction
D	North
E	Northeast
A	East
I	Southeast
H	South
J	Southwest
B	West
F	Northwest



Incremental Plot Mode Directions
Figure 3-1

▶ MAKE COPY — ESC ETB

This command sends PT200 graphics memory, eight bits at a time starting at the left-hand corner of the screen, to the printer port. The printer must be Epson-compatible. Make Copy also clears the bypass.

▶ MOVE ONE LINE DOWN — LF

This command moves the Alpha cursor down one line. If the cursor reaches the bottom of the display, the cursor wraps to the top row of the display and switches the current margin setting. Move One Line Down also clears the bypass. This command can only be performed in Local mode.

▶ MOVE ONE LINE UP — ESC VT

This command moves the Alpha cursor up one line. If the cursor reaches the top of the display, the command performs no action.

▶ MOVE ONE SPACE LEFT — ESC BS

This command moves the Alpha cursor one space left taking the current margin into account. If you backspace past the current margin, the cursor moves to the last position in the current line.

▶ MOVE ONE SPACE RIGHT — ESC HT

This command moves the Alpha cursor one space right taking the current margin into account. If the cursor reaches the last position of the current line when the current line is not the last line of the display, the cursor wraps to the beginning of the next line. If the cursor reaches the last position of the last line on the display, the cursor wraps to the current margin of the top line in the display.

▶ MOVE TO CURRENT MARGIN — CR

This command sends a carriage return to the host. It sets Alpha mode, moves the Alpha cursor to the last known margin, and clears the bypass. If a vector or point has previously been written, the cursor moves to Margin 1 of the Y coordinate position of the last point.

▶ MOVE TO CURRENT VECTOR/POINT POSITION — ESC US

This command sets Alpha mode, moves the Alpha cursor to the last known vector/point coordinates, and clears the bypass. This command performs no action in Alpha or Graphic Cursor mode.

▶ POINT PLOT MODE — FS

This mode plots single points on the display screen, given specified coordinate values. When a series of coordinates is sent after the FS control code, those points are displayed on the screen. The format for coordinates is the same as for vector drawing. For more information, see the section in Chapter 2 on Vector Mode.

▶ RING BELL — ESC BEL

This command rings the bell.

▶ SELECT DOT-DASHED VECTOR — ESC b

This command selects dot-dashed vectors (-·-·-·-·-·-). A normal dash is five pixels long. This command is only valid in Vector mode.

▶ SELECT DOTTED VECTOR — ESC a

This command selects dotted vectors (·····). This command is only valid in Vector mode.

▶ SELECT LARGE CHARACTERS — ESC 8

This command selects the largest character size (the default size). It is only valid in Alpha mode.

Character Size (Pixels)	Screen Size
7 x 9	26 lines x 80 characters in 80-character mode
	25 lines x 80 characters in 132-character mode

▶ SELECT LONG-DASHED VECTOR — ESC d

This command selects long-dashed vectors (— — — —). A long dash is seven pixels long. It is only valid in Vector mode.

▶ SELECT NATIVE GRAPHICS — ESC $ 0

This command can only be entered in Tektronix Graphics. It switches operation from Tektronix Graphics to Native Graphics. If you are in Alpha mode or Graphic Cursor mode when you enter the command, the Alpha or Graphic cursor is removed from the screen.

▶ SELECT SHORT-DASHED VECTOR — ESC c

This command selects short-dashed vectors (- - - - - - - -). A short dash is three pixels long. It is only valid in Vector mode.

▶ SELECT SIZE 2 CHARACTERS — ESC 9

This command selects the second largest character size. The command is only valid in Alpha mode.

Character Size (Pixels)	Screen Size
7 x 7	32 lines x 80 characters in 80-character mode
	30 lines x 80 characters in 132-character mode

▶ SELECT SIZE 3 CHARACTERS — ESC :

This command selects the third largest character size. It is only valid in Alpha mode.

Character Size (Pixels)	Screen Size
5 x 9	26 lines x 102 characters in 80-character mode
	25 lines x 102 characters in 132-character mode

▶ SELECT SMALL CHARACTERS ESC ;

This command selects the smallest character size. This is the default character size in 132-character screen size. This command is only valid in Alpha mode.

Character Size (Pixels)	Screen Size
5 x 7	32 lines x 102 characters in 80-character mode
	30 lines x 102 characters in 132-character mode

▶ SELECT SOLID VECTOR ESC `

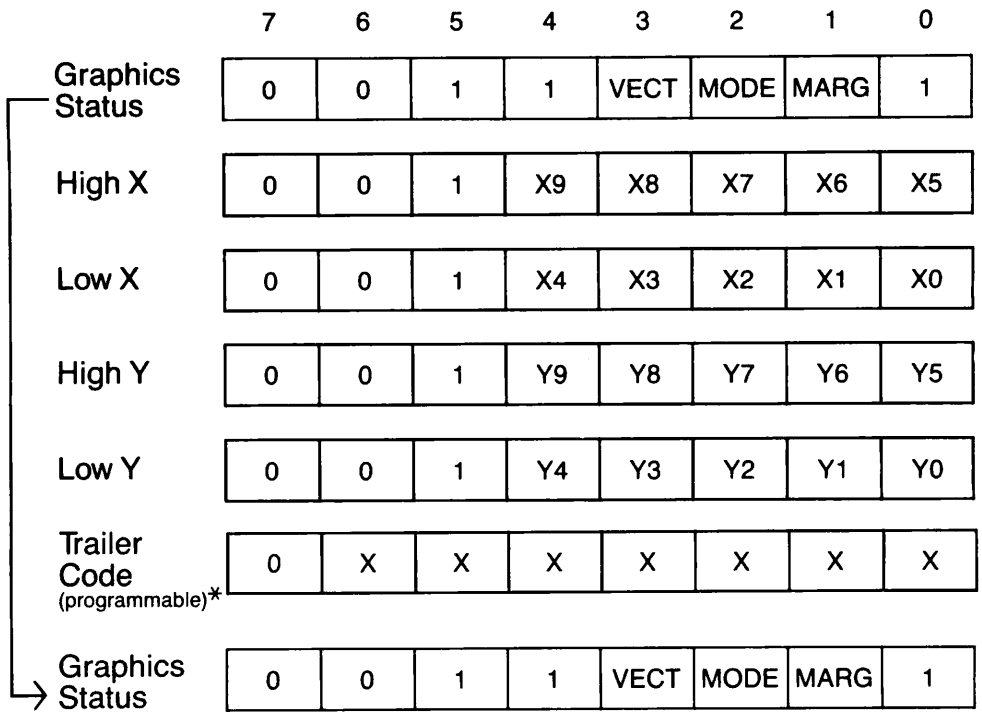
This command selects solid vectors (————) (the default setting). It is only valid in Vector mode.

▶ SET BYPASS ESC CAN

This command prevents the PT200 from responding to echoed data. After you enter this command, the terminal ignores subsequent characters until it receives one of the following bypass-clearing commands: BEL, CR, LF, US, SI, ESC ETB or ESC FF. You can also clear the bypass by executing a vector in Vector mode, or by pressing the Prt Scn, Clear, or Ctrl/Clear keys. The SI control code performs no action except clearing the bypass.

▶ STATUS INQUIRY ESC ENQ

When you enter this command, the terminal sends the current mode status and the current Alpha cursor, vector position, or Graphic cursor coordinates, and the trailer code to the host. If you are in Graphic Cursor mode, the current mode status is not sent, and the terminal exits to Alpha mode after transmission. If the terminal is not online, status is not transmitted. The response to this command is shown in Figure 3-2.



Status Inquiry Format
Figure 3-2

*See Select Trailer Code command

Bit 3 - Vector Mode

0 Vector mode off (default)
1 Vector mode on

Bit 2 - Current Mode

0 Vector, Point, or Graphic Cursor mode
1 Alpha mode (default)

Bit 1 - Current Margin

0 Margin 1 (default)
1 Margin 2

After data transmission, the terminal ignores characters received until you enter a command that clears the bypass. If the terminal is in Local mode when you enter this command, no action is performed.

▶ VECTOR MODE GS

This mode draws vectors (lines) from given 4-byte vector endpoint coordinates. The first coordinate after the GS control code determines the vector starting point. When the second coordinate is sent, a vector is drawn from the initial vector point to the second vector point. When the third coordinate is sent, a vector is drawn from the second vector point to the third vector point, and so on. If you want to draw a vector that does not connect with the previous vectors, enter the GS control code and the new vector endpoint. This reinitializes the vector drawing sequence.

The eight bytes corresponding to each screen coordinate (X and Y) are divided into 4-byte groups so that each screen coordinate has four associated values, High X, Low X, High Y, and Low Y. Figure 3-3 shows the vector drawing sequence.

GS	0	0	0	1	1	1	0	1
High Y	X	0	1	Y9	Y8	Y7	Y6	Y5
Low Y	X	1	1	Y4	Y3	Y2	Y1	Y0
High X	X	0	1	X9	X8	X7	X6	X5
Low X	X	1	0	X4	X3	X2	X1	X0

Vector Drawing Sequence
Figure 3-3

Graphics memory retains the first three bytes of the last executable address so you do not have to enter address points unless they change. The points do not have to be reloaded when the terminal is reset to Alpha or Graphic Cursor mode. Table 3-2 shows which bytes must be sent when using shortened addresses.

Table 3-2

Bytes That Must Be Sent (*)
When Using a Shortened Address

Bytes Changed	Bytes That Must Be Sent			
	High Y	Low Y	High X	Low X
High Y	*	-	-	*
Low Y	-	*	-	*
High X		*	*	*
Low X	-	-	-	*

See Appendix F for vector coordinate values in ASCII and decimal format.

TEKTRONIX 4105 COLOR GRAPHICS COMMANDS

Tektronix 4105 Color Graphics are an enhancement of Tektronix 4014 Graphics. To enter 4105 Color Graphics, first issue the command for entering PT200 color operation:

Select Color Operation ESC [8 {

Follow with the command to enter graphics operation:

Enter Graphics Operation ESC $ 6

Then choose the color map for the graphics session using the Set Surface Color Map command described below. From this point all the capabilities of Tektronix 4014 Graphics are available with Tektronix 4105 Color Graphics. Select the desired color from the map for any graphics operation.

Color works in all modes of 4014 Graphics. Four colors can be chosen for display at any one time, including the background color. A wide range of colors and color variations is available.

The Tektronix 4105 Color Graphics commands listed here apply in full color operation only, except for the Begin Panel Boundary and End Panel commands, which apply in full color and in monochrome operation.

▶ SET SURFACE COLOR MAP (SSCM) ESC T G <s><n><i:c>

This command specifies the color assigned to each of four color indexes. Use the command to set up a color map for the entire graphics session. You can display up to four colors at the same time.

The colors available are listed in Table 3-3. Each color can be varied by selecting from a range of hue, lightness, and saturation represented by decimal numbers.

Table 3-3

Colors Available for Use in the Graphics Color Table:
Decimal Integer Parameters

Color	Hue (degree)	Lightness (%)	Saturation (%)
Black	0	0	0
White	0	100	0
Light red	91-150	50-100	0-100
Dark red	91-150	0-49	0-100
Light green	211-270	50-100	0-100
Dark green	211-270	0-49	0-100
Light blue	0-30,331-360	50-100	0-100
Dark blue	0-30,331-360	0-49	0-100
Light cyan	271-330	50-100	0-100
Dark cyan	271-330	0-49	0-100
Light magenta	31-90	50-100	0-100
Dark magenta	31-90	0-49	0-100
Light yellow	151-210	50-100	0-100
Dark yellow	151-210	0-49	0-100

Indexes 0-3 make up the graphics color map. Index 0 always defines the background color. Each of the four indexes contain four parameters: one parameter defines the index number; the next three parameters define hue, lightness, and saturation. Therefore each color map is composed of 16 parameters if four colors are selected.

Parameter commands are issued in ASCII. Instructions for the conversion of decimal integer parameters to ASCII are contained in Appendix G. The appendix also includes a table which converts decimal integers for you.

The parameter array is as follows:

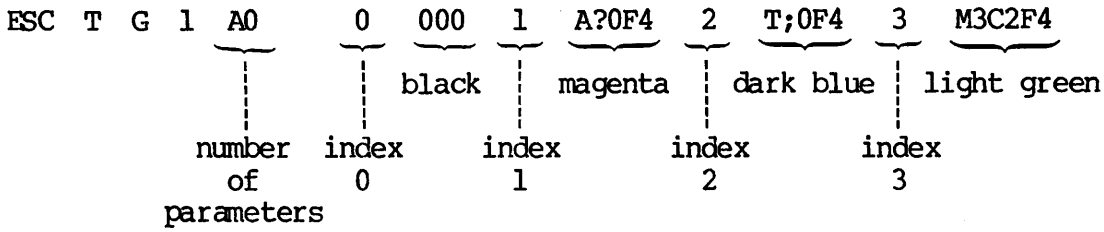
<s> Surface number; it must have a value of 1.

<n> Number of parameters defined in the array.

<i:c> Index, which is defined by four parameters:

- index number (0-3)
- degrees ot its hue (0-360)
- percentage of lightness (0-49 or 50-100)
- percentage of saturation (0-100)

Below is an example of a Set Surface Color Map Sequence in ASCII. This example sets up the color map for the color graphics exercise in Chapter 2. The exercise shows how to plot a triangle with dark magenta lines, to fill it in with light green, and to put dark blue labels on a black background.



The default color map follows. If the user selects full color operation but does not define all four indexes, undefined indexes display in the default color given below.

index 0 : black
index 1 : white
index 2 : light red
index 3 : light green

▶ SET LINE INDEX (SLI) ESC M L <i>

This command specifies the color index for subsequent lines and panel boundaries. The index, <i>, should be in the range of 1 through 3. Any other value will be ignored. If you want to change to a different color, issue a new Set Line Index command. The default line index is 1. The default line index color is white.

The decimal numbers selected for index values from Table 3-3 must be converted to ASCII. Appendix G shows how to convert them and supplies a table of conversions.

▶ SELECT FILL PATTERN (SFP) ESC M P <n>

This command specifies the fill color for subsequent panels. The fill color number, <n>, should be in the range of -3 through -1. Any other number will be ignored. The number specified causes a panel to be filled with a solid color indicated by the negative value of a color index. For example, -2 means "fill the panel with color of index 2". The default fill index is 1 (white). The decimal number values of that index become negative. Consult Appendix G for the ASCII equivalent of negative numbers.

▶ BEGIN PANEL BOUNDARY (BGPB) ESC L P <p><b>

This sequence starts a panel (polygon) definition. The command is applicable in both monochrome and full color operation.

<p> first point in the panel boundary;
it is in the XY-coordinate byte format.

<b> draw-boundary parameter (0 or 1), where:

0 = draw boundary with current fill color index

1 = draw boundary with current line color index

The terminal must be in Vector mode to create the panel boundary. The panel boundary is defined by sending the XY-coordinate bytes representing the boundary line endpoints. The PT200 graphics firmware can support up to 256 vertices per panel. There is no need to create the panel's last boundary segment. When the terminal receives the End Panel command (cf. below), it closes the panel and fills it with the fill index color specified. The triangle constructed in the color graphics exercise in Chapter 2 uses the BGPB command.

A panel with multiple boundaries can be created as follows. Send another Begin Panel Boundary command when you are ready to begin the second boundary. (Do not close the first boundary.) The second Begin Panel Boundary command closes the first boundary and starts another boundary at the specified position. When you issue the End Panel command, the last boundary is closed and the entire panel defined by the multiple boundaries is filled with color.

▶ END PANEL (EP) — ESC L E

This command closes the panel boundary, fills the panel with the current fill color, and sets the current graphics position to the panel's first boundary point. This command applies in both monochrome and full color operation. If more than 256 vertices have been defined, the panel is not filled.

▶ SET TEXT INDEX (STI) — ESC M T <i>

This command specifies the color index for alpha text (labels for graphs and charts). The index, <i>, should be in the range of 1 to 3. Any other value will be ignored. The default text index is 1. The default text index color is white. The decimal numbers selected for index values from Table 3-3 must be converted to ASCII. Appendix G shows how to convert and supplies a table of conversions already done for you.

NATIVE GRAPHICS COMMANDS

Native Graphics commands enhance Tektronix 4014 commands. The commands listed in this section, except for Exit Graphics Operation, are only valid in Native Graphics. Command mnemonics are included for consistency with PT200 terminal commands.

▶ CLEAR GRAPHIC DISPLAY (CGD) — ESC [Ps x

This command clears the specified page of the memory bank. The x stands for a parameter which selects the page. If you do not specify a parameter, the default is assumed. If you specify more than one parameter, you will get an error.

Parameter	Page
0	Clear first page of memory bank.
1	Clear second page of memory bank.
2	Clear both pages of memory bank (default).

▶ EXIT GRAPHICS OPERATION (EXGO) ESC $?

This command exits from graphics operation. All subsequent characters are sent to the PT200 controller board. When you enter the command, the graphics display does not clear, but the status line and standard PT200 cursor are restored to the screen. This sequence is valid in both Native Graphics and Tektronix Graphics.

▶ MEMORY DUMP (MD) ESC > <row>; (count); (page)

This command unloads data, six bits at a time, from graphics memory, starting at the specified row and unloading successively to the right. Each block of six bits is defined as the lower six bits of an ASCII character (char). These characters are sent to the host one row at a time, for the specified count. If the specified count is greater than the number of available rows, wrapping occurs. The # character indicates the end of the Memory Dump sequence.

You will get an error if you do not specify three parameters, if the page number is greater than one, if the specified row is not within PT200 boundaries, or if the specified count is not within allowable values. The graphics board sends the CAN control code to the host after all data has been transmitted. If the terminal is in Local mode when you issue this command, an error results.

The variable row is a decimal, where:

0 <= row <= 299

row 0 starts at the top left-hand corner of screen.

The ASCII characters sent are in the following range:

40 hex <= char <= 7F hex

The variable count is the number (in decimal) of rows sent, where:

1 <= count <= 300

The variable page selects the page within the screen memory bank, where:

Parameter	Page
0	Selects the first page of the screen memory bank.
1	Selects the second page of the screen memory bank.

▶ MEMORY LOAD (ML) ESC 7 <X>; <Y>; (page) (char) ..*

This command loads data six bits at a time into graphics screen memory, starting at the specified address (X,Y) and loading successively to the right. If the number of characters sent to the terminal is greater than the number of available positions in the current row, wrapping occurs. Each block of six bits is defined as the lower six bits of an ASCII character. The * character indicates the end of the Memory Load command.

You will get an error if you do not specify three parameters, if the page number is greater than one, or if the X and Y values are not within PT200 boundaries.

X and Y are decimal screen coordinate values, where X is a multiple of 6, and:

0 <= X <= 714
0 <= Y <= 299

(0,0) is the top left-hand corner of the screen.

The variable page selects the page within the screen memory bank, where:

Parameter	Page
0	Selects the first page of memory.
1	Selects the second page of memory.

The variable char is an ASCII character, where:

40 hex <= char <= 7F hex

▶ PRINT GRAPHIC DISPLAY (PGD) ESC $ 2

This command sends the graphics display memory, which consists of two overlayed pages, to the printer port eight bits at a time starting at the upper left-hand corner of the screen. The printer must be Epson-compatible.

▶ SELECT BLANKING LEVEL (SBL) ESC [Ps w

This command selects one of four plane-blanking levels on a per plane basis. If you do not specify a parameter, the default is assumed. You will get an error if you specify more than one parameter.

Parameter	Plane Blanked
0	Both planes blanked.
1	Plane 0 displayed, plane 1 blanked.
2	Plane 1 displayed, plane 0 blanked.
3	Both planes displayed (default).

▶ SELECT LOGICAL OPERATION (SLO) ESC [Ps v

This command selects one of three logical operations to apply to display data on a per pixel or per character basis. If no parameter is specified, the default parameter value is assumed. If more than one parameter is specified, an error is indicated.

Parameter	Logical Operation
0	"OR" function (default)
1	"XOR" function
2	"erase" function

▶ SELECT TEKTRONIX GRAPHICS (STO) ESC $ 1

This command exits you from Native Graphics and enters you into Tektronix Graphics operation.

▶ SELECT TRAILER CODE (STC) ESC [Ps r

This command selects the trailer code (if any) for the host to transmit in response to a Tektronix Status Inquiry or Graphic cursor position request. If no parameter is specified, the default parameter value is assumed. If more than one parameter is specified, an error results.

Parameter	Trailer Code
0	None (default)
1	Carriage Return (CR)
2	CR and EOT

▶ SELECT VISUAL LEVEL (SVL) ESC [Ps s

This command allows you to select one of four visual levels to be applied to display data (on a per pixel or per character basis). If you do not specify a parameter, the default is assumed. If you specify more than one parameter, an error results.

With a monochrome terminal, all four of the intensity levels below are available. When you select monochrome operation on a color terminal, levels 1 and 2 are the same (low intensity). When you select full color operation on a color terminal, this sequence performs no action.

Parameter	Visual Level
0	No pixel displayed
1	Low intensity
2	Medium intensity
3	Maximum intensity (default)

APPENDIXES

A

PT200 and Tektronix 4014 Graphics Option Differences

The PT200 Graphics Option does not support all Tektronix 4014 graphics features. The features not supported by the PT200 are:

- Write-thru. Write-thru is also called selective write. It is a display operation that writes information on the display screen without storing it in memory.
- Defocused Z-axis (changing dot intensity).
- Origin shifting. Origin shifting of the Alpha cursor is a Tektronix screen-preserving feature.
- Special Point Plot mode. This mode is available in the Tektronix 4014 Enhanced Graphic Module. It allows the user to select different intensity levels on the screen by controlling the size of the plotted point. Special Point Plot mode gives the terminal a gray scale capability.
- Margin control switches. When these keyboard switches are on, they generate a Page Full signal when the margins are set and the terminal feeds past the last alphanumeric line for the margin. A Page Full signal means that the Full indicator on the keyboard is lighted.
- Auto print switch. When this keyboard switch is on, a hard copy of the screen generates when a Page Full signal occurs.

- Alternate character set. The Tektronix 4014 can be modified to allow alternate character sets. The PT200 has an alternate character set in standard operation but not in graphics operation.

- 4096 x 4096 screen/page addressing.

- The four character sizes provided by the PT200 Graphics Option are different than the four character sizes provided by the Tektronix 4014. See Table A-1 for comparison.

Table A-1
Comparison of Tektronix and PT200 Character Sizes

Size	Tektronix	PT200
Very small	133 characters/line 64 lines/page	102 characters/line (80 mode) 32 lines/page
		102 characters/line (132 mode) 30 lines/page
Small	121 characters/line 58 lines/page	102 characters/line (80 mode) 26 lines/page
		102 characters/line (132 mode) 25 lines/page
Medium	81 characters/line 38 lines/page	80 characters/line (80 mode) 32 lines/page
		80 characters/line (132 mode) 30 lines/page
Large	74 characters/line 35 lines/page	80 characters/line (80 mode) 26 lines/page
		80 characters/line (132 mode) 25 lines/page

- The size of the screen differs, therefore the characters take on different shapes. The PT200 screen is 720 pixels in the X-direction and 300 pixels in the Y-direction. The Tektronix 4014 Terminal is 1,024 pixels in the X-direction and 780 pixels in the Y-direction.

B

Graphics Option Hardware Description

This appendix contains information about Graphics Option hardware. The information included here will give you an understanding of Graphics Option board memory, the CPU, and initialization.

The Graphics Option board plugs into the PT200 terminal. It contains a CPU, pixel control logic, control ROM, scratchpad RAM, two planes of 32K bytes bit map RAM, I/O address decoding, and interrupt control logic. Detailed technical specifications for the board are given in Table B-1.

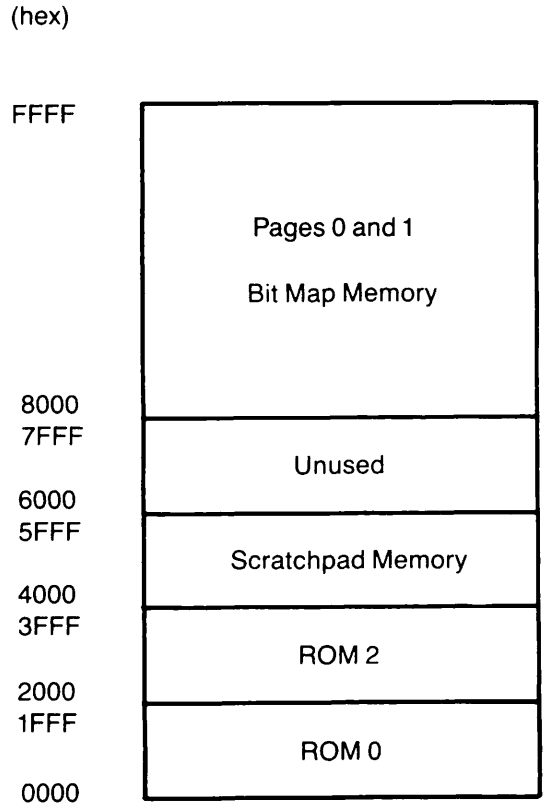
Table B-1
Graphics Option Technical Specifications

Specification	80-character Screen Size	132-character Screen Size
Active pixels	300 x 720 = 216,000	308 x 792 = 243, 936 (only 300 x 720 pixels are used)
Active display bytes per page	27,000	30,492
Number of screen planes	2	2
Horizontal display interval	43.400 microsec.	42.00 microsec.
Pixel period	60.28 nanosec.	53.03 nanosec.
Pixel width	30.14 nanosec.	26.46 nanosec.
Pixel frequency	16.5888 MHz	18.857 MHz
CPU clock	4.0 MHz	4.0 MHz

Graphics Memory

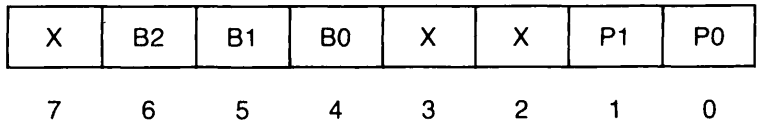
The Graphics Option board has 3 x 8K bytes of EPROM and static RAM and 2 x 32K bytes of dynamic RAM.

The lower 32K of memory addressing is for the CPU while the top 32K is used for the graphics bit map. Figure B-1 shows the memory map.



Graphics Option Board Memory Map
Figure B-1

The CPU accesses the bit map memory one page at a time. Page 0 contains the bit map for Plane 0 and Page 1 contains the bit map for Plane 1. The planes are overlayed on each other so that their bit maps are displayed on the display screen at the same time. With overlays, four shades of gray can be displayed on the graphics display screen. Figures B-2 and B-3 show bit map combinations.



Plane/Bank Select Register
Figure B-2

Plane Select Bits

P1	P0	
0	0	Both planes blanked.
0	1	Plane 0 displayed, Plane 1 blanked.
1	0	Plane 1 displayed, Plane 0 blanked.
1	1	Both planes displayed overlayed.

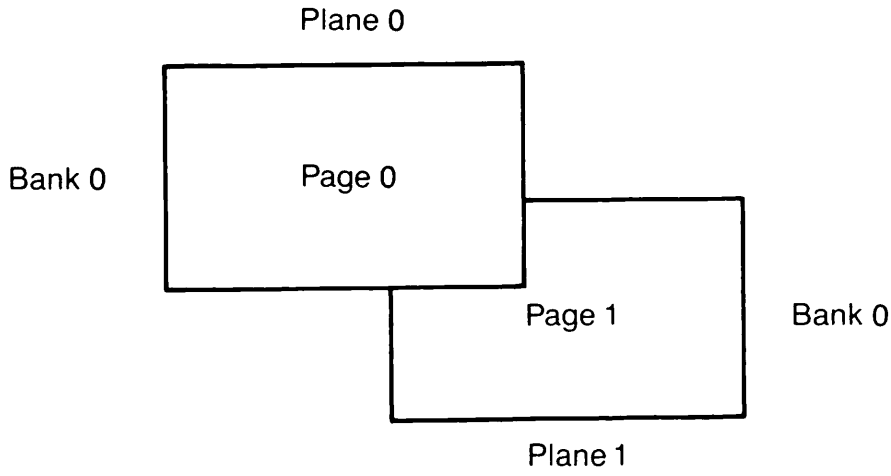
Pixel Intensity Bits

Plane 1 Pixel	Plane 0 Pixel	
0	0	No pixel displayed.
0	1	Low intensity pixel displayed.
1	0	Medium intensity pixel displayed.
1	1	Maximum intensity pixel displayed.

32K Page Select Bits

	B2	B1	B0	
	0	0	0	Select Page 0 for read or write.
	0	0	1	Select Page 1 for read or write.
*	1	0	0	Write Pages 0 and 1 simultaneously.
*	1	0	0	Write Pages 0 and 1 simultaneously.

* Doing a read operation with B2 = 1 is illegal.



Plane/Bank Diagram
Figure B-3

Page Definition

Page 0	Plane 0 page of Bank 0.
Page 1	Plane 1 page of Bank 0.

Plane Definition

Plane 0	Page 0
Plane 1	Page 1

GRAPHICS OPTION BOARD INITIALIZATION

Graphics Option board logic can be initialized in several ways: by power on reset, by the internal reset switch on the graphics board, the Reset to Initial State escape sequence (RIS) issued in standard operation, or by pressing Ctrl/Shift/Stop or Char Set/Ctrl/Clear on the PT200 keyboard.

The graphics board assumes the following states at initialization:

- Interrupts are disabled.
- Fetch address is 0.
- Graphics video is blank.
- CPU instructions are verified.
- Scratch pad RAM is tested.
- Display RAM is tested.
- Checksums in ROMS are verified.
- Display RAM is cleared.
- Request link is sent to the PT200 by sending XON (DC3) and the current graphics board revision number (0-19 decimal in BCD format). The PT200 board accepts this revision number during initialization and later converts this value to ASCII digits when a Display Revision sequence is performed. The Device Attributes sequence parameter value is set equal to 4 if an error-free non-color graphics board is installed or set equal to 7 if an error-free color graphics board is installed.

If the graphics board is installed and working correctly, the message GRAPH OPT is displayed in the last field of the status line at initialization. If the graphics board is not installed or is installed incorrectly, no message is displayed. If there is a graphics board error, the message GRAPH ERR (error code) is displayed. If you have a board error, see Appendix F, PT200 Graphics Option Board Installation Instructions to find out what the error code means, and how to remove the board for return to Prime.

C

Tektronix Graphics Commands, Keys, and Codes

This appendix consists of the following tables:

Table C-1
Tektronix 4014 Color Graphics Commands

Command Name	ESC Sequence
Erase Display and Move Cursor Home	ESC FF
Escape Sequence Introducer	ESC
Escape Sequence Introducer	ESC CR
Escape Sequence Introducer	ESC ESC
Escape Sequence Introducer	ESC LF
Escape Sequence Introducer	ESC NUL
Exit Graphics Operation	ESC $?
Graphic Cursor Mode	ESC SUB
Incremental Plot Mode	ESC RS
Incremental Plot Mode	RS
Make Copy	ESC ETB
Move One Line Down	LF
Move One Line Up	VT
Move One Line Up	ESC VT
Move One Space Left	BS
Move One Space Left	ESC BS
Move One Space Right	HT
Move One Space Right	ESC HT
Move To Current Margin	CR
Move To Current Vector/Point Position	US
Move To Current Vector/Point Position	ESC US
Point Plot Mode	FS
Ring Bell	BEL
Ring Bell	ESC BEL
Select Dot-Dashed Vector	ESC b
Select Dotted Vector	ESC a
Select Large Characters	ESC 8
Select Long-Dashed Vector	ESC d
Select Native Graphics	ESC $ 0
Select Size 3 Characters	ESC :
Select Size 2 Characters	ESC 9
Select Short-Dashed Vector	ESC c
Select Small Characters	ESC ;
Select Solid Vector	ESC `
Set Bypass	ESC CAN
Status Inquiry	ESC ENQ
Vector Mode	GS
Vector Mode	ESC GS

Table C-2
Tektronix 4105 Color Graphics Commands

Command Name	ESC Sequence
Begin Panel Boundary	ESC L P <p><b>
End Panel	ESC L E
Select Fill Pattern	ESC M P <n>
Set Line Index	ESC M L <i>
Set Surface Color Map	ESC T G <s><n><i:c>
Set Text Index	ESC M T <i>

Table C-3
Valid Keys in Tektronix Graphics

PT200 Key	Function	Sequence Generated
↓	Moves Graphic cursor one pixel down.	ESC [B (Cursor Down)
Ctrl/↓	Moves Graphic cursor ten pixels down.	ESC N M
←	Moves Graphic cursor one pixel back.	ESC [D (Cursor Backward)
Ctrl/←	Moves Graphic cursor ten pixels back.	ESC N P
→	Moves Graphic cursor one pixel forward.	ESC [C (Cursor Forward)
Ctrl/→	Moves Graphic cursor ten pixels forward.	ESC N S
↑	Moves Graphic cursor one pixel up.	ESC [A (Cursor Up)
Ctrl/↑	Moves Graphic cursor ten pixels up.	ESC N J
Backspace Shift/Backspace	Moves Alpha cursor one space back taking margins into account.	08 hex (BS)
Ctrl/Backspace Ctrl/Shift/Backspace	The character is not displayed but can be used as a vector coordinate value.	7F hex
Char Set	Toggles the corresponding internal augmentation bit. No SO or SI function is produced.	None

Table C-3 (continued)
Valid Keys in Tektronix Graphics

PT200 Key	Function	Sequence Generated
Clear	Enters Alpha mode, selects Margin 1, moves cursor home, clears screen memory, clears bypass.	ESC $ G (Soft Keyboard Unlock)
Ctrl/Clear	Enters Alpha mode, selects Margin 1, moves cursor home, does not clear screen memory, clears bypass. Resets graphics board to initial status.	ESC ? (Clear Screen)
Char Set/Ctrl/Clear	Performs a hardware reset.	None
Function F1-10, PF1-12 PA1-4	Generates a function.	Single Shift Three
Help	Supplies help information.	ESC _ ESC \ (Application Program Command)
Prt Scn	Sends graphics display screen memory (two overlayed pages) to printer port eight bits at a time.	ESC [0 i (Media Copy)
Ctrl/Return Shift/Return Ctrl/Shift/Return	Sends information from keyboard, enters Alpha mode, moves cursor to current margin.	0D hex (CR)
Stop	Toggles between XOFF and XON.	Ctrl/S, Ctrl/Q

Table C-3 (continued)
Valid Keys in Tektronix Graphics

PT200 Key	Function	Sequence Generated
Shift/Stop	Interrupts running system or application program.	ESC 0 y
Ctrl/Stop	Interrupts running system or application program.	ESC 0 z
Ctrl/Shift/Stop	Interrupts running system or application program.	Reset to Initial State (RIS)
Char Set/Stop	Generates a break.	None
Shift/Tab	Moves cursor one space right.	09 hex (HT)

Table C-4
Valid Control Codes in Tektronix Graphics

Control Character	Function	Code
*NUL	Performs no action.	00
STX	Start of text.	02
ETX	End of text.	03
*BEL	If immediately preceded by GS and followed by vector coordinate values, the specified point is displayed. BEL clears the bypass.	07
*BS	Moves Alpha cursor one space back taking margins into account. If you backspace past the current margin, the cursor moves to the last position of the current line.	08
*HT	Moves Alpha cursor one space forward taking margins into account. If you pass the last position of the current line when the current line is not the last row in the display, the cursor wraps to the beginning of the next line. If you pass the last position of the current line when the current line is the last row in the display, the cursor wraps to the current margin of the top row in the display.	09
*LF	Moves Alpha cursor one line down. If the bottom of the display is reached, the cursor wraps to the top line of the display and switches the current margin setting. LF also clears the bypass.	0A

*Indicates that the control code works differently than in standard operation. See the PT200 Programmer's Reference Guide for information about how the control codes work in standard operation.

Table C-4 (continued)
Valid Control Codes in Textronix Graphics

Control Character	Function	Code
*FF	Performs no action.	0C
*CR	Enters Alpha mode, moves cursor to current margin and clears bypass.	0D
*SO	Performs no action.	0E
*SI	Clears bypass.	0F
DC1	When received, terminal resumes transmission.	11
DC3	When received, terminal stops transmission.	13
*CAN	Sent from graphics board to host to internally notify the PT200 that status transmission is complete.	18
SUB	Substituted for character with parity error.	1A
ESC	Introduces control function.	1B

*Indicates that the control code works differently than in standard operation. See the PT200 Programmer's Reference Guide for information about how the control codes work in standard operation.

D

Native Graphics Commands, Keys, and Codes

This appendix consists of the following tables:

Table D-1
Native Graphics Commands

Command Name	ESC Sequence
Clear Graphic Display	ESC [Ps x
Enter Graphics Operation	ESC $ 6
Exit Graphics Operation	ESC $?
Memory Dump	ESC > <row>; (count); (page) #
Memory Load	ESC 7 <X>; <Y>; (page) (char) ...*
Print Graphic Display	ESC $ 2
Select Logical Operation	ESC [Ps v
Select Blanking Level	ESC [Ps w
Select Native Graphics	ESC $ O
Select Tektronix Graphics	ESC $ l
Select Trailer Code	ESC [Ps r
Select Visual Level	ESC [Ps s

Table D-2
Valid Keys in Native Graphics

PT200 Key	Function	Sequence
Char Set	Toggles the corresponding internal augmentation bit. No SO or SI function is produced.	None
Char Set/Clear	Performs a hardware reset.	None
Function	Generates function. Not local key.	Single Shift Three
Help	Supplies help information. Not local key.	ESC _ ESC \ (Application Program Command)
Prt Scn	Sends graphic display screen memory (two overlayed pages) to printer port eight bits at a time.	Esc [0 i (Media Copy)
Stop	Toggles between XOFF and XON.	Ctrl/S, Ctrl/Q
Shift/Stop	Interrupts running system or application program.	ESC 0 y
Ctrl/Stop	Interrupts running system or application program.	ESC 0 z
Ctrl/Shift/Stop	Interrupts running system or application program.	Reset to Initial State (RIS)
Char Set/Stop	Generates a break.	None

Table D-3
Valid Control Codes in Native Graphics

Control Character	Function	Hex Code
STX	Start of text.	02
ETX	End of text.	03
DC1	When received, terminal resumes transmission.	11
DC3	When received, terminal stops transmission.	13
*CAN	Sent from graphics board to PT200 to internally notify PT200 that memory dump is completed.	18
SUB	Substituted for character with parity error.	1A
ESC	Introduces control function.	1B

*Indicates that the control code works differently than in standard operation. See the PT200 Programmer's Reference Guide for information about how the control codes work in standard operation.

E

Numerical Equivalents to ASCII Format

This appendix contains a table of numerical equivalents to ASCII formats. The keyboard equivalents and Tektronix functions are listed for each character. Note that to use Tektronix functions indicated with an asterisk (*), you must precede each with the ESC character. For example: ESC ETB for Make Copy.

Table E-1
Numerical Equivalents to ASCII Format

Octal	Hex	Keyboard Equivalent (ASCII)	Character	Tektronix Function
000	00	[Ctrl @]	NUL	Null
001	01	[Ctrl A]	SOH	Start of Header
002	02	[Ctrl B]	STX	Start of Text
003	03	[Ctrl C]	ETX	End of Text
004	04	[Ctrl D]	EOT	End of Transmission
005	05	[Ctrl E]	ENQ	*Status Inquiry
006	06	[Ctrl F]	ACK	Acknowledge
007	07	[Ctrl G]	BEL	Ring Bell
010	08	[Ctrl H]	BS	Move One Space Left
011	09	[Ctrl I]	HT	Move One Space Right
012	0A	[Ctrl J]	LF	Move One Line Down
013	0B	[Ctrl K]	VT	Move One Line Up
014	0C	[Ctrl L]	FF	*Erase Display and Move Cursor Home
015	0D	[Ctrl M]	CR	Move to Current Margin
016	0E	[Ctrl N]	SO	Shift Out
017	0F	[Ctrl O]	SI	Shift In
020	10	[Ctrl P]	DLE	Data Link Escape
021	11	[Ctrl Q]	DC1	Xon
022	12	[Ctrl R]	DC2	Tape, Punch On
023	13	[Ctrl S]	DC3	Xoff
024	14	[Ctrl T]	DC4	Tape, Punch Off
025	15	[Ctrl U]	NAK	Negative Acknowledge
026	16	[Ctrl V]	SYN	Synchronous Idle
027	17	[Ctrl W]	ETB	*Make Copy
030	18	[Ctrl X]	CAN	*Set Bypass
031	19	[Ctrl Y]	EM	End of Medium
032	1A	[Ctrl Z]	SUB	*Graphic Cursor Mode
033	1B	[Ctrl []	ESC	Escape
034	1C	[Ctrl \]	FS	Point Plot Mode
035	1D	[Ctrl]]	GS	Vector Mode
036	1E	[Ctrl ^]	RS	Incremental Plot Mode
ESC 037	1F	[Ctrl _]	US	Move to Current Vector/Point Position
040	20	[ ]	SPACE	
041	21	[!]	[!]	
042	22	["]	["]	
043	23	[#]	[#]	
044	24	[$]	[$]	
045	25	[%]	[%]	
046	26	[&]	[&]	
047	27	[']	[']	
050	28	[(]	[(]	
051	29	[)]	[)]	
052	2A	[*]	[*]	

Table E-1 (continued)
Numerical Equivalents to ASCII Format

Octal	Hex	Keyboard Equivalent (ASCII)	Character	Tektronix Function
053	2B	[+]	[+]	
054	2C	[,]	[,]	
055	2D	[-]	[-]	
056	2E	[.]	[.]	
057	2F	[/]	[/]	
060	30	[0]	[0]	
061	31	[1]	[1]	
062	32	[2]	[2]	
063	33	[3]	[3]	
064	34	[4]	[4]	
065	35	[5]	[5]	
066	36	[6]	[6]	
067	37	[7]	[7]	
070	38	[8]	[8]	
071	39	[9]	[9]	
072	3A	[:]	[:]	
073	3B	[;]	[;]	
074	3C	[<]	[<]	
075	3D	[=]	[=]	
076	3E	[>]	[>]	
077	3F	[?]	[?]	
100	40	[@]	[@]	
101	41	[A]	[A]	
102	42	[B]	[B]	
103	43	[C]	[C]	
104	44	[D]	[D]	
105	45	[E]	[E]	
106	46	[F]	[F]	
107	47	[G]	[G]	
110	48	[H]	[H]	
111	49	[I]	[I]	
112	4A	[J]	[J]	
113	4B	[K]	[K]	
114	4C	[L]	[L]	
115	4D	[M]	[M]	
116	4E	[N]	[N]	
117	4F	[O]	[O]	
120	50	[P]	[P]	
121	51	[Q]	[Q]	
122	52	[R]	[R]	
123	53	[S]	[S]	
124	54	[T]	[T]	
125	55	[U]	[U]	
126	56	[V]	[V]	
127	57	[W]	[W]	

Table E-1 (continued)
Numerical Equivalents to ASCII Format

Octal	Hex	Keyboard Equivalent (ASCII)	Character	Tektronix Function
130	58	[X]	[X]	
131	59	[Y]	[Y]	
132	5A	[Z]	[Z]	
133	5B	[[]	[[]	
134	5C	[\]	[\]	
135	5D	[]]	[]]	
136	5E	[^]	[^]	
137	5F	[_]	[_]	
140	60	[`]	[`]	
141	61	[a]	[a]	
142	62	[b]	[b]	
143	63	[c]	[c]	
144	64	[d]	[d]	
145	65	[e]	[e]	
146	66	[f]	[f]	
147	67	[g]	[g]	
150	68	[h]	[h]	
151	69	[i]	[i]	
152	6A	[j]	[j]	
153	6B	[k]	[k]	
154	6C	[l]	[l]	
155	6D	[m]	[m]	
156	6E	[n]	[n]	
157	6F	[o]	[o]	
160	70	[p]	[p]	
161	71	[q]	[q]	
162	72	[r]	[r]	
163	73	[s]	[s]	
164	74	[t]	[t]	
165	75	[u]	[u]	
166	76	[v]	[v]	
167	77	[w]	[w]	
170	78	[x]	[x]	
171	79	[y]	[y]	
172	7A	[z]	[z]	
173	7B	[{]	[{]	
174	7C	[|]	[|]	
175	7D	[}]	[}]	
176	7E	[~]	[~]	
177	7F	[DEL]	[DEL]	

F

Coordinate Conversion Charts

This appendix explains two ways to convert vector coordinate end points to ASCII or decimal equivalents.

METHOD 1

This method allows you to pick ASCII or decimal values for vector end points from Table F-1. The procedure is as follows:

1. Find the X or Y coordinate value in the center of the chart under "X or Y coordinate."

2. Follow the column containing the value to the bottom of the chart to find the decimal (DEC.) or ASCII character which represents the High Y or High X byte.

3. Go back to the coordinate value in the center of the chart.

4. Follow the row containing the value to the left to find the Low Order X value, and to the right to find the Low Order Y value.

For example: the coordinate 44Y, 183X equals 33 108 37 87 in decimal code, and ! l % W in ASCII code.

Table F-1
Vector Coordinates in ASCII and Decimal Format

Low Order X									Low Order Y	
ASCII	DEC.	X or Y Coordinate							DEC.	ASCII
@	64	0	32	64	96	128	160	192	224	96	'
A	65	1	33	65	97	129	161	193	225	97	a
B	66	2	34	66	98	130	162	194	226	98	b
C	67	3	35	67	99	131	163	195	227	99	c
D	68	4	36	68	100	132	164	196	228	100	d
E	69	5	37	69	101	133	165	197	229	101	e
F	70	6	38	70	102	134	166	198	230	102	f
G	71	7	39	71	103	135	167	199	231	103	g
H	72	8	40	72	104	136	168	200	232	104	h
I	73	9	41	73	105	137	169	201	233	105	i
J	74	10	42	74	106	138	170	202	234	106	j
K	75	11	43	75	107	139	171	203	235	107	k
L	76	12	44	76	108	140	172	204	236	108	l
M	77	13	45	77	109	141	173	205	237	109	m
N	78	14	46	78	110	142	174	206	238	110	n
O	79	15	47	79	111	143	175	207	239	111	o
P	80	16	48	80	112	144	176	208	240	112	p
Q	81	17	49	81	113	145	177	209	241	113	q
R	82	18	50	82	114	146	178	210	242	114	r
S	83	19	51	83	115	147	179	211	243	115	s
T	84	20	52	84	116	148	180	212	244	116	t
U	85	21	53	85	117	149	181	213	245	117	u
V	86	22	54	86	118	150	182	214	246	118	v
W	87	23	55	87	119	151	183	215	247	119	w
X	88	24	56	88	120	152	184	216	248	120	x
Y	89	25	57	89	121	153	185	217	249	121	y
Z	90	26	58	90	122	154	186	218	250	122	z
[	91	27	59	91	123	155	187	219	251	123	{
/	92	28	60	92	124	156	188	220	252	124	|
]	93	29	61	93	125	157	189	221	253	125	}
^	94	30	62	94	126	158	190	222	254	126	~
_	95	31	63	95	127	159	191	223	255	127	
DEC.		32	33	34	35	36	37	38	39		
ASCII		SP	!	"	#	$	%	&	'		
		High Order X and Y									

Table F-1 (continued)
Vector Coordinates in ASCII and Decimal Format

Low Order X										Low Order Y	
ASCII	DEC.	X or Y Coordinate								DEC.	ASCII
@	64	256	288	320	352	384	416	448	480	96	'
A	65	257	289	321	353	385	417	449	481	97	a
B	66	258	290	322	354	386	418	450	482	98	b
C	67	259	291	323	355	387	419	451	483	99	c
D	68	260	292	324	356	388	420	452	484	100	d
E	69	261	293	325	357	389	421	453	485	101	e
F	70	262	294	326	358	390	422	454	486	102	f
G	71	263	295	327	359	391	423	455	487	103	g
H	72	264	296	328	360	392	424	456	488	104	h
I	73	265	297	329	361	393	425	457	489	105	i
J	74	266	298	330	362	394	426	458	490	106	j
K	75	267	299	331	363	395	427	459	491	107	k
L	76	268	300	332	364	396	428	460	492	108	l
M	77	269	301	333	365	397	429	461	493	109	m
N	78	270	302	334	366	398	430	462	494	110	n
O	79	271	303	335	367	399	431	463	495	111	o
P	80	272	304	336	368	400	432	464	496	112	p
Q	81	273	305	337	369	401	433	465	497	113	q
R	82	274	306	338	370	402	434	466	498	114	r
S	83	275	307	339	371	403	435	467	499	115	s
T	84	276	308	340	372	404	436	468	500	116	t
U	85	277	309	341	373	405	437	469	501	117	u
V	86	278	310	342	374	406	438	470	502	118	v
W	87	279	311	343	375	407	439	471	503	119	w
X	88	280	312	344	376	408	440	472	504	120	x
Y	89	281	313	345	377	409	441	473	505	121	y
Z	90	282	314	346	378	410	442	474	506	122	z
[	91	283	315	347	379	411	443	475	507	123	{
/	92	284	316	348	380	412	444	476	508	124	|
]	93	285	317	349	381	413	445	477	509	125	}
^	94	286	318	350	382	414	446	478	510	126	
_	95	287	319	351	383	415	447	479	511	127	
DEC.		40	41	42	43	44	45	46	47		
ASCII		(	)	*	+	,	-	.	/		
		High Order X and Y									

Table F-1 (continued)
Vector Coordinates in ASCII and Decimal Format

Low Order X									Low Order Y	
ASCII	DEC.	X or Y Coordinate							DEC.	ASCII
@	64	512	544	576	608	640	672	704	736	96
A	65	513	545	577	609	641	673	705	737	a 97
B	66	514	546	578	610	642	674	706	738	b 98
C	67	515	547	579	611	643	675	707	739	c 99
D	68	516	548	580	612	644	676	708	740	d 100
E	69	517	549	581	613	645	677	709	741	e 101
F	70	518	550	582	614	646	678	710	742	f 102
G	71	519	551	583	615	647	679	711	743	g 103
H	72	520	552	584	616	648	680	712	744	h 104
I	73	521	553	585	617	649	681	713	745	i 105
J	74	522	554	586	618	650	682	714	746	j 106
K	75	523	555	587	619	651	683	715	747	k 107
L	76	524	556	588	620	652	684	716	748	l 108
M	77	525	557	589	621	653	685	717	749	m 109
N	78	526	558	590	622	654	686	718	750	n 110
O	79	527	559	591	623	655	687	719	751	o 111
P	80	528	560	592	624	656	688	720	752	p 112
Q	81	529	561	593	625	657	689	721	753	q 113
R	82	530	562	594	626	658	690	722	754	r 114
S	83	531	563	595	627	659	691	723	755	s 115
T	84	532	564	596	628	660	692	724	756	t 116
U	85	533	565	597	629	661	693	725	757	u 117
V	86	534	566	598	630	662	694	726	758	v 118
W	87	535	567	599	631	663	695	727	759	w 119
X	88	536	568	600	632	664	696	728	760	x 120
Y	89	537	569	601	633	665	697	729	761	y 121
Z	90	538	570	602	634	666	698	730	762	z 122
[	91	539	571	603	635	667	699	731	763	{ 123
/	92	540	572	604	636	668	700	732	764	| 124
]	93	541	573	605	637	669	701	733	765	} 125
^	94	542	574	606	638	670	702	734	766	~ 126
_	95	543	575	607	639	671	703	735	767	127
DEC.		48	49	50	51	52	53	54	55	
ASCII		0	1	2	3	4	5	6	7	
		High Order X and Y								

Table F-1 (continued)
Vector Coordinates in ASCII and Decimal Format

Low Order X										Low Order Y	
ASCII	DEC.	X or Y Coordinate								DEC.	ASCII
@	64	768	800	832	864	896	928	960	992	96	
A	65	769	801	833	865	897	929	961	993	97	a
B	66	770	802	834	866	898	930	962	994	98	b
C	67	771	803	835	867	899	931	963	995	99	c
D	68	772	804	836	868	900	932	964	996	100	d
E	69	773	805	837	869	901	933	965	997	101	e
F	70	774	806	838	870	902	934	966	998	102	f
G	71	775	807	839	871	903	935	967	999	103	g
H	72	776	808	840	872	904	936	968	1000	104	h
I	73	777	809	841	873	905	937	969	1001	105	i
J	74	778	810	842	874	906	938	970	1002	106	j
K	75	779	811	843	875	907	939	971	1003	107	k
L	76	780	812	844	876	908	940	972	1004	108	l
M	77	781	813	845	877	909	941	973	1005	109	m
N	78	782	814	846	878	910	942	974	1006	110	n
O	79	783	815	847	879	911	943	975	1007	111	o
P	80	784	816	848	880	912	944	976	1008	112	p
Q	81	785	817	849	881	913	945	977	1009	113	q
R	82	786	818	850	882	914	946	978	1010	114	r
S	83	787	819	851	883	915	947	979	1011	115	s
T	84	788	820	852	884	916	948	980	1012	116	t
U	85	789	821	853	885	917	949	981	1013	117	u
V	86	790	822	854	886	918	950	982	1014	118	v
W	87	791	823	855	887	919	951	983	1015	119	w
X	88	792	824	856	888	920	952	984	1016	120	x
Y	89	793	825	857	889	921	953	985	1017	121	y
Z	90	794	826	858	890	922	954	986	1018	122	z
[	91	795	827	859	891	923	955	987	1019	123	{
/	92	796	828	860	892	924	956	988	1020	124	|
]	93	797	829	861	893	825	957	989	1021	125	}
^	94	798	830	862	894	926	958	990	1022	126	~
_	95	799	831	863	895	927	959	991	1023	127	
DEC.		56	57	58	59	60	61	62	63		
ASCII		8	9	:	;	<	=	>	?		
		High Order X and Y									

METHOD 2

With this method you calculate two values, WW and RRRRR. These values are used in Table F-2 to obtain ASCII equivalents as follows:

1. Divide the Y coordinate by 32 to obtain a seven-digit number. The number between 0 and 31 to the left of the decimal is called WW. The five-digit remainder to the right of the decimal is called .RRRRR.

   For example:

$$\frac{\text{Y coordinate}}{32} = \text{WW.RRRRR}$$

2. Find your value for WW in the WW column of Table F-2. Find the corresponding High Y ASCII value in Table F-2.

3. Multiply the .RRRRR value by 32. Find this value in the .RRRRR column and locate the corresponding Low Y ASCII value.

4. Repeat this procedure to obtain the High X and Low X ASCII equivalents.

Table F-2
Vector Coordinates in ASCII Format

WW	High X or Y (ASCII)	.RRRRR x 32	Low Y (ASCII)	.RRRRR x 32	Low X (ASCII)
00	SP	00	`	00	@
01	!	01	a	01	A
02	"	02	b	02	B
03	#	03	c	03	C
04	$	04	d	04	D
05	%	05	e	05	E
06	&	06	f	06	F
07	'	07	g	07	G
08	(	08	h	08	H
09	)	09	i	09	I
10	*	10	j	10	J
11	+	11	k	11	K
12	,	12	l	12	L
13	-	13	m	13	M
14	.	14	n	14	N
15	/	15	o	15	O
16	0	16	p	16	P
17	1	17	q	17	Q
18	2	18	r	18	R
19	3	19	s	19	S
20	4	20	t	20	T
21	5	21	u	21	U
22	6	22	v	22	V
23	7	23	w	23	W
24	8	24	x	24	X
25	9	25	y	25	Y
26	:	26	z	26	Z
27	;	27	{	27	[
28	<	28	|	28	\
29	=	29	}	29	]
30	>	30	~	30	^
31	?	31	DEL	31	_

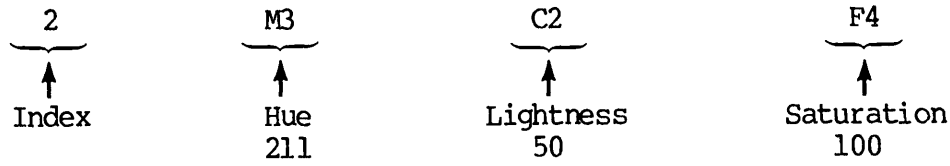
G

Color Parameter Conversion Chart

This appendix demonstrates how to convert, from decimal to ASCII, the integers in Table 3-3 which select color, hue, lightness, and saturation. Conversion is necessary since color commands are issued in ASCII. Note that the encoding process differs from standard decimal to ASCII conversion.

As a convenience, the appendix also supplies conversions of the integers in Table 3-3.

Figure G-1 shows the conversion of the integers from color index 2, on the color map in Figure 3-3. The color encoded is light green, which fills the triangle in the color graphics example in Figure 2-3



Light Green Integer Parameter Converted From Decimal to ASCII
Figure G-1

Decimal values: hue = 211, lightness = 50, saturation = 100.
ASCII values: hue = M3, lightness = C2, saturation = F4.
Color index number: 2 (ASCII).

Follow these conversion steps.

1. Begin with hue value 211.

2. Convert the number to binary: 211 = 11010011.

3. Divide the binary number into its HI digits and LO digits:

```
                1101   0011
                 HI    LO
```

4. Prefix with 0's to make six digits; prefix result with 1:

```
                1 00 1101
= 4D  =   M       HI
(HEX) (ASCII)
```

5. Prefix parameter sign to LO byte; prefix result with "01":

```
011   0011 =  33  =   3
 ↑    LO      (HEX) (ASCII)
 |
 |
1 = sign positive
0 = sign negative
```

Lightness value = 50 = 00110010 in binary.
The HI byte becomes 1 000011 = 43 HEX = C in ASCII.
The LO byte becomes 011 0010 = 32 HEX = 2 in ASCII.

Saturation value = 100 = 01100100 in binary.
The HI byte becomes 1 000110 = 46 HEX = F in ASCII.
The LO byte becomes 011 0100 = 34 HEX = 4 in ASCII.

Combine ASCII characters to get the command parameters for color index 2:

2 M3 C2 F4

Omit the spaces when you enter the parameters into the terminal. They have been inserted here for ease in reading.

Conversion calculations are performed for you in Tables G-1 and G-2.

Table G-1

Integer Parameter Conversions
From Decimal to ASCII, +0 to +360

int	par	int	par	int	par	int	par	int	par	int	par
0	0	45	B=	90	E:	135	H7	180	K4	225	N1
1	1	46	B>	91	E;	136	H8	181	K5	226	N2
2	2	47	B?	92	E<	137	H9	182	K6	227	N3
3	3	48	CO	93	E=	138	H:	183	K7	228	N4
4	4	49	C1	94	E>	139	H;	184	K8	229	N5
5	5	50	C2	95	E?	140	H<	185	K9	230	N6
6	6	51	C3	96	F0	141	H=	186	K:	231	N7
7	7	52	C4	97	F1	142	H>	187	K;	232	N8
8	8	53	C5	98	F2	143	H?	188	K<	233	N9
9	9	54	C6	99	F3	144	I0	189	K=	234	N:
10	:	55	C7	100	F4	145	I1	190	K>	235	N;
11	;	56	C8	101	F5	146	I2	191	K?	236	N<
12	<	57	C9	102	F6	147	I3	192	L0	237	N=
13	=	58	C:	103	F7	148	I4	193	L1	238	N>
14	>	59	C;	104	F8	149	I5	194	L2	239	N?
15	?	60	C<	105	F9	150	I6	195	L3	240	O0
16	A0	61	C=	106	F:	151	I7	196	L4	241	O1
17	A1	62	C>	107	F;	152	I8	197	L5	242	O2
18	A2	63	C?	108	F<	153	I9	198	L6	243	O3
19	A3	64	D0	109	F=	154	I:	199	L7	244	O4
20	A4	65	D1	110	F>	155	I;	200	L8	245	O5
21	A5	66	D2	111	F?	156	I<	201	L9	246	O6
22	A6	67	D3	112	G0	157	I=	202	L:	247	O7
23	A7	68	D4	113	G1	158	I>	203	L;	248	O8
24	A8	69	D5	114	G2	159	I?	204	L<	249	O9
25	A9	70	D6	115	G3	160	J0	205	L=	250	O:
26	A:	71	D7	116	G4	161	J1	206	L>	251	O;
27	A;	72	D8	117	G5	162	J2	207	L?	252	O<
28	A<	73	D9	118	G6	163	J3	208	M0	253	O=
29	A=	74	D:	119	G7	164	J4	209	M1	254	O>
30	A>	75	D;	120	G8	165	J5	210	M2	255	O?
31	A?	76	D<	121	G9	166	J6	211	M3	256	P0
32	B0	77	D=	122	G:	167	J7	212	M4	257	P1
33	B1	78	D>	123	G;	168	J8	213	M5	258	P2
34	B2	79	D?	124	G<	169	J9	214	M6	259	P3
35	B3	80	E0	125	G=	170	J:	215	M7	260	P4
36	B4	81	E1	126	G>	171	J;	216	M8	261	P5
37	B5	82	E2	127	G?	172	J<	217	M9	262	P6
38	B6	83	E3	128	H0	173	J=	218	M:	263	P7
39	B7	84	E4	129	H1	174	J>	219	M;	264	P8
40	B8	85	E5	130	H2	175	J?	220	M<	265	P9
41	B9	86	E6	131	H3	176	K0	221	M=	266	P:
42	B:	87	E7	132	H4	177	K1	222	M>	267	P;
43	B;	88	E8	133	H5	178	K2	223	M?	268	P<
44	B<	89	E9	134	H6	179	K3	224	N0	269	P=

Table G-1 (continued)

Integer Parameter Conversions
From Decimal to ASCII, +0 to +360

int	par	int	par	int	par	int	par	int	par	int	par
270	P>	285	Q=	300	R>	315	S;	330	T:	345	U9
271	P?	286	Q>	301	R=	316	S<	331	T;	346	U:
272	Q0	287	Q?	302	R>	317	S=	332	T<	347	U;
273	Q1	288	R0	303	R?	318	S>	333	T=	348	U<
274	Q2	289	R1	304	S0	319	S?	334	T>	349	U=
275	Q3	290	R2	305	S1	320	T0	335	T?	350	U>
276	Q4	291	R3	306	S2	321	T1	336	U0	351	U?
277	Q5	292	R4	307	S3	322	T2	337	U1	352	V0
278	Q6	293	R5	308	S4	323	T3	338	U2	353	V1
279	Q7	294	R6	309	S5	324	T4	339	U3	354	V2
280	Q8	295	R7	310	S6	325	T5	340	U4	355	V3
281	Q9	296	R8	311	S7	326	T6	341	U5	356	V4
282	Q:	297	R9	312	S8	327	T7	342	U6	357	V5
283	Q;	298	R:	313	S9	328	T8	343	U7	358	V6
284	Q<	299	R;	314	S:	329	T9	344	U8	359	V7
										360	V8

Table G-2

Integer Parameter Conversions
From Decimal to ASCII, -0 to -360

int	par	int	par	int	par	int	par	int	par	int	par
-0	space	-45	B-	-90	E*	-135	H'	-180	K$	-225	N!
-1	!	-46	B.	-91	E+	-136	H(	-181	K%	-226	N"
-2	"	-47	B/	-92	E,	-137	H)	-182	K&	-227	N#
-3	#	-48	C	-93	E-	-138	H*	-183	K'	-228	N$
-4	$	-49	C!	-94	E.	-139	H+	-184	K(	-229	N%
-5	%	-50	C"	-95	E/	-140	H,	-185	K)	-230	N&
-6	&	-51	C#	-96	F	-141	H-	-186	K*	-231	N'
-7	'	-52	C$	-97	F!	-142	H.	-187	K+	-232	N(
-8	(	-53	C%	-98	F"	-143	H/	-188	K,	-233	N(
-9	)	-54	C&	-99	F#	-144	I	-189	K-	-234	N*
-10	*	-55	C'	-100	F$	-145	I!.	-190	K.	-235	N+
-11	+	-56	C(	-101	F%	-146	I"	-191	K/	-236	N,
-12	,	-57	C)	-102	F&	-147	I#	-192	L	-237	N-
-13	-	-58	C*	-103	F'	-148	I$	-193	L!	-238	N.
-14	.	-59	C+	-104	F(	-149	I%	-194	L"	-239	N/
-15	/	-60	C,	-105	F)	-150	I&	-195	L#	-240	O
-16	A	-61	C-	-106	F*	-151	I'	-196	L$	-241	O!
-17	A!	-62	C.	-107	F+	-152	I(	-197	L%	-242	O"
-18	A"	-63	C/	-108	F,	-153	I)	-198	L&	-243	O#
-19	A#	-64	D	-109	F-	-154	I*	-199	L'	-244	O$
-20	A$	-65	D!	-110	F.	-155	I+	-200	L(	-245	O%
-21	A%	-66	D"	-111	F/	-156	I,	-201	L)	-246	O&
-22	A&	-67	D#	-112	G	-157	I-	-202	L*	-247	O'
-23	A'	-68	D$	-113	G!	-158	I.	-203	L+	-248	O(
-24	A(	-69	D%	-114	G"	-159	I/	-204	L,	-249	O)
-25	A)	-70	D&	-115	G#	-160	J	-205	L-	-250	O*
-26	A*	-71	D'	-116	G$	-161	J!	-206	L.	-251	O+
-27	A+	-72	D(	-117	G%	-162	J"	-207	L/	-252	O,
-28	A,	-73	D)	-118	G&	-163	J#	-208	M	-253	O-
-29	A-	-74	D*	-119	G'	-164	J$	-209	M!	-254	O.
-30	A.	-75	D+	-120	G(	-165	J%	-210	M"	-255	O/
-31	A/	-76	D,	-121	G)	-166	J&	-211	M#	-256	P
-32	B	-77	D-	-122	G*	-167	J'	-212	M$	-257	P!
-33	B!	-78	D.	-123	G+	-168	J(	-213	M%	-258	P"
-34	B"	-79	D/	-124	G,	-169	J)	-214	M&	-259	P#
-35	B#	-80	E	-125	G-	-170	J*	-215	M'	-260	P$
-36	B$	-81	E!	-126	G.	-171	J+	-216	M(	-261	P%
-37	B%	-82	E"	-127	G/	-172	J,	-217	M)	-262	P&
-38	B&	-83	E#	-128	H	-173	J-	-218	M*	-263	P'
-39	B'	-84	E$	-129	H!	-174	J.	-219	M+	-264	P(
-40	B(	-85	E%	-130	H"	-175	J/	-220	M,	-265	P)
-41	B)	-86	E&	-131	H#	-176	K	-221	M/	-266	P*
-42	B*	-87	E'	-132	H$	-177	K!	-222	M.	-267	P+
-43	B+	-88	E(	-133	H%	-178	K"	-223	M/	-268	P,
-44	B,	-89	E(	-134	H&	-179	K#	-224	N	-269	P-

Table G-2 (continued)

Integer Parameter Conversions
From Decimal to ASCII, -0 to -360

int	par	int	par	int	par	int	par	int	par	int	par
-270	P.	-285	Q-	-300	R<	-315	S;	-330	T:	-345	U9
-271	P/	-286	Q.	-301	R=	-316	S<	-331	T;	-346	U:
-272	Q	-287	Q/	-302	R>	-317	S=	-332	T<	-347	U;
-273	Q!	-288	R	-303	R?	-318	S>	-333	T=	-348	U<
-274	Q"	-289	R!	-304	S0	-319	S?	-334	T>	-349	U=
-275	Q#	-290	R"	-305	S1	-320	T0	-335	T/	-350	U>
-276	Q$	-291	R#	-306	S2	-321	T1	-336	U0	-351	U?
-277	Q%	-292	R$	-307	S3	-322	T2	-337	U1	-352	V0
-278	Q&	-293	R%	-308	S4	-323	T3	-338	U2	-353	V1
-279	Q'	-294	R&	-309	S5	-324	T4	-339	U3	-354	V2
-280	Q(	-295	R'	-310	S6	-325	T5	-340	U4	-355	V3
-281	Q)	-296	R(	-311	S7	-326	T6	-341	U5	-356	V4
-282	Q*	-297	R)	-312	S8	-327	T7	-342	U6	-357	V5
-283	Q+	-298	R*	-313	S9	-328	T8	-343	U7	-358	V6
-284	Q,	-299	R+	-314	S:	-329	T9	-344	U8	-359	V7
										-360	V8

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