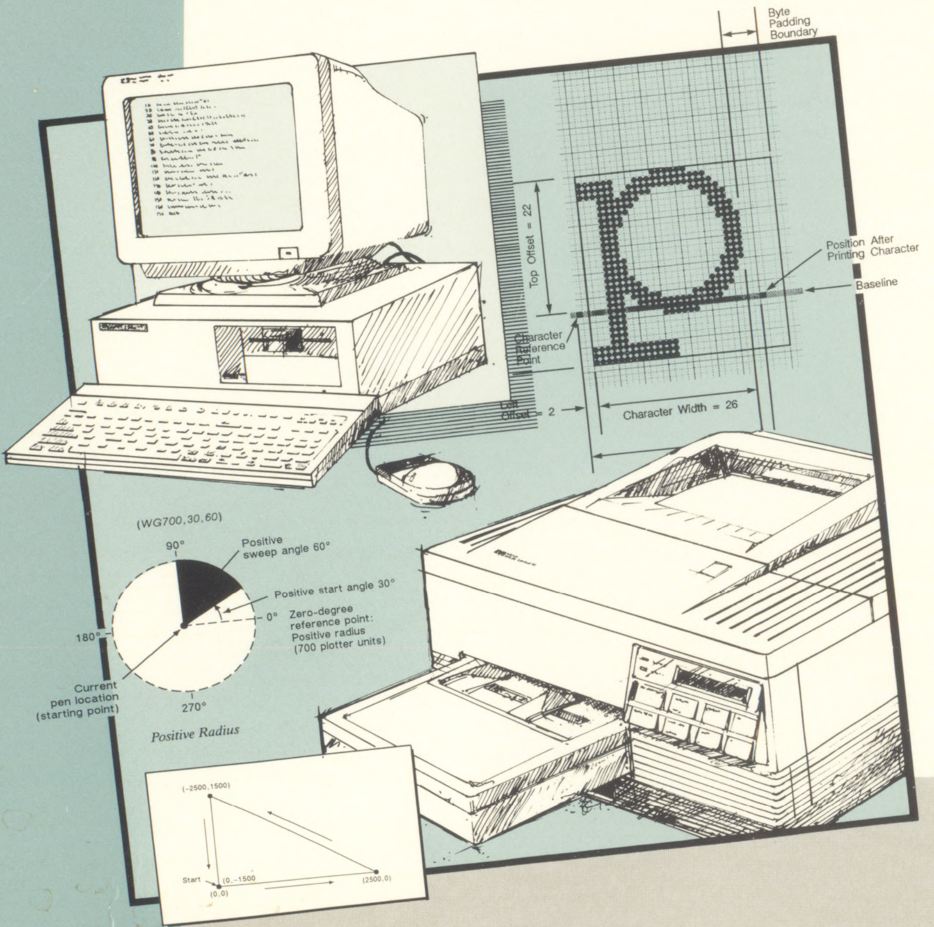
LaserJet III Technical Reference Manual



LaserJet III Printer Technical Reference Manual

HEWLETT PACKARD

HP Part No. 33449 - 90903
Printed in USA

First Edition - March 1990

Notice

Printing History

This manual was created using *HP Tag/Vectra* software on an HP Vectra Personal Computer. The body text is printed in *Century Schoolbook* fonts and the chapter and section headings are printed with Helvetica fonts. The camera-ready copy was printed on an HP LaserJet III printer and was then reproduced using standard offset printing.

First Edition – March 1990

Trademark Credits

Intellifont and *Garth Graphic* are U.S. registered trademarks of Agfa Corporation, (AGFA Compugraphic Division). *CG Triumvirate* and *Shannon* are trademarks of Agfa Corporation, (AGFA Compugraphic Division). *CG Bodoni*, *CG Century Schoolbook*, *CG Goudy Old Style*, *CG Melliza*, *Microstyle*, *CG Omega*, *CG Palacio*, *CG Times* and *CG Trump Mediaeval* are products of Agfa Corporation, (AGFA Compugraphic Division). *CG Times*, a product of Agfa Corporation, is based on *Times New Roman*, a U.S. registered trademark of Monotype Corporation plc. *PCL* is a U.S. registered trademark of Hewlett-Packard Company. *Resolution Enhancement* is a trademark of Hewlett-Packard Company. *IBM* is a registered trademark of International Business Machines Corporation. *Microsoft* and *MS-DOS* are U.S. registered trademarks of Microsoft Corporation. *Centronics* is a U.S. registered trademark of Centronics Corporation. *ITC Avant Garde Gothic*, *ITC Benguiat*, *ITC Bookman*, *ITC Century*, *ITC Cheltenham*, *ITC Galliard*, *ITC Korinna*, *ITC Lubalin Graph*, *ITC Souvenir*, *ITC Zapf Chancery* and *ITC Zapf Dingbats* are U.S. registered trademarks of International Typeface Corporation. *ITC Tiffany* is a trademark of International Typeface Corporation. *Futura* is a U.S. registered trademark of Fundicion Tipografica Neufville, S.A. *Serifa* is a trademark of Fundicion Tipografica Neufville, S.A. *Letraset* is a registered trademark of Esselte Pendaflex Corporation. *Revue* and *University Roman* are trademarks of Esselte Pendaflex Corporation. *Helvetica* and *Times Roman* are trademarks of Linotype AG and its subsidiaries. *Univers* is a U.S. registered trademark of Linotype AG and its subsidiaries. *Antique Olive* is a trademark of Monsieur Marcel OLIVE. *Gill Sans* is a U.S. registered trademark of The Monotype Corporation plc. All typefaces are under license from Agfa Corporation.

Inside This Manual

What You Can Learn From This Manual

Hewlett-Packard has developed a standard set of printer features (and corresponding commands) for use in its printers. The set of features designed by Hewlett-Packard for all of its printers is the PCL language. This manual describes the PCL language features and commands available for the Hewlett-Packard LaserJet III printer, and the basic requirements of PCL language programming.

Experienced Users This manual is written for people who have some programming experience. Many of the concepts discussed assume some programming knowledge.

When writing a PCL language program for this printer the user should be knowledgeable of the PCL language concepts presented in this manual.

Non-technical Users Many software applications (word processing software, spreadsheets, etc.) allow you to embed printer commands as **escape sequences** in the body of your documents. This manual presents the full syntax and explanation of all the commands supported by the LaserJet III printer. These commands will enable you to take advantage of the LaserJet III printer's advanced feature set.

This manual is divided into 22 chapters and 4 appendices. A brief description of each chapter is provided on the next page.

Chapter 1 - Introduction to the HP PCL Language

This chapter gives a brief history of the development of the PCL language, describes the PCL language levels (architecture), and describes PCL commands (control codes and escape sequences).

Chapter 2 - The Page

This chapter introduces the idea of the logical page and identifies the area in which printing can occur. It also describes the PCL language and the HP-GL/2 coordinate systems.

Chapter 3 - The Print Environment

This chapter introduces the printer's feature settings, collectively, as the print environment and how it is affected by printer reset functions. Included are descriptions of the factory default environment, user default environment, and the modified print environment.

Chapter 4 - Job Control Commands

This chapter describes the commands providing job control. Job commands are usually grouped together and sent at the beginning of a job. Job control includes restoration of the user default environment and selection of the number of copies of each page to be printed.

Chapter 5 - Page Control Commands

This chapter describes the commands providing page format control. Page format control provides for selection of the page source, size, orientation, margins, and text spacing.

Chapter 6 - Cursor Positioning

This chapter describes how to position the cursor within the logical page.

Chapter 7 - Fonts

This chapter describes basic font information including font characteristics.

Chapter 8 - Font Selection

This chapter describes how to select a font for printing using the font characteristics commands. The underline feature is described at the end of this chapter.

Chapter 9 - Font Management

Font management provides mechanisms for downloading and manipulating soft fonts.

Chapter 10 - Soft Font Creation

This chapter describes how to organize font/character data for downloading to the printer.

Chapter 11 - Macros

A printing application may perform the same sequence of printer commands numerous times. For tasks performed repeatedly, PCL provides a macro function to reduce the number of commands that must be sent to the printer.

Chapter 12 - The Print Model

The print model allows for special effects when printing.

Chapter 13 - Rectangular Area Fill Graphics

This chapter describes how to define and fill a rectangular area with one of the predefined PCL cross-hatch (line) or shading patterns.

Chapter 14 - Raster Graphics

This chapter describes how to download raster graphics to the printer and includes various techniques for reducing the amount of data needed to define the raster image.

Chapter 15 - An Introduction to HP-GL/2 Graphics

This chapter discusses how to learn HP-GL/2, lists the vector graphics commands, and describes the HP-GL/2 command syntax. An overview of several important topics is also discussed, such as PCL Picture Frame concept, scaling, pen status and location, and absolute vs. relative pen movement.

Chapter 16 - The Picture Frame

This chapter describes how to set up an area on the page for printing vector graphics (the PCL Picture Frame). It discuses the commands necessary to define and position the picture frame, along with the commands used to enter and exit HP-GL/2 mode.

Chapter 17 - The Configuration and Status Group

Chapter 17 describes the commands used to set default conditions and values for programmable HP-GL/2 features. It also explains the commands used for scaling, establishing a soft-clip window, and rotating the HP-GL/2 coordinate system.

Chapter 18 - The Vector Group

This chapter provides information about pen movement and drawing lines, arcs, and circles. Also covered here is a way to encode coordinates for increased print speed.

Chapter 19 - **The Polygon Group**

This chapter explains the polygon mode and how it is used to draw polygons, subpolygons and circles. The commands for drawing and filling wedges and rectangles are also covered in this chapter.

Chapter 20 - **The Line and Fill Attributes Group**

This chapter discusses the commands used to vary the line types and fill patterns used to create HP-GL/2 graphics.

Chapter 21 - **The Character Group**

Chapter 21 contains information about the commands used to print text (labels) in HP-GL/2 mode. This allows you to print HP-GL/2 labels in just about any size, slant and direction using proportional or fixed-spaced fonts.

Chapter 22 - **Programming Hints**

This chapter provides programming information for use during the development of PCL software.

Related Documentation

The following related manuals provide further information about the LaserJet III printer, its features, and its functions.

Your Guide to Setting Up Your LaserJet III Printer

This is an easy-to-follow guide to the successful set-up and configuration of your printer. (HP part number 33449-90905).

LaserJet III User's Manual

The User's Manual provides operation, maintenance, and troubleshooting information for the LaserJet III printer. A basic description of fonts and printer commands is also provided. (HP part number 33449-90901).

Creating Intellifont-Compatible Fonts Using the AGFA Compugraphic FAIS Standard.

This document provides information for designing scalable fonts using AGFA Compugraphic's Font Access Interchange standard. This document can be obtained from AGFA Compugraphic by writing to the addressed below or by phone.

AGFA Compugraphic Typographic Systems Division
OEM Technical Support
90 Industrial Way
Wilmington, MA 01887
(508) 658-5600

Contents

4. Job Control Commands

5. Page Control Commands

6. Cursor Positioning

22. Programming Hints

A. Symbol Sets

1

Introduction to HP PCL

PCL Printer Language History

Hewlett-Packard created the PCL Printer Language to provide an economical and efficient way for application programs to control a range of printer features across a number of printing devices. HP has evolved both the definition and implementations of the PCL printer language to provide the optimal price and performance balance. PCL5 represents a new break through in price/performance leadership. Its features were selected in direct response to customer requests. HP will continue to lead enhancements to the PCL printer language in order to deliver powerful technology advances.

The PCL printer language commands are compact escape sequence codes that embed in the print job data stream. This approach minimizes both data transmission and command decoding overhead. HP PCL printer language formatters and fonts are designed to quickly translate application output into high-quality, device-specific, raster print images.

PCL printer language commonality from HP printer to HP printer helps to minimize printer support problems and protect HP printer customer investment in applications and printer driver software.

PCL Printer Language Architecture

PCL Printer Language structure has been useful to guide language functionality growth and command syntax definition. The PCL Printer Language has evolved through five major levels of functionality driven by the combination of printer technology developments, changing user needs, and application software improvements. The five phases of the PCL Printer Language evolution are:

PCL 1 *Print and Space* functionality is the base set of functionality for simple, convenient, single user workstation output.

PCL 2 *EDP (Electronic Data Processing) /Transaction* functionality is a superset of PCL 1. Functions were added for general purpose, multi-user system printing.

PCL 3 *Office Word Processing* functionality is a superset of PCL 2. Functions were added for high-quality, office document production.

PCL 4 *Page Formatting* functionality is a superset of PCL 3. Functions were added for new page printing capabilities.

PCL 5 *Office Publishing* functionality is a superset of PCL 4. New publishing capabilities include font scaling and HP-GL/2 graphics. The HP LaserJet III printer is a PCL 5 device.

The PCL printer language model succeeds because the following points are observed:

- All HP printers implement PCL printer language features consistently.
- HP printers implement the above language feature groups in very cost-effective formatters.
- HP printers have the ability to ignore most unsupported commands.

What are Printer Commands?

PCL language **printer commands** provide access to printer features. Once a PCL command sets a parameter, that parameter will remain set until that PCL command is repeated with a new value or the printer is reset to its user default environment. For example, if you send the printer a command to set line spacing to 3 lines/inch, each page will print 3 lines/inch until the printer receives a different Line Spacing command or the printer is reset.

Note

- Printer commands are also referred to as **escape sequences**. The two terms are used interchangeably throughout this manual.
- Some escape sequences shown in this manual contain spaces between characters for clarity. Do not include these spaces when using escape sequences.
- Also, in the escape sequence a script "ℓ" is used to indicate a lower case "l" for clarity.

There are three general types of PCL language commands:

- control codes,
- two-character escape sequences, and
- parameterized escape sequences.

Control Codes

A **control code** is a character that initiates a printer function, for example Carriage Return (CR), Line Feed (LF), Form Feed (FF), etc.

Escape Sequences

Escape sequence commands consist of two or more characters. The first character is always the ASCII escape character, identified by the EC symbol. EC is a special control code which identifies the subsequent string of characters as a printer command. As the printer monitors incoming data from a computer, it is "looking" for this character. When this character appears, the printer reads it and its associated characters as a command to be performed and not as data to be printed.

Syntax of Escape Sequences

There are two forms of PCL escape sequences: two character escape sequences and parameterized escape sequences.

Two Character Escape Sequences

Two-character escape sequences have the following form:

EC X

where "**X**" is a character which defines the operation to be performed. (Note,"**X**" may be any character from the ASCII table [see Appendix A] within the range 48-126 decimal ["0" through "~"]). For a list of the two character escape sequences supported by the printer refer to Appendix A.

Following are examples of two character escape sequences:

EC **E**	a two character escape sequence used for resetting the printer.
EC **9**	a two-character escape sequence used for resetting the left and right margins.

Parameterized Escape Sequences

Parameterized escape sequences have the following form:

^E_C X y # z1 # z2 # z3 ... # Zn[Data]

where **y**, **#**, **zi** and **[data]** may be optional, depending on the command.

X — **Parameterized Character** - A character from the ASCII table within the range 33-47 decimal (! through /) indicating that the escape sequence is parameterized.

y — **Group Character** - A character from the ASCII table within the range 96-126 decimal (‘ through ˜) which specifies the group type of control being performed.

— **Value Field** - A group of characters specifying a numeric value. The numeric value is represented as an ASCII string of characters within the range 48-57 decimal (0 through 9) which may be preceded by a + or – sign and may contain a fractional portion indicated by the digits after a decimal point (.). Numeric value fields are within the range -32767 to 32767. If an escape sequence requires a value field and a value is not specified, a value of 0 is assumed.

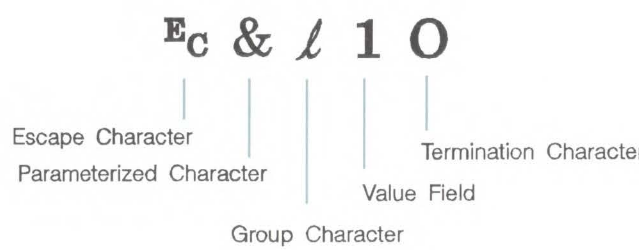
zi — **Parameter Character** - Any character from the ASCII table within the range 96-126 decimal (‘ through ˜). This character specifies the parameter to which the previous value field applies. This character is used when combining escape sequences.

Zn — **Termination Character** - Any character from the ASCII table within the range 64-94 decimal

(@ through ^). This character specifies the parameter to which the previous value field applies. This character terminates the escape sequence.

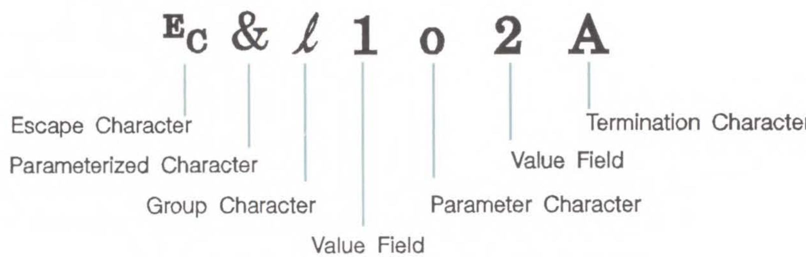
[Data] **Binary Data** is eight-bit data (for example, graphics data, downloaded fonts, etc.). The number of bytes of binary data is specified by the value field of the escape sequence. Binary data immediately follows the terminating character of the escape sequence.

Following is an example of an escape sequence with a termination character and no parameter character. This escape sequence performs a single function.



The following is an example of an escape sequence with a parameter character and a termination character. This escape sequence performs two functions. It is the combination of two commands:

Ec & ℓ 1 O and **Ec & ℓ 2 A**



Notice that the "^E_C" and the "**&ℓ**" are dropped from the second printer command when they are combined. Also, the upper-case "**O**" that terminated the first command becomes a lower-case "**o**" parameter character when these commands are combined.

Use these three rules to combine and shorten printer commands:

1. The first two characters after "^E_C" (the parameterized and group character) must be the same in all of the commands that will be combined. In the example above, these are "**&**" and "*ℓ*".

2. All alphabetic characters within the combined printer command will be lower-case, except the final letter which is always upper-case. In the combined example above, "**O**" becomes "**o**". The final character in the printer command must always be upper-case to let the printer know that the command is complete.

3. The printer commands are performed in the order that they are combined (from left to right). Be sure to combine commands in the order that they are to be performed.

2

The Page

Introduction

This chapter describes the PCL coordinate system. It defines the logical page, the printable area, introduces the HP-GL/2 picture (vector graphics) frame, and identifies the boundaries of each.

Logical Page

The PCL **logical page** (also referred to as the PCL addressable area) defines the area in which the PCL cursor can be positioned. Although the printer does not actually have a cursor (like the blinking underline character used on most computer terminals), the cursor position refers to the currently active printing position. In other words, the location of the "cursor" is the position on the logical page where the next character will be positioned. The cursor can be moved to different points on the logical page using the cursor positioning commands. The cursor cannot be moved outside of the logical page bounds.

The size of the logical page for the media (that is, paper, transparencies, labels, etc.) is defined in Figures 2-3 and 2-4.

PCL Coordinate System

The PCL coordinate system is defined as shown in the following figure:

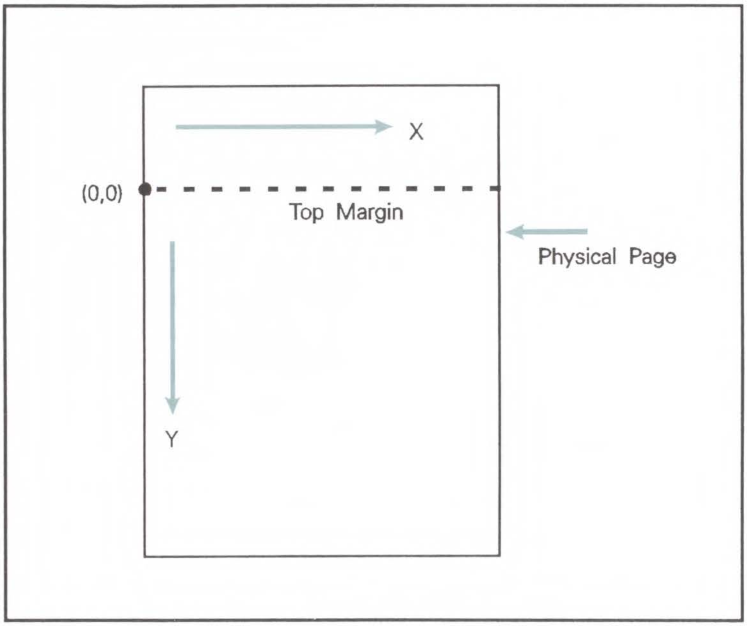


Figure 2-1. X,Y PCL Coordinates

The point (0,0) is at the left edge of the logical page at the current top margin position. Since the top margin may be changed using a printer command, the physical location of the point (0,0) may change.

Units of the PCL Coordinate System

The units of the X-axis of the PCL coordinate system may be **dots**, **decipoints**, or **columns**. The units of the Y-axis may be dots, decipoints, or **rows**.

The dot is the smallest printable unit. On LaserJet family printers, one dot equals $\frac{1}{300}$ inch. The number of dots printed per inch is referred to as the printer's resolution.

A decipoint is $\frac{1}{720}$ inch or one-tenth of a PCL typographic point.

The width of a column is defined by the current **horizontal motion index (HMI)**. The distance between rows is defined by the current **vertical motion index (VMI)**, or **lines-per-inch (lpi)**. HMI, VMI and lpi are described in Chapter 5, Page Control Commands.

Internally, the printer uses a different unit of measure. It maps dots, decipoints, and columns and rows to this unit of measure. This internal unit is $\frac{1}{7200}$ inch. All positioning is kept in internal units and rounded to physical dot positions when data is printed.

HP-GL/2 Picture Frame

In addition to text and raster graphics, **HP-GL/2 vector graphics** can be placed on the PCL logical page. HP-GL/2 vector graphics are incorporated using the concept of the HP-GL/2 picture frame (see Figure 2-2). Within this picture frame, HP-GL/2 uses its own coordinate system and units of measure. The HP-GL/2 coordinate system and units are described in detail in Chapter 15, *Introduction to HP-GL/2 Vector Graphics* and Chapter 16, *The Picture Frame*.

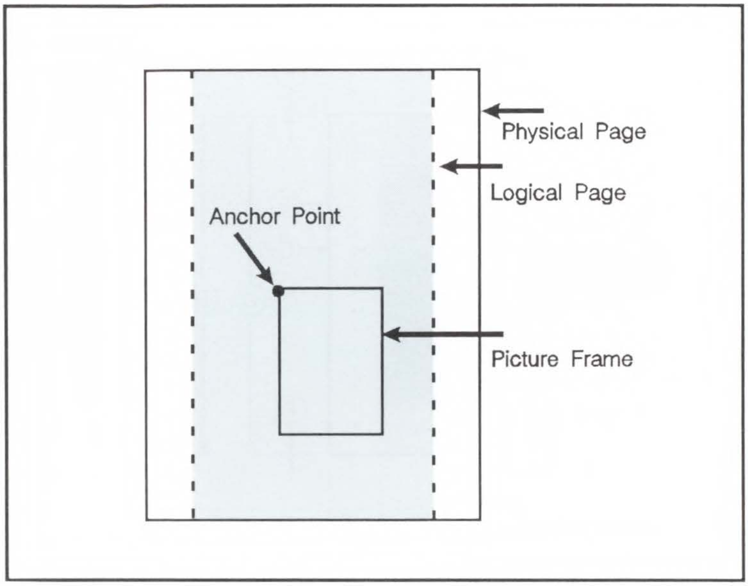
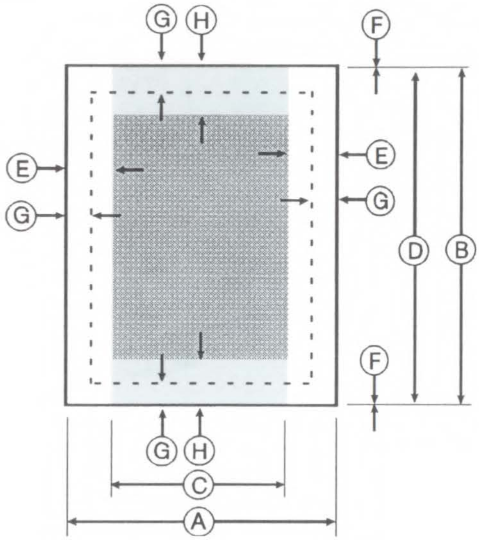


Figure 2-2. PCL Logical Page with HP-GL/2 Picture Frame.

Printable Area

The printable area is the area of the physical page in which the printer is able to place a dot. The physical page refers to the size of the media (that is, paper, transparencies, labels, etc.) installed in the printer.

The relationship between physical page, logical page, default picture frame, and printable area is defined in Figures 2-3 and 2-4.



Physical Page

- - - - Printable Area

Logical Page

HP-GL/2 Default Picture Frame

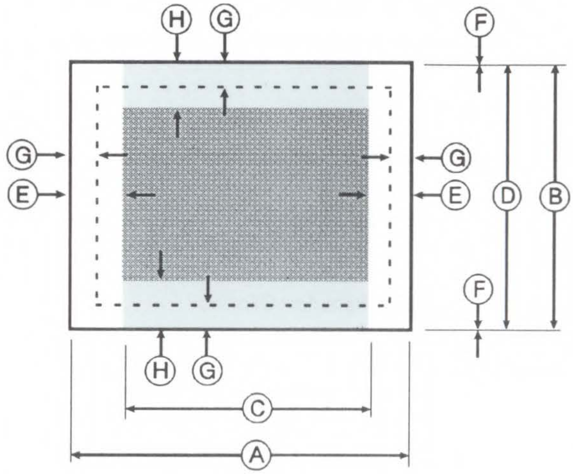
A = Physical Page Width
B = Physical Page Length
C = Logical Page Width
D = Maximum Logical Page Length
E = Distance Between the Edge of the Physical Page and the Logical Page
F = Distance Between the Edge of the Physical Page and the Logical Page
G = Distance Between the Edge of the Physical Page and the Printable Area
H = Distance Between Edge of the Physical Page and Edge of Default HP-GL/2 Picture Frame

Width of the Printable Area = A-2*G
Length of the Printable Area = B-2*G

All dimensions are in dots.

PAPER SIZE	A	B	C	D	E	F	G	H
LETTER	2550	3300	2400	3300	75	0	50	150
LEGAL	2550	4200	2400	4200	75	0	50	150
EXECUTIVE	2175	3150	2025	3150	75	0	50	150
A4	2480	3507	2338	3507	71	0	50	150
COM-10	1237	2850	1087	2850	75	0	50	150
MONARCH	1162	2250	1012	2250	75	0	50	150
C5	1913	2704	1771	2704	71	0	50	150
DL	1299	2598	1157	2598	71	0	50	150

Figure 2-3. Portrait Logical Page and Printable Area Boundaries



Physical Page

Printable Area

Logical Page

HP-GL/2 Default Picture Frame

A = Physical Page Width
B = Physical Page Length
C = Logical Page Width
D = Maximum Logical Page Length
E = Distance Between the Edge of the Physical Page and the Logical Page
F = Distance Between the Edge of the Physical Page and the Logical Page
G = Distance Between the Edge of the Physical Page and the Printable Area
H = Distance Between Edge of the Physical Page and Edge of Default HP-GL/2 Picture Frame

Width of the Printable Area = A-2*G
Length of the Printable Area = B-2*G

All dimensions are in dots.

PAPER SIZE	A	B	C	D	E	F	G	H
LETTER	3300	2550	3180	2550	60	0	50	150
LEGAL	4200	2550	4080	2550	60	0	50	150
EXECUTIVE	3150	2175	3030	2175	60	0	50	150
A4	3507	2480	3389	2480	59	0	50	150
COM-10	2850	1237	2730	1237	60	0	50	150
MONARCH	2250	1162	2130	1162	60	0	50	150
C5	2704	1913	2586	1913	59	0	50	150
DL	2598	1299	2480	1299	59	0	50	150

Figure 2-4. Landscape Logical Page and Printable Area Boundaries

This printer performs pixel level clipping. This means that when printing characters or graphics, if any portion of the character cell or graphic is outside the printable area, only that portion outside the printable area will be clipped (see Figure 2-5).

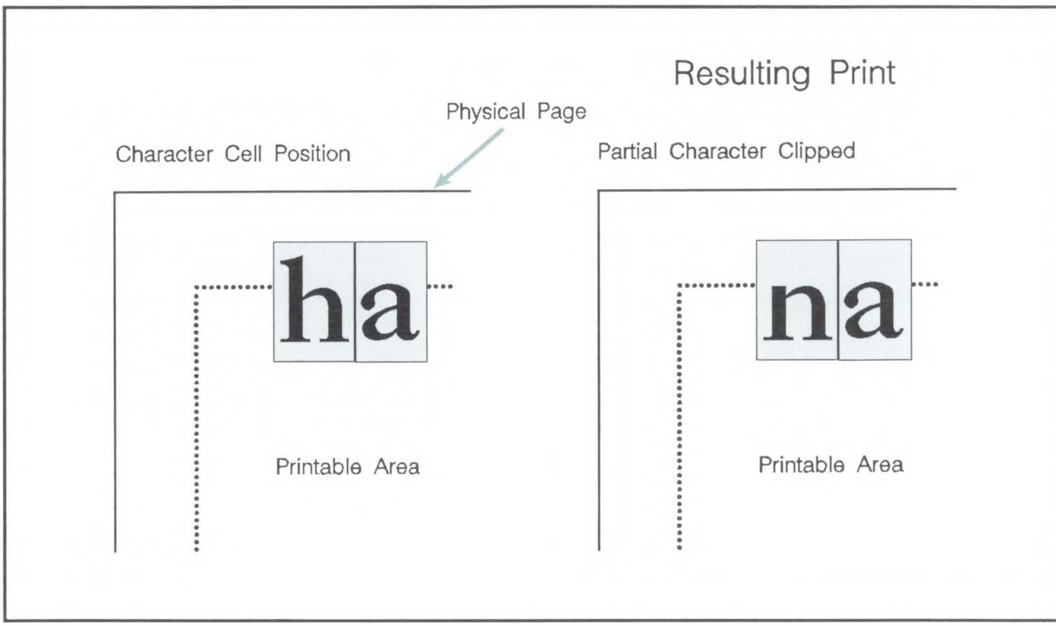


Figure 2-5. Printable Area Character Cell Positioning

3

The Print Environment

Introduction

The group of all of the printer's current feature settings, collectively, is referred to as the print environment. The printer maintains four print environments: the **factory default environment**, the **user default environment**, the **modified print environment** and the **overlay environment**. This chapter describes the factory default environment, the user default environment, and the modified print environment (the overlay environment is described in Chapter 11, *Macros*).

Default settings refer to the settings programmed into the printer at the factory or settings selected using the control panel. The term, default, simply refers to the settings the printer uses unless printer commands select other settings.

Each time a job is printed, some of the printer's feature settings may be changed from their default values to produce the desired printed output for that job. After the job has printed, the job specific feature settings will no longer be required, since the next job will likely have different output requirements. The next job should clear all previous job settings by performing a reset. This allows a job to start with the default settings as a base and vary only those settings that are needed. Returning to the default environment at the beginning of each print job eliminates the need for setting every feature each time a job is run.

Factory Default Environment

A factory default is a feature setting programmed into the printer at the factory. The group of all of the printer's feature settings set to their factory setting is referred to as the factory default environment. (These features are described in this manual.) Since the HP-GL/2 features are used for HP-GL/2 operation only, the printer environment features are separated, for convenience, into two lists or contexts: PCL and HP-GL/2. Table 3-1 lists the printer's PCL factory defaults and Table 3-2 lists the printer's HP-GL/2 factory defaults.

Table 3-1.
Print Environment Default Settings — PCL Context

JOB CONTROL	
Number of Copies*	1
Registration	Left=0, Top=0
PAGE CONTROL	
Print Direction	0
Orientation*	Portrait
Page Size*	Letter
Paper Source	Tray
Vertical Motion Index*	8 (6 lpi)
Horizontal Motion Index	12 (10 cpi)
Top Margin	$\frac{1}{2}''$ (150 dots)
Text Length	Letter size ($\frac{1}{2}''$ top and $\frac{1}{2}''$ bottom margin)
Left Margin	Left logical page boundary
Right Margin	Right logical page boundary
Perforation Skip	On
Line Termination	CR→CR, LF→LF, FF→FF

Continued on next page.

* User default values may be selected by the user from the printer's Operator Control Panel.

Table 3-1. Print Environment Default Settings — PCL Context (continued)

FONTS**	
Symbol Set*	Roman-8
Spacing	fixed
Pitch***	10 cpi
Height***	12 point
Style	Upright
Stroke Weight	Medium
Typeface	Courier
Underlining Mode	Off
FONT MANAGEMENT	
Font ID	0
Character Code	0
RASTER GRAPHICS	
Left Margin	0
Resolution	75 dpi
Compression Method	0
Raster Height	N/A
Raster Width	Logical Page Width

Continued on next page.

* User default values may be selected by the user from the printer's Operator Control Panel for these items.

** The font characteristics are determined by the default font. The default font can be the factory default font or the user selected default font from the Operator Control Panel or from a font cartridge with a default font.

*** Selectable from the front panel if a scalable font has been selected as the user default.

Table 3-1. Print Environment Default Settings — PCL Context (continued)

PRINT MODEL	
Current Pattern	solid
Source Transparency Mode	0 (transparent)
Pattern Transparency Mode	0 (transparent)
RECTANGULAR AREA FILL	
Horizontal Rectangle Size	0
Vertical Rectangle Size	0
Area Fill ID	0
PICTURE FRAME	
Picture Frame Width	logical page width
Picture Frame Height	text length
Picture Frame Anchor Point	left edge of logical page and $\frac{1}{2}''$ down from logical page top
HP-GL/2 plot horizontal size	picture frame horizontal size
HP-GL/2 Plot Vertical Size	picture frame vertical size
MACRO	
Macro ID	0
TROUBLESHOOTING COMMANDS	
End-of-Line Wrap	OFF
Display Functions	OFF

Table 3-2.
Print Environment Default Settings — HP-GL Context

CHARACTER GROUP	
Character Set	Roman-8
Font Spacing	fixed
Pitch	10 cpi
Height	12 point
Posture	upright
Stroke Weight	medium
Typeface	HP-GL stick
Character Direction	horizontal
Character Direction Mode	absolute
Character Size Mode	size transformation off
Character Width	NA
Character Height	NA
Character Slant	0
Extra Horizontal Space	0
Extra Vertical Space	0
Character Fill Mode	no edging and solidly filled
Label Origin	1
Label Terminator	etx
Transparent Data Mode	off
Primary Font ID	0
Secondary Font ID	0
Scalable or Bitmap Font	Select scalable fonts only
VECTOR GROUP	
Plotting Mode	absolute
Pen State	up
POLYGON GROUP	
Polygon Buffer	cleared
Polygon Mode	off

Table 3-2.
Print Environment Default Settings — HP-GL Context
(continued)

LINE AND FILL ATTRIBUTE GROUP	
Line Type	solid
Line Type Repeat Length	4% of the diagonal distance from P1 to P2
Line Cap	butt
Line Join	mitered
Miter Limit	5
Pen Width	0.35mm
Pen Width Selection Mode	metric
Selected Pen	0 (no pen)
Symbol Mode	off
Fill Type	solid (bi-directional)
User-defined Line Type	eight standard line types
Anchor Corner	(0,0) plotter units
User-defined Fill Types	solid fill
Transparency Mode	On (transparency)
Screened Vector	No screening
CONFIGURATION AND STATUS GROUP	
Scale Mode	off
Window	PCL default picture frame (the PCL default logical page less $\frac{1}{2}$ inch at the top and the bottom)
Coordinate System Orientation	orientation of PCL default logical page coordinate system
P1, P2	lower left, upper right corners, respectively, of picture frame

User Default Environment

A user default is a setting selected from the printer's control panel.

There are several PCL features in the printer for which user defaults may be selected through nine Printing Menu selections. These features are as follows:

Number of Copies
Font Selection (Font Source, Font Number, Pitch* or Point Size*)
PAPER (Page Size: Paper and Envelopes)
Manual Feed
Orientation
FORM (Form Length, VMI)
Symbol Set

*Scalable typefaces only - fixed-space typefaces select pitch; proportionally-spaced typefaces select point size.

Note

Refer to discussion on VMI for the implications of setting the user default Form Length (**FORM=**) selection.

For instructions on how to select these user defaults from the control panel refer to the user's manual.

User default settings are stored in the User Default Environment and are retained even if the printer is turned OFF.

The User Default Environment consists of the user default settings (any user default settings selected from the control panel) with the remainder of the environment features set to their factory default values.

Modified Print Environment

The current printer feature settings constitute the modified print environment. Whenever a feature setting is altered using escape sequences, the new setting is recorded in the modified print environment.

The modified print environment is saved during a macro **call** or **overlay** and restored upon its completion. Since HP-GL/2 cannot be accessed within macros, it's settings are not part of the modified print environment.

The modified print environment consists of the current settings for the following features:

Modified Print Environment Features — PCL Context

Page length	Macro ID
Page size	VMI/Line spacing
Orientation	Horizontal rectangle size
Left registration	Vertical rectangle size
Top registration	Area fill ID
Paper source	Raster graphics resolution
Number of copies	Raster graphics presentation mode
Margins	Raster graphics left margin
Perforation skip mode	Pattern ID
Line termination mode	Current pattern
End-of-line wrap	Source transparency mode
Current font (pri/sec)	Pattern transparency mode
Primary font characteristics	Print direction
Secondary font characteristics	Raster graphics compression mode
HMI	Underline mode
Primary font	Raster graphics height
Secondary font	Raster graphics width
Font ID	
Character code	

The following items are not part of the modified print environment:

Current cursor position
Cursor position stack
Downloaded fonts/macros
Picture frame dimensions
HP-GL/2 plot size dimensions
Picture frame anchor point

Resetting the Print Environment

Resets are used to return the printer to a known environment. Depending on the type of reset performed, the printer returns to either the user default environment or the factory default environment.

A **Printer Reset** restores the user default environment and deletes temporary fonts and macros. A Printer Reset is performed by sending the $^{E}\!_{C}$**E** command or by holding [RESET] on the control panel for approximately five seconds, until **07 RESET** appears in the display window. The Printer Reset command is described in Chapter 4, Job Control Commands.

The $^{E}\!_{C}$**E** command prints any partial pages of data which may have been received. The control panel [RESET] discards any formatted pages which have not yet been printed.

Both resets ($^{E}\!_{C}$**E** and the control panel [RESET]) return the HP-GL/2 settings to their default values. $^{E}\!_{C}$**E** used in HP-GL/2 mode returns the printer to PCL mode in addition to resetting the Print Environment. The HP-GL/2 **IN (Initialize)** command resets HP-GL/2 settings to their default values without affecting the PCL settings (refer to the Initialize command described in Chapter 17, Configuration Group, for additional information).

Note

Hewlett-Packard strongly recommends the use of the $^{E}{}_{C}$E command at the beginning and end of each job.

A RESET MENU restores the factory default environment but retains the printer configuration (that is, the Auto Continue and I/O type, RET (Resolution Enhancement Technology), and Page Protect settings), deletes temporary fonts and macros, and discards any formatted pages which have not yet been printed. RESET MENU is performed by holding [RESET MENU] on the control panel for approximately five seconds until **09 RESET MENU** appears in the display window (refer to the user's manual for additional information).

A COLD RESET restores the factory default environment and the factory printer configuration settings. COLD RESET is performed by power cycling the printer while holding [ON LINE] until a **08 COLD RESET** is displayed.

LaserJet Printer Family Compatibility

Control panel functionality has been added to the printer to permit selecting user defaults for certain features. This permits users to tailor their printer's default environment to their printing requirements. For example, European users may choose to select a font other than the factory default font as their default; or, Electronic Data Processing (EDP) users may choose to select 66 lines per letter page rather than 60 lines as their default. To ensure compatibility with applications written for LaserJet family printers, the user defaults must be set equal to their factory default values. The following table shows the factory default setting for each feature for which a user default setting may be selected.

Table 3-3. LaserJet Family Compatibility

HP LaserJet III Control Panel Function	Compatibility Mode
Copies	1
Font Source	I unless installed cartridge has a default mark
Font Number	0
Pitch	10.00 cpi
Point Size	12.00 pt.
Paper	Letter / A4*
Orientation	Portrait
Form	60/64*
Manual Feed	Off
Symbol Set	Roman-8

* Factory default for 220v option

4

Job Control Commands

Introduction

A job typically consists of three parts:

- commands providing job control,
- commands providing page control, and
- document data.

This chapter describes the commands providing job control. Job control commands are usually grouped together and sent at the beginning of a job. Page control commands and data are associated with each printed page of a job. Job control commands include the following:

- restoration of the user default environment, reset,
- selection of the number of copies of each page,
- left and top offset registration

Structure of a Job

Preamble	Job Control Commands
Page 1	Page Control Commands
	Data
Page 2	[Page Control Commands]*
	Data
•	•
•	•
•	•
Page n	Page Control Commands
	Data
	* See note below

Note

If a number of consecutive pages within a job have the same format (such as margins, VMI, HMI, etc.), the associated page control commands only need to be sent once for that group of pages.

Printer Reset

Receipt of the Printer Reset command restores the user default environment, deletes temporary fonts and macros, and prints any partial pages of data which may have been received.

$^{E}_{C}$ E

Hewlett-Packard strongly recommends the use of the printer reset command at the beginning and end of each job.

Number of Copies

The Number of Copies command designates the number of printed copies of each page.

$^{E}_{C}$ & ℓ # X

= Number of copies (1 to 99 maximum)

This command can be received anywhere within a page and affects the current page as well as subsequent pages.

The factory default number of copies is 1.

Example

To print 3 copies of a page, send:

$^{E}_{C}$&ℓ3X

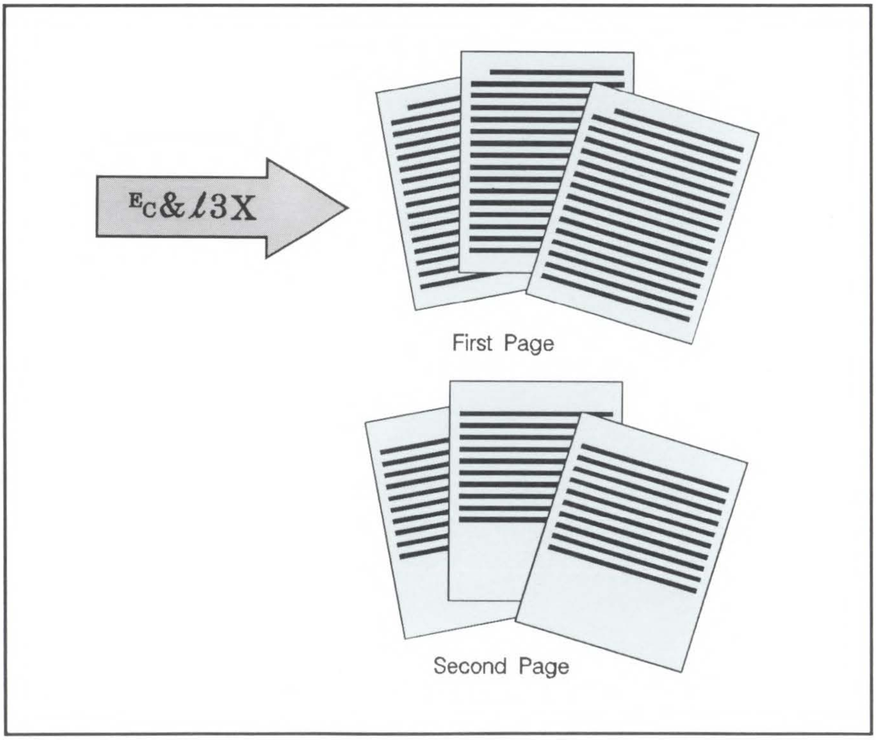


Figure 4-1. Number of Copies

Left Offset Registration

The Left (long-edge) Offset registration command designates the position of the logical page across the width (short side) of the physical page. This command can be used to adjust the text position on the page to allow additional room for the page binding

$^{E}_{C}$ & ℓ # U

= The number of decipoints ($\frac{1}{720}$ inch)

The value (#) is a signed number, valid to 2 decimal places. The units are decipoints. Positive values cause the logical page, regardless of orientation, to move right along the width of the physical page (refer to Figure 4-2).

Negative values cause the logical page, regardless of orientation, to move left along the width of the physical page (refer to Figure 4-2).

1. The +/– value is absolute with respect to the default position of the logical page, along the width of the physical page. It is not relative to the present location.
2. The registration commands may cause data loss by moving the logical page outside the printable area.
3. This command has the same effect regardless of orientation.

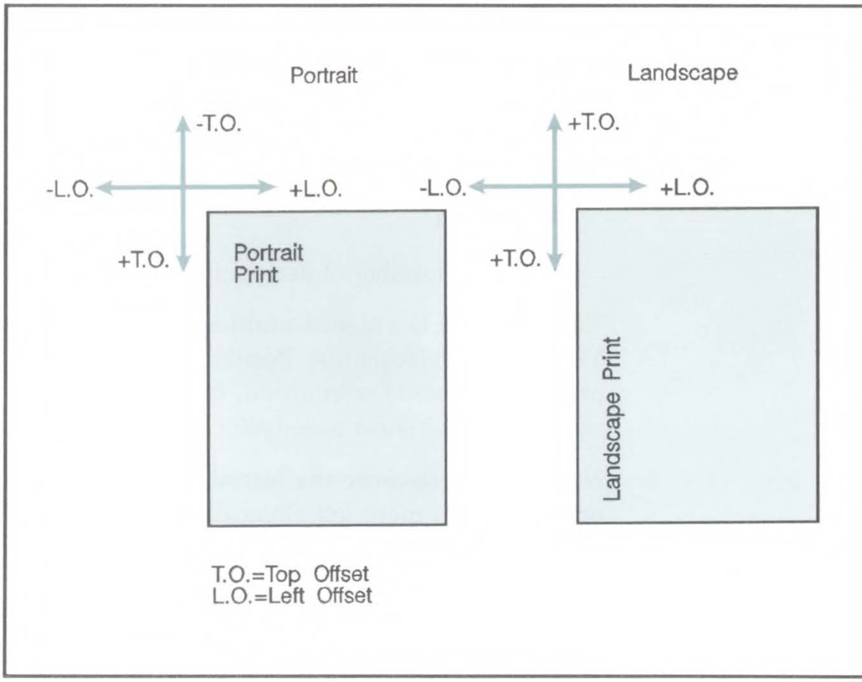


Figure 4-2. Registration Command, Value Field Sign, Offset Direction

Top Offset Registration

The Top (short-edge) Offset registration command designates the position of the logical page along the length (long side) of the physical page.

$^{E}_{C}$ & ℓ # Z

\# = The number of decipoints ($\frac{1}{720}$ inch)

The value (#) is a signed number, valid to 2 decimal places. The units are decipoints. Positive values cause the logical page, regardless of orientation, to move down along the length of the physical page (refer to Figure 4-2).

Negative values cause the logical page, regardless of orientation, to move up, along the length of the physical page (refer to Figure 4-2).

1. The +/− value is absolute with respect to the default position of the logical page, along the length of the physical page. It is not relative to the current location of the logical page.
2. The registration command may cause data loss by moving the logical page outside the printable area.
3. This command has the same effect regardless of orientation.

5

Page Control Commands

Introduction

Page Control commands and data are associated with each printed page of a job. These commands determine such features as page source, size, orientation, margins, and text spacing. This chapter describes the commands providing page format control.

Note

If a number of consecutive pages within a job have the same format, the associated page control commands should only be sent once for that group of pages.

Page Size Command

The Page Size command designates the size of the paper which in turn defines the size of the logical page.

$^{E}_{C}$ & ℓ # A

PAPER:

\# = 1 - Executive ($7\frac{1}{4}$ x $10\frac{1}{2}$ in.)
2 - Letter ($8\frac{1}{2}$ x 11 in.)
3 - Legal ($8\frac{1}{2}$ x 14 in.)
26 - A4 (210mm x 297mm)

ENVELOPES:

\# = 80 - Monarch (Letter - $3\frac{7}{8}$ x $7\frac{1}{2}$ in.)
81 - Com-10 (Business - $4\frac{1}{8}$ x $9\frac{1}{2}$ in.)
90 - International DL (110mm x 220mm)
91 - International C5 (162mm x 229mm)

Upon receipt of this command any unprinted pages will be printed, the top margin, text length, and left and right margins will be set to their user defaults, and the automatic macro overlay will be disabled. The cursor is moved to the left edge of the logical page at the top margin (see Figure 5-5) on the following page. Also, certain HP-GL/2 state variables are reset (refer to Table 5-3, under Sending a Page Size Command).

The factory default Page Size is letter (A4 for 220v option printer); however, a user default Page Size may be selected from the control panel. The Page Size command takes precedence over the printer's control panel FORM setting.

If the Page Size command selection differs from that of the installed paper tray size, a message is displayed on the control panel requesting installation of a paper tray of the specified size.

Note

The Page Size command is not supported on the **LaserJet**, **LaserJet Plus**, or the **LaserJet 500** printers.

Example

To select a legal size page, send:

$^E{}_C$&ℓ3A

If the source paper tray is configured for `LETTER` (that is, `PAPER=LETTER`), this command causes the following attendance message in the printer display window:

```
PC LOAD LEGAL
```

When the printer senses the existing paper supply has been removed and replaced with new paper size, the print job continues automatically.

Page Length

The Page Length command designates the length of the logical page in lines at a given VMI which in turn defines the **physical** page size.

$^E{}_C$ & ℓ # P

- Number of Lines

The value field (#) identifies the length of the logical page in lines. If a request is received for a page length greater than the maximum supported page size or if the Vertical Motion Index (VMI) is 0, the Page Length command is ignored.

If a Page Length command is received that designates a page size different from that of the installed paper tray, a message is displayed on the control panel requesting installation of the appropriate paper size.

Upon receipt of this command any unprinted pages will be printed, the top margin, text length, left and right margins will be set to their user defaults, and the automatic macro overlay will be disabled. The cursor will be moved to the left edge of the logical page at the top margin on the following page. Also, certain HP-GL/2 state variables are reset (refer to Table 5-3, under Sending a Page Length Command).

Note

The Page Length command must be used with the LaserJet, LaserJet Plus, and LaserJet 500 to set the page size. Either the Page Length command or the Page Size command can be used with the LaserJet series II, LaserJet IID, LaserJet IIP, LaserJet III, and LaserJet 2000 printers, however, the Page Size command is preferred over the Page Length command.

The factory default logical page length is defined by the factory default page size, which is letter; however, a user default page size may be selected from the control panel.

Note

A change in the control panel FORM setting results in a modification of the VMI. If the Page Length command follows a VMI change, the physical size of the page is recalculated. The page length command may result in selecting a different paper size.

The following tables list page length values associated with the standard paper sizes.

Table 5-1.
Portrait Orientation
Page Length Settings

Page Size	6 Lines Per Inch	8 Lines Per Inch
Letter	66	88
Legal	84	112
A4	70	93
Executive	63	84

Table 5-2. Landscape Orientation Page Length Settings

Page Size	6 Lines Per Inch	8 Lines Per Inch
Letter	51	68
Legal*	–	–
A4	49	66
Executive	43	58

* Once in landscape orientation, it is not possible to specify legal size paper using the Page Length command. To print a legal size page in landscape orientation, start out in portrait orientation, set the page length using the $^{E}\!_{C}$**&ℓ84P** command, and then set the orientation using the $^{E}\!_{C}$**&ℓ1O** command.

To determine the number of lines per page, simply multiply the line spacing setting (lines per inch) times the length of the physical page in inches.

Most HP-GL/2 state variables retain their previous HP-GL/2 value upon receipt of this command (that is, they are not affected by PCL mode). However, certain changes to the PCL state can affect the HP-GL/2 state (see Table 5-3).

If this is the first time the device has entered HP-GL/2 since an $^{E}\!_{C}$**E**, power-on, or control panel reset, all HP-GL/2 state variables will be at their default settings, as mandated by the picture presentation directives and the current PCL state.

Example

If FORM=80 LINES is set and PAPER=LETTER, a request for Legal $^{E}\!_{C}$&ℓ84P will result in a load executive paper message since 84/4 = 10.5 inches (the physical length of executive size paper.

Paper Source

The Paper Source command designates any one of three paper locations as the paper source or prints the current page.

$^{E}_{C}$ & ℓ # H

\# = 0 - Print the current page (paper source remains unchanged)

1 - Feed paper from the paper tray

2 - Feed paper from manual input

3 - Feed envelope from manual input

The Paper Source command causes the current page to be printed and the cursor to be moved to the left edge of the logical page at the top margin position (see Figure 5-4) for the next page.

Value fields 1 and 2 will accept either paper or envelope sizes. Value Field 3 will accept only envelope sizes.

The factory default paper source is the internal tray.

Example

To feed paper from the manual feed slot, send:

$^{E}_{C}$&ℓ2H

If the selection requires operator action (such as manually feeding paper), a printer attendance message will appear in the display. In this example assume that letter size has already been specified and letter tray is installed, the display will show `PF FEED LETTER`. The printer will wait until the manual feed paper sensor detects that the paper (or envelope) has been placed in the manual feed slot and then begin printing.

Table 5-3. HP-GL/2 State Variables

Esc E or Control Panel Reset:	• executes "IN" command • defaults picture frame • defaults picture frame anchor point • defaults HP-GL/2 plot size
Changing Orientation or Sending a Paper Size Command or Page Length Command:	• defaults picture frame anchor point • defaults picture frame • defaults HP-GL/2 plot size • defaults P1 and P2 ("IP;") • defaults soft-clip window ("IW;") • clears the polygon buffer ("PM0;PM2;") • updates the current position to the lower-left corner of the picture frame (P1).
Redefinition of the Picture Frame:	• defaults P1 and P2 ("IP;") • defaults soft-clip window ("IW;") • clears the polygon buffer ("PM0;PM2;") • updates the current position to the lower-left corner of the picture frame (P1).
Redefinition of the Anchor Point:	• defaults P1 and P2 ("IP;") • defaults soft-clip window ("IW;") • clears the polygon buffer ("PM0;PM2;") • updates the current position to the lower-left corner of the picture frame (P1).
Specifications of a New HP-GL/2 Plot Size:	• changes the picture frame scaling factor.

Logical Page Orientation

Orientation defines the position of the logical page and the direction of print with respect to the physical page as shown in Figure 5-1.

$^{E}_{C}$ & ℓ # O

\# = 0 - Portrait
1 - Landscape
2 - Reverse Portrait
3 - Reverse Landscape

Note

- This command can only be used once per page. To print multiple orientations per page use the Print Direction command.
- If this command does not charge the orientation (that is, sent with the value field set to the current orientation), it is ignored.

The Orientation command causes the page length, top margin, text length, left and right margins, Horizontal Motion Index (HMI) and VMI to be set to their user default values, and disables the automatic macro overlay. Also, all data received prior to this command will be printed and a form feed and carriage return executed (the cursor is moved to the left edge of the logical page at the top margin cursor position (see Figure 5-5)).

The factory default orientation is portrait. Landscape orientation may be selected as the user default orientation using the control panel.

Note

The LaserJet III printer automatically rotates all fonts to the current orientation.

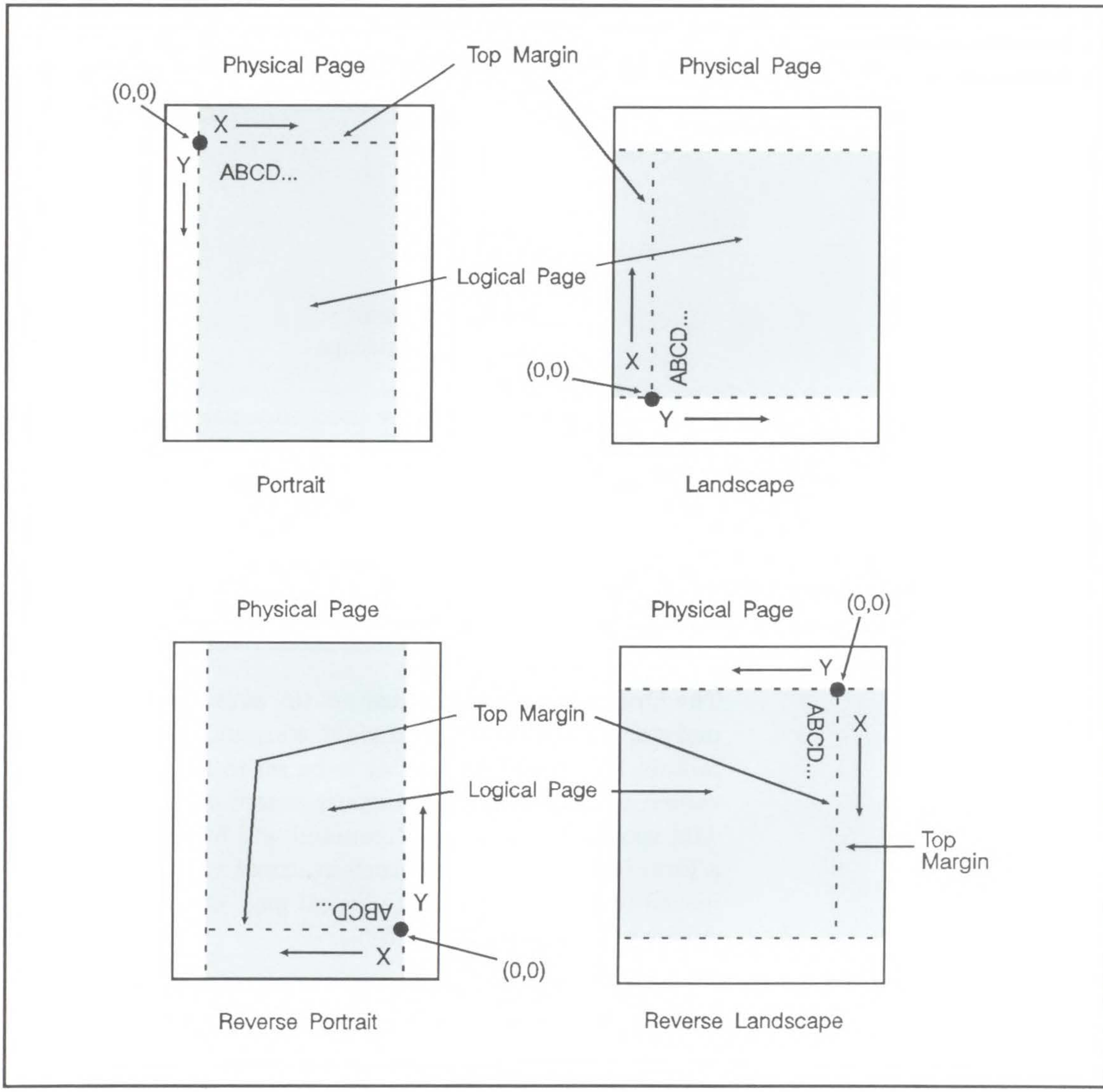


Figure 5-1. Page Orientation

The orientation of the HP-GL/2 picture is also affected by the logical page orientation. Figure 5-2 illustrates the affect of logical page orientation on the HP-GL/2 picture orientation. It is possible to alter the HP-GL/2 picture orientation within the logical page using the HP-GL/2 RO command (refer to Chapter 21, for additional information).

Most HP-GL/2 state variables retain their previous HP-GL/2 value upon receipt of this command (that is, they are not affected by PCL mode). However, certain changes to the PCL state can affect the HP-GL/2 state (see Table 5-3).

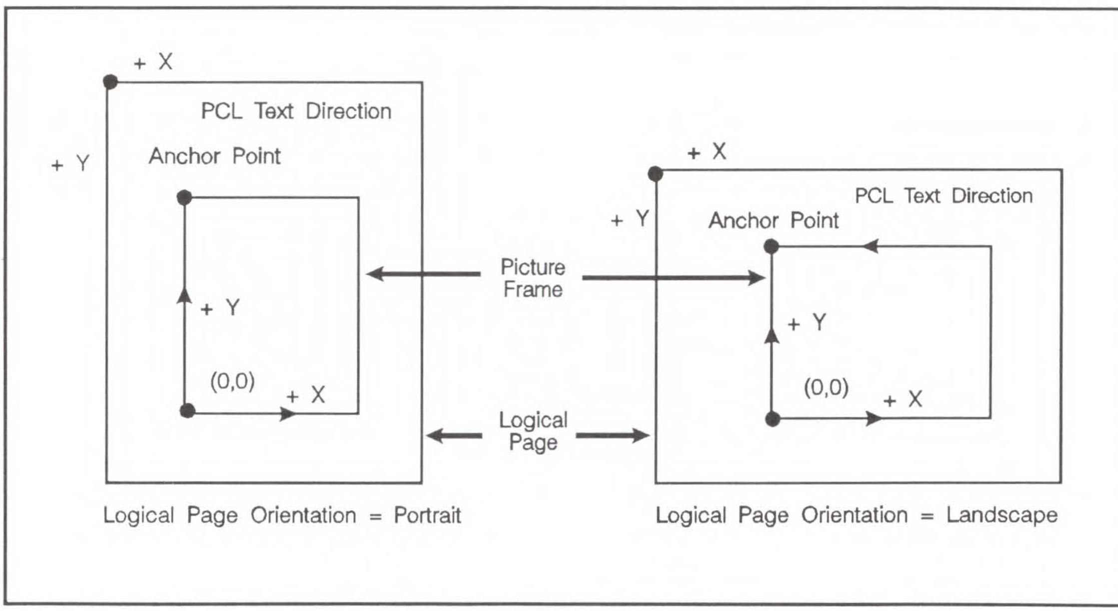


Figure 5-2. HP-GL/2 Picture Orientation with Respect to Logical Page Orientation

5 Page Control

Print Direction

The Print Direction command rotates the logical page coordinate system with respect to the current orientation without performing a page eject. This allows printing in four orientations on the same page. Rotation is performed in 90° increments in a counterclockwise direction.

^E_C & a # P

# =	0	- 0°	Portrait
	90	- 90°	Landscape
	180	- 180°	Reverse Portrait
	270	- 270°	Reverse Landscape

Changing the print direction causes the following:

- The logical page coordinate system (logical page width, length, top and left offset) are transformed accordingly. For example, rotating a default page (portrait orientation, 0° print direction) 90° causes data to print in the landscape direction across the "portrait" page.
- The margins are translated (e.g., when the print direction changes by 90°, the left margin becomes the new top margin, the former top margin becomes the new right margin, etc.)
- The cursor position remains at the same **physical** location.
- All subsequent printing (characters, area fill patterns, raster images) is rotated to coincide with the new print direction.
- Any current raster graphics end when the print direction changes.
- HMI is set to that of the current font used for each new direction.

Note

The Print Direction Command does **not** affect HP-GL/2 vector graphic images. HP-GL/2 graphics can be rotated only with the Orientation command (${}^{E}{}_{C}$**&ℓ#O**) or the HP-GL/2 "RO" command.

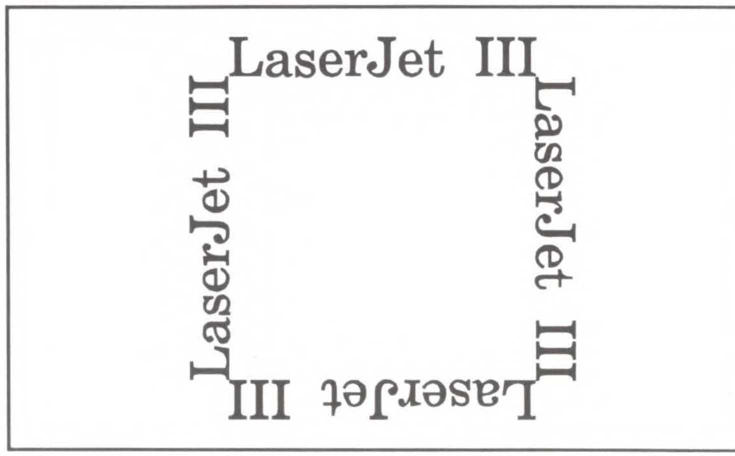


Figure 5-3. Changing Print Direction on a Page

Text Area

Text printing may be restricted to a specific area within the logical page using the left margin, right margin, top margin, text length and perforation skip mode commands. This area is known as the text area.

The left margin defines the distance between the left edge of the logical page and the left edge of the text area. The right margin defines the distance between the left edge of the logical page and the right edge of the text area. The width of the text area is the distance between the left and right margins. The top margin defines the distance between the top of the logical page and the top of the text area. The text length defines the length of the text area which in effect defines the bottom margin. The perforation skip region is the distance from the bottom of the text area to the top of the text area on the next page. The text area is shown in Figure 5-4.

In general, characters will be printed when they fall within the text area. However, characters can be printed between the bottom of the text area and the top of the text area on the next page only if perforation skip is disabled. Characters will be printed outside the text area if a cursor move escape sequence positions the cursor outside the text area (but within the printable area).

Note

- Attempting to print characters outside the printable area will result in data loss.
- The default text area is the default HP-GL/2 picture frame.

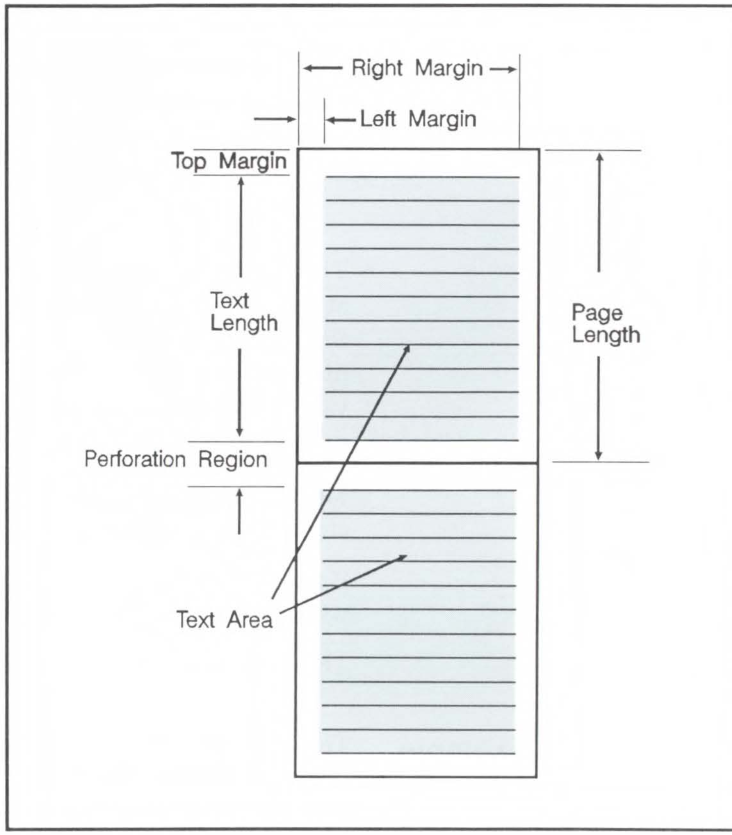


Figure 5-4. Text Area within the Page

Left Margin

The Left Margin command sets the left margin to the left edge of the specified column.

^E_C & a # L

= Column number

The first column within a line is column 0, which is located at the left edge of the logical page (the HMI setting defines the distance between columns, which thereby defines the maximum number of columns on the logical page). If the value field specifies a column greater than the current right margin, the command is ignored.

Margins represent a physical position and once set do not change with subsequent changes in HMI.

If the cursor is to the left of the new left margin, the cursor will be moved to the new left margin.

The factory default left margin is column 0.

Example

To set the left margin to column 5, send:

^E_C&a5L

Right Margin

The Right Margin command sets the right margin to the right edge of the specified column.

^E_C & a # M

= Column number

The maximum right column is located at the right edge of the logical page (the HMI setting defines the distance between columns, which thereby defines the maximum number of columns on the logical page). If the value field specifies a column which is greater than the right edge of the logical page, the right margin is set to the right edge of the logical page. If the value field specifies a column less than the left margin, the command is ignored.

Margins represent a physical position and once set do not change with subsequent changes in HMI.

If the cursor position is to the right of the new right margin, the cursor will be moved to the new right margin.

The factory default right margin is the right edge of the logical page.

Example

To set the right margin to column 45, send:

^E_C&a45M

Clear Horizontal Margins

The Clear Horizontal Margins command resets the left and right margins. The left margin is set to the left edge of the logical page (column 0) and the right margin is set to the right edge of the logical page.

$^{E}_{C}$ **9** - Reset Left and Right Margins

Top Margin

The Top Margin command designates the number of lines between the top of the logical page and the top of the text area.

$^{E}_{C}$ & ℓ # E

= Number of lines

The Top Margin command is ignored if the value field (#) is greater than the current logical page length or if the current VMI is 0 (VMI defines the distance between lines of text).

Receipt of a Top Margin command resets the text length according to the following equation:

Top Margin = logical page length in inches - (top margin in inches + $\frac{1}{2}$ inch).

The top margin represents a physical position and once set does not change with subsequent changes in VMI or line spacing.

The vertical cursor position for the first line of print on the logical page is determined by the current values of the top margin and VMI, using the following equation:

First line in inches = top margin in inches + (0.75 X VMI)

Refer to Figure 5-5. Note that the cursor is positioned down 75% of the VMI distance (0.75 * VMI). This positions the cursor at the base line position of a character for correct character positioning in a character cell.

Example To set the top margin to line 4, send:

$^{E}_{C}$&ℓ4E

Note The first line of the logical page is line 0.

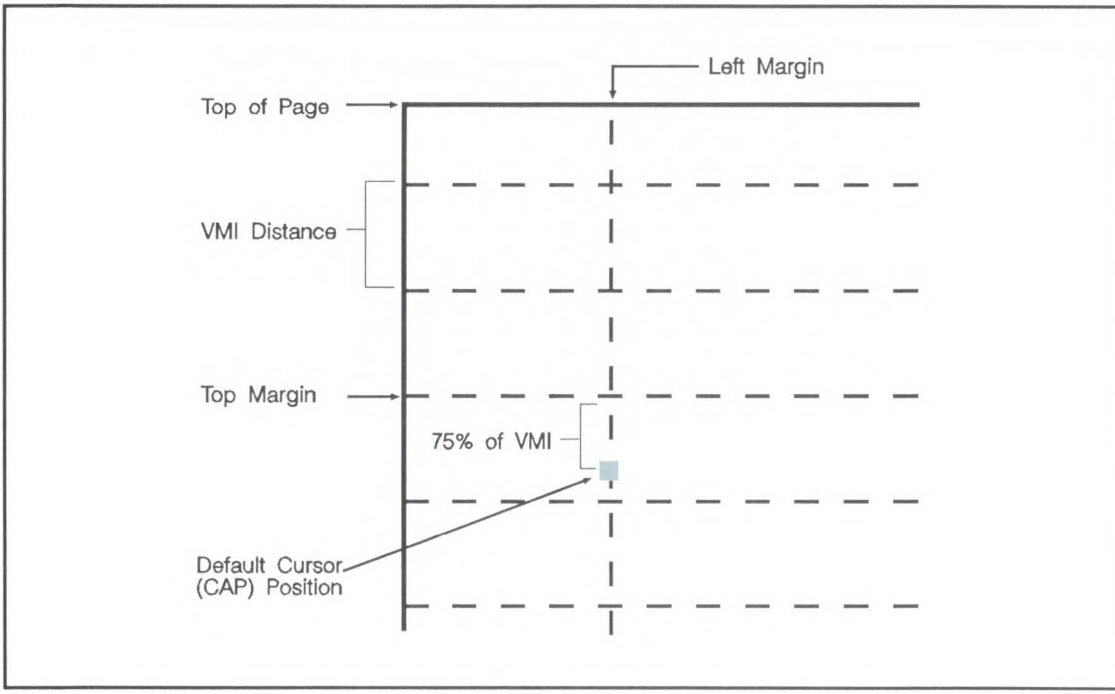


Figure 5-5. Margin Cursor Positioning

Text Length

The Text Length command designates the number of lines (at a given VMI) within the logical page available for printing text, the text area. This effectively defines the bottom margin.

$^{E}{}_{C}$ & ℓ # F

= Number of lines

The value field (#) sets the text length in lines referenced from the top margin. If a value greater than the logical page length minus the top margin is specified or if the current VMI is 0, the command is ignored. The user default text length is invoked whenever the orientation, page length, page size or top margin is changed. The user default text length is computed as follows:

$$\text{Text Length in Lines (Integer portion of)} = \left(\text{(Logical page length in inches - (Top margin inches) - (1/2 inch) X } \frac{48}{\text{VMI}} \right)$$

$$\text{Factory Default Text Length in Lines} = \left(\text{(Logical page length in inches - 1 inch) X } \frac{48}{8} \right)$$

Note

The user default VMI is selectable using the control panel; that is, the VMI is calculated from the FORM menu setting.

Example

To select a text length of 60 lines, send:

$^{E}{}_{C}$&ℓ60F

Perforation Region

The perforation region is the distance from the bottom of the text area of one page to the top of the text area (top margin) of the next page. When perforation skip is enabled a line feed or half line feed that would move the cursor beyond the bottom of the text area, causes the cursor to move to the top of the text area on the next page. When perforation skip is disabled, a line feed or half-line feed will allow the cursor to move to the next line or half-line into the perforation region allowing printing to continue there.

^E_C & ℓ # L

= 0 - Disable
1 - Enable

The factory default is perforation skip enabled.

Whenever the perforation skip mode is changed, the top margin and page length are returned to their default values.

Note

When perforation skip is disabled, some print lines could fall outside the printable area and be lost. If lines of data could fall into the unprintable area, perforation skip should be enabled.

Horizontal Motion Index

The Horizontal Motion Index (HMI) command designates the width of the columns.

$^{E}_{C}$ & k # H

= Number of $\frac{1}{120}$ inch increments.

The value field (#) range is 0 to 32767.

The value field is valid to 4 decimal places. A value of zero (0) indicates no horizontal motion.

When fixed pitch fonts are selected, all printable characters including the space and backspace characters are affected by HMI. When proportional fonts are selected, the HMI affects only the space control code character.

HMI is defaulted when any of the font characteristics are changed and when switching between primary and secondary fonts with shift in and shift out.

The default HMI is equal to the pitch value in the font header. The factory default font's HMI is 12 (which is $\frac{12}{120} = \frac{1}{10}$ inch per character or 10 characters per inch).

Example

To print the printer's resident 16.66 pitch Line Printer font at 17.75 cpi, send **$^{E}_{C}$(s16.66H** to select the Line Printer font, then send the command **$^{E}_{C}$&k6.76H** to change HMI. This value field is calculated as follows:

$$\frac{\text{HMI units}}{\text{Desired CPI}} = \frac{120}{17.75} = 6.76\text{H}$$

Each character will then occupy 6.76/120 inch or 1/17.75 inch.

To use Courier 12 point (10 cpi) and print 80 characters across A4 paper, would require that the HMI value be adjusted. That HMI value would be calculated as follows:

$$\text{A4 Width (inches)} = \frac{\text{2338 dots wide*}}{\text{300 dots/in.}} = \text{7.793 inches}$$

* this value obtained from Figure 2-3 or 2-4 which identify the page sizes (in dots).

$$\text{\# char./inch} = \frac{\text{80 characters}}{\text{7.793 in.}} = \text{10.266 cpi}$$

$$\text{Desired HMI} = \frac{\text{120 HMI units}}{\text{10.266 char./inch}} = \text{11.689 HMI value}$$

Vertical Motion Index

The Vertical Motion Index (VMI) command designates the height of the rows. (The vertical distance the cursor will move for a line feed operation.)

$^{E}{}_{C}$ & ℓ # C

= number of $\frac{1}{48}$ inch increments between rows.

The value field (#) range is from 0 to 32767. If the specified VMI is greater than the current logical page length, the command is ignored.

The value field is valid to 4 decimal places. A 0 in the value field indicates no vertical movement.

This command affects the line feed and half line feed spacing.

The factory default VMI is 8 which corresponds to 6 lines per inch. A user default VMI can be selected from the control panel using the FORM menu item (refer to the HP LaserJet III Printer User's Manual for additional information).

Example

To designate a VMI of 6 (8 lines per inch) send:

$^{E}{}_{C}$&ℓ6C (that is, $\frac{6}{48} = \frac{1}{8}$ inch/line)

The following converts lines-per-inch spacing to VMI:

$$\text{VMI} = 48 \text{ X } \left(\frac{1}{\text{\# of desired lines per inch}} \right)$$

Note

A change in the control panel FORM setting results in a modification of VMI. If the Page Length command (${}^{E}_{C}$**&ℓ#P**) follows a VMI change, the physical size of the page is recalculated. Therefore, depending on the VMI modification made, the printer may request a different paper size.

Common VMI Settings

To print 66 lines per page on letter-size paper, in portrait orientation, with one-half inch top and bottom margins send:

${}^{E}_{C}$**&ℓ7.27C**   7.27 = (10/66) x 48

To print 66 lines per page on letter or legal-size paper, in landscape orientation, with one-half inch top and bottom margins send:

${}^{E}_{C}$**&ℓ5.45C**   5.45 = (7.5/66) x 48

Line Spacing

The Line Spacing command sets the number of lines printed per inch. Only the values listed below are valid.

$^{E}_{C}$ & ℓ # D

# =	1 -	1 lpi
	2 -	2 lpi
	3 -	3 lpi
	4 -	4 lpi
	6 -	6 lpi
	8 -	8 lpi
	12 -	12 lpi
	16 -	16 lpi
	24 -	24 lpi
	48 -	48 lpi

This command performs the same function as the Vertical Motion Index (VMI) command except that it identifies the VMI in lines per inch (lpi).

The factory default lines per inch setting is 6. A user default line spacing can be selected from the control panel using the FORM menu item.

Example

To select 12 lpi, send:

$^{E}_{C}$&ℓ12D

Note

Once a PCL command sets a parameter that parameter will remain in effect until another command changes the parameter; that is, the most recently received command has precedence.

6

Cursor Positioning

Introduction

This section describes the cursor positioning commands. Although the printer does not actually have a cursor, the cursor position refers to the current active position (CAP; like the blinking underline character [cursor] used on most computer terminals). The cursor can be moved anywhere within the logical page using a combination of horizontal and vertical cursor positioning commands and control codes.

In addition to the positioning cursor commands, the cursor is automatically moved after certain operations, such as printing characters and graphics. For example, after printing a character the cursor is positioned to the right, a distance equal to the width of that character. This allows printing characters without the need to manually position the cursor for each new character printed. This is controlled by the character design (refer to Character Cell Width described in Chapter 10 for additional information).

HP-GL/2 has its own cursor that can be positioned within the HP-GL/2 addressable area. For additional information on HP-GL/2 cursor positioning refer to Chapter 15, *Introduction to HP-GL/2 Vector Graphics*.

Absolute/Relative Cursor Positioning

Either absolute or relative motion can be specified.

Absolute motion always specifies the distance to move referenced from the top margin at the left bound of the logical page (0,0), *regardless of the current active cursor position* (see Figure 6-1). An unsigned value field in a cursor position command indicates absolute cursor movement.

Relative motion specifies the distance to move *referenced from the current active position* (see Figure 6-1). A signed (+/-) value field in a cursor position command indicates relative cursor movement.

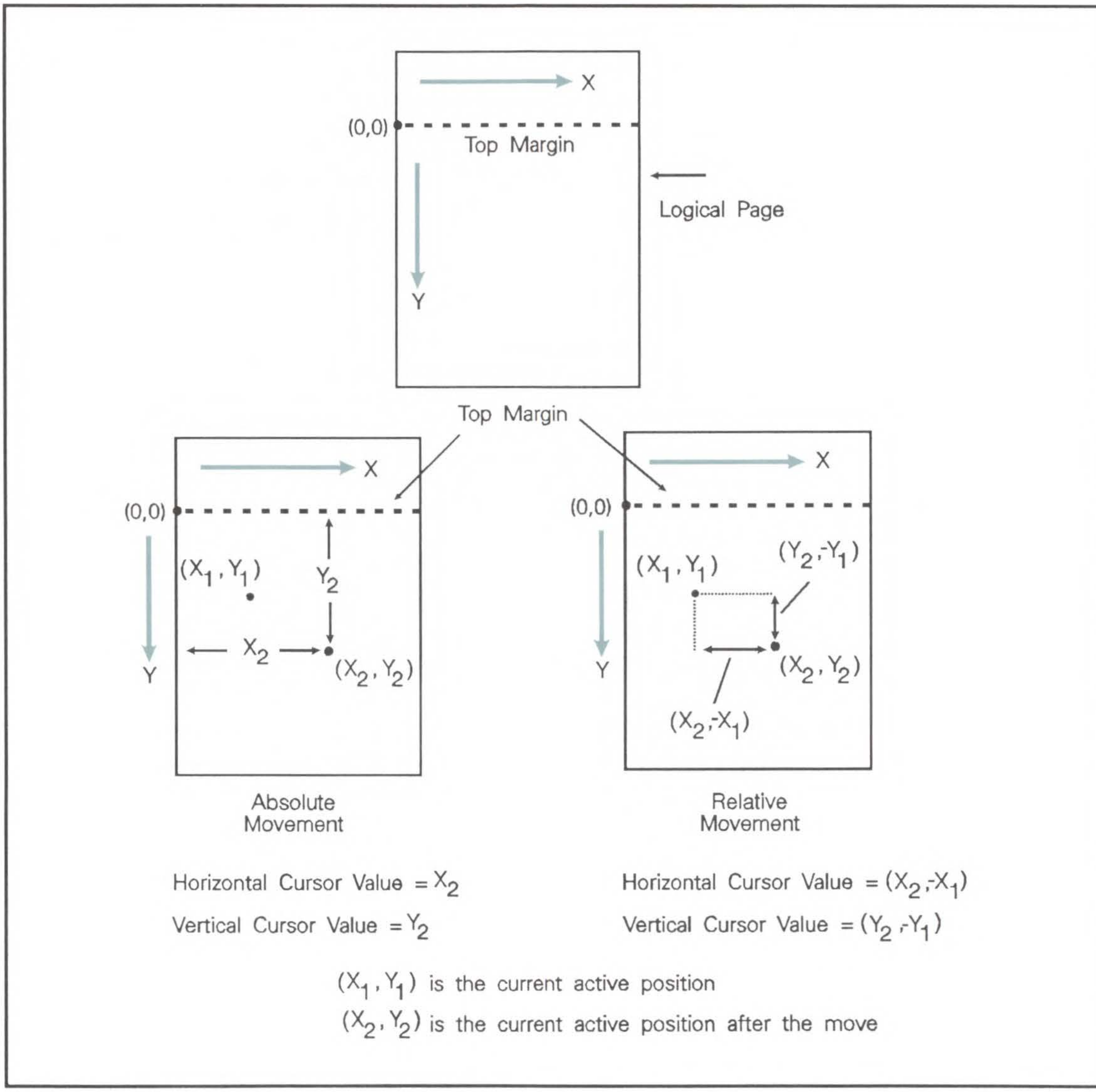


Figure 6-1. Absolute and Relative Cursor Positioning

Cursor Positioning Units

Cursor positioning is done in PCL coordinate system units. The units of the X-axis of the PCL coordinate system may be dots, decipoints or columns. The units of the Y-axis of the PCL coordinate system may be dots, decipoints or rows.

A dot is the smallest printable unit. In the HP LaserJet III printer one dot equals $\frac{1}{300}$ inch. The number of dots printed per inch is referred to as the printer's resolution.

A decipoint is $\frac{1}{720}$ inch or $\frac{1}{10}$ of a PCL typographic point.

The width of a column is defined by the current horizontal motion index (HMI). The distance between rows is defined by the current vertical motion index (VMI). HMI is the distance between consecutive characters. VMI is the distance between consecutive lines of text. HMI and VMI are described in more detail in Chapter 5.

HP-GL/2 has its own coordinate system and units. For additional information about the HP-GL/2 coordinate system and units refer to Chapter 15, *Introduction to HP-GL/2 Vector Graphics*.

Horizontal Cursor Positioning (Columns)

This Horizontal Cursor Positioning command moves the cursor to a new column on the current line.

$^{E}_{C}$ & a # C

= Number of Columns

The width of a column is defined by the current HMI. A value field (#) with a plus sign (+) indicates the new position is to the right of and relative to the current cursor position; a minus sign (−) indicates the new position is to the left of and relative to the current cursor position. No sign indicates an absolute distance which is referenced from the left edge of the logical page. The first column within a line is column 0. This sequence ignores margins and can therefore be used to set the current active position to any location along the current line.

If a request is made for a location outside the printer's logical page, the current active position is moved to the appropriate logical page limit.

The value field is valid to 4 decimal places.

Horizontal Cursor Positioning (Decipoints)

This Horizontal Cursor Positioning command moves the cursor to a new position along the horizontal axis.

$^{E}{}_{C}$ & a # H

= Number of Decipoints ($\frac{1}{720}$ inch)

A value field (#) with a plus sign (+) indicates the new position is to the right of and relative to the current cursor position; a minus sign (–) indicates the new position is to the left of and relative to the current cursor position. No sign indicates an absolute distance which is referenced from the left edge of the logical page. The left most position is 0 and the right most position is the right bound of the logical page.

If a request is made for a location outside the printer's logical page, the current active position is moved to the appropriate logical page limit.

The value field is valid to two decimal places.

Horizontal Cursor Positioning (Dots)

This Horizontal Cursor Positioning command moves the cursor to a new position along the horizontal axis.

$^E{}_C$ * p # X

= Number of dots

A value field (#) with a plus sign (+) indicates the new position is to the right of and relative to the current cursor position; a minus sign (−) indicates the new position is to the left of and relative to the current cursor position. No sign indicates an absolute distance which is referenced from the left edge of the logical page. The left most position is 0 and the right most position is the right bound of the logical page.

If a request is made for a location outside the printer's logical page, the current active position is moved to the appropriate logical page limit.

Horizontal Cursor Positioning Control Codes

There are four control codes which can be used to position the cursor horizontally on the current line. These control codes are explained below.

CR - Carriage Return

Moves the current active position to the left margin on the current line. (Refer to the Line Termination command described later in this chapter.)

SP - Space

Moves the current active position to the right by one column position. Space may be a printable character or a control code. If a character is defined for the space code, space is printable; otherwise, it is a control code. For proportionally spaced fonts a space control code updates the cursor by the current HMI value; however, a printable space updates the cursor the width of the character. For fixed pitch fonts, a space, whether it be a control code or printable, updates the cursor according to the HMI value.

BS - Backspace

Moves the current active position left a distance equal to the width of the last printed symbol or space. If the active position is already at the left margin, no action is taken. When using fixed pitch fonts, the backspace distance is defined by the current print pitch (that is HMI setting).

When using proportionally-spaced fonts, a single backspace moves back in such a way as to center the overstrike character. After printing the overstrike character the cursor position is at the same position as before the backspace. Multiple backspaces each move back the distance of the last printed symbol or space. For example, if "world" was printed with a proportional font and then 5 backspaces were performed, the distance moved back would be five times the width of the "d."

HT - Horizontal Tab

Moves the current active position to the next tab stop on the current line. The tab stops are at the left margin and every 8th column between the left margin and the right bound of the logical page. If the new horizontal position crosses the right margin, the new horizontal position is set to the right margin. If the current HMI value is 0, the command is ignored.

Vertical Cursor Positioning (Rows)

This Vertical Cursor Positioning command moves the cursor to a new line in the same column position.

$^{E}{}_{C}$ & a # R

= Number of Rows

A value field (#) with a plus sign (+) indicates the new position is downward from and relative to the current cursor position and a minus sign (–) indicates the new position is upward from and relative to the current cursor position. No sign indicates the new position is absolute from the top margin. The top position, defined by the top margin, is 0 and the bottom position is determined by the bottom of the logical page.

Note

Since the top margin can be changed using a printer command, the physical location of the point (0,0) may change. This will affect the cursor position on the page.

If a request is made for a location outside the printer's logical page, the current active position is moved to the appropriate logical page limit.

The value field is valid to 4 decimal places.

Vertical Cursor Positioning (Decipoints)

This Vertical Cursor Positioning command moves the cursor to a new position along the vertical axis.

$^{E}_{C}$ **& a # V**

= Number of Decipoints ($\frac{1}{720}$ inch)

A value field (#) with a plus sign (+) indicates the new position is downward from and relative to the current cursor position and a minus sign (−) indicates the new position is upward from and relative to the current cursor position. No sign indicates an absolute distance from the top margin. The top position, defined by the top margin, is 0 and the bottom position is determined by the bottom of the logical page.

Note

Since the top margin can be changed using a printer command, the physical location of the point (0,0) may change. This will affect the cursor position on the page.

If a request is made for a location outside the printer's logical page, the current active position is moved to the appropriate logical page limit.

The value field is rounded to the first decimal place.

Vertical Cursor Positioning (Dots)

This Vertical Cursor Positioning command moves the cursor to a new position along the vertical axis.

^E_C * p # Y

= Number of Dots

A value field (#) with a plus sign (+) indicates the new position is downward from and relative to the current cursor position and a minus sign (−) indicates the new position is upward from and relative to the current cursor position. No sign indicates an absolute distance from the top margin. The top position, defined by the top margin, is 0 and the bottom position is determined by the bottom of the logical page.

Note

Since the top margin can be changed using a printer command, the physical location of the point (0,0) may change. This will affect the cursor position on the page.

If a request is made for a location outside the printer's logical page, the current active position is moved to the appropriate logical page limit.

Half-Line Feed

The Half-Line Feed command moves the cursor to the same character position one-half line down. The distance moved for a half-line feed is one-half of the current line spacing (defined by the last VMI or line spacing setting).

$^{E}_{C}$= Half-line Feed

Vertical Cursor Positioning Control Codes

There are two control codes which can be used to position the cursor vertically. These control codes are explained below.

LF - Line Feed

Advances the current active position to the same horizontal position on the next line. The distance to the next line is defined by the current line spacing (defined by the last VMI or line spacing setting). (Refer to the Line Termination command described later in this chapter.)

FF - Form Feed

Advances the current active position to the same horizontal position at the top of the text area on the next page. (Refer to the Line Termination command described later in this chapter.)

Line Termination

The Line Termination command controls the way the printer interprets CR, LF, and FF control characters.

$^{E}_{C}$ & k # G

\# = 0 - CR→CR; LF→LF; FF→FF

1 - CR→CR-LF; LF→LF; FF→FF

2 - CR→CR; LF→CR-LF; FF→CR-FF

3 - CR→CR-LF; LF→CR-LF; FF→CR-FF

The factory default line termination value is 0.

For example, if a value field of 1 is sent, the printer will insert a line-feed (LF) control code for each carriage-return (CR) received.

Push/Pop Cursor Position

The Push/Pop Cursor Position command allows the current cursor position to be stored and recalled.

$^{E}_{C}$ & f # S

\# = 0 - Push (Store cursor position)
    1 - Pop (Recall a cursor position)

A value field of 0 pushes the cursor position onto the stack (leaving the current position unaffected). A value field of 1 pops the position from the stack, restoring it as the current cursor position.

Note

The last item pushed is the first item popped.

Twenty positions may be pushed. If the user tries to save more than 20 positions, the command is ignored. If the user tries to restore more positions than were pushed, the command is ignored. A printer reset restores the current active position stack to the top (all saved positions are discarded).

The positions stored in the stack are not changed with an orientation change. Therefor, the positions are relative to the top left corner of the current orientation. Also, a position pushed in one orientation and popped in another orientation can result in a position that is outside the logical page. If the position popped is outside the current logical page, the position is moved to the appropriate limit.

7

Fonts

Introduction

A font is a group of symbols that have similar characteristics. A font is described by, its **symbol set spacing**, **height**, **pitch**, **style**, **stroke weight**, and **typeface**.

A typical document is printed using a number of fonts. For example, a large font may be used for the title and chapter headings of a document, a standard size font may be used for the body of the document, and key words or phrases may be highlighted, using a bold or italic font.

For example, this text is printed using a Century Schoolbook typeface; its **height** is 10 point, its **style** is upright, and its **stroke weight** is medium. Some examples of different fonts are shown in Figure 7-1.

A font must be selected for printing by the user. One font is selected at a time. A font is selected by identifying the specific characteristics, of the desired font, to the printer. Font selection commands are used to identify font characteristics to the printer (refer to Chapter 8, Font Selection, for detailed font selection information).

A number of fonts are supplied with the printer. These fonts are referred to as internal fonts. The internal fonts include eight scalable typefaces: four in CG Times typeface and four in Univers typeface; and, two bitmap typefaces, Courier and Line Printer (refer to Tables 7-1 and 7-2). Additional typefaces and fonts can be easily added by inserting font cartridges into the printer or downloading them from disk.

Courier 12 pitch 10 point
abcdefABCDEF12345&%!?

CG Times 12 point
abcdefABCDEF12345&%!?

CG Times Bold Italic 14 point
abcdefABCDEF12345&%!?

Univers Medium 14 point
abcdefABCDEF12345&%!?

Univers Bold 24 point
abcdefABCDEF12345&%!?

Figure 7-1. Font Samples

Cartridge fonts plug into one of two font cartridge slots in the printer. The fonts contained in the cartridge become available once the cartridge is plugged in. A number of font cartridges may be purchased from Hewlett-Packard or an authorized dealer. Refer to your Hewlett-Packard Accessories and Supplies Brochure for a list of available cartridges. Contact your HP Sales Representative or authorized dealer for purchasing information.

Soft fonts are supplied on flexible discs. These discs are inserted into the personal computer disc drive and the font files are transferred (downloaded) into the printer's user (RAM) memory. Once the font has been downloaded into the printer, it may be selected for printing. A number of soft fonts may be purchased from Hewlett-Packard or an authorized dealer. Refer to your Hewlett-Packard Accessories and Supplies Brochure for a list of available soft fonts. Contact your HP Sales Representative or authorized dealer for purchasing information.

A new feature of the LaserJet III printer is scalable fonts. There are now two formats or classes of fonts the printer uses: bitmap and scalable. A bitmap font can only be selected for its one, defined size (point size). Scalable fonts, on the other hand, can be selected (scaled) for a range of sizes (refer to the *Bitmap Fonts and Scalable Typefaces* section later in this chapter for additional information). Both classes of fonts are supplied as internal fonts in the printer or are available in cartridge or on disk (soft fonts/typefaces).

Symbol Set

Symbol set identifies the specific set of symbols provided by a font. Each symbol set is defined with a specific application in mind. For example, the legal and math symbol sets were designed to support legal and scientific applications. The following example shows two of the more common symbol sets, PC-8 and Roman-8. The PC-8 symbol set contains some special symbols and line draw characters not included in the Roman-8 symbol set.

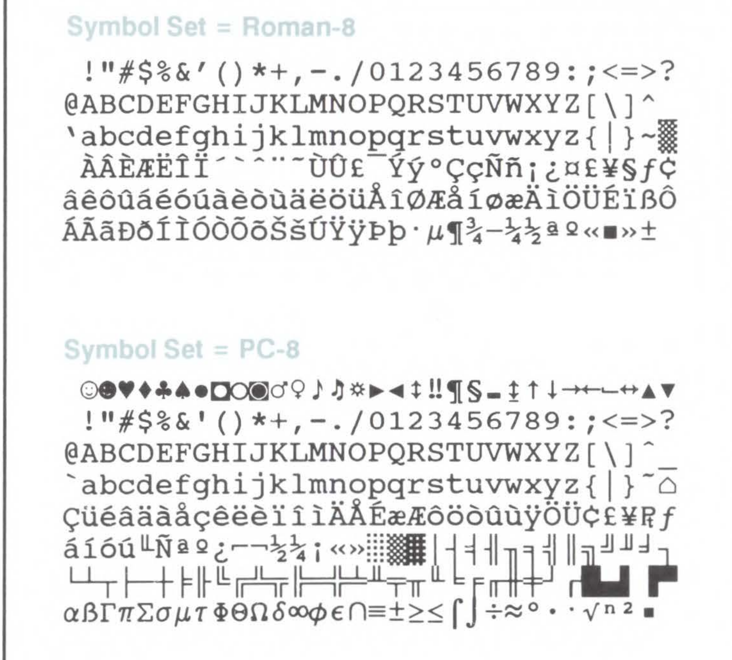


Figure 7-2. Symbol Set

Spacing

Another characteristic that differentiates fonts is spacing. Fonts have either fixed or proportional spacing. Fixed-spaced fonts (Figure 7-3) are those for which the inter-character spacing is constant. Proportionally-spaced fonts (Figure 7-4) are those for which the inter-character spacing varies with the natural shape of a character.

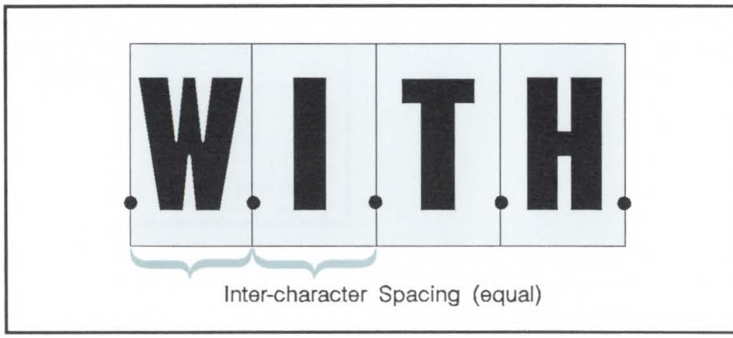


Figure 7-3. Fixed Spacing

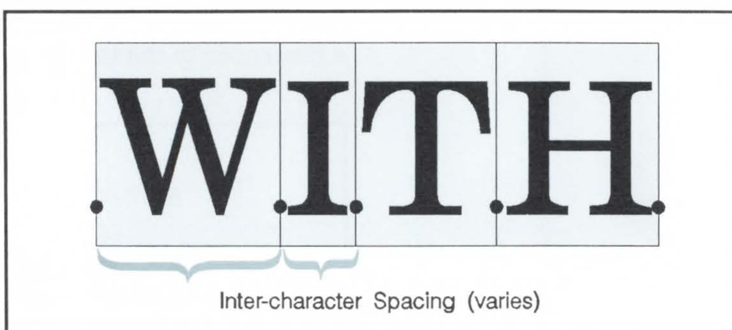


Figure 7-4. Proportional Spacing

Pitch

Pitch describes the number of characters printed in a horizontal inch. Pitch only applies to fixed-spaced fonts since the number of characters per inch varies for proportional fonts.

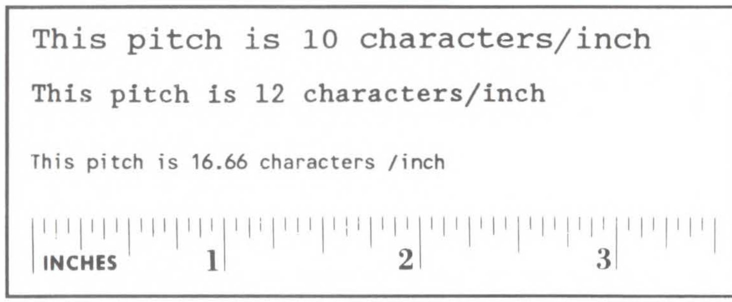


Figure 7-5. Pitch

Height

The height of a font is the measurement of the body of the type in points. A PCL point is $\frac{1}{72}$ inch. The body of the type is slightly larger than the distance from the bottom of a descender to the top of an unaccented capital letter.

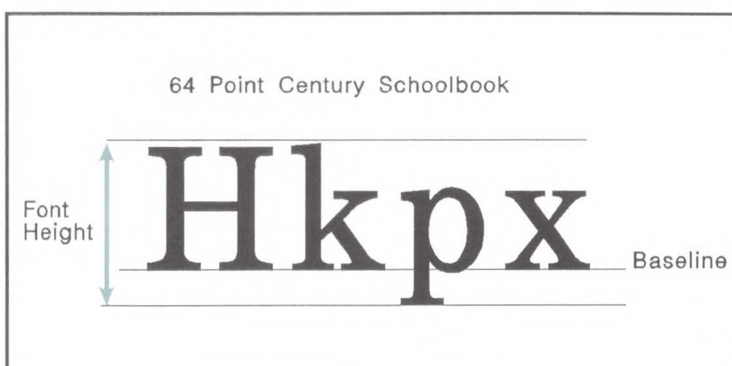


Figure 7-6. Height

Style

Style is defined by three characteristics: posture (upright, italic), width (condensed, normal, expanded, etc.), and structure (solid, outline, shadow etc.). Examples of upright and italic styles are shown.

Upright Upright Upright

Italic Italic Italic Italic

Figure 7-7. Style

Stroke Weight

Stroke weight describes the thickness of the strokes that compose characters. Examples of medium and bold stroke weights are shown in the figure below.

Medium Medium Medium

Bold Bold Bold Bold

Figure 7-8. Stroke Weight

Typeface Family

Typeface identifies the design of the symbols of the font. Each typeface family has unique and distinguishing design characteristics. The following example shows typefaces from various typeface families.

Brush

Uncial

Dom Casual

CG Palacio

University Roman

Futura Book II

Garamond Kursiv

ITC Souvenir Light

ITC Benguiat Book

Microstyle Extended

Figure 7-9. Typeface

Orientation

Orientation defines the position of the logical page and direction of print with respect to the physical page as shown in the following diagram.

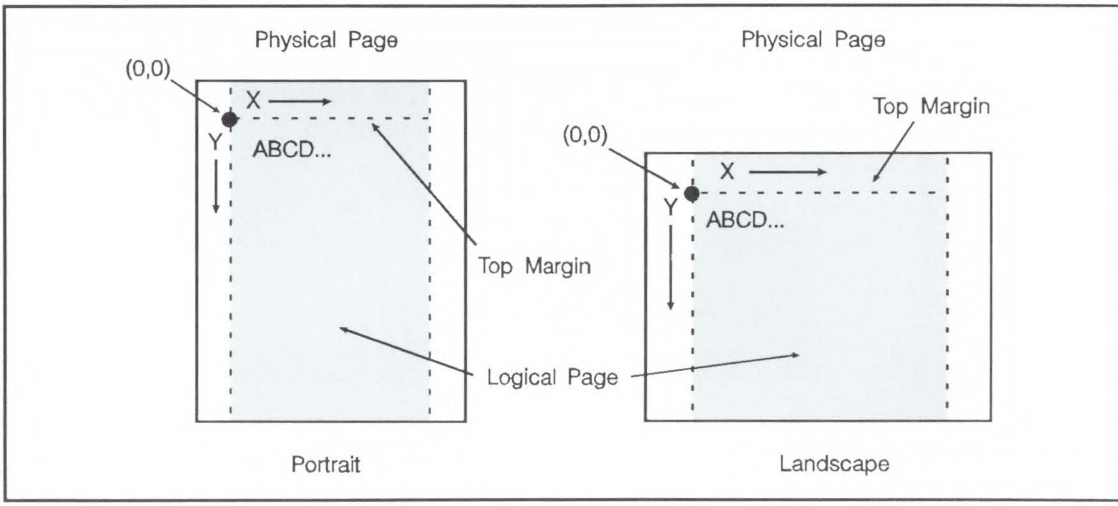


Figure 7-10. Orientation

Some printers require fonts in the orientation which matches the orientation of the page. This is not the case with the LaserJet III printer. This printer automatically rotates fonts to the current orientation; thus, all fonts are available in all four orientations. Orientation is not as important as was with some previous printers which did not rotate fonts.

The orientation of a font becomes important when the amount of user memory available becomes a concern. Internal fonts and cartridge fonts are contained in Read Only Memory (ROM) and do not consume user memory; downloaded fonts, scaled fonts, and rotated fonts are stored in user memory (RAM). If a font is available but not provided in the correct orientation, the printer will rotate that font creating it in user memory (RAM). This consumes user memory which may be required for layout of the page being processed. If a print job will not run as a result of insufficient user memory (a memory overflow error occurs) additional user memory must be made available.

User memory can be saved by providing the desired fonts in the correct orientation. This eliminates the need for the printer to rotate the fonts and, thus, avoid consumption of user memory. In this way, all available user memory can be used for processing the print job.

Bitmap Fonts and Scalable Typefaces

There are two formats or classes of fonts the HP LaserJet III printer uses: bitmap (Figure 7-11) and scalable (Figure 7-12). Previous LaserJet printers supported only bitmap fonts. A bitmap font has a fixed bit pattern (bit-per-dot image) for each character. The size of the character is fixed, depending on the bit pattern. Scalable typefaces, on the other hand, provide a character "outline" for the characters. This "outline" can be scaled by the LaserJet III printer to produce a large range of character sizes.

There is a difference, which should be noted, between a scalable typeface and a scalable font. A **scalable font** is a group of "outline" characters limited to one specific symbol set. For a scalable font, the symbol set, spacing, style, stroke weight, and typeface characteristics are all fixed, height (pitch) is variable (since it is scalable). A **scalable typeface**, on the other hand, is a grouping of "outline" characters of a specific typeface which can produce multiple symbol sets. For a scalable typeface, spacing, style, stroke weight, and typeface characteristics of the font are all fixed, symbol set and height (pitch) are variable.

Note

Scalable fonts and scalable typefaces are selected for printing the same as bitmap fonts; no special, additional selection is required (refer to Chapter 8 for font selection information).

Two scalable typefaces are provided with the printer: CG Times and Univers. Additional scalable typefaces can be obtained on either cartridge or disk. Scalable typefaces cannot be downloaded from a disk to the printer. Only a symbol set bound scalable font can be downloaded. To create a downloadable font from a scalable, disk, typeface requires HP's Type Director 2.0 font management program.

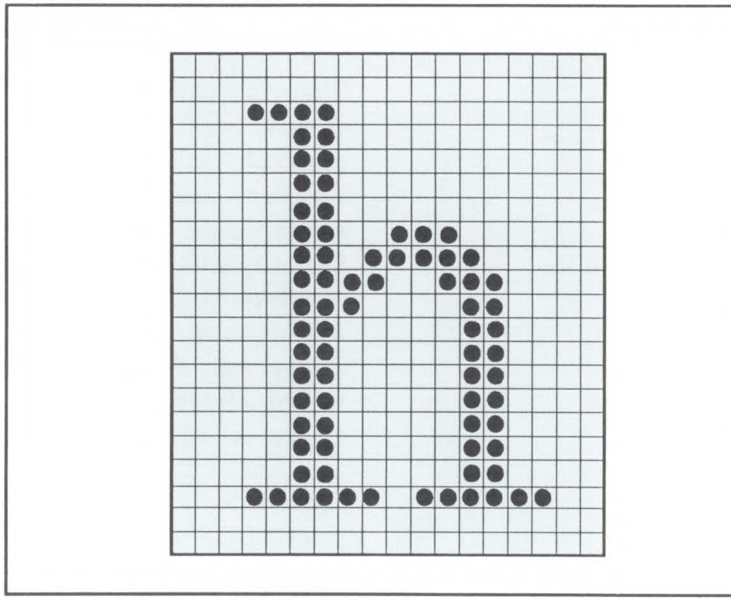


Figure 7-11. Bit Map Character

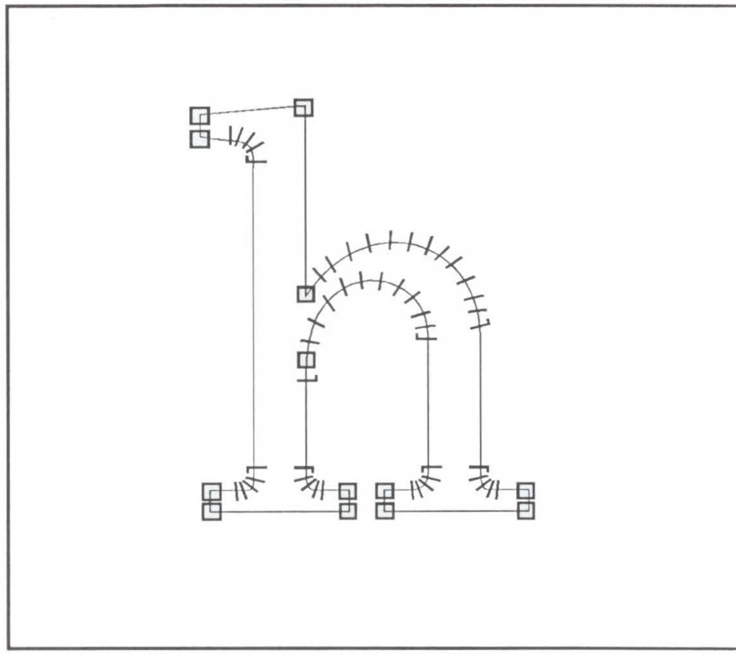


Figure 7-12. Scalable Character

Internal Fonts

The internal bitmap fonts for this printer are listed in Table 7-1 and its internal scalable typefaces are listed in Table 7-2. Both classes of fonts are available in the symbol sets listed in Table 7-3, the scalable typefaces are also available in the additional symbol sets listed in Table 7-4.

Table 7-1. LaserJet III Printer Internal Bitmap Fonts

Typeface	Pitch	Point	Treatment	Native Orientation
Courier*	12	10	medium upright	portrait
Courier	12	10	bold	portrait
Courier	12	10	italic	portrait
Courier	10	12	medium upright	portrait & landscape
Courier	10	12	bold	portrait & landscape
Courier	10	12	italic	portrait
Lineprinter	16.67	8.5	medium upright	portrait & landscape

* The portrait, HP Roman-8, fixed-spaced, 10 pitch, 12 point, upright, medium Courier font is the printer's primary and secondary factory default font. This font is used unless a font cartridge with a default font is installed; or, unless the default symbol set is one listed in Table 7-4 (then CG Times would be the default); or, unless a user default font is selected using the control panel; or, unless font selection commands select a different font.

Table 7-2. LaserJet III Printer Internal Scalable Typeface

Typeface	Pitch	Point	Treatment	Orientation*
CG Times	n/a		medium upright	n/a
CG Times	n/a	.25	italic	n/a
CG Times	n/a	to	bold	n/a
CG Times	n/a	999.75	bold italic	n/a
Univers	n/a		medium upright	n/a
Univers	n/a		italic	n/a
Univers	n/a		bold	n/a
Univers	n/a		bold italic	n/a

* - Scalable typefaces are scaled for the current orientation.

n/a - Not applicable

Table 7-3.
LaserJet III Printer Internal Symbol Sets
(Scalable Typefaces and Bitmapped Fonts)

Symbol Set	Control Panel Display	Symbol Set ID #
Roman-8	ROMAN-8	8U
ECMA-94 Latin 1	EC94-L1	0N
PC-8	PC-8	10U
PC-8 Danish/Norwegian	PC-8 DN	11U
PC-850	PC-850	12U
Legal	LEGAL	1U
ISO IRV*	ISO 2	2U
ISO United Kingdom	ISO 4	1E
ASCII	ISO 6	0U
ISO Swedish/Finnish*	ISO 10	3S
ISO Swedish: names	ISO 11	0S
JIS ASCII*	ISO 14	0K
ISO Italian	ISO 15	0I
ISO Portuguese*	ISO 16	4S
ISO Spanish	ISO 17	2S
ISO German	ISO 21	1G
ISO French*	ISO 25	0F
ISO Chinese*	ISO 57	2K
ISO Norwegian v1	ISO 60	0D
ISO Norwegian v2*	ISO 61	1D
ISO French	ISO 69	1F
ISO Portuguese*	ISO 84	5S
ISO Spanish*	ISO 85	6S
HP German*	German	0G
HP Spanish*	Spanish	1S
* - Not recommended for future use.		

Table 7-4.
LaserJet III Printer Internal Symbol Sets
(for Scalable Typefaces Only)

Symbol Set	Control Panel Display	Symbol Set ID
Ventura Math	VN Math	6M
Ventura International	VN Intl	13J
Ventura US	VN US	14J
PS Math	PS Math	5M
PS Text	PS Text	10J
Math-8	Math-8	8M
Pi Font	Pi Font	15U
Microsoft Publishing	MS Publ	6J
Windows	Windows	9U
DeskTop	DeskTop	7J

Special Effects

The LaserJet III printer allows the user to create special effects when printing characters. These special effects are achieved through the use of the print model feature (refer to Chapter 12, The Print Model) or HP-GL/2 vector graphics (refer to HP-GL/2 Chapters 15-21).

The print model provides a simple means for printing patterned or shaded characters using the printer's predefined cross-hatch/shading patterns. HP-GL/2 vector graphics includes these features plus it provides the ability to print characters in any direction (angle) on a page, print outline characters, even print spiral text. HP-GL/2 also allows anisotropic (non-linear) scaling which produces characters that are stretched in one direction.

8

Font Selection

Introduction

Several characteristics identify a font (as described in Chapter 7, Fonts). These characteristics are used for the selection of a font for printing. These characteristics are identified using the font characteristic selection commands described in this chapter. The characteristics that must be specified include: symbol set, spacing, pitch, height, style, stroke weight, and typeface family. (For example the height characteristic may have a value of 8, 10, 12 points etc.).

To select a font, the printer keeps track of all of the characteristics of the currently selected font. It maintains a **font select table** in its operating code that contains the characteristic values of the current font. After the printer receives a font select command (escape sequence) specifying a new characteristic value, the printer records that characteristic in the table. Whenever the table is updated, receives new characteristic values and text is about to be printed, the printer performs a **font select**. That is, the printer searches the available fonts to select one that matches (or most closely matches) the characteristics as listed in the font select table. Thus a new font is selected.

Note

- **A font must be in the printer to be selected for printing!**
- When a font is selected using the ID #, the characteristics in the Font Select Table are updated to reflect that font's characteristics.

Font Selection Priority

The printer selects a font based on its characteristics, its physical location in the printer, and finally its orientation.

The printer selects a font based on a prioritization of the characteristics. The priority of the characteristics is shown in the following list:

Priority of Characteristics

Symbol Set	highest
Spacing	|
Pitch	|
Point Size	|
Height	|
Style	|
Stroke Weight	|
Typeface Family	|
Location*	|
Orientation	lowest

* Although location is not a font characteristic, it is a font selection consideration. Also the class of a font is considered for selection; a bitmap font has priority over an identical scalable typeface.

When selecting a font, the printer compares the highest priority characteristic in the font select table to the corresponding characteristic of the available fonts. If only one font is available that matches, that font is selected. If several fonts match, the printer compares the next highest priority characteristic to the corresponding characteristic of the available fonts and so on down the list. When only one font remains, that font is selected. However, if after comparison of all the font characteristics, more than one font still remains, then the location of the fonts is considered.

There are three locations where a font may be stored: printer ROM (Read Only Memory), cartridge ROM, and printer RAM (random access memory; user memory). Also, a bitmap font has priority over a scalable font, in the same location provided they are identical in all preceding characteristics. These three font locations are shown below, listed from the highest to lowest priority. The font that matches the characteristics will be selected from the highest priority location.

Soft font (Lowest ID) - Bitmap	Highest
Soft font (Lowest ID) - Scalable	|
Cartridge Font* - Bitmap	|
Cartridge Font* - Scalable	|
Internal Font - Bitmap	|
Internal Font - Scalable	Lowest

* Left cartridge then right cartridge

Finally, the orientation of a font is considered. If two fonts still remain that are similar in all the above characteristics and at the same location, the font with the orientation that matches the orientation of the page is selected. If only one font remains and its orientation is different than the current page, the printer will rotate the font to the orientation of the page. (Page 8-33 summarizes font selection by characteristic.)

Font Select Table

The initial font specification in a job should be made using all of the font characteristics. To select a Roman-8, fixed-spaced, 10 pitch, 12 point, upright, bold, Courier font, for the current page orientation, specify each of the characteristics using font selection escape sequences. Once the characteristics have been specified, the font select table will appear as follows:

Symbol Set	Roman-8
Spacing	Fixed
Pitch	10 cpi
Height	12 point
Style	Upright
Stroke Weight	**Bold**
Typeface Family	Courier

To subsequently select a font with the same characteristics differing only in stroke weight, medium rather than bold, only the stroke weight characteristic must be specified. Note the following change to the printer's font select table:

Symbol Set	Roman-8
Spacing	Fixed
Pitch	10 cpi
Height	12 point
Style	Upright
Stroke Weight	**Medium**
Typeface Family	Courier

In general, when specifying a font, only the characteristics of the new font that differ from those of the previously designated font must be sent (the short, font selection method); however, **it is recommended that all of the characteristics be sent to ensure that the correct font is selected.**

Note

The HP LaserJet III printer can print any number of distinct fonts per page, limited only by available memory.

Primary and Secondary Fonts

The printer maintains two independent font select tables for use in selecting a primary font and a secondary font. All of the characteristics previously described apply to both tables. This provides access to two distinct fonts, only one of which is selected at a given time. To alternate between the primary and the secondary font, the control codes `SI` (Shift In ; ASCII 15) and `SO` (Shift Out ; ASCII 14) are used. The font described by the primary table is designated by the `SI` control code; the font described by the secondary table is designated by the `SO` control code.

The factory default state is primary font designated.

Symbol Set

Symbol Set command identifies the specific symbols in a font. Symbols refer to the specific alphabetic, numeric, punctuation symbols, and/or any other symbols that may be included.

ᴱc (ID Primary Symbol Set

ID = Symbol Set ID number (see Table 8-1)

ᴱc) ID Secondary Symbol Set

ID = Symbol Set ID number (see Table 8-1)

If the specified symbol set does not exist, the default symbol set will be used.

The factory default primary and secondary symbol set is Roman-8. However, the user may select a user default symbol set from the printer control panel, printing menu.

The primary and secondary user default symbol sets are implicitly set when the user default font is selected using the control panel, printing menu (refer to the LaserJet III Printer User's Manual).

Table 8-1 lists HP's PCL Printer Language defined symbol sets.

Example

To specify ASCII as the symbol set for the primary font, send:

ᴱc(0U

To specify Roman-8 as the symbol set for the secondary font, send:

ᴱc)8U

Table 8-1. Symbol Set Values

Symbol Set Name	Symbol Set ID
Default Set	0@
Math-7	0A
Line Draw-7	0B
HP Large Characters (264x Terminals)	0C
ISO 60: Danish/Norwegian	0D
ISO 61: Norwegian version 2*	1D
Roman Extensions*	0E
ISO 4: United Kingdom	1E
ISO 25: French*	0F
ISO 69: French	1F
HP German*	0G
ISO 21: German	1G
Greek-8	8G
Hebrew-7	0H
Hebrew-8	8H
ISO 15: Italian	0I
Microsoft Publishing	6J
DeskTop	7J
Document	8J
PS Text	10J
Ventura International	13J
Ventura US	14J
ISO 14: JIS ASCII*	0K
ISO 13: Katakana*	1K
ISO 57: Chinese*	2K
Kana-8	8K
Korean-8	9K
Line Draw-7 (Same as 0B)	0L
HP Block Characters	1L
Tax Line Draw	2L
Line Draw-8	8L

Continued on next page

Table 8-2. Symbol Set Values - continued

Symbol Set Name	Symbol Set ID
Ventura ITC Zapf Dingbats	9L
PS ITC Zapf Dingbats	10L
ITC Zapf Dingbats Series 100	11L
ITC Zapf Dingbats Series 200	12L
ITC Zapf Dingbats Series 300	13L
Math-7 (Same as 0A)	0M
Tech-7	1M
PS Math	5M
Ventura Math	6M
Math-8	8M
ECMA-94 Latin 1 (ISO 8859/1)	0N
ECMA-94 Latin 2 (ISO 8859/2)	2N
ECMA-128 Latin 5 (ISO 8859/9)	5N
ECMA-113/88 Latin/Cyrillic (ISO 8859/5.2)	10N
OCR A	0O
OCR B	1O
OCR M	2O
APL (Typewriter Paired)	0P
APL (Bit Paired)	1P
Specials	xQ
Cyrillic ASCII (ECMA-113/86, ISO 8859/5)	0R
Cyrillic	1R
PC Cyrillic	3R
ISO 11: Swedish for Names	0S
HP Spanish*	1S
ISO 17: Spanish	2S
ISO 10: Swedish*	3S
ISO 16: Portuguese*	4S
ISO 84: Portuguese*	5S
ISO 85: Spanish*	6S
HP European Spanish	7S
HP Latin Spanish	8S

Continued on next page

Table 8-3. Symbol Set Values - continued

Symbol Set Name	Symbol Set ID
HP-GL Download	16S
HP-GL Drafting	17S
HP-GL Special Symbols	18S
Thai-8	0T
Turkish-8	8T
ISO 6: ASCII	0U
Legal	1U
ISO 2: International Reference Version*	2U
HPL Language Set	5U
OEM-1	7U
Roman-8	8U
Windows	9U
PC-8	10U
PC-8 D/N (Danish/Norwegian)	11U
PC-850	12U
PC-852	17U
Pi Font	15U
Arabic (McKay's version)	0V
Arabic-8	8V
3 of 9 Barcode	0Y
Industrial 2 of 5 Barcode	1Y
Matrix 2 of 5 Barcode	2Y
Interleaved 2 of 5 Barcode	4Y
CODABAR Barcode	5Y
MSI/Plessey Barcode	6Y
Code 11 Barcode	7Y
UPC/EAN Barcode	8Y
USPS Zip	15Y

* Not recommended for future use. This symbol set is of limited usage and is being discontinued.

ISO Symbol Sets

The printer provides several ISO (International Organization for Standardization) symbol sets to support European languages. Each ISO symbol set is a unique ordering of symbols contained in the Roman-8 symbol set (see Table 8-2). The printer automatically generates the requested ISO symbol set from an HP Roman-8 symbol set.

Example

To select the ISO 69 French symbol set for the primary font, send:

$^{E}_{C}$(1F

Table 8-4. ISO Substitution Characters

<table>
<tr><th></th><th></th><th></th><th colspan="12">DECIMAL CHARACTER EQUIVALENTS</th></tr>
<tr><th>ISO</th><th>Name</th><th>ID</th><th>35</th><th>36</th><th>64</th><th>91</th><th>92</th><th>93</th><th>94</th><th>96</th><th>123</th><th>124</th><th>125</th><th>126</th></tr>
<tr><td>6</td><td>ASCII</td><td>0U</td><td>#</td><td>$</td><td>@</td><td>[</td><td>\</td><td>]</td><td>^</td><td>‘</td><td>{</td><td>|</td><td>}</td><td>~</td></tr>
<tr><td>2</td><td>ISO IRV *</td><td>2U</td><td>#</td><td>¤</td><td>@</td><td>[</td><td>\</td><td>]</td><td>^</td><td>`</td><td>{</td><td>|</td><td>}</td><td>¯</td></tr>
<tr><td>4</td><td>ISO United Kingdom</td><td>1E</td><td>£</td><td>$</td><td>@</td><td>[</td><td>\</td><td>]</td><td>^</td><td>`</td><td>{</td><td>|</td><td>}</td><td>¯</td></tr>
<tr><td>25</td><td>ISO French *</td><td>0F</td><td>£</td><td>$</td><td>à</td><td>°</td><td>ç</td><td>§</td><td>^</td><td>`</td><td>é</td><td>ù</td><td>è</td><td>¨</td></tr>
<tr><td>69</td><td>ISO French</td><td>1F</td><td>£</td><td>$</td><td>à</td><td>°</td><td>ç</td><td>§</td><td>^</td><td>µ</td><td>é</td><td>ù</td><td>è</td><td>¨</td></tr>
<tr><td></td><td>German *</td><td>0G</td><td>£</td><td>$</td><td>§</td><td>Ä</td><td>Ö</td><td>Ü</td><td>^</td><td>`</td><td>ä</td><td>ö</td><td>ü</td><td>ß</td></tr>
<tr><td>21</td><td>ISO German</td><td>1G</td><td>#</td><td>$</td><td>§</td><td>Ä</td><td>Ö</td><td>Ü</td><td>^</td><td>`</td><td>ä</td><td>ö</td><td>ü</td><td>ß</td></tr>
<tr><td>15</td><td>ISO Italian</td><td>0I</td><td>£</td><td>$</td><td>§</td><td>°</td><td>ç</td><td>é</td><td>^</td><td>ù</td><td>à</td><td>ò</td><td>è</td><td>ì</td></tr>
<tr><td>14</td><td>JIS ASCII *</td><td>0K</td><td>#</td><td>$</td><td>@</td><td>[</td><td>¥</td><td>]</td><td>^</td><td>`</td><td>{</td><td>|</td><td>}</td><td>¯</td></tr>
<tr><td>57</td><td>ISO Chinese *</td><td>2K</td><td>#</td><td>¥</td><td>@</td><td>[</td><td>\</td><td>]</td><td>^</td><td>`</td><td>{</td><td>|</td><td>}</td><td>¯</td></tr>
<tr><td>10</td><td>ISO Swedish *</td><td>3S</td><td>#</td><td>¤</td><td>@</td><td>Ä</td><td>Ö</td><td>Å</td><td>^</td><td>`</td><td>ä</td><td>ö</td><td>å</td><td>¯</td></tr>
<tr><td>11</td><td>ISO Swedish names</td><td>0S</td><td>#</td><td>¤</td><td>É</td><td>Ä</td><td>Ö</td><td>Å</td><td>Ü</td><td>é</td><td>ä</td><td>ö</td><td>å</td><td>ü</td></tr>
<tr><td></td><td>Spanish *</td><td>1S</td><td>#</td><td>$</td><td>@</td><td>¡</td><td>Ñ</td><td>¿</td><td>°</td><td>`</td><td>{</td><td>ñ</td><td>}</td><td>˜</td></tr>
<tr><td>17</td><td>ISO Spanish</td><td>2S</td><td>£</td><td>$</td><td>§</td><td>¡</td><td>Ñ</td><td>¿</td><td>^</td><td>`</td><td>°</td><td>ñ</td><td>ç</td><td>˜</td></tr>
<tr><td>85</td><td>ISO Spanish: *</td><td>6S</td><td>#</td><td>$</td><td>·</td><td>¡</td><td>Ñ</td><td>Ç</td><td>¿</td><td>`</td><td>´</td><td>ñ</td><td>ç</td><td>¨</td></tr>
<tr><td>16</td><td>ISO Portuguese *</td><td>4S</td><td>#</td><td>$</td><td>§</td><td>Ã</td><td>Ç</td><td>Õ</td><td>^</td><td>`</td><td>ã</td><td>ç</td><td>õ</td><td>°</td></tr>
<tr><td>84</td><td>ISO Portuguese: *</td><td>5S</td><td>#</td><td>$</td><td>´</td><td>Ã</td><td>Ç</td><td>Õ</td><td>^</td><td>`</td><td>ã</td><td>ç</td><td>õ</td><td>˜</td></tr>
<tr><td>60</td><td>ISO Norwegian v1</td><td>0D</td><td>#</td><td>$</td><td>@</td><td>Æ</td><td>Ø</td><td>Å</td><td>^</td><td>`</td><td>æ</td><td>ø</td><td>å</td><td>¯</td></tr>
<tr><td>61</td><td>ISO Norwegian v2 *</td><td>1D</td><td>§</td><td>$</td><td>@</td><td>Æ</td><td>Ø</td><td>Å</td><td>^</td><td>`</td><td>æ</td><td>ø</td><td>å</td><td>|</td></tr>
</table>

* Not recommended for future use.

Note

HP font cartridge products A through H, J through N, P through R, T through Y and HP soft font products AD, AF, and DA support a subset of the new HP Roman-8 symbol set. Characters with decimal character codes 177, 178, and 242 to 245 have since been added. These characters include:

Ý ý · μ ¶ ¾

Refer to Appendix A, symbol set tables, for additional symbol set information.

Spacing

Inter-character spacing can be specified as either proportional or fixed.

^E_C **(s # P** - Primary spacing

^E_C **) s # P** - Secondary spacing

\# = 0 - Fixed spacing

1 - Proportional spacing

When proportional spacing is specified and a proportionally-spaced font is not available (in the requested symbol set), a fixed pitch font with the current pitch specification will be selected.

For fixed-spaced bitmap fonts both pitch and height (point size) are used for selection of font character size. However, for fixed-spaced scalable fonts only pitch is used. For proportional bitmap and scalable fonts only height is used for selection of font character size.

The user default primary and secondary spacings are implicitly set by selection of a user default font from the control panel printing menu (refer to the LaserJet III Printer User's Manual).

Example

To specify proportional spacing for the primary font, send:

^E_C**(s1P**

To specify fixed spacing for the secondary font, send:

^E_C**)s0P**

Pitch

The Pitch command designates the horizontal spacing of a fixed-spaced (bitmap or scalable) font in terms of the number of characters per inch. This characteristic is ignored when selecting a proportionally-spaced (bitmap or scalable) font but is saved in the font select table and available when fixed-spaced font is selected.

$^{E}_{C}$ **(s # H** - Primary pitch

$^{E}_{C}$ **) s # H** - Secondary pitch

= Pitch in characters/inch

The value field (#) is valid to two decimal places.

If a pitch is specified that is not available, the next greater available pitch will be selected. If no greater value is available, the closest available lesser value will be selected.

The factory default primary and secondary pitches are ten characters per inch.

The user default primary and secondary pitches are implicitly set by selection of a user default font from the control panel printing menu (refer to the LaserJet III Printer User's Manual).

For a fixed-spaced scalable font, any specified pitch is available in the supported PCL range (576 to .10 characters/inch). However, the pitch value is actually converted to a corresponding point size (height) value which is scaled by the printer. Since fonts are scaled in quarter point increments (one quarter point increment is about one dot at 300 dots per inch), the pitch of the font created may not be exactly the pitch requested (plus or minus one dot). The formula the printer used to convert pitch values to point size values for scalable fixed-pitch fonts, is shown by the following equation.

$$\text{Height} = \frac{1}{\text{Desired Pitch} \times \left(\dfrac{\text{Master Design Pitch in Font Header}}{\text{Scale Factor}} \right) \times 0.01383}$$

The requested pitch value is then plugged into the range from .25 point to 999.75 point, with the closest point size being selected. For example, the pitch in the font header of a Courier scalable font is 5291 for a scale factor of 8782. If the requested pitch is 10, then using the above equation, LaserJet III printer calculates the corresponding point size as follows:

$$\frac{1}{10.00} \times \frac{5291}{8782} \times 0.01383 = 12.00 \text{ point}$$

Example

To specify 10 pitch for the primary font, send:

$^{E}_{C}$(s10H

To specify 16.66 pitch for the secondary font, send:

$^{E}_{C}$)s16.66H

Height

The Height command specifies the height of the font in points. This characteristic is ignored when selecting a fixed-spaced scalable font, however, the value is saved and available when a proportionally-spaced font is selected.

$^E{}_C$ **(s # V** - Primary Height

$^E{}_C$ **) s # V** - Secondary Height

= Height in points

The value field (#) is valid to two decimal places. If the requested height is unavailable, the closest height will be selected. All bitmap fonts whose heights are within a quarter point of the specified height are considered to have the specified height. For scalable fonts the value field is from .25 to 999.75 points in increments of 0.25 point (anything $\frac{1}{8}$ point or above is rounded up; anything below $\frac{1}{8}$ is rounded down).

The factory default primary and secondary heights are 12 point. A PCL typographic point is $\frac{1}{72}$ (0.01389) inch.

The user default primary and secondary heights are implicitly set by selection of a user default font from the control panel printing menu (refer to the LaserJet III Printer User's Manual).

Note

If a scalable font is selected using an ID number, the Height command should be sent to specify the point size; otherwise, the size will be determined by the height characteristic value of the, former, font (as listed in the font select table).

Example

To specify a height of 12 points for the primary font, send:

$^{E}{}_{C}$(s12V

To specify a height of 14.4 points for the secondary font, send:

$^{E}{}_{C}$)s14.4V

If the above sequence was used for selection of a scalable font the actual font would be scaled to 14.5 points.

Style

The Style command identifies the posture of a character, its width and structure of the font symbols.

^E_C (s # S - Primary Style

^E_C) s # S - Secondary Style

Style values for the most common typefaces are listed in Table 8-3. Additional style values may also be obtained from the related font documentation provided with HP's font products.

Table 8-5. Common Font Styles

Value	Font Styles
0	(upright, solid)
1	italic
4	condensed
5	condensed italic
8	compressed, or extra condensed
24	expanded
32	outline
64	inline
128	shadowed
160	outline shadowed

Note

- With the introduction of the LaserJet IID printer, Hewlett-Packard expanded the style values (in the Font Descriptor typeface value field) from a one-byte to a two-byte value field, expanding the typeface range from 0-255 to 0-32767. This expansion allows for additional styles.
- For selection of style, an exact match is required. If there is no match, this characteristic is ignored, but, stored in the font select table, available for the next selection.

Example

To specify an upright style for the primary font, send:

^E_C(s0S

To specify an italic style for the secondary font, send:

^E_C)s1S

Stroke Weight

The Stroke Weight command designates the thickness of the strokes that compose the characters of a font.

^E_C **(s # B** - Primary stroke weight

^E_C **) s # B** - Secondary stroke weight

The value field (#) specifies the thickness of the strokes used in the design of the font. The supported stroke weight values are −7 through 7. The thinnest font available is −7; the thickest font available is +7. The standard stroke weight for a medium font is 0; the standard stroke weight for a bold font is 3; the standard stroke weight for a light font is −3.

Table 8-3. Stroke Weights

Value (#)	Typeface
-7	Ultra Thin
-6	Extra Thin
-5	Thin
-4	Extra Light
-3	**Light**
-2	Demi Light
-1	Semi Light
0	**Medium, Book, or Text**
1	Semi Bold
2	Demi Bold
3	**Bold**
4	Extra Bold
5	Black
6	Extra Black
7	Ultra Black

If the specified stroke weight is greater than or equal to 0 and is not available, the next thicker available stroke weight will be selected. If no thicker stroke weight is available, the closest available thinner stroke weight will be selected.

If the specified stroke weight is less than zero and is not available, the next thinner available stroke weight will be selected. If no thinner stroke weight is available, the closest available thicker stroke weight will be selected.

The factory default primary and secondary stroke weights are zero (medium).

The user default primary and secondary stroke weights are implicitly set by selection of a user default font from the control panel printing menu (refer to the LaserJet III Printer User's Manual).

Example

To specify a bold stroke weight for the primary font, send:

$^{E}{}_{C}$(s3B

To specify a medium stroke weight for the secondary font, send:

$^{E}{}_{C}$)s0B

Note

Many typefaces were designed for advertising use, and a "medium" was used to describe the standard treatment. Later, additional treatments were designed for text use. Therefore, the typeface treatment designation "medium" may not always take a PCL value of Ø. This weight value may be assigned to "book" or "text" treatment instead.

Typeface Family

The Typeface Family command designates the design of the font.

$^{E}_{C}$ **(s # T** - Primary typeface family

$^{E}_{C}$ **) s # T** - Secondary typeface family

= Typeface family value (see Table 8-4 on the following page for values)

If the value field (#) specifies a typeface that is unavailable, this characteristic is ignored during font selection.

The factory default primary and secondary typefaces are Courier.

The user default primary and secondary typefaces are implicitly set by selection of a user default font from the control panel printing menu (refer to the LaserJet III Printer User's Manual).

8 Font Selection

Two-Byte Typeface Values

With the introduction of the LaserJet IID printer, Hewlett-Packard expanded the typeface value field (in the Font Descriptor) from a one-byte to a two-byte value field, thus, expanding the typeface range from 0-255 to 0-32767. This expansion allows for additional typefaces.

The two-byte numbers include the one-byte number values. That is, in the font descriptor, the two-byte number (or typeface word) consists of the typeface LSB byte (which is the one-byte value) and the typeface MSB byte (which is the new extension to the typeface field, added with the introduction of the IID printer). The typeface LSB byte contains the one-byte typeface value. The MSB byte adds identification of a font vendor plus identification for that vendors version to the typeface value should the vendor create an updated version of the typeface. Refer to Chapter 10, Font Creation, Typeface, for additional information.

Since the two-byte values are based on one-byte values, the one-byte (or two-byte) values, in some cases, may be used to select a font described by a two-byte (or one-byte) value. For example, AGFA Compugraphic's version of Univers value is 4148. This font might be selected using either the two-byte value (4148) or the earlier typeface family number 52 (one-byte value). The type of typeface value (one-byte or two-byte) used to select the font typeface type (one-byte or two-byte) varies across the LaserJet printer line. The typeface, selection, compatibility for these new values is identified for the various LaserJet printers in Table 8-5.

Note

The two-byte typeface values, listed in Table 8-4, should be used for future typeface selection.

Example

To specify CG Times as the typeface family of the primary font, send:

^E_C(s4101T

To specify Letter Gothic as the typeface family of the secondary font, send:

^E_C)s6T

This table represents the typeface values assigned to AGFA Compugraphic version 1 typefaces.

Table 8-4. Typeface Two-Byte Values*

Two-Byte Value	Typeface Family	One-Byte Value
4168	Antique Olive	72
4127	ITC Avant Garde	31
4135	Baskerville	39
4158	ITC Benguiat	62
4149	CG Bodoni	53
4143	ITC Bookman	47
4128	Brush	32
4119	CG Century Schoolbook	23
4159	ITC Cheltenham	63
4135	ITC Clearface	57
4142	Cooper	42
4157	Dom Casual	61
4172	ITC Eras	76
4110	Futura II	14
4126	ITC Galliard	30
4197	Garamond	18

Continued on next page.

* Additional typefaces will be available in the future. Some typefaces listed here are not or may not be available as products from Hewlett-Packard. One-byte values are not recommended for future use, but are provided for PCL backwards compatibility purposes.

Table 8-4. Typeface Two-Byte Values*
(continued)

Two-Byte Value	Typeface Family	One-Byte Value
4147	Gill Sans	51
4138	CG Goudy Old Style	42
4123	ITC Korina	27
4174	ITC Lubalin Graph	78
4151	CG Melliza	55
4175	Microstyle	79
4113	CG Omega	17
4111	CG Palacio	15
4155	Park Avenue	59
4193	Revue	97
4150	Rockwell	54
4112	ITC Souvenir	16
4152	ITC Tiffany	56
4101	CG Times	5
4100	CG Triumvirate	4
4169	Uncial	73

* Additional typefaces will be available in the future. Some typefaces listed here are not or may not be available as products from Hewlett-Packard. One-byte values are not recommended for future use, but are provided for PCL backwards compatibility purposes.

Table 8-5. One-Byte/Two-Byte Typeface Selection Compatibility

Typeface Selection Command $^{E}{}_{C}$(s#T	Printer Font One-byte/ Two-byte Typeface Descriptor	III	IIP	IID	series II***
Two-Byte	Two-Byte	Typeface Selected	Typeface Selected	Typeface Selected	Ignores typeface (value field too large)
Two-Byte	One-Byte	Ignores typeface for font selection	Ignores typeface for font selection	Ignores typeface for font selection	Ignores typeface for font selection (value field too large)
One-Byte	Two-Byte	Typeface** selected	Ignores typeface for font selection	Ignores typeface value for font selection.	Typeface* may be selected (font descriptor typeface MSB field is ignored)
One-Byte	One-Byte	Typeface Selected	Typeface Selected	Typeface Selected	Typeface Selected

This table assumes that the typeface specified is available in the printer.

* The MSB typeface byte in the Font Descriptor is ignored by the printer, only the LSB typeface byte is read.

** If two fonts are available in the printer that have the same value in the lower (LSB) byte of the font descriptor typeface field (such as 4112 and 4244), the typeface selected will be one of these selected at random.

*** The LaserJet series II printer will only accept a typeface selection value field range of 0-255.

Table 8-6. Typeface Values*

Value (One-Byte)	Typeface**	Value (One-Byte)	Typeface**
0	Line Printer	1	Pica
2	Elite	3	Courier
4	Helvetica	5	Times Roman
6	Letter Gothic	7	Script
8	Prestige	9	Caslon
10	Orator	11	Presentation
12	Helvetica Condensed***	13	Serifa
14	Futura	15	Palatino
16	ITC Souvenir	17	Optima
18	ITC Garamond	19	Cooper Black***
20	Coronet	21	Broadway
22	Bauer Bodoni Black Condensed***	23	Century Schoolbook
24	University Roman	25	Helvetica Outline***
26	Futura Condensed***	27	ITC Korinna
28	Naskh	29	Cloister Black
30	ITC Galliard	31	ITC Avant Garde Gothic
32	Brush	33	Blippo
34	Hobo	35	Windsor
36	Helvetica Compressed***	37	Helvetica Extra Compressed***
38	Peignot	39	Baskerville
40	ITC Garamond Condensed***	41	Trade Gothic
42	Goudy Old Style	43	ITC Zapf Chancery
44	Clarendon	45	ITC Zapf Dingbats

* Additional typefaces will be available in the future.

** These typeface names may be registered trademarks of a third party. Use of these fonts may be conditional upon a license grant from the owners of the fonts. Hewlett-Packard makes no representation as to the quality or performance of the fonts, and any reference to the fonts does not grant any license or right to use the fonts.

*** These typeface codes are soon to be reassigned, since they specify treatments of a typeface that may now be expressed in the style value. Not recommended for future use.

Continued on next page.

Table 8-7. Typeface Values* Continued

Value (One-Byte)	Typeface**	Value (One-Byte)	Typeface**
46	Cooper	47	ITC Bookman
48	Stick	49	HP-GL Drafting
50	HP-GL Spline	51	Gill Sans
52	Univers	53	Bodoni
54	Rockwell	55	Melior
56	ITC Tiffany	57	ITC Clearface
58	Amelia	59	Park Avenue
60	Handel Gothic	61	Dom Casual
62	ITC Benguiat	63	ITC Cheltenham
64	Century Expanded	65	Franklin Gothic
66	Franklin Gothic Expressed***	67	Franklin Gothic Extra Condensed***
68	Plantin	69	Trump Mediaeval
70	Futura Black		
72	Antique Olive	73	Uncial
74	ITC Bauhaus	75	Century Oldstyle
76	ITC Eras	77	Friz Ouadrata (ITC)
78	ITC Lubalin Graph	79	Eurostile
80	Mincho	81	ITC Serif Gothic
82	Signet Roundhand	83	Souvenir Gothic
84	Stymie	87	Bernhard Modern
89	Excelsior	90	Gando Ronda Script

* Additional typefaces will be available in the future.

** These typeface names may be registered trademarks of a third party. Use of these fonts may be conditional upon a license grant from the owners of the fonts. Hewlett-Packard makes no representation as to the quality or performance of the fonts, and any reference to the fonts does not grant any license or right to use the fonts.

*** These typeface codes are soon to be reassigned, since they specify treatments of a typeface that may now be expressed in the style value. Not recommended for future use.

Continued on next page.

Table 10-2. Typeface Values* Continued

Value (One-Byte)	Typeface**	Value (One-Byte)	Typeface
91	Ondine	92	P.T. Barnum
93	Kaufman	94	ITC Bolt Bold
96	Helvetica Monospaced***	97	Revue
101	Garamond (Stempel)	102	Garth Graphic
103	ITC Ronda	104	OCR-A
		106	Englische Schreibschrift
107	Flash	108	Gothic Outline (URW)
109	Stencil (ATF)	110	OCR-B
111	Akzidenz-Grotesk	112	TD Logos
113	Shannon	114	ITC Century
152	Maru Gosikku	153	Gossikku
154	Socho	155	Kyokasho
156	Kaisho	157	Traditional Arabic Script
158	Arabic News		
160	Devanagari (Hindi)	161	Krishna (Gujarati)
162	Ranjit (Gurmukhi)	163	Raj Raja (Tamil)
164	Gyosho	165	Hebrew
166	Nork	167	Ousbouh
168	Koufi		
261	Greek Times		

* Additional typefaces will be available in the future.

** These typeface names may be registered trademarks of a third party. Use of these fonts may be conditional upon a license grant from the owners of the fonts. Hewlett-Packard makes no representation as to the quality or performance of the fonts, and any reference to the fonts does not grant any license or right to use the fonts.

*** These typeface codes are soon to be reassigned, since they specify treatments of a typeface that may now be expressed in the style value. Not recommended for future use.

Orientation

The Orientation command ($^{E}_{C}$**&ℓ#O**)designates the position of the logical page and direction of print with respect to the physical page. In earlier LaserJet printers this command was required to specify a font's orientation that matched that of the logical page. However, the LaserJet III printer automatically rotates the font to match the page orientation. Therefore all fonts are available in all page orientations. Because of auto-rotation, this command is no longer required for font selection. Refer to Chapter 6, Page Control Commands, for a description of the Orientation Command.

Font Selection Examples

This example illustrates how to select a primary, bitmap, Courier, fixed-spaced font with the following characteristics (note that all of the font characteristics are specified):

CHARACTERISTIC	VALUE	ESCAPE SEQUENCE
Symbol set	ASCII	**EC(0U**
Spacing	Fixed	**EC(s0P**
Pitch	10 cpi	**EC(s10H**
Height	12 point	**EC(s12V**
Style	Upright	**EC(s0S**
Stroke weight	Bold	**EC(s3B**
Typeface family	Courier	**EC(s3T**

The following escape sequences could be sent to the printer to select a primary font with the above characteristics:

EC(0U EC(s0P EC(s10H EC(s12V EC(s0S EC(s3B EC(s3T

The previous sequence can be shortened by combining sequences that have the same two characters following the EC character.

EC(0UEC(s0p10h12v0s3b3T

This example illustrates how to select a primary, scalable, CG Times, proportional-spaced font with the following characteristics (note that all of the font characteristics are specified except pitch which is not required for a proportional font):

CHARACTERISTIC	VALUE	ESCAPE SEQUENCE
Symbol set	ASCII	**Ec(0U**
Spacing	Proportional	**Ec(s1P**
Height	14.25 point	**Ec(s14.25V**
Style	Upright	**Ec(s0S**
Stroke weight	Bold	**Ec(s3B**
Typeface family	CG Times	**Ec(s4101T**

The following escape sequences could be sent to the printer to select a primary font with the above characteristics:

Ec(0U Ec(s1P Ec(s14.25V Ec(s0S Ec(s3B Ec(s4101T

Combining the above sequences results in the following:

Ec(0UEc(s1p14.25v0s3b4101T

Once the font has been selected as explained above, selecting another font with similar characteristics only requires changing the characteristics that are different. For example, to specify a font differing only in style (italic) and stroke weight (medium), only style and stroke weight need to be specified, as shown below:

$^{E}_{C}$(s1S$^{E}_{C}$(s0B

or combining commands would produce:

$^{E}_{C}$(s1s0B

Note

- If an escape sequence does not contain a value field, the printer assumes a value of zero; therefore, the command **$^{E}_{C}$(sB** could be sent to the printer instead of **$^{E}_{C}$(s0B**.
- Sending shortened font selection commands often result in selection of an unexpected font. This is due to the user not tracking previously specified characteristics and their selection priority in relation to the current font selection. Thus, it is recommended that all of the characteristics be sent to ensure that the correct font is selected.

Summary of Font Selection by Characteristic

The following summarizes the procedure the printer uses to select a font. Basically selection by characteristic is an elimination process. The nine steps are performed in the following order.

1. **Symbol Set** - if the specified symbol set exists, that symbol set is selected; otherwise, the default symbol set is selected.
2. **Spacing** - if proportional spacing is specified and available, proportional spacing is selected. If proportional spacing is specified but is not available, fixed spacing is selected in the current pitch. (A proportionally-spaced font is always available in the printer but it may not be available in the specified symbol set.)
3. **Pitch** - applies only to fixed spaced fonts. If fixed spacing is specified and available, fixed spacing in the specified pitch is selected. If the specified pitch is not available, the next greater available pitch is selected. If no greater pitch is available, the closest available lesser pitch is selected. If fixed spacing is specified but is not available, a proportional-spaced font is selected and the pitch characteristic is ignored.

Note

- For a fixed-spaced scalable font any specified pitch is available. The Height selection command is not required. The printer calculates the appropriate height to correspond to the pitch and maintains the aspect ratio of the font. The user's height request is recorded in the printers font select table for later font selections but is ignored for this selection.
- The pitch of a 16.66 cpi font is greater than the pitch of a 12 cpi font, and the pitch of a 10 cpi font is lesser than the pitch of a 12 cpi font.

- **Height** - the closest height available from the remaining fonts is selected. The closest height is in terms of absolute difference. All bitmap fonts whose heights are within a quarter point of the specified height are considered to have the specified height. For example, if the printer has 6, 8, and 12 point fonts and the specified height is 10, both 8 and 12 point fonts are picked for the next selection criterion. Similarly, if 9.8, 10.2, and 10.00 point fonts were available, all three would be picked for the next selection criteria.

Note

For proportionally-spaced scalable fonts, any specified height is available to the nearest quarter point. For fixed-spaced scalable fonts, the designated height is recorded, and the height is calculate from the requested pitch.

- **Style** - if the specified style is available in the remaining fonts, that style is selected; otherwise, this characteristic is ignored.
- **Stroke Weight** - if the specified stroke weight is available in the remaining fonts, that stroke weight is selected. If the specified stroke weight is greater than or equal to 0 and is not available, the next thicker available stroke weight will be selected. If no thicker stroke weight is available, the closest available thinner stroke weight will be selected.

  If the specified stroke weight is less than 0 and is not available, the next thinner available stroke weight will be selected. If no thinner stroke weight is available, the closest available thicker stroke weight will be selected.
- **Typeface Family** - if the requested typeface is available in the remaining fonts, that typeface is selected; otherwise, this characteristic is ignored.

- **Location** - if after performing all the preceding steps, more than one font remains, the available font from the highest priority font location is selected. The priority of the font locations are:

Soft Font (Lowest ID first) - Bitmap	highest
Soft Font (Lowest ID first) - Scalable	|
Cartridge Font* - Bitmap	|
Cartridge Font* - Scalable	|
Internal Font - Bitmap	|
Internal Font - Scalable	lowest

* The left cartridge has priority over the right cartridge.

- **Orientation** - for bitmap fonts the last criteria considered for the selection is its orientation. If two fonts still remain and match in all the above characteristics except orientation, that font which matches the current page orientation will be selected.

  It should be noted that if there is a soft font (highest priority location) available that matches all selection characteristics but is not in the current orientation and there is an identical font available in a cartridge or internal font (lower priority location) that is in the current orientation, the soft font will be selected and rotated.

Font Selection by ID

Soft fonts can be specified using their associated ID numbers. (ID numbers are assigned to font using the Font ID command described in Chapter 9, Font Management).

$^{E}_{C}$ **(# X** - Designates soft font # as primary

$^{E}_{C}$ **) # X** - Designates soft font # as secondary

= font ID number

If the designated font is present, the font is selected as the primary/secondary font and all primary/secondary font characteristics are set to those of the selected font. However, if the selected font is proportionally spaced, the pitch characteristic is not changed.

If the designated font is not present, the current font is retained.

If the font is a scalable font, height is determined from the values contained in the printers font selection table. To specify a different height, a height command should be sent prior to the Font Selection ID command.

Selection of a font using the ID number causes the printer's font select table to be updated with the values of that font.

Note

For shared or multi-user environments, Hewlett-Packard recommends that soft fonts be selected by characteristics rather than ID number.

To specify the font associated with ID number 7 as the primary font, send:

$^{E}_{C}$**(7X**

To specify the font associated with ID number 5 as the secondary font, send:

$^{E}_{C}$**)5X**

Select Default Font Command

The Default Font command sets all of the font characteristics to those of the user (control panel selected) default font.

^E_C **(3 @** - Default primary font characteristics

^E_C **) 3 @** - Default secondary font characteristics

Note

If the user default font is a proportionally-spaced font, the pitch characteristic will not be affected by the default font command.

HP-GL/2 Font Selection

Fonts can also be selected and printed from within HP-GL/2 mode using any of the HP-GL/2 label commands (refer to Chapter 21, *Character Group*). Any of the fonts available in the priner can be selected from HP-GL/2 mode. HP-GL/2 font selection allows the user to label vector graphic images. It also allows the user to create some special effects with fonts that are not otherwise available. These special effects include printing outline fonts from fonts which are not outline style fonts, printing mirror images of fonts, and printing fonts on any angle on the logical page. Fonts can also be scaled using HP-GL/2 vector graphics, however it is rather program intensive, and not the recommended method (refer *HP-GL/2 Programming* in Chapter 22 for additional information).

Transparent Print Data

The Transparent Print Data command provides printing access to those characters the printer normally defines as unprintable. These characters include decimal character codes 0, 7-15, and 27.

$^{E}_{C}$ **& p # X** [Transparent Print Data]

= Number of bytes of transparent print data.

Each transparent print data byte is interpreted as a single character code. The appropriate character is printed if one exists; otherwise, a space is processed. For example, control codes such as LF, CR, FF are treated as print data while in Transparent Print Data mode.

Example

Assuming the currently selected symbol set is PC-8, send the following to print a right arrow (decimal code 26):

$^{E}_{C}$**&p1X[14]**

The brackets "[]" are provided for clarity and are not part of the command sequence.

Note

In the ASCII symbol set, decimal 14 is the Shift Out control code (no printable character); however, in the PC-8 symbol set, decimal code 14 is the musical notes (printable character). Refer to Appendix A for the character codes for the various symbol sets.

Underline Command

The Underline commands control automatic text underlining.

$^{E}_{C}$ **& d # D** - Enable underline

\# = 0 - Fixed position

3 - Floating position

$^{E}_{C}$ **& d @** - Disable underline

Once underlining is enabled, any positive horizontal movement causes an underline to be drawn. Positive horizontal movement includes the printing of text and positive horizontal cursor motion.

When fixed position underlining is enabled, the underline is drawn five dots below the baseline and is three dots thick. (The baseline is an imaginary dot row on which all of the characters in a given line stand, see Chapter 10.) When floating position underline is enabled, the underline position is determined by the greatest underline distance below the baseline of all of the fonts printed on the current line. (The underline distance is defined in a font's descriptor, see Chapter 10.)

Note

The underline and the underscore character may not necessarily be aligned or the same thickness.

9

Font Management

Introduction

A number of fonts are supplied with the printer. These fonts are referred to as internal fonts. Additional fonts can be added to the printer by inserting font cartridges,scalable typeface cartridges, or by downloading soft fonts. Font management provides mechanisms for manipulating soft fonts. It provides the means for controlling which soft fonts will be saved in user memory (RAM) or deleted. This is accomplished by assigning a font as either temporary or permanent, or deleting a soft font. It also provides a mechanism for making a copy of an internal or cartridge (ROM) font to RAM for the purpose of assigning an ID. In addition, font management includes the command for assigning ID numbers to RAM fonts.

Note

Font management is identical for bitmap fonts and scalable fonts.

Downloading Soft Fonts

The process of transferring soft fonts from a host computer to the printer's user memory (RAM) is called downloading. A unique identification (ID) number should be designated prior to the download of a font. This number is then associated with the soft font. This number is assigned using the Font ID command, described later in this chapter. Subsequent manipulation of the soft font is accomplished using the font's ID number. If a font is already associated with this ID number in the printer, the existing font will be deleted during the download.

Several commands are required to download fonts to the printer. These commands are described in detail in Chapter 10. Hewlett-Packard font files include the necessary commands that define the symbols of a font. Assigning a font ID number and then copying the file to the printer, downloads the font. Bitmap fonts may simply be copied to the printer to download them. However, to create a downloadable scalable font requires HP's scalable-download program. This program is available in HP's Type Director 2.0 font management program and also provided in some application programs. Once created they are downloaded in much the same manner as a bitmap font.

Once downloaded, a soft font occupies a portion of user memory (RAM). The number of soft fonts that can be stored in user memory is limited only by the amount of available user memory.

Temporary / Permanent Fonts

Once downloaded, a font is automatically designated as temporary. A temporary soft font is one that is deleted from user memory during a printer reset or when a Font Printout is performed from the printer's control panel. A soft font can be designated as permanent to prevent the printer from deleting it during a printer reset. A soft font is designated as temporary or permanent by reference to its ID number using the Font Control command (refer to the Font Control command described on page 9-5).

Note

Temporary and permanent fonts are removed from user memory whenever the printer's power is turned off.

Deleting Fonts

There are several mechanisms provided by PCL font management that deletes soft fonts from user memory. These include commands to delete all soft fonts, all temporary soft fonts, or an individual soft font by reference to its font ID number (refer to the Font Control command described on page 9-4).

Note

- A font will be deleted when a new font, with the same ID number as an existing font, is downloaded. The new font replaces the existing font.
- Fonts are also deleted when the printer is power-cycled.

Font ID

The Font ID command is used to specify an ID number for use in subsequent font management commands. The ID number of a font can be used to select the font for printing (refer to Chapter 8, Font Selection by ID).

$^{E}_{C}$*c#D

= ID number - (0 through 32767)

The font ID number will be used during subsequent soft font downloads, selections or deletions.

The factory default font ID is 0.

Example

To specify a font ID number of 1, send:

$^{E}_{C}$*c1D

Font Control

The Font Control command provides mechanisms for manipulating soft fonts.

$^E{}_C$ * c # F

\# = 0 - Delete all soft fonts
1 - Delete all temporary soft fonts
2 - Delete soft font (last ID specified)
3 - Delete Character Code
(last ID and Character Code specified)
4 - Make soft font temporary (last ID specified)
5 - Make soft font permanent (last ID specified)
6 - Copy/Assign current invoked font as temporary
(last ID specified)

Note

If the primary or secondary font is deleted, a new primary or secondary font is automatically selected from the remaining fonts.

Examples

To remove all soft fonts from user memory, send:

$^E{}_C$*c0F

To remove only those soft fonts that are temporary, send:

$^E{}_C$*c1F

To delete the soft font with an ID of 1, send:

$^E{}_C$*c1d2F

To delete the character "p" (112 decimal) in the soft font with an ID of 1, send:

^E_C*c1d112e3F

(A control code space is executed for the deleted character.)

To make the soft font with an ID of 2 temporary, send:

^E_C*c2d4F

To make the soft font with an ID of 2 permanent, send:

^E_C*c2d5F

To make a copy of the currently invoked (selected) font, with an ID of 9, send:

^E_C*c9d6F

The Copy/Assign font control feature can be used to copy either ROM or RAM fonts into RAM assigning them ID numbers.

Font Management Example

This example illustrates several typical font management operations. It assumes a bitmap soft font is stored and available on an MS-DOS based hard disc.

1. Set the font ID number to 2:

   $^{E}_{C}$*c2D

2. Download a soft font file using the MS-DOS COPY command with the /B option:

   >COPY /B *filename* PRN

   (Refer to your DOS manual for information on using the DOS Copy command.)

   Note that the soft font is associated with font ID 2.

3. Make the soft font permanent in order to prevent its deletion during a printer reset:

   $^{E}_{C}$*c5F

4. Designate the permanent soft font as primary:

   $^{E}_{C}$(2X

10

Soft Font Creation

Introduction

To format a font for use in the LaserJet III printer, one must provide the information as required by the **font descriptor** and the **character descriptor**. The font descriptor is a block of data that identifies the basic characteristics common to all characters of a font, such as: font type, baseline position, character cell width and height, character orientation, symbol set etc. The character descriptor is a block of data that identifies the characteristics for a specific character, such as its position, the cursor position after printing, and the character data that defines the shape of the character. Together, a font descriptor and one or more character descriptors define a soft font.

This chapter describes the font descriptor format and the character descriptor format for both bitmap and scalable fonts. By formatting a font consistent with the descriptor format requirements, a user may download this information (the font) to the printer using the Font Descriptor command and the Character Descriptor/Data command. One additional command, the Character Code command, is required to identify the ASCII character code assigned to each character.

The definition of a font with n characters would appear as shown below.

Font Descriptor
Character Code_1
  Character Descriptor_1
   Character Data_1
Character Code_2
  Character Descriptor_2
   Character Data_2
      ⋮
Character Code_n
  Character Descriptor_n
   Character Data_n

Font Class

There are two basic font classes the HP LaserJet III accepts: **PCL bitmap** and **Intellifont scalable**. The font descriptor and character descriptor information for these two designs are different. Both are presented in this chapter.

With the information provided in this section for bitmap fonts, it is possible to format a bitmap character/font for the printer. However, to format an Intellifont scalable font, additional information is required.

Scalable fonts are formated to use AGFA Compugraphic's Intellifont Scaling Technology. The Intellifont scalable font descriptor and Intellifont character descriptor information provided here is not complete. To format non-hinged Intellifont scalable fonts, additional formatting information is required. This information can be obtained from the *Creating Intellifont-Compatible Fonts Using the AGFA Compugraphic FAIS Standard* document (referred to as the FAIS document). This document is available from AGFA

Compugraphic (refer to *Related Documents* section, located in the front of this manual, for information on how to obtain this document).

The FAIS document describes how to format **un-hinted** scalable typefaces for processing using Intellifont Scaling Technology. To obtain formatting specifications for typefaces which are hinted or contain Intellifont Scaling intelligence for heighest quality rendering, contact AGFA Compugraphic.

Coordinate System

Both bitmap fonts and Intellifont scalable characters are designed in an area referred to as cell or window and each has its own coordinate system and set of units.

Bitmap Fonts

Characters of a bitmap font are designed within a rectangular area referred to as a cell. The dimensions of the cell are in PCL Coordinate system dots and are therefore page-orientation independent (refer to Chapter 2, The Page, for a complete description of the PCL coordinate system).

Character design dimensions within the cell are in physical coordinate system dots (rather than PCL Coordinate System dots). The physical coordinate system is defined in terms of the directions of raster scan (X) and paper motion (Y) as illustrated in the following figure:

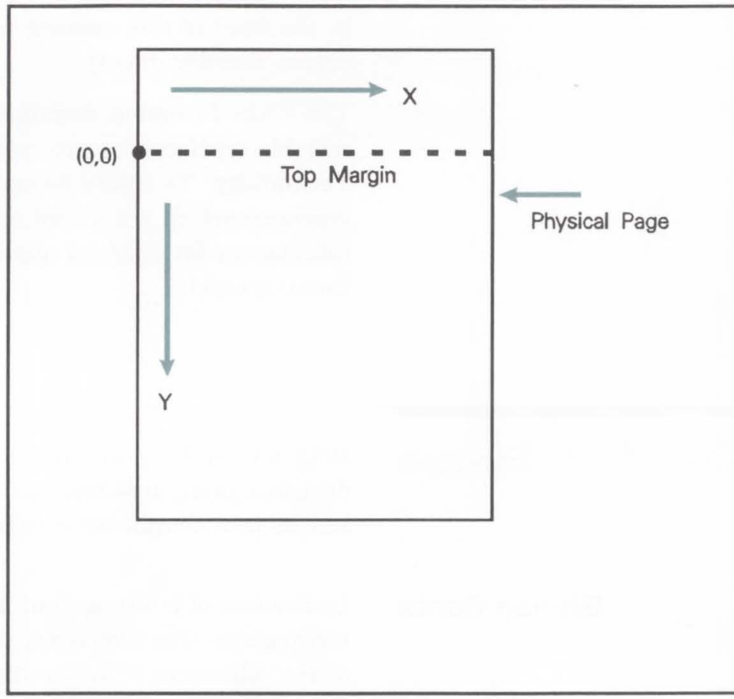


Figure 10-1. Bitmap Physical Coordinate System

Since the raster scan and paper motion directions of a device are fixed, the physical coordinate system is page-orientation dependent. Character design dimensions within the cell are in physical coordinate system dots and therefore depend on the print orientation.

Note

Hewlett-Packard recommends that bitmap softfonts be designed in portrait (0), using the paper motion and raster scan direction of the HP LaserJet Plus and LaserJet series II printers. The LaserJet IID, LaserJet IIP, LaserJet III, and the LaserJet 2000 printers will rotate the font to match the paper's physical coordinate system, for various paper sizes.

Intellifont/PCL Scalable Fonts

Characters of a scalable font are designed within a rectangular area known as the AGFA-Compugraphic Design Window (Figure 10-2). The units of this coordinate system are .01mm square.

The master font design size is 250 points (a CG point=.01383 inches). There are 8782 units per EM at the Master Font Size.

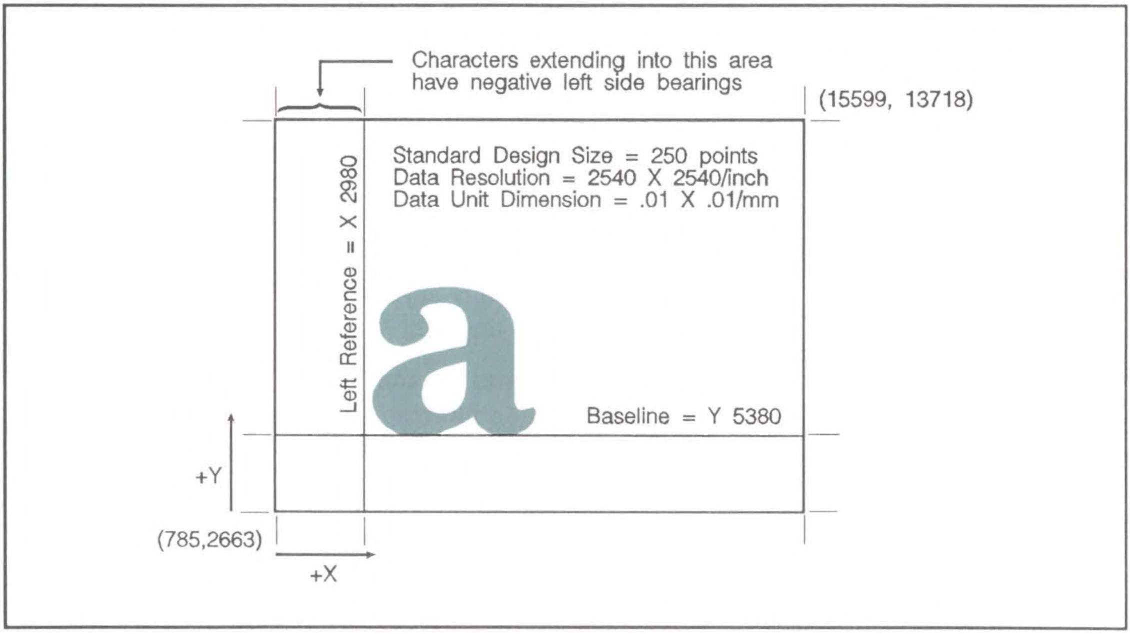


Figure 10-2. AGFA Compugraphic Design Window

Font Descriptor Format

The **font descriptor** describes those characteristics of a font which are common to all the characters of the font. There are two font descriptors described here: bitmap and Intellifont scalable.

Scalable font formatting requires an additional document, the *Creating Intellifont-Compatible Fonts Using the AGFA Compugraphic FAIS Standard* (FAIS document) which supplements the information provided here. For information on how to obtain this document, refer to the Related Documents section, in the front of this manual.

The FAIS document describes how to format a typeface for processing using AGFA Compugraphic's Intellifont Scaling Technology core contained in the LaserJet III printer. The format described in the FAIS document is for un-hinted outlines. The un-hinted outlines do not produce as high quality output as those which are hinted or contain Intellifont scaling intelligence. Hinted Intellifont scalable outlines are automically adjusted during scaling to produce the highest quality output.

Figure 10-3 illustrates the font header format for a bitmap font and Figure 10-4 illustrates the font header for an Intellifont scalable font. The individual fields for the font headers are described in the following two figures.

Note

- Although some devices do not use all of the data in the font descriptor and this printer ignores many fields, a font creator should use valid values in all of the font descriptor fields. This ensures font compatibility across the LaserJet printer family and with future printers, which may use this field.
- Those font descriptor fields identified as "reserved" should be set to 0.

Byte	15 (MSB) 8	7 (LSB) 0
0	Font Descriptor Size (64)	
2	Descriptor Format (0)	Font Type
4	Style MSB	Reserved
6	Baseline Position	
8	Cell Width	
10	Cell Height	
12	Orientation	Spacing
14	Symbol Set	
16	Pitch (Default HMI)	
18	Height	
20	x-Height	
22	Width Type	Style LSB
24	Stroke Weight	Typeface LSB
26	Typeface MSB	Serif Style
28	Quality	Placement
30	Underline Distance	Underline Height
32	Text Height	
34	Text Width	
36	First Code	
38	Last Code	
40	Pitch Extended	Height Extended
42	Cap Height	
44-47	Font Number ⋮	
48-63	Font Name ⋮	
64	Copyright (optional)	

Figure 10-3. PCL Bitmap Font Descriptor Format

Byte	15 (MSB) 8	7 (LSB) 0
0	Font Descriptor Size (80)	
2	Descriptor Format (10)	Font Type
4	Style MSB	Reserved
6	Baseline Position	
8	Cell Width	
10	Cell Height	
12	Orientation	Spacing
14	Symbol Set	
16	Master Design Pitch (default HMI)	
18	Height	
20	x-Height	
22	Width Type	Style LSB
24	Stroke Weight	Typeface LSB
26	Typeface MSB	Serif Style
28	Quality	Placement
30	Underline Distance	Underline Height
32	Reserved (0)	
34	Reserved (0)	
36	First Code	
38	Last Code	
40	Pitch Extended	Height Extended
42	Cap Height	
44-47	Font Number ⋮	
Continued on next page.		

Figure 10-4. Intellifont Scalable Font Descriptor Format

Byte	15 (MSB) 8	7 (LSB) 0
48-63	Font Name ⋮	
64	Scale Factor	
66	Master X Resolution	
68	Master Y Resolution	
70	Master Underline Position	
72	Master Underline Height	
74	LRE Threshold	
76	Global Italic Angle	
78	Global Intellifont Data Size	
80	Global Intellifont Data ⋮	
n	Copyright (optional) ⋮	
	Reserved (0)	Checksum

Figure 10-4. Intellifont Scalable Font Descriptor Format - Continued

Note

The following notation is used to define the data type of each field in the font descriptor

Font Descriptor Field Data Type Notation

(B)	: Boolean	(0, 1)
(UB)	: Unsigned Byte	(0 . . 255)
(SB)	: Signed Byte	(-128 . . 127)
(UI)	: Unsigned Integer	(0 . . 65535)
(SI)	: Signed Integer	(-32768 . . 32767)
(ULI)	: Unsigned Long Integer	(0 . . 2^{32})
(SLI)	: Signed Long Integer	(-2^{31} . . 2^{31}-1)
(ASCxx)	: ASCII string	array (0 . . xx-1) of characters

Font Descriptor Size (UI)

Specifies the number of bytes in the font descriptor. This value is ignored by the HP LaserJet III printer. The standard Hewlett-Packard font descriptor size for bitmap fonts is 64 bytes and for the Intellifont scalable font descriptor size is 80.

Descriptor Format (UB)

The Descriptor Format byte identifies the font as either bitmap font format (0) or Intellifont scalable format (10).

Descriptor Format Values

Value	Format
0	Bitmap
10	Intellifont Scalable

Font Type (UB)

The font type specifies one of the following defined font types. The font type should be set appropriately for the font's symbol set.

Font Type Values

Value	Font Type
0	7-bit (96 characters) – character codes 32 to 127 [decimal] are printable.
1	8-bit (192 characters) – character codes 32 to 127 [decimal] and 160 to 255 [decimal] are printable.
2	8-bit (256 characters) – All character codes are printable, however to print 0, 7 to 15, and 27 [decimal] the printer must be in Transparency mode.

Note

Access to those codes that are unprintable, that have a character defined, requires the use of the Transparent Print Data command.

Style MSB (UI)

The Style MSB (byte 4) is combined with the Style LSB (byte 23) to make the style word. The contents of the style word are described below. The Style word (decimal) is calculated using the formula:

Style Word = Posture + (4 x Width) + (32 x Structure)

The binary structure of the Style word is shown below.

15		9	4	1 0
X	Reserved	Structure	Width	Posture

Value	Posture (StyleWord partial sum)
0	Upright
1	Italic
2	Alternate Italic
3	Reserved

Value	Width (Multiply by 4 for StyleWord partial sum)
0	Normal
1	Condensed
2	Compressed or Extra Condensed
3	Extra Compressed
4	Ultra Compressed
5	Reserved
6	Extended or Expanded
7	Extra Extended or Extra Expanded

Value	Structure (Multiply by 32 for StyleWord partial sum)
0	Solid
1	Outline
2	Inline
3	Contour
4	Solid with Shadow
5	Outline with Shadow
6	Inline with Shadow
7	Contour with Shadow
8-11	Patterned (Complex patterns, subjective to type family)
12-15	Patterned with Shadow
16	Inverse
17	Inverse in Open Border
18-31	Reserved

Baseline Distance (UI)

Bitmap Font - Specifies the distance from the top of the cell to the baseline. The baseline is an imaginary dot row on which all of the characters in a line stand. The measurement of this distance is in PCL coordinate system dots. The legal range for the baseline distance value is from 0 to cell height minus 1. This field is ignored by the HP LaserJet III printer.

Intellifont Scalable - Specifies the distance from the top vertical reference to the baseline in design window units. This field is ignored by the LaserJet III printer.

Cell Width (UI)

Specifies the width of the cell. The cell width range is 1 to 65535. This field is ignored by the LaserJet III printer.

Bitmap Font - Specified in PCL coordinate system dots.

Intellifont Scalable - Specified in design window units.

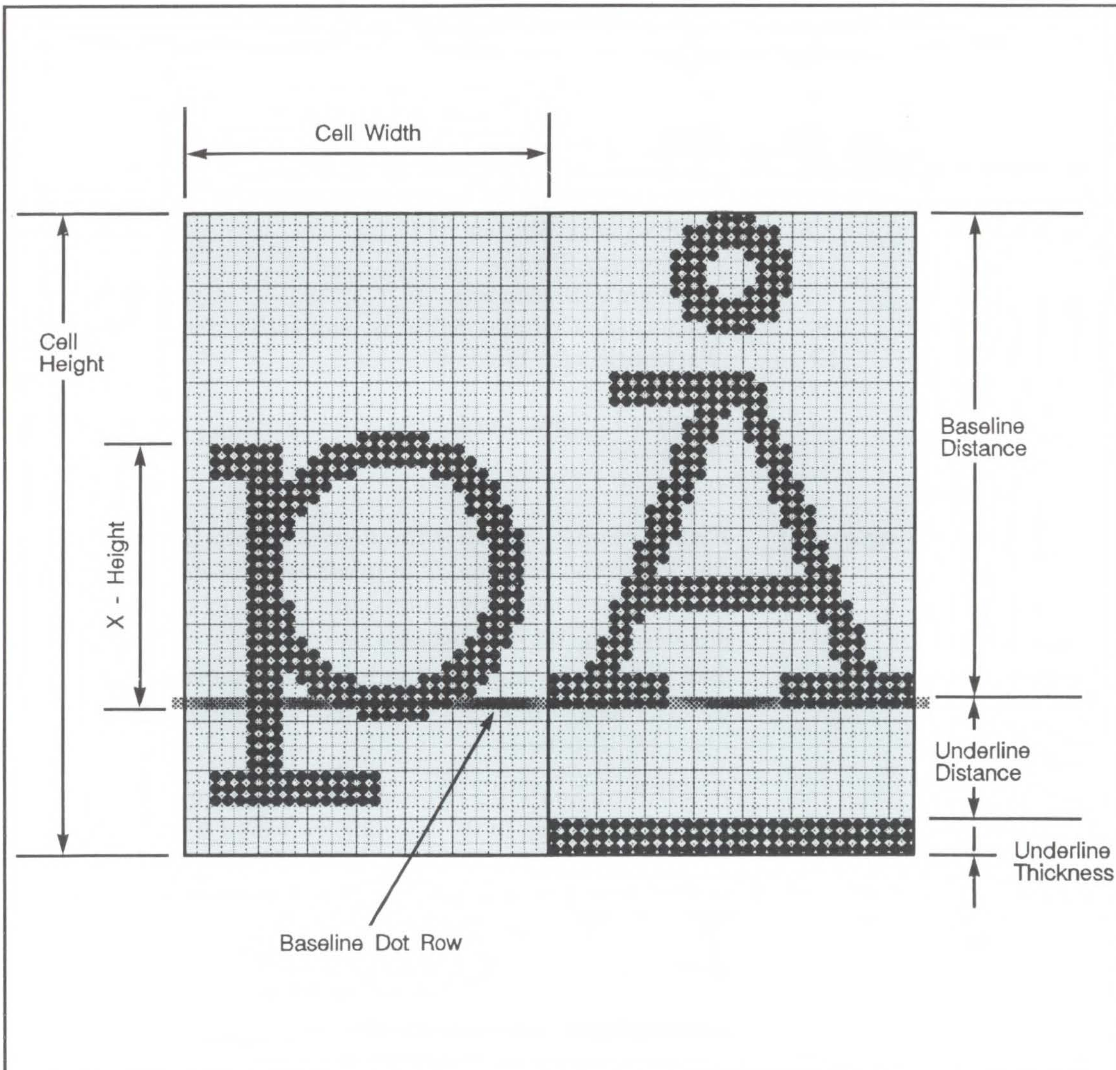


Figure 10-5. Character Cell - Bitmap

Cell Height (UI)

Specifies the height of the cell. The legal range is 1 to 65535. This field is ignored by the LaserJet III printer.

Bitmap Font - Specified in PCL coordinate system dots.

Intellifont Scalable - Specified in design window units.

Orientation (UB)

Specifies the orientation of the font. All characters within the font must have the same orientation as those specified in the font descriptor; otherwise they will be discarded as they are downloaded.

0 =	portrait	0 degrees; the orientation of the raster scan of the printer
1 =	landscape	90 degrees counterclockwise
2 =	reverse portrait	180 degrees counterclockwise
3 =	reverse landscape	270 degrees counterclockwise

Bitmap Font - Unsupported values invalidate font creation.

Intellifont Scalable - Ignored by the LaserJet III printer.

Note

Hewlett-Packard recommends that bitmap soft fonts be designed in portrait (0°), using the paper motion and raster scan direction of the HP LaserJet Plus and LaserJet series II printers. The HP LaserJet IID, LaserJet IIP, LaserJet III and LaserJet 2000 printer will rotate the fonts to match the paper's physical coordinate system for the various paper sizes.

Spacing (B)

Specifies the spacing of the font. Zero specifies fixed spacing and one specifies proportional spacing.

Symbol Set (UI)

Specifies the symbol set for the font. This value is computed by taking the value of the value field for the symbol set, multiplying it by 32, adding the ordinal value (ASCII decimal value) of the termination character of the escape sequence, and subtracting 64.

```
Font Descriptor Symbol Set Value =

    (Escape Sequence Value Field Value * 32) +
    (Decimal Value of Escape Sequence Termination
    Character - 64).
```

For example:

```
    Symbol set 0U = (0*32) + (85 -64) = 21
```

The legal range of symbol set escape sequence value field values is 0 to 2047. Refer to Table 10-1 for the HP defined font descriptor symbol set values.

HP reserves the right to specify the font descriptor symbol set values of 0 to 1023. Symbol set escape sequence value field values 1024 to 2047 are available for use by independent font vendors.

Symbol set escape sequence termination characters can be any upper case ASCII character "A" through "V".

Note

Symbol set ID's of "@" and "X" do not have a corresponding Symbol Set selection command, sets marked as such can only be selected with the Font ID.

Table 10-1. Symbol Set Values

Symbol Set Name	Symbol Set ID
Default Set	0@
Math-7	0A
Line Draw-7	0B
HP Large Characters (264x Terminals)	0C
ISO 60: Danish/Norwegian	0D
ISO 61: Norwegian version 2*	1D
Roman Extensions*	0E
ISO 4: United Kingdom	1E
ISO 25: French*	0F
ISO 69: French	1F
HP German*	0G
ISO 21: German	1G
Greek-8	8G
Hebrew-7	0H
Hebrew-8	8H
ISO 15: Italian	0I
Microsoft Publishing	6J
DeskTop	7J
Document	8J
PS Text	10J
Ventura International	13J
Ventura US	14J
ISO 14: JIS ASCII*	0K
ISO 13: Katakana*	1K
ISO 57: Chinese*	2K
Kana-8	8K
Korean-8	9K
Line Draw-7 (Same as 0B)	0L
HP Block Characters	1L
Tax Line Draw	2L
Line Draw-8	8L

Continued on next page

Table 10-2. Symbol Set Values - continued

Symbol Set Name	Symbol Set ID
Ventura ITC Zapf Dingbats	9L
PS ITC Zapf Dingbats	10L
ITC Zapf Dingbats Series 100	11L
ITC Zapf Dingbats Series 200	12L
ITC Zapf Dingbats Series 300	13L
Math-7 (Same as 0A)	0M
Tech-7	1M
PS Math	5M
Ventura Math	6M
Math-8	8M
ECMA-94 Latin 1 (ISO 8859/1)	0N
ECMA-94 Latin 2 (ISO 8859/2)	2N
ECMA-128 Latin 5 (ISO 8859/9	5N
ECMA-113/88 Latin/Cyrillic (ISO	10N
OCR A	0O
OCR B	1O
OCR M	2O
APL (Typewriter Paired)	0P
APL (Bit Paired)	1P
Specials	xQ
Cyrillic ASCII (ECMA-113/86, ISO 8859/5)	0R
Cyrillic	1R
PC Cyrillic	3R
ISO 11: Swedish for Names	0S
HP Spanish*	1S
ISO 17: Spanish	2S
ISO 10: Swedish*	3S
ISO 16: Portuguese*	4S
ISO 84: Portuguese*	5S
ISO 85: Spanish*	6S
HP European Spanish	7S
HP Latin Spanish	8S

Continued on next page

Table 10-3. Symbol Set Values - continued

Symbol Set Name	Symbol Set ID
HP-GL Download	16S
HP-GL Drafting	17S
HP-GL Special Symbols	18S
Thai-8	0T
Turkish-8	8T
ISO 6: ASCII	0U
Legal	1U
ISO 2: International Reference Version*	2U
HPL Language Set	5U
OEM-1	7U
Roman-8	8U
Windows	9U
PC-8	10U
PC-8 D/N (Danish/Norwegian)	11U
PC-850	12U
PC-852	17U
Pi Font	15U
Arabic (McKay's version)	0V
Arabic-8	8V
3 of 9 Barcode	0Y
Industrial 2 of 5 Barcode	1Y
Matrix 2 of 5 Barcode	2Y
Interleaved 2 of 5 Barcode	4Y
CODABAR Barcode	5Y
MSI/Plessey Barcode	6Y
Code 11 Barcode	7Y
UPC/EAN Barcode	8Y
USPS Zip	15Y

* Not recommended for future use. This symbol set is of limited usage and is being discontinued.

Pitch (UI)

Bitmap Font - Specifies the pitch of the font in quarter-dot units (four quarter dot units equal one dot; also known as radix dots). It combines with Pitch Extended to specify the pitch of the font in 1024^{th}-dots. Pitch defines the default HMI for the font.

For example, at 300 dpi (1200 quarter-dots/inch), a 17 cpi font would have a pitch value of 70 radix dots as calculated:

$$\frac{\text{1 inch}}{\text{17 char.}} \times \frac{\text{300 dots}}{\text{inch}} \times \frac{\text{4 quarter-dots}}{\text{dot}} = \text{70.588 radix dot}$$

The remainder 0.588 is converted back to dots and then to 1024^{th}-dots as shown below:

$$\frac{\text{0.588 radix dot}}{\text{4 radix dot}} \times \frac{\text{1024 units}}{\text{dot}} = \text{150 units/dot}$$

Pitch Extended is set to 150 1024^{ths}-units.

Note

For a proportional font, the default width "printed" for a control code space is determined by the pitch value.

Intellifont Scalable - Contains the master design width (escapement) of the font in design window units.

Height (UI)

Bitmap Font - Specifies the design height of the font in quarter-dot units. This value, converted to points, is used as the height characteristic value of the font. A PCL point is $\frac{1}{72}$ (0.01389) inch. It combines with Height Extended to specify the design height of the font in 1024^{th}-dot.

For example, a 10 point font at 300 dpi would have a height of 166 quarter-dots (1200 quarter dots/inch, $\frac{1}{72}$ inch/point) as calculated:

$$\frac{10\ \text{point}}{} \times \frac{1\ \text{inch}}{72\ \text{point}} \times \frac{300\ \text{dots}}{\text{inch}} \times \frac{4\ \text{quarter-dots}}{\text{dot}} = 166.667$$

The remainder 0.667 is converted back to dots and then to 1024^{th}-dot for a value of 170 1024^{th}-dot for the Height Extended field (similar to that shown in the example for Pitch, above).

Intellifont Scalable - Specifies the master design height of the font in $\frac{1}{8}$ points.

xHeight (UI)

Bitmap Font - Specifies the height of the lower case "x" in quarter-dot units. This field is ignored by the LaserJet III printer.

Intellifont Scalable - Specifies the distance from the baseline to the lower case "x" height in design window units.

Width Type (SB)

Specifies the proportionate width of characters in the font. This field is ignored by the LaserJet III printer.

Width Type Values

Value	Width Type
-5	Ultra Compressed
-4	Extra Compressed
-3	Compressed or Extra Condensed
-2	Condensed
0	Normal
2	Expanded
3	Extra Expanded

Additional width types may be added by HP.

Style LSB (UB)

The least significant byte (LSB) of the Style word. Refer to Style MSB for a description of the Style word.

Stroke Weight (SB)

Specifies the thickness of the strokes used in designing the font. The supported stroke weight values are −7 through 7. The thinnest stroke available is −7; the thickest stroke weight is 7. The standard stroke weight for a medium font is 0; the standard stroke weight for a bold font is 3; and, the standard stroke weight for a light font is −3.

The available design stroke weights are listed in the following table.

Stroke Weight Values

Value (#)	Stroke Weight
-7	Ultra Thin
-6	Extra Thin
-5	Thin
-4	Extra Light
-3	**Light**
-2	Demi Light
-1	Semi Light
0	**Medium, Book, or Text**
1	Semi Bold
2	Demi Bold
3	**Bold**
4	Extra Bold
5	Black
6	Extra Black
7	Ultra Black

Typeface Family (UB)

The Typeface word which consists of the Typeface Least Significant Byte (LSB; the original, one-byte typeface value) and the Typeface Most Significant Byte (MSB) fields in the font descriptor, identifies the typeface of the font.

The typeface field includes a 4-bit field to specify the vendor number, a 2-bit field for the version number, and a 9-bit field for the actual typeface family number. The most significant bit of the MSB is always zero. The typeface word is shown below.

Vendor Numbers

15	14	10	8	0
0	Vendor	Version	Typeface Family Value	

Note

There are some compatibility concerns when selecting a typeface, when typeface selection mixes the two-btye (0-32767) typeface values with one-byte (0-255) values between the typeface selection command and that contained in the font header. The two-byte typeface family field (typeface word: typeface MSB and typeface LSB) was first used in the LaserJet IID printer. The series II printer ignores the typeface MSB byte. There are also some compatibily concerns regarding the LaserJet IID and IIP (refer to Chapter 8, Typeface Command, for additional font selection conpatibility information).

For future compatibility the two-byte (typeface MSB/LSB) field must be used.

Vendor Number

The value of the Vendor Number (bits 11-14) is assigned by HP and is between 0 and 15.

Vendor Number Values

Value	Vendor
0,1	Reserved
2	AGFA Compugraphic
3-15	(Reserved)

Vendor Version

The Vendor Version (bits 10, 9) value is between 0 and 3. The value will change when the vendor changes the width of the characters in a font.

Typeface Family Value

The Typeface Family Number (bits 0 through 8) ranges from 0 to 511. Some of these values refer to the styles that vary by structure and appearance width (that is, Helvetica Condensed, Helvetica Outline, etc.). These values should not be used in new designs since they are being deleted. Refer to Table 10-2 for a list of typeface families and their numbers.

For example, the HP typeface number for Compugraphic's Dom Casual typeface is 4157 (vendor value = 2, version value = 0, and typeface value = 61).

Vendor Number 0 with Version Number 0 are reserved for generic typeface selection. A typeface request with a vendor and version number of 0 causes the printer to select a font typeface independently of the vendor or version. This means that for typeface numbers less than 512, the printer exactly matches the typeface number and the least significant bits of the font's escape sequence typeface selection. Typeface numbers greater than or equal to 512 result in matches using the full 16 bits of a font's typeface selection number (see Table 10-2).

Note

The typefaces listed in Table 10-2 are provided for identification of the PCL byte value used in the font descriptor. Hewlett-Packard does provide some fonts with these typefaces but it does not sell all of the listed typefaces.

Table 10-4. Typeface Values*

Value (One-Byte)	Typeface**	Value (One-Byte)	Typeface**
0	Line Printer	1	Pica
2	Elite	3	Courier
4	Helvetica	5	Times Roman
6	Letter Gothic	7	Script
8	Prestige	9	Caslon
10	Orator	11	Presentation
12	Helvetica Condensed***	13	Serifa
14	Futura	15	Palatino
16	ITC Souvenir	17	Optima
18	ITC Garamond	19	Cooper Black***
20	Coronet	21	Broadway
22	Bauer Bodoni Black Condensed***	23	Century Schoolbook
24	University Roman	25	Helvetica Outline***
26	Futura Condensed***	27	ITC Korinna
28	Naskh	29	Cloister Black
30	ITC Galliard	31	ITC Avant Garde Gothic
32	Brush	33	Blippo
34	Hobo	35	Windsor
36	Helvetica Compressed***	37	Helvetica Extra Compressed***
38	Peignot	39	Baskerville
40	ITC Garamond Condensed***	41	Trade Gothic
42	Goudy Old Style	43	ITC Zapf Chancery
44	Clarendon	45	ITC Zapf Dingbats

* Additional typefaces will be available in the future.

** These typeface names may be registered trademarks of a third party. Use of these fonts may be conditional upon a license grant from the owners of the fonts. Hewlett-Packard makes no representation as to the quality or performance of the fonts, and any reference to the fonts does not grant any license or right to use the fonts.

*** These typeface codes are soon to be reassigned, since they specify treatments of a typeface that may now be expressed in the style value. Not recommended for future use.

Continued on next page.

Table 10-5. Typeface Values* Continued

Value (One-Byte)	Typeface**	Value (One-Byte)	Typeface**
46	Cooper	47	ITC Bookman
48	Stick	49	HP-GL Drafting
50	HP-GL Spline	51	Gill Sans
52	Univers	53	Bodoni
54	Rockwell	55	Melior
56	ITC Tiffany	57	ITC Clearface
58	Amelia	59	Park Avenue
60	Handel Gothic	61	Dom Casual
62	ITC Benguiat	63	ITC Cheltenham
64	Century Expanded	65	Franklin Gothic
66	Franklin Gothic Expressed***	67	Franklin Gothic Extra Condensed***
68	Plantin	69	Trump Mediaeval
70	Futura Black		
72	Antique Olive	73	Uncial
74	ITC Bauhaus	75	Century Oldstyle
76	ITC Eras	77	Friz Ouadrata (ITC)
78	ITC Lubalin Graph	79	Eurostile
80	Mincho	81	ITC Serif Gothic
82	Signet Roundhand	83	Souvenir Gothic
84	Stymie	87	Bernhard Modern
89	Excelsior	90	Gando Ronda Script

* Additional typefaces will be available in the future.

** These typeface names may be registered trademarks of a third party. Use of these fonts may be conditional upon a license grant from the owners of the fonts. Hewlett-Packard makes no representation as to the quality or performance of the fonts, and any reference to the fonts does not grant any license or right to use the fonts.

*** These typeface codes are soon to be reassigned, since they specify treatments of a typeface that may now be expressed in the style value. Not recommended for future use.

Continued on next page.

Table 10-2. Typeface Values* Continued

Value (One-Byte)	Typeface**	Value (One-Byte)	Typeface
91	Ondine	92	P.T. Barnum
93	Kaufman	94	ITC Bolt Bold
96	Helvetica Monospaced***	97	Revue
101	Garamond (Stempel)	102	Garth Graphic
103	ITC Ronda	104	OCR-A
		106	Englische Schreibschrift
107	Flash	108	Gothic Outline (URW)
109	Stencil (ATF)	110	OCR-B
111	Akzidenz-Grotesk	112	TD Logos
113	Shannon	114	ITC Century
152	Maru Gosikku	153	Gossikku
154	Socho	155	Kyokasho
156	Kaisho	157	Traditional Arabic Script
158	Arabic News		
160	Devanagari (Hindi)	161	Krishna (Gujarati)
162	Ranjit (Gurmukhi)	163	Raj Raja (Tamil)
164	Gyosho	165	Hebrew
166	Nork	167	Ousbouh
168	Koufi		
261	Greek Times		

* Additional typefaces will be available in the future.

** These typeface names may be registered trademarks of a third party. Use of these fonts may be conditional upon a license grant from the owners of the fonts. Hewlett-Packard makes no representation as to the quality or performance of the fonts, and any reference to the fonts does not grant any license or right to use the fonts.

*** These typeface codes are soon to be reassigned, since they specify treatments of a typeface that may now be expressed in the style value. Not recommended fur future use.

Independent font vendors should contact their Hewlett-Packard representative for assignment of typeface values.

Serif Style (UB)

Specifies one of the following defined serif styles.

Serif Style values 0-63 (the lower six bits of the style field) are ignored by the printer for bitmap fonts. However, the upper two bits (bits 7 and 8) are used by Intellifont scalable font header to determine the serif style of the typeface insensitive characters to complement the font. Serif style values for the lower six bits are listed in the table below. Serif style values for the upper two bits are listed in the following table.

Serif Style Values

Value	Serif Style
0	Sans Serif Square
1	Sans Serif Round
2	Serif Line
3	Serif Triangle
4	Serif Swath
5	Serif Block
6	Serif Bracket
7	Rounded Bracket
8	Flair Serif, Modified Sans
9	Script Nonconnecting
10	Script Joining
11	Script Calligraphic
12	Script Broken Letter

Values for bits 6 & 7	
64	Sans Serif
128	Serif
192	Reserved

Additional serif styles may be added.

Quality (UB)

This field specifies the quality of the font.

This field is ignored by the LaserJet III printer.

Quality Values

Value	Quality
0	Data processing
1	Near Letter Quality
2	Letter Quality

Placement (SB)

Placement specifies the position of character patterns relative to the baseline.

This field is ignored by the LaserJet III printer.

Bitmap Font - The placement values for bitmap fonts are listed in the following table.

Bitmap Font Placement Values

Value	Placement
1	Superior
0	Normal
-1	Inferior

Intellifont Scalable - Ignores this field.

Underline Distance (SB)

Bitmap Font - Specifies the distance from the baseline to the top dot row of the underline in dots. Zero specifies an underline position at the baseline. A positive value specifies an underline position above the baseline. A negative value specifies an underline position below the baseline.

Intellifont Scalable - Underline Distance is ignored (zero) for character scaling (see Master Underline Position). The Master Underline Position (bytes 70 and 71) in the Intellifont Font Descriptor identifies this information for scalable fonts, thus, this field (byte 30) should be set to zero.

Underline Height (UB)

Specifies the thickness of the underline in dots for a bitmap font.

Bitmap Font - This field is ignored by the LaserJet III printer. A bitmap font always prints three-dot thick underlines.

Intellifont Scalable - Underline Height is ignored (zero) for character scaling (see Master Underline Height). The Master Underline Height (bytes 72 and 73) in the Intellifont Font Descriptor identifies this information for scalable fonts, thus, this field (byte 31) should be set to zero.

Text Height (UI)

Specifies the font's optimum inter-line spacing. This value is typically equal to 120% of the height of the font.

This field is ignored by LaserJet III printer.

Bitmap Font - Specified in quarter-dot units.

Intellifont Scalable - Specified in design window units.

Text Width (UI)

Specifies the font's average lowercase character width. HP recommends setting this value to the average width of the lower case letters a through z.

This field is ignored by the LaserJet III printer.

Bitmap Font - Specified in quarter-dots.

Intellifont Scalable - Specified in design window units.

First Code (UI)

First Code specifies the character code of the first printable character in the font. This value will be between 0 and 255 inclusive. The space character may be printable and will print an image if one is defined, otherwise a space control code is executed. The First Code field is ignored by LaserJet III printer. Currently, the LaserJet III printer uses the Font Type field to determine the first and last codes of the symbol set, as shown below:

Font Type	First Code../..Last Code
0	32/127
1	32/127 - 160/255
2	0/255

Last Code (UI)

Specifies the Last code in the font. This value may be greater than the last code of the symbol set as implied by the font type because there may be components of compound characters that are not part of the symbol set but must be downloaded. The printable codes are implied by the font type (refer to first code described above).

Pitch Extended (UB)

Bitmap Font - This is an addition to the Pitch field which extends the pitch an extra eight bits. The value of this field is in 1024^{ths} of one dot. For example, a 17 pitch font would have a Pitch field of 70 (17.5 dots, or 17.1429 cpi) and a Pitch Extended field of 150 (0.1465 dots additional, which adds to 17.6465 dots, or 17.0005 pitch). An example for calculating the Pitch and Pitch Extended fields is provided in the Pitch field description, above.

Intellifont Scalable - Pitch Extended field is ignored for character scaling and should be set to zero.

Height Extended (UB)

Bitmap Font - This is an addition to the Height field which extends the height an extra eight bits. The value of this field is in 1024ths of one dot. For example, a 10 point font would have a Height field of 166 (41.5 dots, or 9.96 points) and a Height Extended field of 170 (0.1660 dots additional, which adds to 9.9998 points). This field is calculated similar to the Pitch Extended field, refer to the Pitch description, above.

Intellifont Scalable - The Height Extended field is ignored for character scaling and should be set to zero.

Cap Height (UI)

Cap Height is a percentage of the em of the font and is used to calculate the distance from the capline (top of an unaccented, upper-case letter, such as an "H") to the baseline.

This field is ignored for bitmap fonts.

Bitmap Font - Fonts containing a 0 in this field are assumed to have a cap height percentage of 70.87% of em.

The Cap Height data is represented as the product of the cap height percentage and the maximum unsigned integer:

```
0.7087 X 65535 = 46,445
```

For non-zero values, the Cap Height % is calculated as follows:

$$\% = \frac{\text{Cap Height Data}}{65535} \times 100$$

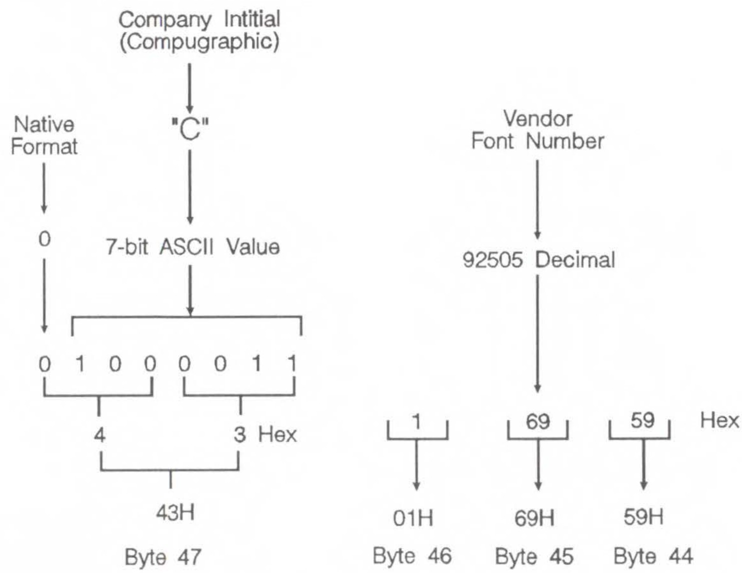
Intellifont Scalable - Contains the cap height in design window units.

Font Number (ULI)

The Font Number field uses four bytes (byte 44, 45,46, and 47). The lower three bytes (44, 45, and 46) contain the font number in hexadecimal. This is the number the vendor assigns to their font. The most significant byte (byte 47) consists of a flag in the most significant bit indicating whether the font is in its native (0) format or has been converted (1) from another format. The remaining lower seven bits contain the ASCII decimal value for the first initial of the font vendor's name in the remaining 7 bits (this is assigned by Hewlett-Packard).

For example, to identify the Font Number for a CG Times Bold Italic, native format, font. The number Compugraphic assigns for this font is 92505. This number is converted to hexidecimal and used for the lower three bytes of the Font Number. Bit 8 of byte 47 will be 0, since the native format is being used and the lower seven bits will be the

ASCII value for "C" (C for Compugraphic; 0100 0011). This process is summarized below.



This field is ignored by the LaserJet III printer for bitmap fonts.

Note

If a user does not assign numbers to their typefaces, then this field (16 bits) should be set to zero.

Font Name (ASC16)

This is a 16 character ASCII field to which the user may assign a font name. The font name is used in the Font List printout, under **Name or Typeface**.

Note

All the remaining font descriptor fields apply only to the Intellifont scalable font descriptor.

Scale Factor (UI)

The Scale Factor field indicates the scale factor in design window units. It is used in the Intellifont scalable font data. For detailed information on Scale Factor, refer to the FAIS document.

Note

For information on how to obtain the FAIS document, refer to the "Related Documents" section in the front of this manual.

Master X Resolution (UI)

The Master X Resolution field is the pixel resolution in the X scan direction at which the font was designed. For detailed information on Master X Resolution, refer to the FAIS document.

Master Y Resolution (UI)

The Master Y Resolution field is the pixel resolution in the Y scan direction at which the font was designed. For detailed information on Master Y Resolution, refer to the FAIS document.

Master Underline Position (SI)

The Master Underline Position is the position of the Intellifont scalable underline on the master design grid in design window units. For detailed information on Master Underline Position, refer to the FAIS document.

Master Underline Height (UI)

The Master Underline Height field is the height (thickness) of the underline on the master design grid in design window units for Intellifont scalable data. For detailed information on Master Underline Height, refer to the FAIS document.

LRE Threshold (UI)

The Low Resolution Enhancement (LRE) Threshold is the pixel size in Design Window Units above which the Low Resolution Enhnacement process is cut into the Intellifont scaling and rasterization process.

Global Italic Angle (SI)

The Global Italic Angle field contains the tangent of the italic angle times 2^{15}. It should be set to zero for upright fonts. For detailed information on Global Italic Angle, refer to the FAIS document.

Global Intellifont Scalable Data Size (UI)

The Global Intellifont Scalable Data Size identifies the size of the Global Intellifont scalable data block. For detailed information on Global Intellifont Scalable Data Size, refer to the FAIS document.

Global Intellifont Scalable Data

For detailed information on Global Intellifont Scalable Data refer to the FAIS document. This document describes how to format un-hinted font data. Un-hinted fonts do not utilize AGFA Compugraphic's "scaling hints" which optimizes the quality of 300 dpi scaled fonts. To design hinted fonts, the hinted font scaling technology must be licensed from AGFA Compugraphic. Contact AGFA Compugraphic for license details.

Checksum

The Checksum field is over bytes 64 through the end of the copyright. It is a checksum of each byte. This byte should contain a value, such that, when added to the sum of byte 64 through the reserved byte, results in a total of (modulo 256 arithmetic. For example, if the sum = 10,234 then, 10,234 mod 256 = 250 therefore the checksum should = 6 (since 250+6 = 256 is 0 [mod 256]).

Copyright The copyright begins with the length in an unsigned integer (UI) followed by the copyright data.

Application Support Application support data identifies a block of data used by application programs.

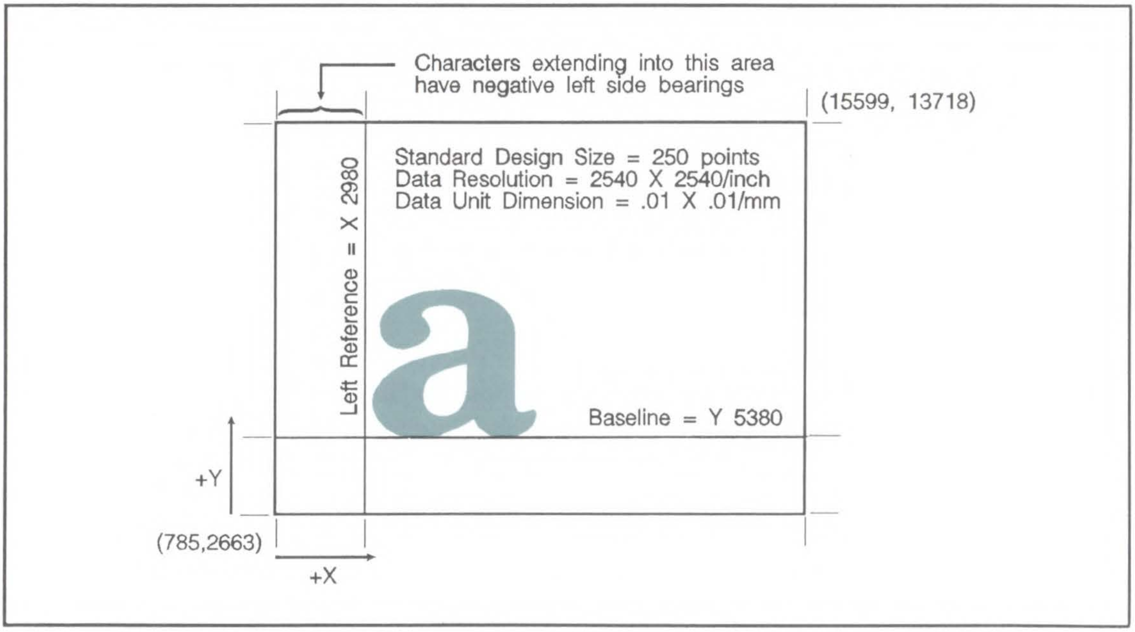


Figure 10-6. Design Window - Intellifont Scalable

Font Descriptor Command

The Font Descriptor command is used to download font descriptor data to the printer.

$^{E}_{C}$ **) s # W** [font descriptor data]

The value field (#) identifies the number of bytes in the font descriptor (see example on the following page). The font descriptor byte fields are described in the previous section under *Font Descriptor Format*.

Two examples for downloading a Font Descriptor are provided below, one for a bitmap font and one for an Intellifont scalable font.

Bitmap Example

To download a bitmap font descriptor for a portrait HP Roman-8, 10 pitch, 12 point, upright, medium, Courier font, with an ID number of one, send:

$^{E}_{C}$ *** c 1 D** (set Font ID to 1)

$^{E}_{C}$ **) s 64 W** [64 bytes of font descriptor data]

An example of the bitmap header is shown on the following page.

FIELD NAME	VALUE	DESCRIPTION
Font Descriptor Size	64	Bytes
Descriptor Format	0	Bitmap Font Format
Font Type	1	Eight Bit
Style MSB	0	
Reserved	0	
Baseline Position	40	
Cell Width	30	
Cell Height	53	
Orientation	0	Portrait
Spacing	0	Fixed Pitch
Symbol Set	277	8U: Roman-8
Pitch	120	Quarter Dots (30.00 Dots)
Height	200	Quarter Dots (50.00 Dots)
x Height	88	Quarter Dots (22.00 Dots)
Appearance Width	0	Normal
Style LSB	0	Upright, Normal Width, Solid (0,0,0)
Stroke Weight	0	Medium
Typeface LSB	3	Courier
Typeface MSB	0	No Font Vendor ID, Version 0
Serif Style	2	Serif Line
Quality	0	
Placement	0	
Underline Position	-10	
Underline Thickness	3	
Text Height	240	Quarter dots (60.00 Dots)
Text Width	120	Quarter Dots (30.00 Dots)
First Code	33	
Last Code	254	
Pitch Extended	0	
Height Extended	0	
Cap Height	36713	56.02% of Em
Font Number	0	No Font Vendor Number
Font Name	Courier	
.... Copyright Statement (optional)....		
.... Application Support (optional)....		

Intellifont Scalable Example

To download an Intellifont scalable descriptor for a portrait HP Roman-8, upright, medium, CG Times scalable font, with an ID number of one, send:

^E_C *** c 1 D** (set Font ID to 1)

^E_C **) s 80 W** [80 bytes of font descriptor data]

FIELD NAME	VALUE	DESCRIPTION
Descriptor Size	80	Bytes
Descriptor Format	10	Scalable Font Format
Font Type	1	Eight Bit
Style MSB	0	
Reserved	0	
Baseline Location	5380	Y reference in Design Window
Cell Width	0	..not defined for scalable fonts
Cell Height	0	..not defined for scalable fonts
Orientation	0	..not defined for scalable fonts
Spacing	1	Proportional
Symbol Set	277	8U: Roman-8
Master Design Pitch	2602	29.63% Em Default HMI
Design Height	2000	250 Points * 8
x-Height	4009	45.65% Em, 68.52% Cap Height
Appearance Width	0	Normal
Style LSB	0	Upright, Normal Width, Solid (0,0,0)
Stroke Weight	0	Medium or Text Weight
Typeface LSB	5	Times Roman (generic design family)
Typeface MSB	16	AGFA Compugraphic, Version 0
Serif Style	134	Serif, Bracketed (2,6)
Quality	0	..not defined for scalable fonts
Placement	0	..not defined for scalable fonts
Underline Distance	0	..not defined for scalable fonts
Underline Height	0	..not defined for scalable fonts
Text Height	0	..not defined for scalable fonts
Text Width	4391	Width of En Space

Continued on next page

FIELD NAME	VALUE	DESCRIPTION
First code	33	
Last Code	273	Compound Pieces Present (n>255)
Pitch Extended	0	..not defined for scalable fonts
Height Extended	0	..not defined for scalable fonts
Cap Height	5851	66.7% Em
Font Number	hex 43 01 69 54	Native, AGFA Compugraphic, CG Times (0,C,92500)
Font Name "CG Times"		
Scale Factor	8782	
Master X Resolution	2540	
Master Y Resolution	2540	
Master Underline Pos	-1747	
Master Underline Thick	449	
LRE Threshold	176	
Global Italic Angle	0	
Global Intellifont Data Size	112	
.... Global Intellifont Data....		
.... Copyright Statement (optional)....		
.... Application Support (optional)....		

Character Descriptor and Data Format for PCL Bitmap Fonts

Following the font descriptor, the individual characters must be defined. Individual characters are defined using the character descriptor. This descriptor consists basically of two components: the character header and the character shape data. The character header contains 16 bytes that identify information about the character that varies from character to character, such as character width and height, and left and right offsets.

The character data is binary (raster) data that identifies the shape of the character.

Character descriptor/data is downloaded using the Character Descriptor command. This command is described later in this chapter.

Note

A unique character code must be designated prior to the download of a character descriptor and data. If the font being downloaded already contains a character with this code, the existing character will be deleted during the download of the character descriptor and data. Unless otherwise specified, inappropriate values in a character descriptor field will invalidate the character download process; a character will not be created, and the associated descriptor and data will be discarded.

Character descriptor fields identified as "reserved" should be set to 0.

Figure 10-8 shows the format of the bitmap character descriptor and data.

If the total byte count of the character descriptor and data exceeds 32767 bytes then the remaining data must be sent using the continuation descriptor (see Figure 10-8).

Byte	15 - MSB 8	7 LSB - 0
0	Format (4)	Continuation (0)
2	Descriptor Size (14)	Class (1)
4	Orientation	Reserved (0)
6	Left Offset	
8	Top Offset	
10	Character Width	
12	Character Height	
14	Delta X	
16	Raster Character Data: (in bytes) ⋮	

Figure 10-7. PCL Bitmap Character Descriptor and Data Format

Byte	15 - MSB 8	7 LSB - 0
0	Format (4)	Continuation (non-zero)
2	Raster Character Data: (in bytes) ⋮	

Figure 10-8. PCL Bitmap Continuation Character Descriptor and Data Format

Note

The following notation is used to define the data type of each field in the character descriptor.

Character Descriptors/Data Continuation Block

(B)	: Boolean	(0,1)
(UB)	: Unsigned Byte	(0 . . 255)
(SB)	: Signed Byte	(-128 . . 127)
(UI)	: Unsigned Integer	(0 . . 65535)
(SI)	: Signed Integer	(-32768 . . 32767)

Format (UB)

Specifies the format of the character descriptor and data. The format number used by the HP LaserJet III printer is 4. This format must match that of the Font Descriptor.

Format Values

Value	Format
4	LaserJet Family (Raster)
10	Intellifont Scalable

If the format number is different from that expected by the device, the character is discarded.

Continuation (B)

Specifies whether the following data is a character descriptor (0) block or a continuation (1) of the data associated with the previous character descriptor. Because the value field in a Character Descriptor command is limited to 32767 bytes, characters whose byte count execeed this must be sent or continued in two or more blocks. The remaining bytes must be sent using the continuation descriptor (see Figure 10-8).

Descriptor Size (UB)

Specifies the size of the character descriptor in bytes. The descriptor size used by the LaserJet printer family (including the LaserJet III printer) for bitmap fonts is 14. (The descriptor size for Itellifont scalable fonts is 2.)

Class (UB)

Specifies the format of the character data. For bitmap fonts only values 1 and 2 will be used, as described below. Classes 3 and 4 are used for Intellifont scalable fonts and are described in the following section *Character Descriptor and Data Format for Intellifont Scalable Fonts*.

Value	Class
1	Bitmap
2	Compressed Bitmap
3*	Contour (Intellifont Scalable)
4*	Compound Contour (Intellifont Scalable)

*These are described in the next section.

Class 1 - Bitmap Data

Class 1 or bitmap (raster) character data is a string of bytes containing the dot-per-bit image of the character, no data compression. If a bit is set to one, the corresponding dot will be printed. The data is grouped in dot rows; a row describes a one-dot high strip of the character from left to right, in the direction of the printer's raster scan (see the Portrait Bitmap Character Data Example, at the end of this chapter). Zeroed bits must be added to the end of each row to make it contain an integral number of bytes. The dot rows are organized from top to bottom of the character, for example, the first dot row of data corresponds to the top dot row of the character.

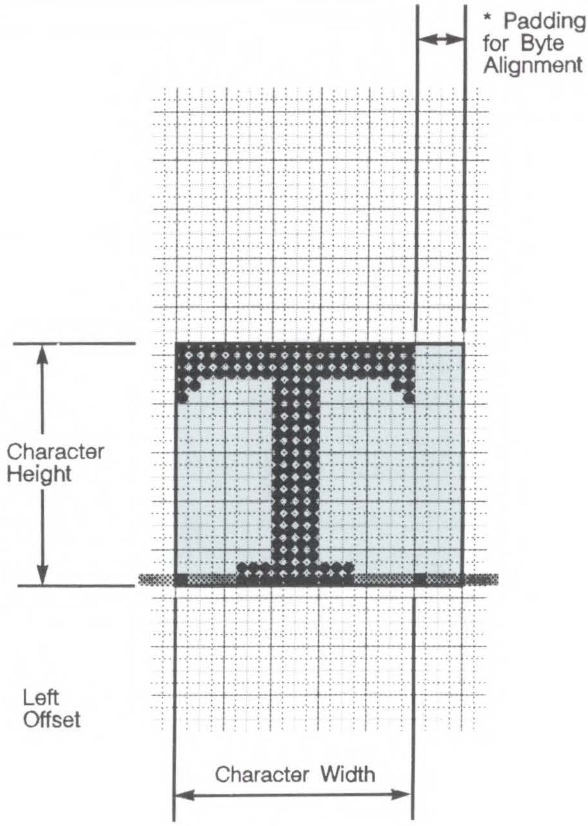
The number of bytes of the character data should be exactly Character Width (in bytes) times Character Height. If more data is received, it is discarded; if less data is received, the character consists of only the data downloaded.

Class 2 - Compressed Bitmap Character Data

For bitmap compressed raster character data the data is composed of a string of bytes using a run-length with line repetition compressed format (see Figure 10-9). The first byte indicates the number of times the first raster row is repeated after its initial occurrence. It is assumed that the first pixel in a row is white, hence the second byte indicates how many white pixels start the row. The third byte indicates how many black pixels, the fourth byte indicates the number of white pixels again, etc. If the first pixel in a row is black, the white pixel indicator (the second byte) would be 0. If there are more than 255 pixels in a row of the same type, there would be a byte containing 255, followed by a 0 byte, followed by a byte containing the count of remaining pixels of the current type.

The width of each row is determined by the character width (in dots) as specified in the character descriptor for the character. The pixel count (number of 1's and 0's bits) for each row in the character cell must equal the character width. For example, in Figure 10-9, the cell width in is 20, thus each row (excluding the repetition count byte) adds up to 20.

Once the row has been filled, the row is duplicated as indicated in its first byte, then a new row is started.



Line Repetition	# white pixels	# black pixels	# white pixels	# black pixels	# white pixels	# black pixels
2	0	20	-	-	-	-
0	0	2	6	4	6	2
0	0	1	7	4	7	1
12	8	4	8	-	-	-
1	5	10	5	-	-	-

Uncompressed - 60 Bytes
Compressed - 25 Bytes

* Byte alignment is necessary only for raster data i.e. (Not necessary for compressed raster data.)

Figure 10-9. Class 2 Character Data.

Orientation (UB)

Orientation byte specifies the orientation of the character. The orientation of the character must match the orientation of the font.

Value	Orientation
0	Portrait
1	Landscape
2	Reverse portrait
3	Reverse landscape

If the orientation is not supported or is different from the orientation specified in the font descriptor, the character is discarded.

Left Offset (SI)

Left offset specifies the distance in dots from the reference point to the left side of the character pattern on the physical page coordinate system (i.e, this value is orientation dependent). The left and top offsets locate the character reference point about the cursor position (see Figures 10-10 and 10-11). Left offset is orientation dependent.

This printer supports kerning (both negative left and right side bearings) of both fixed-pitch and proportionally-spaced fonts. Note that large offsets could place the character off the printable area of the page causing the character to be clipped.

The legal range for the left offset is −16384 to 16384 dots.

Top Offset (SI)

Top offset specifies the distance in dots from the reference point to the top of the character pattern on the physical coordinate system (that is, this value is orientation dependent.) The left and top offsets locate the character reference point about the cursor position (see figures 10-10 and 10-11). The legal range for the top offset is −16384 to 16384 dots.

Character Width (UI)

The Character Width, used for bitmap fonts only, identifies the width of the character in dots on the physical coordinate system. Generally, this width is from the farthest left black dot to the farthest right black dot. Character width is orientation dependent.

The legal range for character width is 1 to 16384 dots.

Character Height (UI)

Character Height specifies the height of the character in dots on the physical coordinate system. Character height is orientation dependent.

The legal range for character height is 1 to 16384 dots.

Delta X (SI)

Delta X specifies the number of quarter-dot units by which the horizontal position within the logical page coordinate system will be incremented after printing the character. This value is only used by the printer when the font is proportionally spaced.

The legal range for delta X is 0 to 32767 quarter-dots.

Character Data

Character data is a string of bytes containing the dot-per-bit image of the character or a run-length with line repetition compressed format.

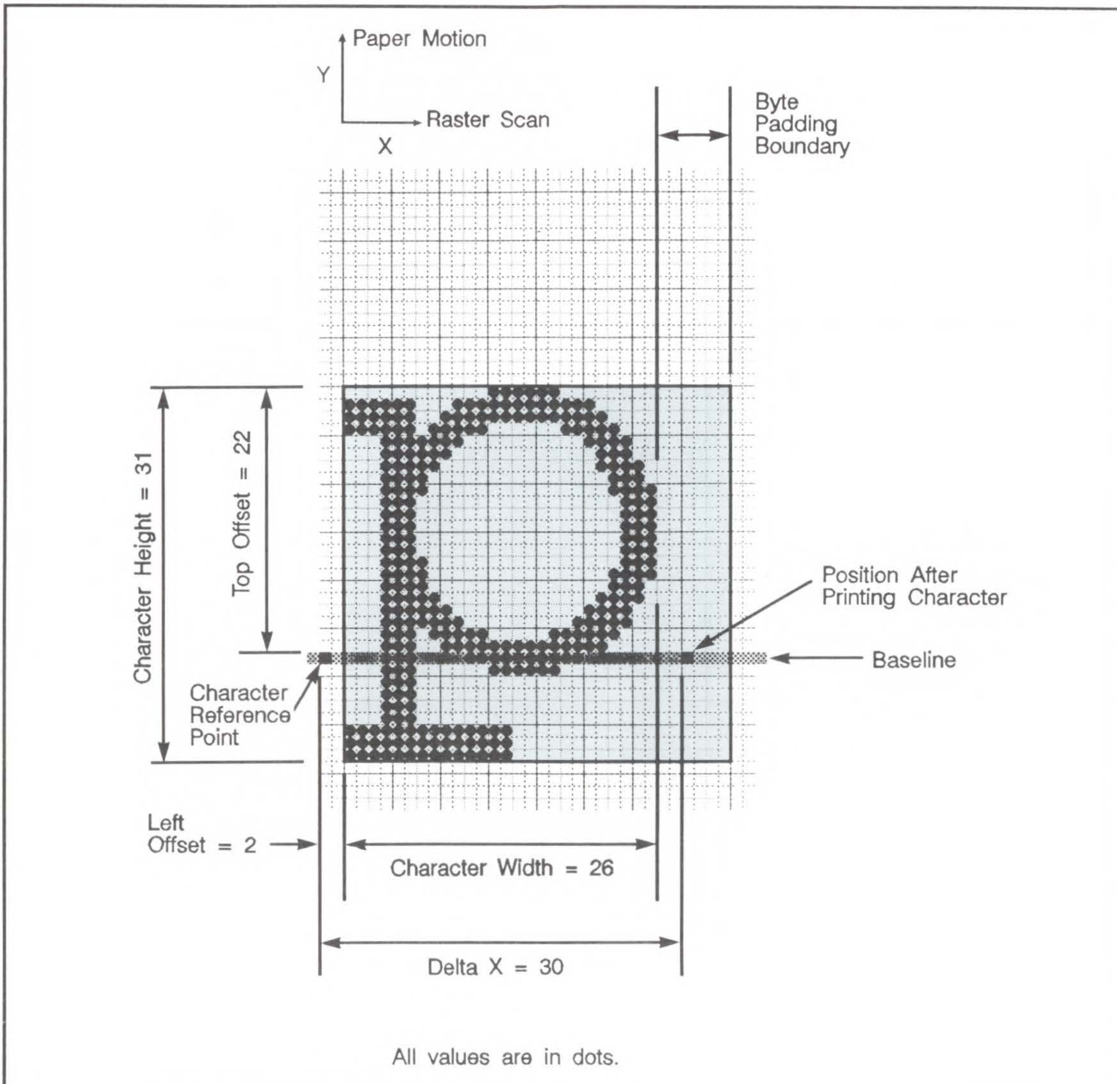


Figure 10-10. Portrait Character Example

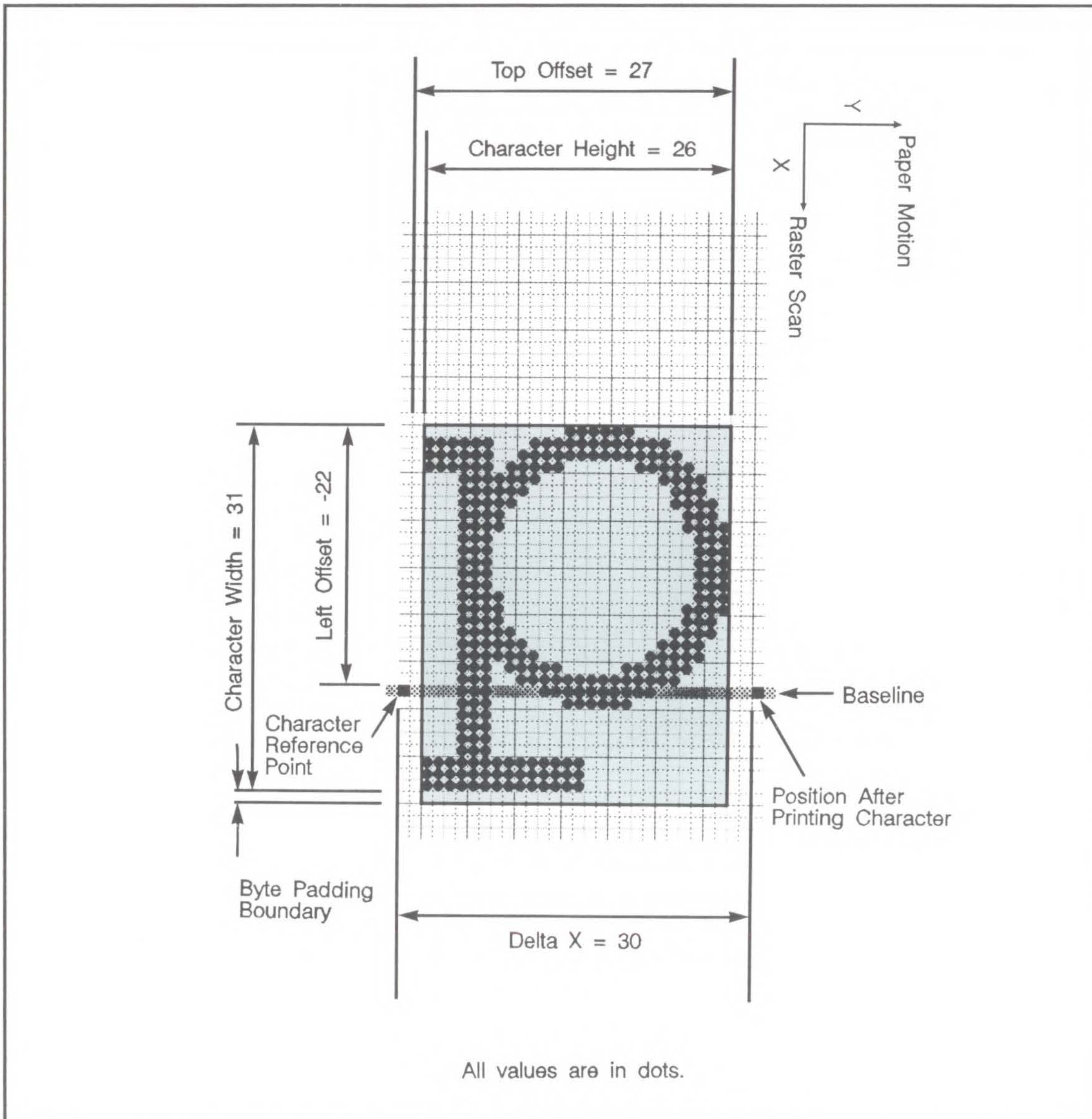


Figure 10-11. Landscape Character Example

Character Descriptor and Data Format for Intellifont Scalable Fonts

Following the font descriptor, the individual characters must be defined. Individual characters are defined using the character descriptor. This descriptor consists basically of two components: the character header and the character shape data. The character header contains a block of bytes that identify information about the character that varies from character to character which includes the character outline data.

Character descriptor/data is downloaded using the Character Descriptor command. This command is described later in this chapter.

Note

- A unique decimal character code (such as ASCII 33) must be designated prior to the download of a character descriptor and data. If the font being downloaded already contains a character with this code, the existing character will be deleted during the download of the character descriptor and data. Unless otherwise specified, inappropriate values in a character descriptor field will invalidate the character download process; a character will not be created, and the associated descriptor and data will be discarded.
- An undefined printable character is one which is in the printable range of the font type but has no defined pattern. Attempts to print an undefined printable character from a font results in the execution of a space control code.

Those character descriptor fields identified as "reserved" should be set to 0.

If the total byte count of the character descriptor and data exceeds 32767 bytes then the remaining data must be sent using the continuation descriptor (see Figure 10-14).

Figures 10-12 and 10-13 show the format of the Intellifont scalable character descriptor and data.

Byte	15 - MSB 8	7 LSB - 0
0	Format (10)	Continuation (0)*
2	Descriptor Size (2)	Class (3)
4	Contour Character Data: (in bytes) ⋮ see Figure 10-13 for Contour Character Data	
	Reserved (0)	Checksum **

* Continuation is supported for classes 1,2, and 3 only.

** These bytes appear only on the last continuation.

Figure 10-12. Intellifont Scalable Character Descriptor and Data Format

Byte	15 - MSB 8	7 LSB - 0
4	Contour Data Size	
6	Metric Data Offset	
8	Character Intellifont Data Offset	
10	Contour Tree Offset	
12	XY Data Offset	
14		
	Metric Data ⋮	
	Character Intellifont Data ⋮	
	Contour Tree Data ⋮	
	XY Coordinate Data ⋮	
	0	Checksum

Figure 10-13. Intellifont Scalable Contour Data Format

Byte	15 - MSB 8	7 LSB - 0
0	Format (10)	Continuation (1)*
2	Contour Character Data: (in bytes) ⋮	
	Reserved	Checksum**

* Continuation is supported for Intellifont scalable fonts for class 3 only.

** This byte appears only on the last continuation.

Figure 10-14. Intellifont Scalable Character Descriptors/Data Continuation Block

Byte	15 - MSB 8	7 LSB - 0
0	Format (10)	Continuation (0)
2	Descriptor Size (2)	Class (4)
4	Compound Character Escapement	
6	Number of Components	
8	Component List	
	⋮ see Figure 10-16 for Component List Data	

Figure 10-15. Intellifont Scalable Compound Character Descriptor and Data Format

Format (UB)

Specifies the format of the character descriptor and data. The format number used by the HP LaserJet III printer for Intellifont scalable fonts is 10.

Value	Format
4	LaserJet Family (Raster)
10	Intellifont Scalable

If the format number is different from that expected by the device, the character is discarded.

Continuation (B)

Specifies whether the following data is a character descriptor block (0) or a continuation (1) of the data associated with the previous character descriptor.

Because the value field in a Character Descriptor command is limited to 32767 bytes, characters whose byte count exceed this must be sent or continued in additional descriptor blocks. The remaining bytes must be sent using the continuation descriptor (see Figure 10-8). Figure 10-14 shows the continuation block for an Intellifont Scalable font.

Note

Compound characters cannot be continued.

Descriptor Size (UB)

Specifies the size of the character descriptor in bytes. The descriptor size used by the LaserJet printer family (including the LaserJet III printer) for scalable fonts is 2. (The descriptor size for bitmap fonts is 14.)

Class (UB)

Specifies the format of the character data. For Intellifont scalable fonts values 3 and 4 are used, as described below. (Classes 1 and 2 are used for bitmap fonts and are described in the preceding section, *Character Descriptor and Data Format for Bitmap fonts*.)

Value	Class
1	Bitmap
2	Compressed Bitmap
3	Contour (Intellifont Scalable)
4	Compound Contour (Intellifont Scalable)

Class 3 -Intellifont Scalable Character Contour Data

Class 3 is for Intellifont scalable contour character data. The Descriptor Size field in the character descriptor (Figure 10-12) should be set to 2. The contour character data is organized as described in Figure 10-13. Bytes 0-3 contain the character descriptor.

Class 4 - Intellifont Scalable Compound Character Data

A class 4 character is a compound character and composition data follows. The descriptor Size field in the character header should be set to 2. The composition data is organized as described in Figure 10-16. Bytes 0-3 contain the character descriptor. The compound descriptor allows combining two different characters to produce a single compound character.

Contour Data Size (UI)

The size of the contour data including the size of this field. For a detailed description of this field, refer to the FAIS document.

Metric Data Offset (SI)

The offset to the Metric Data relative to the address of the Contour Data Size field. For a detailed description of this field, refer to the FAIS document.

Character Intellifont Scalable Data Offset (SI)

The offset to the Character Intellifont Scalable Data relative to the address of the Contour Data Size field. For a detailed description of this field, refer to the FAIS document.

Contour Tree Offset (SI)

The offset to the contour Tree Data relative to the address of the Contour Data Size field. Contact AGFA Compugraphic for license details.

XY Data Offset (SI)

The offset to the XY data relative to the address of the Contour Data Size field. For a detailed description of this field, refer to the FAIS document.

Note

For information on how to obtain the FAIS document, refer to the "Related Documents" section in the front of this manual.

Metric Data

For information about Metric Data refer to the FAIS document.

Character Intellifont Scalable Data

Contact AGFA Compugraphic for license details.

Contour Tree Data

For information about Contour Tree Data refer to the FAIS document.

XY Coordinate Data

For information about XY Coordinate Data refer to the FAIS document.

Checksum

The checksum of all the contour character data. A checksum for a continuation block is not a running sum. That is, there is a checksum for each individual block and not for the sum of all individual character blocks.

Compound Character Escapement (SI)

The escapement in design window units of a resulting compound character. For a detailed description of this field, refer to the FAIS document.

Number of Components (UB)

The number of components of a compound character. For a detailed description of this field, refer to the FAIS document.

Note

For information on how to obtain the FAIS document, refer to the "Related Documents" section in the front of this manual.

Component List

The component list consists of 6 bytes which identify three components as shown below:

Byte	15 - MSB 8	7 LSB - 0
0	Character Code	
2	X Offset	
4	Y Offset	

Figure 10-16. Component List

The Character Code number of the components of a compound character, X offset is the offset of a component from the reference point (origin) in the x direction in design window units, and Y offset is the offset in the y direction of a component from the reference point (origin) in design window units.

Note

The character code may be greater than the last code of the symbol set that is implied by the font type since a compound character can include components that are not part of the symbol set.

Character Code Command

The Character Code command establishes the decimal code that will be associated with the next character downloaded. This value is used to reference the character for printing.

^E_C * c # E

= character code

Example

To designate the character code for an ASCII lower-case "p", send:

^E_C*c112E

Character Descriptor and Data Command

The Character Descriptor and Data command is used to download the character descriptor and associated character data to the printer for both bitmap and Intellifont Scalable fonts.

$^{E}_{C}$ **(s # W** [character descriptor and data]

The value field (#) identifies the number of bytes in the character descriptor and data. The maximum number is 32767.

For a detailed description of the Character Descriptor fields for bitmap fonts refer to the *Character Descriptor and Data Format for Bitmap Fonts* or for Intellifont scalables refer to the *Character Descriptor and Data Format for Intellifont Scalables* section in this chapter.

Example - Bitmap Portrait Character

To download a bitmap character descriptor and data for a portrait, 10 Pitch, 12 point, upright medium, Courier lower-case "p", send:

$^{E}_{C}$***c112E** (112 is the decimal character code for an ASCII lower-case "p")

$^{E}_{C}$**(s140W** [character descriptor and data]

Character Format, Continuation, and Descriptor

FIELD NAME	VALUE	DESCRIPTION
Format	4	LaserJet Printer Family
Continuation	0	Not A Continuation Record
Descriptor Size:	14	Bitmap
Class:	1	Normal Raster
Orientation:	0	Portrait
Left Offset:	2	dots
Top Offset:	22	dots
Character Width:	26	dots
Character Height:	31	dots
Delta X:	120	Quarter Dots (30 Dots)

Portrait Character Data Example

Dot Row	Bit Map	Decimal Equivalent			
01	00000000 00001111 11000000 00000000	0	15	192	0
02	11111100 01111111 11111000 00000000	252	127	249	0
03	11111100 11111111 11111100 00000000	252	255	252	0
04	11111101 11110000 00111110 00000000	253	240	62	0
05	00011111 11000000 00001111 00000000	31	192	15	0
06	00011111 10000000 00000111 00000000	31	128	7	0
07	00011111 00000000 00000111 10000000	31	0	7	128
08	00011110 00000000 00000011 10000000	30	0	3	128
09	00011110 00000000 00000011 11000000	30	0	3	192
10	00011100 00000000 00000001 11000000	28	0	1	192
11	00011100 00000000 00000001 11000000	28	0	1	192
12	00011100 00000000 00000001 11000000	28	0	1	192
13	00011100 00000000 00000001 11000000	28	0	1	192
14	00011100 00000000 00000001 11000000	28	0	1	192
15	00011110 00000000 00000001 11000000	30	0	1	192
16	00011110 00000000 00000011 11000000	30	0	3	192
17	00011110 00000000 00000011 10000000	30	0	3	128
18	00011111 00000000 00000111 10000000	31	0	7	128
19	00011111 10000000 00001111 00000000	31	128	15	0
20	00011111 11000000 00011111 00000000	31	192	31	0
21	00011101 11110000 01111110 00000000	29	240	126	0
22	00011100 11111111 11111100 00000000	28	255	252	0
23	00011100 00111111 11110000 00000000	28	63	240	0
24	00011100 00001111 11000000 00000000	28	15	192	0
25	00011100 00000000 00000000 00000000	28	0	0	0
26	00011100 00000000 00000000 00000000	28	0	0	0
27	00011100 00000000 00000000 00000000	28	0	0	0
28	00011100 00000000 00000000 00000000	28	0	0	0
29	11111111 11111100 00000000 00000000	255	252	0	0
30	11111111 11111100 00000000 00000000	255	252	0	0
31	11111111 11111100 00000000 00000000	255	252	0	0

Example - Bitmap Landscape

To download the character descriptor and data for a landscape, 10 pitch, 12 point, upright, medium, Courier lower-case p, send:

$^{E}_{C}$***c112E** (112 is the decimal character code for an ASCII lower-case p)

$^{E}_{C}$**(s120W** [character descriptor and data]

Character Format, Continuation and Descriptor

FIELD NAME	VALUE	DESCRIPTION
Format	4	LaserJet Printer Family
Continuation	0	Not A Continuation Record
Descriptor Size:	14	Bitmap
Class:	1	Normal Raster
Orientation:	1	Landscape
Left Offset:	-22	dots
Top Offset:	27	dots
Character Width:	31	dots
Character Height:	26	dots
Delta X:	120	Quarter Dots (30 dots)

Landscape Character Data Example

Dot Row	Bit Map	Decimal Equivalent			
01	00000000 01111110 00000000 00000000	0	126	0	0
02	00000011 11111111 11000000 00000000	3	255	192	0
03	00001111 11111111 11110000 00000000	15	255	240	0
04	00011111 10000001 11111000 00000000	31	129	248	0
05	00111110 00000000 01111100 00000000	62	0	124	0
06	00111000 00000000 00111100 00000000	56	0	124	0
07	01111000 00000000 00011110 00000000	120	0	30	0
08	01110000 00000000 00001110 00000000	112	0	14	0
09	11100000 00000000 00001111 00000000	224	0	15	0
10	11100000 00000000 00000111 00000000	224	0	7	0
11	11100000 00000000 00000111 00000000	224	0	7	0
12	11100000 00000000 00000111 00000000	224	0	7	0
13	11100000 00000000 00000111 00001110	224	0	7	14
14	11100000 00000000 00000111 00001110	224	0	7	14
15	01110000 00000000 00001110 00001110	112	0	14	14
16	01110000 00000000 00001110 00001110	112	0	14	14
17	00111000 00000000 00011100 00001110	56	0	28	14
18	00111100 00000000 00111100 00001110	60	0	60	14
19	00011110 00000000 01111000 00001110	30	0	120	14
20	00001111 10000001 11110000 00001110	15	129	250	14
21	01111111 11111111 11111111 11111110	127	255	255	240
22	01111111 11111111 11111111 11111110	127	255	255	240
23	01111111 11111111 11111111 11111110	127	255	255	240
24	01110000 00000000 00000000 00001110	112	0	0	14
25	01110000 00000000 00000000 00001110	112	0	0	14
26	01110000 00000000 00000000 00001110	112	0	0	14

11

Macros

Introduction

A Macro is a group of PCL commands and/or data created by the user that is downloaded and stored in the printer. Once stored in the printer, a macro can be performed upon request (using the assigned macro ID number), again and again using a single command. When printing letters, for example, which include a company letter head, the letter head is repeated for each letter. This letter head could be created as a macro and stored in the printer. Thus, whenever the letter is printed a macro command, sent to the printer, initiates the macro to print the letter head. This allows a letter head to be easily printed for each letter.

Macros eliminate the need to download the same information over and over again, thus saving transmission time. However, the trade off is that they consume user memory. If memory usage is a concern, a possible solution might be an HP custom macro cartridge.

Custom macros can be written and stored in font-type cartridges. With the macro cartridge installed in the printer, the macros in the cartridge become available for selection. The user does not have to download the macro and no user memory is consumed.

Hewlett-Packard provides a service to assist you by developing these custom products. For information contact:

Hewlett-Packard
Boise Printer Division
Attention: Product Specials
11311 Chinden Blvd.
Boise, ID 83714
(208) 323-3684

Macro Creation

A unique identification (ID) number should be designated prior to the definition of a macro using the Macro ID command. This number is assigned to the macro. If a macro is already associated with this ID number, the previously existing macro will be deleted from user memory during the definition of the new macro. Subsequent macro operations are accomplished using the macro ID number.

A macro is created in the printer in several steps. First, the start macro command is sent to the printer to indicate the start of a macro definition. Next, the printer commands, control codes, and data that constitute the macro are sent to the printer, in the intended order of their execution. Finally, the end macro command is sent to the printer to indicate the end of the macro definition.

Assign ID Number	Macro ID command assigns a unique identification number.
Start Macro Definition	Macro Control command, $^{E}_{C}$&fØX, indicates the following commands and data are to be stored as a macro.
Macro data • • •	Escape sequences, control codes and text required to perform the desired operation
Macro data	
Stop Macro Definition	Macro Control command, $^{E}_{C}$&f1X, identifies the end of the macro data (definition).

To perform a macro send the Macro ID command with the ID number of the macro then send the Macro Control command with a value field of 2, 3, or 4 ($^{E}_{C}$&f2X, $^{E}_{C}$&f3X, or $^{E}_{C}$&f4X). This will perform the macro in the specified mode: Execute (value field=2), Call (value field=3), or Overlay (value field=4). Refer to the following section "Macro Invocation" for a description of these modes.

Macros occupy a portion of user memory. The number of macros that can be stored simultaneously in user memory is limited only by the amount of available user memory.

Macro Invocation

There are three ways to invoke a macro: **execute**, **call** and **overlay**, using the Macro Control command.

When a macro is **executed**, it begins performing its commands using the current modified print environment. Changes made to feature settings during macro execution are recorded in the modified print environment; these changes are retained upon completion of the macro execution.

When a macro is **call**ed, it begins performing its commands using the current modified print environment. Changes made to feature settings during a macro call are recorded in the modified print environment; however, these changes are not retained upon completion of the macro call. The modified print environment that existed prior to the macro call is restored.

When a macro is enabled for automatic **overlay**, its execution will be the final operation each time a page is printed. Before the macro is performed, the current modified print environment is saved and replaced with the overlay environment. The overlay environment is a combination of the user default and the current modified print environments. Changes, made to feature settings during macro overlay, are recorded in the modified print environment; however, these changes are not retained upon completion of the macro overlay. The modified print environment that existed prior to the macro overlay is restored.

Note

The Enter HP-GL/2 mode ($^{E}_{C}$%#B) command and the PCL picture frame directives are not allowed in a macro; that is, HP-GL/2 mode is not supported in a macro.

The overlay environment consists of the current settings for the following features with the remainder of the environmental features set to their user default values:

Page length	**Paper source**
Page size	**Number of copies**
Orientation	**Cursor position stack**
Registration	

Refer to Chapter 3 for descriptions of environments.

Note

The cursor (CAP) position is not part of the modified print environment. Therefore, the cursor position is not saved when a macro is called, nor is it restored upon completion. The Push/Pop Cursor Position command can be used to save and recall a cursor position.

Temporary / Permanent Macros

During its definition, a macro is automatically designated as temporary. A temporary macro is one that is deleted from user memory during a printer reset. A macro can be designated as permanent to prevent the printer from deleting it during a printer reset. A macro is designated as temporary or permanent by reference to its ID number, using the Macro Control command described later in this chapter.

Note

Temporary and permanent macros are removed from user memory whenever the printer's power is turned off.

Deleting macros

There are several mechanisms provided by PCL macro control for explicit deletion of macros from user memory. These include commands to delete all macros, all temporary macros, or an individual macro by reference to its macro ID number, using the Macro Control command described later in this chapter.

Both temporary and permanent macros are deleted from memory whenever the printer's power is turned off.

Macro ID

The Macro ID command specifies an ID number for use in subsequent macro commands.

$^{E}{}_{C}$ & f # Y

= Macro ID number (0 to 32767)

This number will be used in subsequent macro operations.

The factory default macro ID is 0.

Example

To establish a macro ID number of 5, send:

$^{E}{}_{C}$ & f 5 Y

Macro Control

The macro control command provides mechanisms for definition, invocation, and deletion of macros.

$^{E}_{C}$ & f # X

\# = 0 - Start macro definition (last ID specified)
1 - Stop macro definition
2 - Execute macro (last ID specified)
3 - Call macro (last ID specified)
4 - Enable macro for automatic overlay (last ID specified)
5 - Disable automatic overlay
6 - Delete all macros
7 - Delete all temporary macros
8 - Delete macro (last ID specified)
9 - Make macro temporary (last ID specified)
10 - Make macro permanent (last ID specified)

Note

- A macro may call or execute another macro which in turn may call or execute another macro; two levels of "nesting" are allowed.
- Other than call and execute, no macro control operations may occur within a macro.
- A printer reset command is not allowed in a macro.
- The Enter HP-GL/2 mode ($^{E}_{C}$**%#B**) command and the PCL picture frame directives are not allowed in a macro; that is, HP-GL/2 mode is not supported in a macro.

Note

- Macro cartridges include the macro ID numbers for the macros. These numbers are designed into the cartridge and cannot be changed. It is possible for a downloaded macro to be assigned the same ID number as a cartridge macro. If this occurs, the downloaded macro will have precedence. To access the cartridge macro, the downloaded macro must be deleted.
- The ID numbers for cartridge macros range from 0-32767.
- If two macro cartridges are inserted into the printer that contain macros with the same ID, the macro whose cartridge was inserted last has precedence. To access the first macro cartridge, remove the other macro cartridge.

Example

To define a macro with an ID of 7, send:

$^E{}_C$&f7yØX

•

•

•

escape sequences, control codes, and data

•

•

•

$^E{}_C$&f1X

To make the macro with an ID of 7 permanent, send:

$^E{}_C$&f7y1ØX

To enable the macro with an ID of 7 for automatic overlay, send:

$^E{}_C$&f7y4X

To delete the macro with an ID of 7, send:

$^E{}_C$&f7y8X

Macro Control Example

The following illustrates the definition of a letterhead macro.

EC&f1Y	Specify the Macro ID as one.
EC&f0X	Start Macro Definition.
EC&a540h360V	Position logo at (540, 360) decipoints in the PCL coordinate system.
EC*t150R	Set graphics resolution to 150 dots-per-inch.
EC*r1A	Start raster image of logo.
EC*b60W [Raster data]	Send the first raster line.
•	•
•	•
•	•
EC*b60W [Raster data]	Send the last raster line.
EC*rB	Stop raster graphics.
EC&a540h780V	Position for lettering at (540, 780) decipoints.
EC(1X	Select font with ID of 1.
ABC Corp.	Text
Post Office Box 15	Text
Fred, Texas 83707	Text
EC&a540h960V	Position first rule at (540, 960) decipoints.

$^{E}_{C}$*c1ØvØ468ØH	Set rule height and width.
$^{E}_{C}$*cØP	Print the first rule.
$^{E}_{C}$&a54Øh98ØV	Position second rule at (540, 980) decipoints.
$^{E}_{C}$*cØP	Print second rule.
$^{E}_{C}$&a54Øh12ØØV	Position for first line of text at (540, 1200) decipoints.
$^{E}_{C}$&f1X	Stop Macro Definition.

This macro can now be **executed** , **called** or enabled for automatic **overlay** .

12

The Print Model

Introduction

The Print Model feature allows images and characters to be filled with any of the printer's predefined shading or cross-hatch patterns. Images are any raster graphic, such as: one created with PCL raster graphics commands (as described in Chapter 14, Raster Graphics); a rectangular fill area (as described in Chapter 13, Rectangular Area Fill Graphics); or, a character or characters selected from any font.

Print model operation defines a **pattern**, **source image** and **destination image**. These images are applied to each other using the print model's transparent and opaque modes to produce an image that is a combination of the others. The print model features, listed below, are illustrated in Figure 12-1 and 12-2, and described on the following pages.

- Pattern
- Source Image
- Destination Image
- Source Transparency Mode
- Pattern Transparency Mode

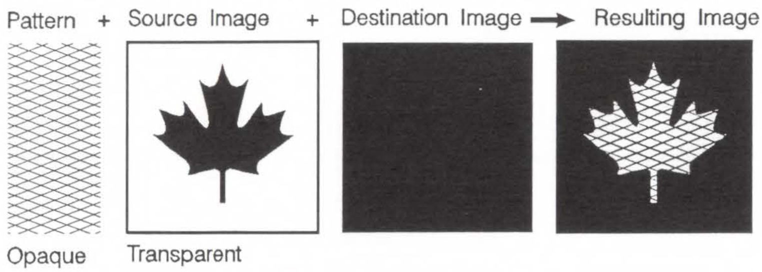


Figure 12-1. Print Model Imaging

Pattern The design "painted" through the black ("1" bits) area of the source image onto the destination image. For patterns, the Print Model uses one of the printer's internal predefined eight shading patterns (see Figure 12-4) or one of the six cross-hatch patterns (see Figure 12-5).

Note

When printing a page, text and raster images are printed using the **current pattern**. The default is 100% black. The print model allows the current pattern to be changed to white, to one of the predefined six cross-hatch patterns, or one of eight shading patterns. Once the current pattern is changed, it stays in effect until another is selected or the printer is reset. A reset returns the current pattern back to its default value (100% black).

The current pattern does not always apply to rectangular area fill, which uses patterns defined by the rectangular area fill pattern commands. Refer to the *Transparency Mode and Rectangular Area Fills* section in the back of this chapter for additional information.

Source Image An image in which the black ("1" bits) will be replaced by the specified pattern. This may be thought of as a stencil through which the pattern is applied to the destination image. The source image may be defined as a rectangular fill area, a raster graphics image, or characters.

Destination Image The image onto which the source image/pattern combination is placed. The destination image is the result of any previous operations.

Source Transparency Mode The transparency or opaqueness of the source image's white pixels (the "0" bits) as they are applied to the destination image. Setting the source transparency mode to 1 (opaque) causes the source image's white pixels to be applied to the destination image; setting it to 0 (transparent) causes these pixels to have no effect on the destination.

Pattern Transparency Mode The transparency or opaqueness of the white pixels in the pattern. When set to 0 (transparent), these pixels have no effect on the destination; when set to 1 (opaque), they are applied through the black pixels to the destination.

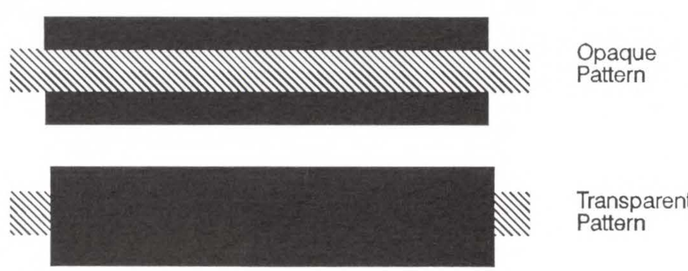


Figure 12-2. Opaque and Transparency Modes

Figure 12-3 illustrates the effects of the source and pattern transparency modes on the final image.

In the first example, the transparency mode for both the source image and the pattern are transparent. Since the source mode is "transparent", only the black-pixeled region (the circle) of the source image will be overlaid on the destination. Since the pattern mode is also transparent, the patterned source image is applied only to the white areas of the destination image.

In the second example, the source mode is still "transparent", but the pattern mode is "opaque" – so the pattern's white pixels are applied to the destination. The resulting image shows the entire circle region visible and patterned.

In the third example, the source mode is "opaque" and the pattern mode is transparent. Since the source mode is opaque, the entire source image (the circle and the surrounding square) appears overlaid onto the destination. The pattern, however, is allowed to pour through only onto the white-pixeled area of the destination. The circle is visible in the result, but only two opposing quarters appeared patterned.

In the fourth example, both source and pattern modes are "opaque". The entire source image is overlaid onto the destination, and the entire circle is patterned.

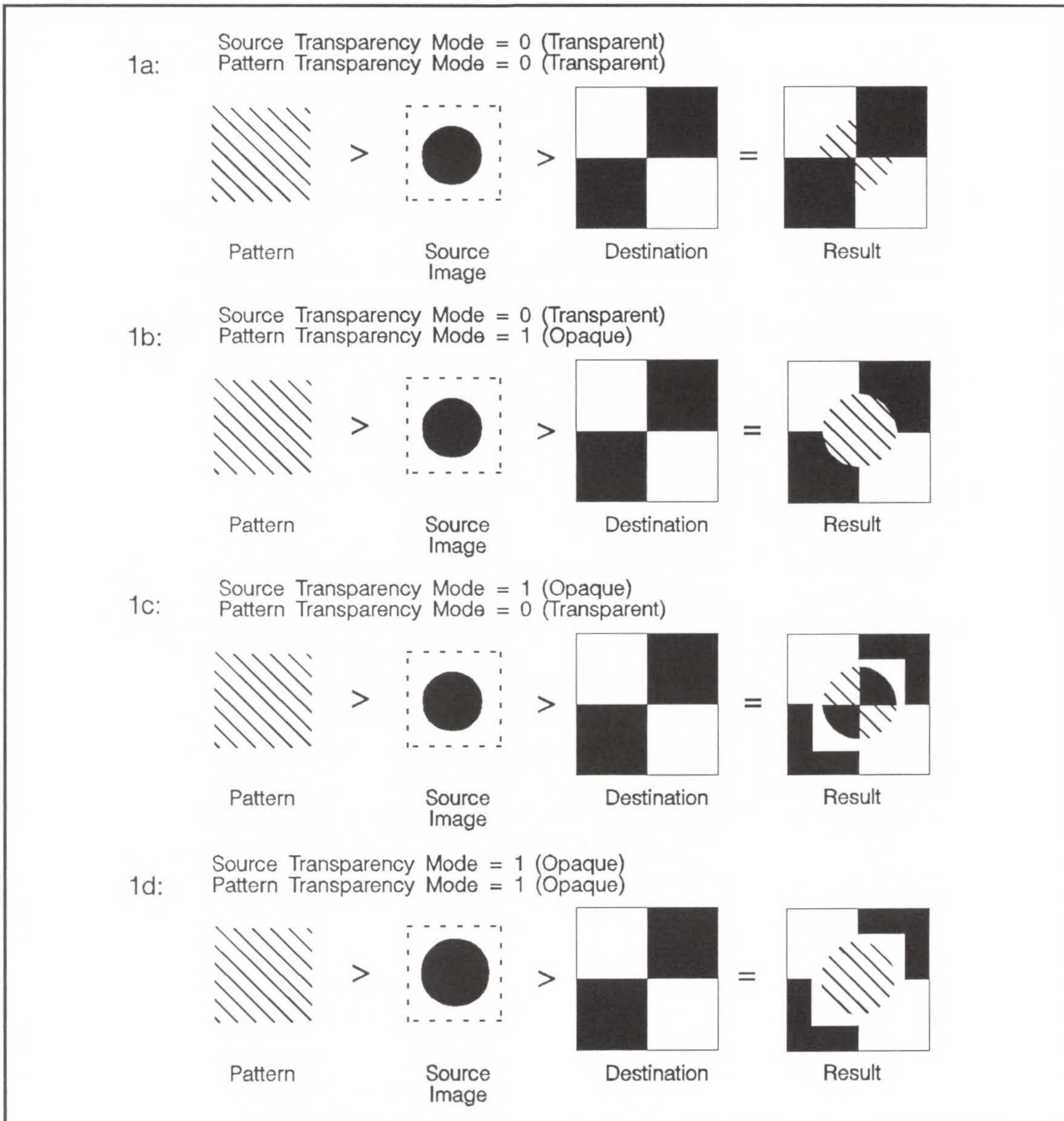


Figure 12-3. Effect of Transparency Modes on Images

Command Sequence

The following illustration shows the sequence of commands for selecting a current pattern and using it to fill a destination image.

Print Model Command Sequence

Operation	Comments
•	
•	
Download Page Data	All data downloaded (raster and character) to the page is considered destination image
•	
•	
Select Transparency Modes	$^{E}_{C}$*v#N and/or $^{E}_{C}$*v#O
Select Specific Pattern ID	Area Fill ID $^{E}_{C}$*c#G
Select Pattern	$^{E}_{C}$v#T (redefines current pattern)
Download Page Data (Source Data)	Raster image/characters
Return to regular print mode	Default current pattern and transparency modes: $^{E}_{C}$*v0T (100% black pattern selected) and $^{E}_{C}$*v0N $^{E}_{C}$*v0O (transparency mode selected).
•	
•	
Download remaining page data	Transfer data for regular printing.
•	
•	
End of Page Data	

Source Transparency Mode

The Select Source Transparency Mode command sets the source image's transparency mode to transparent or opaque.

^E_C * v # N

\# = 0 - Transparent
     1 - Opaque

The default value is 0. Any value other than 0 or 1 is ignored.

A transparency mode of "0" (transparent) means that the white regions of the source image will not be copied onto the destination. A transparency mode of "1" (opaque) means that the white pixels in the source will be applied directly onto the destination.

Refer to the preceding definitions and the discussion of Figure 12-3 for an explanation of the effects of transparency.

Pattern Transparency Mode Command

The Pattern Transparency Mode command sets the pattern's transparency mode to transparent or opaque.

$^{E}{}_{C}$ * v # O

= 0 - Transparent
1 - Opaque

The default value is 0. Any value other than 0 or 1 is ignored.

A transparency mode of "0" (transparent) means that the white regions of the pattern image will not be copied onto the destination. A transparency mode of "1" (opaque) means that the white pixels in the pattern will be applied directly onto the destination.

Note

When printing white rules, the pattern transparency is treated as if it were "opaque"; that is, white rules erase black rules regardless of the transparency mode.

Refer to the preceding definitions and the discussion of Figures 12-3 and 12-6 for and explanation of the effects of transparency.

Area Fill ID

The Area Fill ID command selects the shading level or cross hatch pattern. (This command is also used for rectangular area fill, refer to Chapter 13, Rectangular Area Fill Graphics).

^{E}C * c # G

= the percentage of shading or the type of

cross-hatching.

The default is 0 (no pattern). Values outside the range 0 - 100 are ignored.

For rectangular areas, the pattern material is determined by both the pattern ID and the value of the Fill Rectangular Area command. For other images, the pattern material is determined by the pattern ID and the value of the Select Pattern command.

Figures 12-4 and 12-5 illustrate the HP-defined shading patterns and cross-hatched patterns, respectively.

Note

This command is used for both the Select Pattern and Area Fill graphics (it is also described in Chapter 13, Rectangular Area Fill Graphics). It is duplicated here for convenience.

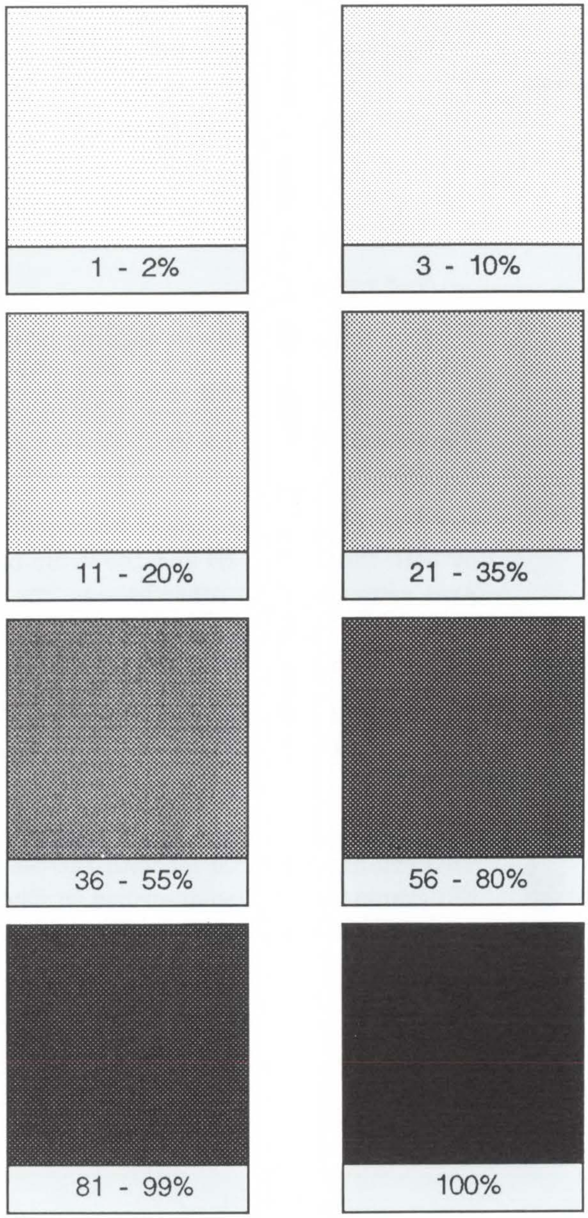


Figure 12-4. Shading Patterns

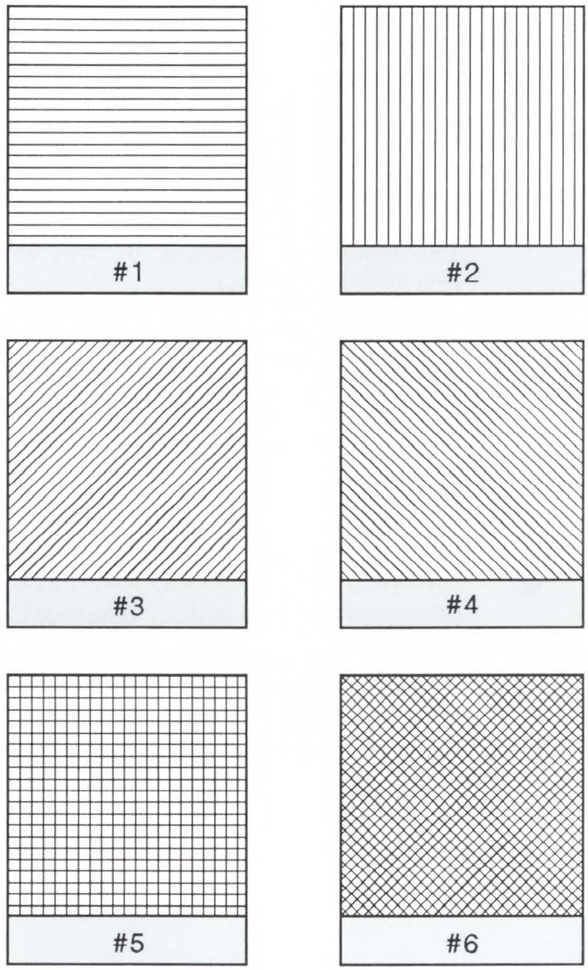


Figure 12-5. Cross-hatch patterns

Select Current Pattern

The Select Current Pattern command identifies the type of pattern to be applied onto the destination.

$^{E}_{C}$ * v # T

= 0 - solid black (default)
1 - solid white
2 - HP-defined shading pattern
3 - HP-defined cross-hatch pattern

The default is solid black (0). Any values outside the range of 0 to 3 are ignored.

This command selects which *type* of pre-defined pattern will be applied. For values 2 and 3, the shading level and cross-hatch pattern number (see Figure 12-4 and 12-5) are identified by the Area Fill ID command described in this chapter.

Note

For selecting or changing the current pattern, the Select Current Pattern ($^{E}_{C}$*v#T) and the Area Fill ID ($^{E}_{C}$*c#G) commands work together. Sending the current pattern (Select Current Pattern command) alone does not change the current pattern, the Area Fill ID must be sent first. However, when selecting solid white (white rule) or solid black (black rule) only the Select Current Pattern command is required.

Transparency Mode and Rectangular Area Fills

Rectangular areas, described in the next chapter, are special case images for transparency mode. The pattern and pattern type are selected by the Area Fill ID command (^E_C*c#G) and the Rectangular Area Fill (^E_C*c#P) command (described in Chapter 13, Rectangular Area Fill Graphics).

Source transparency mode has no effect on rectangular area fills. The rectangular areas are assumed to be a solid black (all 1's) source image. The pattern transparency modes apply as defined, except that white fill (see the Fill Rectangular Area command, Chapter 13) is always opaque.

The effect of transparency modes on rectangular areas is illustrated in Figure 12-6. In both examples, the source transparency mode is opaque regardless of the actual setting. In the first example, the pattern transparency mode is transparent; the white pixels in the pattern are not applied to the destination, so that the pattern is visible in only two quadrants of the destination. In the second example, the pattern transparency mode is opaque, and the pattern is visible in the entire rectangular area.

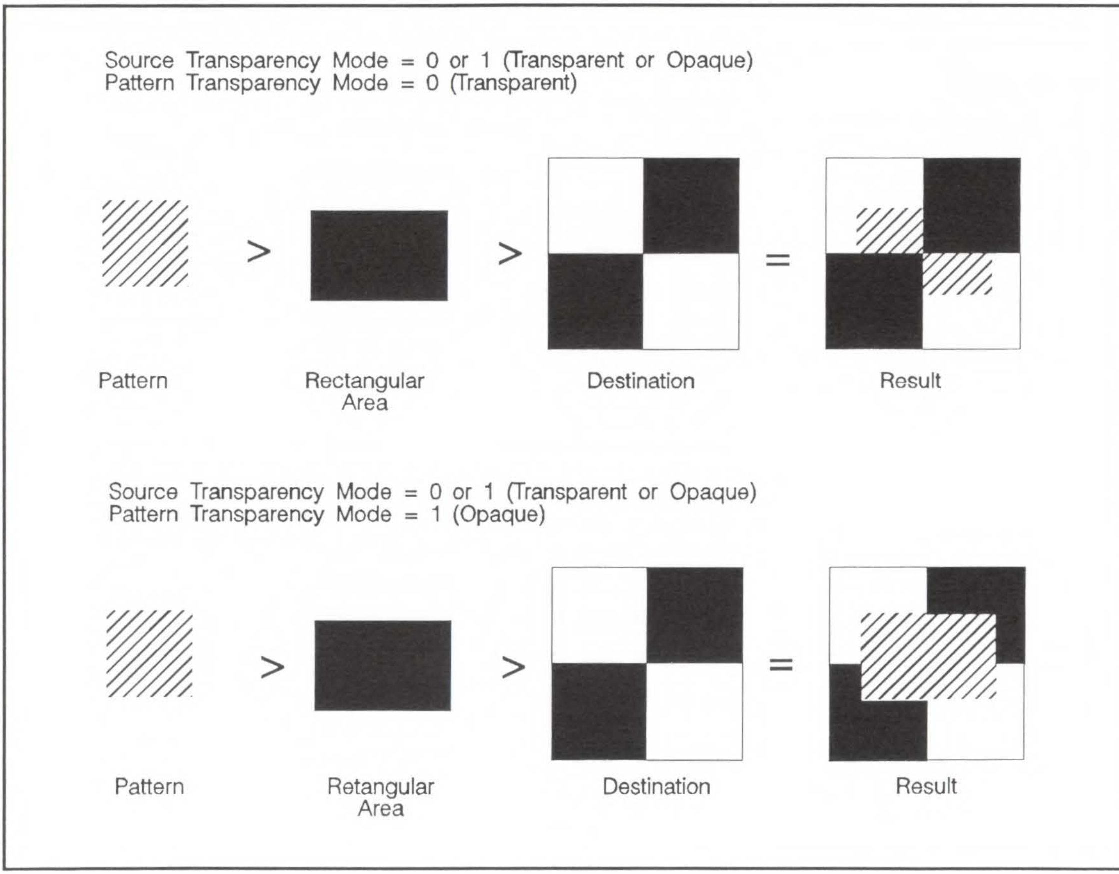


Figure 12-6. Effect of Transparency Modes on Rectangular Areas

13

Rectangular Area Fill Graphics

Introduction

The PCL language includes commands for filling or shading rectangular areas on the page with pre-defined patterns. There are eight shading patterns and six cross-hatch patterns available in the printer.

To fill an area, the dimension of the area must first be defined using the horizontal and vertical rectangle size commands. The Horizontal Rectangle Size command identifies the width of the rectangle and the Vertical Rectangle Size command identifies the height. Next, the cursor must be positioned as the reference point for the rectangle. The cursor identifies location of the upper left corner of the rectangle. Once the rectangle size and position are specified, either **shading** (see Figure 13-1) or **cross-hatch pattern** (see Figure 13-2) must be selected as the fill pattern. After the type is selected, the specific pattern must be specified to complete the procedure.

Rectangular Area Fill Procedure

- Position Cursor
- Specify width of rectangle
- Specify height of rectangle
- Specify either shade or cross-hatch pattern (area fill ID)*
- Fill rectangular area with pattern (this ends the procedure and prints the patterned area)

* Also, white, black or current pattern can be specified.

Note

- Rectangular areas are not affected by the raster graphics resolution command. The resolution for area fills is always 300 dpi.
- Rectangular areas are printed in the orientation of the logical page. An area's width extends in the positive X-direction of the PCL coordinate system; an area's height extends in the positive Y-direction.

The pattern transparency mode, described in Chapter 12 - The Print Model, controls how a pattern fills a rectangular area. Pattern transparency mode determines what effect (transparent or opaque) the white pixels of the pattern have on the rectangular area (refer to the Pattern Transparency command described in Chapter 12).

Horizontal Rectangle Size (Decipoints)

This Horizontal Rectangle Size command specifies the rectangle width in decipoints.

$^{E}_{C}$ *** c # H**

= Number of decipoints ($\frac{1}{720}$ inch)

The value field (#) is valid to 2 decimal places.

The printer converts the specified width to dots by rounding up to an integral number of dots. For example, 5 decipoints, which corresponds to 2.08 dots on the LaserJet III printer, is converted to 3 dots.

The factory default horizontal rectangle size is 0.

Horizontal Rectangle Size (Dots)

This Horizontal Rectangle Size command specifies the rectangle width in dots.

$^{E}_{C}$ *** c # A**

= Number of dots ($\frac{1}{300}$ inch)

The factory default horizontal rectangle size is 0.

Vertical Rectangle Size (Decipoints)

This Vertical Rectangle Size command specifies the rectangle height in decipoints.

$^{E}_{C}$ * c # V

= Number of decipoints ($\frac{1}{720}$ inch)

The value field (#) is valid to 2 decimal places.

The printer converts the specified width to dots by rounding up to an integral number of dots. For example, 5 decipoints, which corresponds to 2.08 dots on the LaserJet III printer, is converted to 3 dots.

The factory default vertical rectangle size is 0.

Vertical Rectangle Size (Dots)

This Vertical Rectangle Size command specifies the rectangle height in dots.

$^{E}_{C}$ * c # B

= Number of dots ($\frac{1}{300}$ inch)

The factory default vertical rectangle size is 0.

Area Fill ID

This command specifies the shading pattern (see Figure 13-1) or cross-hatch pattern (Figure 13-2) to be used when filling a rectangular area.

$^{E}_{C}$ * c # G

If Shaded fill is selected:		OR	If Cross-Hatch fill is selected:	
# =	1 thru 2 = 1- 2% shade		# =	1 - Pattern #1
	3 thru 10 = 3-10% shade			2 - Pattern #2
	11 thru 20 = 11-20% shade			3 - Pattern #3
	21 thru 35 = 21-35% shade			4 - Pattern #4
	36 thru 55 = 36-55% shade			5 - Pattern #5
	56 thru 80 = 56-80% shade			6 - Pattern #6
	81 thru 99 = 81-99% shade			
	100 = 100% shade			

The value field (#) identifies the level of shading or the cross-hatch pattern. There are eight HP defined shading patterns defined within the PCL language. To specify a shading pattern use a value within the range indicated in Figure 11-5 for the desired shading. For example, any value in the range 56 through 80 will select the 56-80% shade shown in Figure 13-1.

There are six HP defined cross-hatch patterns. To specify a cross-hatch pattern type use a value between 1 and 6 to select a pattern as shown in Figure 13-2.

Values outside the legal range are ignored.

Note

- The Fill Rectangular Area Command, described next, identifies whether the value field in this command selects a shade or cross-hatch pattern.
- This command is used to identify which pattern is selected for both the Select Current Pattern Command and the Fill Rectangular Command.

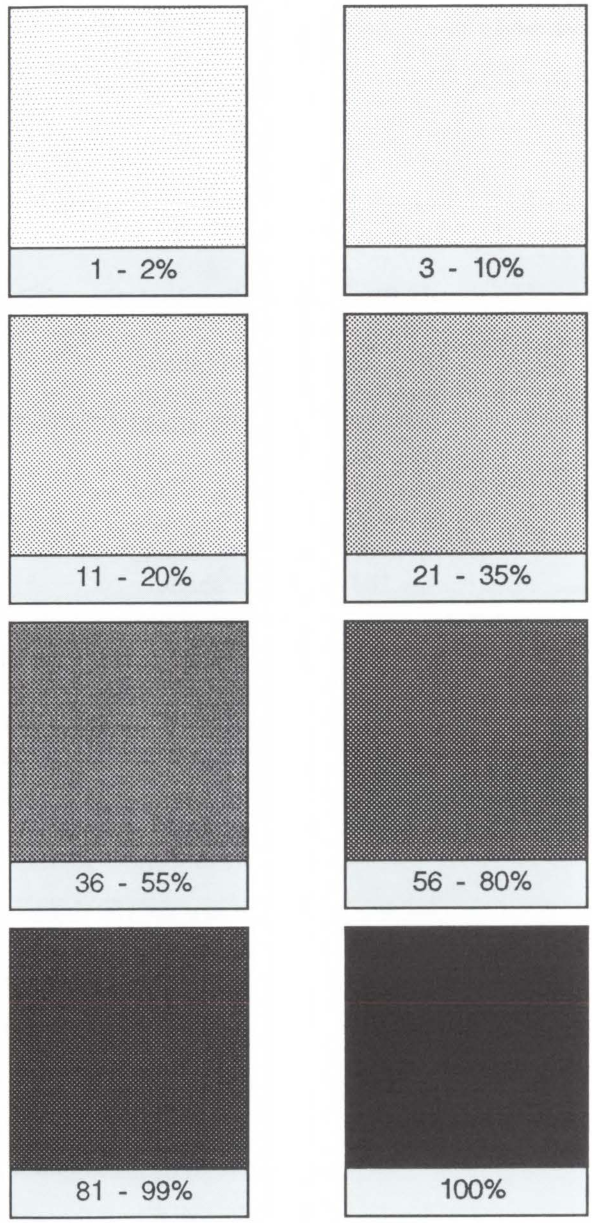


Figure 13-1. Shading Patterns

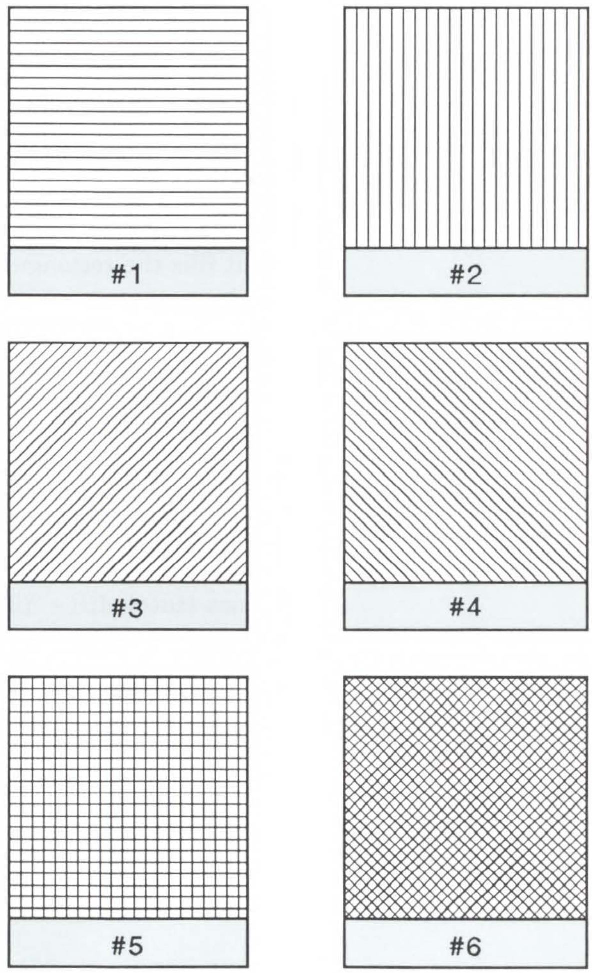


Figure 13-2. Cross-hatch Patterns

Fill Rectangular Area

This command fills (prints) a rectangular area of the specified width and height with the specified area fill.

$^{E}_{C}$ * c # P

= 0 - Black fill (rule)
1 - Erase (white) fill
2 - Shaded fill
3 - Cross-hatch fill
5 - Current pattern fill

Black fill – fills the rectangular area with black fill.

White fill – erases any fill in the rectangular area. That is, it fills the rectangular area with white fill.

Note

The order in which data (patterns/rules, text, raster) is received is the order in which it will be processed during the rasterization of the page.

Shaded fill – fills the rectangular area with one of the eight shading patterns as specified by the Area Fill ID command.

Cross-Hatch fill – fills the rectangular area with one of the six cross-hatched patterns as specified by the Area Fill ID command.

Current Pattern – fills the rectangular area with the current pattern.

Note

- Normally the current pattern will not be applied to a rectangular area unless specified by this command.
- The fill or pattern used as the current pattern is selected using the Select Current Pattern ($^{E}_{C}$*v#T) command. For a detailed description of the Select Current Pattern, command refer to Chapter 12, The Print Model.
- Black fill (value field 0), also known as black rule, and the white fill (value field of 1) "patterns" do not have a choice of different patterns and thus, do not require a pattern specification using the Area Fill ID command.

The upper left corner of the rectangular area is located at the cursor position when printing a rectangular area. After printing the rectangular area the cursor is returned to the upper left corner; that is, the cursor position does not change positions as a result of printing a rectangular area.

Rectangular areas are independent of the text area and perforation skip mode, these boundaries are ignored.

Addressable rectangular areas are limited to the logical page. Rectangular areas that extend outside the logical page are clipped at the logical page boundaries (refer to Figures 2-3 and 2-4 for logical page and printable area boundary specifications).

Transparency mode, described in Chapter 12, controls how the area fill pattern is applied to the page. Refer to the following section for a description of how transparency mode affects the rectangular fill area.

A white fill "erases" any data placed within the rectangular area prior to receipt of the white fill, regardless of the transparency mode settings. Data placed in a previously erased area will be visible.

Pattern Transparency for Rectangular Area Fill

Pattern transparency, described in Chapter 12, under the Pattern Transparency command, affects how a pattern is applied to the rectangular fill area.

Note

Source transparency has no affect on the rectangular fill area since the rectangular area is viewed as an all 1's (solid black) source image.

When applying a pattern (area fill) to the rectangular area, the usual transparency mode settings apply. The pattern transparency mode determines what affect the white pixels of the pattern will have on the destination for value fields 0 (black fill), 2 (shaded fill), 3 (cross-hatch fill), or 5 (current pattern fill) of the Fill Rectangular Area command. The "0" bits of the area fill are either applied (opaque) or ignored (transparent) based on the transparency mode setting. When a value field of 1 (white fill) is used, pattern transparency mode is always treated as if it were opaque.

Rectangular Area Fill Examples

To print a 3 inch by 5 inch black rule, then white fill a small area inside the black rectangle, perform the following steps.

1. Position the cursor:

EC*p3ØØx4ØØY	This moves the cursor to dot position (300, 400) within the PCL coordinate system.

2. Specify the width of the rule:

EC*c9ØØA	This sets the rule width to 900 dots (3 inches).

3. Specify the height of the rule:

EC*c15ØØB	This sets the rule height to 1500 dots (5 inches).

4. Print the rule:

EC*cØP	This example prints a black filled rectangular area.

5. Position the cursor inside the rectangular area:

EC*p6ØØx7ØØY

6. Specify the width and height for the smaller white fill rectangular area:

EC*c3ØØa6ØØB

7. Select the white fill and print.

EC*c1P

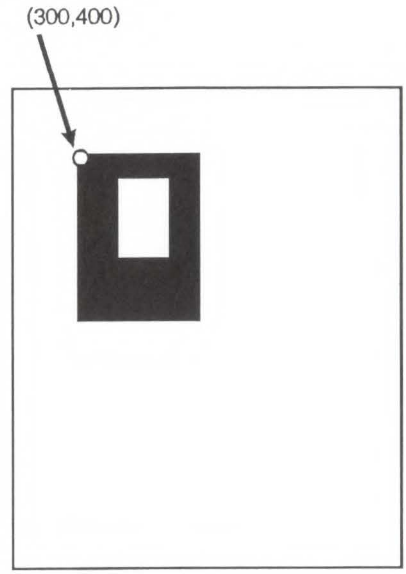


Figure 13-3. Solid Fill Example

To print a 3 inch by 5 inch 25% shaded rectangle, perform the following steps.

1. Position the cursor:

EC*p3ØØx4ØØY	This moves the cursor to dot position (300, 400) within the PCL coordinate system.

2. Specify the width of the rectangle:

EC*c9ØØA	This sets the rectangle width to 900 dots (3 Inches).

3. Specify the height of the rectangle:

EC*c15ØØB	This sets the rectangle to 1500 dots (5 inches).

4. Specify the area fill ID:

EC*c25G	This sets the area fill ID to 25.

5. Print the rectangular shaded area:

EC*c2P	This example prints the following:

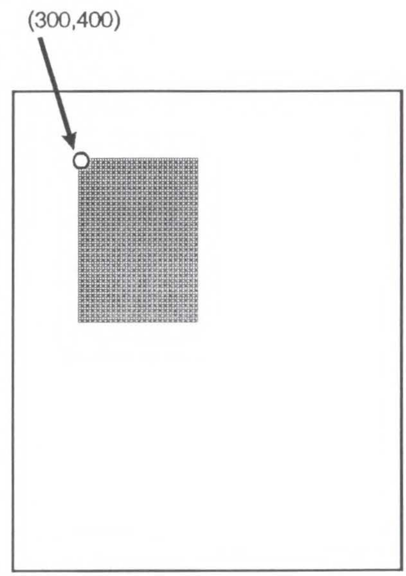


Figure 13-4. Shaded Fill Example

To print a 3 inch by 5 inch rectangular area filled with a horizontal cross-hatch pattern, perform the following steps:

1. Position the cursor:

EC*p3ØØx4ØØY	Moves the cursor to dot position (300,400) within the PCL coordinate systems.

2. Specify the width of the rectangle:

EC*c9ØØA	Sets the rectangle width to 900 dots (3 inches).

3. Specify the height of the rectangle:

EC*c15ØØB	Sets the rectangle height to 1500 dots (5 inches).

4. Specify the area fill ID:

EC*c1G	Sets the area fill ID to 1.

5. Print the rectangular pattern-filled area:

EC*c3P	This example prints the following:

Figure 13-5. Patterned Fill Example

14

Raster Graphics

Introduction

A raster image is an image composed of dots. Pictures in newspapers or television screens (also, a page printed by this printer) are examples of raster images. The PCL language includes commands for printing raster images. The LaserJet printer has the capability to receive binary data and print it as a raster image.

The binary data used to create a raster image is divided into dot rows: a row describes a one dot high strip of the image. A dot row of raster image data is transferred to the printer as a string of bytes containing a dot-per-bit representation of the row. If a bit in a row is set to one, a dot will be printed; if the bit is set to zero, no dot will be printed for that position.

This Binary Data

```
Row 1   000000000000000000000000
Row 2   000000000000000000000000
Row 3   000000001111111100000000
Row 4   000000001111111100000000
Row 5   000000001111111100000000
Row 6   000000001111111100000000
Row 7   000000000000000000000000
Row 8   000000000000000000000000
```

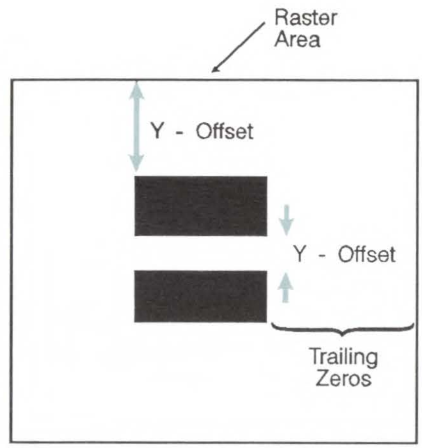
Prints This *

* Not actual size

Since it takes a considerable amount of data to create even a small raster, several ways are provided to reduce the amount of data needed to define an image. (Note, that the above illustration would create a rectangle 0.013 by 0.027 inches; a binary "1" = 1 dot = 1/300 inch.) These reduction techniques include several binary data compression modes plus, additional reduction techniques associated with the **raster area** concept. The raster area is a PCL feature that has been added to the LaserJet III printer.

Data compression modes include: run-length encoding, tagged image file format (TIFF), and delta row compression. These techniques are described in detail, later in this section, under the Set Compression Mode command.

The raster area, established by defining a raster area width and height, provides raster reduction techniques. The raster area width and height are set using the Raster Width and the Raster Height commands. Once a raster area is defined it is possible to eliminate zeroed rows from both the top and bottom of the image, within the image, and also trailing zeros. The zeroed rows at to top of the image and within the image can be eliminated by using the y-offset feature. Y-Offset identifies how many rows to skip (zero fill). The y-offset is set using the Y-Offset command. When this command sets the y-offset, the printer will fill in the required zero rows. Thus, providing a reduction in data for increased efficiency.



Also, any trailing, zeroed rows at the end of the image do not need to be sent. The printer will automatically fill in any unsent zeroed rows from the end of the raster image (last raster row with any "1"'s) to the bottom of the raster area. When the printer receives an End Raster Graphics command, it will automatically fill in zeroed rows to the bottom of the raster area.

The final data reduction technique provided by the raster area involves the printer's ability to fill in trailing zeros to the edge of the raster area. Any zeroes following the last "1" in the raster row to the edge of the picture area do not need to be sent. This technique eliminates the need for transmitting raster data rows that are all the same length, as required without the raster area.

The raster area represents a boundary. Within this boundary the printer will zero-fill missing rows and fill in short rows to the edge of the raster area. However, in addition to filling to the boundaries of the raster area, the printer will also clip any raster line which extends beyond the boundary. Thus, if an image extends beyond the raster area, then that portion of the image will not be printed.

When the raster reduction techniques that are available with the raster area are used in conjunction with the raster compression techniques, a considerable savings in data can be accomplished. This results in a saving of memory storage and data transmission time.

Raster Graphics Command Sequence

PCL raster commands include: Start Raster Graphics and End Raster Graphics commands, Transfer Raster Data by Row, Raster Compression, Raster Presentation, Raster Resolution, Raster Height and Raster Width (which define the raster area), and Raster Y Offset commands. The normal sequence of execution for these commands to make use of the raster area is shown below:

Raster Presentation
Raster Resolution
Raster Height
Raster Width
Start Raster Graphics
Y Offset
Raster Compression
Transfer Raster Data
.
Transfer Raster Data
Y Offset
Transfer Raster Data
.
.
Y Offset
Raster Compression
Transfer Raster Data
.
.
Raster Compression
Transfer Raster Data
End Raster Graphics

The emphasis in the above command sequence is that the raster presentation mode, raster resolution, raster height, and raster width are all set outside the *start..data..end* sequence of commands. Also, that the entire image is sent during the *start..data..end* sequence, choosing the most effective compression mode for each raster row of data to minimize the amount of data needed to be sent.

Raster Presentation, Raster Resolution, Raster Height, Raster Width, and Raster Compression are all true modes; that is, once specified the printer remains in that mode unless explicitly changed by issuing the command again or they are reset to their default values by a soft reset, self test, font printout, or power cycle.

Note

Only raster data appearing within the intersection of the logical page, the printable area, the raster width, and height will be printed. If raster width and/or raster height have not been set (are defaulted), then the intersection of the logical page and the printable area determine where raster graphics will appear; raster data is clipped to the printable area.

Raster Graphics Resolution

Raster graphics can be printed at 300, 150, 100 or 75 dots-per-inch. This command designates the resolution of subsequent raster data transfers.

$^{E}_{C}$ * t # R

\# = 75 - 75 dots-per-inch
100 - 100 dots-per-inch
150 - 150 dots-per-inch
300 - 300 dots-per-inch

This command must be sent prior to the start graphics command. The factory default resolution is 75 dots-per-inch.

The LaserJet III print resolution is 300 dots-per-inch. The printer automatically expands raster graphics transferred at resolutions less than 300 dots-per-inch to 300 dots-per-inch during printing. Figure 14-1 illustrates how a single bit is translated into the corresponding printed dots in each of the four resolutions:

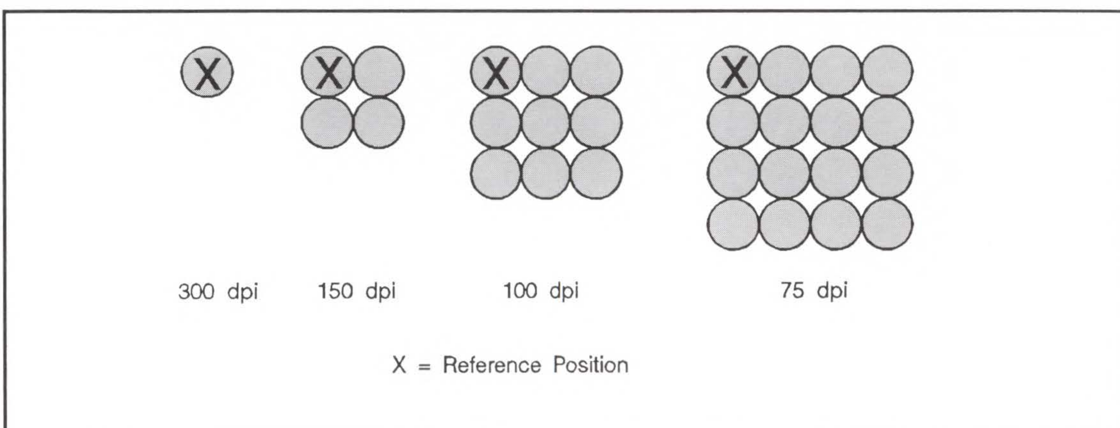


Figure 14-1. Dot Resolution

14 Raster Graphics

Lower resolution graphics occupy less user memory. For example, the number of bits required to represent a two-inch by three-inch image at 75 dots-per-inch is 33,750. The same image at 300 dots-per-inch requires 540,000 bits.

Note

Rectangular area fills are not affected by changes in resolution. Rectangular Area fills always print at 300 dpi regardless of the resolution setting.

Raster Graphics Presentation Mode

The Raster Graphics Presentation command specifies the orientation of the raster image on the logical page.

^E_C *** r # F**

\# = 0 - raster image prints in orientation of logical page

3 - raster image prints along the width of the physical page

A factory default is 3.

A value of 0 indicates that the raster graphics will be printed in the orientation of the logical page.

A value of 3 indicates that the raster graphics will be printed along the width of the physical page, regardless of logical page orientation. In portrait orientation, a raster row will be printed in the positive X-direction of the PCL coordinate system and a subsequent raster row will be printed beginning at the next dot row position in the positive Y-direction. In landscape orientation, a raster row will be printed in the positive Y-direction of the PCL coordinate system and a subsequent raster row will be printed beginning at the next dot row position in the negative X-direction. Figure 14-2 illustrates presentation mode 0 and 3.

Raster Presentation Mode	Orientation	Default Graphics Margin
0	portrait	logical page left bound
0	reverse portrait	logical page left bound
0	landscape	logical page left bound
0	reverse landscape	logical left page bound
3	portrait	logical page left bound
3	reverse portrait	logical page left bound
3	landscape	50 dots in from the logical page *top* bound
3	reverse landscape	50 dots in from the logical page *top* bound

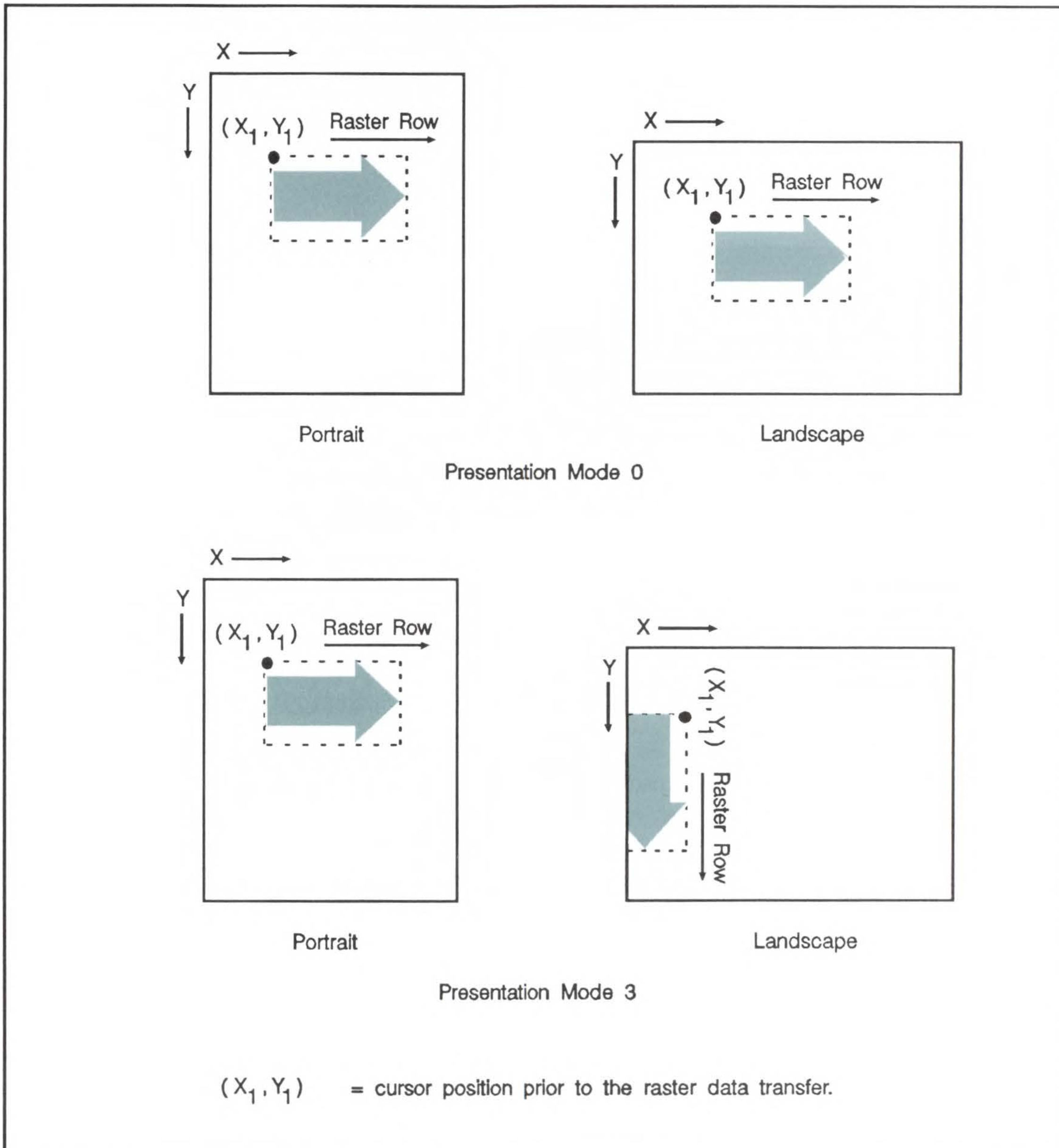


Figure 14-2. Raster Graphics Presentation Mode

Raster Height

The Raster Height specifies the height in raster rows of the raster area denoted by the next Start Raster Graphics ($^{E}_{C}$***r#A**) command. Height is the direction perpendicular to the direction that raster rows are laid down, hence, height is subject to the current Raster Presentation Mode.

$^{E}_{C}$ * r # T

\# = Height in raster rows

Range = 0 to (logical page length - Y-position of the cursor position)*

* Greater values default to (logical page length - ; Y-position of the cursor position)

This command allows the user to tell the printer to pad a raster area to the full raster height with zeroed rows. Unspecified rows map to either white or transparent depending on the source transparency mode.

When a Transfer Raster Data command is received that causes any raster row to extend beyond the row boundary set by the Raster Height command, the row outside the boundary will be clipped. This includes the case where the cursor is moved beyond the height boundary with a Raster Y Offset command and the printing of raster data is attempted.

If the user has specified either a raster height or a raster width of 0 and a Start Raster Graphics (or Transfer Raster Data) command is received, then the entire raster graphic is clipped. If, however, both a raster height and a raster width are specified (non-zero) and a Start Raster Graphics (or Transfer Raster Data) command is received then the raster area is guaranteed to be logically zeroed-out.

If the user has not set the raster height, the raster height is ignored so that no padding or clipping of rows takes place.

This command is ignored after the Start Raster Graphics or Transfer Raster Data commands until the next End Raster Graphics command.

Note

Only raster data appearing within the intersection of the logical page, the printable area, and if set, the raster width and height will be printed. Data outside the intersection is clipped.

Upon receiving an End Raster Graphics ($^{E}_{C}$***rB**) command the cursor position is set to the left graphics margin of the next raster row after the raster height boundary.

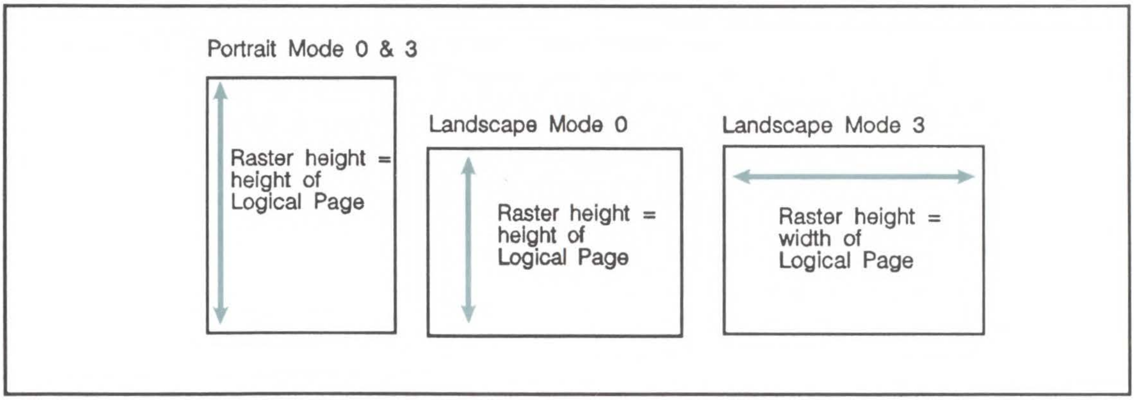


Figure 14-3. Maximum Raster Height

Raster Width

The Raster Width command specifies the width in pixels of the raster area denoted by the next Start Raster Graphics command. Width is in the direction that the raster rows are laid down, hence, width is subject to the current raster presentation mode.

$^{E}_{C}$*r#s/S

\# = Width in pixels of the specified resolution

Range = 0 to (logical page width - left graphics margin)*

*Greater values default to the (logical page width – left graphics margin).

This command allows the user to implicitly tell the printer to pad raster rows that are not specified for the full raster width with zeros. Unspecified data maps to either white or transparent depending on the source transparency mode.

When a Transfer Raster Data command is received that specifies a row of data that is longer than the raster width, the data that extends past the raster width is clipped.

This command is ignored after the Start Raster Graphics or Transfer Raster Data commands, until the next End Raster Graphics command.

Note

Only raster data appearing within the intersection of the logical page, the printable area, and if set, the raster width and height will be printed. Data outside the intersection is clipped.

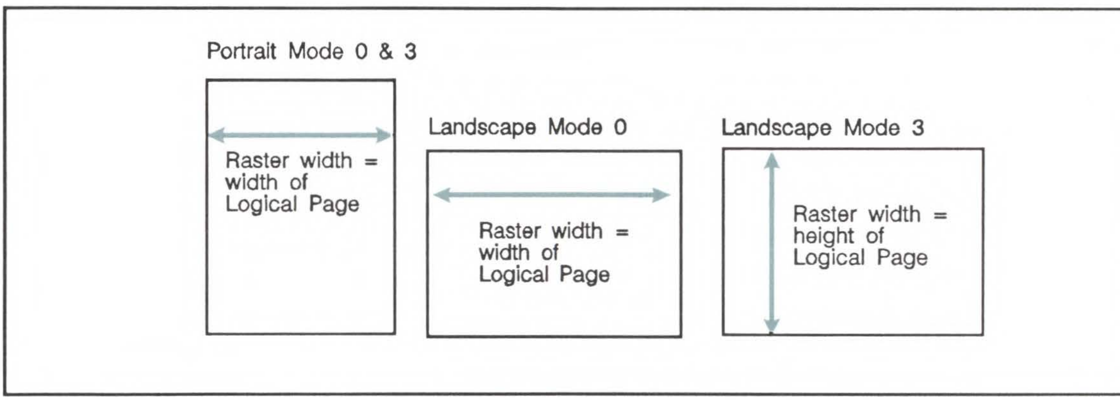


Figure 14-4. Maximum Raster Width

Start Raster Graphics

The Start Raster Graphics command identifies the beginning of the raster data and also specifies the left graphics margin.

$^E{}_C$ * r # A

\# = 0 - left graphics margin location is x-position 0.

1 - left graphics margin at the current cursor x-position.

A value of 0 specifies that the left graphics margin is at the default left margin of the page (X-position 0). A value of 1 specifies that the left graphics margin is at the current X-position.

Once a Start Raster Graphics command is received by the printer, raster graphics resolution, raster graphics presentation mode, raster height, raster width, and left raster graphics margin are fixed until an end raster graphics command is received.

Once in Raster Graphics Mode, PCL commands and text will imply an End Raster Graphics ($^E{}_C$***rB**) except for the following commands:

- Transfer Raster Data
- Set Raster Compression Mode
- Raster Y Offset

In addition, the following commands are ignored (i.e., locked out) while in Raster Graphics Mode and do not imply an End Raster Graphics command:

- Start Raster Graphics
- Set Raster Width
- Set Raster Height
- Set Raster Presentation Mode
- Set Raster Graphics Resolution

Note that an implied End Raster Graphics resets the Raster Compression Mode 3 seed row but does not reset the Raster Compression Mode nor the left raster graphics margin.

Raster Y Offset

The Raster Y Offset command moves the cursor position vertically the specified number of raster lines from the current raster position in the raster area.

$^E{}_C$ * b # Y

Value (#)	=	Number of raster lines of vertical movement
Default	=	NA
Range	=	0 - 32767

This command is recognized only while in raster graphics mode and only within the raster area.

Set Compression Mode

The Set Compression Mode command allows you to code raster data in one of three compressed formats: Run-length encoding, tagged imaged file format (TIFF) rev. 4.0, and delta row compression. The choice of compression modes impacts both the amount of code needed to generate a raster graphic image and the efficiency with which the image is printed.

$^{E}_{C}$ * b # M

\# = 0 - Unencoded

1 - Run-Length Encoding

2 - Tagged Imaged File Format (TIFF) rev. 4.0

3 - Delta Row Compression

The default value is 0. Any value outside the range (0-3) is ignored.

Unencoded

This is a simple binary transfer of data: no compression. Each bit describes a single dot. Bit 7 of the first byte corresponds to the first dot within the raster row, bit 0 corresponds to the eighth dot, and so on.

Run-length Encoding

Run-length encoding interprets raster data in pairs of bytes. The first byte of each pair is the repetition count for the data in the second byte. The second byte is the raster data byte to be printed. A repetition count of 0 signifies the pattern in the data byte is not repeated – that is, it occurs only once. A repetition count of 1 signifies the pattern occurs twice. The repetition count can range from 0 to 255.

[(Repetition count byte 1-256)(pattern byte)] . [.] [ ]

Tagged Image File Format Encoding

Tagged image file format encoding interprets raster data as TIFF "Packbits". This format combines features of modes 0 and 1. A **control byte** precedes the raster data. The control byte determines whether the subsequent byte or bytes of raster data are repeated or literal patterns (unencoded) and the number of repetitions or bytes of literal data.

A negative value (−1 to −127, represented by twos complement) in the control byte means that the subsequent byte is a repeated pattern, and the control byte's absolute value indicates the number of repetitions. For example, a control byte value of -5 means the raster pattern in the subsequent data byte is repeated 5 times (6 occurrences).

A zero or positive value in the control byte means that the subsequent byte or bytes are non-replicated bytes of data. The value of the control byte *plus one* indicates the number of data bytes following. For example, a control byte value of 0 means the following 1 byte is literal raster data. A control byte of 6 indicates that the following 7 bytes are literal raster data bytes.

TIFF encoding also allows you to include a non-operative (NOP) control byte, represented by the value −128. This byte is ignored, and the subsequent byte is treated as the new control byte.

Coding Efficiency

It is more efficient to code two consecutive identical bytes as a repeated byte. If these bytes are preceded and followed by literal bytes, however, it is more efficient to code the entire group as literal bytes.

Examples

The following are examples show how a raster row can be coded using each of the compression modes. Note that the compression examples use characters to represent the binary data stream.

Byte Number	#1	#2	#3	#4	#5	#6	#7
Bits	01010101	01010101	01010101	01010101	01000001	01010100	01010100
ASCII	U	U	U	U	A	T	T

Unencoded

E_C*r1A
E_C*b0m7WUUUUATT
E_C*rB

Run-length Encoding

E_C*r1A
E_C*b1m6W(3)U(0)A(1)T
E_C*rB

TIFF Encoding

E_C*r1A
E_C*b2m6W(-3)U(0)A(-1)T or E_C*b2m6W(-3)U(2)ATT
E_C*rB

Note that the parenthesis "()" in the above examples are NOT part of the data. They are included to highlight the control byte only and should not be included in an actual data transmission.

Delta Row Compression (Mode 3)

Delta row compression identifies a section of bytes in a row that are different from the preceding row and then transmits only that data that is different (the delta data). If a row is completely different from its preceding row, then the entire row must be sent as the delta (not very efficient); if only one bit is different then only one byte is identified and sent. To reassemble the raster data rows (image), the printer takes the current row (referred to as the seed row) and makes the changes indicated by the delta data, to create the new row. The new row (which becomes the new seed row) is used by the next delta compression data to create another row.

A delta compression row consists of two parts, a command byte and the replacement bytes, as shown below:

[(Command byte)(1 to 8 Replacement bytes)]

The command byte identifies two things: 1) the number of replacement (delta) bytes that follow; and 2) where to position to replacement byte string (the left offset). The replacement bytes are some number (up to eight bytes) of consecutive bytes that are used to create the new row from the seed row.

Command Byte

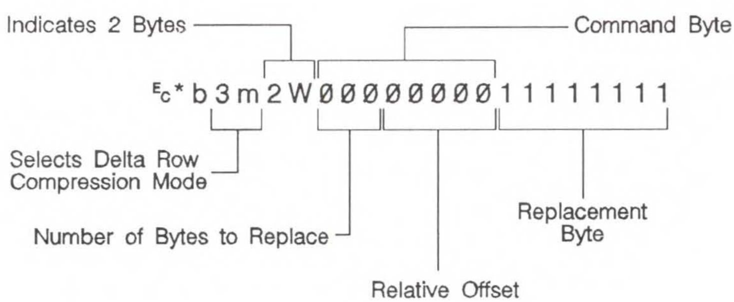
7 — 5	4 — 0
Number of bytes to replace (1-8)	Relative offset from last untreated byte

If more than eight bytes replacement (delta) bytes are needed, additional command byte/replacement bytes may be added, as shown below:

[(Command Byte)(1 to 8 Replacement Bytes)][(Command Byte)(1 to 8 Replacement Bytes)] ...

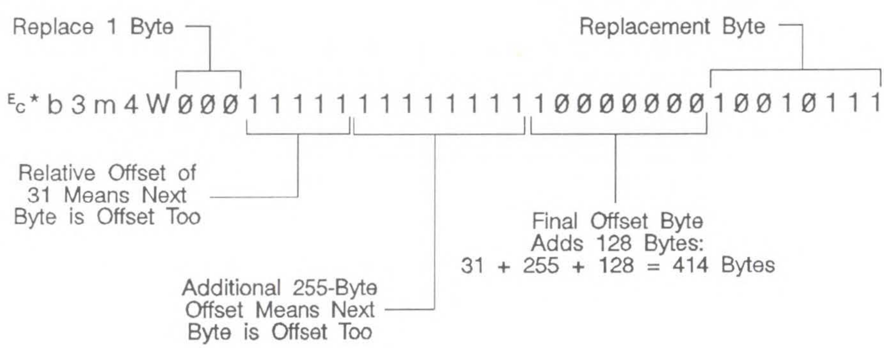
In the command byte, the upper three bits identify the number of replacement (delta) bytes (which can be 1 to 8 bytes). The lower five bits identify the location the replacement bytes are to be positioned. This position is identified as some number of bytes in, from the first untreated byte, referred to as the **offset**. For example, if there are 5 replacement bytes and the offset is 7, then the replacement bytes will replace byte 7, 8, 9, 10, and 11 (the five bytes beginning at byte 7 from the seed row).

If there is more than one replacement in a row, the second offset is counted from the next untreated byte in the row; the first byte following the last replacement byte.



As mentioned, the offset is contained in the lower five bits of the command byte, allowing an offset value from 0 to 31. Compression mode allows offsets larger than 31 bytes as follows:

- An offset value of 0-30 indicates that the replacement bytes will be offset from the 1st byte to the 31st byte.
- A value of 31 indicates an additional **offset byte** will follow the command byte. This allows offset values larger than 31. Also if this second offset byte is set to 255 (all ones) additional offset bytes follow until the required offset value is obtained. When the formatter detects an offset byte less than 255, it is assumed to be the last offset value and the offset bytes are added. The following example shows an offset larger than 31:



The total offset 414, which is the sum of the three offset values: 31 + 255 + 128.

Seed Row

The seed row is basically the current raster data row; the row that is currently being printed. It is maintained by the printer for use by delta compression. The delta compression replacement bytes are applied to the seed row to create the new row. This new data row is printed and is also the new, seed row. It' a vicious circle. Where will it end?

The seed row is updated by every raster graphic transfer, regardless of the compression mode. This allows delta compression mode to be mixed with other modes to achieve better compression performance.

Repeating a Row

$^{E}_{C}$*b0W

When using delta compression mode it is possible to repeat or copy the previous raster row using the Raster Data Transfer command. This is accomplished by setting the Raster Data Transfer command, value field, to zero.

Printing A Zeroed Row (Setting the Seed Row to Zero)

$^{E}_{C}$*b1Y

It is possible to print a row of all zeros using the Raster Y-Offset command. Sending a Raster Y Offset command with a value field of 1, sets the seed row to zero and prints the zeroed row. Note, that the next delta row will be applied to a zeroed seed row.

Other cursor position moves cause the seed row to be set to zeros. (Remember, non-graphic cursor moves have the same effect as an end graphics command.)

Note

If the byte count of the Transfer Raster Data command value field is less than the number of bytes that can be replaced, the byte count has precedence. Also, if the last byte is a control byte, it is ignored. Therefore, ^E_C***b1W** does not affect the seed row, but causes the previous row to be replicated.

Example: Delta Row Compression

The following example demonstrates how to compress the following data using the delta row compression. (The bytes highlighted in italic type indicate those bytes needing replacement - that is, those bytes that are different from the previous row, the seed row.)

Byte No.	0	1	2	3	4
Row 1	00000000	*11111111*	00000000	00000000	00000000
Row 2	00000000	11111111	*11110000*	00000000	00000000
Row 3	*00001111*	11111111	11110000	*10101010*	*10101010*

^E_C***r1A** – The *start raster graphics* command initializes the seed row to all zeros.

Row 1 – ^E_C***b3m2W**(00000001)(11111111)

The **3m** selects the delta row compression mode and the **2W** indicates the 2 bytes of data will follow. The first three bits of the first data byte, the command byte, signify a single byte replacement (all three bits are 0). The next five bits indicate an offset of 1 byte from the current position. The replacement byte follows and contains **11111111**.

Row 2 – $^{E}_{C}$***b2W**(00000010)(11110000)

The first three bits of the command byte indicate that one byte will be replaced and the next five bits indicate a relative offset of 2, so the replacement will occur 2 bytes from the current position. The replacement byte follows and contains **11110000**.

Row 3 – $^{E}_{C}$***b5W**(00000000)(00001111)(00100010)(10101010)(10101010)

As in the other rows, the first three bits of the command byte are zero, indicating a single byte replacement. The five offset bytes indicate a relative offset of zero bytes. The replacement byte follows and is 00001111. The third byte is another command byte and the first three bits signify the replacement of two bytes (the top three bits are 001). The offset bits indicate an offset of two bytes from the current position. The fourth and fifth bytes are the two replacement bytes.

Transfer Raster Data

The Transfer Raster Data command is used to transfer a row of raster data to the printer.

$^{E}_{C}$ *** b # W** [raster data]

The value field (#) identifies the number of bytes in the raster row. These bytes are interpreted as one row of raster graphics data that will be printed at the current Y position at the left raster graphics margin. Upon completion of this command, the cursor position is at the beginning of the next raster row at the left raster graphics margin.

Within the raster data, each bit describes a single dot. The most significant bit (bit 7 is the most significant, bit 0 is the least significant) of the first byte of data corresponds to the first dot within the row. If a bit is set to 1, the corresponding dot will be printed. Each dot of the raster data is expanded according to the specified raster resolution.

Raster graphics is independent of the text area and perforation skip mode, that is, these boundaries are ignored.

Raster graphic images, raster height, and raster width are limited to the printable area; images that extend beyond the printable area are clipped.

Byte Counts

The byte count of the value field in the Transfer Raster Data command has precedence over the literal or the command byte, byte count. For example, the command,

$^{E}{}_{C}$***b2m3W** [*binary data*]

sets compression mode=2 and sends 3 bytes of raster data for the row. Suppose the binary data appears as follows:

00000010 00000001 00000001 00000001

The control (first) byte value of +2 indicates that 3 bytes of literal (unencoded) raster data will follow. The Transfer Raster Data command, however, specified only three bytes total (including the control byte) in the raster row. The control byte and the following two data bytes are read, and the remaining data byte is ignored.

If the last byte indicated by the value field in the Transfer Raster Data command is a control byte, that byte is ignored.

End Raster Graphics

The End Raster Graphics command signifies the end of the transfer of a raster graphic image.

$^{E}_{C}$ * r B

Receipt of this command causes 3 operations:

1. Resets the raster compression seed row to zeros.
2. Moves the cursor to the raster row immediately following the end of the raster area if a source raster height was specified.
3. Allows raster commands which were previously locked out to be processed.

Raster Graphics Example

To transfer a raster graphic image (see Figure 14-3) in the shape of an arrow perform the following steps:

1. Position the cursor:

^E_C*p3ØØx4ØØY	This moves the cursor to dot position (300, 400) within the PCL coordinate system.

2. Specify the raster graphics resolution:

^E_C*t75R	This sets the raster graphics resolution to 75 dots-per-inch.

3. Specify the raster graphics presentation mode:

^E_C*rØF	This specifies that the raster graphics will be printed in the orientation of the logical page.

4. Specify the left raster graphics margin:

^E_C*r1A	This sets the left graphics margin to the current X position (300).

5. Transfer the raster data to the printer:

Divide the image into dot rows and transfer each dot row to the printer as a string of bytes as illustrated on the following page.

6. Signify the end of the raster graphic image transfer:

^E_C*rB	This example prints the arrow as shown in Figure 11-2.

Example of Raster Graphic Image Data

Dot Row	byte 1	byte 2	byte 3	byte 4	Decimal Equivalent
1	00000000	00000000	10000000	00000000	Ec*b4W[0, 0,128, 0]
2	00000000	00000000	11000000	00000000	Ec*b4W[0, 0,192, 0]
3	00000000	00000000	11100000	00000000	Ec*b4W[0, 0,224, 0]
4	00000000	00000000	11110000	00000000	Ec*b4W[0, 0,240, 0]
5	00000000	00000000	11111000	00000000	Ec*b4W[0, 0,248, 0]
6	00000000	00000000	11111100	00000000	Ec*b4W[0, 0,252, 0]
7	00000000	00000000	11111110	00000000	Ec*b4W[0, 0,254, 0]
8	00000000	00000000	11111111	00000000	Ec*b4W[0, 0,255, 0]
9	00000000	00000000	11111111	10000000	Ec*b4W[0, 0,255,128]
10	11111111	11111111	11111111	11000000	Ec*b4W[255,255,255,192]
11	11111111	11111111	11111111	11100000	Ec*b4W[255,255,255,224]
12	11111111	11111111	11111111	11110000	Ec*b4W[255,255,255,240]
13	11111111	11111111	11111111	11111000	Ec*b4W[255,255,255,248]
14	11111111	11111111	11111111	11111100	Ec*b4W[255,255,255,252]
15	11111111	11111111	11111111	11111110	Ec*b4W[255,255,255,254]
16	11111111	11111111	11111111	11111111	Ec*b4W[255,255,255,255]
17	11111111	11111111	11111111	11111111	Ec*b4W[255,255,255,255]
18	11111111	11111111	11111111	11111110	Ec*b4W[255,255,255,254]
19	11111111	11111111	11111111	11111100	Ec*b4W[255,255,255,252]
20	11111111	11111111	11111111	11111000	Ec*b4W[255,255,255,248]
21	11111111	11111111	11111111	11110000	Ec*b4W[255,255,255,240]
22	11111111	11111111	11111111	11100000	Ec*b4W[255,255,255,224]
23	11111111	11111111	11111111	11000000	Ec*b4W[255,255,255,192]
24	00000000	00000000	11111111	10000000	Ec*b4W[0, 0,255,128]
25	00000000	00000000	11111111	00000000	Ec*b4W[0, 0,255, 0]
26	00000000	00000000	11111110	00000000	Ec*b4W[0, 0,254, 0]
27	00000000	00000000	11111100	00000000	Ec*b4W[0, 0,252, 0]
28	00000000	00000000	11111000	00000000	Ec*b4W[0, 0,248, 0]
29	00000000	00000000	11110000	00000000	Ec*b4W[0, 0,240, 0]
30	00000000	00000000	11100000	00000000	Ec*b4W[0, 0,224, 0]
31	00000000	00000000	11000000	00000000	Ec*b4W[0, 0,192, 0]
32	00000000	00000000	10000000	00000000	Ec*b4W[0, 0,128, 0]
			Raster Image		**Raster Data Commands**

The brackets and commas are not part of the raster data command; they are used only to delineate the data.

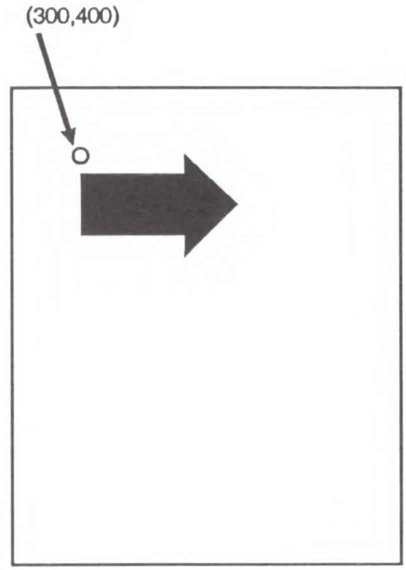


Figure 14-5. Example of Raster Graphic Image Data

15

An Introduction to HP-GL/2 Graphics

The LaserJet III printer provides the ability to print vector graphics using the HP-GL/2 graphics language. HP-GL/2 graphs may be created within application software or imported from existing applications. For various types of images (many technical drawings and business graphics, for example), it is advantageous to use vector graphics instead of raster graphics. The advantages of using vector graphics include faster I/O transfer of large images and smaller disk storage requirements.

Note

As a guideline, use raster graphics for small, complex images or those images that cannot be accomplished with HP-GL/2 (such as scanned photographs). Use HP-GL/2 for images that would involve a large amount of I/O data transfer if printed using raster graphics, or for drawings that are already in HP-GL/2 format. If the image is easier to describe using vectors instead of raster lines, the image will usually print faster using HP-GL/2.

Printing with HP-GL/2 requires leaving the PCL printer language mode and entering the HP-GL/2 mode. Switching between modes involves only a few commands and software applications may easily switch between the two modes as needed–without affecting performance.

Learning HP-GL/2

The best way to learn to use HP-GL/2 commands is to first read through this chapter and Chapter 16 for a general overview of the language and its relationship to the PCL printer language. Then, flip through the other HP-GL/2 chapters until you see an example that interests you or fits your objective. Read through the examples and try printing them using your choice of programming languages. If you need a little help in converting the generic commands shown in the examples to a programming language, see the *Using HP-GL/2 with Programming Languages* discussion later in this chapter.

As you see commands that you are unfamiliar with, find the page number of the command description in the index and read about the command. After trying some examples and seeing how the commands interact, you should be well on your way to learning the HP-GL/2 language. Think of an application that you would like to program and then look for an example that uses some of the elements you desire. In your search to create your drawing, you will be steadily learning to print using the HP-GL/2 language.

In the process of giving you an overview of HP-GL/2, this chapter describes the interaction between the PCL printer language and the HP-GL/2 modes and introduces the following topics:

- HP-GL/2 Commands and Syntax
- Using HP-GL/2 with Programming Languages
- Defining the Image Area and Scaling Factor
- The HP-GL/2 Coordinate System
- HP-GL/2 and PCL Orientation Interactions
- The Vector Graphic Limits
- Units of Measure
- Pen Position and Location

- Scaling
- Automatic Image Enlargement/Reduction
- Absolute and Relative Pen Movement

Chapter 16 covers more of the HP-GL/2 fundamentals and the remaining chapters (17 - 21) discuss the HP-GL/2 commands and their syntax.

HP-GL/2 Commands and Syntax

There are two classes of commands used to print vector graphics: PCL printer language commands and HP-GL/2 commands. As their name implies, the *PCL printer language commands* are used when in the PCL printer language mode. They define the area on the page where the HP-GL/2 graphics will be printed and provide a means to enter the HP-GL/2 mode. The *HP-GL/2 commands* are used within HP-GL/2 mode, define the image that will be printed, and allow you to return to the PCL printer language mode. The HP-GL/2 language has its own syntax and each command is listed in this section of the manual.

To make it easier to learn and use the vector graphics commands, they have been grouped into functional categories. The categories are designated as shown in Tables 15-1 to 15-5:

Table 15-1. The HP-GL/2 Commands by Group

CONFIGURATION GROUP	
DF	Default Values
IN	Initialize
IP	Input P1 and P2
IR	Input Relative P1 and P2
IW	Input Window
PG	Advance Page
RO	Rotate Coordinate System
RP	Replot
SC	Scale

Table 15-2.

VECTOR GROUP	
AA	Arc Absolute
AR	Arc Relative
AT	Absolute Arc (Three Point)
CI	Circle
PA	Plot Absolute
PD	Pen Down
PE	Polyline Encoded
PR	Plot Relative
PU	Pen Up
RT	Relative Arc (Three Point)

Table 15-3.

POLYGON GROUP	
EA	Edge Rectangle Absolute
EP	Edge Polygon
ER	Edge Rectangle Relative
EW	Edge Wedge
FP	Fill Polygon
PM	Polygon Mode
RA	Fill Rectangle Absolute
RR	Fill Rectangle Relative
WG	Fill Wedge

Table 15-4.

CHARACTER GROUP	
AD	Alternate Font Definition
CF	Character Fill Mode
CP	Character Plot
DI	Absolute Direction
DR	Relative Direction
DT	Define Label Terminator
DV	Define Variable Text Path
ES	Extra Space
FI*	Select Primary Font
FN*	Select Secondary Font

* Indicates these commands are part of the Dual Context Extensions to the HP-GL/2 language.

Table 15-4. (continued)

CHARACTER GROUP	
LB	Label
LO	Label Origin
SA	Select Alternate Font
SB*	Scalable or Bitmap Fonts
SD	Standard Font Definition
SI	Absolute Character Size
SL	Character Slant
SR	Relative Character Size
SS	Select Standard font
TD	Transparent Data

* Indicates these commands are part of the Dual Context Extensions to the HP-GL/2 language.

Table 15-5.

LINE AND FILL ATTRIBUTES GROUP	
AC	Anchor Corner
FT	Fill Type
LA	Line Attributes
LT	Line Type
PW	Pen Width
RF	Raster Fill Definition
SM	Symbol Mode
SP	Select Pen
SV*	Screened Vectors
TR*	Transparency Mode
UL	User Defined Line Type
WU	Pen Width Unit Selection

* Indicates these commands are part of the Palette Extensions to the HP-GL/2 language.

Each of the above command categories is discussed in its own chapter, beginning with Chapter 17, *The Configuration Group*.

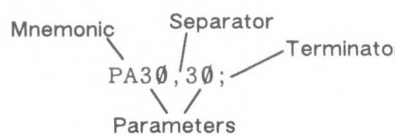
As shown in the tables above, each HP-GL/2 command is a two-letter mnemonic code designed to remind you of its function. For example, IN is the INitialize command, SP is the Select Pen command, and CI is the CIrcle command. Parameters are used with certain HP-GL/2 commands to tell the printer to complete the command in a particular way. A typical HP-GL/2 command appears as follows:

FT1

The mnemonic (FT, for Fill Type) tells the printer a fill type will be specified; the "1" parameter specifies a solid black fill.

Understanding HP-GL/2 Syntax

HP-GL/2 commands have four components: a mnemonic, parameter(s), separator(s), and a terminator. Refer to the following illustration of a typical HP-GL/2 command and the description of its components.



- **Mnemonic**–The two-letter mnemonic is designed to remind you of the command's function. The mnemonic can be uppercase or lowercase.
- **Parameter(s)**–Some commands have no parameters; for those commands having them, parameters can be either required or optional (as indicated in the description of that command);
- **Separator(s)**–When you use parameters, you must separate them with a comma or space, or in the case of a numeric parameter, with a + or - sign. (Commas are recommended because some computers eliminate spaces, especially when sending variables.)
- **Terminator**–All commands require a terminator. HP-GL/2 commands are terminated by a semicolon or the first letter of the next mnemonic. The last command prior to exiting HP-GL/2 mode *must* be terminated with a semicolon.

The following illustration shows the flexibility of the syntax. Each variation of the two-command sequence is permissible; however, the first method is recommended for your programming. The recommended method uses the first letter of the next mnemonic to terminate commands, uses no space between the mnemonic and its parameters, and separates parameters with a comma. (For clarity, examples in this HP-GL/2 section of the manual use semicolons as terminators [as shown in the middle example below].)

```
PDPU1Ø,2Ø            PD;PU1Ø,2Ø;            PD PU 1Ø 2Ø;
```

Recommended

The next section explains how the syntax of individual commands is presented.

Notations Used to Express Syntax

The following describes the notations used in the syntax section of each command description:

Mnemonic

For readability, the mnemonic is shown in uppercase and separated from the parameters and/or terminator.

parameters

Parameters are shown in italic.

[ ]

Parameters in square brackets are optional.

[param1,param2 ... [,param1,param2]]

These optional parameters must be paired.

params . . . params

These parameters may be given the number of times specified in the command description.

text . . . text

This parameter indicates that you can type in any number of ASCII characters, such as in the Label (LB) command.

(. . . .)

Indicates you can use any number of the previous parameter; however, all X coordinates must have a corresponding Y coordinate.

;

Command terminator. A semicolon is optional and is shown in parentheses in most command syntax. The Polyline Encoded (PE) command is an exception, and must be terminated by a semicolon. Also, the last HP-GL/2 command before leaving HP-GL/2 mode *must* always be followed by a semicolon.

,

A comma is always shown as the separator between parameters. A space, +, or - is also valid (although not preferred). (A + or - is only a valid separator for numeric parameters.)

Note

Remember that while X,Y coordinates are shown in parentheses in text [for example (3,4) or (0,0)], the parentheses are not part of the syntax. Do not enter these parentheses in your commands.

Omitting Optional Parameters

Some commands have optional parameters that take on default values if they are omitted. When you omit a parameter, you must omit all subsequent parameters in the same command (the Define Label Terminator (DT) command is an exception).

For example, the Line Type (LT) command has three optional parameters: type, pattern length, and mode. The following command shows all three being used (*type* = 6, *pattern length* = 25, *mode* = 1).

LT6,25,1

If you omit the second parameter you must also omit the third parameter, as shown below. The printer uses the most recently specified pattern length and mode. If you have not specified a length or mode since sending a Default Values (DF) or Initialize (IN) command, the printer uses the parameter's defaults.

LT6

For example, do *not* send the following command (the printer would interpret 1 as the second parameter).

LT6,1

Parameter Formats

You must give parameters in the format (type of units) required by each HP-GL/2 command. The required format is stated in the parameter table of each command's description, and is described as follows.

1. *Integer*–An integer from -1,073,741,824 (-2^{30}) to 1,073,741,823 (2^{30} - 1). The printer automatically rounds fractional parameters to the nearest integer. Using a number outside the specified range causes an error.
2. *Clamped Integer*–An integer from -32,768 (-2^{15}) to 32,767 (2^{15} -1). The printer automatically rounds fractional parameters to the nearest integer. Sending a number outside this range does not cause an error, but the number is "clamped" to the limits of the range. For

example, when parsing a clamped integer, the printer treats all numbers between 32,767 and 67,108,863 as 32,767.

Certain commands have parameters which are restricted to a smaller range. These ranges are listed in the parameter tables for each command. Sending a number outside the reduced parameter range may produce unexpected results.

3. *Real*–A number where the integer portion is from -1,073,741,824 (-2^{30}) to 1,073,741,823 (2^{30} - 1). You are assured of at least 6 significant digits (including integer and fractional portion). You may omit the decimal point when no decimal fraction is specified. If you don't specify a sign, the parameter is assumed to be positive. Using a number outside this range causes the command to be ignored.

4. *Clamped Real*–A number where the integer portion is from -32,768 to 32,767; you are assured of at least 6 significant digits (including integer and fractional portion). You may omit the decimal point when no decimal fraction is specified. If you don't specify a sign, the parameter is assumed to be positive. Sending a number outside this range does not cause an error, but the number is "clamped" to the limits of the range. For example, the printer treats all numbers between 32,767 and 67,108,863 as 32,767.

   Certain commands have parameters which are restricted to a smaller range. These ranges are listed in the parameter tables for each command. Sending a number outside the reduced parameter range causes the command to be ignored.

5. *Label*–Any sequence of characters. In the HP-GL/2 language, text is described using the term "label." Refer to the Label (LB) command in Chapter 21 for a complete description.

Note

Numbers within the above-mentioned ranges do not cause errors; however, the range may exceed the printer's physical printing area. Numbers that move the pen position outside the *effective window* result in image clipping. This topic is discussed in more detail later in this chapter in the *Vector Graphics Limits* discussion.

When you see the term current units in a parameter table, the unit system of that parameter depends on whether scaling is on or off. When scaling is on, the units are user units; when scaling is off, the units are plotter units.

Note

The printer cannot use exponential format numbers (for example, 6.03E8). If you are using a computer or language that uses the exponential format, you must use integer variables or a formatting technique to output fixed-point real numbers.

Using HP-GL/2 With Programming Languages

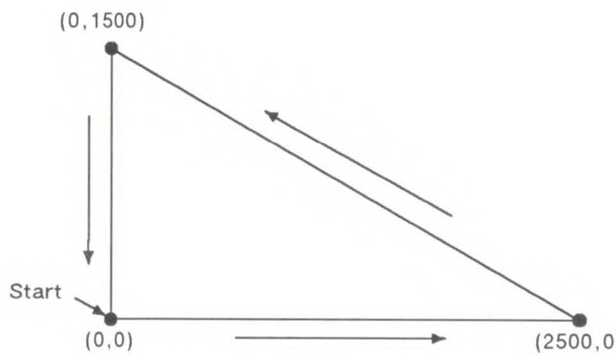
The HP-GL/2 examples included in this manual are given in a "generic" format; that is, the examples show the commands required to perform a specific function but usually do not use a specific programming language. In most cases, the commands are accompanied by a brief description of the command being used.

To see how HP-GL/2 commands are used in BASIC and the C programming language, see the following examples.

Example: BASIC

This example uses BASIC to implement the generic *Drawing Lines* example on page 18-3.

```
10 LPRINT CHR$(27);"E"; :REM Reset the printer
20 LPRINT CHR$(27);"%0B"; :REM Enter HP-GL/2 Mode
30 LPRINT "IN"; :REM Initialize HP-GL/2 Mode
40 LPRINT "SP1PA0,0"; :REM Select Pen & move to 0,0
50 LPRINT "PD2500,0,0,1500,0,0;"; :REM Pen down & draw
60 LPRINT CHR$(27);"%0A"; :REM Enter PCL Mode
70 LPRINT CHR$(27);"E"; :REM Reset to end job/eject page
```



Example: C Programming Language

This example uses the C programming language to implement the same example (the *Drawing Lines* example on page 18-3).

```
#include <stdio.h>

main()

{

FILE *prn;  /* initialization section */

prn = fopen("PRN","wb");

fprintf(prn,"\33E");  /* send an esc E to reset printer */

fprintf(prn,"\33%0B"); /* Esc%0B to Enter HP-GL/2 */

fprintf(prn,"IN"); /* Initialize HP-GL/2 Mode */

fprintf(prn,"SP1PA0,0"); /* Select pen 1 & move to 0,0 */

fprintf(prn,"PD2500,0,0,1500,0,0;"); /* Pen down & draw */

fprintf(prn,"\33%0A"); /* enter PCL at previous CAP */

fprintf(prn,"\33E"); /* Reset to end job/eject page */

}
```

Defining the Image Area and Scaling Factor

There is a group of commands that allows you to specify an area on the page for placing an HP-GL/2 graphic image. These commands are called the *Picture Presentation Directives* and are used to define a bounding rectangle to contain the HP-GL/2 image and to determine a scaling factor for enlarging or reducing it.

Defining the Image Area

Figure 15-1 illustrates the Picture Presentation Directives. The rectangular area surrounding the image is called the PCL Picture Frame and the page location of the *PCL Picture Frame* is determined by the *picture frame anchor point.*

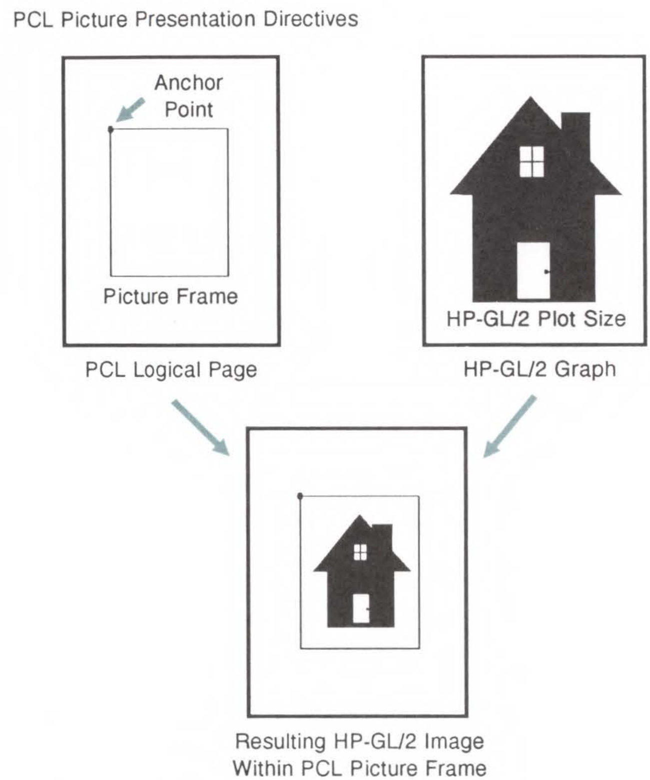


Figure 15-1. The Picture Presentation Directives

The Scaling Factor

The ratio of the HP-GL/2 plot size to the PCL Picture Frame determines the *picture frame scaling factor*. The picture frame scaling factor is used when importing an existing image and placing it in the PCL Picture Frame. Each of the above-mentioned Picture Presentation Directives is discussed in detail in Chapter 16.

The HP-GL/2 Coordinate System

The default HP-GL/2 coordinate system is different than the PCL coordinate system. When in the HP-GL/2 mode, the printer uses the Cartesian coordinate system. The Cartesian coordinate system is a grid formed by two perpendicular axes, usually called the X- and Y- axes. Refer to the following illustration. The intersection of the axes is called the origin of the system and has a location of (0,0).

Note

The HP-GL/2 coordinate system can be set up so that it matches the PCL coordinate system. See the example entitled *Adapting the HP-GL/2 Coordinate System to Match the PCL System* (Chapter 17).

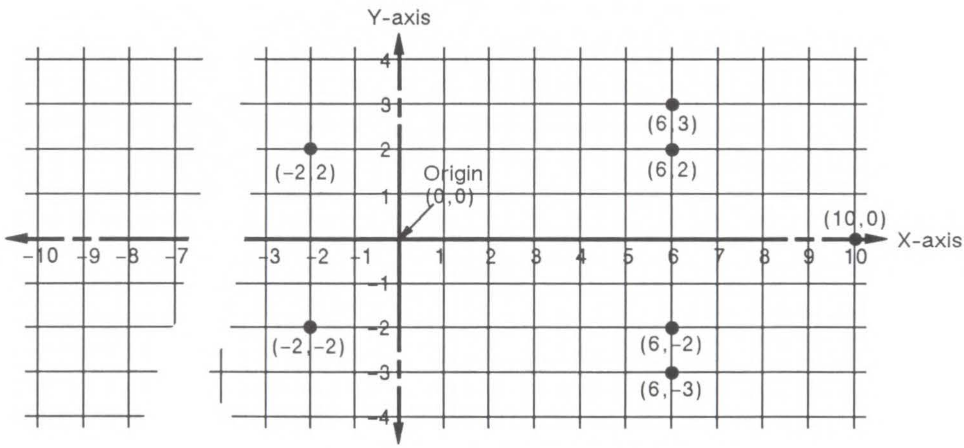


Figure 15-2. The HP-GL/2 Coordinate System

To locate any point on the grid (the printing area within the PCL Picture Frame), move from the origin a number of units along the X-axis, then move a number of units parallel to the Y-axis. The number of units you move is called a coordinate. Each point is designated by the combination of its X-coordinate and Y-coordinate, known as an X,Y coordinate pair. Positive X values are plotted to the right of the origin, and positive Y values are plotted above the origin.

Look at the previous illustration again to locate these points: (0,0); (-2,2); (6,2); (6,3); (10,0); (6,-3); (6,-2); (-2,-2); (0,0). Now draw a straight line between each point in the order listed. (You should have drawn an arrow.) This is a simple demonstration that illustrates the way you define a picture when in HP-GL/2 mode.

Note

To specify a point when programming an application, you must always give a complete X,Y coordinate pair; the X coordinate is first and the Y coordinate second. This manual shows coordinate pairs in parentheses (X,Y) for clarity, but the parentheses should not be used in your program.

Using the default HP-GL/2 coordinate system, the origin is in the lower left corner of the PCL Picture Frame, as shown in the following drawing. Using the IP or IR commands, you can move the origin to other locations. Then, using the SC command, you can set up your HP-GL/2 coordinate system for practically any value. (This process is discussed in more detail later in this chapter under *Scaling*, and also in Chapter 17.)

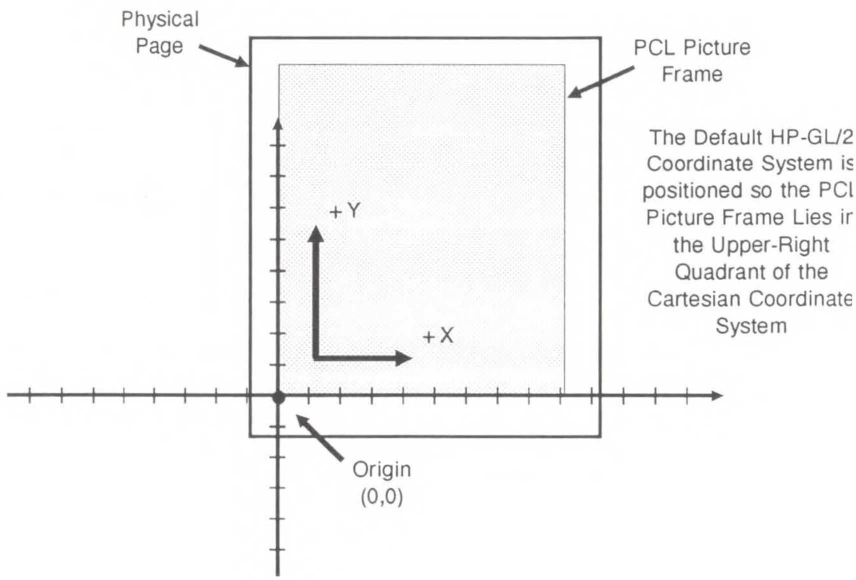


Figure 15-3. The Default HP-GL/2 Coordinate System

HP-GL/2 & PCL Orientation Interactions

The relationship between the orientation of the HP-GL/2 coordinate system and the PCL coordinate system is important. Figure 15-4 illustrates this relationship for the default HP-GL/2 orientation (RO 0) and the PCL logical page orientation. As shown in the illustration, when the HP-GL/2 orientation is defaulted, the origin of the HP-GL/2 coordinate system defaults to the lower-left corner of the PCL Picture Frame. (HP-GL/2 and PCL X-coordinates increase in the same direction, but the Y-coordinates increase in opposite directions.) Notice that a change in the PCL logical page orientation changes the orientation of the PCL coordinate system and the HP-GL/2 coordinate system.

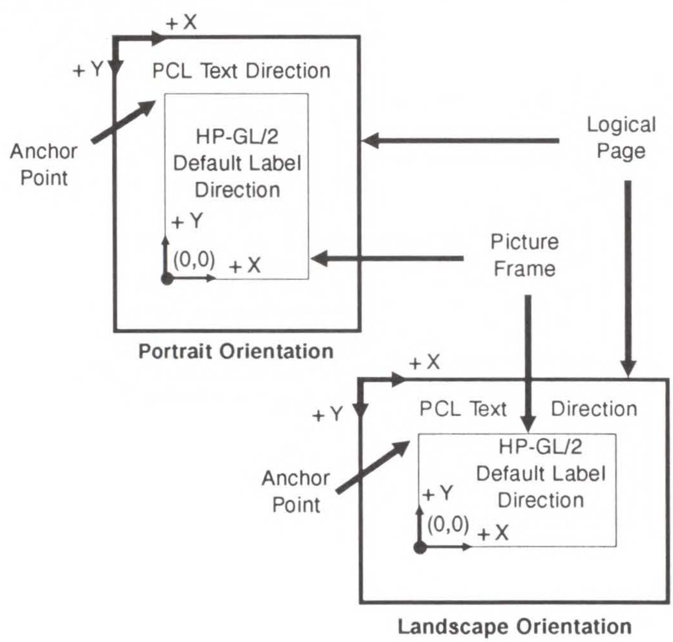


Figure 15-4.
Orientation Interactions Between PCL and HP-GL/2

The relationship between the coordinate systems can be changed using the HP-GL/2 Rotate (RO) command. Rotations specified by the RO command are relative to the default HP-GL/2 orientation. Figure 15-5 shows how the RO command modifies the default HP-GL/2 orientation.

Note A change in print direction has no effect on the HP-GL/2 orientation, the physical position of the picture frame, or the picture frame anchor point.

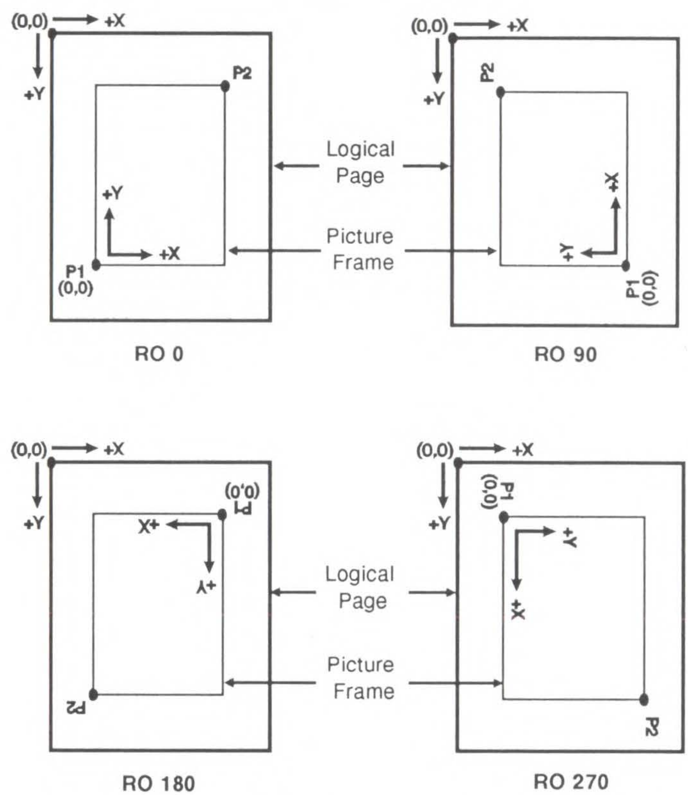


Figure 15-5. Modifying HP-GL/2 Orientation

The Vector Graphics Limits

The area on the page where a vector graphics image can be printed is determined by the intersection of the following four boundaries:

- Hard-clip Limits
- Soft-clip Limits
- Logical Page
- PCL Picture Frame

The *hard-clip limit* refers to the boundaries resulting from the physical limits of the printer (in PCL mode, this area is referred to as the *printable area*). The *soft-clip limit* refers to the area defined using the HP-GL/2 *Input Window* (IW) command. An HP-GL/2 graphic will appear on the page only if it falls within the *effective window*, which is the area defined by the intersection of the hard-clip limits, the PCL logical page, the PCL Picture Frame, and the soft-clip window (user-defined window).

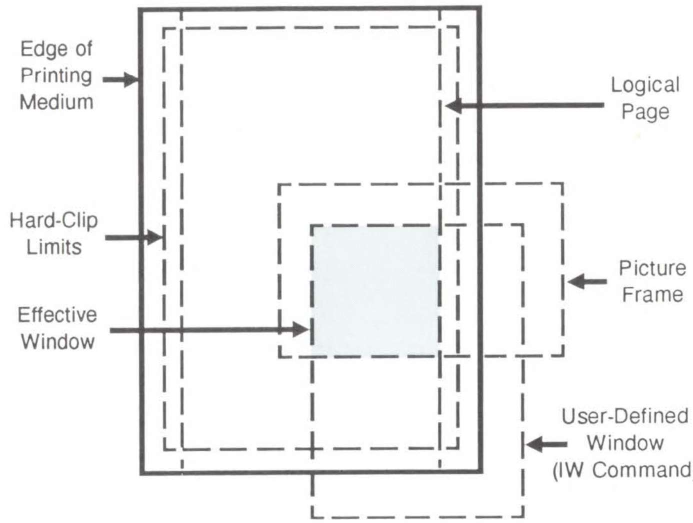


Figure 15-6.
The Effective Window

Note

For more information on the PCL coordinate system and the LaserJet III printer's printable limits, see Chapter 2.

Units of Measure

In HP-GL/2 mode, you can measure along the X,Y axes and express coordinates using two types of units: *plotter units* and *user units*.

Plotter Units (plu)

One *plotter unit* equals 0.025 mm. When specifying distances in plotter units, the printer converts the number of plotter units to equivalent dot coordinates before printing. Under default conditions, the printer uses plotter units.

The following table lists equivalent measurements for plotter units.

Table 15-6.

Plotter Units	Equivalent Value
1 plu =	0.025 mm or 0.00098 in.
40 plu =	1 mm
1016 plu =	1 in.

User Units

The size of units along the X and Y axes may be redefined using the Scale (SC) command. User units allow you to customize the coordinate system to your particular needs. For example, you could plot the moon cycle for the year by dividing the X-axis into 31 units for days of the month and the Y-axis into 12 units for months of the year. To mark a point on December 25, you would simply give the coordinate (25,12) rather than calculating the exact location in plotter units.

User units can represent months, years, dollars, francs, distances, temperatures, population, or whatever meets your requirements. Before printing, the printer internally converts user units to dot locations. To establish user units, you use the Scale command (SC), which is discussed later in this chapter and in Chapter 17.

Pen Status and Location

Since printing vector graphics has traditionally been performed with plotters, the terms *pen* and *pen position* are used to described the imaginary cursor and the current active position (CAP) when in HP-GL/2 mode. Like a physical pen, this imaginary pen must be selected if you want to draw images. Commands such as Pen Up (PU) or Pen Down (PD) and phrases such as "current pen position" or "moving the pen" apply to the imaginary pen just as they would a physical pen on a plotter.

Pen Status

Pen status refers to whether the "pen" is up or down. Use the Pen Up (PU) command with X,Y coordinates to move the pen to the desired printing location without drawing a line. Use the Pen Down (PD) command with X,Y coordinates to lower the pen and begin drawing from the current location to the specified X,Y coordinate.

Upon entering the HP-GL/2 mode for the first time following a reset (ᴱ꜀E) command, no pen has been selected and the pen is up. *This means that no lines will be drawn when HP-GL commands are given until a pen is selected.* This can be done using the Select Pen command, SP.

All drawing commands also require that the pen be lowered to produce marks on the page. Once the pen is lowered with a Pen Down (PD) command, the pen remains down for subsequent HP-GL/2 printing commands until a Pen Up (PU) or Initialize (IN) command is issued. The pen remains selected until a new SP command is received. You must be aware of the pen's up/down status to avoid drawing stray lines between parts of your picture.

Note

Upon entry into HP-GL/2 mode, a good programming practice is to select a pen and do a pen-up move to the starting position. This ensures that a pen is selected and that the pen is in the proper position to begin drawing.

Every time you use a PU or PD command the printer updates the pen up/down status. The following list shows the commands that include an automatic PD command as part of their function. After performing their complete function, they return the pen to its previous up/down state.

Table 15-7. Commands That Include an Automatic Pen Down

Command		Group
CI	Circle	*The Vector Group*
EA	Edge Rectangle Absolute	*The Polygon Group*
EP	Edge Polygon	
ER	Edge Rectangle Relative	
EW	Edge Wedge	
FP	Fill Polygon	
RA	Fill Rectangle Absolute	
RR	Fill Rectangle Relative	
WG	Fill Wedge	
LB	Label	*The Character Group*
SM	Symbol Mode	*The Line and Fill Attributes Group*

Note

Whenever the printer receives a Pen Down command, it produces a dot at the current pen location. If the pen is already down when the printer receives a command with an automatic Pen Down, the unnecessary dot can mar your final output. For best results, include a Pen Up (PU) command before any command with an automatic Pen Down.

The definition of each command will tell you whether it has an automatic pen down. If you find that part of your image isn't drawn, make sure your program uses the PD command before the affected commands. Sending an IN command sets the pen in the up position.

Pen Location

Pen location refers to the X,Y coordinates of the current active position (the point at which the next HP-GL/2 command will begin drawing). Most commands, when completed, update the pen location. The next command then begins at that location. Some commands do not update the current pen location. The definition of each command tells you whether the current pen location is updated or restored. Use the Pen Up (PU) command with the desired X,Y coordinates to lift the pen and move it to a new location.

The Default Values (DF) command does not reset the current pen location; the Initialize (IN) command moves it to the lower-left corner of the PCL Picture Frame. You must specify your beginning pen location for each HP-GL/2 drawing.

Scaling

When you *scale* a drawing, you define your own units of measurement instead of using plotter units; the printer converts your units (called *user units*) to dot positions for placing the image on the page. *Scaling* lets you command the printer using units that make sense to you and are easy for you to work with.

For example, you can scale your drawing to divide the drawing area into 100 squares. As you plan the drawing, you can think in terms of those 100 squares rather than plotter units. Here is another use of scaling: since 400 plotter units equals 1 centimetre, you can establish this scale to print in user units equal to 1 centimeter each.

Scaling begins with the scaling points, P1 and P2. Think of P1 and P2 as two points marking opposite corners of a rectangle. You can make this rectangle any size and place it anywhere in relation to the origin depending on the plotter unit coordinates you specify for P1 and P2. (P1 and P2 default to the lower left and upper right corners of the picture frame, respectively, but you can change their locations using the Input P1 and P2 (IP) or Input Relative P1 and P2 (IR) commands.)

After you have defined the positions for P1 and P2, or accepted the default, you use this imaginary rectangle to set up scaling for your drawing. With the Scale (SC) command you specify how many sections the rectangle should be divided into horizontally (the X-axis) and how many sections the rectangle should be divided into vertically (the Y-axis). With this process you have created your user units.

Scaling allows you to use the units you find easiest to work with, and also allows you to enlarge or reduce your image by changing the locations of P1 and P2. P1 and P2 represent physical locations in relation to the PCL Picture Frame. When the imaginary rectangle formed by P1 and P2 is enlarged or reduced with the IP or IR commands, the HP-GL/2 image is also enlarged or reduced to fit the new P1/P2 rectangle. (For a more detailed explanation of scaling and the Scale (SC) command, see Chapter 17.)

For importing existing HP-GL/2 images, another method of enlarging or reducing drawings exists. It involves varying the size of the PCL Picture Frame and is described next.

Automatically Adjusting Image Size to Fit the PCL Picture Frame

Imported HP-GL/2 drawings can be automatically adjusted to fit the size of the PCL Picture Frame without changing the locations of P1 and P2 (in Scale mode) as just described. This is called *picture frame scaling*.

When using picture frame scaling, the HP-GL/2 plot size should be specified unless the drawing is page size independent [described below]). If a drawing *is not* page-size independent, the printer will not adjust the size of the image to fit the picture frame without the HP-GL/2 plot size command, because the drawing and the picture frame are assumed to be the same size. If a drawing *is* page-size independent, it will automatically enlarge or reduce to fit within the picture frame without specifying an HP-GL/2 plot size.

Creating a Page-Size Independent Plot

As mentioned, if an imported HP-GL/2 drawing is page-size independent, it can be automatically adjusted to fit different page sizes without specifying the HP-GL/2 plot size. In order for a drawing to be page-size independent, it must not specify any parameters in absolute units. This implies that:

- No parameter of any command is in plotter units. The scaled mode (SC command) must be used exclusively; either the default locations of P1 and P2 are used or their positions are specified with the IR (Input Relative P1 and P2) command. The default window is used or the window is specified in user units (using the IW command).

- For labels, only the SR (Relative Character Size) mode is used; the SI (Absolute Character Size) mode is not used.
- The Pen Width selection mode (WU) is specified as relative instead of metric.
- The pattern length for the Line Type (LT) is specified as relative instead of metric.

If a drawing does not meet the above criteria and the drawing is not the same size as the picture frame, the HP-GL/2 plot size must be specified in order to accomplish the desired scaling. If it is not specified, the image will be clipped to the effective window and no scaling will occur.

Note

The above bulleted items are required for automatic scaling when the picture frame size changes, *without* specifying the HP-GL/2 plot size. However, if an HP-GL/2 plot size is specified, *any* unscaled HP-GL/2 image (that is, any image created without the SC command) is automatically enlarged or reduced to fit the PCL Picture Frame; the amount of enlargement or reduction is determined by the picture frame scaling factor (the ratio of the HP-GL/2 plot size to the PCL Picture Frame size).

Absolute and Relative Pen Movement

The Plot Absolute (PA) and Plot Relative (PR) commands allow you to set whether you want to draw using absolute or relative "pen" moves. *Absolute* pen movement uses X,Y coordinates to specify an exact, fixed point relative to the origin (0,0). In the following illustration, the coordinates (3,8), (5,4), and (8,1) are always in the same place with respect to the origin, no matter where the pen is when the coordinates are issued.

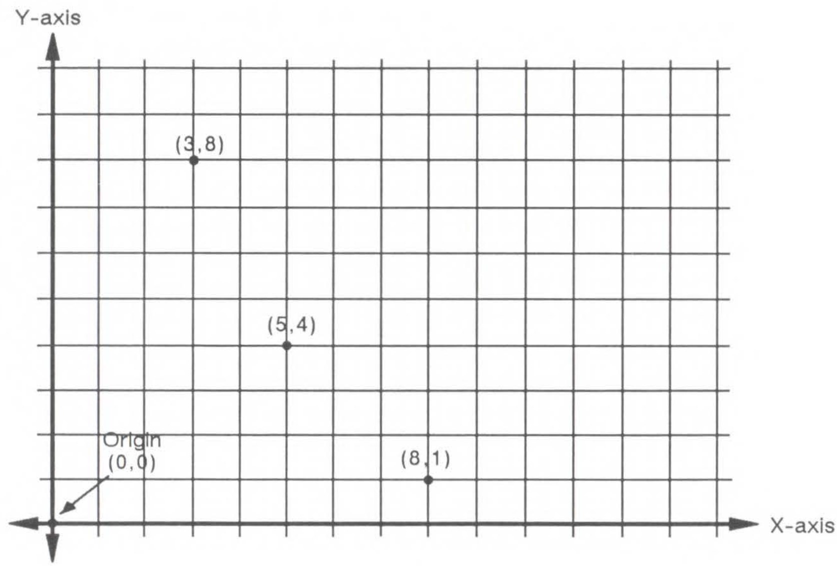


Figure 15-7. Absolute Coordinates

Relative pen movement uses X,Y *increments* to specify the number of units the pen moves from its current pen location. All commands that use relative increments include "relative" in their name (except the PE command). (An example is the Edge Rectangle Relative (ER) command.

In Figure 15-8 for example, assume that the pen is currently at the origin (0,0). To get to the absolute points shown in Figure 15-7 using relative coordinates, count 3 units to the right and 8 units up from the current pen location; these are both positive directions with respect to the origin. This is the relative location (3,8). Now move 5 positive X-units and 7 negative Y-units from this location to the lower point; this is the relative location (5,-7). From this location, move to the last point by moving 3 negative X-units and 3 positive Y-units (-3,3).

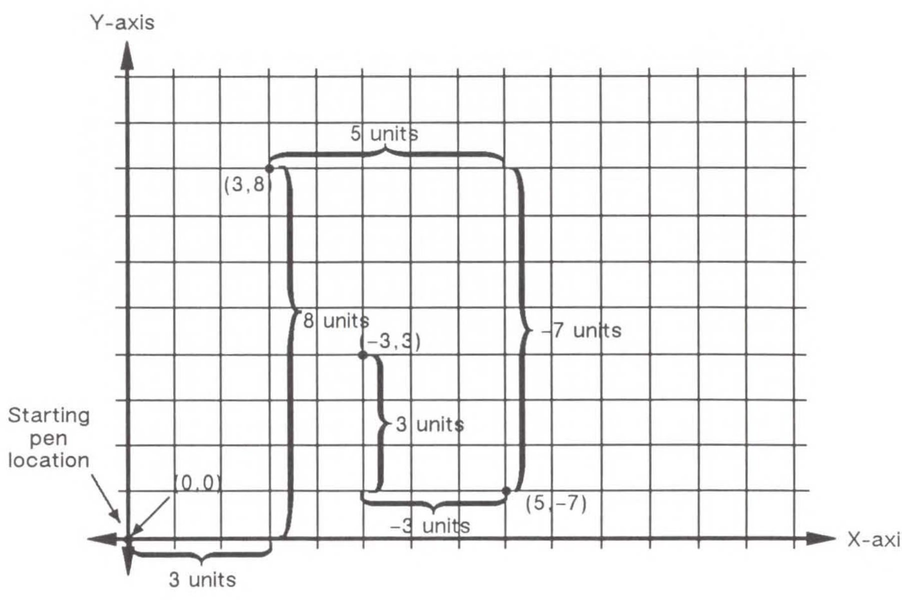


Figure 15-8. Relative Coordinates

Relative movement is very useful in many applications where you know the dimensions of the shape you want, but don't want to calculate the absolute coordinates. For example, if you knew you wanted a box 4 X-units by 8 Y-units, you could use the Edge Rectangle Relative (ER) command to draw the box without having to calculate the absolute coordinates of the opposite corner. (The ER command draws a rectangle using the current pen location as one corner and the specified relative coordinates as the opposite corner.)

Absolute printing is the default mode; coordinates received within a PU (Pen Up) or PD (Pen Down) command are interpreted as absolute plotter units unless a PR (Plot Relative) command establishes relative mode. As with absolute coordinates, the relative units can be either user units or plotter units, depending on whether the SC command is in effect.

Note

Relative increments add to the current pen location. The printer automatically converts the new relative location to absolute coordinates and updates the current pen location. Using relative coordinates can be faster in cases where the I/O speed is limiting your print speed, since relative coordinates are generally smaller numbers and therefore result in less data transmitted over the I/O.

16

The Picture Frame

Introduction

When importing an existing HP-GL/2 file or creating an HP-GL/2 image within an application, you use several PCL commands to set up the picture frame size, choose the picture frame location, and enter and exit HP-GL/2 mode. This chapter explains these commands that surround the HP-GL/2 commands.

Before we discuss the actual commands and how they operate, the following demonstration shows the general sequence in which these commands are used to print HP-GL/2 files.

Typical HP-GL/2 Plot Command Sequence

The following command sequence is usually followed when creating HP-GL/2 images:

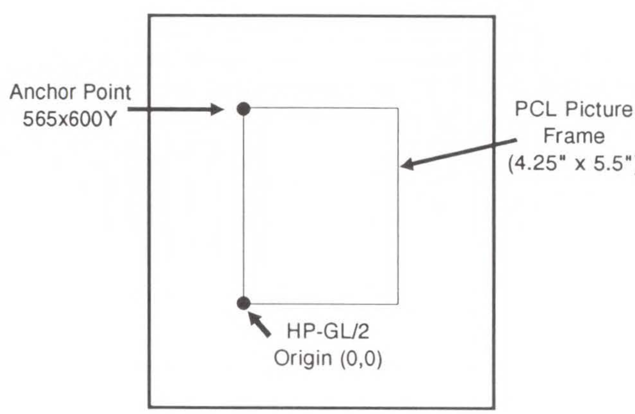
- Send the *job control* and *page control* commands, and any other PCL commands that you wish to send before drawing the HP-GL/2 image. (See Chapters 3, 4, and 5 for job control and page control information.)
- Specify the PCL Picture Frame dimensions using the $^{E}_{C}$*c#X (Picture Frame Horizontal Size) and $^{E}_{C}$*c#Y (Picture Frame Vertical Size) commands. These commands determine the boundary of the window in which you place or draw your image. The PCL Picture Frame represents the maximum boundary for your HP-GL/2 drawing (see Figure 15-6).

- Specify the *picture frame anchor point* using the EC*c#T (Set Picture Frame Anchor Point) command. This command determines the position on the logical page where the upper left corner of the PCL Picture Frame is placed.
- If importing an existing plot, specify the HP-GL/2 plot size using the EC*c#K (Horizontal HP-GL/2 Plot Size) and EC*c#L (Vertical HP-GL/2 Plot Size). This plot size represents the size of the original HP-GL/2 image. *If you are creating a drawing within an application, do not send these commands.*
- Enter the HP-GL/2 mode using the EC%#B command.
- Send your HP-GL/2 commands (IN;SP1; . . .).
- Exit the HP-GL/2 mode by sending the EC%#A (Enter PCL Mode) command.
- Send more PCL commands if desired or issue an ECE command to end the job and eject the page.

A sample program looks something like the following example:

Example: Creating and Using a PCL Picture Frame

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$&l2A	Set the page size to letter.
$^{E}_{C}$&lØO	Specify portrait orientation.
$^{E}_{C}$*c3Ø6Øx396ØY	Specify a 4.25-inch wide by 5.5-inch high PCL Picture Frame (4.25in. x 720 decipoints/in. = 3060 decipoints; 5.5in. x 720 decipoints/in. = 3960 decipoints).
$^{E}_{C}$*p565x6ØØY	Move the cursor to the point you desire as the picture frame anchor point.
$^{E}_{C}$*cØT	Set the picture frame anchor point to the current active position.



(continued on next page)

$^{E}_{C}$*c8.5k11L	Specify that the original HP-GL/2 plot size is 8.5 inches wide by 11 inches high. This sets up a scaling factor of 2:1 because the original HP-GL/2 plot size is twice as large as the PCL Picture Frame (4.25 x 5.5 inches). (*If you are creating a drawing within an application instead of importing an existing plot, don't send this command.*)
$^{E}_{C}$%1B	Enter the HP-GL/2 mode with the cursor (pen) at the PCL current active position. In this example, the cursor would be at the picture frame anchor point (600 dots [2 in.] down from the top of the logical page and 300 dots [1 in.] to the right of the left logical page boundary).
IN;SP1;PU5Ø,5Ø; ...	Send the HP-GL/2 commands you desire to send. (The IN command defaults the pen position to the HP-GL/2 origin, the lower-left corner of the PCL Picture Frame.)
$^{E}_{C}$%1A	Enter the PCL mode with the cursor at the current HP-GL/2 pen position.
TextTextText	Send some text or more PCL commands.
$^{E}_{C}$E	Reset the printer to end the job and eject a page.

The above example gives you an idea of what commands are involved in printing an HP-GL/2 plot, whether importing an existing drawing or creating one within an application. The example describes one way to print a plot, but many things can be varied such as the picture frame size and location, and the cursor position when entering and leaving the HP-GL/2 mode. If you desire, you can even switch back and forth between the PCL and HP-GL/2 modes many times without adversely affecting print performance.

The commands that allow you to set up a PCL Picture Frame and enter/exit HP-GL/2 mode are discussed in detail in the rest of this chapter. By reading the following command descriptions, you can see how changing command parameters can affect your printed output.

Horizontal Picture Frame Size (decipoints)

This command specifies the horizontal dimension of the window to be used for printing an HP-GL/2 plot.

$^{E}_{C}$*c#X

\# = Horizontal size in decipoints (1/720th inch)

default = The width of the current logical page

Range = 0 - 32767 (valid to 4 decimal places)

Note The horizontal dimension specified is parallel to the PCL X-axis when the print direction is set to 0 degrees (the default).

Using this command defaults the location of P1 to the lower left corner of the picture frame and P2 to the upper right corner of the picture frame. It also resets the soft-clip window to the PCL Picture Frame boundaries, clears the polygon buffer, and updates the cursor position to the lower-left corner of the picture frame (P1), as viewed from the current orientation.

If no horizontal picture frame size command is used, the printer defaults the picture frame size to the logical page width. A parameter value of Ø or the *reset*, *page length*, *paper size*, or *orientation* commands default the horizontal picture frame size.

If an HP-GL/2 plot size is specified, the horizontal picture frame size is used to determine the horizontal scaling factor used for scaling the image to fit in the picture frame.

Example: To specify a horizontal picture frame size of 5 inches, send:

$^{E}_{C}$*c3600X

(5 in. x 720 decipoints/in. = 3600 decipoints).

Vertical Picture Frame Size (Decipoints)

This command specifies the vertical dimension of the window to be used for printing an HP-GL/2 plot.

$^{E}_{C}$*c#Y

= Vertical size in decipoints (1/720th inch)

default = The distance between the default top and bottom margins (the default text length)

Range = 0 - 32767 (valid to 4 decimal places)

Note The vertical dimension specified is parallel to the PCL Y-axis when the print direction is set to 0 degrees (the default).

Example: To specify a vertical picture frame size of 6.5 inches, send:

$^{E}_{C}$*c4680Y

(6.5 in. x 720 decipoints/in. = 4680 decipoints)

Set Picture Frame Anchor Point

This command specifies the location of the PCL Picture Frame anchor point.

EC*c#T

0 = Set picture frame anchor point to the current active position

default = At the left edge and top margin of the current logical page

Range = 0 (all other values are ignored)

The position of the picture frame anchor point defines the location of the upper left corner of the PCL Picture Frame. The "upper left" refers to the corner whose X and Y coordinates are minimized when the print direction is 0.

A parameter value of zero (EC*c0T) specifies that the picture frame anchor point should be set to the current active position (CAP). Since this is the case, sending a cursor move command prior to sending this command places the picture frame anchor in the desired location. All parameter values other than zero are ignored, but if you don't send a Set Picture Frame Anchor command, the printer defaults the anchor point to the left edge and default top margin of the logical page.

Note

The print direction command does not affect the physical location of the anchor point or the picture frame.

Using this command defaults the location of P1 and P2, defaults the soft-clip window, clears the polygon buffer, and updates the HP-GL/2 cursor position to the lower left corner of the picture frame, as viewed from the current orientation.

Example:

To set the picture frame anchor point to a position 6 inches from the left logical page boundary and 5 inches below the top margin, send:

$^{E}_{C}$*p1800x1500Y$^{E}_{C}$*cØT

In this example, the cursor is first moved to the desired location (6 inches x 300 dots/inch = 1800 dots; 5 inches x 300 dots/inch = 1500 dots). Then the $^{E}_{C}$*cØT command sets the picture frame anchor point to that location.

HP-GL/2 Plot Horizontal Size

Specifies the horizontal size of the HP-GL/2 drawing being imported.

$^{E}_{C}$*c#K

= The horizontal size in inches

default = The width of the currently selected picture frame

Range = 0 to 32767 (valid to 4 decimal places)

The horizontal HP-GL/2 plot size determines the horizontal scaling factor used to fit the drawing into the PCL Picture Frame. For example, if the horizontal HP-GL/2 plot size is specified as 12 inches and the PCL Picture Frame width is 4 inches, the horizontal scaling factor would be 3:1; the horizontal component of the image would be reduced to one-third its original size to fit into the PCL Picture Frame.

A parameter value of zero or a *reset*, *page length*, *paper size*, or *orientation* command defaults the HP-GL/2 plot size to the width of the currently selected picture frame, resulting in no scaling.

Example:

If the original HP-GL/2 drawing is 8.5 inches wide, send:

$^{E}_{C}$*c8.5K

HP-GL/2 Plot Vertical Size

Specifies the vertical size of the HP-GL/2 drawing being imported.

EC*c#L

= The vertical size in inches

default = The height of the currently selected picture frame

Range = 0 to 32767 (valid to 4 decimal places)

The vertical HP-GL/2 plot size value determines the vertical scaling factor used to fit the drawing into the PCL Picture Frame. For example, if the vertical HP-GL/2 plot size is specified as 7 inches and the PCL Picture Frame height is 14 inches, the vertical scaling factor would be 1:2; the vertical component of the image would be enlarged to twice its original size to fit into the PCL Picture Frame.

A parameter value of zero or a *reset*, *page length*, *paper size*, or *orientation* command defaults the HP-GL/2 plot size to the height of the currently selected picture frame, resulting in no scaling.

Example:

If the original HP-GL/2 drawing is 7 inches tall, send:

EC*c7L

Enter HP-GL/2 Mode

This command causes the printer to interpret subsequent commands as HP-GL/2 commands instead of PCL printer language commands.

$^{E}_{C}$%#B

 # = Ø – Use previous HP-GL/2 pen position

 # = 1 – Use current PCL cursor position (CAP)

default = Not Applicable

Range = 0, 1 (even values are mapped to 0; odd values are mapped to 1; $^{E}_{C}$%B is the same as $^{E}_{C}$%0B)

As soon as the printer receives this command, it switches to HP-GL/2 mode, interpreting commands as HP-GL/2 commands until it receives an Enter PCL Mode or $^{E}_{C}$E command, or until the printer power switch is switched off and on. (For information on the effect PCL settings have on the HP-GL/2 mode, see the *Default Settings* discussion later in this chapter.)

The value field (#) determines the cursor position once the HP-GL/2 mode is entered.

Ø– This parameter option ($^{E}_{C}$%ØB) sets the pen position to the previous HP-GL/2 position; if this is the first time the HP-GL/2 mode is entered in the present print job (assuming an $^{E}_{C}$ or IN has been sent), the pen position is at the lower left corner of the PCL Picture Frame (0,0).

1– This parameter option ($^{E}_{C}$%1B) specifies that the pen position be the same as the current PCL cursor position.

Example:

To set the pen position to the current PCL cursor position, send:

$^{E}_{C}$%1B

Enter PCL Mode

This command causes the printer to return to PCL mode from the HP-GL/2 mode.

$^{E}_{C}$%#A

 # = ∅ – Use previous PCL cursor position

 # = 1 – Use current HP-GL/2 pen position for CAP

default = ∅

Range = ∅, 1 (even values are mapped to ∅; odd values are mapped to 1)

Sending the Enter PCL Mode command causes the printer to stop interpreting the incoming data as HP-GL/2 commands and to begin interpreting the data as PCL commands. The value field (#) specifies the cursor position when PCL mode is entered.

∅– A ∅ parameter ($^{E}_{C}$%∅A) sets the pen position to the previous PCL position (that is, the cursor position before the HP-GL/2 mode was entered).

1– A 1 parameter ($^{E}_{C}$%1A) sets the cursor position to the current HP-GL/2 pen position. If the current HP-GL/2 pen position is outside the bounds of the PCL logical page, the nearest point on the logical page boundary becomes the new PCL cursor position.

No PCL variables except the cursor position are affected by entering and exiting HP-GL/2 mode.

Example:

To exit HP-GL/2 mode using the current active cursor position (CAP) that existed before entering HP-GL/2 mode, send:

$^{E}_{C}$%∅A

Default Settings

When you enter the HP-GL/2 mode, most vector graphics variables retain their previous HP-GL/2 value. However, the following changes in the PCL environment can affect the HP-GL/2 environment:

- An $^{E}_{C}$E or control panel reset:

  Executes an IN (Initialize) command

  Defaults the PCL Picture Frame size

  Defaults the PCL Picture Frame anchor point

  Defaults the HP-GL/2 plot size

  Defaults the PCL logical page orientation

- Issuing a page size, page length, or orientation command:

  Defaults the PCL Picture Frame anchor point

  Defaults the PCL Picture Frame

  Defaults the HP-GL/2 plot size

  Defaults P1 and P2 (IP,IR commands)

  Defaults the soft-clip window (IW command)

  Clears the polygon buffer (PMØ,PM2)

  Updates the current active position to the lower-left corner of the picture frame (P1).

- Redefinition of the PCL Picture Frame:

  Defaults P1 and P2 (IP,IR commands)

  Defaults the soft-clip window (IW)

  Clears the polygon buffer (PMØ,PM2)

  Updates the current pen position to the lower-left corner of the picture frame (P1)

- Setting the picture frame anchor point:

  Defaults P1 and P2 (IP,IR commands)

Defaults the soft-clip window (IW command)

Clears the polygon buffer (PMØ,PM2)

Updates the current pen position to the lower-left corner of the picture frame (P1)

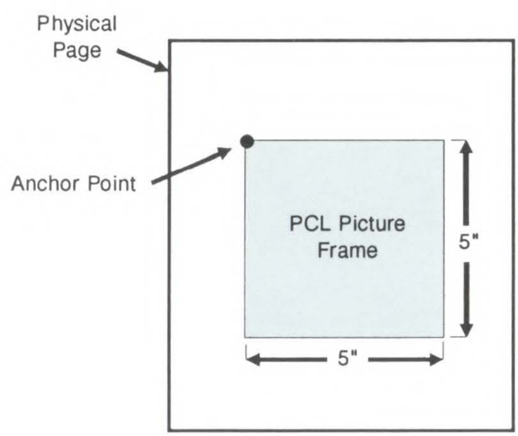
- Setting an HP-GL/2 plot size:

Changes the picture frame scaling factor

As the printer enters HP-GL/2 mode for the first time since $^{E}_{C}$E, power-on, or control panel reset, all HP-GL/2 variables are at their default settings, as determined by the Picture Presentation Directives (the PCL Picture Frame Size, Picture Frame Anchor Point, and HP-GL/2 Plot Size commands).

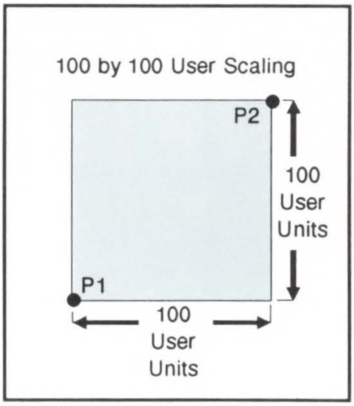
Example: Creating a Simple Drawing

${}^{E}_{C}$E	Reset the printer.
${}^{E}_{C}$&l2A	Set the page size to letter.
${}^{E}_{C}$&l∅O	Specify portrait orientation.
${}^{E}_{C}$*c3600x3600Y	Specify a 5-inch wide by 5-inch high PCL Picture Frame (5in. x 720 decipoints/in. = 3600 decipoints).
${}^{E}_{C}$*p450x675Y	Move the cursor to the point you desire as the picture frame anchor point.

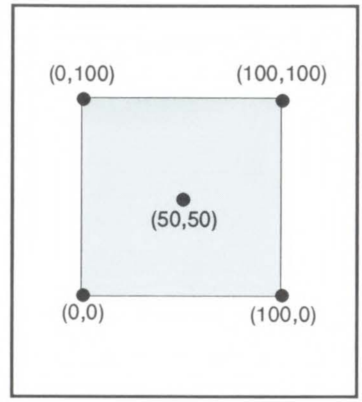


${}^{E}_{C}$*c∅T	Set the picture frame anchor point to the current active position.

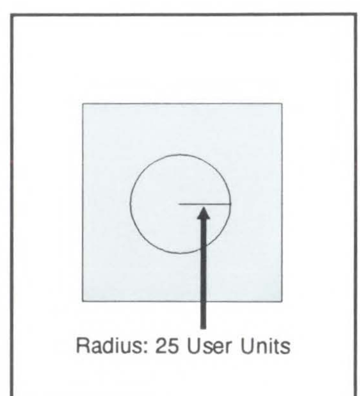
$^{E}_{C}$%1B	Enter the HP-GL/2 mode with the cursor (pen) at the PCL current active position. In this example, the cursor would be at the picture frame anchor point (450 dots [1.5 in.] down from the top margin and 675 dots [2.25 in.] to the right of the left logical page boundary).
IN;SP1;	Initialize the HP-GL/2 command values and select pen number 1 (black). (The IN command moves the pen position from the anchor point to the HP-GL/2 origin, the lower-left corner of the PCL Picture Frame.)
SC0,100,0,100;	Set up user scaling so that P1 is (0,0) and P2 is (100,100) (these points are the lower-left and upper-right corners of the PCL Picture Frame, respectively).



PD100,0,100, 100,0,100,0,0;	Draw a box marking the perimeter of the PCL Picture Frame.



PU50,50;CI25;	Lift the pen and move to the center of the PCL Picture Frame (50,50); draw a circle with a radius that is 25% of the picture frame width.



$^{E}_{C}$%1A	Enter the PCL mode with the cursor at the current HP-GL/2 pen position.
$^{E}_{C}$E	Reset the printer to end the job and eject a page.

17

The Configuration and Status Group

The configuration and status group commands help you with the following:

- Establishing default conditions and values for programmatical features.
- Scaling images in the dimensional units you want to use.
- enlarging/reducing images for different media sizes.
- Establishing a window (soft-clip limits).
- Drawing equal-sized and mirror-imaged drawings.
- Rotating the HP-GL/2 coordinate system.

Table 17-1 shows the HP-GL/2 commands described in this chapter.

Table 17-1. The Configuration and Status Group Commands

Command	Summary
DF, Default	Sets most programmable HP-GL/2 features to their default conditions.
IN, Initialize	Sets all programmable HP-GL/2 features to their default conditions.
IP, Input P1 and P2	Establishes new or default locations for the scaling points P1 and P2.
IR, Input Relative P1 and P2	Establishes P1 and P2 locations as a percentage of the PCL Picture Frame.
IW, Input Window	Sets up a window (soft-clip limits).
PG, Advance Full Page	This command is ignored.*
RO, Rotate Coordinate System	Rotates the HP-GL/2 coordinate system.
RP, Replot	This command is ignored.*
SC, Scale	Establishes a user-unit coordinate system.
* These commands are useful in plotter applications, but are not the optimal solution for the LaserJet III printer. Other PCL commands perform similar functions (see the Number of Copies and Form Feed command descriptions).	

Establishing Default Conditions

Whether you are using the HP-GL/2 mode or strictly the PCL printer language mode, you should establish default conditions at the beginning of each print job to prevent unexpected results due to "leftover" command parameters from a previous job. From within HP-GL/2 mode there are two ways to establish default conditions: using the Initialize (IN) command or using the Default (DF) command.

Using the IN command sets the printer to its factory defaults. This process is called initialization. The reset command (ᴱ꜀E) executes an Initialize (IN) command automatically, so if a reset was sent at the beginning of your print job, the HP-GL/2 command parameters will be at their factory default state when the HP-GL/2 mode is first entered. (See Chapter 3 for a more thorough discussion of the printer environment and how it is affected by the reset command.)

Note

HP-GL/2 command parameters are set to their default values the first time the HP-GL/2 mode is entered during a print job (assuming that an $^{E}_{C}$E reset is sent at the beginning of the job). After commands have been sent to modify the current print environment, the command parameters are no longer set to their defaults. When re-entering the HP-GL/2 mode, immediately sending an IN command ensures that the HP-GL/2 features are set to their default conditions (if that is desired).

The DF command is not as powerful as the IN command. The conditions set by the DF and IN commands are described later in this chapter.

The Scaling Points P1 and P2

When you scale a drawing, you define your own units of measurement, which the printer then converts to plotter units. Scaling relies on the relationship between two points: P1 and P2. These two points are called the scaling points because they take on the user unit values that you specify with the Scale (SC) command. You can change the locations of P1 and P2 using either the Input P1 and P2 (IP) or Input Relative P1 and P2 (IR) command.

P1 and P2 always represent an absolute location in relation to the PCL Picture Frame, defined in plotter-units. They designate opposite corners of a rectangular printing area within the picture frame. You can change the size of the rectangular printing area and move it anywhere within the picture frame, or even outside the picture frame, depending on the plotter-unit coordinates you specify using the IP or IR commands.

Using the Scale Command

Scaling lets you establish units of measure with which you are familiar, or which are more logical to your drawing. The Scale command (SC) determines the number of user units along the X- and Y-axes between P1 and P2. The actual size of the units depends on the locations of P1 and P2 and the range of user units set up by the SC command.

There are three types of scaling:

- Anisotropic
- Isotropic
- Point-factor

Anisotropic scaling indicates that the size of the units along the X-axis may be different than the size of the units on the Y-axis. Isotropic scaling, then, indicates that the units are the same size on both axes. Point-factor scaling sets up a ratio of plotter units to user units.

The Scale command does not change the locations of P1 and P2, only their coordinate values. Also, scaling is not limited to the rectangular area defined by P1 and P2, but extends across the entire printing area within the PCL Picture Frame.

For example, to divide the X-axis into 12 units representing weeks, and the Y-axis into 10 units representing thousands of dollars, specify the X-axis to scale from 0 to 12, and the Y-axis to scale from 0 to 10. P1 becomes the origin with user-unit coordinate (0,0) and P2 becomes (12,10). The entire plotting area is now divided into the desired units. Subsequent plotting commands will use these units (see Figure 17-1). If you command the printer to move to the point (3,4), the printer will move to the location equivalent to (3,4) user units (*not* (3,4) plotter units).

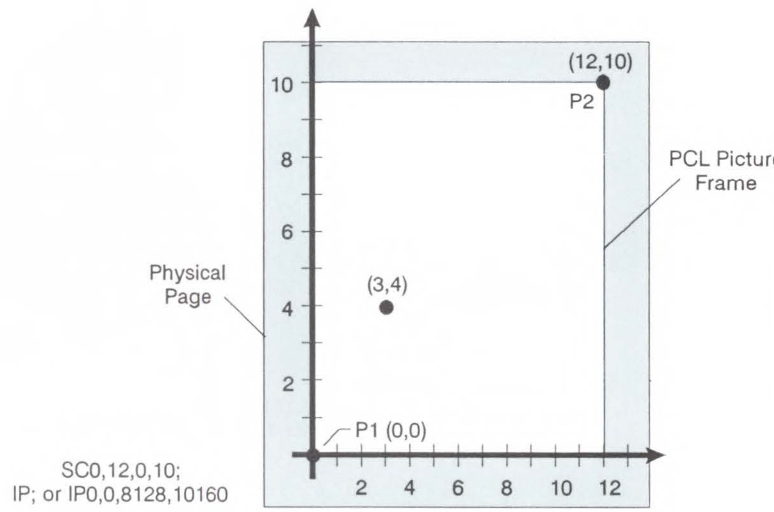


Figure 17-1. User-Unit Scaling with Default P1 and P2

If you move the locations of P1 and P2, the size of the user units will change. Let's say the previous illustration showed P1 and P2 in their default locations (the lower-left and upper-right corners, respectively, of the PCL Picture Frame). In the following example, P1 and P2 have the same user-unit values (set with the Scale command [SC]), but their physical locations have been changed (using Input P1 and P2 [IP]). Note that the size of the user units decreased.

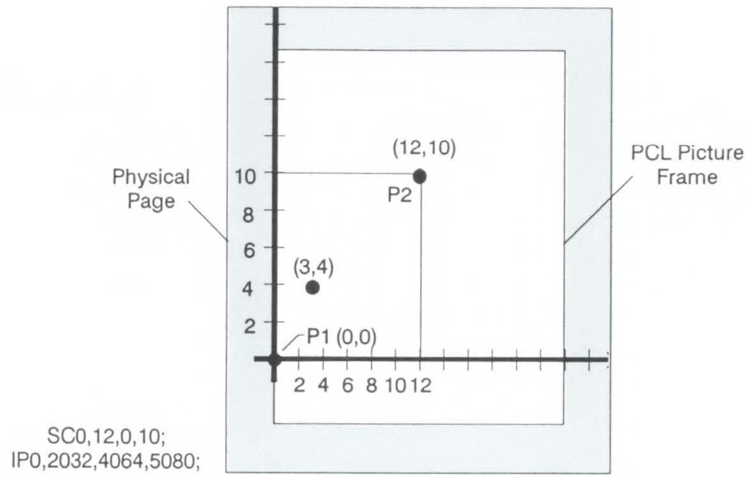


Figure 17-2. Same User-Unit Scaling with New P1 and P2

To further illustrate the flexibility of user-unit scaling, the next illustration shows the P1 and P2 locations with negative user-unit values. Note that the framework set by the scaling points P1 and P2 is *not* a graphics limit. The user-unit coordinate system extends across the entire PCL Picture Frame area. You can print to a point beyond P1 or P2 as long as you are within the PCL Picture Frame.

Note

You can use coordinate points that are outside of the PCL Picture Frame boundaries or even off of the page, but only that portion of the vector graphics image that falls within the effective window will be printed. For example, you can draw a small portion of the circumference of a circle with a 5-foot radius by moving the pen 5 feet from the page and issuing a CI command (specifying a 5-foot radius); only the portion of the arc that falls within the effective window will be printed (see Figure 15-6).

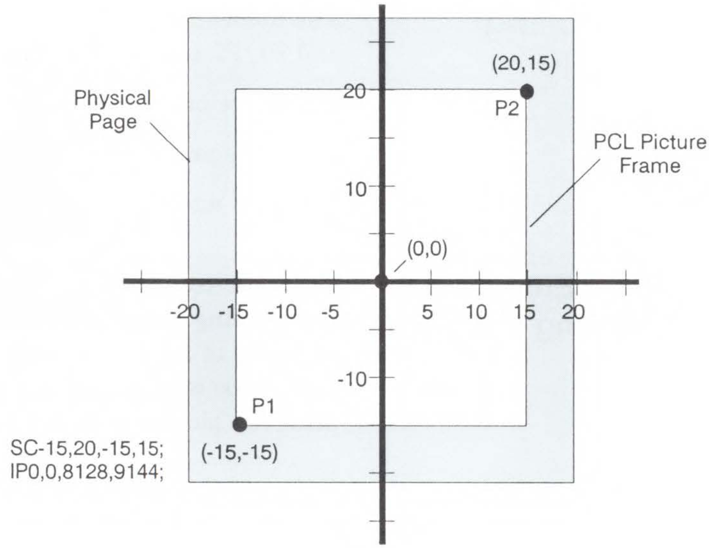


Figure 17-3.
New P1 and P2 User-Unit Scaling with Negative Values

Refer to the Scale (SC) command at the end of this chapter for more information on scaling drawings.

Using Scaling Effectively

The following sections show you how to combine scaling and P1/P2 concepts to do the following.

- Enlarge or reduce the size of a drawing
- Draw equal-size pictures on the same page.
- Create mirror-imaged pictures

Enlarging or Reducing a Picture

The basic technique for changing a picture's size is to scale the printing area defined by P1 and P2, then move the locations of P1 and P2 so they define a smaller or larger area. This is especially useful when you want to be able to print the picture on any portion of the page.

Note

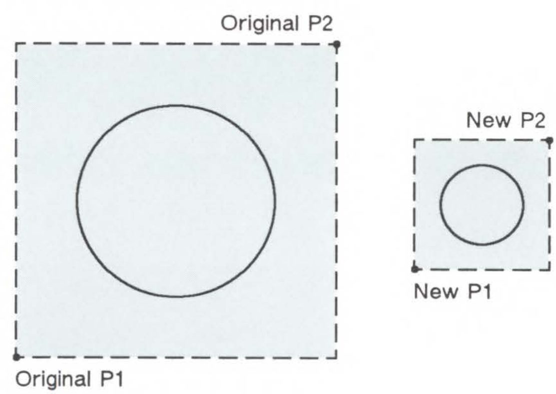
Only scaled drawings (those using the SC command) are enlarged/reduced when the P1/P2 locations change. Use PCL Picture Frame scaling when importing HP-GL/2 images created without the SC command.

To maintain the proportions of scaled plots, set P1 and P2 so they define an area with the same aspect ratio as the original scaling rectangle. For example, if the area defined by P1 and P2 is 3000 x 2000 plotter units, its aspect ratio is 3:2. To enlarge the plot, set P1 and P2 to define a larger area that maintains a 3:2 ratio.

The following example illustrates this technique using a square P1/P2 scaling rectangle with a scale of 0 to 10 for both axes. By definition, a square always has an aspect ratio of 1:1. After drawing a circle within the scaled area, the locations of P1 and P2 move to form a new rectangular area that maintains the 1:1 ratio. Note that the circle printed in the new area is smaller but is proportionately identical.

Example: Changing the Size of a Drawing

$^{E}_{C}$%ØB	Enter HP-GL/2 mode, using the default picture frame size and anchor point.
IN;	Initialize HP-GL/2 mode.
IPØ,Ø,2ØØØ,2ØØØ;	Set P1 to be (0,0) and P2 to be (2000,2000).
SCØ,1Ø,Ø,1Ø;	Set up user unit scaling to range from (0,0) to (10,10).
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA5,5;	Begin absolute plotting from the center of the square (5,5).- 1000



CI3;	Print a circle with a radius of 3 user units.
IP25ØØ,5ØØ,35ØØ,15ØØ;	Input a new P1 and P2 position for printing the smaller circle.
PA5,5;	Begin absolute plotting from the center of the new square (5,5).
CI3;	Print the second circle with a radius of 3 user units.

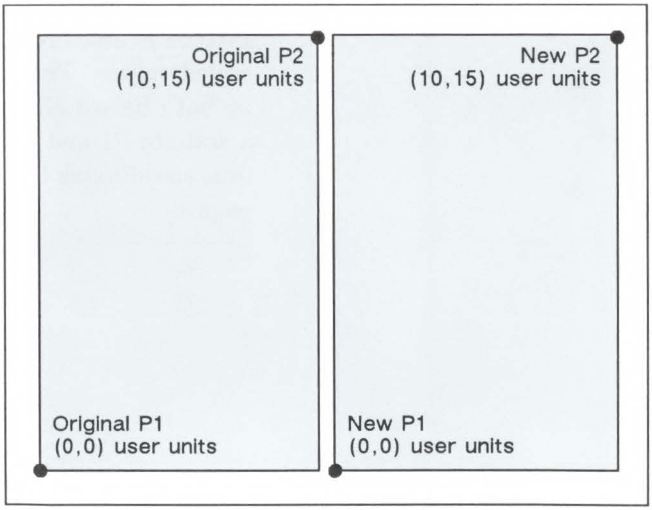
Drawing Equal-Size Pictures on a Page

You may occasionally want to print more than one drawing on the same page for a side-by-side comparison. This can be useful for comparing parts, assemblies, layouts, or other similar information. The easiest way to draw equal-sized pictures on one piece of paper is to take advantage of the fact that P2 follows P1 whenever you change the location of P1.

The following example illustrates this fact. The example locates P1 and P2 on the left side of the paper and scales the area for the first image. Then, for the second image, only the P1 location is moved to the right side of the paper; P2 automatically tracks P1 so the printing area retains the same dimensions as the first drawing. The printed rectangle around the second area shows P2 in its new location.

Example: Drawing Equal-Size Pictures on a Page

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$&l1O	Select landscape orientation.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode, using the default picture frame size and anchor point.
IN;	Initialize HP-GL/2 mode.
IP5ØØ,5ØØ,545Ø, 75ØØ;	Set P1 to be (500,500) and P2 to be (5450,7500).
SCØ,1Ø,Ø,15;	Set up user unit scaling to range from (0,0) to (10,15).
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.- 1000



Example: Drawing Equal-Size Pictures on a Page (continued)

PAØ,Ø;	Begin absolute plotting from the origin (0,0).
PD1Ø,Ø,1Ø,15,Ø,15,Ø,Ø;PU;	Pen Down and print from (0,0) to (10,0) to (10,15) to (0,15) to (0,0); then Pen Up.
IP555Ø,5ØØ	Input a new P1 and allow P2 to automatically track it.
PAØ,Ø;	Begin absolute plotting from the new origin.
PD1Ø,Ø,1Ø,15,Ø,15,Ø,Ø;PU;	Pen Down and print from (0,0) to (10,0) to (10,15) to (0,15) to (0,0); then Pen Up.
$^{E}_{C}$**%ØA**	Enter PCL Mode.
$^{E}_{C}$**E**	Reset the printer to complete the job and eject the page.

Note

The P1/P2 frames are not windows or graphics limits; the pen can print HP-GL/2 images anywhere within the PCL Picture Frame. Note that the new P1 and P2 retain their scaled values. This allows you to use the same coordinates on both halves of the page. In contrast, if you do not assign a scale to P1 and P2, you must calculate the new plotter unit coordinates for the drawing on the second half of the page.

Creating Mirror Images

For most drawings, you will probably set P1 and P2 so that P1 is in the lower-left corner and P2 is in the upper-right corner of the scaling area. However, you can change the relationship of P1 and P2 to produce a mirror-image effect.

You can "mirror-image" any *scaled* drawing (those drawings using the SC command) by changing the relative locations of P1 and P2. You can mirror-image labels using the Absolute Direction and Relative Direction (DI and DR) commands or the Relative Character Size (SR) command. (The DI, DR, and SR commands are discussed in Chapter 21, *The Character Group.*)

The following example uses a subroutine to draw the same picture (an arrow) four times. Because the program changes the relative locations of P1 and P2, the direction of the arrow is different in each of the four drawings. The program sets P1 and P2, draws the plot, then returns to reset P1 and P2 (using the IP command). This continues until all four possible mirror images are plotted. (The original drawing is shown in each picture so you can compare the orientation of the mirror image.)

Example: Creating a Mirror Image

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%0B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. You must use the SP command to enable printing.
IP1500,3600,3000,5100;	Specify the P1/P2 locations for the first arrow figure.
SC-15,15,-10,10;	Set up user scaling: (-15,-10) to (15,10).
(Run subroutine)	Run the subroutine (below) that prints the arrow image.
IP3000,3600,1500,5100;	Change the physical locations of P1 and P2 to flip the image to the left.
(Run subroutine)	Print the second image.
IP1500,5100,3000,3600;	Change the physical locations of P1 and P2 to flip the image down.
(Run subroutine)	Print the third image.
IP3000,5100,1500,3600;	Change P1/P2 locations to flip the image to the left and down.
(Run subroutine)	Print the fourth image.
$^{E}_{C}$%0A	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.
SUBROUTINE: PA1,2;PD1,4,3,4,3,7,2,7, 4,9,6,7,5,7,5,4,12,4,12, 5,14,3,12,1,12,2,1,2; PU;	Subroutine that prints the arrow figure.

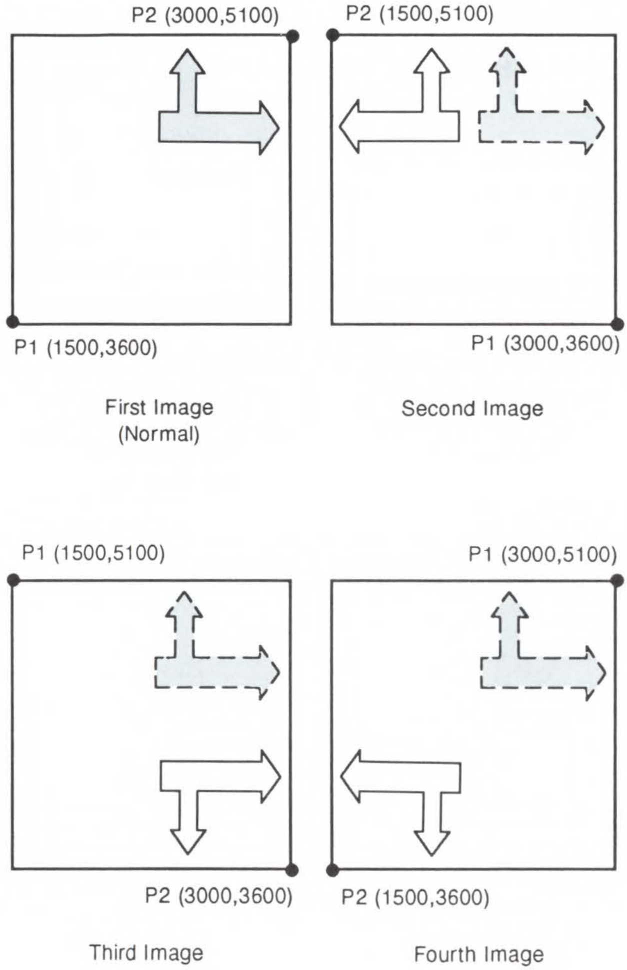


Figure 17-4. Creating a Mirror Image

Adapting the HP-GL/2 Coordinate System to Match the PCL System

The following example uses the IP and SC commands to change HP-GL/2 coordinate system so that it matches the default PCL coordinate system. The IP command is used to invert the Y-axis so that the Y values increase as the pen moves down the page. The SC command equates user units to dot positions (300 dots per inch). The example draws a few lines in both PCL and HP-GL/2 modes to demonstrate that the coordinate systems are lined up correctly (the end points of the lines intersect correctly).

Note

Sending an IN (Initialize) or DF (Default) command causes the coordinate system to revert to the HP-GL/2 default. Remember that since this example is based on the default top margin and text length, changing these values will move the two coordinate systems out of synchronization.

Example: Adapting the HP-GL/2 Coordinate System to Match the PCL System

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$&l2A	Set the page size to letter.
$^{E}_{C}$&l0O	Specify portrait orientation.
$^{E}_{C}$%1B	Enter the HP-GL/2 mode with the cursor (pen) at the PCL current active position. The PCL Picture Frame defaults to the area bounded by the top and bottom margins and the left and right logical page boundaries.
IN;SP1;	Initialize the HP-GL/2 command values and select pen number 1 (black). (The IN command moves the pen position from the anchor point to the HP-GL/2 origin, the lower-left corner of the PCL Picture Frame.)

Example: Adapting the HP-GL/2 Coordinate System to Match the PCL System (continued)

SC0,2400,0,3000;	Set up user scaling so every inch is equal to 300 dots, just as in the PCL system (8"x 300 dpi = 2400 dots; 10" x 300 dpi = 3000 dots).
IP0,10160,8128,0;	Move P1 to the PCL origin (the intersection of the top margin and the left logical page boundary) and P2 to the right logical page boundary at the bottom margin. This lines up the origins of the PCL and HP-GL/2 grids and reverses the Y coordinate system to match the PCL system (that is, positive Y values are below the X-axis rather than above the X-axis).
PU0,0;	Lift the pen and move to (0,0). Since the HP-GL/2 coordinate system is now set up to match the PCL coordinate system, every pen move can be specified using the same coordinate numbers in either mode. The following commands demonstrate that the grids are synchronized.
PU300,300; PD600,600;	Lift the pen and move it to (300,300); then draw a line to (600,600). This will draw a line at a 45° angle down from the starting point.
$^{E}_{C}$%1A$^{E}_{C}$*p600x600Y	Enter the PCL mode and move the cursor to (600,600).

Example: Adapting the HP-GL/2 Coordinate System to Match the PCL System (continued)

EC*c300a4b0P	Draw a horizontal line (rule) that is 1 inch wide by 4 dots high. (Note that the cursor position after a rule is printed is at the beginning of the rule–in this case, (600,600).)
EC%1BPU;PR300,0; PD;PR0,500;	Enter the HP-GL/2 mode and lift the pen; move to a point 300 user units (dots) to the right; place the pen down and print a line 500 user units down.
EC%1A	Enter the PCL mode with the cursor at the current HP-GL/2 pen position.
ECE	Reset the printer to end the job and eject a page.

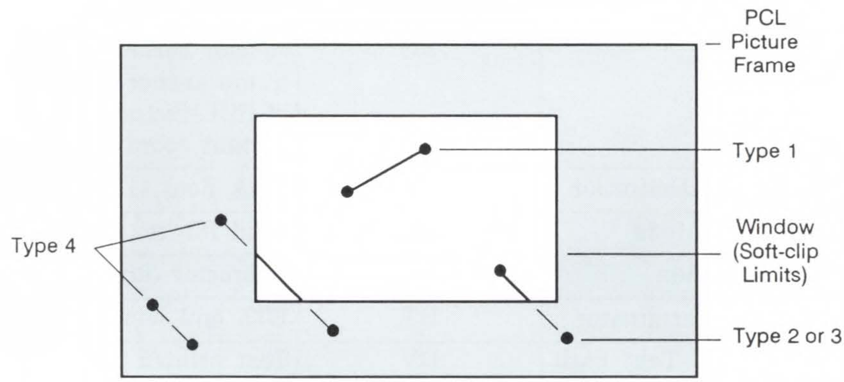
Windowing: Setting Up Soft-Clip Limits

Soft-clip limits temporarily restrict pen movement to a rectangular area, or window. When you initialize or set the printer to default conditions, the soft-clip limits are the same as the PCL Picture Frame limits. To create a window, you use the Input Window (IW) command. The window has the same effect as the PCL Picture Frame – the printer does not draw outside the window.

The following illustration shows the four types of line segments you can specify from one point to another.

Table 17-2. The Four Types of Line Segments

Type	From Last Point	To New Point
1	Inside window area	Inside window area
2	Inside window area	Outside window area
3	Outside window area	Inside window area
4	Outside window area	Outside window area



The IW command lets you control the size of the HP-GL/2 printing area so that you can draw a particular portion of a drawing. You can leave the rest as white space, or use the remaining area for labels, or another drawing. Refer to *Graphic Limits* in Chapter 15 and the IW command description later in this chapter.

DF, Default Values

This command returns the printer's HP-GL/2 settings to the factory default settings. Use the Default Values (DF) command to return the printer to a known state while maintaining the current locations of P1 and P2 (unlike the IN command). When you use DF at the beginning of a program, graphics parameters such as character size, slant, or scaling are not inherited from another program.

DF *[;]*

The DF command resets the printer to the conditions listed in Table 17-3:

Table 17-3. Default Conditions

Function	Command	Default Condition
Anchor Corner	AC	Anchor corner (not the same as the picture frame anchor point) set to lower-left corner of PCL Picture Frame, relative to the current coordinate system.
Alternate Font Definition	AD	Stick Font (11.5-pt., 9-cpi, upright, medium)
Character Fill Mode	CF	Solid fill, no edging.
Absolute Direction	DI1,0	Character direction parallel to X-axis.
Define Label Terminator	DT	**ETX** and nonprinting mode.
Define Variable Text Path	DV	Text printed left to right with normal line feed.
Extra Space	ES	No extra space.
Fill Type	FT	Solid fill.
Input Window	IW	Set equal to PCL Picture Frame Window.
Line Attributes	LA	Butt caps, mitered joins, and miter limit=5.
Label Origin	LO1	Standard labeling starting at current location.
Line Type	LT	Solid line, relative mode, pattern length=4% of diagonal distance from P1 to P2.
Plotting Mode	PA	Absolute plotting.
Polygon Mode	PM0PM2	Polygon buffer cleared.

Table 17-3. Default Conditions (continued)

Function	Command	Default Condition
Raster Fill	RF	Solid black.
Scalable or Bitmap Fonts	SB0	Scalable fonts only.
Scale	SC	User-unit scaling off.
Screened Vectors	SV	No screening
Standard Font Definition	SD	Stick Font (11.5-pt., 9-cpi, upright, medium)
Absolute Character Size	SI	Turns off size transformation.
Character Slant	SL	No slant.
Symbol Mode	SM	Off.
Select Standard Font	SS	Standard font.
Transparency Mode	TR1	Transparency mode on.
Transparent Data	TD	Normal printing mode.
User-Defined Line Type	UL	Defaults all 8 line types.

In addition, the printer updates the carriage-return point for labeling to the current pen location. (See Chapter 21, The Character Group, for more information on the carriage return point.)

The DF command does not affect the following HP-GL/2 conditions.

- Locations of P1 and P2.
- Current pen, its location, width, width unit selection, and up/down position.
- HP-GL/2 drawing rotation.

Related Commands	Group
IN, Initialize	The Configuration/Status Group

IN, Initialize

Resets all programmable HP-GL/2 functions to their default settings. Use the IN command to return the printer to a known state and to cancel settings that may have been changed by a previous program. (The $^{E}_{C}$E Reset issues an automatic IN command.)

IN *[;]*

In this manual, all program examples begin with IN to clear unwanted conditions from the previous program, even though an $^{E}_{C}$E command automatically executes an IN command.

Note

Once the HP-GL/2 mode is entered and commands are issued, the HP-GL/2 conditions are no longer initialized; it is a good idea to send the IN command upon re-entering HP-GL/2 mode, unless the default conditions are not desired.

The IN command sets the printer to the same conditions as the DF command, plus the following:

Raises the pen (PU).

Returns the pen location to the lower-left corner of the PCL Picture Frame (PA0,0).

Cancels drawing rotation (RO).

Sets P1 and P2 to the lower-left and upper-right corners, respectively, of the PCL Picture Frame (IP).

Sets pen width mode to metric; units are millimeters (WU).

Sets the pen width to 0.35 mm (PW).

Sets number of pens to 2 (black [1] and white [0]).

Related Commands	Group
DF, Default Values	The Configuration/Status Group

IP, Input P1 and P2

Establishes new or default locations for the scaling points P1 and P2. P1 and P2 are used by the Scale (SC) command to establish user-unit scaling. You can also use IP in advanced techniques such as printing mirror images, enlarging/reducing drawings, and enlarging/reducing relative character size, or changing label direction.

IP $P1_X, P1_Y[, P2_X, P2_Y;]$ or

IP *[;]*

Parameter	Format	Functional Range	Default
$P1_X, P1_Y[, P2_X, P2_Y]$	integer	-2^{30} to $2^{30} - 1$	(see below)

The default location of P1 is the lower-left corner of the PCL Picture Frame; the default location of P2 is the upper-right corner, as shown in the following illustration. (The default picture frame extends from the top margin to the bottom margin, and from the left edge to the right edge of the logical page.)

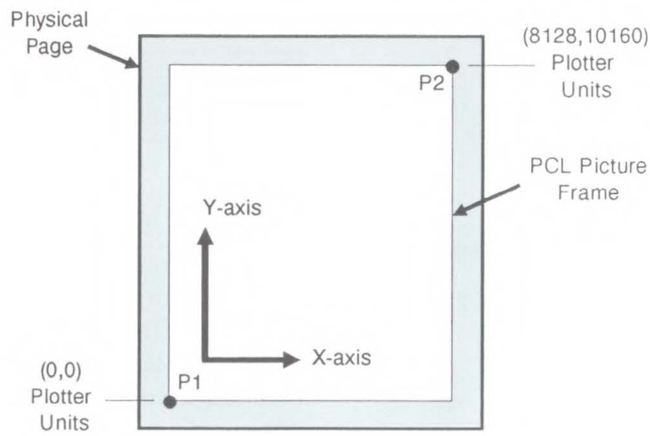


Figure 17-5. The Default P1/P2 Locations

- **No Parameters** – Sets P1 and P2 to their default locations, adjusted by any current axis rotation.

Note

If an IP command without parameters is executed after the axes have been rotated with the RO command, P1 and P2 locations change to reflect the rotation (see Figure 15-5).

- **X,Y Coordinates** – Specify the location of P1 (and, optionally, P2) in plotter units. Specifying P2 is not required. If P2 is not specified, P2 tracks P1 and its coordinates change so that the X,Y distances between P2 and P1 stay the same. This tracking process can cause P2 to end up located outside the effective window. Used carefully, the tracking function can be useful for preparing more than one equal-sized drawing on a page. For an example, refer to Drawing Equal-Sized Pictures on a Page earlier in this chapter.

  Neither X,Y coordinate of P1 can equal the corresponding coordinate of P2. If either coordinate of P1 equals the corresponding coordinate of P2, the coordinate of P2 is incremented by 1 plotter unit.

The locations of P1 and P2 interact with the following commands:

Commands Affected by P1/P2	Group
IW, Input Window RO, Rotate Coordinate System SC, Scale	The Configuration/Status Group
FT, Fill Type LT, Line Type PW, Pen Width WU, Pen Width Unit Selection	The Line and Fill Attributes Group
DR, Relative Direction LB, Label SR, Relative Character Size	The Character Group

An IP command remains in effect until another IP command is executed, an IR command is executed, or the printer is initialized.

Related Commands	Group
IR, Input Relative P1 and P2 RO, Rotate Coordinate System SC, Scale	The Configuration/Status Group

IR, Input Relative P1 and P2

Establishes new or default locations for the scaling points P1 and P2 relative to the PCL Picture Frame size. P1 and P2 are used by the Scale (SC) command to establish user-unit scaling. IR can also be used in advanced techniques such as printing mirror images, enlarging/reducing drawings, and enlarging/reducing relative character size, or changing label (text) direction.

IR $P1_X,P1_Y[,P2_X,P2_Y;]$ or

IR *[;]*

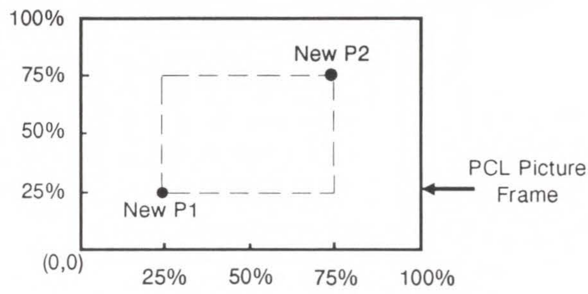
Parameter	Format	Functional Range	Default
$P1_X,P1_Y[,P2_X,P2_Y;]$	clamped real	0 to 100%	0,0,100,100%

When P1 and P2 are set using IR, the scaled area is page-size independent. This means that as the PCL Picture Frame changes size, P1 and P2 keep the same relative position within the PCL Picture Frame boundaries.

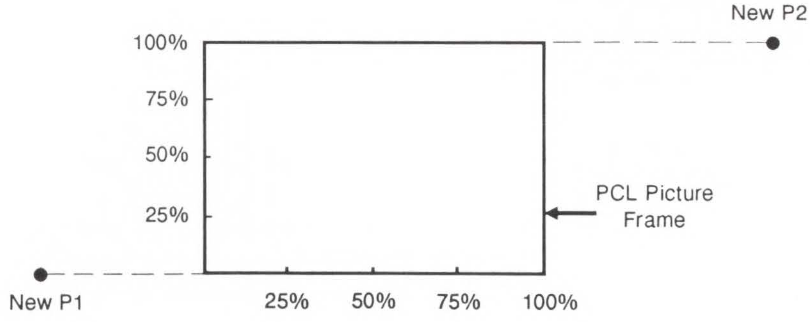
- **No Parameters** – Defaults P1 and P2 to the lower-left and upper-right corners of the PCL Picture Frame, respectively.
- **X,Y Coordinates** – Specify the location of P1 (and, optionally, P2) as percentages of the PCL Picture Frame limits. Specifying P2 is not required. If P2 is not specified, P2 tracks P1; the P2 coordinates change so that the distances of X and Y between P1 and P2 remain the same. This tracking process can cause P2 to end up located outside the effective window. Used carefully, the tracking function can be useful for preparing more than one equal-sized drawing on a page. For an example, refer to Drawing Equal-Sized Pictures on a Page earlier in this chapter.

Neither X,Y coordinate of P1 can equal the corresponding coordinate of P2. If either coordinate of P1 equals the corresponding coordinate of P2, the coordinate of P2 is incremented by 1 plotter unit.

Sending the command **IR25,25,75,75** establishes new locations for P1 and P2 that create an area half as high and half as wide as the PCL Picture Frame, in the center of the picture frame. Refer to the following illustration.



P1 or P2 can also be set outside the PCL Picture Frame by specifying parameters less than zero and greater than 100. For example, sending (IR-50,0,200,100) would set P1 and P2 as shown in the following illustration.



If you specify P1 and P2 beyond the PCL Picture Frame, your drawing will be scaled with respect to those locations; however, only the portion of the drawing fitting within the effective window will be drawn.

Note

The specified P1/P2 percentages are converted to the equivalent plotter unit coordinates; if the coordinate system orientation subsequently changes (e.g., by sending an RO command) the plotter unit position is maintained with respect to the new orientation.

The locations of P1 and P2 interact with the following commands:

Commands Affected by P1/P2	Group
IW, Input Window RO, Rotate Coordinate System SC, Scale	The Configuration/Status Group
FT, Fill Type LT, Line Type PW, Pen Width WU, Pen Width Unit Selection	The Line and Fill Attributes Group
DR, Relative Direction LB, Label SR, Relative Character Size	The Character Group

An IR command remains in effect until another IR command is executed, an IP command is executed, or the printer is initialized.

Related Commands	Group
RO, Rotate Coordinate System SC, Scale	The Configuration/Status Group

IW, Input Window

Defines a rectangular area, or window, that establishes soft-clip limits. Subsequent HP-GL/2 drawing is restricted to this area. Use IW to restrict printing to a specified area on the page.

IW X_{LL},Y_{LL},X_{UR},Y_{UR}*[;]* or

IW *[;]*

Parameter	Format	Functional Range	Default
X_{LL},Y_{LL},X_{UR},Y_{UR}	current units	-2^{30} to $2^{30} - 1$	PCL Picture Frame

The printer interprets the command parameters as follows.

- **No Parameters** – Defaults the soft-clip limits to the PCL Picture Frame limits.
- **X,Y Coordinates** – Specify the opposite, diagonal corners of the window area, usually the lower-left (LL) and upper-right (UR) corners. Coordinates are interpreted in the current units: as user units when scaling is on; as plotter units when scaling is off.

When scaling is on, subsequent changes to P1 and P2 cause the window to move in relation to the physical page, but keep the same user coordinate locations. However, sending a subsequent SC command binds the window to its equivalent plotter units. The window then does not change with any subsequent IP or IR commands.

When you turn the printer on, the window is automatically set to the PCL Picture Frame boundaries. You can define a window that extends beyond the picture frame, however the printer can not print vector graphics beyond the picture frame limits. All programmed pen motion is restricted to this area. For more information, refer to *Windowing: Setting Up Soft-Clip Limits* at the beginning of this chapter.

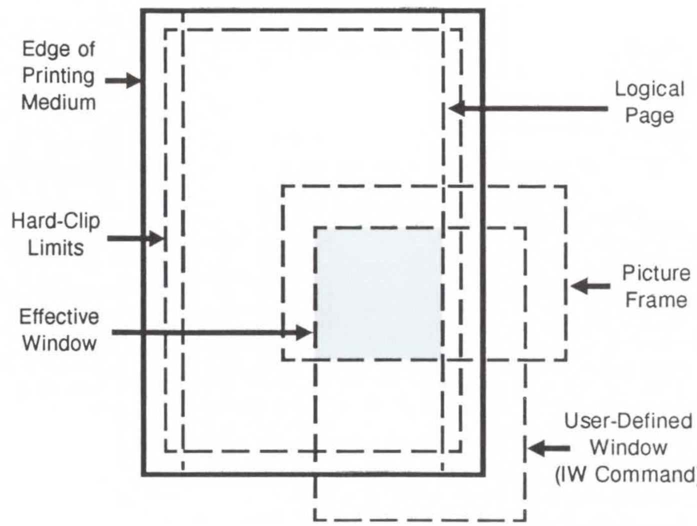


Figure 17-6. The Effective Window

If the window falls entirely outside of the PCL Picture Frame, no image will be drawn. The IW command remains in effect until another IW command is executed, or the printer is initialized or set to default conditions.

The following example draws a label, then establishes a window and again draws the label along with a line. Notice how the line and label are clipped after the window has been established, but not before.

Example: The IW Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%1B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
SI.2,.35;	Set Absolute Character Size to .2 x .35 cm.
PA2ØØØ,32ØØ;	Specify absolute plotting and move to location (2000,3200) (plotter units).
DT@,1;	Define label terminator to be the "@" character, without printing the character.
LBTHIS IS AN EXAMPLE OF IW@;	Print a label beginning at (2000,3200).
IW3ØØØ,13ØØ,45ØØ,37ØØ;	Specify a soft-clip window (in plotter units).
PD2ØØØ,17ØØ	Pen Down; print a line from the current pen position to (2000,1700). Current pen position at start of command is at the letter W baseline.
LBTHIS IS AN EXAMPLE OF IW@;	Print the same label at (2000,1700).
PU3ØØØ,13ØØ;	Pen Up and move to position (3000,1300).

Example: The IW Command (continued)

PD45ØØ,13ØØ,45ØØ,37ØØ;	Pen Down and begin drawing box indicating the soft-clip window.
PD3ØØØ,37ØØ,3ØØØ,13ØØ;	Finish drawing the soft-clip window box
PU;	Pen Up
^E_C%ØA	Enter PCL Mode.
^E_CE	Reset the printer to end the job and eject the page.

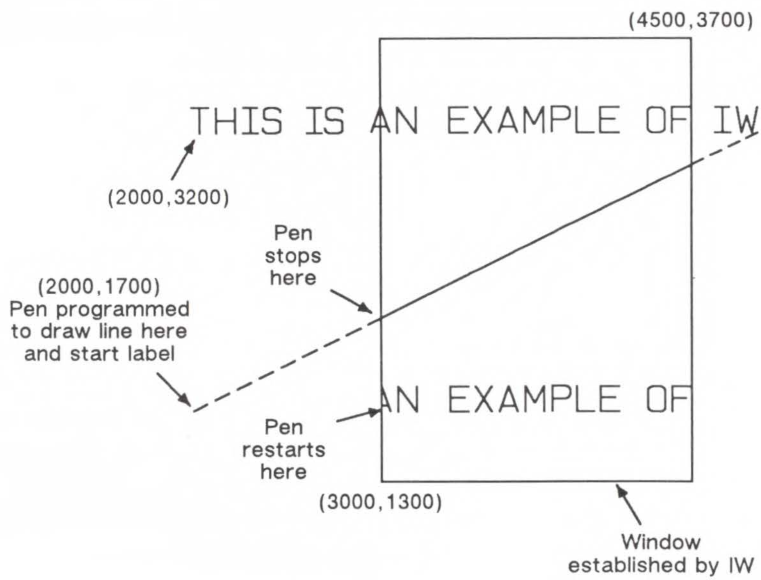


Figure 17-7. Clipping an Image with the IW Command

Related Commands	Group
IP, Input P1 and P2 IR, Input Relative P1 and P2 SC, Scale	The Configuration/Status Group

PG, Advance Full Page

This HP-GL/2 command is ignored by the LaserJet III printer since it could cause undesirable results when importing plots. A page eject can only be accomplished from the PCL printer language mode.

The following commands cause a conditional page eject, meaning that a page will be ejected if there is any printable data in the print buffer:

- ${}^{E}_{C}$E Reset
- Page Length
- Page Size
- Orientation
- Paper Source

When a page is ejected using one of the above commands, the PCL cursor position is set to the top of form on the new page. (The Top of Form is 3/4 of a line below the top margin.)

An alternative method of ejecting a page is the Form Feed control code. A Form Feed causes an unconditional page eject and advances the current active cursor position to the top of form on the next page. The horizontal cursor position remains the same as before the page eject.

Note

The HP-GL/2 cursor position is not affected by a page eject; it occupies the same position on the next page.

RO, Rotate Coordinate System

Rotates the printer's coordinate system counterclockwise relative to the default plotter-unit coordinate origin– in the following rotations: 90°, 180°, and 270°. Use RO to orient your drawing vertically or horizontally, or to reverse the orientation.

RO *angle[;]* or

RO *[;]*

Parameter	Format	Functional Range	Default
angle	clamped integer	0°, 90°, 180°, or 270°	0°

The printer interprets the command parameters as follows:

- **No Parameter** – Defaults the orientation of the coordinate system to 0° (horizontal). Equivalent to *(RO0)*.
- **Angle** – Specifies the degree of rotation (see Figure 15-5):

0	Sets the orientation to horizontal.
90	Rotates and shifts the coordinate system counterclockwise 90 degrees to place the plotter-unit origin at the appropriate corner of the PCL Picture Frame.
180	Rotates and shifts the coordinate system counterclockwise 180 degrees to place the plotter-unit origin at the appropriate corner of the PCL Picture Frame.
270	Rotates and shifts the coordinate system counterclockwise 270 degrees to place the plotter-unit origin at the appropriate corner of the PCL Picture Frame.

Note that the pen location does not change when you rotate the coordinate system. Instead, the printer updates the pen's X,Y coordinate location to reflect the new orientation.

The scaling points P1 and P2 rotate with the coordinate system. However, they maintain the same X,Y coordinate values as before the rotation. This means that P1 and P2 can be located outside of the PCL Picture Frame. Follow the *(RO90)* or *(RO270)* commands with *(IP)* or *(IR)* to relocate points P1 and P2 to the lower-left and upper-right corners of the picture frame. When the RO command is used, the soft-clip window is also rotated, and any portion that is rotated outside of the picture frame is clipped to the picture frame boundaries. The soft-clip window can be set equal to the picture frame by issuing an "IW;" command.

Note The RO command also rotates the contents of the polygon buffer.

The RO command remains in effect until the rotation is changed by another RO command or the printer is initialized.

The following illustration shows the default orientation and the result of rotating the orientation without relocating P1 and P2.

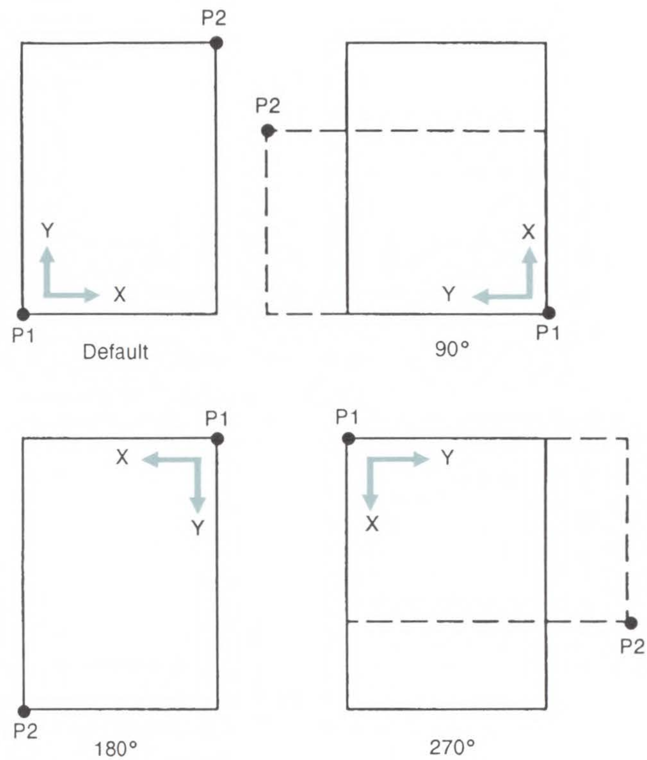


Figure 17-8.
Using the RO Command Without Using the IP Command

The next illustration shows the locations of P1 and P2 when you follow the rotation with the IP command.

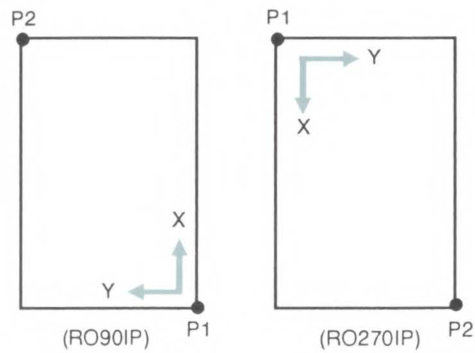


Figure 17-9. Using IP after the RO Command

When you set up a soft-clip window (see the IW command), RO also rotates the window. If a portion of a window rotates outside the hard-clip limits, it is clipped. Note that *IP* does not affect the window limits. Use *IW* to reset the window to the size of the PCL Picture Frame.

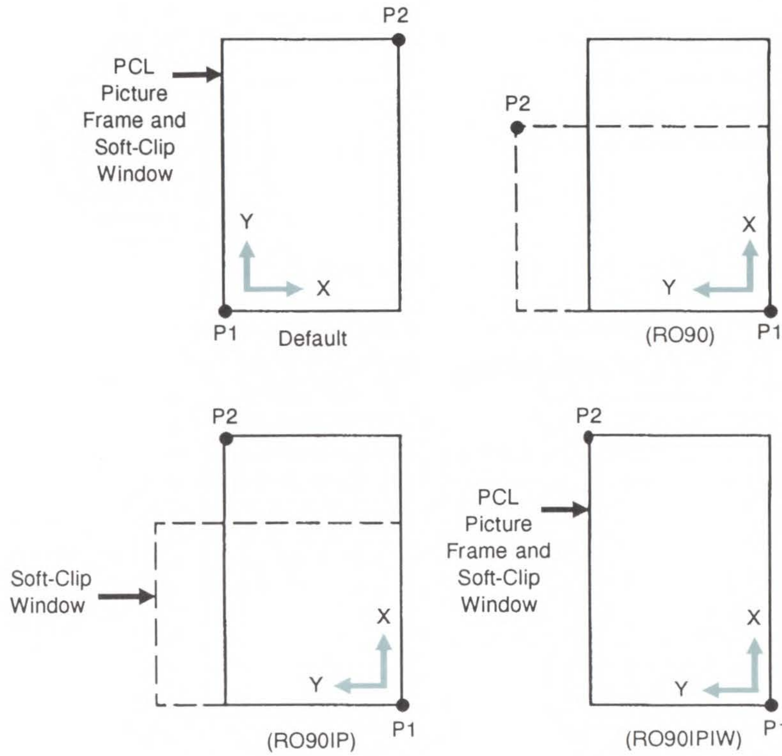


Figure 17-10. Using IP and IW after the RO Command

Related Command	Group
IP, Input P1 and P2 IR, Input Relative P1 and P2 IW, Input Window	The Configuration/Status Group

RP, Replot

This command is ignored by the LaserJet III printer; to eject a page, the printer must be in PCL printer language mode. The following commands cause a conditional page eject, meaning that a page will be ejected if there is any printable data in the print buffer:

- $^{E}_{C}$E Reset
- Page Length
- Page Size
- Orientation
- Paper Source

The PCL Form Feed command causes an unconditional page eject and advances the current active cursor position to the top of form on the next page.

Note

A page eject caused by any of the above commands does not affect the HP-GL/2 pen position.

For information about printing more than one copy of an HP-GL/2 illustration, see the Number of Copies command discussion in Chapter 4 .

SC, Scale

Establishes a user-unit coordinate system by mapping user-defined coordinate values onto the scaling points P1 and P2. Use the SC command to print in units convenient to your application. In addition, use SC to establish automatic isotropic scaling or to relocate the origin and set a specific ratio of plotter units to user units.

SC $X_{MIN}, X_{MAX}, Y_{MIN}, Y_{MAX}$ *[,type[,left,bottom;]]* or

SC $X_{MIN}, X_{FACTOR}, Y_{MIN}, Y_{FACTOR}$*,type[;]* or

SC *[;]*

Parameter	Format	Functional Range	Default
X_{MIN}, X_{MAX},	real	-2^{30} to $2^{30} - 1$	no default
Y_{MIN}, Y_{MAX}	real	-2^{30} to $2^{30} - 1$	no default
type	clamped integer	0, 1, or 2	0
left	clamped real	0 to 100%	50%
bottom	clamped real	0 to 100%	50%
X_{FACTOR}, Y_{FACTOR}	real	-2^{30} to $2^{30} - 1$	no default

For a discussion of the basic concept of scaling, refer to *Using Scaling* earlier in this chapter.

There are three forms of scaling: anisotropic, isotropic, and point-factor. The *Type* parameter tells the printer which form you are using. Refer to the following table.

Scaling Form	Type	Description
Anisotropic	0	Establishes standard user-unit scaling.
Isotropic	1	Establishes standard user-unit scaling.
Point Factor	2	Establishes P1 user-unit location and a specific ratio of plotter units to user units.

- **No Parameters** – Turns off scaling; subsequent coordinates are in plotter units.

For Scaling Types 0 and 1:

The following forms of scaling establish a user-unit coordinate system by mapping user-defined coordinate values onto the scaling points P1 and P2. The type parameter selects between anisotropic (Type 0) and isotropic scaling (Type 1).

Scaling Form	Type	Syntax
Aisotropic	0	SCX_{MIN},X_{MAX},Y_{MIN},Y_{MAX}*(,type;)*
Isotropic	1	SCX_{MIN},X_{MAX},Y_{MIN},Y_{MAX}*(,type(,left,bottom);)*

- X_{MIN}, X_{MAX}, Y_{MIN}, Y_{MAX} – These parameters represent the user unit X- and Y-axis ranges, respectively. For example, *SC0,15,0,10* indicates 15 user-units along the X-axis and 10 user-units along the Y-axis. As a result, the first and third parameters (X_{MIN} and Y_{MIN}) are the coordinate pair that is mapped onto P1; the second and fourth parameters (X_{MAX} and Y_{MAX}) are the coordinate pair that is mapped onto P2. Using the same example, the coordinate location of P1 is (0,0) and P2 is (15,10). This is different from the IP command, where the parameters are expressed as X,Y coordinate pairs rather than as ranges.

Note

X_{MIN} cannot be set equal to X_{MAX}, and Y_{MIN} cannot be set equal to Y_{MAX}.

As their names suggest, you will normally want to specify X_{MIN} smaller than X_{MAX}, and Y_{MIN} smaller than Y_{MAX}. If you specify X_{MIN} larger than X_{MAX} and Y_{MIN} larger than Y_{MAX}, your illustration is drawn as a mirror image, reversed and/or upside down, depending on the relative positions of P1 and P2.

The parameters of the SC command are always mapped onto the current P1 and P2 locations. P1 and P2 retain these new values until scaling is turned off or another SC command redefines the user-unit values. Thus, the size of a user unit could change if any change is made in the relative position and distance between P1 and P2 *after* an SC command is executed.

- **Type** – Specifies anisotropic or isotropic scaling.

0	**Anisotropic scaling.** Allows a user unit along the X-axis to be a different size than user-units along the Y-axis. Printed shapes are distorted when you use anisotropic scaling. For example, a circle might be drawn as an ellipse–oval-shaped instead of round. (*Left and bottom* parameters are ignored for anistropic scaling.)
1	**Isotropic scaling.** Produces user units that are the same size on both the X- and Y-axes. The following illustrations show how the printer adjusts the location of (X_{MIN},Y_{MIN}) and (X_{MAX},Y_{MAX}) to create the largest possible isotropic area within the P1/P2 limits. (Remember the user units are always square regardless of the shape of the isotropic area.)

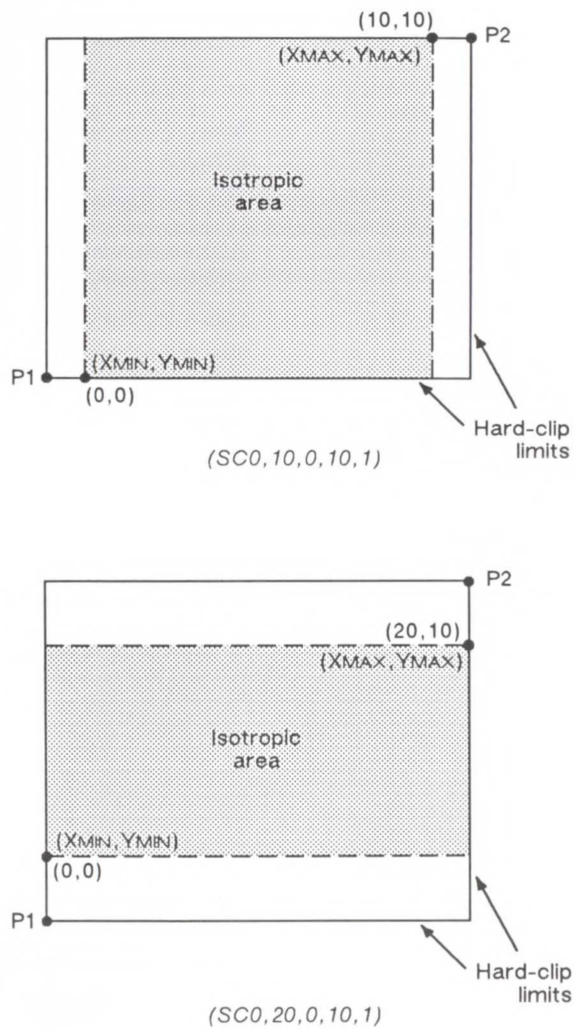


Figure 17-11. Isotropic Scaling

- **Left, Bottom** – Positions the isotropic area in the P1/P2 limits. (These parameters are always specified together and are valid for isotropic scaling only.) The left parameter indicates the percentage of the unused space on the left of the isotropic area; the bottom parameter indicates the percentage of unused space below.

  The defaults for the left and bottom parameters are each 50%. This centers the isotropic area on the page with the unused space equally divided between left and right or top and bottom, as shown in the previous illustrations.

  Although you must specify both parameters, the printer applies only one: the left parameter applies when there is extra horizontal space; the bottom parameter applies when there is extra vertical space. The following examples illustrate left and bottom parameters of 0% and 100%.

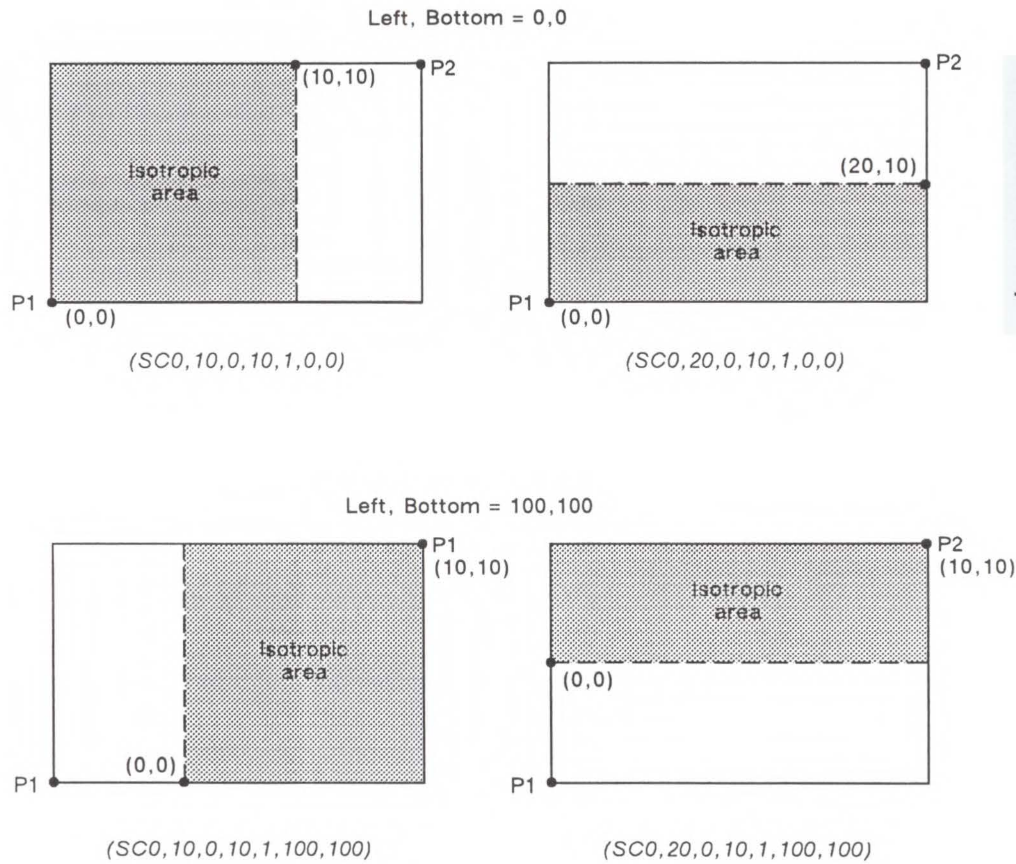


Figure 17-12. The Left and Bottom Parameters

For Scaling Type 2: The third form of scaling, point-factor scaling, sets a specific ratio of plotter units to user units and establishes the user-units coordinate of P1.

Scaling Form	Type	Syntax
Point Factor	2	SCX_{MIN},X_{FACTOR},Y_{MIN},Y_{FACTOR},*type[;]*

- X_{MIN},X_{FACTOR},Y_{MIN},Y_{FACTOR} – Establish the user unit coordinates of P1 and the ratio of plotter to user units. X_{MIN} and Y_{MIN} are the user unit coordinates of P1. X_{FACTOR} sets the number of plotter units per user unit on the X-axis; Y_{FACTOR} sets the number of plotter units per user unit on the Y-axis.
- **Type** – Must be 2 for this type of scaling.

An SC command remains in effect until another SC command is executed, or the printer is either initialized or set to default conditions.

EXAMPLE: The following examples explain the effect of several parameter selections.

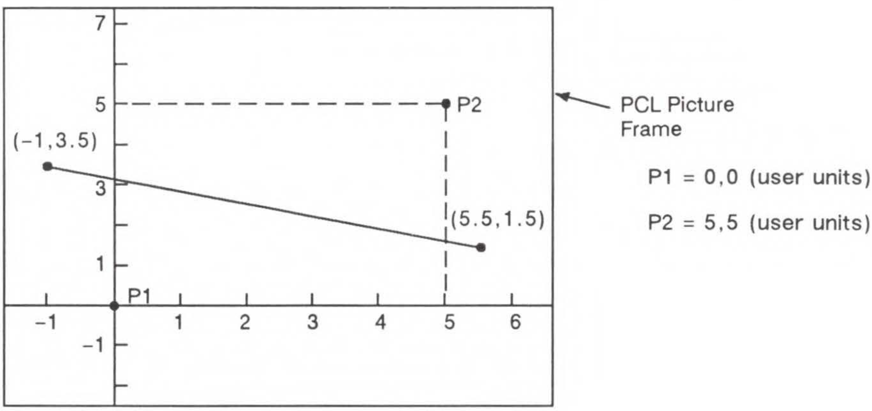
(SC0,1,0,1,2) moves the origin to P1 and establishes a one-to-one ratio of plotter to user units. This allows you to continue printing in plotter units with the advantage of using real numbers.

(SC0,40,0,40,2) allows scaling in millimeters since 1 millimetre = 40 plotter units. Each user unit will be 1 millimetre.

(SC0,1.016,0,1.016,2) allows scaling in thousandths of an inch since 1 inch = 1016 plotter units. Each user unit will be $\frac{1}{1000}$ of an inch.

While scaling is on (after either form of the SC command has been executed), only those HP-GL/2 commands that can be issued in 'current units' are interpreted as user units; the commands that can only be issued in plotter units are still interpreted as plotter units. (The command syntax discussion pertaining to each command tells you which kind of units each parameter requires.)

Remember that the SC parameters are mapped onto the current locations of P1 and P2. P1 and P2 do *not* represent a graphic limit; therefore, the new user-unit coordinate system extends across the entire range of the plotter-unit coordinate system. Thus, you can print to a point beyond P1 or P2, as long as you are within the effective window. For example, you can print from the point (-1,3.5) to the point (5.5,1.5) as shown in the following illustration.



Related Commands	Group
IP, Input P1 and P2	The Configuration/Status Groupts

Possible Error Conditions

Condition	Printer Response
no parameters	turns scaling off
more than 7 parameters	executes first 7 parameters
for types 0 or 1: 6 parameters or less than 4 parameters	ignores command
for type 2: any more or less than 5 parameters	ignores command
$X_{MIN} = X_{MAX}$ or $Y_{MIN} = Y_{MAX}$ or number out of range	ignores command
$X_{FACTOR} = 0$ or $Y_{FACTOR} = 0$	ignores command

18

The Vector Group

The information in this chapter enables you to achieve the following results in your programs:

- Use absolute and relative coordinates when plotting.
- Draw lines, arcs, and circles.
- Encode coordinates to greatly increase your printer's throughput.

The following commands are described in this chapter.

Table 18-1. The Vector Group Commands

Command	Summary
AA, Arc Absolute	Draws an arc using absolute coordinates.
AR, Arc Relative	Draws an arc using relative coordinates.
AT, Absolute Arc Three Point	Draws an arc from the current pen location through two absolute points.
CI, Circle	Draws a circle with a specified radius.
PA, Plot Absolute	Enables movement to absolute coordinate locations (with respect to the origin [0,0]).

Table 18-1.
The Vector Group Commands (continued)

Command	Summary
PD, Pen Down	Lowers the "pen" to the page.
PE, Polyline Encoded	Increases throughput by encrypting common HP-GL/2 commands.
PR, Plot Relative	Enables movement relative to the current pen location.
PU, Pen Up	Lifts the pen from the page.
RT, Relative Arc Three Point	Draws an arc from the current pen location through two relative points.

Drawing Lines

You can draw lines between two points (X,Y coordinate pairs) using the PD (Pen Down) command and a series of absolute and/or relative coordinate pairs. The printer draws only the portion of the line that falls within the *effective window*.

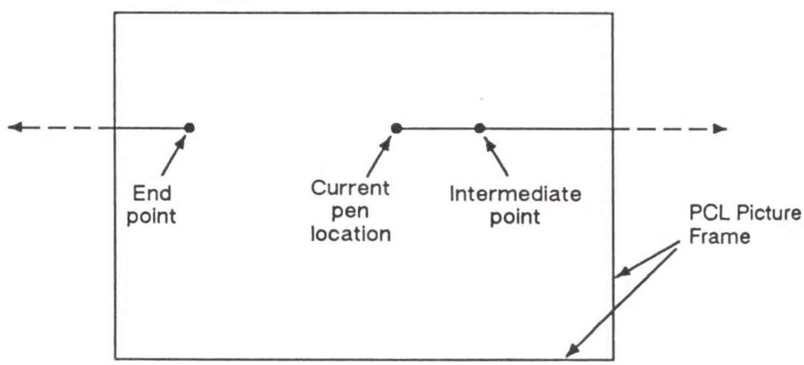
Note

When using HP-GL/2 to draw lines, you can increase your printer's throughput by using the Polyline Encoded (PE) command to send coordinates. The PE command requires that you convert coordinates from decimal to base 64 or 32. This conversion especially increases throughput when using an RS-232-C interface. The PE command, with its parameters, is used in place of the PA, PD, PR, and PU commands.

In the following example, note that the PA (Plot Absolute) command specifies absolute plotting, and the coordinate pair (0,0) sets the beginning pen location.

Example: Drawing Lines

$^{E}_{C}$**E**	Reset the printer.
$^{E}_{C}$**%ØB**	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1 (black). You must use the SP command to be able to print HP-GL/2 images.
PA0,0;	Begin absolute plotting from coordinate (0,0).
PD2500,0,0,1500,0,0;	Specify Pen Down and draw lines between the points.
$^{E}_{C}$**%ØA**	Enter the PCL mode.
$^{E}_{C}$**E**	Send a reset to end the job and eject the page.



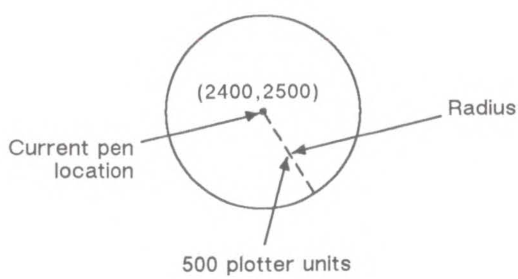
Drawing Circles

The Circle (CI) command uses your current pen position as the center of the circle; you specify the radius of the circle.

The following example shows a simple program using CI to draw a circle with a radius of 500 plotter units.

Example: Drawing Circles

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize the printer.
SP1;	Select pen number 1. The SP command must be used in order to enable printing.
PA2400,2500;	Specify absolute plotting and move to position (2400,2500).
CI500;	Draw a circle with a radius of 500 plu; the center of the circle is the current pen location (2400,2500).
$^{E}_{C}$%ØA	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.



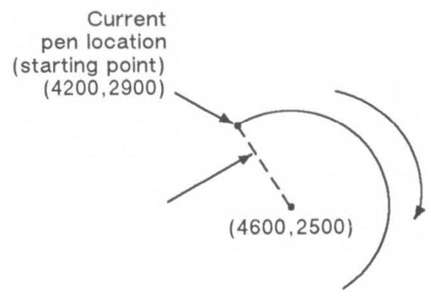
Drawing Arcs

The Arc Absolute (AA) and Arc Relative (AR) commands use the following method for drawing arcs. Your current pen location becomes one end of the arc; you specify the center point with one parameter (setting the radius) and set another parameter to specify the number of degrees through which you want the arc drawn.

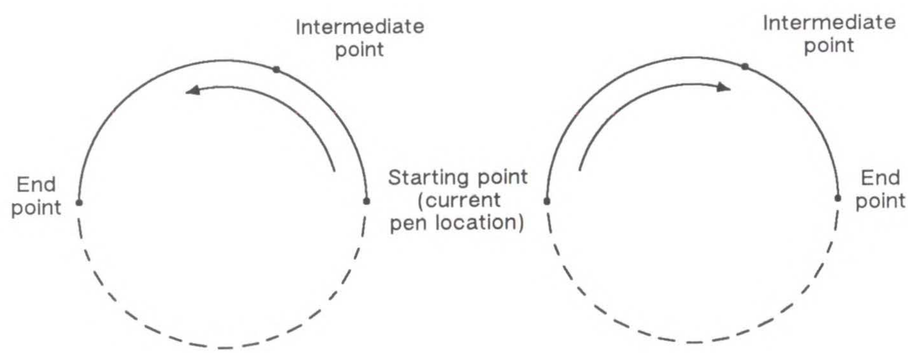
The following illustration shows a simple program using the AA command to draw a circle and an arc:

Example: Drawing Arcs

ᴱcE	Reset the printer.
ᴱc%ØB	Enter HP-GL/2 mode.
IN;	Initialize the printer.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA4200,2900;PD;	Set starting point to (4200,2900) and set pen down.
AA4600,2500,-180;	Using the Arc Absolute command, specify the center of the arc, thereby setting the radius; draw the arc for 180° clockwise.
ᴱc%ØA	Enter the PCL mode.
ᴱcE	Send a reset to end the job and eject the page.



You can also draw arcs using the Absolute Arc Three Point (AT) and Relative Arc Three Point (RT) commands. These commands use three known points (your current pen location plus two points you specify) to calculate a circle and draw the appropriate arc segment of its circumference. The arc is drawn clockwise or counterclockwise, as necessary, so that it passes through the intermediate point before the end point. Refer to the following illustration.



AA, Arc Absolute

Draws an arc, using absolute coordinates, which starts at the current pen location and pivots around the specified center point.

AA X_{center},Y_{center},*sweep angle[,chord angle;]*

Parameter	Format	Functional Range	Default
X_{center},Y_{center}	current units	-2^{30} to $2^{30}-1$	no default
sweep angle	clamped real	-32768 to 32767	no default
chord angle	clamped real	0.5° to 180°	5°

The AA command draws an arc starting at the current pen location using the current pen up/down status and line type and attributes. After drawing the arc, the pen location remains at the end of the arc.

Note

Do *not* use an adaptive line type when drawing arcs with small chord angles. The printer will attempt to draw the complete pattern in every chord (there are 72 chords in a circle using the default chord angle).

- **X_{Center}, Y_{Center}** – Specify the absolute location of the center of the arc. (The center of the arc is the center of the circle that would be drawn if the arc were 360 degrees.)

  Coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off. If current scaling is not isotropic, the arc drawn is elliptical rather than circular.

- **Sweep Angle** – Specifies in degrees the angle through which the arc is drawn. A positive angle is drawn counterclockwise from the current pen location; a negative angle is drawn clockwise.

- **Chord Angle** – Specifies the chord angle used to draw the arc. The default is a chord angle of 5 degrees. The chord angle specifies, in degrees, the maximum angle created when lines from each end of the chord intersect the center point of the circle (see drawing below). The smaller the chord angle, the smoother the curve.

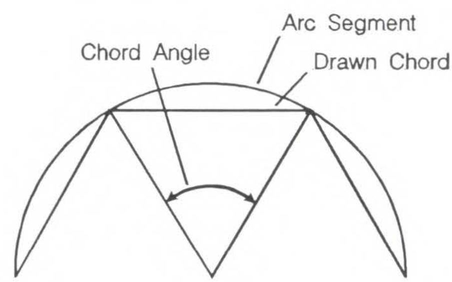


Figure 18-1. Chord Angle

For a specific chord angle, a circle or arc will always have the same number of chords, regardless of its size. For example, for the default chord angle, a circle is always composed of 72 chords (360°/5° per chord = 72 chords). This results in larger circles appearing less smooth than smaller circles having the same chord angle; setting the chord angle to a smaller number will help large circles or arcs appear more smooth.

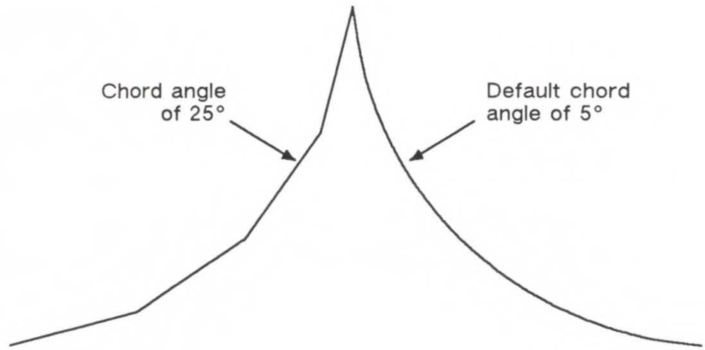


Figure 18-2.
Changing Arc Smoothness with the Chord Angle

Example: Varying the Chord Angle

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA2000,0;	Specify (2000,0) as the starting point.
PD;AA0,0,45,25;	With the pen down, draw a 45° arc (counterclockwise) with center coordinates of (0,0) and a chord angle of 25°.
PU1050,1060;	Lift the pen and move to (1050,1060).
PD;AA0,0,-45,10;	With the pen down, draw a 45° arc (clockwise) using the same center point as the first arc, but with a 10° chord angle.-1000

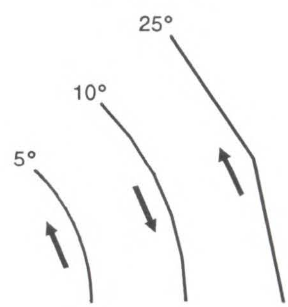


Figure 18-3. Changing the Chord Angle

PU1000,0;	Lift the pen and move to (1000,0).
PD;AA0,0,45;	With the pen down, draw another 45° arc (counterclockwise) with the same center point, but with the default chord angle (5°).
$^{E}_{C}$%ØA	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.

Related Commands	Group
AA, Arc Absolute AR, Arc Relative CI, Circle RT, Relative Arc Three Point	*The Vector Group*
LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

AR, Arc Relative

Draws an arc, using relative coordinates, which starts at the current pen location and pivots around the specified center point.

AR $X_{increment}$,$Y_{increment}$,*sweep angle[,chord angle;]*

Parameter	Format	Functional Range	Default
$X_{increment}$,$Y_{increment}$	current units	-2^{30} to $2^{30} - 1$	no default
sweep angle	clamped real	-32768 to 32767	no default
chord angle	clamped real	0.5° to 180°	5°

The AR command draws the arc starting at the current pen location using the current pen up/down status, line type, and attributes. After drawing the arc, the pen location remains at the end of the arc.

Note

Do *not* use an adaptive line type when drawing arcs with small chord angles. The printer will attempt to draw the complete pattern in every chord (there are 72 chords in a circle using the default chord angle).

- **$X_{Increment}$, $Y_{Increment}$** – Specify the center of the arc relative to the current location. (The center of the arc is the center of the circle that would be drawn if the arc were 360 degrees.)

  Coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off. If current scaling is not isotropic, the arc drawn is elliptical rather than circular.

- **Sweep Angle** – Specifies (in degrees) the angle through which the arc is drawn. A positive angle draws counterclockwise from the current pen location; a negative angle draws clockwise.

- **Chord Angle** – Specifies the chord angle used to draw the arc. The default is a chord angle of 5 degrees. Refer to the Arc Absolute (AA) command discussion (earlier this chapter) for information on setting and determining the chord angle.

Example: Using Arc Relative to Draw Arcs

^E_CE	Reset the printer.
^E_C%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA1500,1500;PD;	Specify the starting position as (1500,1500) and put the pen down.
AR0,2000,80,25;	Draw an arc with a center point 0 plu in the X direction and 2000 plu in the Y direction from (1500,1500). Specify the arc section to be 80° (counterclockwise), with a chord angle of 25°
AR2000,0,80;	Draw an arc with a center point 2000 plu in the X direction and 0 plu in the Y direction from the current pen position. Specify the arc section to be 80° (counterclockwise), with a default chord angle (5°).
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.

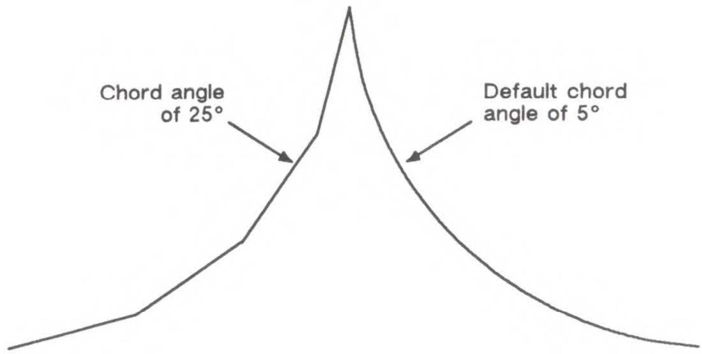


Figure 18-4. Drawing Arcs Using the AR Command

Related Commands	Group
AA, Arc Absolute AT, Absolute Arc Three Point RT, Relative Arc Three Point	*The Vector Group*
LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

AT, Absolute Arc Three Point

Draws an arc segment, using absolute coordinates, from a starting point, through an intermediate point, to an end point. Use AT when you know these three points of an arc.

AT X_{inter},Y_{inter}, X_{end},Y_{end}*[,chord angle;]*

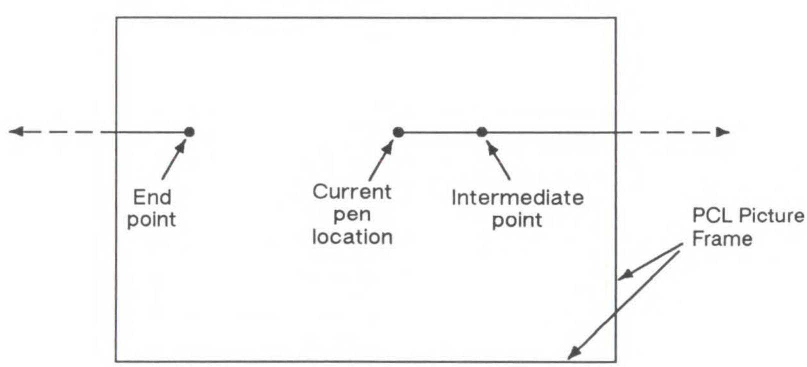
Parameter	Format	Functional Range	Default
X_{inter}, Y_{inter}	current units	-2^{30} to 2^{30} - 1	no default
X_{end}, Y_{end}	current units	-2^{30} to 2^{30} - 1	no default
chord angle	clamped real	0.5° to 180°	5°

The AT command uses the current pen location and two specified points to calculate a circle and draw the appropriate arc segment of its circumference. The arc starts at the current pen location, using the current pen, line type, line attributes and pen up/down status. You specify the intermediate and end points. After drawing the arc, the pen location remains at the end of the arc.

- **X_{Inter},Y_{Inter}** – Specify the absolute location of an intermediate point of the arc. The arc is drawn clockwise or counterclockwise, as necessary, so that it passes through the intermediate point before the end point.
- **X_{End},Y_{End}** – Specify the absolute location of the end point of the arc.
- **Chord Angle** – Specifies the chord angle used to draw the arc. The default is a chord angle of 5°. (The Arc Absolute (AA) command description [earlier in this chapter] contains more information on chords and chord angles.)

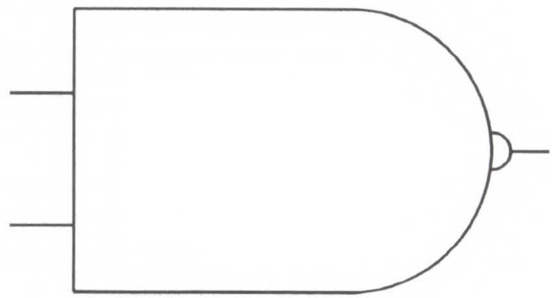
Intermediate and end point coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off. If current scaling is not isotropic, the arc drawn is elliptical rather than circular. Note the following about locating the intermediate and end points:

- If the intermediate point and end point are the same as the current pen location, the command draws a dot.
- If the intermediate point is the same as either the current pen location or the end point, a line is drawn between the current pen location and the end point.
- If the end point is the same as the current pen location, a circle is drawn, with its diameter being the line from the current pen position to the intermediate point.
- If the current pen position, intermediate point, and end point are collinear, a straight line is drawn.
- If the intermediate point does not lie between the current pen location and the end point, two lines are drawn, one from the current pen location and the other from the end point, leaving a gap between them. Refer to the following illustration. Both lines extend to the PCL Picture Frame limits or current window.



Example: Using the AT Command

^E_CE	Reset the printer.
^E_C%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1 (black).
PA1000,100; PD2500,100;	Specify (1000,100) as the starting location, place the pen down, and draw a line to (2500,100).
PU650,1150; PD1000,1150;	Lift the pen, move to (650,1150), place the pen down, and draw a line to (1000,1150).
PU650,450; PD1000,450;	Lift the pen, move to (650,450), place the pen down, and draw a line to (1000,450).
PU1000,100; PD1000,1500, 2500,1500;	Lift the pen, move to (1000,100), place the pen down, draw a line to (1000,1500), then to (2500,1500).
AT3200,800,2500, 100;	Print an arc, starting at current pen position (2500,1500), passing through (3200,800) and ending at (2500,100).
PU3200,900;PD;	Lift the pen, move to (3200,900) and set the pen down.
AT3300,800,3200, 700;	Print an arc, starting at the current pen position, passing through (3300,800) and ending at (3200,700).
PU3300,800; PD3500,800;	Lift the pen, move to (3300,800), pen down, and draw a line to (3500,800).
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.



Related Commands	Group
AA, Arc Absolute AR, Arc Relative RT, Relative Arc Three Point	*The Vector Group*
LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

CI, Circle

Draws the circumference of a circle using the specified radius and chord angle. If you want a filled circle, refer to the WG or PM commands.

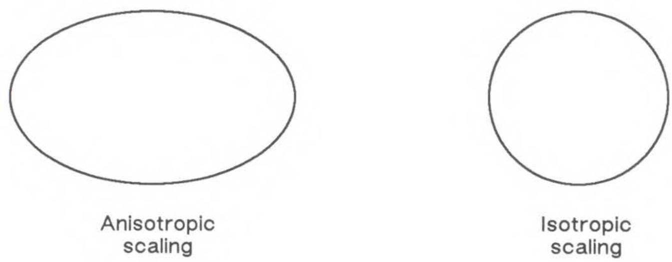
CI *radius[,chord angle;]*

Parameter	Format	Functional Range	Default
radius	current units	-2^{30} to 2^{30} - 1	no default
chord angle	clamped real	0.5° to 180°	5°

The CI command includes an automatic pen down. When a CI command is received, the pen lifts, moves from the center of the circle (the current pen location) to the starting point on the circumference, lowers the pen, draws the circle, then returns with the pen up to the center of the circle. After the circle is drawn, the previous pen up/down status is restored. To avoid leaving a dot at the center of the circle, move to and from the circle's center with the pen up.

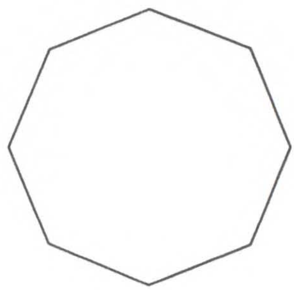
- **Radius** – Measured from the current pen location. Coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off.
- **Chord Angle** – Specifies the chord angle used to draw the arc. The default is a chord angle of 5°. Refer to the Arc Absolute (AA) command discussion, earlier in this chapter, for an explanation of the chord angle.

Each chord of the circle is drawn using the currently defined line type, width, and attributes. (Refer to Chapter 20, *The Line and Fill Attributes Group*, for more information.) Do not use an adaptive (negative) line type to draw a circle, as the printer will attempt to draw a complete pattern for every chord (72 with the default chord angle). Always use isotropic scaling in drawings that contain circles, unless you want your circles to "rubber" with aspect ratio changes of the drawing (anisotropic scaling may produce an ellipse). For more information, refer to Chapter 17 for the scaling discussion and the Scale (SC) command description.

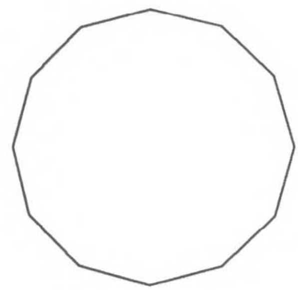


Example: Effects of Chord Angle on Circle Smoothness

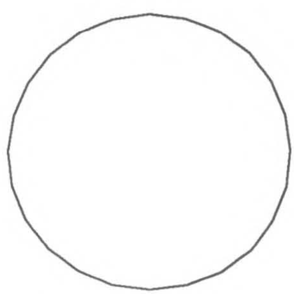
$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1 (black).
SC-3000,3000, -2000,2000,1;	Specify scaling mode, making P1 equal to (-3000,-2000) user units and P2 equal to (3000,2000) user units. Isotropic scaling is specified.
PA-1700,2000; CI750,45;	Specify absolute plotting and move to (-1700,2000), the center of the circle to be drawn. Draw a circle with a radius of 750 user units and a chord angle of 45°.
PA300,2000; CI750,30;	Specify absolute plotting and move to (300,2000) to draw another circle. Draw this circle with a radius of 750 user units and a chord angle of 30°.
PA-1700,-200; CI750,15;	Specify absolute plotting and move to (-1700,-200), the center point of a third circle. Draw this circle with a radius of 750 user units and a chord angle of 15°.
PA300,-200;CI750;	Specify absolute plotting and move to (300,-200), the center of the fourth circle. Draw this circle with a radius of 750 user units and a chord angle of 5° (default).
$^{E}_{C}$%ØA	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.



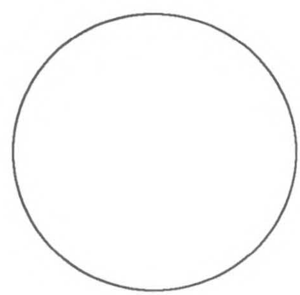
45-Degree chord angle



30-Degree chord angle



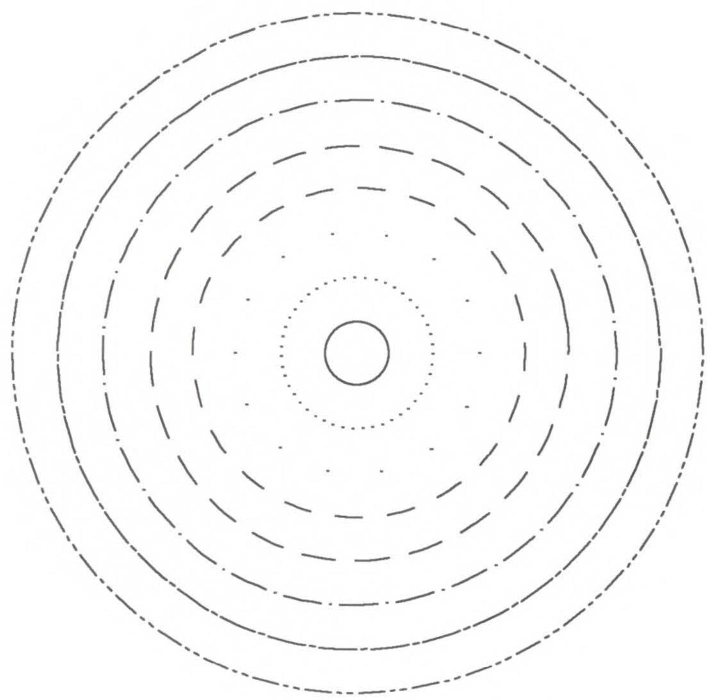
15-Degree chord angle



5-Degree chord angle

Example: Drawing Circles with Different Radii and Line Types

E_CE	Reset the printer.
E_C%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1 (black).
SC-75,75,-75,75,1;	Set up user scaling with (-75,-75) as P1 and (75,75) as P2; the "1" parameter specifies isotropic scaling.
PA0,0;	Specify absolute plotting and move to user unit location (0,0).
LT;CI5;	Specify a default line type (solid) and draw a circle with a radius of 5 user units.
LT0;CI-12;	Select line type 0 (dotted) and draw a circle with a radius of 12 user units (the minus sign indicates drawing in the clockwise direction).
LT1;CI19;LT2; CI-26;	Select line type 1 and draw a circle with a radius of 19 user units. Then select line type 2 and draw a circle with a radius of 26 user units.
LT3;CI33;LT4; CI-40;	Select line type 3, draw a circle with a radius of 33 user units. Then select line type 4 and draw a circle with radius of 40 user units.
LT5;CI47;LT6;CI54;	Draw the outer two circles; the first with a line type of 5 and a radius of 47 user units; the second with a line type of 6 and a radius of 54 user units.
E_C%ØA	Enter the PCL mode.
E_CE	Send a reset to end the job and eject the page.



Related Commands	Group
WG, Fill Wedge	*The Polygon Group*
SC, Scale	*The Configuration/Status Group*
AA, Arc Absolute AR, Arc Relative RT, Relative Arc Three Point	*The Vector Group*
LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

PA, Plot Absolute

Establishes absolute plotting and moves the pen to the specified absolute coordinates from the current pen position.

PA *X,Y [, ... ;]*

or

PA *[;]*

Parameter	Format	Functional Range	Default
X,Y coordinates	current units	-2^{30} to $2^{30} - 1$	no default

The printer interprets the parameters as follows:

- **No Parameters** – Establishes absolute plotting for subsequent commands.

- **X,Y Coordinates** – Specify the absolute location to which the pen moves. When you include more than one coordinate pair, the pen moves to each point in the order given, using the current pen up/down status. If the pen is up, PA moves the pen to the point; if the pen is down, PA draws a line to the point. Lines are drawn using the current line width, type, and attributes.

  When you use the symbol mode (SM) command, PA draws the specified symbol at each X,Y coordinate. When you use the polygon mode (PM) command, the X,Y coordinates enter the polygon buffer for use when the polygon is edged or filled.

  Coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off.

Note

If an odd number of coordinates is specified (in other words, an X coordinate without a corresponding Y coordinate), the printer ignores the last unmatched coordinate.

Related Commands		Group
PE,	Polyline Encoded	*The Vector Group*
PR,	Plot Relative	

PD, Pen Down

Lowers the printer's "logical pen" and draws subsequent graphics commands.

PD *X,Y[, ... ;]*

or

PD *[;]*

Parameter	Format	Functional Range	Default
X,Y coordinates/increments	current units	-2^{30} to 2^{30} - 1	no default

- This command emulates a pen plotter which must lower the pen to draw lines on the page.
- **No Parameters** – Prepares the printer to draw subsequent graphics commands.
- **X,Y Coordinates/Increments** – Draws (in current units) to the point specified. You can specify as many X,Y coordinate pairs as you want. When you include more than one coordinate pair, the printer draws to each point in the order given.

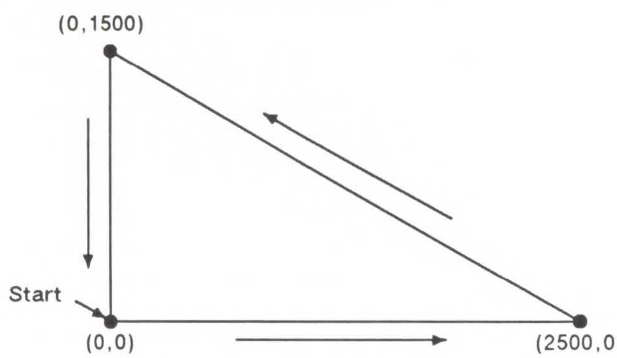
  Coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off.

  Whether the PD command uses coordinates or increments depends on the most recently executed PA or PR command. If you have not issued a PA or PR command, absolute plotting (PA) is used.

  When you use the symbol mode (SM) command, PD draws the specified symbol at each X,Y coordinate. When you use the polygon mode (PM) command, the X,Y coordinates enter the polygon buffer (and are used when the polygon is edged or filled).

Example: Using the Pen Down Command

^E_CE	Reset the printer.
^E_C%∅B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA0,0;	Begin absolute plotting from coordinate (0,0).
PD2500,0,0,1500,0,0;	Set the Pen Down and draw lines between the specified points.
^E_C%∅A	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.



Note

If an odd number of coordinates is specified (in other words, an X coordinate without a corresponding Y coordinate), the printer ignores the last unmatched coordinate.

Related Commands	Group
PA, Plot Absolute PE, Polyline Encoded PR, Plot Relative PU, Pen Up	*The Vector Group*

18 Vector Group

PE, Polyline Encoded

Incorporates the PA, PR, PU, PD, and SP commands into an encrypted format that substantially decreases the size of your file and the time required for data transmission. (This command is especially useful when using an RS-232-C interface.)

PE *[flag][value]|coord_pair ... [flag][value]|coord_pair;*

or

PE;

Note

Parameter values are self-terminating; do not use commas with this command. Also, you *must* use a semicolon to terminate PE.

Parameter	Format	Functional Range	Default
flag	character	':', '<', '>', '=', or '7'	no default
value	character	flag dependent*	
coordinate pair	character	-2^{30} to 2^{30} -1	no default

* Refer to the table following the parameter description.

Lines are drawn using the current line type and current units. The printer draws to all points with the pen down unless a pen up flag precedes the X,Y coordinates. If the final move is made with the pen up, the pen will remain in the up position; otherwise the pen is left in the down position.

The PE command causes the printer to interpret coordinate pairs as relative coordinates unless they are preceded by an absolute value flag (=). Relative integer coordinates produce the most compact data stream. For best results, scale your drawings so you use only integer coordinates and use relative plotting mode. After PE is executed, the previous plotting mode (absolute or relative) is restored.

The PE command represents vectors in base 64 (default) or base 32 (explained under *Encoding PE Flag Values and X,Y Coordinates*). In parameter value data, all spaces, delete characters, and control characters are ignored, as well as ASCII characters 128-160 and 255.

- **No parameters** – Updates the carriage return point. The PE command without parameters does not affect the pen's current location or up/down status.
- **Flag** – Indicates how the printer interprets subsequent values. Flags are ASCII characters and are not encoded. The printer disregards the eighth bit of a flag (e.g., a character code of 61 and a character code of 189 both send a '=' [the absolute flag]).

Table 18-2. PE Flag Descriptions

Flag	Meaning	Description
:	Select Pen	Indicates that the subsequent value is the desired pen number. A PE command without pen select defaults to the currently selected pen.
<	Pen Up	Raises the pen and moves to the subsequent coordinate pair value. (All coordinate pair values not preceded by a pen up flag are considered pen down moves.)*
>	Fractional Data	Indicates that the subsequent value specifies the number of fractional binary bits contained in the coordinate data. Default is zero.
=	Absolute	Indicates that the next point is defined by absolute coordinates.
7	7-bit Mode	Indicates that all subsequent coordinate pair values should be interpreted in 7-bit mode. Once you send a seven-bit flag, base 32 is used and eighth bits are ignored for the remainder of the command.

* We recommend you always follow a pen up flag with a relative move of (0,0). This ensures that the next plotting coordinates will be drawn.

Note

Because SP is not allowed in polygon mode, if you select a pen within PE while in polygon mode, the Select Pen command is ignored.

- **Value** – Specifies data according to the preceding flag. For example, a value following a select-pen flag should be a pen number; values following an absolute flag should be coordinate pairs. Flag values are encoded in the same manner as coordinate data. Instructions for encoding flag values follow the parameter descriptions.

Table 18-3. PE Values

Value	Format	Range
pen number	integer	0 to 1
number of fractional binary bits	integer	-26 to 26
X,Y coordinates	real	*

* PR and PE have extended ranges of -2^{30} to $2^{30} - 1$ plotter units. If the current pen position goes out of this range, the printer ignores plotting commands until it receives an absolute PA or PE coordinate within the extended ranges.

- **Pen Number** – Specifies the pen to be selected (black [1] or white [0]). The pen number must be encoded into a base 64 or base 32 equivalent.
- **Number of Fractional Binary Bits** – Specifies the number of fractional binary bits contained in the coordinate data. The number of fractional binary bits must be encoded into a base 64 or base 32 equivalent (see the explanation on the next page).
- **X,Y Coordinates** – Specifies a coordinate pair encoded into a base 64 (default) or a base 32 equivalent. Use base 64 if your system can send 8 bits of data without parity. Use 7-bit mode and base 32 coordinate values if your system requires a parity bit.

When you are in symbol mode (refer to the SM command in Chapter 20, *The Line and Fill Attributes Group*), PE draws the specified symbol at each X,Y coordinate. When you are in polygon mode (refer to the PM command in Chapter 19, *The Polygon Group*), the X,Y coordinates enter the polygon buffer; they are used when the polygon is edged or filled.

Encoding PE Flag Values and X,Y Coordinates

Flag values and X,Y coordinates are encoded into a base 64 (default) or base 32 equivalent (7-bit mode). Use base 64 if your system can send 8 bits of data without parity. Use 7-bit mode and base 32 coordinate values if your system requires a parity bit.

The following steps give a generic algorithm for encoding a number. Assume x is the number to be encoded. Use steps 1 and 2 only if you are encoding fractional data; otherwise, begin with step 3.

1. **Fraction adjustment.** If you are using fractional data, this step converts the number of decimal places in your data to the number of binary fractional bits. Assume "n" is the number of fractional binary bits specified by the fractional data flag.
   a. Multiply the number of decimal places contained in the data by 3.33.
   b. Round that number up to the next integer to get integer n.

   $n = \text{round (decimal places} \times 3.33)$

   $x = x \times 2^n$

2. **Round to an integer.** Round the results of step 1 to the nearest integer.

   $x = \text{round}(x)$

3. **Set the sign bit.** If x is positive, multiply it by two. If x is negative, multiply the absolute value of x by two and add one. This sets the sign bit.

   if $(x \geq 0)$

   $x = 2 \times abs(x)$

   else

   $x = 2 \times abs(x) + 1$

4. **Convert the number to base 64 or 32 and encode the data.** Convert x to a base 64 number if your system sends 8 bits without parity. Convert x to a base 32 number if your system sends 7 bits with parity (seven-bit flag is sent).

   Encode each base 64 or 32 digit into the ASCII character range, as described below. Output each character as it is encoded, starting with the least significant digit. The most significant digit is used to terminate the number and is encoded into a different ASCII character range than the low order digits.

   Each number in a coordinate pair is represented as zero or more nonterminator characters, followed by a terminator character. A character is a nonterminator or terminator depending on the range it is in; refer to the following table. For example, in base 64 there are 64 nonterminator and 64 terminator characters. Either kind represents a 'digit'.

Range Type	Nonterminator	Terminator
8-bit Range (base 64)	63-126	191-254
7-bit Range (base 32)	63-94	95-126

Values following the fractional data or select pen flag must also be encoded.

Base 64. Encode all the low order digits into the ASCII range 63 to 126. For a digit with value i, use ASCII character CHR$(63 + i). Encode the highest order digit (or the single digit in a one-digit number) into the range 191 to 254.

Base 32. Encode all the low order digits into the ASCII range 63 to 94. For a digit with value i, use ASCII character CHR$(63 + i). Encode the highest order digit (or the single digit in a one-digit number) into the range 95 to 126.

```
while n ≥ base
        output CHR$(63 + (n MOD base))
        n = n DIV base
    end
    if base = 64 then n = 191 + n
    if base = 32 then n = 95 + n
    output CHR$(n)
```


Programming Considerations

When using PE (in the default relative mode), the application program does not know the current pen location after printing a label (normally, the current pen location is updated to the end of the label.) If this presents a problem in your program, take the following steps.

1. Create a flag called "lost" in your program.
2. After labeling (or any command which changes the current pen location and does not update it), set lost to true.
3. If lost = true at the beginning of the PE command, use an absolute flag for the first coordinate pair only (subsequent coordinates are interpreted as relative).
4. Set lost to false.

Note

At the beginning of your application program, set lost to true. Then specify the next coordinate in absolute mode (PA or PE=).

When converting and encoding data, note the following.

- n DIV 64 = n.shift right.6 bits. You can optimize your application by shifting 6 bits to the right since shifting is faster than division.
- n MOD 64 = n.AND.63. The number is logically AND'd with 63.

Example: Using the PE Command The following BASIC program converts three relative real coordinates to base 64.

```
1Ø LPRINT CHR$(27);"E"; 'Reset the Printer.
2Ø LPRINT CHR$(27);"%0B"; 'Enter HP-GL/2 Mode.
3Ø LPRINT "IN;SC1,20,1,20,1;SP1;PU5,5;";
4Ø PRINT "Input number of fractional decimal places in data"
5Ø INPUT F   'In this example, 2 decimal places (line 290).
6Ø 'Calculate Number of Fractional Binary Bits
7Ø F = F * 3.33
8Ø F = INT(F)
9Ø A = F
1ØØ IF F >= Ø THEN F = 2*ABS(F) ELSE F = 2*ABS(F)+1
11Ø F = 191+F
12Ø PRINT #1, "PE>"+CHR$(F)
13Ø 'Convert coordinate data to base 64
14Ø FOR J = 1 to 6
15Ø READ C
16Ø C = C * (2^A)
17ØC = INT(C)
18ØIF C >= Ø THEN C = 2*ABS(C) ELSE C = 2*ABS(C)+1
19Ø WHILE C >= 64
2ØØ LPRINT CHR$(63+(C MOD 64))
21Ø C = C\64
22Ø WEND
23Ø C = 191+C
```

```
24Ø LPRINT CHR$(C)
25Ø NEXT J
26Ø LPRINT ";";
27Ø LPRINT CHR$(27);"%0A"; 'Enter PCL Mode
28Ø LPRINT CHR$(27);"E"; 'Reset to end job/eject page.
29Ø DATA 1Ø.58,Ø,-5.58,1Ø.67,-5,-1Ø.67
3ØØ END
```

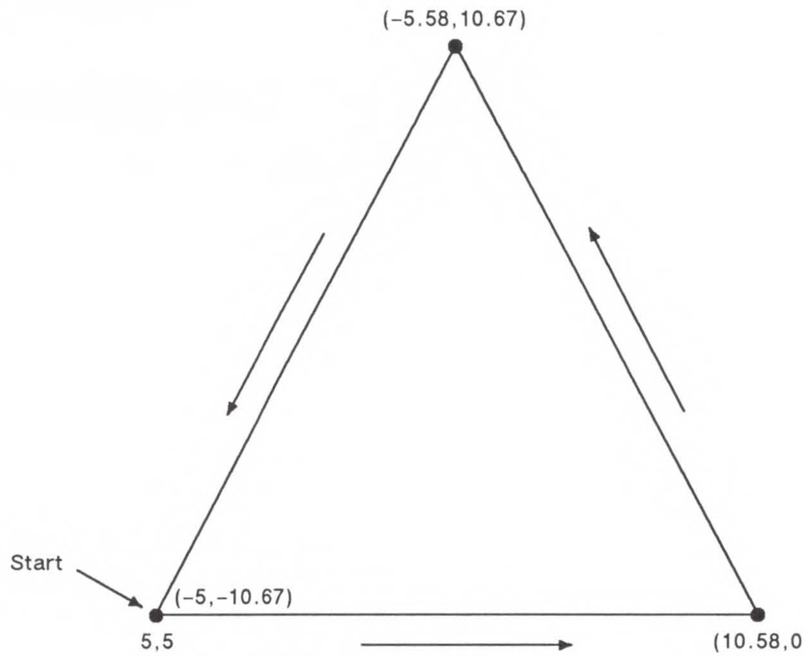


Figure 18-5. Using the PE Command

PR, Plot Relative

Establishes relative plotting and moves the pen to specified points, with each move relative to the current pen location.

PR *X,Y[, ... ;]*

or

PR *[;]*

Parameter	Format	Functional Range	Default
X,Y (increments)	current units	-2^{30} to 2^{30} - 1	no default

* PR and PE have extended ranges of -2^{30} to 2^{30} - 1 plotter units. If the current pen position goes out of this range,the printer ignores HP-GL/2 commands until it receives an absolute PA or PE coordinate within the extended range.

The printer interprets the parameters as follows:

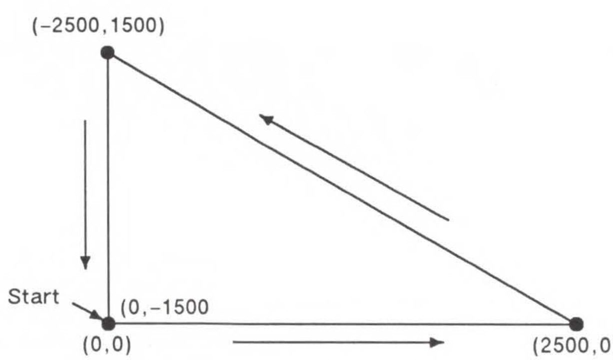
- **No Parameters** – Defaults to relative plotting mode for subsequent commands.
- **X, Y (Increments)** – Specify incremental moves relative to the current pen location. When you include more than one relative coordinate pair, the pen moves to each point in the order given (relative to the previous point), using the current pen up/down status. If the pen is up, PR moves the pen to the point; if the pen is down, PR draws a line to the point. Lines are drawn using the current line width, type, and attributes.

  When you use the symbol mode (SM) command, PR draws the specified symbol at each X,Y coordinate. When you use the polygon mode (PM) command, the X,Y coordinates enter the polygon buffer (and are used when the polygon is edged or filled).

Coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off.

Example: Using the PR Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%0B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. The SP command must be used in order to enable printing.
PA0,0;PD;	Move to absolute position (0,0) and put the pen down.
PR2500,0,-2500, 1500,0,-1500;	Specify relative plotting and draw lines beginning at (0,0) and then moving the relative coordinate distances indicated.
$^{E}_{C}$%0A	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.



Note

If an odd number of coordinates is specified (in other words, an X coordinate without a corresponding Y coordinate), the printer ignores the last unmatched coordinate.

Related Commands	Group
PA, Plot Absolute PE, Polyline Encoded	*The Vector Group*

PU, Pen Up

Moves to subsequent points without drawing. Use PU to move to another location without drawing a connecting line.

PU *X,Y[, . . . ;]*

or

PU *[;]*

Parameter	Format	Functional Range	Default
X,Y coordinates/increments	current units	-2^{30} to $2^{30} - 1$	no default

This command emulates a pen plotter which must raise the pen to prevent drawing stray lines on the page.

- **No Parameters** – Prevents drawing subsequent graphics commands (unless the command contains an automatic pen down).
- **X, Y Coordinates/Increments** – Move to the point(s) specified. You can specify as many X,Y coordinate pairs as you want. When you include more than one

coordinate pair, the printer moves to each point in the order given.

When you use the Symbol Mode (SM) command, PA draws the specified symbol at each X,Y coordinate. When you use the polygon mode (PM) command, the X,Y coordinates enter the polygon buffer (for use when the polygon is edged or filled).

Coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off.

Whether the PU command uses absolute coordinates or relative coordinates (increments) depends on the most recently executed PA or PR command. If you have not issued a PA or PR command, absolute plotting (PA) is used.

Note

If an odd number of coordinates is specified (in other words, an X coordinate without a corresponding Y coordinate), the printer ignores the last unmatched coordinate.

Related Commands	Group
PA, Plot Absolute PD, Pen Down PE, Polyline Encoded PR, Plot Relative	*The Vector Group*

RT, Relative Arc Three Point

Draws an arc segment, using relative coordinates, from a starting point through an intermediate point to an end point. Use RT when you know these three points of an arc.

RT $X_{incr\ inter}, Y_{incr\ inter}, X_{incr\ end}, Y_{incr\ end}$*[,chord angle;]*

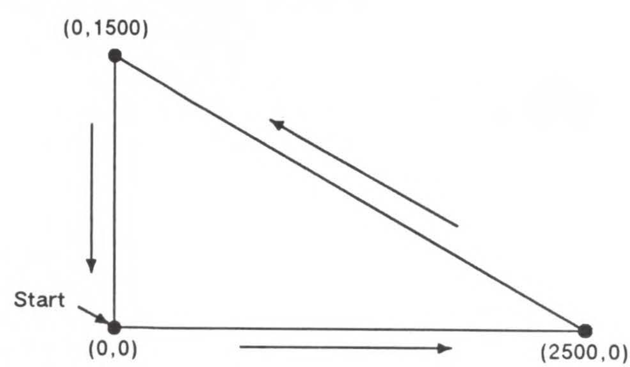
Parameter	Format	Functional Range	Default
$X_{incr\ inter}$, $Y_{incr\ inter}$	current units	-2^{30} to $2^{30} - 1$	no default
$X_{incr\ end}$, $Y_{incr\ end}$	current units	-2^{30} to $2^{30} - 1$	no default
chord angle	clamped real	0.5° to 180°	5°

The RT command uses the current pen location and two specified points to calculate a circle and draw the approprate arc segment of its circumference. The arc starts at the current pen location, using the current pen, line type, line attributes and pen up/down status. You specify the intermediate and end points. After drawing the arc, the pen location remains at the end of the arc.

- **$X_{Incr\ Inter}$, $Y_{Incr\ Inter}$** – Specify the location of an intermediate point of the arc in relative increments (relative to the current pen location). The arc is drawn clockwise or counterclockwise, as necessary, so that it passes through the intermediate point before the end point.
- **$X_{Incr\ End}$, $Y_{Incr\ End}$** – Specify the location of the end point of the arc in relative increments (relative to the current pen location).
- **Chord Angle** – Specifies the chord angle used to draw the arc. The default is a chord angle of 5°. (The Arc Absolute command description, earlier in this chapter, contains more information on chords and chord angles.)

Intermediate and end point coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off. If current scaling is not isotropic, the arc drawn is elliptical rather than circular. Note the following about intermediate and end points:

- If the intermediate point and end point are the same as the current pen location, the command draws a dot.
- If the intermediate point is the same as either the current pen location or the end point, a line is drawn between the current pen location and the end point.
- If the end point is the same as the current pen location, a circle is drawn, with its diameter being the distance between the current pen position and the intermediate point.
- If the current pen position, intermediate point, and end point are collinear, a straight line is drawn.
- If the intermediate point does not lie between the current pen location and the end point, two lines are drawn, one from the current pen location and the other from the end point, leaving a gap between them. Refer to the following illustration. Both lines extend to the PCL Picture Frame limits or current window.

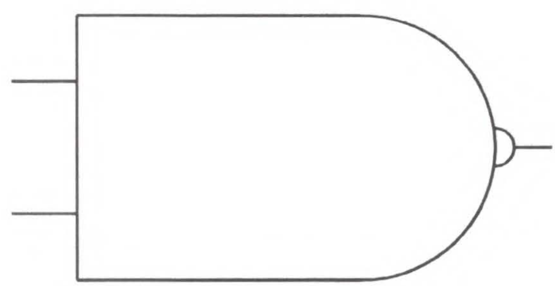


Example: Using the RT Command (Relative Arc Three Point)

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA1000,100;	Specify the absolute point (1000,100) as the starting location.
PR;PD1500,0;	Specify relative plotting, pen down, and draw (1500,0) relative plotter units from the current pen location (1000,100).
PU-1850,1050; PD350,0;	Lift the pen, move (-1850,1050) relative coordinates, place the pen down, and draw a line 350 plu in the X direction.
PU-350,-700; PD350,0;	Lift the pen, move (-350,-700) plu from the current location, place the pen down, and draw a line 350 plu in the X direction.
PU0,-350;PD0, 1500,1500,0;	Lift the pen, move 350 plu to the left, place the pen down, draw a line 1500 plu up and then another line 1500 units to the right.
RT700,-750,0,-1500;	Draw an arc from the current pen position through a point (700,-750) plu away, with an ending point (0,-1500) plu from the beginning of the arc.
PU700,850;PD;	Lift the pen and move it (700,850) plu from the current pen position; pen down.

Example: Using the RT Command (Relative Arc Three Point) (continued)

RT100,-100,0,-200;	Draw an arc from the current pen position, through a point (100,-100) plu away, with an ending point (0,-200) from the starting point of the arc.
PU100,100;PD200,0;	Lift the pen and move it (100,100) plu from the current pen position, pen down, and draw a line 200 plu in the X direction.
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.



Related Commands	Group
AA, Arc Absolute AR, Arc Relative AT, Absolute Arc Three Point	*The Vector Group*
LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

19

The Polygon Group

All of the commands in this group use the *polygon buffer*, a temporary data storage area in your printer. Using the polygon buffer is an integral part of drawing wedges, rectangles, and other types of polygons. Some of the commands in this chapter define and draw complete shapes while others act only on the contents of the polygon buffer. The information in this chapter enables you to achieve the following results in your programs:

- Draw circles, wedges, and rectangles.
- Use polygon mode for drawing polygons, subpolygons, and circles.

The following commands are described in this chapter:

Table 19-1. The Polygon Group Commands

Command	Summary
EA, Edge Rectangle Absolute	Outlines a rectangle defined with absolute coordinates.
EP, Edge Polygon	Outlines the contents of the polygon buffer.
ER, Edge Rectangle Relative	Outlines a rectangle defined with relative coordinates.
EW, Edge Wedge	Defines and outlines a wedge-shaped polygon.
FP, Fill Polygon	Fills the polygon shape specified in the polygon buffer.
PM, Polygon Mode	Allows you to create user-defined polygons in the polygon buffer.
RA, Fill Rectangle Absolute	Fills a rectangle specified with absolute coordinates.
RR, Fill Rectangle Relative	Fills a rectangle specified with relative coordinates.
WG, Fill Wedge	Defines and fills a wedge-shaped polygon.

Using the Polygon Buffer

As mentioned, a buffer is a temporary storage area for information. The *polygon buffer* collects the commands and coordinates that define a polygon you wish to print. This polygon remains in the buffer until replaced by another polygon, or until the buffer is cleared by initializing the printer. Some commands use the polygon buffer automatically, while other commands require that you enter the polygon mode. The following commands use the polygon buffer but do not require you to enter polygon mode first.

Table 19-2.

Mnemonic	Command Name
EA,	Edge Rectangle Absolute
ER,	Edge Rectangle Relative
EW,	Edge Wedge
RA,	Fill Rectangle Absolute
RR,	Fill Rectangle Relative
WG,	Fill Wedge

The LaserJet III polygon buffer holds a minimum of 512 points, or indices, and automatically allocates more memory for the polygon buffer if needed. The total buffer capacity is limited only by the amount of available user memory in the printer, but there is always enough room for at least 512 indices. User memory is affected by the amount of fonts, macros, and graphics that have been downloaded to the printer.

Note

For more information about the polygon buffer size and its relation to the complexity of an image, please refer to *Approximating Polygon Buffer Use* later in this chapter.

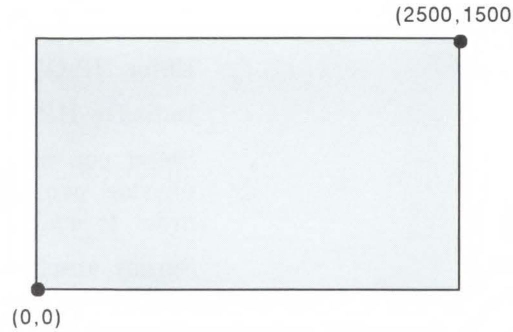
Drawing Rectangles

You can draw a rectangle by outlining (edging) the defined area using the Edge Rectangle Absolute (EA) or Edge Rectangle Relative (ER) commands. (You can also create filled rectangles, covered in the next section.)

To draw a rectangle, the printer uses the current pen location for one corner; you give the coordinates for the diagonally opposite corner. The printer draws the rectangle defined by these two points. The following simple program uses EA to draw a rectangle.

Example: Drawing Rectangles

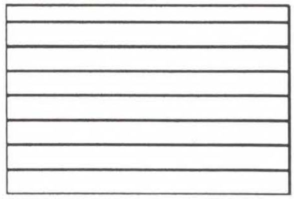
EcE	Reset the printer.
Ec%0B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1 (black). You must select a pen to print HP-GL/2 images.
PA0,0;	Specify absolute plotting and move to (0,0).
EA2500,1500;	Draw the outline of a rectangle, with the lower left corner being the current pen location (0,0) and the upper right corner being (2500,1500).
Ec%0A	Enter the PCL mode.
EcE	Send a reset to end the job and eject the page.

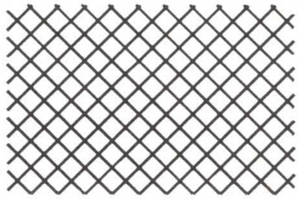


The Fill Rectangle Absolute (RA) and Fill Rectangle Relative (RR) commands, both discussed in Chapter 20, fill their rectangles with the default or current fill pattern. When you use an open fill type, you may also want to edge (or outline) the rectangle for better image definition. The following program draws two filled rectangles: one edged and one not.

Example: Filled Rectangles

^E_CE	Reset the printer.
^E_C%∅B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA0,0;	Specify absolute plotting and move to location (0,0).
FT3;	Specify fill type 3 (hatching–parallel lines).
RR1500,1000;	Fill a rectangular shape with the currently active fill pattern. The lower left corner of the rectangle should be the current location (0,0), and the upper right corner should be 1500 plu in the X direction and 1000 plu in the Y direction from the starting location.
EP;	Draw an edge around the rectangle that was just drawn. Since the previous RR command leaves its definition in the polygon buffer (1500,1000), you don't need to specify the coordinates again.
PR2000,0;	Specify relative plotting and move the cursor 2000 plu in the X direction from the current pen location.
FT4,100,45;	Specify fill type number 4 (cross-hatching), set the spacing to 100 plu between fill lines, and set the fill line angle to 45°.
RR1500,1000;	Fill a rectangle with the currently specified fill type. Use the current pen location (0,0) as the lower left corner of the rectangle and a point (1500,1000) relative plu away for the upper right corner.
^E_C%∅A	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.

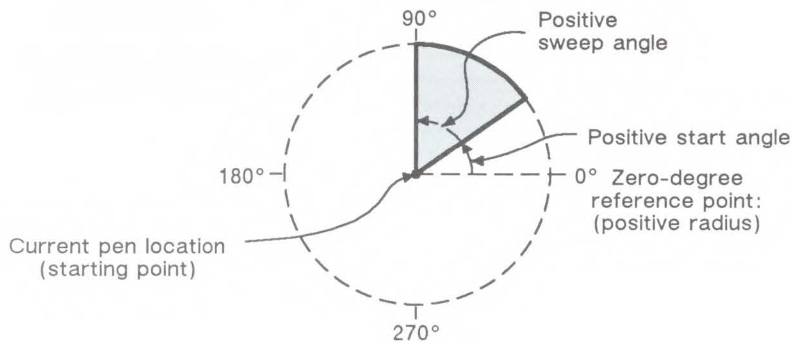




Drawing Wedges

A wedge is a section of a circle. Wedges are commonly used to draw pie charts. You can draw a wedge by outlining (edging) the defined area using the Edge Wedge (EW) command, or you can create filled wedges using the Fill Wedge (WG) command.

The wedge commands use your current pen location as the center point; you specify the radius, the start angle, and the sweep angle. The *radius* determines the length of the two sides of the wedge. The sign (positive or negative) of the radius determines the location of a 'zero-degree' reference point. The *start angle* is the number of degrees from the zero reference point at which you want to draw the first radius. The *sweep angle* is the number of degrees through which you want to draw the arc. To draw or fill a circle, simply specify a 360-degree sweep angle. The following illustration shows the different parameters of a wedge with a positive radius.



The following example draws a wedge using the EW command. The radius of the wedge is 600 plotter units, the wedge begins 90° from the zero-degree reference point, and the wedge "sweeps" for 60°.

Example: Drawing Wedges

^E_CE	Reset the printer.
^E_C%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA2500,3500;	Specify absolute plotting and move to location (2500,3500).
EW600,90,60;	Draw the outline of a wedge, using the current pen location (2500,3500) as the point of the wedge. The wedge has a radius of 600 plotter units, begins at 90° from the default zero-degree reference point, and "sweeps" for 60°.
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.

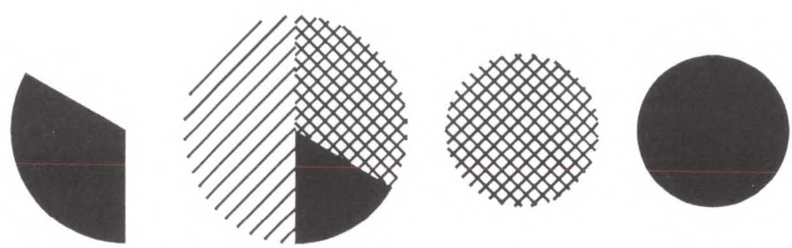
The following example uses different fill types with wedges and circles.

Example: Filling Wedges and Circles

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1 (black).
PA1400,2500;	Select absolute plotting mode and move to (1400,2500).
WG600,150,120;	Fill a wedge with radius 600 plu, a start angle of 150°, and a sweep angle of 120°. Since no fill type was specified, the wedge will be black (solid black is the default fill type).
PA2300,2500;FT3, 75,45;	Specify absolute plotting and move to (2300,2500). Select fill type number 3 (hatching–parallel lines), with 75 plu between hatching lines, and hatching lines tilted at 45°
WG600,90,180;	Fill a wedge with the current fill type; use a radius of 600 plu, a start angle of 90°, and a sweep angle of 180°.

Example: Filling Wedges and Circles (continued)

FT1,0,0;WG600, 270,60;	Specify a fill type of solid black and fill a wedge using the same center and radius as the previous wedge. Start the wedge at 270° with a sweep of 60°.
FT4,60,45;WG600, 330,120;	Specify fill type number 4 (cross-hatching) with 60 plu between lines and the lines tilted at 45°. Fill a wedge using the same center and radius as the previous two wedges. Start the wedge at 330° with a sweep of 120°.
PA3500,2500; WG400,0,360;	Select absolute plotting and move to (3500,2500). Create a filled circle using the current fill type (cross-hatching), specifying a start angle of 0° and a 360° sweep.
PA4500,2500;FT; WG400,0,360;	Move to (4500,2500), select a solid fill, and fill a 360° wedge (circle).
$^{E}_{C}$%ØA	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.



Drawing Polygons

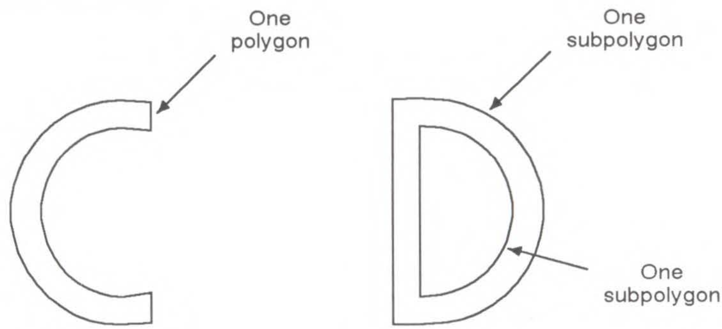
A polygon consists of one or more closed sequences of connected line segments (which may cross each other). Drawing polygons requires the use of the polygon mode. The Polygon Mode (PM) command tells the printer to store subsequent commands and coordinates in the polygon buffer before printing the shape. (Rectangles and wedges are polygons which have their own drawing commands; the printer automatically generates and stores the coordinates in the polygon buffer.)

You can use the following commands in polygon mode to create polygons. These commands are stored in the polygon buffer until they are replaced with another polygon or the printer is initialized.

Polygon Definition Commands	Group
AA, Arc Absolute AR, Arc Relative AT, Absolute Arc Three Point CI, Circle PA, Plot Absolute PD, Pen Down PE, Polyline Encoded PR, Plot Relative PU, Pen Up RT, Relative Arc Three Point	*The Vector Group*
PM1/PM2, Polygon Mode	*The Polygon Group*

Drawing Subpolygons

While in polygon mode, you can define either one polygon or a series of subpolygons. Like a polygon, a subpolygon is a closed sequence of connected line segments. For example, the block letter C is one complete polygon. However, the block letter D is actually two subpolygons: the outline and the 'hole.'



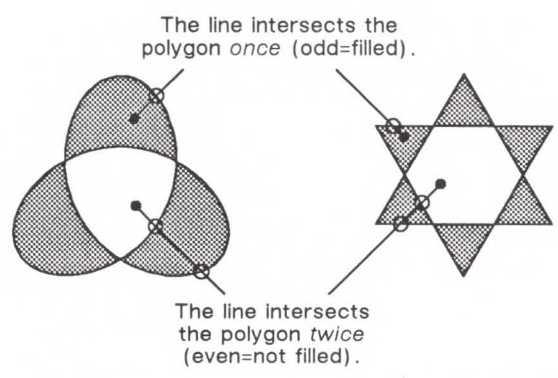
To create one polygon (e.g., the letter C), move the pen to the starting location for the polygon, then use the Polygon Mode (PM) command to enter polygon mode. Define the shape of the C using the appropriate commands and coordinates, then exit polygon mode. Now draw the polygon using either the Edge Polygon (EP) or Fill Polygon (FP) command.

To create a series of subpolygons (e.g., the letter D), move the pen to the starting location of the first subpolygon, then enter polygon mode. Define the outer shape of the letter D using the appropriate commands and coordinates, then close the subpolygon, staying in polygon mode. Define the inner shape of the D, then exit polygon mode. Now draw the subpolygons using either the Edge Polygon (EP) or Fill Polygon (FP) command. For more information on entering and exiting polygon mode, refer to the Polygon Mode (PM) command at the end of this chapter.

In polygon mode, you can define points with the pen up or down. However, the Edge Polygon (EP) command only draws between points that were defined when the pen was down. In contrast, the Fill Polygon (FP) command fills between all points, regardless of whether they were defined when the pen was up or down. (Exception: the line connecting two subpolygons is never drawn, and is not a fill boundary.)

Filling Polygons

There is a simple way to determine which portions of a single polygon or series of subpolygons will be filled when you send a Fill Polygon (FP) command: Draw a straight line extending from any point within an enclosed area of the polygon to a point outside the polygon. FP fills the enclosed area in question only if the line you have drawn intersects the polygon an odd number of times. An illustration of this 'odd-even' rule is shown below.



Single polygon *Two subpolygons*

Drawing Circles in Polygon Mode

Polygon mode interprets the Circle (CI) command differently than the other HP-GL/2 commands. The printer treats a circle as a complete subpolygon. The printer automatically closes the first polygon (if any) before starting the circle, and uses the first coordinates (if any) after the circle is drawn to start a new subpolygon.

If you have not completely closed your first polygon before sending the CI command, the printer automatically closes the polygon by adding a point (at the starting point of the previous subpolygon). This can change your current pen location and the placement of the circle in your polygon, resulting in an inaccurate polygon.

Note

In polygon mode, the smaller a circle's chord angle, the more chords will be stored in the polygon buffer to draw it.

Approximating Polygon Buffer Use

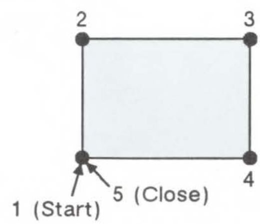
You can use the following formula to estimate how much buffer space a polygon consumes. Each point in a polygon uses 8 bytes. For example, the minimum number of points a LaserJet III printer will hold is 512. If you multiply 512 points by 8 bytes per point, the result is 4096 bytes (4 Kbytes). That means the minimum your printer can store in the polygon buffer is 4 Kbytes. That is the worst case, however. Unless the printer has a substantial amount of fonts, macros, or graphics already downloaded into user memory, you can put much more into the polygon buffer. As we just calculated, for every 4 Kbytes of extra unused user memory, the polygon buffer can store 512 more points. You can see how in most cases there is little chance of a polygon buffer overflow, especially with the addition of optional printer memory.

The following formula explains how to calculate the buffer space used by a polygon:

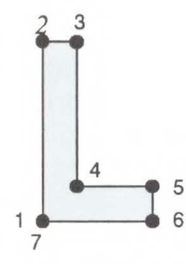
> # of points in polygon × 8 = buffer space consumed by polygon

Counting the Points in a Polygon

The starting pen location and each subsequent point define a polygon. As shown in the following illustration, a rectangle is defined by five points, not four. This is because the starting location is counted again as the ending location.



The following shape has seven points.



Counting the Points in a Circle or Arc

When a circle or arc defines a polygon, the number of points depends on the number of chords in the arc. Use the following formula to determine the number of points used to draw a circle or arc:

19 Polygon Group

$$\# \text{ of Points} = \frac{\text{Arc Angle (degrees)}}{\text{Chord Angle (degrees)}} + 1$$

Using this formula, a full circle with the default chord angle of 5° consists of 73 points (360/5 + 1 = 73), and a 45° arc with a chord angle of 3° consists of 16 points (45/3 + 1 = 16).

Note

If the chord angle does not divide evenly into the arc, round up to the next integer before adding one: 45/2 + 1 = 23 + 1 = 24.

EA, Edge Rectangle Absolute

Defines and outlines a rectangle using absolute coordinates. Use EA when drawing charts or schematic diagrams that require rectangles.

EA *X,Y[;]*

Parameter	Format	Functional Range	Default
X,Y coordinates	current units	-2^{30} to $2^{30} - 1$	no default

The EA command defines and edges a rectangle using absolute coordinates and the current pen, line type and line attributes. The EA command includes an automatic pen down. When the command execution is complete, the original pen location and up/down status are restored.

- **X,Y Coordinates** – Specify the opposite corner of the rectangle from the current pen location. The current pen location is the starting point of the rectangle. Coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off.

Note

The following illustration shows the current pen location in the lower left corner and the command's X,Y coordinates in the upper-right corner. Depending on the coordinate values, the points can be in any two diagonally opposite corners.

The only difference between the EA command and the RA (Fill Rectangle Absolute) command is that the EA command produces an outlined rectangle, and RA, a filled one.

The EA command clears the polygon buffer and then uses it to define the rectangle before drawing. Refer to

Drawing Polygons at the beginning of this chapter for more information.

The following example uses absolute coordinates to draw some rectangles. The same image is drawn later using the ER command instead. Compare this example with the ER example to understand the differences between the coordinates used (relative vs. absolute).

Example: Using EA to Draw Rectangles

^E_CE	Reset the printer.
^E_C%∅B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
SC0,150,0,150,1;	Set up user scaling, with P1 being (0,0) user units and P2 being (150,150) user units. (Isotropic scaling is specified.)
PA75,105; EA115,130;	Specify absolute plotting mode and move to (75,105). Use EA to outline the shape of a rectangle that begins at (75,105) and has an upper right corner of (115,130) user units.
PA95,105;PD95,95;	Draw a line from (95,105) to (95,95).
PD65,95,65,90;	Draw a line from the current pen location (95,95) to (65,95), and another line from there to (65,90).
PU45,90;EA85,65;	Lift the pen and move to (45,90). Draw the outline of a rectangle with an upper left corner of (45,90) and an lower right corner of (85,65).
PU95,95;PD125, 95,125,90;	Lift the pen and move to (95,95). Lower the pen and draw a line to (125,95), then to (125,90).
PU145,90;EA105,65;	Lift the pen and move to (145,90). Draw the outline of a rectangle, with the upper right corner at (145,90) and the lower left corner at (105,65).
^E_C%∅A	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.

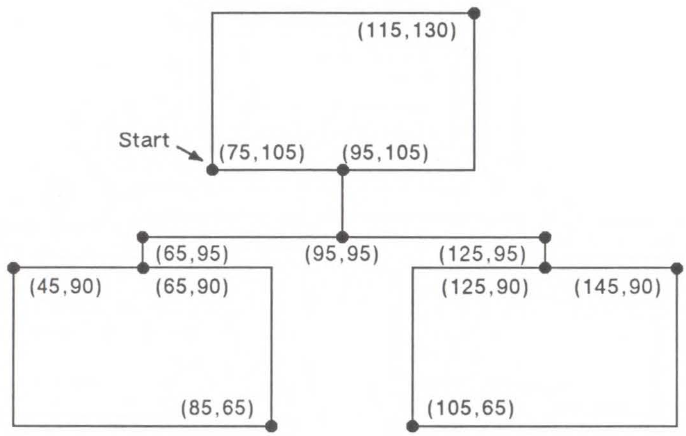


Figure 19-1. Using EA to Draw Rectangles

Related Commands	Group
EP, Edge Polygon	*The Polygon Group*
ER, Edge Rectangle Relative	
FP, Fill Polygon	
RA, Fill Rectangle Absolute	
RR, Fill Rectangle Relative	

EP, Edge Polygon

Outlines the polygon currently stored in the polygon buffer. Use EP to edge polygons that you defined in polygon mode and with the Fill Rectangle and Wedge Commands (RA, RR, and WG).

EP *[;]*

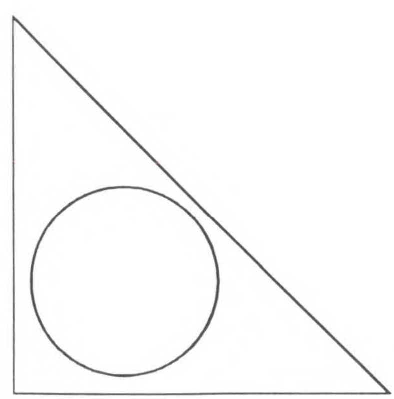
The EP command outlines any polygon that is currently in the polygon buffer. This includes wedges and rectangles defined using the EA, ER, EW, RA, RR, and WG commands. EP accesses the data in the polygon buffer, but does not clear the buffer or change the data in any way.

The EP command only edges between points that were defined with the pen down, using the current pen, line type and attributes. When the command execution is complete, the original pen location and up/down status are restored.

The following example creates a shape in polygon mode, then uses EP to outline it.

Example: Using the EP Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1 (black).
PA2000,0;	Specify absolute plotting and move to position (2000,0).
PM0;PD0,2000,0,0, 2000,0;PM1;	Enter polygon mode, store a pen down command, and then store points (0,2000), (0,0), and (2000,0). Close the polygon.
PU600,600; CI500;PM2;	While still in polygon mode, lift the pen and move to (600,600). Draw a circle with a diameter of 500 plu, then close the current subpolygon and exit polygon mode.
EP;	Outline the polygon that was just stored in the polygon buffer.
$^{E}_{C}$%ØA	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.



Related Commands	Group
EA, Edge Rectangle Absolute ER, Edge Rectangle Relative EW, Edge Wedge PM, Polygon Mode	*The Polygon Group*
LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

ER, Edge Rectangle Relative

Defines and outlines a rectangle using relative coordinates. Use ER when drawing charts or schematic diagrams that require rectangles.

ER *X,Y[;]*

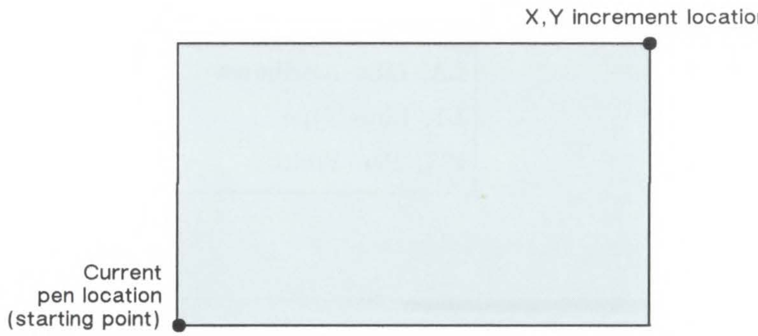
Parameter	Format	Functional Range	Default
X,Y increments	current units	-2^{30} to $2^{30} - 1$	no default

The ER command defines and edges a rectangle using relative coordinates and the current pen, line type, and line attributes. The ER command includes an automatic pen down. When the command operation is complete, the original pen location and up/down status are restored.

- **X,Y Increments** – Specify the opposite corner of the rectangle from the current pen location. The current pen location is the starting point of the rectangle. Increments are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off.

Note

The following illustration shows the current pen location in the lower left corner and the command's X,Y increment location in the upper right corner. When drawing a rectangle, these points can be in any two diagonally opposite corners.



The only difference between the ER command and the RR (Fill Relative Rectangle) command is that the ER command produces an outlined rectangle, and RR, a filled one.

The ER command clears the polygon buffer and then uses it to define the rectangle before drawing. Refer to *Drawing Polygons* earlier in this chapter for more information.

The following example uses relative coordinates to draw the same image shown in the EA command example. Compare this example with the EA example to understand the differences between the coordinates used.

Example: Using ER to Draw Rectangles

^E_CE	Reset the printer.
^E_C%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1 (black) to enable printing.
SC0,150,0,150,1;	Specify user scaling, with P1 being (0,0) and P2 (150,150); the "1" indicates isotropic scaling.
PA75,105;ER40,25;	Enter absolute plotting mode and move to (75,105). Draw a rectangle using the current pen location as the lower left corner and a point (40,25) user units away as the upper right corner.
PR20,0;PD0,-10;	Specify relative plotting and move the pen 20 user units to the right. Place the pen down and draw a line to a point 10 user units down.
PD-30,0,0,-5;	With the pen down, move 30 user units to the left and 5 units down.
PU-20,0;ER40,-25;	Lift the pen and move 20 user units to the left, then draw the outline of a rectangle with the current pen location as one corner and a point (40,-25) user units away as the opposite corner.
PU50,5;PD30,0, 0,-5;	Lift the pen and move 50 user units to the right and 5 units up. Place the pen down and draw a line 30 user units to the right, then 5 units down.

Example: Using ER to Draw Rectangles (continued)

PU20,0;ER-40,-25; Lift the pen and move 20 user units to the right. Draw a rectangle from that point, with the current pen location being one corner and the opposite corner being 40 user units to the left and 25 units down.

$^{E}_{C}$%0A Enter the PCL mode.

$^{E}_{C}$E Send a reset to end the job and eject the page.

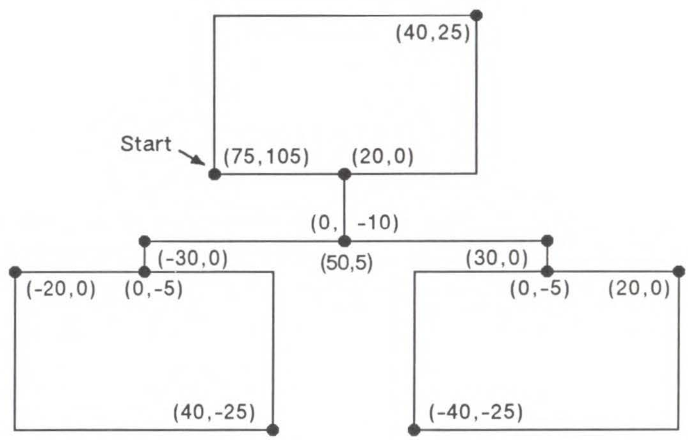


Figure 19-2. Drawing Rectangles with the ER Command

Related Commands	Group
EA, Edge Rectangle Absolute	*The Polygon Group*
EP, Edge Polygon	
FP, Fill Polygon	
RA, Fill Rectangle Absolute	
RR, Fill Rectangle Relative	

EW, Edge Wedge

Outlines any wedge. Use EW to draw sections of pie charts.

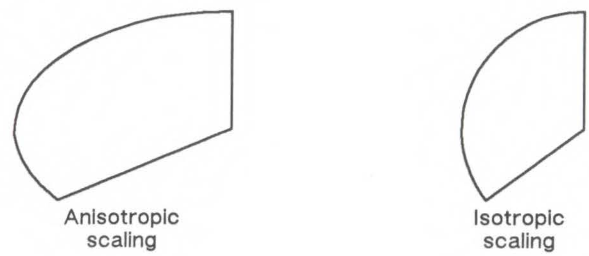
EW *radius,start angle,sweep angle,[,chord angle;]*

Parameter	Format	Functional Range	Default
radius	current units	-2^{30} to $2^{30} - 1$	no default
start angle	clamped real	-32768 to 32767 modulo 360	no default
sweep angle	clamped real	$\pm 360^\circ$	no default
chord angle	clamped real	0.5° to 180°	5°

The EW command defines and edges a wedge using the current pen, line type and attributes. The EW command includes an automatic pen down. When the command execution is complete, the original pen location and up/down status are restored.

The only difference between the EW command and the WG (Fill Wedge) command is that the EW command produces an outlined wedge, and the WG command, a filled one.

Always use isotropic scaling in drawings that contain wedges unless you wish the wedges to "rubber" with changes in the aspect ratio of the drawing (causing elliptical wedges). For more information, refer to the discussion of scaling and the Scale (SC) command description in Chapter 17.



- **Radius** – Specifies the distance from the current pen location to the start of the wedge's arc. Since the wedge is a portion of a circle, this parameter is the radius of the circle. It specifies the distance from the current pen location (which becomes the center of the circle), to any point on the circumference of the circle.

  The radius is interpreted in current units: as user units when scaling is on; as plotter units when scaling is off. The sign (positive or negative) of the radius determines the location of the zero-degree reference point. The illustration following the parameter descriptions shows the location of the zero-degree reference point for a positive and a negative radius.

- **Start Angle** – Specifies the beginning point for the arc as the number of degrees from the zero-degree reference point. A positive start angle positions the radius counterclockwise (the direction from the positive X-axis toward the positive Y-axis) from the zero-degree reference point; a negative start angle positions the radius clockwise from the zero-degree reference point. If you specify a start angle greater than 360°, a start angle equal to the remainder of the start angle/360° is used.

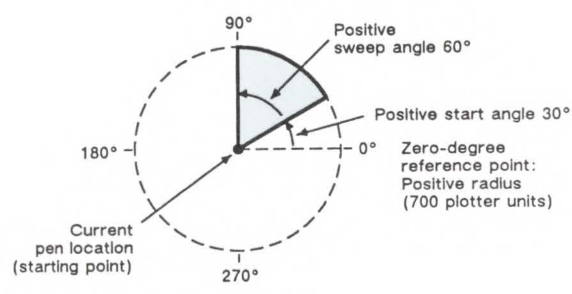
Note

Clockwise is defined as going in the same direction as from the +X axis to the -Y axis in the current coordinate system. Depending on the SC, IP, and IR commands in effect at the time, the *clockwise* direction may actually be *counterclockwise*.

Sweep Angle – Specifies the number of degrees through which the arc is drawn. A positive sweep angle draws the arc counterclockwise; a negative sweep angle draws the arc clockwise. If you specify a sweep angle greater than 360 degrees, a 360-degree angle is used.

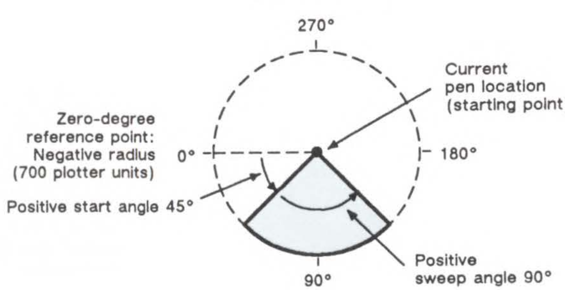
Chord Angle – Specifies the chord angle used to draw the arc. The default is a chord angle of 5 degrees. Refer to the Arc Absolute (AA) command discussion in Chapter 18 for further information on chords and chord angles.

(EW700,30,60)



Positive Radius

(EW-700,45,90)

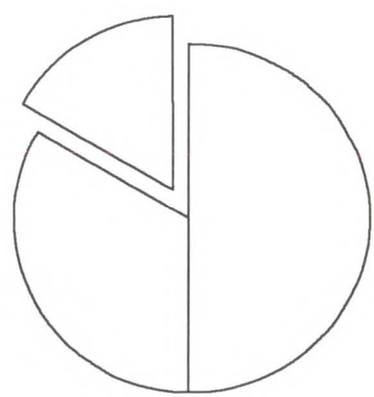


Negative Radius

19 Polygon Group

Example: Using EW to Draw a Pie Chart

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%0B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
SC-3000,3000, -2000,2000,1;	Enter the scaling mode, specifying P1 as (-3000,-2000) and P2 as (3000,2000). Use isotropic scaling.
PA0,0;	Specify absolute plotting and move to user-unit location (0,0).
EW-1000,90,180;	Draw a wedge section with a radius of 1000 user units, a start angle of 90°, and a sweep angle of 180°. The minus sign before the radius (-1000) sets the zero-degree reference point to the left side of the drawing.- 1000



Example: Using EW to Draw a Pie Chart (continued)

EW-1000, 330,120;	Using the same center point and zero-degree reference point, draw a wedge section outline starting at 330° and sweeping 120°.
PR-60,110;	Move the cursor 60 user units to the left and 110 user units up.
EW-1000,270,60;	From the new center point location, draw a wedge using a negative zero-reference point, starting at 270° and sweeping for 60°.
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.

Related Commands	Group
EP, Edge Polygon FP, Fill Polygon WG, Fill Wedge	*The Polygon Group*
SC, Scale	*The Configuration/Status Group*
LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

POSSIBLE ERROR CONDITIONS:

Condition	Printer Response
polygon buffer overflow	edges contents of buffer

FP, Fill Polygon

Fills the polygon currently in the polygon buffer. Use FP to fill polygons defined in polygon mode or with the Edge Rectangle or Edge Wedge commands (EA, ER, and EW).

FP *[;]*

The FP command fills any polygon that is currently in the polygon buffer. This includes wedges and rectangles defined using the EA, ER, EW, RA, RR, or WG commands. FP accesses the data in the polygon buffer, but does *not* clear the buffer or change the data in any way.

The FP command fills between points defined with either the pen down or the pen up. The polygon is filled using the current pen, fill type, line type and attributes (if the fill type is not solid). The FP command includes an automatic pen down. When the command execution is complete, the original pen location and up/down status are restored.

The following example creates a polygon composed of two subpolygons. In this case, the FP command fills alternating areas, beginning with the outside area.

Example: Using the FP Command

^E_CE	Reset the printer.
^E_C%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA1500,1500;	Specify absolute plotting and move to (1500,1500).
PM0;CI1000,60; PA1500,1500; CI500;PM2;	Enter the polygon mode, store a circle with radius of 1000 plu and a 60° chord angle, store a pen move to (1500,1500), and another circle with a 500 plu radius and a 5° (default) chord angle. Close the current polygon and exit polygon mode.-1000

LT4;FT3,50,45;	Select line type 4 and fill type 3. Specify a 50 plu distance between the fill lines, and slant the lines at a 45° angle.
FP;	Fill the polygon currently in the polygon buffer with the line and fill types just specified.
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.

Related Commands	Group
PM, Polygon Mode RA, Fill Rectangle Absolute RR, Fill Rectangle Relative WG, Fill Wedge	*The Polygon Group*
FT, Fill Type LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

POSSIBLE ERROR CONDITIONS:

Condition	Printer Response
previous PM, RA, RR, or WG command polygon buffer overflowed*	fills buffer contents

* It is possible to define and edge a polygon, but not be able to fill it.

PM, Polygon Mode Command

Enters polygon mode for defining shapes, such as block letters or any unique area, and exits for subsequent filling and/or edging. Fill polygons using the Fill Polygon (FP) command and/or outline them using the Edge Polygon (EP) command.

PM *polygon definition [;]*

or

PM *[;]*

Parameter	Format	Functional Range	Default
polygon definition	clamped integer	0, 1, and 2	0

In polygon mode, you define the area of the polygon(s) using graphics commands. These commands (and associated X,Y coordinates) are stored in the polygon buffer. The polygon is not printed until you exit polygon mode and fill and/or outline the area.

- **No Parameters** – Clears the polygon buffer and enters polygon mode. Equivalent to (PM0).
- **Polygon Definition** – Defines polygon mode status as follows.

  0 – Clears the polygon buffer and enters polygon mode.

  1 – Closes the current polygon (or subpolygon) and remains in polygon mode; all commands sent following PM1 but before a PM2 (or the next PM1) are stored as one subpolygon.

  2 – Closes current polygon (or subpolygon) and exits polygon mode.

The following paragraphs explain how to use each parameter. The order in which you use these commands is very important.

(PM0) or (PM)

Use *(PM0)* to clear the polygon buffer and enter polygon mode. While in polygon mode, you can use certain commands to define your polygon. The following list contains these commands:

Polygon Definition Commands	Group
DF, Default Values IN, Initialize	*The Configuration/Status Group*
AA, Arc Absolute AR, Arc Relative AT, Absolute Arc Three Point CI, Circle PA, Plot Absolute PD, Pen Down PE, Polyline Encoded PR, Plot Relative PU, Pen Up RT, Relative Arc Three Point	*The Vector Group*
PM1/PM2, Polygon Mode	*The Polygon Group*

The polygon buffer stores the lines (vectors) that define your polygon. These vectors are accessed later when you exit polygon mode and fill and/or edge the polygon.

Note

While in polygon mode, the CI command is interpreted differently than other graphics commands. Refer to *Drawing Circles in Polygon Mode*, earlier in this chapter for more details.

When you define polygons, the pen location before (*PM0*) is the first point (vertex) of the polygon, and the first point stored in the polygon buffer. For example, if you execute the commands (*PA0,1750;PM0*) the absolute coordinates (0,1750) specify the first point of your polygon. Each subsequent pair of coordinates defines a point, or vertex, of the polygon.

You can define points with the pen up or down. However, the EP command only draws between points that are defined when the pen is down. On the other hand, the FP command fills the area(s) between all vertices, regardless of whether the pen is up or down when defined.

It is good programming practice to 'close' the polygon before exiting polygon mode. Closing a polygon means adding the final vertex that defines a continuous shape; the last coordinates or increments represent the same location as the first. If you have not closed the polygon, executing (*PM1*) or (*PM2*) forces closure by adding a point to close the polygon.

You can also use the Initialize (IN) or Default Values (DF) commands while in polygon mode. Both commands exit polygon mode, clear the polygon buffer, and begin executing subsequent commands immediately. You must exit polygon mode to execute other HP-GL/2 graphics commands.

Note

Sending an $^{E}_{C}$E while in polygon mode causes the printer to exit polygon mode, clear the polygon buffer, exit HP-GL/2 mode, and eject a page. Sending an $^{E}_{C}$E while in polygon mode is not recommended, but it performs an important function (allowing you to recover from a previous job that left the printer in polygon mode).

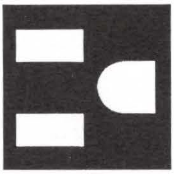
(PM1) Use (*PM1*) to close the current polygon (or subpolygon) and remain in polygon mode; the printer will add a closure point if necessary. When you use (*PM1*), the point after (*PM1*) becomes the first point of the next subpolygon. This move is not used as a boundary when filling a polygon with FP. When drawing the polygon, the pen will always move to this point in the up position, regardless of the current pen status. Each subsequent coordinate pair after (*PM1*) defines a point of the subpolygon.

(PM2) Use (*PM2*) to close the current polygon (or subpolygon) and exit polygon mode. Remember, if you have not closed your polygon, executing (*PM2*) adds a point to close the polygon. Refer to *Pen Position* in Chapter 15, *Introduction to HP-GL/2 Graphics*.

The following example draws the surface area of a 3-prong electrical receptacle as a series of subpolygons, then fills and edges it using the FP and EP commands, respectively.

Example: Using the PM Command

^E_CE	Reset the printer.
^E_C%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA2000,2000;	Specify absolute plotting and move to (2000,2000).
PM0;PD3000,2000, 3000,3000;	Enter polygon mode, store a Pen Down command, and store locations (3000,2000) and (3000,3000).
PD2000,3000, 2000,2000;	Store two more pen-down locations, (2000,3000) and (2000,2000).
PM1;	Close the first polygon.- 1000



PD2080,2160,2480, 2160, 2480,2340, 2080,2340,2080, 2160;	Store 5 pen-down locations for a subpolygon.

Example: Using the PM Command (continued)

PM1;	Close the subpolygon.
PD2080,2660,2480, 2660,2480,2840, 2080,2840,2080, 2660;	Store pen-down locations for another subpolygon.
PM1;	Close the second subpolygon.
PD2920,2340,2920, 2660,2720,2660;	Begin a third subpolygon that will draw the ground plug portion of the receptacle.
AA2720,2500,180; PD2920,2340;	Store a 180° arc that goes from (2720,2660) to (2720,2500).
PM2;FP;EP;	Close the subpolygon and exit the polygon mode. Fill and then edge the polygon and subpolygons currently stored in the buffer.
^E_C**%ØA**	Enter the PCL mode.
^E_C**E**	Send a reset to end the job and eject the page.

Related Commands	Group
EP, Edge Polygon FP, Fill Polygon	*The Polygon Group*

POSSIBLE ERROR CONDITIONS:

Condition	Printer Response
invalid command used in polygon mode	ignores invalid command
buffer overflow	ignores overflowing points

RA, Fill Rectangle Absolute

Defines and fills a rectangle using absolute coordinates. Use RA to fill rectangular shapes in drawings. (To outline a rectangle using absolute coordinates, use the EA command.)

RA *X,Y[;]*

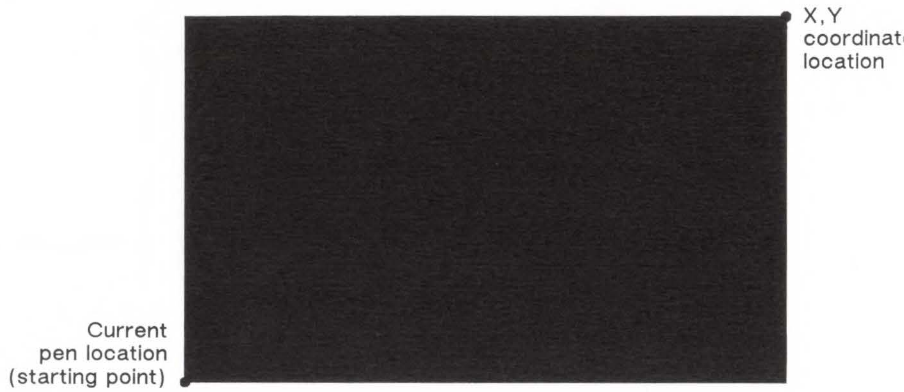
Parameter	Format	Functional Range	Default
X,Y coordinates	current units	-2^{30} to $2^{30} - 1$	no default

The RA command defines and fills a rectangle using the current pen, the current line and fill types, and absolute X,Y coordinates. The RA command includes an automatic pen down. When the command operation is complete, the original pen location and up/down status are restored.

- **X,Y Coordinates** – Specify the corner of the rectangle that is diagonally opposite from the current pen location (the starting point of the rectangle). Coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off.

Note

The following illustration shows the current pen location in the lower-left corner and the command's X,Y coordinates in the upper-right corner. Depending on the X,Y coordinates used, these points can be in any two diagonally opposite corners.



The only difference between the RA command and the EA (Edge Rectangle Absolute) command is that the RA command produces a filled rectangle, and EA, an outlined one.

The RA command clears the polygon buffer and then uses it to define the rectangle before drawing. Refer to *Using the Polygon Buffer* earlier in this chapter.

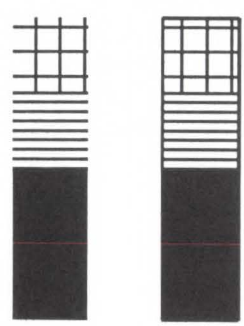
The following example uses RA with three different fill types to create rectangles such as those you might use in a PERT chart. The rectangles in the right bar are edged using the EA command. (For more information about fill types, refer to the FT command description in Chapter 20.)

Example: Using the RA Command with Different Fill Types

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA400,400; **RA800,1200;**	Enter absolute plotting mode and move to (400,400). Draw a rectangle with (400,400) as the lower left corner and (800,1200) as the upper right corner.
PA400,1200;FT3, **50;RA800,1600;**	Move the pen to (400,1200), select fill type 3 (parallel lines) with a 50 plu space between lines, and draw a rectangle with (400,1200) as the lower left corner and (800,1600) as the upper right corner.
PA400,1600;FT4; **RA800,2000;**	Move to (400,1600) and specify fill type 4 (cross-hatching). Draw a rectangle with a lower left corner of (400,1600) and an upper right corner of (800,2000).
PA1200,400;FT; **RA1600,1200;** **EA1600,1200;**	Move to location (1200,400) and select the default fill type (solid black). Fill and edge a rectangle using (1200,400) as the lower left corner and (1600,1200) as the upper right corner.

Example: Using the RA Command with Different Fill Types (continued)

PA1200,1200;FT3, 50;RA1600,1600; EA1600,1600;	Move to absolute position (1200,1200) and select fill type 3, with a 50 plu distance between each line. Draw a rectangle with (1200,1200) as the lower left corner and (1600,1600) as the upper right. Using the default line type, edge the rectangle just drawn.
PA1200,1600;FT4; RA1600,2000; EA1600,2000;	Move to (1200,1600) and select the cross-hatch pattern fill type. Draw a rectangle with the current pen location as one corner and (1600,2000) as the opposite corner.
$^{E}_{C}$**%ØA**	Enter the PCL mode.
$^{E}_{C}$**E**	Send a reset to end the job and eject the page.



Related Commands	Group
EA, Edge Rectangle Absolute EP, Edge Polygon ER, Edge Rectangle Relative RR, Fill Rectangle Relative	*The Polygon Group*
FT, Fill Type LT, Line Type RF, Raster Fill Definition	*The Line and Fill Attributes Group*

RR, Fill Rectangle Relative

Defines and fills a rectangle using relative coordinates. Use RR to fill rectangular shapes in drawings. (To outline a rectangle using relative coordinates, use the ER command.)

RR *X,Y[;]*

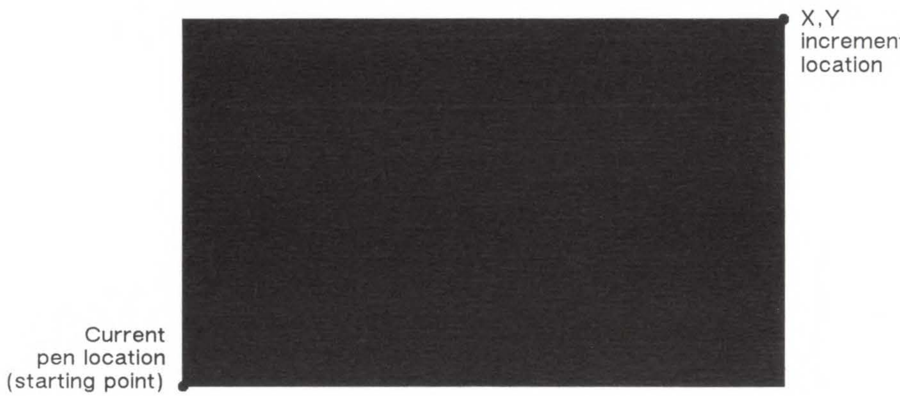
Parameter	Format	Functional Range	Default
X,Y increments	current units	-2^{30} to $2^{30} - 1$	no default

The RR command defines and fills a rectangle using the current pen, the current line and fill types, and relative coordinates. The RR command includes an automatic pen down. After the command is executed, the original pen location and up/down status are restored.

- **X,Y Increments** – Specify the corner of the rectangle that is diagonally opposite from the current pen location, which is the starting point of the rectangle. Coordinates are interpreted in current units: as user units when scaling is on; as plotter units when scaling is off.

Note

The following illustration shows the current pen location in the lower-left corner and the command's X,Y increments in the upper-right corner. However, these points can be in any two opposite corners depending on the coordinates used.



The only difference between the RR command and the ER (Edge Relative Rectangle) command is that the RR command produces a filled rectangle, and ER, an outlined one.

The RR command clears the polygon buffer and then uses it to define the rectangle before drawing. A rectangle requires enough buffer space to hold five points.

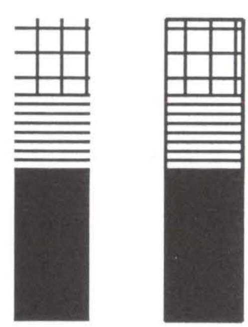
The following example uses RR with three different fill types (refer to the FT command description) to create rectangles such as those you might use in a bar chart. The rectangles in the right bar are edged using the ER command.

Example: Using the RR Command with Different Fill Types

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA400,400; **RR400,800;**	Specify absolute plotting and move to location (400,400). Fill a rectangle with the default fill (black), with (400,400) as the lower left corner and the upper right corner 400 plu to the right and 800 plu up from there.
PR0,800;FT3,50; **RR400,400;**	Enter the relative plotting mode and move 800 plu in the Y direction and select fill type 3 (parallel lines). Draw a rectangle using the current pen location as the lower left corner; the upper right corner is 400 plu to the right and 400 plu up from the lower left corner.
PR0,400;FT4; **RR400,400;**	Move 400 plu up and select fill type 4 (cross-hatching). Draw a rectangle using the current pen position as the lower left corner and a point 400 plu to the right and 400 plu up as the upper right corner.
PA1200,400;FT; **RR400,800;** **ER400,800;**	Move to absolute location (1200,400) and select the default fill type (solid black). Draw and edge a rectangle that begins at the current pen position and extends 400 plu to the right, then 800 plu up from there.

Example: Using the RR Command with Different Fill Types (continued)

PR0,800;FT3,50; **RR400,400;** **ER400,400;**	Move 800 plu up from the current position and select fill type 3 (parallel lines), with 50 plu between each line. Draw a rectangle using the current pen location as the lower left corner and a point 400 plu up and 400 plu to the right as the upper right corner. Edge the rectangle.
PR0,400;FT4; **RR400,400;** **ER400,400;**	Move 400 plu up from the current pen position. Select fill type 4 (cross-hatching). Draw a rectangle using the current pen location as the lower left corner, the right corner being (400,400) relative plotter units away.
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.



Related Commands	Group
EA, Edge Rectangle Absolute	*The Polygon Group*
ER, Edge Rectangle Relative	
RA, Fill Rectangle Absolute	

WG, Fill Wedge

Defines and fills any wedge. Use WG to draw filled sections of a pie chart.

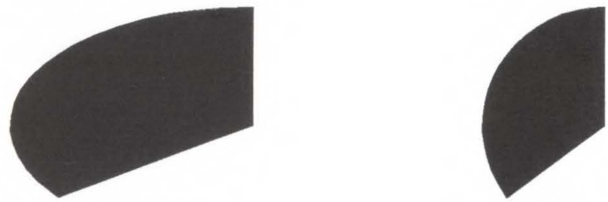
WG *radius,start angle,sweep angle[,chord angle;]*

Parameter	Format	Functional Range	Default
radius	current unit	-2^{30} to 2^{30} - 1	–
start angle	clamped real	-32768 to 32767	–
sweep angle	clamped real	$\pm 360^{\circ}$	–
chord angle	clamped real	0.5° to 180°	5°

The WG command defines and fills a wedge using the current pen, fill type, and line types. The WG command includes an automatic pen down. When the command operation is complete, the original pen location and up/down status are restored.

The only difference between the WG command and the EW (Edge Wedge) command is that the WG command produces a filled wedge, and the EW, an outlined one.

Always use isotropic scaling in any drawing that contains wedges (to avoid drawing an elliptical wedge). (Refer to the discussion of scaling in Chapter 17 for more information.)



- **Radius** – Specifies the distance from the current pen location to the start of the wedge's arc. Since the wedge is a portion of a circle, this parameter is the radius of the circle. It specifies the distance from the current pen location (which becomes the center of the circle), to any point on the circumference of the circle.

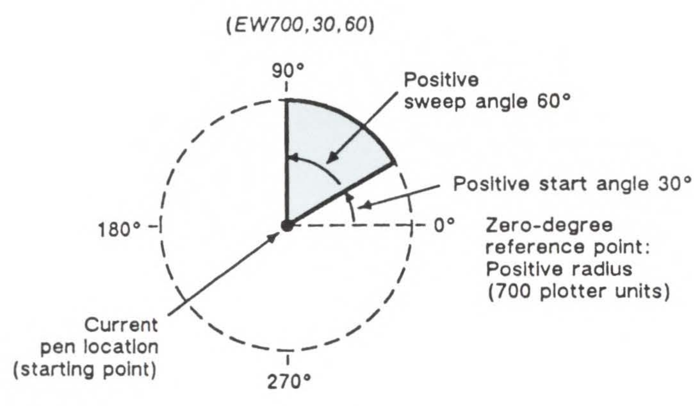
  The radius is interpreted in current units: as user units when scaling is on; as plotter units when scaling is off. The sign of the radius (+ or -) determines the location of the zero-degree reference point. The illustration following the parameter descriptions shows the location of the zero-degree reference point for a positive and negative radius.

- **Start Angle** – Specifies the beginning point of the arc as the number of degrees from the zero-degree reference point. A positive start angle positions the radius counterclockwise (the direction from the positive X-axis toward the positive Y-axis) from the zero-degree reference point; a negative start angle positions the radius clockwise from the zero-degree reference point. If you specify a start angle greater than 360°, a start angle equal to the remainder of the start angle/360° is used.

Note

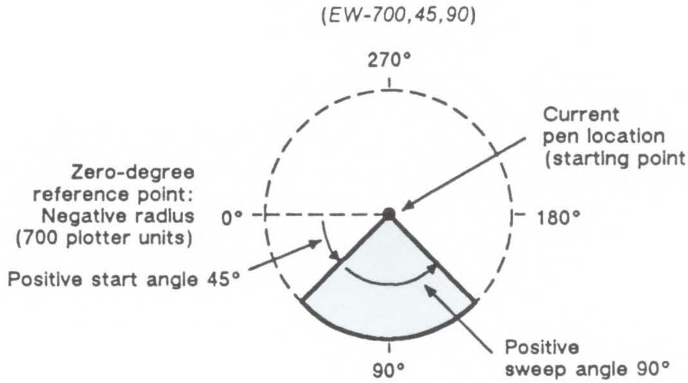
Clockwise is defined as going in the same direction as from the +X axis to the -Y axis in the current coordinate system. Depending on the SC, IP, and IR commands in effect at the time, the *clockwise* direction may actually be *counterclockwise*.

- **Sweep Angle** – Specifies the number of degrees through which the arc extends. A positive sweep angle defines the arc counterclockwise; a negative sweep angle defines the arc clockwise. If you specify a sweep angle greater than 360 degrees, a 360-degree angle is used.
- **Chord Angle** – Specifies the chord angle used to define the arc. The default is 5 degrees. Refer to the *Chord Angle* discussion in the Arc Absolute (AA) command discussion (Chapter 18) for information on setting the chord angle.



Positive Radius

19 Polygon Group



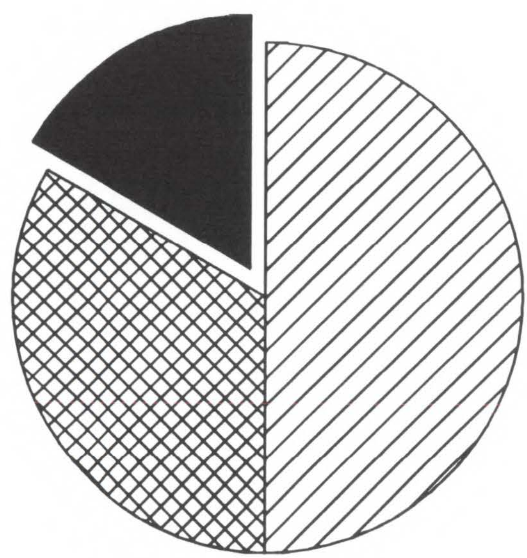
Negative Radius

Example: Using the WG Command to Draw a Pie Chart

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
SC-3000,3000, -2000,2000,1;	Set up user scaling, with P1 being (-3000,-2000) and P2 being (3000,2000). Specify isotropic scaling.
PA0,0;FT3,75,45; WG-1000,90,180;	Enter absolute plotting mode and move to user-unit position (0,0). Select fill type 3 (parallel lines), with 75 user units between lines and the lines slanted 45°. Fill a wedge with the current fill pattern; use a radius of 1000 user units, a starting angle of 90° and a sweep angle of 180°. The zero-degree reference point is on the left side of the circle (indicated by the negative radius parameter [-1000]).
EW-1000,90,180;	Draw an outline (edge) around the same wedge.
FT4,60,45; WG-1000,330,120;	Select fill type 4 (cross-hatching), specifying 60 user units between lines and with the lines tilted at 45°. Fill a wedge that has the same radius and center point, but with a starting angle of 330° and a sweep angle of 120°.

Example: Using the WG Command to Draw a Pie Chart (continued)

EW-1000,330,120;	Edge the same wedge.
PR-60,110;FT1;	Specify relative plotting and move the pen 60 user units to the left and 110 units up. Select fill type 1 (solid black).
WG-1000,270,60;	Fill a wedge with a radius of 1000 user units, a start angle of 270°, and a sweep angle of 60°.
EW-1000,270,60;	Edge the outline of the wedge that was just filled.
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.



Related Commands	Group
EP, Edge Polygon EW, Edge Wedge	*The Polygon Group*
SC, Scale	*The Configuration/Status Group*
FT, Fill Type LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

POSSIBLE ERROR CONDITIONS:

Condition	Printer Response
polygon buffer overflow	fills contents of buffer

20

The Line and Fill Attributes Group

The information in this chapter enables you to achieve the following results in your HP-GL/2 applications:

- Enhance your drawings with various line types.
- Enhance your drawings with different fill types.
- Position fill type patterns.

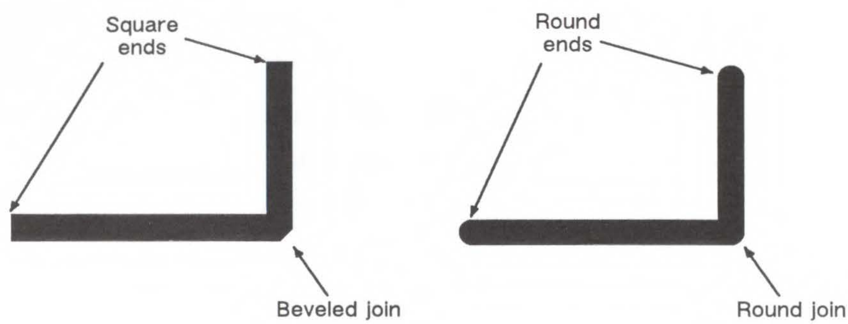
The following commands are described in this chapter:

Table 20-1. The Line and Fill Attribute Commands

Command	Summary
AC, Anchor Corner	Specifies the starting point for fill patterns.
FT, Fill Type	Selects the pattern to use when filling polygons.
LA, Line Attributes	Specifies how line ends and joins are shaped.
LT, Line Type	Selects the line pattern to use for drawing lines.
PW, Pen Width	Specifies a new pen width.
RF, Raster Fill Definition	Defines a pattern for use as area fill.
SM, Symbol Mode	Draws a symbol at each coordinate location.
SP, Select Pen	Selects a pen for plotting.
SV, Screened Vectors	Selects the type of area fill to be applied to vectors (lines, cross-hatching lines, arcs, circles, edges of polygons, rectangles, and wedges).
TR, Transparency Mode	Defines how the white areas of the source graphics image affect the destination graphics image.
UL, User-Defined Line Type	Defines a line pattern.
WU, Pen Width Unit Selection	Specifies whether the pen width is defined in millimeters or as a percentage of the P1/P2 distance.

Using Line Attributes and Types

You can change the appearance of the lines you draw by using the Line Attribute (LA) and Line Type (LT) commands. The Line Attribute command lets you specify whether the ends of lines and corners of joined lines should appear as square, triangular, round, or beveled.



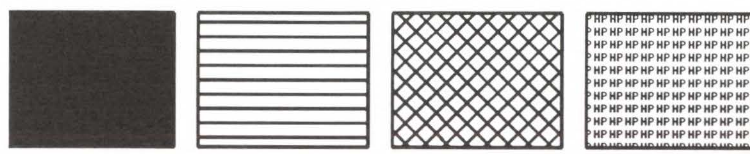
Line types are repeated patterns of dots and/or dashes (including solid lines). The following shows some examples of line types. Note that you can also vary the width of the lines and line types you draw by using the Pen Width (PW) command.

Once you specify a line type and line attributes, all lines created by the following commands are drawn using the new line type and attributes. Line types and their interactions with fill patterns are discussed later in this chapter.

Commands Affected by Line Types	Group
AA, Arc Absolute AR, Arc Relative AT, Absolute Arc Three Point CI, Circle PA, Plot Absolute PD, Pen Down PE, Polyline Encoded PR, Plot Relative RT, Relative Arc Three Point	*The Vector Group*
EA, Edge Rectangle Absolute EP, Edge Polygon ER, Edge Rectangle Relative EW, Edge Wedge FP, Fill Polygon RA, Fill Rectangle Absolute RR, Fill Rectangle Relative WG, Fill Wedge	*The Polygon Group*

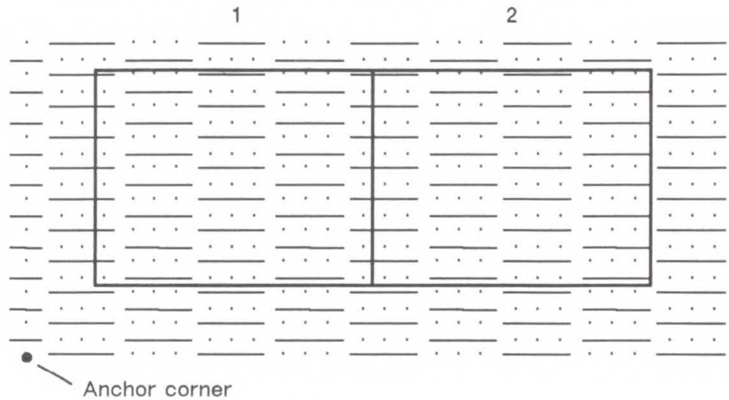
Using Fill Types

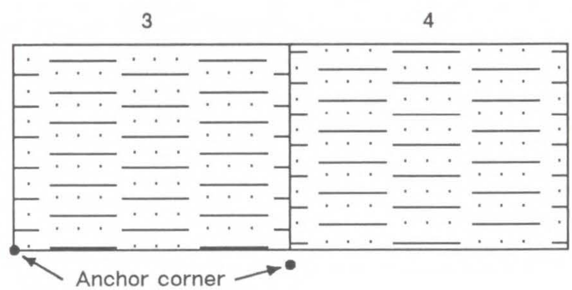
Using the Fill Type (FT) command adds detail to your drawings and increases their visual effectiveness. The fill type affects the RA (Fill Rectangle Absolute), RR (Fill Rectangle Relative), WG (Fill Wedge), and FP (Fill Polygon) commands. The LaserJet III printer supports solid, parallel line (hatching), cross-hatching and raster fill types (shading is a special type of raster fill). The following illustration shows these four fill types. As shown in the pattern on the right, you can also use the RF (raster fill) command to create a user-defined fill type.



When you use hatching or cross-hatching fill types, the lines are drawn using the currently selected line width, type, and attributes. For example, if you have selected a dashed line type and a hatched fill type, your figure will be filled with dashed, parallel lines.

All fill types have an *anchor corner*, the starting point of the fill pattern. Its default location is in the lower-left corner of the PCL Picture Frame. Conceptually, the fill type replicates out from the anchor corner in the X- and Y-directions, as shown in the following illustration. Figures are filled by that portion of the fill type resident to the area (refer to rectangles 1 and 2).





Use the AC (Anchor Corner) command to position the fill type in relation to the figure. Rectangle 3 has an anchor corner set in its the lower-left corner. Rectangle 4 has an anchor corner set below the lower-left corner to alter the pattern's position and give contrast to the adjacent figure.

Selecting a "Pen" and Changing Line Width

Even though the LaserJet III printer doesn't print with a physical pen as a plotter does, the printer uses a "logical pen" which emulates the action of a physical pen. You must use the SP1 (Select Pen) command to draw black lines on the paper.

You can change the width of the logical pen using the Pen Width (PW) command. Subsequent lines are drawn using the new width. Use PW to vary line thicknesses and enhance your plots. You may change widths as often as you like, without sending an SP command again.

Pen (line) widths can be specified either in millimeters or as a percentage of the diagonal distance from P1 to P2. Use the WU (Pen Width Unit Selection) command to select how the pen width is specified. Since using the WU command defaults the width of both pens (black and white), send WU *before* a PW command.

AC, Anchor Corner

This command positions the starting point of any fill pattern. Use AC to ensure that the selected fill pattern will be positioned as expected within the figure.

AC *X,Y[;]*

or

AC *[;]*

Parameter	Format	Functional Range	Default
X,Y coordinates	current units	-2^{30} to $2^{30} - 1$	no default

The 'anchor corner' is the point at which any fill pattern starts. Setting the anchor corner guarantees that a corner point of the selected fill pattern will be at the specified coordinate, aligned vertically and horizontally.

- **No Parameters** – Defaults the anchor corner to the lower-left corner of the PCL Picture Frame (relative to the current coordinate system). Equivalent to (AC0,0).
- **X,Y Coordinates** – The coordinate position defines the position of the starting point for any fill pattern.

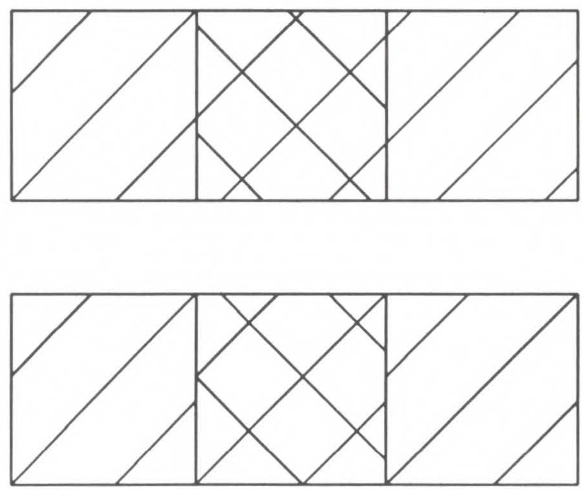
The following example prints three adjacent squares whose fill patterns are anchored at the lower-left corner of the PCL Picture Frame. The fill pattern is continuous across each of the squares. In the set of squares below that, each square has an anchor corner set in its own lower-left corner. Notice how this helps distinguish between the adjacent figures.

Example: Changing the Anchor Corner

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. The SP command must be used in order to enable printing.
PA3000,3000;	Specify absolute plotting and move to location (3000,3000).
FT3,400,45; **RR1000,1000;** **ER1000,1000;**	Specify fill type number 3 (parallel lines), with each line 400 plu apart and set at a 45° angle; fill a rectangle using the current pen location as the lower left corner, and a point 1000 plu to the right and 1000 plu up as the upper right corner; edge the outline of the rectangle just filled.
PR1000,0; FT4,400,45; **RR1000,1000;** **ER1000,1000;**	Move 1000 plu to the right; select fill type number 4 (cross-hatching); create a rectangle the same size as the first one, fill it with cross-hatching, and edge its outline.
PR1000,0; FT3,400,45; **RR1000,1000;** **ER1000,1000;**	Move to the right another 1000 plu and create another rectangle of the same size, this time filled with pattern number 3 again.
PA3000,1500; **AC3000,1500;** **RR1000,1000;** **ER1000,1000;**	Move to absolute location (3000,1500); move the anchor corner to location (3000,1500); fill a rectangle with the same dimensions as the previous three rectangles and edge its outline.
PA4000,1500; **AC4000,1500;** **FT4,400,45;** **RR1000,1000;** **ER1000,1000;**	Move to location (4000,1500) and specify the location as the anchor corner; select fill type number 4 (cross-hatching); fill and edge another rectangle.

Example: Changing the Anchor Corner (continued)

PA5000,1500; **AC5000,1500;** **FT3,400,45;** **RR1000,1000;** **ER1000,1000;**	Move to absolute location (5000,1500) and specify that location as the anchor corner; select fill type number 3; fill and edge another rectangle.
$^{E}_{C}$**%0A**	Enter the PCL mode.
$^{E}_{C}$**E**	Send a reset to end the job and eject the page.



Related Commands	Group
FT, Fill Type RF, Raster Fill Definition	*The Line and Fill Attributes Group*
RA, Fill Rectangle Absolute RR, Fill Rectangle Relative WG, Fill Wedge	*The Polygon Group*

FT, Fill Type

Selects the shading pattern used to fill polygons (FP), rectangles (RA or RR), or wedges (WG). Use FT to enhance drawings using solid fill, shaded fill, parallel lines (hatching), cross-hatching, or patterned (raster) fill.

FT *fill type[,option1[,option2;]]*

or

FT *[;]*

Parameter	Format	Functional Range	Default
fill type	clamped integer	1 to 4, 10, 11, 21	1
option1, option2	clamped real	type dependent*	type dependent*

*Refer to the table following the parameter descriptions.

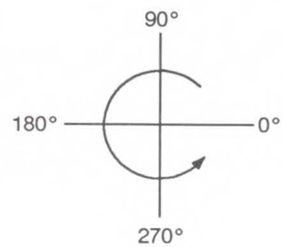
There are seven forms of fill types. The type parameter tells the printer which form you are using. If the fill type is specified, but the option1 and/or option2 parameter is omitted, values previously given for the specified fill type are assumed, or the defaults are assumed if none have been specified.

- **No Parameters** – Defaults all FT parameters and sets the fill type to solid fill. Equivalent to (FT1).
- **Type** – Selects the fill pattern. The table below lists the parameter values and corresponding fill types.
- **Option1, Option2** – The definition of these optional parameters depends on the type of fill selected. The following table lists the options available for each fill type.

Fill Type	Description	Option1	Option2
1 and 2	solid black	ignored	ignored
3	hatching (parallel lines)	spacing of lines	angle of lines
4	cross-hatching	spacing of lines	angle of lines
10	shading	shading level	ignored
11	user-defined	raster-fill index	ignored
21	PCL cross-hatch patterns	pattern type	ignored

For fill types 3 and 4, the *option1* parameter specifies the distance between the lines in the fill. This distance is specified in current units measured along the X-axis. Option1 must be a positive number (if zero, then 1% of the diagonal distance from P1 to P2 is used). The default spacing is 1% of the diagonal distance from P1 to P2. Subsequent changes in the P1/P2 locations affect this distance only if the spacing is defined in user units (that is, an SC command is in effect).

For fill types 3 and 4, the *option2* parameter specifies an angle, in degrees, of the lines in the fill. This angle is referenced counterclockwise from the positive plotter-unit X-axis, as shown in the following illustration (0 and 180 are horizontal; 90 and 270 are vertical). The first set of lines for cross-hatched fill types are drawn at the specified angle and the next set drawn at that angle plus 90 degrees.



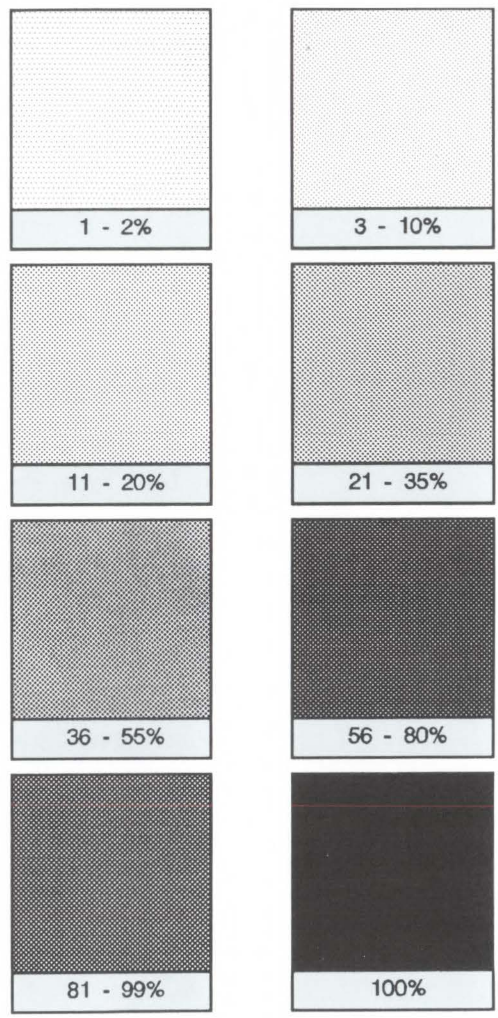
Types 3 and 4 use the current pen and line type defined by the Line Type, Pen Width, and Line Attribute commands.

If the spacing between lines is defined in plotter units (no Scale command used), turning scaling on or changing the locations of P1 and P2 has no affect on the spacing. If, however, the spacing is defined in user units, the spacing fluctuates with changes in the location of P1 and P2 (the X_{min},Y_{min} and X_{max},Y_{max} points if scaling is isotropic) or subsequent scaling command changes. Turning off scaling causes the spacing to be frozen in the plotter-unit equivalent of the current user-unit value. If the spacing is a percentage of the diagonal distance from P1 to P2, the percentage is maintained and spacing fluctuates with changes to P1 and P2 (the X_{min},Y_{min} and X_{max},Y_{max} points if scaling is isotropic).

Note

The end points of hatching fills are drawn with the current line cap. Lines are not clipped to the polygon.

For fill type 10, the option1 parameter specifies the level of shading. The level is specified as a percentage from 0 to 100. The following illustration shows the available shading patterns.

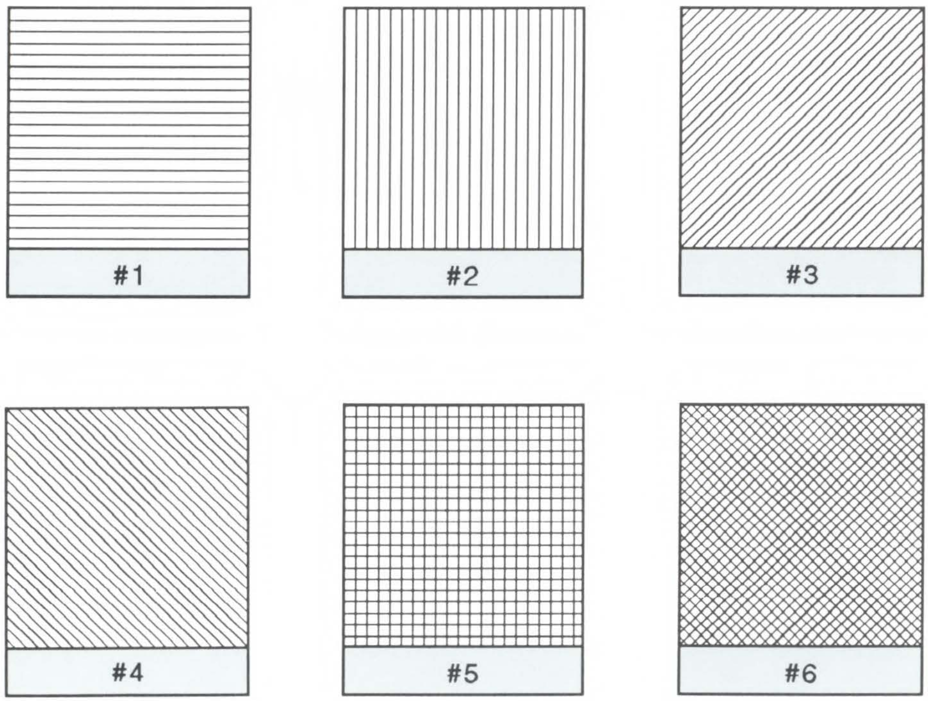


HP-Defined Shading Patterns

For fill type 11, the option1 parameter selects the corresponding user-defined raster fill using the index number specified in the RF command. Refer to the Raster Fill Definition (RF) command for more information about creating user-defined fill types. If you have not issued an RF command, the printer will use solid fill.

Example of a User-Defined Pattern

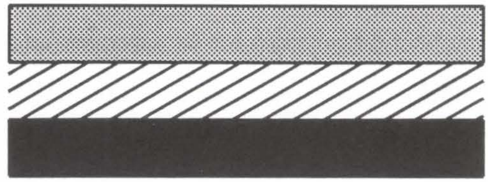
For fill type 21, the option1 parameter selects one of the six predefined PCL cross-hatch patterns using a value between 1 and 6. The following illustration shows the six different PCL cross-hatch patterns and their corresponding parameter numbers.



PCL Cross-Hatch Patterns

Example: Using the FT Command

^E_CE	Reset the printer.
^E_C%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA2000,2000;	Specify absolute plotting and move to location (2000,2000).
FT;RR2500,300; **ER2500,300;**	Select the default fill type (solid black); fill a rectangle using solid black fill, with the lower left corner being the current pen location and the upper right corner a point 2500 plu to the right and 300 plu up; edge the rectangle that was just filled.
PR0,300;FT3,80,30; **RR2500,300;**	Specify relative plotting and move the pen up 300 plu; select fill type number 3 (parallel lines), with 80 plu between each line, with each line tipped 30°; fill a rectangle with the just-specified fill, using the rectangle bounded at the lower left corner by current the pen location and a point 2500 X-units and 300 Y-units away as the upper right corner.
PR0,300;FT10,36; **RR2500,300;** **ER2500,300;**	Move the pen position up 300 plu; specify the fill type as 36% shading; fill a rectangle with 36% shading, with the lower left corner being the current pen location and the upper right corner 2500 plu to the right and 300 plu up from there; edge the outline of the same rectangle.
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.



Related Commands	Group
LA, Line Attributes LT, Line Type PW, Pen Width RF, Raster Fill Definition	*The Line and Fill Attributes Group*

LA, Line Attributes

Specifies how line ends and line joins are physically shaped. Use this command when drawing lines thicker than 0.35 mm.

LA *kind,value[,kind,value[,kind,value;]]*

or

LA *[;]*

Parameter	Format	Functional Range	Default
kind	clamped integer	1 through 3	1
value	clamped integer	Kind 1: 1 - 4	1 (Butt)
	clamped integer	Kind 2: 1 - 6	1 (Mitered)
	clamped real	Kind 3: 1 to 32,767	5

There are three line attributes: *line ends*, *line joins*, and the *miter limit*. The LA command parameters are used in pairs: the first parameter, *kind*, selects a line attribute, and the second parameter, *value*, defines the appearance of that attribute. The printer uses the current line attributes when the optional parameter pairs are omitted.

- **No Parameters** – Defaults the line attributes to butt ends, mitered joins, and a miter limit of 5. Equivalent to (LA1,1,2,1,3,5).
- **Kind**– Specifies the line attribute for which you are setting a value. Attributes and kind parameter values are listed in the following table.
- **Value**– Defines the characteristics of the attribute specifed by the kind parameter. The available values are listed in the following table and described under each attribute.

Attribute	Kind	Value	Description
Line Ends*	1	1	Butt (default)
		2	Square
		3	Triangular
		4	Round
Line Joins*	2	1	Mitered (default)
		2	Mitered/beveled
		3	Triangular
		4	Round
		5	Beveled
		6	No join applied
Miter Limit	3	**	5 (default, refer to description under *Miter Limit*)

* Lines with a width of 0.35 mm or less always have butt caps and no join, regardless of the current attribute setting.

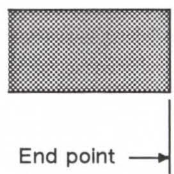
** Full range is 1 to 32,767, but values less than 1 are automatically set to 1.

Note

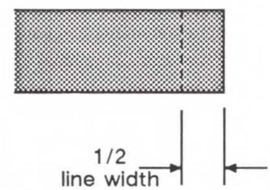
Labels are always drawn with rounded ends and joins.

Line Ends

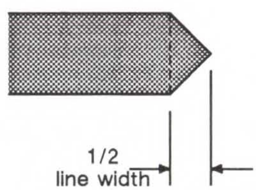
The value you specify for line ends determines how the ends of line segments are shaped. The following illustration describes the four types of line ends.



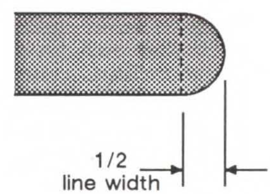
Butt ends (1) Terminate at the end point.



Square ends (2) Terminate one half line width beyond the end points.



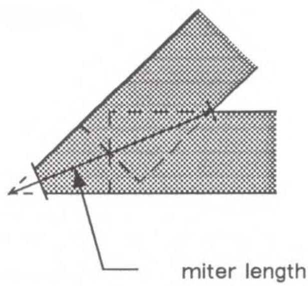
Triangular ends (3) Terminate one half line width beyond the end points.



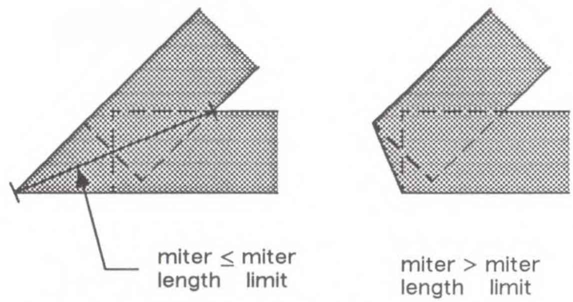
Round ends (4) Terminate in semicircle with a diameter equal to the current line width.

Line Joins

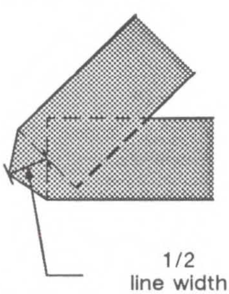
The value you specify for the line joins attribute determines how connecting line ends (corners) are shaped. The following illustration describes the five types of line joins. If the first and last points of a series of lines are the same, they join according to the current line join and miter limit.



Mitered join (1)
Formed by two lines extending from the outer edge of each vector until they meet. The miter limit applies to this join.

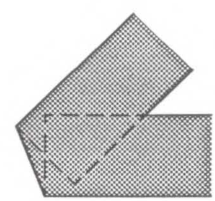


Mitered/beveled join (2) Formed by two lines extending from the outer edge of each vector until they meet. If the miter length exceeds the miter limit, a beveled join is used.



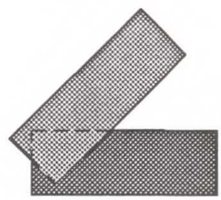
Triangular join (3) Formed by two lines extending from the outer edge of each vector to a point 1/2 line width beyond the end intersection of the vectors.

Rounded join (4) Formed by an arc with a diameter equal to the current line width

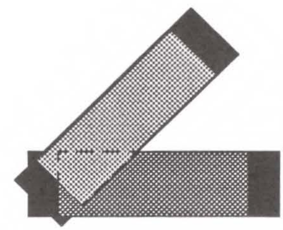


Beveled join (5)
Formed by a line connecting the outer edge of one vector to the outer edge of the other vector.

When you select 'no join' (LA2,6;), the currently selected line ends for the two lines merely overlap. Refer to the following illustration.



No Join
Butt End



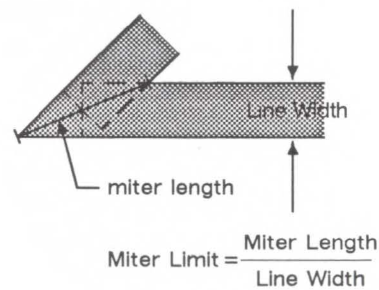
No Join
Square End

No Join
Triangular End

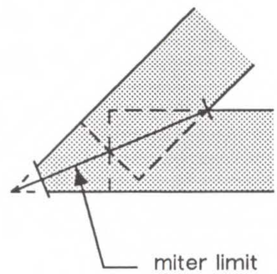
No Join
Round End

Miter Limit

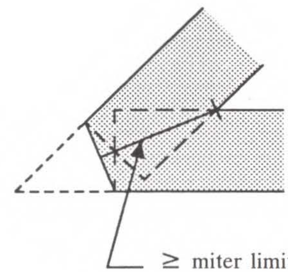
The value you specify for miter limit determines the maximum 'length' of a mitered join, as shown in the following illustration. The miter limit is the ratio of the miter length (the length of the diagonal line through the join of two connecting lines), to the line width. For example, with the default miter limit of 5, the miter length can be as long as 5 times the line width.



When the miter limit exceeds the miter limit, the point of the miter is clipped to the miter limit (the clipped miter is equivalent to a beveled join). The default miter limit is usually sufficient to prevent clipping except at very narrow join angles.



Clipped mitered join



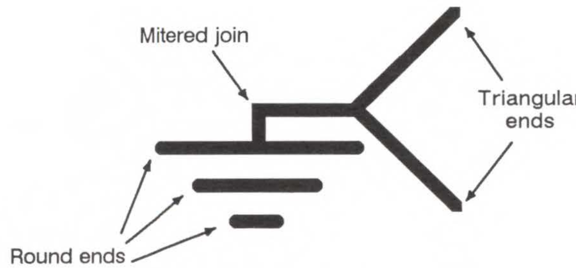
Maximum clipped mitered join (beveled join)

An LA command remains in effect until another LA command is executed, or the printer is initialized or set to default conditions.

The following example draws an electrical ground symbol using the LA command.

Example: Using the LA Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%∅B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA4000,3000;	Specify absolute plotting and move the pen to (4000,3000).
PW2;LA1,3; PD3500,2500, 4000,2000;	Set the pen width to 2 mm; specify a triangular line end, place the pen down, and draw from the current location to (3500,2500), then to (4000,2000).
PU3500,2500; LA2,2,3,20; PD3000,2500, 3000,2300;	Lift the pen and move to (3500,2500); set the line join to mitered/beveled and the miter limit to 20; set the pen down and draw a line to (3000,2500), then to (3000,2300).
PU2500,2300; LA1,4; PD3500,2300;	Lift the pen and move it to (2500,2300); specify round line ends and draw a line to (3500,2300).
PU2700,2100; PD3300,2100;	Lift the pen and move to (2700,2100), then set the pen down and draw a line to (3300,2100).
PU2900,1900; PD3100,1900;	Lift the pen and move to (2900,1900), then draw a line to (3100,1900).
$^{E}_{C}$%∅A	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.



Related Commands	Group
LT, Line Type PW, Pen Width UL, User-Defined Line Type	*The Line and Fill Attributes Group*

LT, Line Type

Specifies the line pattern to be used when drawing lines. Use LT to vary lines and enhance your plot. Note that the ends of dashed line segments in a line pattern are affected by current line attributes (refer to the LA command earlier in this chapter).

LT *line type[,pattern length[,mode;]]*

or

LT *[;]*

or

LT99 *[;]*

Parameter	Format	Functional Range	Default
line type	clamped integer	-8 to 8	solid line
		99	restores previous line type
pattern length	clamped real	>0	4% of the distance between P1 and P2
mode	clamped integer	0 or 1	0 (relative)

The LT command applies to lines drawn by the AA, AR, AT, CI, EA, EP, ER, EW, FP, PA, PD, PE, PR, RA, RR, RT, and WG commands. Line types are drawn using the current line attributes set by the Line Attribute (LA) command. For example, if you have used LA to specify rounded ends, the printer draws each dash in a dashed line pattern with rounded ends.

- **No Parameters**– Defaults the line type to solid and saves the previous line type, pattern length, and any unused portion of the pattern (residue).
- **Line Type**– Subsequent lines are drawn with the corresponding line pattern. Line patterns can be of fixed or adaptive type.

  Positive line types (1 - 8) are fixed line types and use the specified pattern length to draw lines. Any unused part of the pattern (the residue) is carried over into the next line. The residue is saved when any of the following commands are received: CI, EA, EP, ER, EW, FP, PM, RA, RR, or WG. The residue is restored when the current pen position is restored upon completion of the HP-GL/2 command.

The following commands clear current residue and vector end points:

Commands that Affect LT1 - LT8	Group
AC, Anchor Corner LA, Line Attributes LT, Line Type (except (LT) and (LT99)) PW, Pen Width RF, Raster Fill Definition SP, Select Pen TR, Transparency Mode UL, User-Defined Line Type WU, Pen Width Unit Selection	*The Line and Fill Attributes Group*
DF, Default Values IN, Initialize IP, Input P1 and P2 IR, Input Relative P1 and P2 IW, Input Window RO, Rotate Coordinate System SC, Scale	*The Configuration and Status Group*

A zero line type (0) draws only a dot at the X,Y coordinates for AA, AR, AT, CI, PA, PD, PR, and RT commands. Zero pen down values and zero length lines also produce dots. A dot is a one-plotter unit long vector, drawn using the current line end and pen width. (Dots within lines are drawn at the correct angle, but zero length vectors are drawn along the user's current X-axis.)

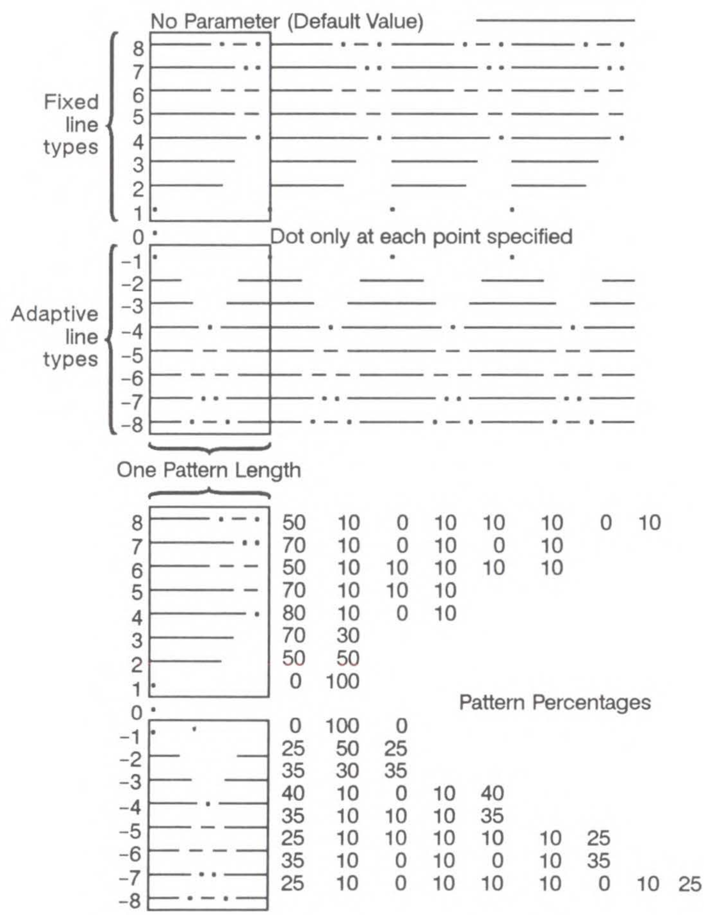
Negative line types (-1 – -8) are adaptive line types. The pattern length is automatically adjusted so that each line contains one or more complete patterns.

Line patterns are composed of alternate pen down and pen up moves which are percentages of the pattern length (the first percentage is always pen down).

The following illustration first shows the line type patterns, then gives the pattern percentages.

Note

Do not use an adaptive line type when drawing circles, arcs, wedges, or polygons. The printer will attempt to draw the complete pattern in every chord (there are 72 chords in a circle using the default chord angle).



99 (LT99) restores the previous line type (and residue if it is a fixed-line type).

Note

If a solid line type is selected (LT;) when the LT99 command is issued, and the current pen position has not changed, the previously selected line type can be invoked using LT99. LT99 is ignored when a non-solid line type is in effect or if the pen is in a different position than when the previous non-solid line ended. An example using this command is to print a line in a non-solid line type, followed by a rectangle in solid black; beginning at the end point of the previous line, use LT99 to print another line in the previous non-solid line type.

Sending any of the following commands while plotting with a solid line type clears the previous line type and a subsequent (LT99) has no effect:

Commands that Affect LT99	Group
AC, Anchor Corner LA, Line Attributes LT, Line Type (except (LT) and (LT99)) PW, Pen Width RF, Raster Fill Definition SP, Select Pen TR, Transparency Mode UL, User-Defined Line Type WU, Pen Width Unit Selection	*The Line and Fill Attributes Group*
DF, Default Values IN, Initialize IP, Input P1 and P2 IR, Input Relative P1 and P2 IW, Input Window RO, Rotate Coordinate System SC, Scale	*The Configuration and Status Group*

- **Pattern Length**– Specifies the length of one complete line pattern, either as a percentage of the diagonal distance between the scaling points P1 and P2 or in millimeters (see *mode* below). You must specify a length greater than zero or the printer ignores the command. If you don't specify a length, the printer uses the last value specified.
- **Mode**– Specifies how the values of the pattern length parameter are interpreted. If you don't specify a mode, the printer uses the last value specified. Values other than 0 or 1 invalidate the command.

  0 – Relative mode. Interprets the pattern length parameter as a percentage of the diagonal distance between P1 and P2.

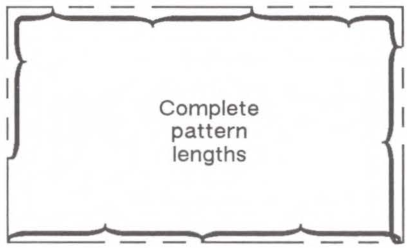
  When specified as a percentage, the pattern length changes along with changes in P1 and P2.

  1 – Absolute mode. Interprets the pattern length parameter in millimeters.

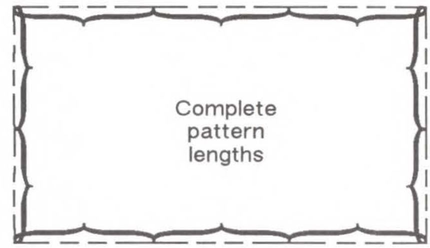
  When specified in millimeters, fixed line-type patterns assume the specified length, but adaptive line-type pattern lengths are adjusted to fit an integral number of patterns per vector. (This is true for relative mode and absolute mode.)

If you do not specify the pattern length and mode parameters, then the printer uses their current values. When using relative mode and isotropic scaling, the pattern length changes with changes to X_{min},Y_{min} and X_{max},Y_{max}.

An LT command remains in effect until another LT command is executed or the printer is initialized or set to default conditions.



Fixed *LT6*



Adaptive *LT-6*

Dots *LT1*

Dots *LT0*

Examples of Line Types

Related Commands	**Group**
FT, Fill Type PW, Pen Width UL, User-Defined Line Type	*The Line and Fill Attributes Group*
AA, Arc Absolute AR, Arc Relative AT, Absolute Arc Three Point CI, Circle PA, Plot Absolute PD, Pen Down PE, Polyline Encoded PR, Plot Relative RT, Relative Arc Three Point	*The Vector Group*
EA, Edge Rectangle Absolute EP, Edge Polygon ER, Edge Rectangle Relative EW, Edge Wedge FP, Fill Polygon RA, Fill Rectangle Absolute RR, Fill Rectangle Relative WG, Fill Wedge	*The Polygon Group*

PW, Pen Width

Specifies a new width for the logical pen. Subsequent lines are drawn in this new width. Use PW to vary your lines and enhance your drawings. Pen width can be specified as a fixed value or relative to the distance between P1 and P2. The pen width units are selected via the WU command (the default is metric–millimeters).

PW *width[,pen;]*

or

PW *[;]*

Parameter	Format	Functional Range	Default
width	clamped real	-32768 to 32767	Dependent*
pen	integer	0 or 1	1 (Black)

* Dependent on the mode set by the Pen Width Unit Selection (WU) command: if mode is metric, default width is 0.35 mm; if mode is relative, default width is 0.1% of the diagonal distance from P1 to P2.

You may change the pen width as often as you like, without sending another SP command. If the pen is down when you change the width, the new width takes effect at the next line. *If you use WU to change the type of units used for the width parameter (metric or relative), send the WU command before PW.*

- **No Parameters**– Defaults the pen line width according to the current units set by WU: 0.35 mm if metric; .1% of the diagonal distance from P1 to P2 if relative.
- **Width**– Specifies the line width. When the parameter is zero, the printer assumes the thinnest line width (1 dot wide).

Metric widths are scaled by the ratio of the size of the PCL Picture Frame to the HP-GL/2 plot size. For example, if the HP-GL/2 plot size is twice as large as the PCL Picture Frame, "WU;PW.3;" will set the width of vectors to 0.15mm. (If the ratios are different for the X and Y axes, the smaller ratio is used. If the width is less than the thinnest available, then the thinnest width is used.)

- **Pen**– Specifies the pen number to which the new width applies. If the pen parameter is not specified, the printer applies the width to both pens. Specifying pen numbers other than 0 or 1 causes the printer to ignore the command.

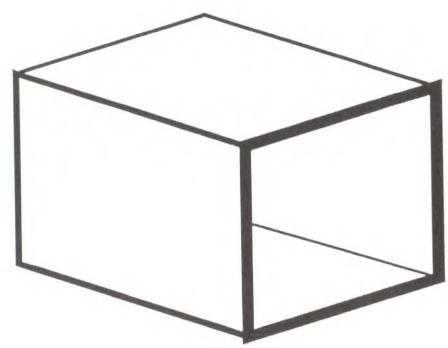
Note

Pen width does not set the width of lines for drawing labels (unless the stroke weight value is set to 9999 [Stick font only]). The width of character lines is determined by the stroke weight attribute of the Alternate Font Definition (AD) or Standard Font Definition (SD) commands.

A PW command remains in effect until another PW command or a WU command is executed. PW is not defaulted by the Default Values (DF) command.

Example: Using the PW Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA3500,2500;	Specify absolute plotting and move the pen to (3500,2500).
PW1.5;PD4500,2800, 4500,1800,3500, 1500,3500,2500;	Select a pen width of 1.5 mm. Set the pen down and draw a line from the current position to (4500,2800), then (4500,1800), next to (3500,1500), and then to (3500,2500).
PW.8;PD2300,2900, 2300,1900,3500, 1500;	Set the pen width to .8 mm. Place the pen down and print a line to (2300,2900), then to (2300,1900), and finally to (3500,1500).



20 Line and Fill Attributes

Example: Using the PW Command (continued)

PW.5;PU2300,2900; PD3300,3200,4500, 2800;	Set the pen width to .5 mm, lift the pen, and move to (2300,2900). Set the pen down and draw a line to (3300,3200) and then another line to (4500,2800).
PW.25;PU4500,1800; PD3500,2100;	Set the pen width to .25 mm, lift the pen, and move to (4500,1800). Set the pen down and print a line to (3500,2100).
$^{E}_{C}$**%0A**	Enter the PCL mode.
$^{E}_{C}$**E**	Send a reset to end the job and eject the page.

Related Commands	Group
SP, Select Pen WU, Pen Width Unit Selection	*The Line and Fill Attributes Group*

RF, Raster Fill Definition

Defines a rectangular pattern that may be used as area fill and for screened vectors (lines). Use RF to create your own fill types and screen patterns.

RF *index,width,height,pen number[, ... pen number;]*

or

RF *index[;]*

or

RF *[;]*

Parameter	Format	Functional Range	Default
index	clamped integer	1 to 8	1 (solid)
width	clamped integer	1 to 255	–
height	clamped integer	1 to 255	–
pen number	integer	0 or 1	–

The RF command does not *select* a fill type; use the Fill Type (FT) command with a type parameter of 11 and the corresponding raster fill index number for the second parameter (for example, [FT,11,3] for an index number of 3).

- **No Parameters**– Defaults all raster fill patterns to solid fill.
- **Index**– Specifies the index number of the pattern being defined. Eight patterns can exist concurrently.

  When you send RF with an index parameter only (RFn), the corresponding pattern is defaulted to solid fill.
- **Width, Height**– Specify the width and height (in pixels) of the pattern being defined.

Note

A pixel is equal to the size of one dot. The LaserJet III printer prints 300 dots per linear inch (300 by 300 dots per square inch).

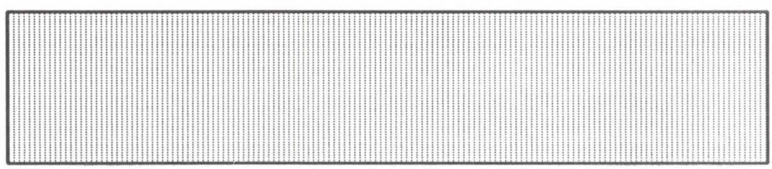
- **Pen Number** – Represents a pixel in the pattern being defined and indicates its color (black or white).

0	–	White
>**0**	–	Black

The pen number parameter defines pixels left to right, top to bottom. The total number of pen number parameters should be equal to the width times height parameters. For example, to define a pattern that is 8 x 16 pixels, you need 128 pen number parameters. If you do not include enough pen number parameters, the rest of the pixels are assumed to be white (zero). Patterns are printed in rows parallel to the plotter-unit X-axis.

Example: Creating and Printing a Fill Pattern

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PU5,5;	Lift the pen and move to absolute position (5,5).
PA3500,2500;	Specify absolute plotting and move to (3500,2500).
RF2,8,4, 0,0,0,0,0,0,0,0, 0,0,0,1,1,0,0,0, 0,0,0,1,1,0,0,0, 0,0,0,0,0,0,0,0;	Define a raster fill pattern (index number 2) that is 8 dots wide by 4 dots high.



Example: Creating and Printing a Fill Pattern (continued)

FT11,2;	Select the user-defined pattern having an index number of 2.
RR4000,800;EP;	Fill a rectangle with the fill pattern just specified, with a lower left corner of (3500,2500) and an upper right corner 4000 plu to the right and 800 plu up; edge the outline of the rectangle.
$^{E}_{C}$%ØA	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.

Related Commands	Group
FT, Fill Type SV, Screened Vectors	*The Line and Fill Attributes Group*

SM, Symbol Mode

Draws the specified symbol at each X,Y coordinate point using the PA, PD, PE, PR, and PU commands. Use SM to create scattergrams, indicate points on geometric drawings, and differentiate data points on multiline graphs.

SM *character[;]*

or

SM *[;]*

Parameter	Format	Functional Range	Default
character	label	most printing characters (decimal codes 33-58, 60-126, 161 and 254)*	–

*Decimal code 59 (the semicolon) is an HP-GL/2 terminator and cannot be used as a symbol in any character set. Use it only to cancel symbol mode (e.g., (SM;)).

The SM command draws the specified symbol at each X,Y coordinate point for subsequent PA, PD, PE, PR, and PU commands. The SM command includes an automatic pen down; after the symbol is drawn, the pen position and any dashed-line residue are restored.

- **No Parameter**–Terminates symbol mode.
- **Character**–Draws the specified character centered at each subsequent X,Y coordinate. The symbol is drawn in addition to the usual function of each HP-GL/2 command.

  The character is drawn in the font selected at the time the vectors are drawn. If you change to a new symbol set, the character changes to the corresponding character from the new symbol set. The size (SI and SR), slant (SL), and direction (DI and DR) commands affect how the character is drawn. Specifying a nonprinting character cancels symbol mode.

An SM command remains in effect until another SM command is executed or the printer is initialized or set to default conditions.

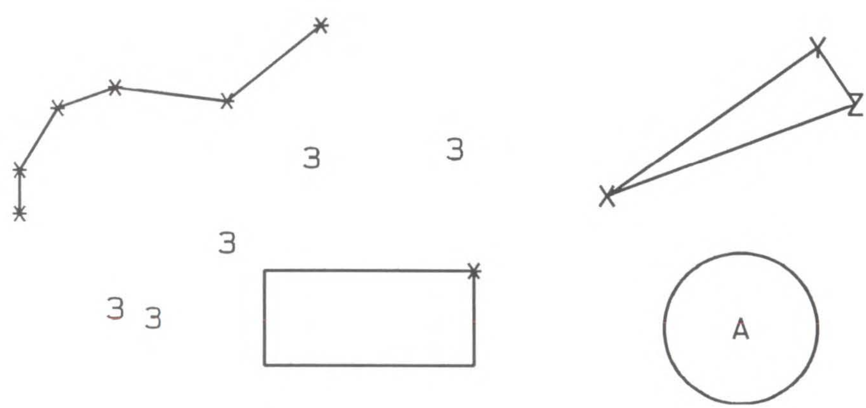
The following example shows several uses of symbol mode: with the pen down for a line graph, with the pen up for a scattergram, and with the pen down for geometric drawings.

Note

Symbol mode works only with the PA, PD, PE, PR, and PU commands. Notice that the circle and rectangle have symbols only for the PA command coordinate point.

Example: Using the Symbol Mode Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
SM*;PA200,1000; PD200,1230,400, 1560;	Enter symbol mode, using the asterisk (*) as the symbol; move to absolute location (200,1000), set the pen down, and draw first to (200,1230), then to (400,1560).
PD700,1670,1300, 1600,1800,2000; PU;	Place the pen down and draw from the current pen position (400,1560) to (700,1670), then to (1300,1600), then to (1800,2000); lift the pen.



Example: Using the Symbol Mode Command (continued)

SM3;PA700,500, 900,450,1300,850;	Enter symbol mode again with "3" as the current symbol; print a "3" in the following locations: (700,500), (900,450), and (1300,850).
PA1750,1300,2500, 1350;PU;SM;	With the pen still up and "3" still the current symbol, print a "3" at (1750,1300) and (2500,1350); lift the pen and exit symbol mode.
PA3300,1100;PD; SMY;PA4400,1890; SMZ;	Move to (3300,1100), set the pen down, and enter symbol mode with "Y" as the symbol; draw a line to (4400,1890) and print a "Y"; re-enter symbol mode with "Z" as the current symbol.
PA4600,1590;SMX; PA3300,1100;PU;	Draw a line to (4600,1590) and print a "Z"; specify "X" as the next symbol, move to (3300,1100), and print an "X"; lift the pen.
SMA;PA4000,400; CI400;	Specify "A" as the new symbol and move to (4000,400); draw a circle with a radius of 400 plu and print an "A" in the center.
SM*;PA2600,700; EA1500,200;	Specify "*" as the new symbol and move to (2600,700); edge the outline of a rectangle and print an "*" at the starting point.
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.

Related Commands	Group
PA, Plot Absolute PD, Pen Down PE, Polyline Encoded PR, Plot Relative PU, Pen Up	*The Vector Group*

SP, Select Pen

Selects the printer's 'logical' pen for subsequent plotting. An SP command must be included at the beginning of each program to enable the printer to draw.

SP *pen number[;]*

or

SP *[;]*

Parameter	Format	Functional Range	Default
pen number	integer	0 or 1	0 (No pen)

Although your printer does not have physical pens, for the purpose of compatibility it has a 'logical' pen which you must select to print your drawing.

- **No Parameters**– Cancels pen selection; subsequent plotting commands are not drawn. Equivalent to (SP0).
- **Pen Number**– Selects the printer's 'logical' pen. The printer will not draw unless an SP is sent.

  0 – Selects the white pen (default); unless there is a black background where you are attempting to print, and the transparency mode is also set to off (TR0;), selecting a white pen is the same as not selecting a pen.

  1 – Selects the black pen; numbers greater than 1 are also interpreted as 1.

Use the Pen Width (PW) command to change the line width. You may change widths as often as you like, without sending an SP command again.

Note

If you are not using the Transparency Mode (TR) command, white is always transparent; that is, it is equivalent to no pen. For more information on the Transparency Mode command, see the command's description later in this chapter.

Related Commands	Group
PW, Pen Width WU, Pen Width Unit Selection TR, Transparency Mode	*The Line and Fill Attributes Group*

SV, Screened Vectors

The SV command selects the type of screening (area fill) to be applied to vectors (lines, hatching patterns (fill types 3 and 4), arcs, circles, and edges of polygons, rectangles, and wedges). SV does not affect solid fill types, labels, stroked characters, or edges of characters.

SV *[screen_type [,option1 [,option2]]][;]*

or

SV *[;]*

Parameter	Format	Functional Range	Default
screen_type	clamped integer	0, 1, or 2	No screening (solid)
option1, option2	clamped integer	type dependent*	type dependent

* Refer to the table following the parameter descriptions.

There are three types of screen fill: shaded fill, user-defined raster fill, and predefined PCL cross-hatch patterns.

- **No Parameters** – Defaults to no screening (solid fill–same as SV0;).
- **screen_type** – Selects the types of screening as follows:

  0 – No screening

  1 – Shaded fill

  2 – User-defined raster fill (RF command)

  21 – Predefined PCL cross-hatch patterns

- **Option1, Option2** – The definition of these optional parameters depends on the screen type selected. The following table lists the options available for each fill type.

Screen Type	Description	Option1	Option2
1	Shaded Fill	% Shading (0 to 100)	Ignored
2	User-defined Raster Fill	Pattern Index	Ignored Pen Color: 0–Pen No. 1 1–Current Pen
21	PCL Cross-hatch	1 - 6	Ignored

For Type 1, specify the shading percentage using a number from 0 to 100. For example, to print vectors that are shaded 15%, specify (SV1,15;).

For Type 2, option1 specifies the index number of the fill pattern created using the RF (Raster Fill Definition) command. Option2 specifies whether the pattern should be printed in the color of pen number 1 (option 2 = **0** parameter) or the current pen (option 2 = **1** parameter). The selected pen is applied to the 1's pixels in the raster pattern.

For Type 21, The option1 parameter selects one of the six predefined PCL cross-hatch patterns using a value between 1 and 6. Refer to the FT command for an illustration of the six different patterns and their corresponding parameter numbers.

All parameters are optional. If all parameters are omitted, screening is turned off (the vectors are solid).

If screen_type is present, but option1 and/or option2 are omitted, values previously specified for the specified screen_type are used. If none have been specified since the last power-on, IN, DF, or $^{E}{}_{C}$E Reset, the defaults are assumed.

All screening patterns use the current anchor corner (see the AC command description).

Related Commands	Group
AC, Anchor Corner FT, Fill Type RF, Raster Fill Definition WU, Pen Width Unit Selection	*The Line and Fill Attributes Group*

POSSIBLE ERROR CONDITIONS:

Condition	Printer Response
1 or more parameters	ignores parameter

TR, Transparency Mode

The transparency mode defines how the white areas of the source graphics image affect the destination graphics image.

TR *[n][;]*

or

TR *[;]*

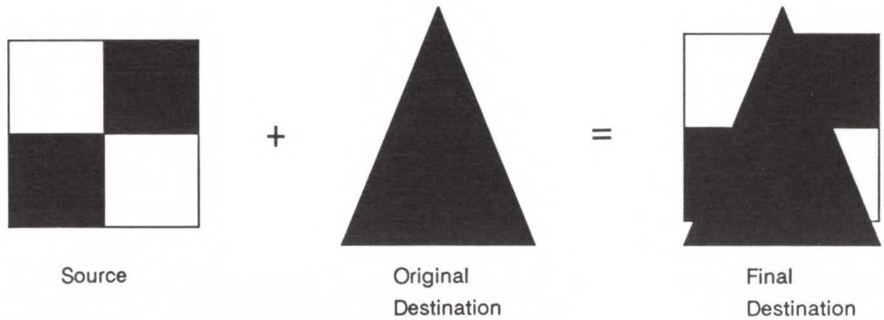
Parameter	Format	Functional Range	Default
n	clamped integer	0 or 1	1 (on)

- **No Parameters** – Defaults to transparency mode = on (TR1;).
- **n** – Specifies whether transparency mode is on or off:

  0 – Transparency mode = off.

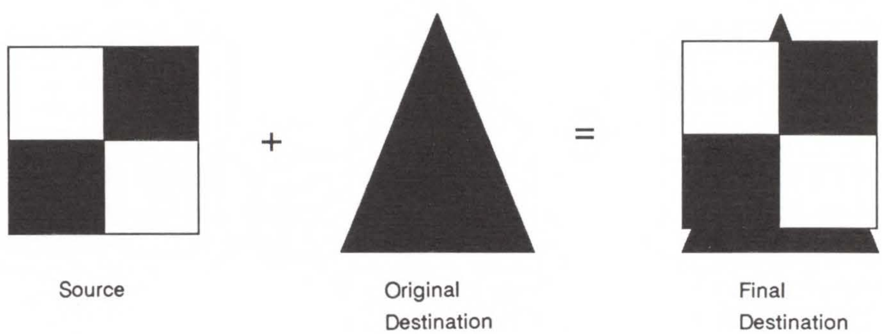
  1 – Transparency mode = on (default).

When transparency mode is on (default), the portion of a source image which is defined by white pixels does not affect the destination; that is, whatever was already written to the page "shows through" the white areas in the new image.



Transparency Mode = ON

When transparency mode is off, all source pixels are written to the destination, obscuring any underlying images.



Transparency Mode = OFF

The transparency mode is defaulted by the $^{E}_{C}$E Reset, IN, or DF commands.

Note For more information on the transparency mode, see the discussion of the *source transparency mode* in Chapter 12, *The Print Model*.

UL, User-Defined Line Type

Creates line types by specifying gap patterns, which define the lengths of spaces and lines comprising a line type.

UL *index [,gap1, . . . ,gap20;]*

or

UL *[;]*

Parameter	Format	Functional Range	Default
index	clamped integer	1 through 8	–
gaps	clamped real	0 to 32767	default line types

The UL command allows you to define and store your own line types. The command does not itself select a line type. Use the LT command to select the line type once you've defined it with UL.

- **No Parameters** – Defaults all line types (refer to the LT command).
- **Index** – Identifies the number of the line type to be redefined. Specifying an index number without gap parameters sets the line type identified by the index to the default pattern for that number. The index number may not be 0.

  The index parameter uses absolute values, so (UL-n) is the same as (ULn). Redefining a standard fixed line type automatically redefines the corresponding adaptive line type.
- **Gaps** – Specify alternate pen-down and pen-up stretches in the line type pattern; if gaps are numbered starting with 1, odd numbered gaps are pen-down moves, even numbered gaps are pen-up moves. The first gap is a pen-down move. Gap values are converted to percentages of the LT command's pattern length parameter.

A maximum of 20 gaps are allowed for each user-defined line type. Gap values must be non-negative; a gap value of zero produces a dot if specified for an odd numbered gap that is preceded or followed by a non-zero even-numbered gap. The sum of the gap parameters must be greater than zero.

The following example demonstrates redefining and printing a line type.

Example: Using the UL Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%0B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA4000,3000;	Specify absolute plotting and move to (4000,3000).
UL8,0,15,0,15, 0,15,40,15;	Redefine the user-defined line type with an index number of 8; specify the lines and spaces as follows, in percentages of the line distance: gap1 as a dot (0%), gap2 as a space (15%), gap3 as another dot (0%), gap4 as a space (15%), gap5 as another dot (0%), gap6 as a space (15%), gap7 as a line (40%), and gap8 as a space (15%).
LT8,10;PU2000, 2500;PD5000, 2500;	Specify line type number 8 (just defined), with a pattern length of 10% of the distance between P1 and P2 (in this case, the lower-left and upper-right corners of the default PCL Picture Frame); lift the pen and move to (2000,2500); set the pen down and draw to (5000,2500).
$^{E}_{C}$%0A	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.

Related Commands	Group
LA, Line Attributes LT, Line Type	*The Line and Fill Attributes Group*

POSSIBLE ERROR CONDITIONS:

Condition	Printer Response
sum of gap parameters equals zero	ignores command
a gap is negative	ignores command
index = 0 or |index| > 8	ignores command

WU, Pen Width Unit Selection

Specifies how the width parameter of the Pen Width (PW) command is interpreted (whether metric or relative units).

WU *type[;]*

or

WU *[;]*

Parameter	Format	Functional Range	Default
type	clamped integer	0 to 1	0 (metric)

Since using WU, with or without parameters, defaults all pen widths, you should send the WU command *before* a PW command (which sets a new pen width).

- **No Parameters** – Defaults type parameter to 0 (metric) and all pen widths to 0.35 mm.
- **Type** – Specifies how the width parameter of the Pen Width (PW) command is interpreted.

  0 – Metric. Interprets the pen width parameter in millimeters. Specifying type 0 defaults all pen widths to 0.35mm.

  1 – Relative. Interprets the pen width parameter as a percentage of the diagonal distance between P1 and P2. Specifying type 1 defaults all pen widths to 0.1% of the diagonal distance from P1 to P2.

If the specified type parameter is not 0 or 1, the printer ignores the command.

A WU command remains in effect until another WU command is executed, or the printer is initialized. WU is not defaulted by the Default Values (DF) command.

Related Commands	Group
PW, Pen Width SP, Select Pen	*The Line and Fill Attributes Group*

21

The Character Group

When you have created an HP-GL/2 graphic and want to add text, you can either enter PCL mode to add text to your image or you can print text from within the HP-GL/2 mode. If this is your first experience with HP-GL/2, you should know that the term "label" is used throughout this chapter to indicate the printing of text. This chapter discusses the various ways you can "label" your images using the LaserJet III printer's vector graphics commands.

The information in this chapter enables you to perform the following:

- Position and print labels using any LaserJet font.
- Change label size, slant, and direction.
- Designate and select standard and alternate fonts.
- Print with proportional- and fixed-spaced fonts.
- Work with the character cell.

The following commands are described in this chapter:

Table 21-1. The Character Group Commands

Command	Summary
AD, Alternate Font Definition	Specifies an alternate font for labeling.
CF, Character Fill Mode	Specifies how outline fonts will be rendered.
CP, Character Plot	Moves the pen the specified number of character cells from the current pen location.
DI, Absolute Direction	Specifies the slope of labels independent of P1 and P2 locations.
DR, Relative Direction	Specifies the slope of labels relative to P1 and P2 locations.
DT, Define Label Terminator	Defines the character or code that 'turns off' labeling.
DV, Define Variable Text Path	Specifies the label path as right, left, up, or down.
ES, Extra Space	Increases or reduces space between label characters and lines.
FI, Select Primary Font	Selects as standard a font previously assigned a PCL *font ID* number.
FN, Select Secondary Font	Selects as alternate a font previously assigned a PCL *font ID* number.
LB, Label	Prints text using the currently selected font.
LO, Label Origin	Positions labels relative to the current pen location.

Table 21-1. The Character Group Commands (continued)

Command	Summary
SA, Select Alternate Font	Selects the font designated by AD for labeling.
SB, Scalable or Bitmap Fonts	Specifies the type of fonts to be used for labels.
SD, Standard Font Definition	Specifies the standard font for labeling.
SI, Absolute Character Size	Specifies an absolute character size (in centimeters).
SL, Character Slant	Specifies the slant at which labels are printed.
SR, Relative Character Size	Specifies the size of characters as a percentage of the P1/P2 distance.
SS, Select Standard Font	Selects the font designated by SD for labeling.
TD, Transparent Data	Specifies whether control characters perform their function or are printed as characters when printing text.

Printing Labels

Use the Label command (LB) to create text charts or to emphasize areas of a diagram or graph that need special attention or explanation. You can control almost all aspects of the label's appearance: its position, size, slant, spacing, and direction. All labels are drawn using the font currently designated (refer to the SD or AD commands) and selected for use (refer to the SS or SA commands).

If you are using a font other than the default, use SD (Standard Font Definition) or AD (Alternate Font Definition) commands to designate a font that can be selected. Then, use the SS (Select Standard Font) or SA (Select Alternate Font) commands to select the designated font for use. You can follow the LB (Label) command with virtually any characters, including nonprinting control codes, such as a Line Feed or Carriage Return.

When you are through with your label, you must use a special label terminator (set by the DT command) to signify the end of text. Without the label terminator in place, your printer will continue to label your picture with the remaining HP-GL/2 commands and parameters.

The following example demonstrates printing a simple label using the SD command to designate a font, the SS command to select that font, the DT command to define a label terminator, and the LB command to print the label, including Carriage Returns and Line Feeds.

Example: Printing Labels

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%∅B	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA1500,2500;	Specify absolute plotting and move to (1500,2500).
SD1,21,2,1,4,25, 5,1,6,0,7,52;	Designate the 25-point Univers Italic font as the standard font.
DT*,1;	Define the asterisk character as the label terminator (the 1 indicates the terminator shouldn't be printed).
SA;	Select the alternate font for printing. Since an alternate font hasn't been designated, the default 11.5-point Stick font is selected.
LBThis is the Stick Font (Default) *CR-LF CR-LF* *;	Print the first line of text, followed by two Carriage Returns and two Line Feed control codes. Notice how the asterisk terminates the label.

This is the Stick Font (Default).

This is Univers Italic

Example: Printing Labels (continued)

SS;	Select the standard font.
LBThis is Univers Italic*;	Print the next line of text in the newly specified font.
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.

Moving to the Carriage Return Point

When you begin labeling, the current pen location is the Carriage Return point. That is, the beginning of your line of text is the point at which the pen will be "returned" when a Carriage Return control code is sent to the printer. When the printer encounters a Character Plot (CP) command, or a Carriage Return (CR) within a Label command, the pen moves to the Carriage Return point, adjusted up or down by any line feeds. (The Character Plot command is described later in this chapter.)

The following commands update the Carriage Return point to the current pen location:

Commands Updating Carriage Return Point to Current Location

Mnemonic	Command Name*
AA	Arc Absolute
AR	Arc Relative
AT	Absolute Arc (Three Point)
DF	Default Values
DI	Absolute Direction
DR	Relative Direction
DV	Define Variable Text Path
IN	Initialize
LO	Label Origin
PA	Plot Absolute
PE	Polyline Encoded
PR	Plot Relative
RO	Rotate Coordinate System
RT	Relative Arc (Three Point)

* A PD or PU command with parameters also updates the Carriage Return point. The CP command with a nonzero lines parameter updates the Carriage Return point's vertical location.

The Label (LB) command does not update the Carriage Return point to the current pen location, but continues labeling from the current pen location. This feature allows you to issue several label commands that write one long label and still use a Carriage Return to get to the beginning of the entire label.

Control Codes

You can effectively use the following control characters in labels. All other control codes are ignored.

Commands Updating Carriage Return Point to Current Location

Control Code	Decimal Code
Backspace	8
Horizontal tab	9
Line feed	10
Carriage return	13
Shift Out*	14
Shift In**	15
Space	32

* Equivalent to Select Alternate Font (SA) command.

** Equivalent to Select Standard Font (SS) command.

Default Label Conditions

The following label default conditions are established when the printer is initialized, or set to default conditions. To change these settings, refer to the appropriate chapter or command.

- **Symbol Set (Character Set)** – Roman-8.
- **Font Spacing** – Fixed.
- **Pitch** – 9 characters per inch.
- **Height** – 11.5 point.
- **Posture** – Upright.
- **Stroke Weight** – Medium
- **Typeface** - HP-GL/2 Stick.
- **Label terminator** – ASCII end-of-text character ETX (decimal code 3). Refer to the Define Label Terminator (DT) command.
- **Label starting point** – Current pen location. Also, refer to the Label Origin (LO) command.
- **Label direction** – Horizontal. Refer to the DI, DR, and DV commands.
- **Space between characters and lines** – Normal (no extra space). Refer to the Extra Space (ES) command.
- **Character Slant** – None (vertical). Refer to the Character Slant (SL) command.
- **Character Fill Mode** – Solidly filled, no edging.

Enhancing Labels

You can enhance your labels by changing such aspects as the character size and slant, the space between characters and lines, and the orientation and/or placement of the label on the page. To effectively use these enhancements you should understand the properties of the character cell. Refer to *Working with the Character Cell* later in this chapter.

Character Size and Slant

You can change the size of the characters using the Absolute Character Size and the Relative Character Size (SI and SR) commands. The Absolute Character Size (SI) command establishes the size of the uppercase A in centimeters and maintains this character size independent of the location of P1 and P2 or the page size. The Relative Character Size (SR) establishes the size of the uppercase A as a percentage of the distance between P1 and P2. Subsequent changes in the location of P1 and P2 cause the character size to change. Changing the character size changes the size of the CP cell and proportionally changes the line width used in labels (refer to AD and SD).

Note

When the Shift In (SI) or Shift Out (SO) control codes are used to select a font, the font size reverts to that specified using the AD or SD commands.

You can use the Character Slant (SL) command to slant the characters at a specified angle in either direction from the left vertical side of the CP cell. The CP cell is not altered.

Character Spaces and Text Lines

You can use the Extra Space (ES) command to automatically put extra spaces or lines between all characters or lines. For example, you could use ES to skip a space between every character in a label (such as, M E M O R A N D U M) or to skip a line between every line of text, double-spacing your text. You can also decrease the spacing between characters and lines.

You can use the Character Plot (CP) command to move the pen a specific number of lines or spaces (character cells) from the current pen location. Use the CP command, for example, to indent a label a certain number of spaces.

Label Orientation and Placement

You can place your labels anywhere on the page in any orientation you want. The Absolute Direction (DI) command specifies the angle at which you want to print the characters, independent of the location of P1 and P2. The Relative Direction (DR) command specifies the angle at which you want to print the characters as a function of the P1 and P2 distance; thus when you change P1 and P2, the label angle changes to maintain the same orientation.

The DI and DR commands allow you to print text at any angle with the letters in their normal side-by-side orientation.

The Define Variable Text Path (DV) command allows you to specify the text path (right, left, up, or down) and the direction of Line Feeds with respect to the text path.

The Label Origin (LO) command greatly simplifies placing labels on a drawing. Normally the first character origin is the current pen location when the Label command is issued. The LO command allows you to specify that the label be centered and/or right- or left-justified from the current pen location. For example, the following illustration shows four centered lines of text.

Lines of any length
can easily be
centered
without cumbersome calculations.

These lines use one (X,Y) coordinate pair, one LO command to center labels, and a Carriage Return and Line Feed after each line. Without this command, an alternative method would involve calculating the length of the line in CP cells, dividing by two, and using the CP command to 'backspace' the required number of cells – and that's just the first line. The LO command saves you calculation, decreases the number of characters sent to the printer, and allows you to take advantage of proportional fonts when the character widths are not known to the software.

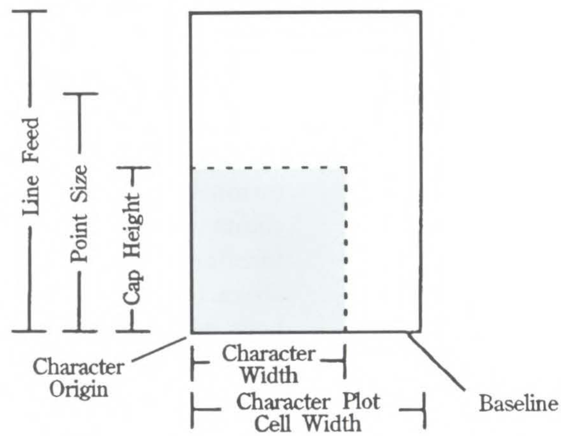
Terminating Labels

LB tells the printer to print every character following the command, rather than interpreting the characters as graphics commands. In order to allow the normal terminator, the semicolon (;), to be used in text, the command is defined so that you must use a special 'label terminator' to tell the printer to once again interpret characters as graphics commands. (If the command had been defined otherwise, you wouldn't be able to print semicolons in your text.)

The default label terminator is the nonprinting ASCII end-of-text character ETX (decimal code 3). You must use the label terminator, or the printer will print the rest of your file as text instead of executing the commands. You can change the label terminator using the Define Label Terminator (DT) command.

Working with the Character Cell

In each font, the basis for each character or space is the character cell. Think of the character cell as a rectangular area around a character that includes blank areas above and to the right of the character. Refer to the following illustration.



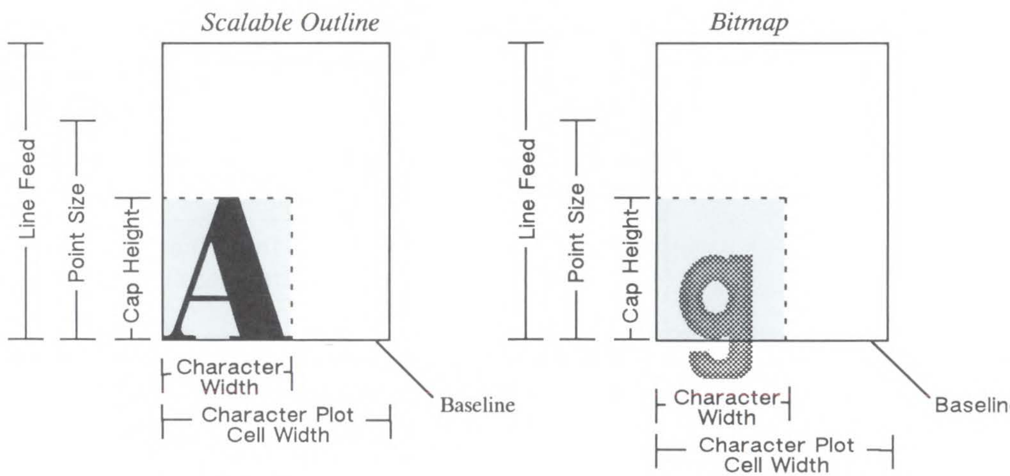
Term	Description
Baseline	The imaginary line on which a line of text rests. A character's descender (such as the bottom of a lowercase "g") extends below the baseline.
Linefeed	The distance from the baseline of a line of text to the baseline of the next character line above or below. For most fonts, the linefeed is about 1.2 times the point size (1.33 times the point size for Stick fonts).
Point Size	Traditional character measure roughly equivalent to the height of a capital letter M plus the depth of a descender.
Cap Height	The distance from the baseline to the top of a capital letter.
Character Origin	The point at which the baseline meets the left edge of the character cell.
Character Width	The lateral area allocated for character rendering.
Character Cell Width	The distance from the left edge of one character to the beginning of the next character
Character Cell	A rectangular area with the height of a linefeed and a width extending from the beginning of one character to the beginning of the next.

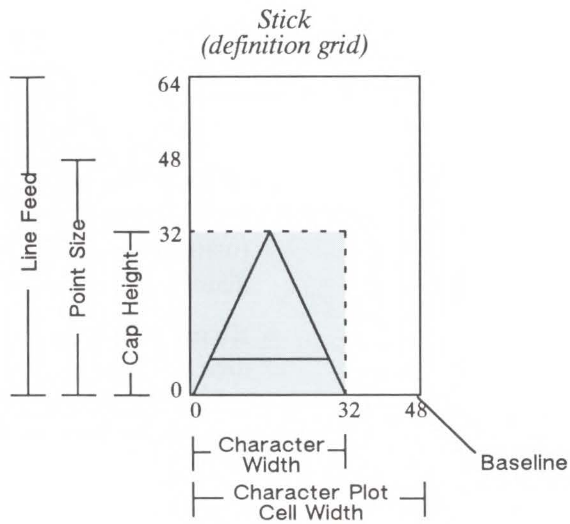
The LaserJet III printer implements the following different types of fonts:

- Scalable outline font
- Bitmap font
- HP-GL/2 stick font

These are described in more detail in *Using Fonts* later in this chapter. The following shows each type of font in relation to its character cell.

Note Proportional fonts do not actually have a fixed character "cell." The width occupied by each character depends on the character's shape.





When you use the SI (Absolute Character Size) or SR (Relative Character Size) commands to change the size of the characters or use the ES (Extra Space) command to add extra space around them, you alter the size of the CP cell. For more information, refer to *Working with the Character Cell* later in this chapter.

You can control almost all aspects of the label's appearance: its position, size, slant, spacing, and direction. This chapter explains the commands that control these features. This chapter also tells you how to select fonts other than the default font.

Using Fonts

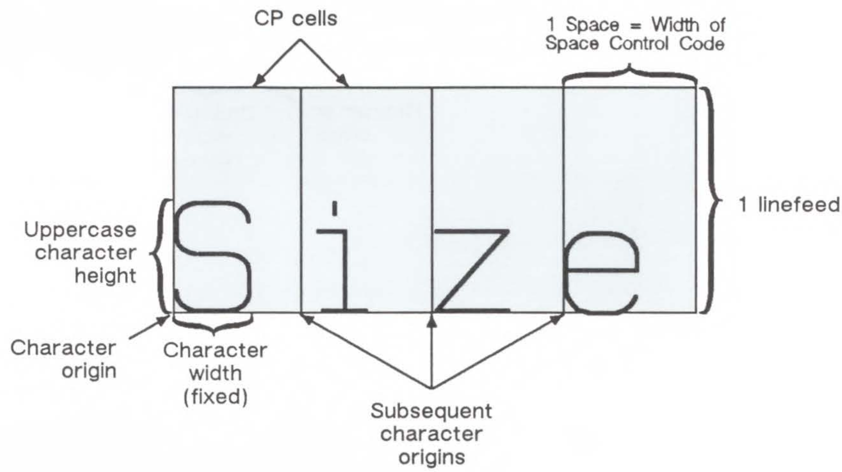
In HP-GL/2 mode, the LaserJet III printer uses three different types of fonts:

- **Scalable fonts** – Characters can be displayed at any size. The characters are defined as a set of points on the outline of a character and corresponding mathematical relationships describing the interaction between these outline points. A scalable outline character can be resized (using SI and SR), rotated (using DI and DR), and distorted (using SL).
- **Bitmap fonts** – Characters defined as an array of dots in a raster pattern. A bitmap character cannot be transformed using DI, DR, SI, SR, or SL, but they can be used with all of the other commands in this chapter (see the SB command).
- **Stick font** – Characters are drawn as a series of vectors. The characters are defined as a set of endpoints. You can resize (using SI or SR), rotate (using DI and DR), and distort (using SL) Stick fonts. Stick fonts are defined on a dimensionless grid. The main body of each character fits within a 32- by 32-unit box, with descenders extending beneath. The LaserJet III Stick font is fixed-spaced.

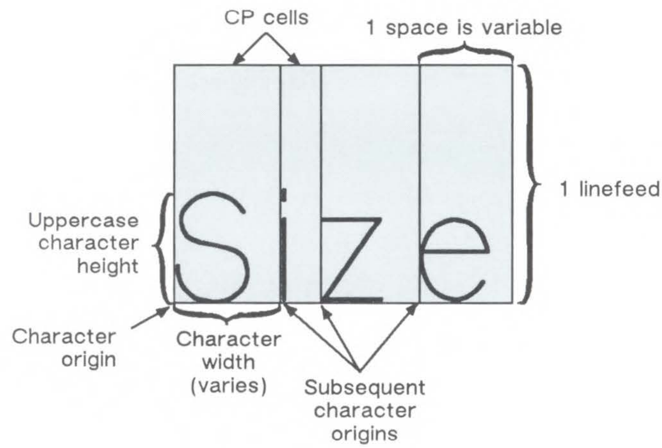
Printing with Fixed-Spaced and Proportional Fonts

Proportional fonts, by definition, use different amounts of horizontal space for each letter. This variation produces some differences in the definition of the character cell and in the way some of the labeling commands work with these fonts. These differences are described in this section.

The following illustration shows the difference between fixed-spaced and proportional fonts.



With proportional fonts, the actual space occupied by each character will vary according to the character's width. Refer to the following illustration.



Proportional Font

When printing proportional fonts, the Character Plot (CP) command uses the width of the Space control code to determine horizontal spaces and the Line Feed height for determining vertical spacing. The Extra Space (ES) command uses the horizontal escapement distance (a font metric) to compute horizontal spaces and the Line Feed height for determining vertical spacing. Both of the character size commands (SI and SR) use cap height and average character width in calculating character size. Otherwise, these commands behave the same as they do with fixed-spaced fonts.

Designating and Selecting Fonts

If you always intend to label with the default fixed-spaced font (Stick), you do not need to use the SD or AD commands for designating standard and alternate fonts. However, if you intend to use a different font (for example, to match accompanying PCL text), you must use the SD or AD commands to designate fonts before you can select those fonts for labeling (using either SA or SS).

Standard and Alternate Fonts

The following outlines some of the principles to use when labeling with different fonts:

- Designate the standard and alternate fonts using the SD and/or AD commands before labeling. If you are using the Stick font (the default) as your standard font, you need specify only your alternate font.

- Select either the standard or alternate font using either the SS or SA command before labeling.

  Note that labeling always begins with the standard font unless you use the SA command before you begin your label (or finish the previous label in the alternate font).

- Switch from the standard font to the alternate font either using SS and SA or the Shift In/Shift Out method. If you are changing fonts within a text string, the Shift In/Shift Out method is usually more efficient. Switch from the standard font to the alternate font using the ASCII Shift Out control character (SO, decimal code 14). Switch from the alternate font to the standard font using the ASCII Shift In control character (SI, decimal code 15). (Note that a Shift In or Shift Out outside of the label command string is ignored.)

AD, Alternate Font Definition

Similar to the Standard Font Definition (SD) command that defines the primary HP-GL/2 font, this command defines an alternate HP-GL/2 font and its attributes: font spacing, pitch, height, posture, stroke weight, and typeface. Use AD to set up an alternate font that you can easily access when labeling.

AD *kind,value ... (,kind,value;)*

or

AD *(;)*

Parameter	Format	Functional Range	Default
kind	clamped integer	1 to 7	no default
value	clamped real	kind dependent*	kind dependent*

* Refer to the table following the parameter descriptions.

The AD command lets you define another font and its font attributes.

- **No Parameters** – Defaults the alternate font attributes to that of the Stick font (see table below).
- **Kind** – Specifies the attribute for which you are setting a value (see table below).

Kind	Attribute	Default Value	Description
1	Symbol Set	277	Roman-8
2	Font spacing	0	fixed spacing
3	Pitch	9	characters per inch
4	Height	11.5	font point size
5	Posture	upright	upright
6	Stroke Weight	0	medium
7	Typeface	48	Stick (fixed vector)

- **Value** – Defines the characteristics of the attribute specified by the *kind* parameter.

Note

When selecting fonts, the different attributes (symbol set, spacing, pitch, etc.) are prioritized as shown in the table above, with symbol set being the highest priority and typeface being the lowest. The font selection priority is the same for HP-GL/2 as for PCL font selection. For more information about the priority of font attributes, see the *Font Selection by Attribute* discussion in Chapter 8.

To avoid duplication of many pages of tables, the tables listing the *kind* parameters (symbol set, spacing, typeface, etc.) are located with the description of the SD (Standard Font Description) command.

The following example shows the command used to designate a 30-point *CG Times Bold Italic* font in the ASCII symbol set (use the Select Alternate Font (SA) command to select this font after it is designated):

$$\mathrm{AD}\underbrace{1,21}_{\text{Symbol Set}},\underbrace{2,1}_{\text{Font Spacing}},\underbrace{4,30}_{\text{Height}},\underbrace{5,1}_{\text{Posture}},\underbrace{6,3}_{\text{Stroke Weight}},\underbrace{7,5}_{\text{Typeface}}$$

Note that the *pitch* parameter is missing in the above command because the designated font is proportionally spaced.

Related Commands	Group
LB, Label	*The Character Group*
SA, Select Alternate Font	
SB, Scalable or Bitmap Fonts	
SD, Standard Font Definition	
SI, Absolute Character Size	
SR, Relative Character Size	
SS, Select Standard Font	

CF, Character Fill Mode

The Character Fill Mode command specifies the way scalable fonts are filled and edged; bitmap and Stick fonts cannot be edged and can be filled only with raster fill, shading, or PCL cross-hatch patterns. Scalable characters may be filled with any of the fill patterns as specified by the FT command (shading, hatching, cross-hatching, and user-defined raster fill patterns).

CF *fill mode[,edge pen[;]]*

or

CF *[;]*

Parameter	Format	Functional Range	Default
fill mode	clamped integer	0, 1, 2, or 3	0 (solid fill)
edge pen	integer	-2^{30} to $2^{30} - 1$	0 (no edging)

- **No Parameters** – Defaults characters to solid fill with no edging. Equivalent to CF0,0.
- **Fill mode** – Specifies how the printer will render filled characters according to the following parameter values.

  0 – Specifies solid fill using the current pen and edging with the specified pen (or current pen if the edge pen parameter is not specified).

  1 – Specifies edging with the specified pen (or current pen if the edge pen parameter is not specified). Characters are filled only if they cannot be edged (bitmap or stick characters), using the edge pen.

2 – Specifies filled characters using the current fill type (refer to the FT command in Chapter 20, *The Line and Fill Attributes Group*). The currently selected pen is used. Characters are not edged. If the edge pen parameter is specified, it is ignored.

3 – Specifies filled characters using the current fill type (refer to the FT command in Chapter 20, *The Line and Fill Attributes Group*). The currently selected pen is used. Characters are edged with the specified pen (or current pen if the edge pen parameter is not specified).

- **Edge pen** – For characters that are to be edged, this parameter indicates the pen that will be used to edge the character (black or white).

  0 –White edging.

  1 –Black edging. The outline pen width is not selectable, but varies in thickness in proportion to the point size of the font.

Note that the Absolute Direction (DI) and Relative Direction (DR) commands do not cause rotation of fill patterns. Fill patterns remain fixed with respect to the current coordinate system. The CF command remains in effect until another CF command is executed, or the printer is initialized or set to default conditions.

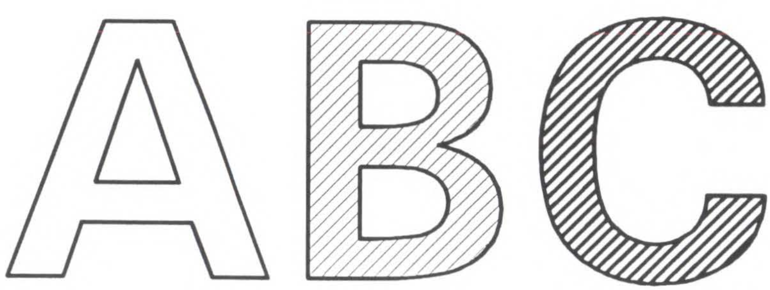
Note

The edge pen width is not specifiable; its thickness automatically increases in proportion with the point size.

The thickness of fill lines for hatching and cross-hatching is selected using the PW (Pen Width) command. Due to the way hatching and cross-hatching lines are drawn, they may extend beyond the character outline by up to $\frac{1}{2}$ of the current pen width. When using a small pen width and specifying a black edge pen, the edging covers up hatching lines that extend outside the character outline. However, as the pen width increases, the edge pen may not be wide enough to compensate for this, resulting in a fill that overlaps the character edges. To ensure that the character fill looks correct when using hatching patterns, use a narrow pen width, especially for small point sizes (see illustration below).

Example: Using the CF Command

^E_CE	Reset the printer.
^E_C%ØB	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1 (black).
SD1,21,2,1,4,140, 5,0,6,3,7,52;SS;	Specify a 140-point Univers Bold font and select it for printing.
PA1000,3000;DT*;	Specify absolute plotting and move to (1000,3000); specify (*) as the label terminator.
FT3,50,45;	Specify a hatching fill type with 50 plotter units between each line, with the lines set at a 45° angle.
CF1,1;LBA*;	Select character fill mode 1 (edge) and edge with pen number 1 (black); print the letter "A".
PR127,0;	Move the pen position 127 plu to the right.
PW.1;CF3,1;LBB*;	Set the pen width to .1 mm; select character fill mode 3 (fill & edge) and edge with pen number 1 (black); print the letter "B".
PW.5;LBC*;	Set the pen width to .5 mm to change the thickness of the fill lines; print the letter "C".
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.



Related Commands	Groups
DI, Absolute Direction DR, Relative Direction SB, Scalable or Bitmap Fonts	*The Character Group*
FT, Fill Type	*The Line and Fill Attributes Group*

CP, Character Plot

Moves the pen the specified number of spaces and lines from the current pen location. Use CP to position a label for indenting, centering, etc.

CP *spaces,lines [;]*

or

CP *[;]*

Parameter	Format	Functional Range	Default
spaces	clamped real	−32768 to 32767	no default
lines	clamped real	−32768 to 32767	no default

The CP command includes an automatic pen up. When the command is completed, the original pen up/down status is restored.

CP moves the pen position in relation to the current position. CP is a movement command and doesn't affect the margin; to repeat the same movement for subsequent labels, you must issue new CP commands. (For information about the carriage return point, see *Moving to the Carriage Return Point* in the *Printing Labels* discussion near the beginning of this chapter. For more information on spaces, lines, and the character cell, refer to *Working with the Character Cell* earlier in this chapter.)

- **No Parameters** – Performs a Carriage Return and Line Feed (moves one line down and returns to the Carriage Return point).
- **Spaces** – Specifies the number of spaces the pen moves relative to the current pen location. Positive values specify the number of spaces the pen will move to the right of the current pen position; negative values specify the number of spaces the pen moves to the left. Right and left are relative to current label direction. The space width is uniquely defined for each font; use the ES command to adjust the width.

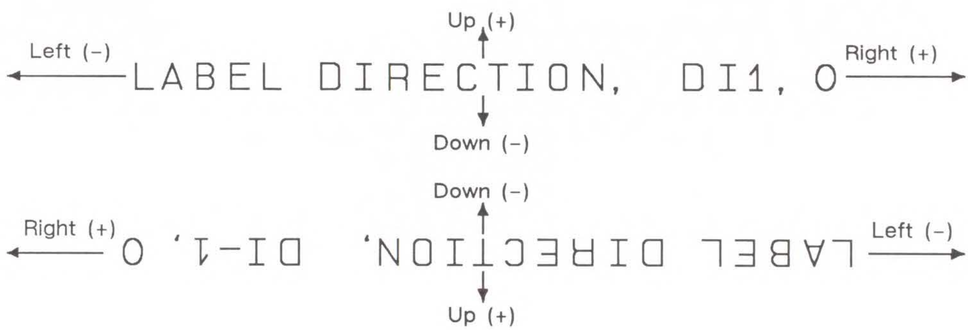
Note

If you are using a proportionally-spaced font, the width of the Space control code will be used.

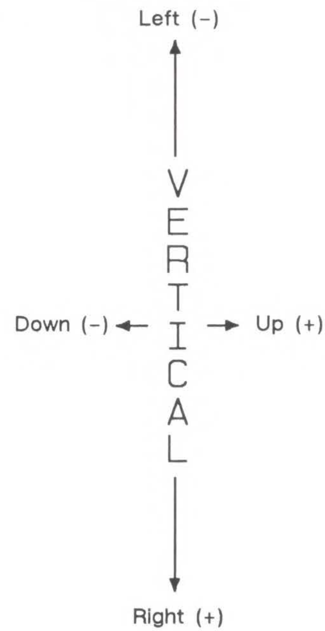
- **Lines** – Specifies the number of lines the pen will move relative to the current pen location. Positive values specify the number of lines the pen will move up from the current pen position; negative values specify the number of lines the pen moves down (a value of -1 is equivalent to a Line Feed). Up and down are relative to the current label direction. The Line Feed distance is uniquely defined for each font; use the Extra Space (ES) command to adjust the height.

When you move the pen up or down a specific number of lines, the Carriage Return point shifts up or down accordingly.

The illustration below shows the interaction of label direction and the sign (+/–) of the parameters.



The following illustration shows the direction of labeling with a vertical text path (set by (DV1) or (DV1,0); refer to the Define Variable Text Path (DV) command for more information).



The following example produces lettering along a line (but not directly on top of it) and aligns labels along a left margin. Movement of the carriage return point is demonstrated as well as different methods of placing the text. The text is placed using the CP command with parameters, then with a Carriage Return-Line Feed (CR-LF) combination, and also using a CP command without parameters to emulate a CR-LF.

Example: Using the CP Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%0B	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1 (black).
PA5000,2500; PD1500,2500; PU;	Specify absolute plotting and move to (5000,2500); set the pen down and draw a line to (1500,2500); lift the pen.
CP5,.35;	Move the pen 5 spaces to the right and .35 lines up so that the label will be placed just above the line.
DT$,1;	Define a label terminator ($) and specify that it doesn't print.
SD1,21,2,1,4,14,5, 0,6,3,7,52;SS;	Designate a 14-point Univers Bold font and select it.
LBABOVE THE LINE$;	Print the first line of text.
PA2500,2500; WG20,0,360;	Move the pen to (2500,2500) and draw a dot marking the new Carriage Return point (360° black-filled wedge with a diameter of 20 plu).
CP0,-.95LBBELOW THE LINE ***CR-LF*** **WITH A NEAT$;**	Print the second line; Carriage Return-Line Feed; print the third line.
CP;LBMARGIN$;	Print the fourth line. Notice how the CP command without parameters functions as a CR-LF.
$^{E}_{C}$%0A	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.

Related Commands	Group
DI, Absolute Direction DR, Relative Direction DV, Define Variable Text Path ES, Extra Space LO, Label Origin SB, Scalable or Bitmap Fonts SI, Absolute Character Size SR, Relative Character Size	*The Character Group*

DI, Absolute Direction

Specifies the slope or direction at which labels are drawn, independent of P1 and P2 settings. Use DI to change labeling direction when you are labeling curves in line charts, schematic drawings, blueprints, and survey boundaries.

DI *run,rise [;]*

or

DI *[;]*

Parameter	Format	Functional Range	Default
run (or cos θ)	clamped real	−32768 to 32767	1
rise (or sin θ)	clamped real	−32768 to 32767	0

The DI command updates the Carriage Return point to the current location. While DI is in effect, with or without parameters, the label direction is not affected by changes in the locations of P1 and P2. However, the Define Variable Text Path (DV) command interacts with the DI command (and DR), as explained later in this section.

- **No Parameters** – Defaults the label direction to absolute and horizontal (parallel to X-axis). Equivalent to (DI1,0).
- **Run or Cos** θ – Specifies the X-component of the label direction.
- **Rise or Sin** θ – Specify the Y-component of the label direction.

  Together, the parameters specify the slope and direction of the label.

You can express the parameters in measured units as rise and run, or using the trigonometric functions cosine and sine according to the following relationship.

Where: run and rise = number of measured units

θ = the angle measured in degrees

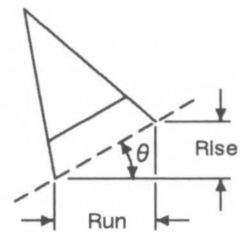
$\sin\theta/\cos\theta$ = rise/run

$\theta = \tan^{-1}$(rise/run)

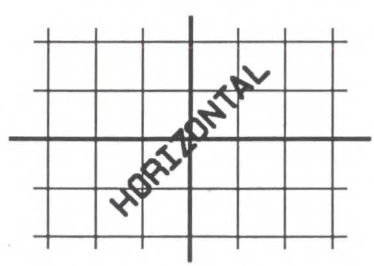
and

$\tan\theta = \sin\theta/\cos\theta$

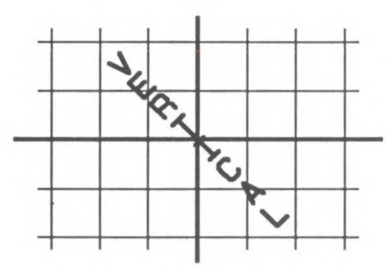
Note that the run and rise determine the slope or angle of an imaginary line under the base of each character in the label. Refer to the following illustration.



When plotting in horizontal mode (you haven't used the DV command), the run and rise appear to determine the slope of the entire label. However, if you have used the Define Variable Text Path (DV) command to label in a vertical path, the label appears to slant in the opposite direction even though the base of each letter is plotted on the same slope. The following illustration compares how labels plotted with the same run and rise parameters appear with horizontal (DV0) and vertical (DV1) text paths.



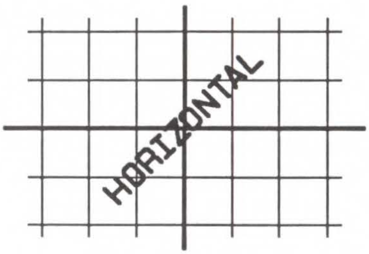
DV0



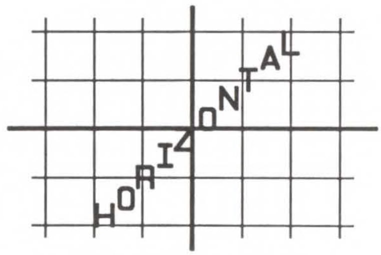
DV1

Note

If an (SB1;) command has been sent, the printer draws the label along the nearest perpendicular. In the case of bisection, the angle is rounded down (e.g., 45° would round to 0°). Refer to the following illustration.

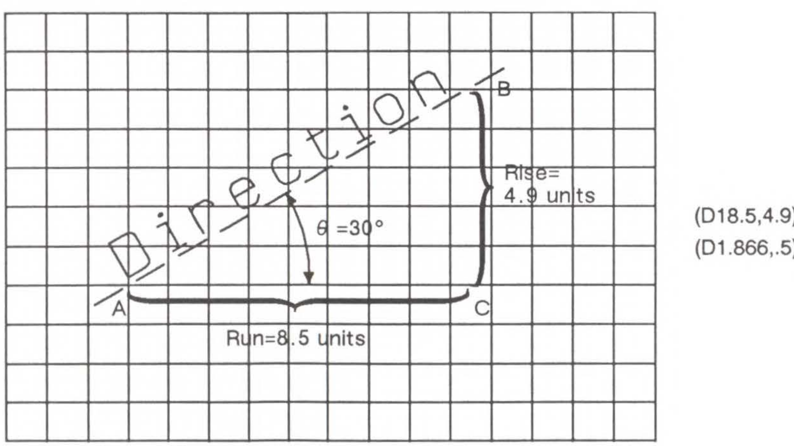


Vector Font (SB0)



Bitmap Font (SB1)

Suppose you want your label plotted in the direction shown in the following illustration. You can do this in one of two ways: measure the run and rise, or measure the angle.



To measure the run and rise, first draw a grid with the lines parallel to the X- and Y-axis. The grid units should be the same size on all sides, but their actual size is irrelevant. Then draw a line parallel to the label and one parallel to the X-axis. The lines should intersect to form an angle.

Select a point on the open end of your angle (where another line would create a triangle). On the line parallel to the X-axis, count the number of grid units from the intersection of the two lines to your selected point. This is the run. In the illustration above, the run is 8.5. Now, count the number of units from your selected point along a perpendicular line that intersects the line along the label. This is the rise. In the illustration above, the rise is 4.9.

Your DI command using the run and rise would be (DI8.5,4.9).

If you know the angle (θ), you can use the trigonometric functions sine (sin) and cosine (cos). In this example, $\theta = 30°$, $\cos 30° = 0.866$, and $\sin 30° = 0.5$.

Your DI command using the sine and cosine would be (DI.866,.5).

Whichever set of parameters you use, the label will be drawn in the same direction as shown in the previous illustration.

Use the following table when you know the angle and want to specify the cosine and sine values. You can also use the SIN and COS functions available in most programming languages. The example at the end of this section shows both methods.

θ		Cosine	Sine
360	0	1	0
330	−30	0.87	−0.50
315	−45	0.71	−0.71
300	−60	0.50	−0.87
270	−90	0	−1
240	−120	−0.50	−0.87
225	−135	−0.71	−0.71
210	−150	−0.87	−0.50
180	−180	−1	0
150	−210	−0.87	0.50
135	−225	−0.71	0.71
120	−240	−0.50	0.87
90	−270	0	1
60	−300	0.50	0.87
45	−315	0.71	0.71
30	−330	0.87	0.50
0	−360	1	0

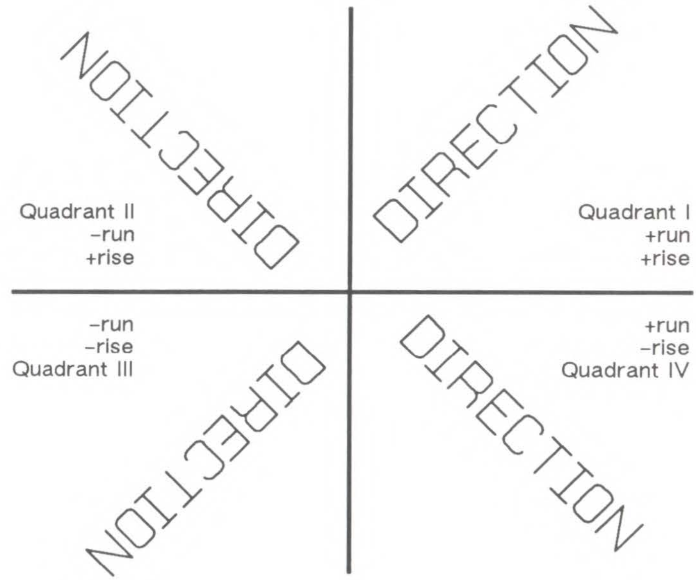
When using either method, at least one parameter must not be zero. The ratio of one parameter to the other is more important than the actual numbers. The following table lists three common label angles produced by using 1's and 0's.

DI Command	Label Direction
DI 1,0	horizontal
DI 0,1	vertical
DI 1,1 or DI 0.7,0.7 (or any parameters equal to each other)	45° angle

The relative size and sign of the two parameters determine the amount of rotation. If you imagine the current pen location to be the origin of a coordinate system for the label, you can see that the signs of the parameters determine which quadrant the label will be in.

Example: Using the DI Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA3500,2500;	Enter absolute plotting mode and move to (3500,2500).
DT*;	Define (*) as the label terminator.
DI1,1;LB DIRECTION *CR**;	Print the word "DIRECTION" in the first quadrant and send a Carriage Return to return the pen to the Carriage Return point (3500,2500).
DI1,-1;LB DIRECTION *CR**;	Print the same word in the fourth quadrant and return the carriage to the Carriage Return point.
DI-1,-1;LB DIRECTION *CR**;	Print the same word in the third quadrant and Carriage Return.
DI-1,1;LB DIRECTION *CR**;	Print the word in the fourth quadrant and Carriage Return.
$^{E}_{C}$%ØA	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.

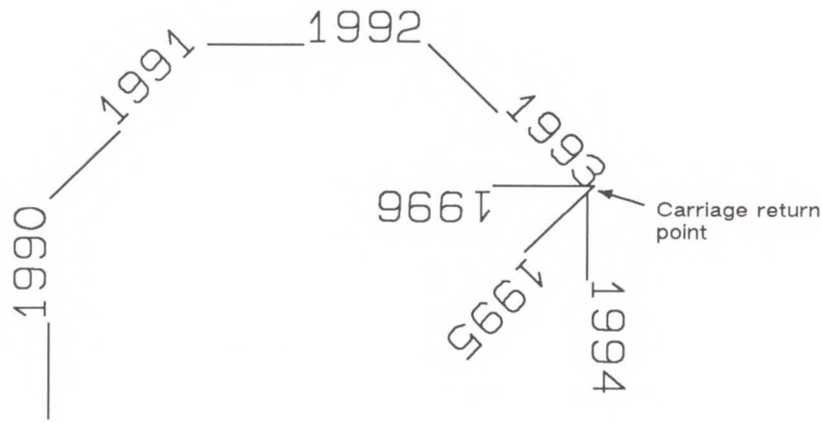


The DI command remains in effect until another DI or DR command is executed, or the printer is initialized or set to default conditions.

The following example illustrates the use of positive and negative parameters, the use of the cosine and sine, how the LB command updates the current pen location, and how DI updates the Carriage Return point.

Example: Another DI Example (continued)

^E_CE	Reset the printer.
^E_C%ØB	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1 (black).
PA3500,2500;	Specify absolute plotting and move to (3500,2500).
DT#,1;	Define the "#" character as the label terminator.
DI0,1;LB___1990#;	Set the label direction to print at 90° and print "___1990".
DI1,1;LB___1991#;	Set the label direction to 45° and print "___1991".
DI1,0;LB___1992#;	Set the label direction to 0° and print "___1992";
DI,.71,-.71; **LB___1993#;**	Change the label direction using the cosine and sine of 315° and print "___1993".
DI,0,-1;LB___1994 *CR#*;	Change the label direction using the cosine and sine of 270° and print "___1994"; Carriage Return.
DI,-.71,-.71; **LB___ 1995** *CR#*;	Set the label direction using the cosine and sine of 270° and print "___1995".; Carriage Return.
DI,-1,0;LB___1996 *CR#*;	Set the label direction using the cosine and sine of -180° and print "___1996"; Carriage Return.
^E_C%ØA	Enter the PCL mode.
^E_CE	Send a reset to end the job and eject the page.



Related Commands	Group
DR, Relative Direction DV, Define Variable Text Path LB, Label	*The Character Group*

POSSIBLE ERROR CONDITIONS:

Error Condition	Printer Response
both parameters = 0 or number out of range	ignores command

DR, Relative Direction

Specifies the direction in which labels are drawn, relative to the scaling points P1 and P2. Label direction is adjusted when P1 and P2 change so that labels maintain the same relationship to the scaled data. Use DR to change labeling direction when you are labeling curves.

DR *run,rise[;]*

or

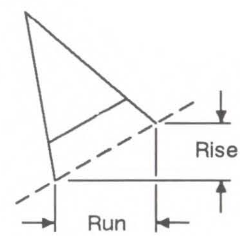
DR *[;]*

Parameter	Format	Functional Range	Default
run	clamped real	−32768 to 32767	1% of $P2_X - P1_X$
rise	clamped real	−32768 to 32767	0

The DR command updates the Carriage Return point to the current location. While DR is in effect, with or without parameters, the label direction is affected by changes in the location of P1 and P2. DR is also affected by the Define Variable Text Path (DV) command. Refer to the DI command earlier in this chapter for an explanation of this interaction.

- **No Parameters** – Defaults the label direction to relative and horizontal (parallel to the X-axis). Equivalent to (DR1,0).
- **Run** – Specifies a percentage of the distance between $P1_X$ and $P2_X$.
- **Rise** – Specifies a percentage of the distance between $P1_Y$ and $P2_Y$.

You define the parameters of run and rise as shown in the following illustration:

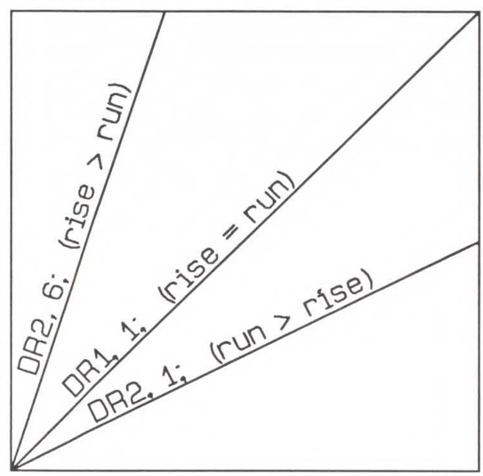


With the DR command, the use of run and rise is somewhat different than with DI. Run is expressed as a percentage of the horizontal distance between P1 and P2; rise is expressed as a percentage of the vertical distance between P1 and P2.

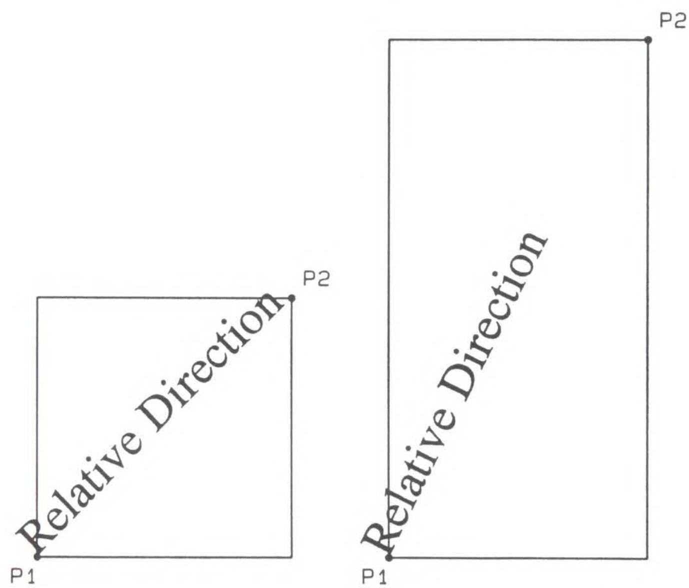
actual run = run parameter * ($P2_X - P1_X$)

actual rise = rise parameter * ($P2_Y - P1_Y$)

The following illustration shows the effects of using three different sets of run/rise parameters. Notice how the text baseline varies as the run percentage is greater than, equal to, and less than the value for rise.



If the P1/P2 rectangle is square, the DR and DI commands have exactly the same effect. The advantage of using the DR command is that, as the locations of P1 and P2 change, the slope of the baseline changes to match the stretching or compressing of the P1/P2 rectangle. For example, if the relative direction is set so that rise = run, the slope of the baseline is 45° as long as the P1/P2 rectangle is square. If the P1/P2 rectangle stretches so that it is twice as high as it is wide, the slope of the baseline will remain parallel to an imaginary line running from P1 to P2 (see illustration below).

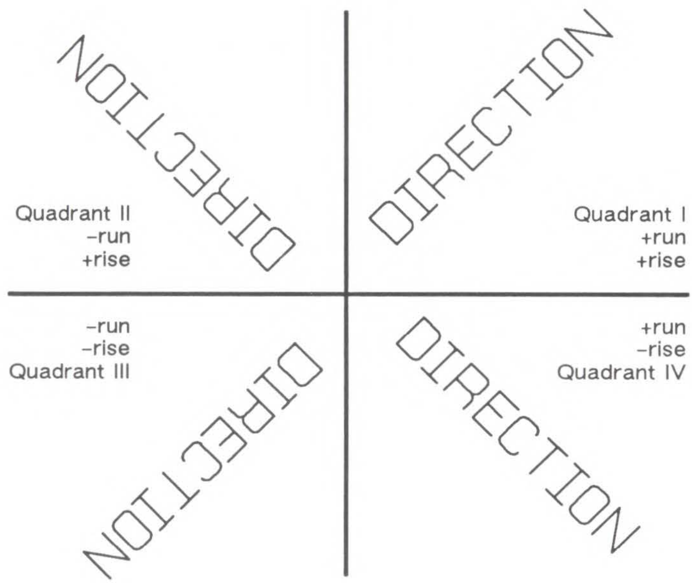


Labels begin at the current pen location and thus are drawn parallel to the directional line, not necessarily on it. Also, negative parameters have the same effect on direction as described for the DI command.

At least one parameter must not be zero. The ratio of the parameters to each other is more important than the actual numbers. The table below lists three common label angles produced by using ones and zeros.

DR Command	Label Direction
DR 1,0	horizontal
DR 0,1	vertical
DR 1,1 or DI 0.7,0.7 (any parameters equal to each other)	diagonal from P1 to P2

The relative size and sign of the two parameters determine the amount of rotation. If you imagine the current pen location to be the origin of a coordinate system for the label, you can see that the signs of the parameters determine in which quadrant the label will be.



A DR command remains in effect until another DR or DI command is executed, or until the printer is initialized or set to default conditions.

Example: Using the DR Command

This example illustrates the use of positive and negative parameters, how the LB command updates the current pen location, and how DR updates the Carriage Return point.

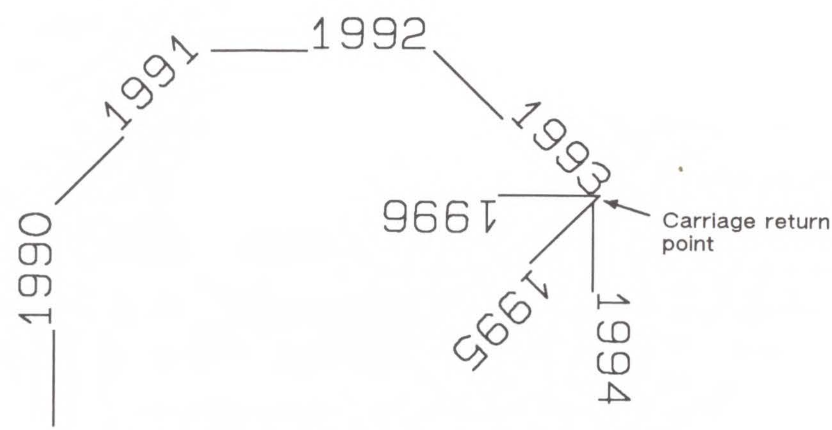
Note that this is the same example shown with the DI command. The only changes are switching the DI to DR and using the 1:0 ratio instead of the sine and cosine. However, if you print them both and measure them, you'll discover that they are slightly different sizes. The size difference results from the DR command's use of the percentage of the P2/P1 distance.

Note

Labels begin at the current pen location and thus will be drawn parallel to the directional line, not necessarily on it.

Example: Using the DR Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1 (black).
PA3500,2500;	Specify absolute plotting and move to (3500,2500).
DT#,1;	Define the "#" character as the label terminator.
DR0,1;LB ___1990#;	Set the label direction and print "___1990".
DR1,1;LB ___1991#;	Set the label direction and print "___1991".
DR1,0;LB___1992#;	Set the label direction and print "___1992";
DR,1,-1; LB___1993#;	Change the label direction and print "___1993".
DR,0,-1;LB___1994 *CR#*;	Set the label direction, print "___1994", and Carriage Return.
DR,-1,-1;LB___1995 *CR#*;	Set the label direction and print "___1995".; Carriage Return.
DR,-1,0;LB___1996 *CR#*;	Set the label direction and print "___1996"; Carriage Return.
$^{E}_{C}$%ØA	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.



Example: Using the DR Command (continued)

Related Commands	Group
DI, Absolute Direction DV, Define Variable Text Path LB, Label SB, Scalable or Bitmap Fonts	*The Character Group*
IP, Input P1 and P2	*The Configuration/Status Group*

POSSIBLE ERROR CONDITIONS:

Error Condition	Printer Response
both parameters = 0 or number out of range	ignores command

DT, Define Label Terminator

Specifies the character to be used as the label terminator and whether it is printed. Use DT to define a new label terminator if you desire a different one or if your computer cannot use the default (ETX, decimal code 3).

DT *label terminator[,mode;]*

or

DT;

Parameter	Format	Functional Range	Default
label terminator	label text	any character except NULL, LF, $^{E}_{C}$, and ; (decimal codes 0, 5, 27, and 59 respectively)	ETX (decimal code 3)
mode	clamped integer	0 or 1	1 (nonprinting)

The character immediately following DT is interpreted to be the new label terminator. You must terminate all Label (LB) commands following a DT command with the specified label terminator.

- **No Parameter** – Defaults the label erminator to ETX (not a semicolon) and the mode to nonprinting (1).
- **Label Terminator** – Specifies the label terminator as the character immediately following the DT mnemonic. (If you use a space between the mnemonic and the label terminator parameter the space becomes the label terminator.)

- **Mode** – Specifies whether the label terminator is printed.

  0 – The label terminator prints if it is a printable character and performs its function if it is a control code.

  1 – (Default) The label terminator does not print if it is a printing character and does not perform its function if it is a control code.

A DT command remains in effect until another DT command is executed, or the printer is initialized or set to default conditions.

The following command shows how to define and print using a non-printing label terminator:

DT#;LBThe label terminator WILL NOT print.#;

This command would print as:

The label terminator WILL NOT print.

This example shows how to define and use a printable label terminator:

DT#,0;LBThe label terminator WILL print.#;

This command would print as:

The label terminator WILL print.#

For another example using the DT command, see the example in the Character Plot (CP) command discussion.

Related Commands	Group
LB, Label	*The Character Group*

DV, Define Variable Text Path

Specifies the text path for subsequent labels and the direction of Line Feeds as either right, left, up, or down. Use DV to "stack" characters in a column.

DV *path[,line;]*

or

DV *[;]*

Parameter	Format	Functional Range	Default
path	clamped integer	0, 1, 2, or 3	0 (horizontal)
line	clamped integer	0 or 1	0 (normal Line Feed)

The DV command determines the *text path*, the direction that the current location moves after each character is drawn and the direction that the Carriage Return point moves when a Line Feed is included in the label string.

- **No Parameter** – Defaults the text path to horizontal (not stacked) with normal Line Feed. Equivalent to (DV0,0).
- **Path** – Specifies the location of each character with respect to the preceding character, relative to the labeling direction defined by the DI or DR commands. The text path set by DV is not affected by changes in P1 and P2.

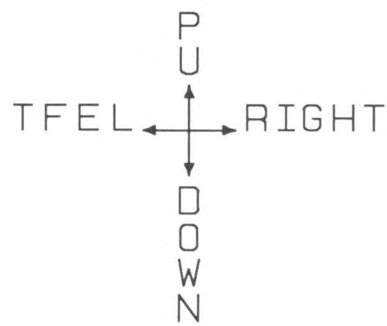
  0 – 0 degrees. (Right) Each character begins to the right of the previous character. This is a horizontal text path (unless altered by DI or DR.)

  1 – −90 degrees. (Down) Each character begins below the previous character. This is a vertical text path (unless altered by DI or DR.)

2 – –180 degrees. (Left) Each character begins to the left of the previous character. This is a horizontal text path (unless altered by DI or DR.)

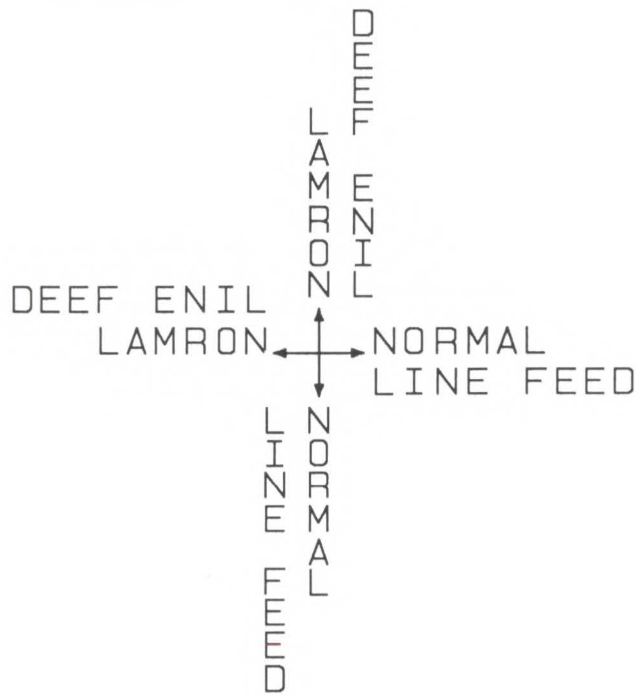
3 – –270 degrees. (Up) Each character begins above the previous character. This is a vertical text path (unless altered by DI or DR.)

The following illustration shows the four text paths.

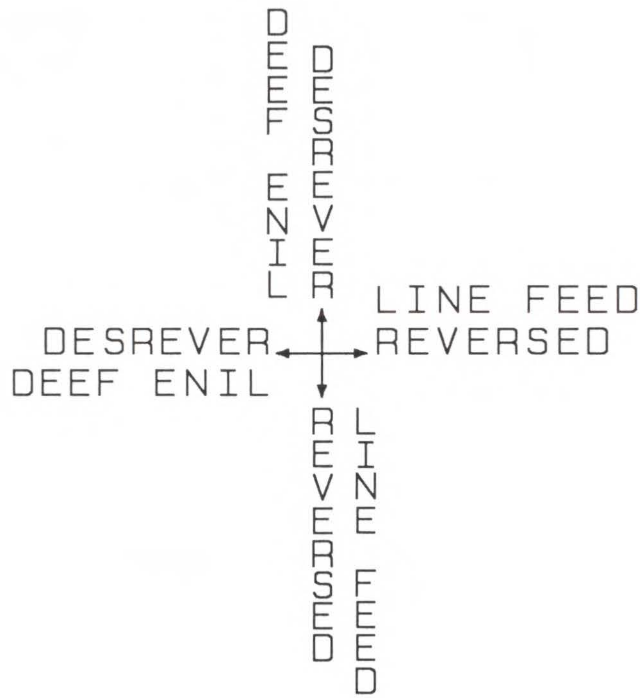


- **Line** – Specifies the location of each character with respect to the preceding character, relative to the labeling direction defined by the DI or DR commands.

  0 – −90 degrees. (Normal Line Feed) Sets the direction of Line Feeds −90 degrees with respect to the text path.



0 – +90 degrees. (Reverse Line Feed) Sets the direction of Line Feeds +90 degrees with respect to the text path.

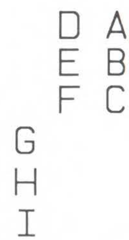


Example: Using the DV Command

The following example illustrates how Line Feeds and Carriage Returns affect vertical labels. Horizontal labels are shown for comparison.

Example: Using the DV Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA1000,3000;DV1;	Specify absolute plotting and move to (1000,3000). Define the text path so that each character begins below the previous character (vertical text path).
DT@;	Define the "@" character as the label terminator (non-printing).
LBABC *CR-LF@;*	Print ABC, followed by a Carriage Return/Line Feed (CR-LF).
LBDEF *LF@;*	Print DEF, followed by a Line Feed.
LBGHI@;	Print GHI (without CR or LF).
PA3000,3000;DV0;	Move to (3000,3000) and define the text path so that each character begins to the right of the previous one (horizontal [default] text path).
LBABC *CR-LF@;*	Print ABC, followed by CR-LF.
LBDEF *LF@;*	Print DEF, followed by Line Feed.
LBGHI@;	Print GHI (without CR or LF).
$^{E}_{C}$%ØA	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.



Related Commands	Group
DI, Absolute Direction DR, Relative Direction LO, Label Origin	*The Character Group*

ES, Extra Space

Adjusts space between characters and lines of labels without affecting character size.

ES *width[,height;]*

or

ES *[;]*

Parameter	Format	Functional Range	Default
width	clamped real	−32768 to 32767	0
height	clamped real	−32768 to 32767	0

The printer interprets the parameters as follows:

- **No Parameters** – Defaults the spaces and lines between characters to no extra space. Equivalent to (ES0,0).
- **Width** – Specifies an increase (positive number) or decrease (negative number) in the space between characters. For maximum legibility, do not specify more than one extra space or subtract more than half a space.
- **Height** – Specifies an increase (positive number) or decrease (negative number) in the space between lines. For maximum legibility, do not specify more than two extra lines or subtract more than half a line.

An ES command remains in effect until another ES command is executed, or until the printer is initialized or set to default conditions.

Example: Using the ES Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%0B	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA2500,3200; **SI.187,.269;**	Specify absolute plotting and move to (2500,3200); specify a relative character size of .187 cm wide by .269 cm high.
DT#;ES;	Define the "#" character as the label terminator and set the extra space setting to default (no extra space).
LBES; CAUSES#;	Print "ES; CAUSES".
CP;LBTHIS **SPACING.#;**	Send a CP command as a CR-LF and print "THIS SPACING."
PA2500,2500;	Move to (2500,2500).
ES-.1,-.25; **LBES-.1,-.25;** **CAUSES#;**	Decrease the inter-character spacing by .1 and the inter-line spacing by .25; print "ES-.1,-.25; CAUSES".
CP;LBTHIS **SPACING.#;**	Send CP in place of CR-LF and print "THIS SPACING."
PA2500,1800;	Move to (2500,1800).
ES.2,.25;LBES.2,.25; **CAUSES#;**	Increase the inter-character spacing by .2 and the inter-line spacing by .25 of the Space control code; print "ES.2,.25; CAUSES".
CP;LBTHIS **SPACING.#;**	Send CP in place of CR-LF and print "THIS SPACING."
$^{E}_{C}$%0A	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.

ES; CAUSES
THIS SPACING.

ES-.1, -.25; CAUSES
THIS SPACING.

ES.2, .25; CAUSES
THIS SPACING.

Related Commands	Group
CP, Character Plot LB, Label	*The Character Group*

FI, Select Primary Font

This command allows any accessible font that has been assigned a *font ID* number to be selected as the primary (standard) font. As mentioned, the font must be accessible to the printer as either a resident font, a downloaded font, or a loaded cartridge font. In order to be selected, the font must have been previously assigned a font ID number in PCL mode. Also, for scalable fonts, the FI command must be preceded by an SD command specifying the font's point size or pitch (see the *Using the FI Command* example).

FI *font_ ID[;]*

Parameter	Format	Functional Range	Default
font_ID	Integer	0 to 32767	no default

When the printer receives this command and the selected font is present, the primary font attributes are set to those of the selected font. If the selected font is proportionally spaced, the pitch attribute is not changed.

Example: Using the FI Command

The following example demonstrates assigning a font ID number from within PCL mode, entering HP-GL/2 mode, using the FI command to select that font, and printing a short line of text.

Example: Using the FI Command

␛E	Reset the printer.
␛*c15D	Specify a font ID number of 15.
␛(s1p18v0s3b52T	Select an 18-point Univers Bold font as the primary font.
␛*c6F	Assign the currently selected font as a temporary font with the current ID number (15).

Example: Using the FI Command (continued)

$^{E}_{C}$%0B	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA1500,1500;	Move to location (1500,1500).
DT#;	Define "#" as a label terminator (non-printing).
LBLaserJet Printers *CR-LF#*;	Print "LaserJet Printers" in the currently selected font, which is the default Stick font; Carriage Return/Line Feed.
SD4,18;FI15;	Use the SD command to designate an 18-point font from within HP-GL/2 mode; then select the PCL font with font ID number of 15 as the primary font.
LBLaserJet Printers#;	Print "LaserJet Printers" in the newly selected font.
$^{E}_{C}$%0A	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.

LaserJet Printers

LaserJet Printers

Related Commands	Group
AD, Alternate Font Definition	*The Character Group*
SA, Select Alternate Font	
SD, Standard Font Definition	
SS, Select Standard Font	
$^{E}_{C}$(#X, Select Primary Font by ID #	*PCL Commands*
$^{E}_{C}$)#X, Select Secondary Font by ID #	

FN, Select Secondary Font

This command allows any accessible font that has been assigned a *font ID* number to be selected as the secondary (alternate) font. The font must be accessible to the printer as either a resident font, a downloaded font, or a loaded cartridge font. In order to be selected, the font must have been previously assigned a font ID number in PCL mode. Also, the FN command must be accompanied by an AD command specifying the font's point size (see the *Using the FI Command* example).

FN *font_ID[;]*

Parameter	Format	Functional Range	Default
font_ID	Integer	0 to 32767	no default

When the printer receives this command and the selected font is present, the secondary font attributes are set to those of the selected font. If the selected font is proportionally spaced, the pitch attribute is not changed.

Example: Using the FN Command

The following example demonstrates assigning a font ID number from within PCL mode, entering HP-GL/2 mode, using the FN command to select that font, and printing a short line of text.

Example: Using the FN Command

ᴱ꜀E	Reset the printer.
ᴱ꜀*c28D	Specify a font ID number of 28.
ᴱ꜀(s1p18v0s3b52T	Select an 18-point Univers Bold font as the primary font.

Example: Using the FN Command (continued)

EC*c6F	Assign the currently selected font as a temporary font with the current ID number (28).
EC%0B	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA1500,1500;	Move to location (1500,1500).
DT#;	Define "#" as a label terminator (non-printing).
LBLaserJet Printers *CR-LF#*;	Print "LaserJet Printers" in the currently selected font, which is the default Stick font; Carriage Return/Line Feed.
AD4,18;FN28;	Use the AD command to designate an 18-point font from within HP-GL/2 mode; then select the PCL font with font ID number of 28 as the secondary font.
LBLaserJet Printers#;	Print "LaserJet Printers" in the newly selected font.
EC%0A	Enter the PCL mode.
ECE	Send a reset to end the job and eject the page.

LaserJet Printers

LaserJet Printers

Related Commands	Group
AD, Alternate Font Definition	*The Character Group*
SA, Select Alternate Font	
SD, Standard Font Definition	
SS, Select Standard Font	
$^{E}_{C}$(#X, Select Primary Font by ID #	*PCL Commands*
$^{E}_{C}$)#X, Select Secondary Font by ID #	

LB, Label

Prints text using the currently defined font. Use LB to annotate drawings or create text-only charts.

LB *text ... text label terminator*

Parameter	Format	Functional Range	Default
text ... text	character	any character(s)	no default

The LB command includes an automatic *pen down* function. When the command is completed, the original pen up/down status is restored.

- **text ... text** – Includes up to 1024 ASCII characters. Characters are drawn using the currently selected font. (Refer to AD, SA, SD, and SS commands for details on specifying and selecting fonts.)

  You can include nonprinting characters such as the Carriage Return (CR, decimal code 13) and Line Feed (LF, decimal code 10). These characters invoke the specified function, but are not drawn. Refer to Appendix A for a list of ASCII characters.

The label begins at the current pen location, (unless altered by LO). After each character is drawn, the pen location is updated to be the next character origin (refer to *Working With the Character Cell* earlier in the chapter.)

- **Label Terminator** – Terminates the LB command. You must use the special label terminator (refer to the DT command) to tell the printer to exit from the label mode. If you don't use the label terminator, everything following the LB mnemonic will be printed in the label, including other commands. The default label terminator is the nonprinting end-of-text character ETX (decimal code 3). You can define a different terminator using the DT command.

Example: Printing Text with the LB Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%0B	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA2500,2500;	Move to absolute location (2500,2500).
DT*;	Specify the asterisk (*) as the label terminator.
SD1,21,2,1,4,25,5,0, 6,3,7,52;SS;	Designate the 25-point Univers Bold font as the standard font and select it.
LBThis is a Label.*;	Prints "This is a Label." in the currently selected font.
$^{E}_{C}$%0A	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.

This is a Label.

Related Commands	Group
AD, Alternate Font Definition	*The Character Group*
CP, Character Plot	
DI, Absolute Direction	
DR, Relative Direction	
DT, Define Label Terminator	
DV, Define Variable Text Path	
FI, Select Primary Font	
FN, Select Secondary Font	
LO, Label Origin	
SA, Select Alternate Font	
SB, Scalable or Bitmap Fonts	
SD, Standard Font Definition	
SI, Absolute Character Size	
SL, Character Slant	
SR, Relative Character Size	
SS, Select Standard Font	

LO, Label Origin

Positions labels relative to the current pen location. Use the LO command to center, left justify, or right justify labels. The label can be drawn above or below the current pen location and can also be offset by an amount equal to .25 times the point size (or 16 grid units [0.33 times the point size] for the Stick font).

LO *position[;]*

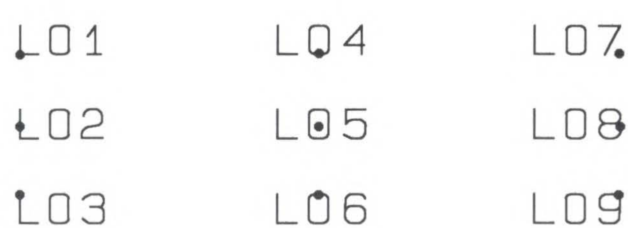
or

LO *[;]*

Parameter	Format	Functional Range	Default
position	clamped integer	1 to 9 and 11 to 19	1

The printer interprets the parameters as follows:

- **No Parameters** – Defaults the label origin. Equivalent to (LO1).
- **Position** – The position numbers are graphically illustrated below. Each dot represents the current pen location.



The label positions LO 11 through LO 19 differ from LO 1 through LO 9 only in that the labels are offset from the current pen location.

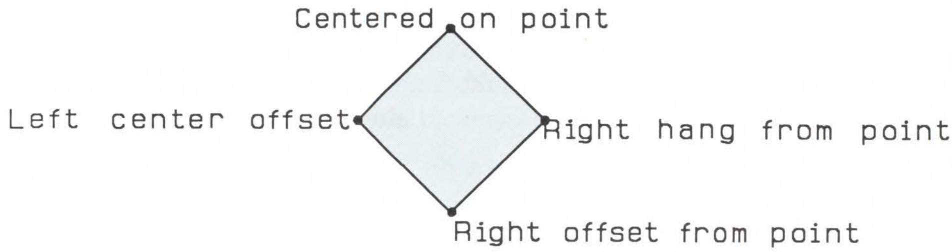
Each time an LO command is sent, the Carriage Return point is updated to the location the pen was in when the LO command was received. The current pen location (but not the Carriage Return point) is updated after each character is drawn and the pen automatically moves to the next character origin. If you want to return a pen to its previous location prior to the next label command, you can send a Carriage Return after the label text but before the label terminator.

When you embed Carriage Return characters in a label, each portion of the label is positioned according to the label origin, just as if they were written as separate label commands.

An LO command remains in effect until another LO command is executed, or the printer is initialized or set to default conditions.

Example: Using the LO Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%0B	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;SC-4000,4000, -5000,5000;	Select pen number 1; specify scaling by assigning (-4000,-5000) to P1 and (4000,5000) to P2.
SI.17,.26;PA0,500;	Set the absolute character size to .17 cm wide by .26 cm high; move to (0,500).
PD-500,0,0,-500, 500,0,0,500;	Set the pen down and draw lines from (0,500) to (-500,0), to (0,-500), to (500,0), and then to (0,500).
DT#;	Define label terminator as "#" character.
CI10;LO4; LBCentered on point#;	Draw a small circle (radius – 10 plu) to represent the label origin point, specify a label origin of 4, and print "Centered on point."
PU-500,0;CI10; LO18;	Lift the pen and move to (-500,0), draw another small circle, and specify a label origin of 18.
LBLeft center offset#;	Print "Left center offset."
PU0,-500;CI10; LO13;	Lift the pen, draw another small circle, and specify label origin number 13.
LBRight offset from point#;	Print "Right offset from point."
PA500,0;CI10;LO3;	Move to (500,0), draw another small circle (dot), and specify label origin number 3.
LBRight hang from point#;	Print the last label.
$^{E}_{C}$%0A	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.



Related Commands	Group
DV, Define Variable Text Path LB, Label	*The Character Group*

SA, Select Alternate Font

Selects the alternate font (already designated by the AD command) for subsequent labeling. Use the SA command to shift from the currently selected standard font to the designated alternate font.

SA *[;]*

The SA command tells the printer to draw subsequent labeling commands using characters from the alternate character set previously designated by the AD command. The SA command is equivalent to using the Shift Out control character (SO, decimal 14) within a label string.

The default designated alternate font uses character set 277 (Roman-8). The alternate font remains in effect until an SS command is executed, a Shift In control character (SI, decimal 15) is encountered, or the printer is initialized or set to default conditions.

Related Commands	Group
AD, Alternate Font Definition FI, Select Primary Font FN, Select Secondary Font LB, Label SD, Standard Font Definition SS, Select Standard Font	*The Character Group*

SB, Scalable or Bitmap Fonts

This command specifies which types of fonts will be used for labeling commands. It allows you to restrict font selection to only scalable fonts and the Stick font, disregarding bitmap fonts.

SB *[n;]*

or

SB *[;]*

Parameter	Format	Functional Range	Default
n	Clamped Integer	0 or 1	0

This command is defaulted by the Default Values (DF) command. The SB command takes effect immediately, changing both the standard (primary) and alternate (secondary) fonts to be *scalable only* or *bitmap allowed*, as requested.

- **No Parameter** – Defaults to scalable fonts. Equivalent to SB0.
- **n** – Determines the type of font according to the following parameter values:

  0 – Scalable fonts only.

  1 – Bitmap fonts allowed.

Note

When (SB1;) is active, *all* fonts obey the same restrictions as bitmappped fonts regarding Character Fill, Orientation, Size, and Slant (see table on next page).

Scalable fonts respond more accurately to some HP-GL/2 commands. The choice of scalable or bitmap fonts can affect the performance of the following HP-GL/2 commands:

Affected Commands	Limitation
CF	Bitmapped characters cannot be edged.
DI,DR	Bitmapped characters can be printed only with orthogonal orientations (0°, 90°, 180°, or 270°).
SI,SR	Sizes of bitmapped fonts are approximate only.
SL	The Slant command is ignored for bitmapped fonts.

Note

The FI and FN commands implicitly change the value of SB. For example, if SB = 0 and FI selects a bitmap font, SB is set to 1.

SD, Standard Font Definition

Defines the standard font and its attributes: symbol set, font spacing, pitch, height, posture, stroke weight, and typeface.

SD *kind,value ... [,kind,value;]*

or

SD *[;]*

Parameter	Format	Functional Range	Default
kind	clamped integer	1 to 7	no default
value	clamped real	kind dependent*	kind dependent*

* Refer to the table following the parameter descriptions.

- **No Parameters** – Defaults the standard font attributes.
- **Kind** – Specifies the attribute for which you are setting a value.

Kind	Attribute	Default Value	Description
1	Symbol set	277	Roman-8
2	Font spacing	0	fixed spacing
3	Pitch	9	characters per inch
4	Height	11.5	font point size
5	Posture	upright	upright
6	Stroke Weight	0	medium
7	Typeface	48	Stick (fixed vector)

- **Value** – Defines the characteristics of the attribute specified by the *kind* parameter.

Note

When selecting fonts, the different attributes (symbol set, spacing, pitch, etc.) are prioritized as shown in the table above, with symbol set being the highest priority and typeface being the lowest. The font selection priority is the same for HP-GL/2 as for PCL font selection. For more information about the priority of font attributes, see the *Font Selection by Attribute* discussion in Chapter 8.

The following tables list the *kind* parameters with their associated values (note that these tables are also valid for the AD [Alternate Font Definition] command):

Kind 1: Symbol Set

The symbol set attribute defines the set of characters to be used in the alternate font.

Kind 1: Symbol Set Values

Symbol Set Value	Description	ISO Number
1	Math-7	–
2	Line Draw-7	–
3	HP Large Characters	–
4	Norwegian v1	60
5	Roman Extensions	–
6	French v1	25
7	HP German	–
8	Hebrew-7	–
9	Italian	15
11	JIS ASCII	14
12	Line Draw-7	–
13	Math-7	–
14	ECMA-94 Latin 1 (8-bit version)	8859/1
15	OCR-A	–
16	APL (typewriter paired)	–
18	Cyrillic ASCII	–
19	Swedish for names	11
20	Thai-8	–
21	ASCII	6
22	Arabic (MacKay's Version)	–
25	3 of 9 Barcode	–
26	Not used	–
36	Danish/Norwegian v2	61
37	United Kingdom	4

Kind 1: Symbol Set Values (continued)

Symbol Set Value	Description	ISO Number
38	French v2	69
39	German	21
43	Katakana	13
44	HP Block Characters	–
45	Tech-7	–
47	OCR-B	–
48	APL (bit paired)	–
50	Cyrillic	–
51	HP Spanish	–
53	Legal	–
57	Industrial 2 of 5 Barcode	–
75	Chinese	57
76	Tax Line Draw	–
78	ECMA-94 Latin 2	8859/2
79	OCR-M	–
83	Spanish	17
85	International Reference Version	2
89	Matrix 2 of 5 Barcode	–
114	PC Cyrillic	–
115	Swedish	10
147	Portuguese	16
153	Interleaved 2 of 5 Barcode	–
173	PS Math	–
174	ECMA-128 Latin 5	8859/9
179	Portuguese	84
181	HPL Language Set	–
185	CODABAR Barcode	–
202	Microsoft Publishing	–
205	Ventura Math	–
211	Spanish	85
217	MSI/Plessey Barcode	–
234	DeskTop	–
243	HP European Spanish	–
245	OEM-1 (DEC Set)	–

Kind 1: Symbol Set Values (continued)

Symbol Set Value	Description	ISO Number
249	Code 11 Barcode	–
263	Greek-8	–
264	Hebrew-8	–
266	Document	–
267	Kana-8	–
268	Line Draw 8	–
269	Math-8	–
275	HP Latin Spanish	–
276	Turkish-8	–
277	Roman-8 (Default)	–
278	Arabic-8	–
281	UPC/EAN Barcode	–
299	Korean-8	–
300	Ventura ITC Zapf Dingbats	–
309	Windows	–
330	PS Text	–
332	PS ITC Zapf Dingbats	–
334	ECMA-113/88 Latin/Cyrillic	8859/5.2
341	PC-8	–
364	ITC Zapf Dingbats Series 100	–
369	ITC Zapf Dingbats Series 200	–
373	PC-8 D/N	–
405	PC-850	–
426	Ventura International	–
428	ITC Zapf Dingbats Series 300	–
458	Ventura U.S.	–
501	Pi Font	–
505	USPS Zip	–
531	HP-GL Download	–
563	HP-GL Drafting	–
595	HP-GL Special Symbols	–

Kind 2: Font Spacing

The font spacing attribute defines whether the spacing is fixed (all characters occupying an equal horizontal space) or proportional (each character occupying a space proportional to its size). Refer to *Using Fonts* in the beginning of this chapter.

Kind 2: Font Spacing Values

Font Spacing Value	Description
0	fixed spacing (default)
1	proportional spacing

Kind 3: Pitch

The pitch attribute is a horizontal measurement defining the number of characters per inch for fixed-spaced fonts.

Note

When selecting proportional fonts, you should not include pitch in your AD command.

Kind 3: Pitch Values

Pitch Values	Description
0 to 32 767.9999	characters per inch (default: 9)

Fixed-spaced fonts depend on pitch to determine character size. Proportional fonts ignore pitch. Note that with the AD command you cannot create tall, skinny characters or short, wide characters; the character aspect ratio is preserved unless an SI or SR command overrides it.

Kind 4: Height

For proportional fonts, the height attribute defines the font point size, i.e., the height of the character cell. (For fixed-spaced fonts, the point size is calculated using the font pitch.) There are approximately 72 points in an inch. Note that with the AD command, you cannot create tall, skinny characters or short, wide characters; the character aspect ratio is preserved.

Kind 4: Height Values

Height Values	Description
0 to 32 767.9999	font point size (default: 11.5)

Kind 5: Posture

Posture defines the character's vertical posture. The default posture is upright.

Kind 5: Posture Values

Posture Values	Description
0	Upright (Default)
1	Italic
2	Alternate Italic

Kind 6: Stroke Weight

The stroke weight attribute defines the line thickness used in the font's design. The default stroke weight is medium. When relative sizing is in effect, changes in P1 and P2 cause the relative stroke weight to change in relation to the change in P1/P2. In other words, if the aspect ratio of the P1/P2 rectangle is maintained as P1 and P2 are moved, a medium stroke weight font will still look "medium" after it is enlarged or reduced.

Kind 6: Stroke Weight Values

Stroke Weight Value	Description
-7	Ultra Thin
-6	Extra Thin
-5	Thin
-4	Extra Light
-3	Light
-2	Demi Light
-1	Semi Light
0	Medium, or Text
1	Semi Bold
2	Demi Bold
3	Bold
4	Extra Bold
5	Black
6	Extra Black
7	Ultra Black
9999	* (for Stick font only)

* When the Stick font (typeface 48) is selected, the value 9999 causes it to be rendered using the current pen width.

Kind 7: Typeface

The typeface attribute selects the font's design style, which gives the font its distinctiveness. Typefaces can only be printed if the printer has access to them; that is, if they are resident fonts, are soft fonts that are downloaded to the printer, or if they reside in a font cartridge that is plugged in. The LaserJet III printer has three resident scalable typefaces: Univers (52), CG Times (5), and the Stick font (48). (For more information about the printer's resident fonts, see the *Internal Fonts* discussion in Chapter 8.)

Note

These typeface names may be registered trademarks of a third party. Use of these fonts may be conditional upon a license grant from the owners of the fonts. Hewlett-Packard makes no representation as to the quality or performance of the fonts, and any reference to the fonts does not grant any license or right to use the fonts.

Kind 7: Typeface Values*

Value (One-Byte)	Typeface**	Value (One-Byte)	Typeface**
0	Line Printer	1	Pica
2	Elite	3	Courier
4	Helvetica	5	Times Roman
6	Letter Gothic	7	Script
8	Prestige	9	Caslon
10	Orator	11	Presentation
12	Helvetica Condensed***	13	Serifa
14	Futura	15	Palatino
16	ITC Souvenir	17	Optima
18	ITC Garamond	19	Cooper Black***
20	Coronet	21	Broadway
22	Bauer Bodoni Black Condensed***	23	Century Schoolbook
24	University Roman	25	Helvetica Outline***
26	Futura Condensed***	27	ITC Korinna
28	Naskh	29	Cloister Black
30	ITC Galliard	31	ITC Avant Garde Gothic
32	Brush	33	Blippo
34	Hobo	35	Windsor
36	Helvetica Compressed***	37	Helvetica Extra Compressed***
38	Peignot	39	Baskerville
40	ITC Garamond Condensed***	41	Trade Gothic
42	Goudy Old Style	43	ITC Zapf Chancery
44	Clarendon	45	ITC Zapf Dingbats

* Additional typefaces will be available in the future.

** These typeface names may be registered trademarks of a third party. Use of these fonts may be conditional upon a license grant from the owners of the fonts. Hewlett-Packard makes no representation as to the quality or performance of the fonts, and any reference to the fonts does not grant any license or right to use the fonts.

*** These typeface codes are soon to be reassigned, since they specify treatments of a typeface that may now be expressed in the style value. Not recommended for future use.

Continued on next page.

Table 21-2. Typeface Values* Continued

Value (One-Byte)	Typeface**	Value (One-Byte)	Typeface**
46	Cooper	47	ITC Bookman
48	Stick	49	HP-GL Drafting
50	HP-GL Spline	51	Gill Sans
52	Univers	53	Bodoni
54	Rockwell	55	Melior
56	ITC Tiffany	57	ITC Clearface
58	Amelia	59	Park Avenue
60	Handel Gothic	61	Dom Casual
62	ITC Benguiat	63	ITC Cheltenham
64	Century Expanded	65	Franklin Gothic
66	Franklin Gothic Expressed***	67	Franklin Gothic Extra Condensed***
68	Plantin	69	Trump Mediaeval
70	Futura Black		
72	Antique Olive	73	Uncial
74	ITC Bauhaus	75	Century Oldstyle
76	ITC Eras	77	Friz Ouadrata (ITC)
78	ITC Lubalin Graph	79	Eurostile
80	Mincho	81	ITC Serif Gothic
82	Signet Roundhand	83	Souvenir Gothic
84	Stymie	87	Bernhard Modern
89	Excelsior	90	Gando Ronda Script

* Additional typefaces will be available in the future.

** These typeface names may be registered trademarks of a third party. Use of these fonts may be conditional upon a license grant from the owners of the fonts. Hewlett-Packard makes no representation as to the quality or performance of the fonts, and any reference to the fonts does not grant any license or right to use the fonts.

*** These typeface codes are soon to be reassigned, since they specify treatments of a typeface that may now be expressed in the style value. Not recommended for future use.

Continued on next page.

Table 10-2. Typeface Values* Continued

Value (One-Byte)	Typeface**	Value (One-Byte)	Typeface
91	Ondine	92	P.T. Barnum
93	Kaufman	94	ITC Bolt Bold
96	Helvetica Monospaced***	97	Revue
101	Garamond (Stempel)	102	Garth Graphic
103	ITC Ronda	104	OCR-A
		106	Englische Schreibschrift
107	Flash	108	Gothic Outline (URW)
109	Stencil (ATF)	110	OCR-B
111	Akzidenz-Grotesk	112	TD Logos
113	Shannon	114	ITC Century
152	Maru Gosikku	153	Gossikku
154	Socho	155	Kyokasho
156	Kaisho	157	Traditional Arabic Script
158	Arabic News		
160	Devanagari (Hindi)	161	Krishna (Gujarati)
162	Ranjit (Gurmukhi)	163	Raj Raja (Tamil)
164	Gyosho	165	Hebrew
166	Nork	167	Ousbouh
168	Koufi		
261	Greek Times		

* Additional typefaces will be available in the future.

** These typeface names may be registered trademarks of a third party. Use of these fonts may be conditional upon a license grant from the owners of the fonts. Hewlett-Packard makes no representation as to the quality or performance of the fonts, and any reference to the fonts does not grant any license or right to use the fonts.

*** These typeface codes are soon to be reassigned, since they specify treatments of a typeface that may now be expressed in the style value. Not recommended for future use.

The following example shows the command used to designate a 25-point *Univers Bold* font in the ASCII symbol set (use the Select Standard Font (SS) command to select this font after it is designated):

$$\text{SD}\underbrace{1,21}_{\text{Symbol Set}},\underbrace{2,1}_{\text{Font Spacing}},\underbrace{4,25}_{\text{Height}},\underbrace{5,0}_{\text{Posture}},\underbrace{6,3}_{\text{Stroke Weight}},\underbrace{7,52}_{\text{Typeface}};$$

Note that the *pitch* parameter is missing in the above command because the designated font is proportionally spaced.

Related Commands	Group
AD, Alternate Font Definition FI, Select Primary Font FN, Select Secondary Font LB, Label SA, Select Alternate Font SI, Absolute Character Size SR, Relative Character Size SS, Select Standard Font	*The Character Group*

SI, Absolute Character Size

Specifies the size of labeling characters in centimeters. Use SI to establish character size independent of P1 and P2.

SI *width, height[;]*

or

SI *[;]*

Parameter	Format	Functional Range	Default
width	clamped real	−32768 to 32767	dependent*
height	clamped real	−32768 to 32767	dependent*

* Dependent on the current pitch and font height set by the AD or SD commands.

While SI is in effect, with or without specifying parameter values, the size of characters in the currently selected font are not affected by changes in P1 and P2.

- **No Parameters** – Character size is as specified by the SD (Standard Font Definition) and AD (Alternate Font Definition) commands.
- **Width** – Specifies the width of the nominal character in centimeters. A negative width parameter mirrors labels in the right-to-left direction.

Note

Changing character size also changes the width of line used to draw Stick font characters.

- **Height** – Specifies the cap height in centimeters. A negative height parameter mirrors labels in the top-to-bottom direction.

Note that in most languages the width of a letter is typically less than the height. If you set your characters to have a different 'aspect ratio', they may look odd to your readers.

An SI command remains in effect until another SI command is executed, an SR command is executed, or the printer is initialized or set to default conditions.

Note

If the (SB1;) command is in effect, an SI command may not accurately be executed. Labels will be rendered using the bitmap font that most closely approximates the character height or width specified by SI (character size is determined by height for proportional fonts and by width for fixed-spaced fonts).

Also note that, when (SB1;) is in effect, characters cannot be mirrored with negative SI parameters.

Example: Using the SI Command

The following example demonstrates the SI command using both the default Stick typeface and the Univers typeface. The samples on the left were printed using the Stick font, first using the default (11.5-point) and then specifying an absolute character size of 1 cm wide by 1.5 cm high. On the right, a Univers font was used, first at 12-point and scaled to 1 cm by 1.5 cm using the SI command.

Example: Using the SI Command

$^E{}_C$E	Reset the printer.
$^E{}_C$%ØB	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
PA700,3000;	Enter absolute plotting mode and move to (700,3000).
DT#;	Define the label terminator as the "#" character.
LBPrint#;	Print the word "Print" in the default font.
PA700,2000;SI1,1.5; LBPrint#;	Move to (700,2000), specify an absolute character size of 1cm wide by 1.5 cm high, and print the word "Print."
SI;	Send SI with no parameters to return to the default size.
SD1,21,2,1,4,12, 5,0,6,0,7,52;SS;	Designate a 12-point Univers font and select it.
PA4000,3000; LBPrint#;	Move to (4000,3000) and print "Print" in 12-point Univers.
PA4000,2000; SI1,1.5;LBPrint#;	Move the pen to (4000,2000) and specify a character size of 1 cm by 1.5 cm, then print "Print."
$^E{}_C$%ØA	Enter the PCL mode.
$^E{}_C$E	Send a reset to end the job and eject the page.

Print Print

Print Print

The following are examples of negative parameters producing mirror images of labels. A negative width parameter mirrors labels in the right-to-left direction.

SI-.6,.9;LBPrint#;

A negative height parameter mirrors labels in the top-to-bottom direction.

SI.6,-.9;LBPrint#;

Negative width and height parameters together mirror labels in both directions, causing the label to appear to be rotated 180 degrees.

SI-.6,-.9;LBPrint#;

Related Commands	Group
AD, Alternate Font Definition DI, Absolute Direction DR, Relative Direction SB, Scalable or Bitmap Fonts SD, Standard Font Definition SR, Relative Character Size	*The Character Group*

SL, Character Slant

Specifies the slant at which labels are drawn. Use SL to create slanted text for emphasis, or to reestablish upright labeling after an SL command with parameters has been in effect. (Note that the SL command has no effect when an (SB1;) command is in effect.)

SL *tangent of angle[;]*

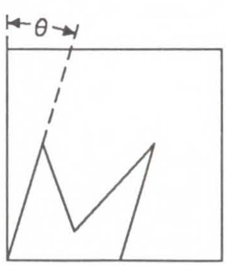
or

SL *[;]*

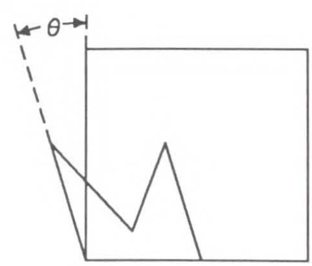
Parameter	Format	Functional Range	Default
tangent of angle	clamped real	−32768 to 32767	0

The printer interprets the parameters as follows:

- **No Parameter** – Defaults the slant to zero (no slant). Equivalent to (SL0).
- **Tangent of Angle** – Interpreted as an angle θ from vertical. The base of the character always stays on the horizontal as shown in the following illustration.



Positive Slant



Negative Slant

The SL command only affects each character relative to an imaginary line beside the label. The direction or placement of the label on the drawing does not affect the SL command; neither do the settings of P1 and P2. The DI and DR commands, however, do affect the slant direction since the base of a character always stays on the baseline of the label.

You can specify the actual tangent value, or you can use the TAN function available in most computer languages. The following table lists tangent values for selected angles.

Table 21-3.
Tangent Values
for Common Angles

θ	Tangent
0	0
-10	-0.18
-20	-0.36
-30	-0.58
-40	-0.84
-45	-1.00
0	0
10	0.18
20	0.36
30	0.58
40	0.84
45	1.00

An SL command remains in effect until another SL command is executed, or the printer is initialized or set to default conditions.

Example: Using the SL Command

The following example illustrates the Slant command using a tangent value listed in the previous table.

Note

If you are unfamiliar with computing tangents using your programming language, many languages require that tangents be calculated in radians. Please consult your programming language documentation if you are not familiar with your language's tangent function.

Example: Using the SL Command

ECE	Reset the printer.
EC%ØB	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
SD1,21,2,1,4,25, 5,0,6,0,7,5;	Designate the 25-point CG Times font as the standard (primary) font.
SI.7,1;PA1000,1000;	Set the absolute character size to .7 cm wide by 1 cm high; establish absolute plotting and move to (1000,1000).
DT#,1;	Specify a label terminator (#).

Example: Using the SL Command (continued)

SL.36;LBSlant#;	Set the slant angle for 20° from vertical (forward slant), and print "Slant."

Example: Using the SL Command (continued)

PA1000,300; **SL-.36;LBSlant#;**	Move to (1000,300), change the slant angle to -20° from upright and print "Slant."
EC%0A	Enter the PCL mode.
ECE	Send a reset to end the job and eject the page.

Related Commands	Group
SB, Scalable or Bitmap Fonts DI, Absolute Direction DR, Relative Direction LB, Label	*The Character Group*

SR, Relative Character Size

Specifies the size of characters as a percentage of the distance between P1 and P2. Use SR to establish relative character size so that if the P1/P2 distance changes, the character size adjusts to occupy the same relative amount of space.

SR *width height[;]*

or

SR *[;]*

Parameter	Format	Functional Range	Default
width	clamped real	−32768 to 32767	0.75% of P2X−P1X
height	clamped real	−32768 to 32767	1.5% of P2Y−P1Y

While the SR command is in effect (with or without parameters), changes in P1 and P2 affect the size of characters in the currently selected font.

- **No Parameters** – Defaults the relative character width to 0.75% of the distance (P2X − P1X) and the height to 1.5% of the distance (P2Y − P1Y).
- **Width** – Sets the character width to the specified percentage of the distance between the X-coordinates of P1 and P2. A negative width parameter mirrors labels in the right-to-left direction.

Note

Changing character size also changes the apparent stroke weight of labels; the printer adjusts characters relative to changes in P1/P2. As long as the aspect ratio remains the same with changes in P1/P2, characters will have the same appearance relative to the new P1/P2 rectangle.)

- **Height** – Sets the character height to the specified percentage of the distance between the Y-coordinates of P1 and P2. A negative height parameter mirrors labels in the top-to-bottom direction.

The character size you specify with SR is a percentage of (P2X – P1X) and (P2Y – P1Y). The printer calculates the actual character width and height from the specified parameters as follows:

$$\text{actual width} = (\text{width parameter}/100) \times (P2_X - P1_X)$$
$$\text{actual height} = (\text{height parameter}/100) \times (P2_Y - P1_Y)$$

For example, suppose P1 and P2 are located at (–6956,–4388) and (6956,4388), respectively. If you establish relative sizing and specify a width of 2 and a height of 3.5, the printer determines the actual character size as follows:

$$\text{width} = (2/100) \times (\,6956 - (-6956)\,) = 278.24 \text{ plu or } 0.695 \text{ cm}$$
$$\text{height} = (3.5/100) \times (4388 - (\,-4388)\,) = 307.16 \text{ plu or } 0.768 \text{ cm}$$

If you changed P1 and P2 settings to (100,100) and (5000,5000), but didn't change the SR parameters, the character size would change as follows:

$$\text{width} = (2/100) \times (5000 - 100) = 98 \text{ plu or } 0.245 \text{ cm}$$

$$\text{height} = (3.5/100) \times (5000 - 100) = 171.5 \text{ plu or } 0.429 \text{ cm}$$

Note that in most languages the width of a letter is typically less than the height. If you set your characters to have a different "aspect ratio", they may look odd to your readers.

Note

Either negative SR parameters or switching the relative position of P1 and P2 will produce mirror images of labels. When P1 is in the lower left and P2 is in the upper right, the SR command gives the same mirroring results as the SI command. However, if you move P1 to the right of P2, characters are mirrored right-to-left; when you move P1 above P2, characters are mirrored top-to-bottom. When both of these situations occur (using negative parameters in the SR command with an unusual P1/P2 position) double mirroring may result in either direction, in which case the two inversions cancel, and lettering appears normal.

An SR command remains in effect until another SR command is executed, an SI command is executed, or the printer is initialized or set to default conditions.

Example: Using the SR Command

The following example first shows a label with a character size relative to P1 and P2 (SR). Next, the locations of P1 and P2 are changed; then, the character size percentages are specified. Notice that the new character size has equal parameters of 2.5; because the P1/P2 area is square, the resulting characters are square.

Example: Using the SR Command

^E_CE	Reset the printer.
^E_C%ØB	Enter HP-GL/2 mode.
IN;	Initialize the HP-GL/2 mode.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used in order to enable printing.
IP-6956,-4388, 6956,4388;	Move P1 to (-6956,-4388) and P2 to (6956,4388).
DT@;	Specify "@" as the label terminator.
SR;PA0,2700; LBRELATIVE LABEL SIZE@;	Default the character size as a percentage of the P1/P2 rectangle, move the pen to (0,2700), and print "RELATIVE LABEL SIZE."
IP0,0,5500,5500; PA0,2000;	Move P1 to (0,0) and P2 to (5500,5500), then move the pen to (0,2000).
LBNEW P1 AND P2 CHANGE LABEL SIZE@;	Print "NEW P1 AND P2 CHANGE LABEL SIZE."
PA0,1000;SR2.5,2.5;	Move to (0,1000) and set the character size to 2.5% by 2.5% of the P1/P2 rectangle.
LBNEW SR INSTRUCTION@;CP;	Print "NEW SR INSTRUCTION" and send CP for Carriage Return/Line Feed.

Example: Using the SR Command (continued)

LBCHANGES LABEL SIZE@;	Print "CHANGES LABEL SIZE."
$^{E}_{C}$%ØA	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.

RELATIVE LABEL SIZE

NEW P1 AND P2 CHANGE LABEL SIZE

NEW SR INSTRUCTION
CHANGES LABEL SIZE

Related Commands	Group
SB, Scalable or Bitmap Fonts DI, Absolute Direction DR, Relative Direction IP, Input P1 and P2 IR, Input Relative P1 and P2 SI, Absolute Character Size	*The Character Group*

SS, Select Standard Font

Selects the standard font (already designated by the Standard Font Definition (SD) command) for subsequent labeling. Use the SS command to shift from the currently selected alternate font to the designated standard font.

SS *[;]*

The SS command tells the printer to print subsequent labeling commands using characters from the standard character set designated by the SD command. The SS command is equivalent to using the Shift In control character (SI, ASCII decimal code 15) within a label string.

The default designated standard font is the Stick font and uses symbol set 277 (Roman-8). This font is in effect when the printer is initialized or set to default conditions. The SS command remains in effect until an SA command is executed.

Related Commands	Group
AD, Alternate Font Definition LB, Label SA, Select Alternate Character Set SD, Standard Font Definition	*The Character Group*

TD, Transparent Data

Specifies whether control characters perform their associated function or print as characters when labeling. Use the TD command to print characters that function only as control characters in normal mode.

TD *mode[;]*

or

TD *[;]*

Parameter	Format	Functional Range	Default
mode	clamped integer	0 or 1	0 (normal)

The printer interprets the parameters as follows:

- **No Parameters** – Defaults the labeling mode to normal. Equivalent to (TD0).
- **Mode** – Selects the normal or transparent data mode for labeling.

  0 – Normal. Control codes with an associated functionality perform their function and do not print. Refer to the symbol set tables in Appendix A.

  1 – Transparent. All characters print and perform no other function (except the currently defined label terminator, which terminates the label). The printer prints a space for nonprinting or undefined characters.

Transparent data mode must be enabled to access printable characters whose character code has an associated functionality in normal mode. For example, the left arrow in the PC-8 character set has a character code of 27. In normal mode, a character code of 27 is interpreted as an escape character (^{E}C); in transparent data mode, a character code of 27 causes the printer to print a left arrow.

Related Commands	Group
AD, Alternate Font Definition	*The Character Group*
DT, Define Label Terminator	
LB, Label	
SA, Select Alternate Font	
SD, Standard Font Definition	
SS, Select Standard Font	

22

Programming Hints

Introduction

This chapter provides information for use during the development of PCL software.

PCL Command Parsing

A job stream may contain commands that are device specific. If these commands are not supported by the PCL device, they are ignored. For example, a job separation command will have no effect on the LaserJet, LaserJet Plus, LaserJet series II and LaserJet III printers; however, the LaserJet 500 Plus, and LaserJet 2000 printers will perform job separation.

Job Control

Printer Reset

A printer reset ($^{E}_{C}$E) should be included as the first and last command of every job. A printer reset should not be used within a job.

Page Control

Paper Source

The primary use for the paper source command is to allow you access to "locked out" (secured) paper trays.

Page Size

Specifies the exact size of the page (media) to be used.

Text Area/Margins

Avoid setting the top margin or text length to values outside of the printable area. This may cause data loss.

Top margin and text length commands use the current line spacing (i.e., the last VMI or lpi commands).

Specifying the text length establishes the bottom margin.

When using both the top margin and text length commands, the top margin command should be sent before the text length command.

To address the entire logical page set the top margin to 0, set perforation skip mode OFF, and position the cursor to the desired location.

The user default VMI is selectable from the control panel printing menu, using the FORM menu item (see the LaserJet III Printer User's Manual). If the Page Length command (**$^{E}{}_{C}$&l#P**) follows a VMI change (produced by a control panel selection or a PCL command), the length of a page will be recalculated; therefore, the printer may request a different page size.

HMI

When a font is selected, HMI is automatically set to correspond to the pitch of the selected font. Therefore, when using a non-standard HMI value, the value must be re-specified following each font selection.

Cursor Positioning

Horizontal (decipoint, dot and column) positioning ignores margins and can therefore be used to move the cursor anywhere along the present line.

When performing cursor positioning with decipoints, dots, or rows and columns, do not use margins. Margins are intended for print and space (i.e., CR, LF, FF) applications.

Vertical (decipoint, dot and row) positioning allows the cursor to be moved into the perforation region.

The top margin is the reference point for absolute vertical positioning.

The left edge of the logical page is the reference point for absolute horizontal positioning.

Fonts

Character spacing information for proportionally-spaced fonts can be obtained in several ways. The preferred method is using Hewlett-Packard's AutoFont Support. AutoFont Support is a standard method for identifying font information. It provides basic font information including spacing information in AutoFont format, in a file with a TFM (tagged font metric) extension. AutoFont support files can be created for any softfont using Hewlett-Packard's **Type Director 2.0**. AutoFont support files for Hewlett-Packard's newer font cartridge products are furnished TFM files on a disk.

Character spacing information for proportionally spaced fonts is available from Hewlett-Packard. Spacing information can be obtained from Hewlett-Packard's Type Director 2.0 typeface and font management program

Character spacing information can also be obtained from listings generated through the operation of the spacing feature available from Hewlett-Packard's Font Load Utility.

Since line spacing is independent of font height, line spacing may require adjustment following font selection to insure proper vertical alignment of text.

To insure compatibility with future products, select fonts by specifying **all** of the font characteristics. If all of the characteristics are not designated, the primary and secondary font tables in the printer may not contain the correct information to select the requested font from those available in the printer.

The shortcut method of font selection is not recommended (as documented in some previous font product literature) and may not result in the desired font change. This is due to the increased number of available fonts in the printer.

The transparent print data command is required to access printable characters with character codes in the decimal range of 0, 7-15, and 27 in the PC symbol sets.

All information about the design of a font, as well as the design of its characters, can be found in the font and character descriptors.

A control code space is printed when an attempt is made to print a non-existent character.

When a soft font is specified using an ID number with which no soft font has been associated, no font change occurs.

Font designers designing fonts should not define the space character. The printer's control code space should be used for character spacing. Defining the space character in the font results in a significant reduction in performance.

Raster Graphics

To minimize I/O transmission time and conserve memory, avoid sending unnecessary raster data to the printer that represents white space. This is accomplished using the raster compression modes and raster reduction techniques available with the raster picture area provided with the HP LaserJet III printer.

Resolution should be set prior to the start raster graphics command. Once the start raster command is received, the resolution cannot be set until after a subsequent end raster graphics command.

Presentation mode should be set prior to the Start Raster Graphics command. Once the start raster command is received, the presentation mode cannot be set until after a subsequent End Raster Graphics Command.

Some applications and I/O drivers insert carriage returns or line feeds into the data stream sent to the printer. This modification of the data stream must be suppressed for correct printer operation.

The most efficient way to draw lines (horizontal and vertical) is using graphics rules (black-fill rectangular areas). The most efficient way to draw diagonal lines is using HP-GL/2 vector graphics.

Macros

When a macro ID is specified for which no macro has been defined, the macro invocation, macro deletion, and make macro permanent or temporary commands are ignored.

The macro enabled for auto macro overlay is executed on each page, until the macro is disabled or deleted, a reset occurs ("$^{E}_{C}$E" or control panel), or the page length, page size or orientation is changed.

When the modified print environment is restored, if the page length, page size, or the orientation has changed, or the primary or secondary font has been deleted, the following will occur:

1. If the original page length or page size is different than the current page length and page size, the current page is closed and printed, the page length and page size are changed to their original value, and the cursor is positioned at the left edge of the logical page at the top margin on the following page.
2. If the primary or secondary font is deleted, a new primary or secondary font is automatically selected from the remaining fonts using the current font characteristics.

HP-GL/2 is not supported within a macro.

Macro problems can often be avoided by first ensuring that the data will format outside the macro environment.

HP-GL/2 Vector Graphics

There are different approaches (commands) and techniques that can be used to create an HP-GL/2 image. To assist the user in determining the most efficient approach to creating an image, several points are identified below:

- When using line caps and joins:
  - Most efficient - Round join with butt cap
  - Least efficient - Round join with triangular cap

The round join is the most efficient while the triangular join is less efficient.

- Default pen widths (5 dots wide or less) produce the highest speed.
- Hewlett-Packard recommends using polygon mode when the number of points in a polygon is 1000 or less.
- The Polyline Encoded command can reduce data by 60% to 70%.
- When drawing shapes, try to use a command that was designed to draw that shape. That is, to draw a rectangle or a circle, use the ER or CI command to produce it, instead of stroking the shape line by line.
- To Scale text, use the HP-GL/2 font selection commands, such as SD or AD, that use Intellifont to scale the text. Scaling text in HP-GL/2, using the SR or SI commands, is much less efficient.
- Font transformations in HP-GL/2, such as, mirroring, scaling, slanting, rotating, and outlining are very processing intensive. An error 21 (print overrun) may occur. The error can be controlled by using the "Page Protection" feature of the LaserJet III printer.

Performance

PCL Commands

Since PCL printers are command driven devices and each command takes a finite amount of time to process, pages that are composed of a large number of commands may not print at maximum speed. Most commands can be used frequently on a page without adversely affecting the printer's performance; however, certain commands take more time to process and therefore, if used frequently on a page, may decrease printer performance. An excessive number of font selections per page (selection using font characteristic commands or selection by ID number) may decrease printer performance.

Print Data

There is a limit on the amount of data, as well as the number of commands, that the printer can process per page at maximum speed. In general, the LaserJet III printer can print at least 5000 uniformly distributed 12-point characters per page at maximum speed. This assumes the data does not contain any PCL commands and there are no I/O or host CPU constraints.

Print Overrun

As data is received by the printer, it is processed and stored in an intermediate format. The intermediate data is later processed and printed. During the physical printing of a page, the page moves through the printer at a constant speed. Thus, there are pages that cannot be printed because the page's intermediate data cannot be processed fast enough to keep up with the physical speed of the page as it moves through the printer. When this condition occurs, "21 PRINT ERROR" is displayed on the printer's control panel. A page causing this error can be printed by setting the printers page protect on.

Page Protection

The **Page protection** feature is available only if the printer contains at least 1-Mbyte of additional optional memory. If enabled, page protection reserves an amount of memory for the page image process, allowing the printer to create the entire page image (in memory) before physically moving the paper through the printer. This process ensures that the entire page will be printed. Page protection can be set for LTR (letter), A4, or LGL (legal) sized pages. Set page protection for the page size most often used.

I/O

The Parallel (Centronics) I/O has higher throughput than the RS-232C serial I/O. While text processing may not benefit from a faster I/O, raster graphics processing and soft font downloads will usually benefit from increased I/O throughput.

End-of-Line Wrap

The End-of-Line Wrap command defines the action that occurs when a line of text reaches the right margin.

$^{E}_{C}$ & s # C

\# = 0 - Enables End-of-Line Wrap

1 - Disables End-of-Line Wrap

When end-of-line wrap is enabled, a character or space that would move the cursor to the right of the right margin causes a CR-LF to be executed (prior to the printing of the character or space).

When end-of-line wrap is disabled, a character or space that would move the cursor to the right of the right margin may be clipped (refer to Chapter 2). When a character is clipped, the cursor is set to the right margin.

The primary use of this command is with display functions mode.

The factory default is end-of-line wrap disabled.

Example

To enable end-of-line wrap mode, send:

$^{E}_{C}$&s0C

Display Functions Mode

The Display Functions Mode command allows all escape sequences and control codes to be printed instead of being executed.

$^{E}_{C}$ **Y** - Enables Display Functions Mode

$^{E}_{C}$ **Z** - Disables Display Functions Mode

When the printer is in display functions mode, all control codes and escape sequences are printed and not executed with the following exceptions.

- CR is printed and executed as CR-LF.
- $^{E}_{C}$**Z** is printed and executed.

Display functions mode instructs the printer to display rather than execute the data it receives. The data is printed using the current text area and selected font.

Note

In order to print characters 0, 7-15, and 27 in fonts which have printable characters in these positions (such as PC-8), the printer must be in Display Function Mode.

Example

To enable display functions mode, send:

$^E{}_C$&s0C	Enables end-of-line wrap to prevent data truncation.
$^E{}_C$Y	Enable Display Functions Mode.
	•
	•
	•
	Data sent to the printer.
	•
	•
	•
$^E{}_C$Z	Disable Display Functions Mode.

Note

Most symbol sets do not have printable characters defined in the control code decimal range 0 to 31 and 128 to 159. If a printable character is not defined, a control code space is printed while in display functions mode. The PC 850 symbol sets do have printable characters defined in this range.

Auto Continue Mode

Automatic error clearing (refer to the LaserJet III Printer User's Manual for a list of clearable errors) can be achieved by setting Auto-Continue Mode to ON using the Operator Control Panel configuration menu. When "Auto-Cont" is set to ON, the device will display a message for 10 seconds and then attempt to continue printing the job. When "Auto-Cont" mode is set to OFF, all errors cause the device to stop printing.

Common Errors

20 ERROR This error occurs when the printer runs out of memory during a font download, macro creation, raster graphic download, or page composition. To alleviate this error, the quantity of data sent to the printer must be reduced. This can be accomplished by eliminating unnecessary fonts or macros, reducing the raster graphics white space sent to the printer, or selecting a lower resolution for the raster graphics. An alternative solution is to install additional memory. Additional memory is available from your Hewlett-Packard Sales Representative or authorized dealer.

21 ERROR This error results when a page is too complex to print. The error can be corrected by reducing the complexity of the page or by enabling Page Protection mode from the control panel. (Refer to the "Print Overrun" section described earlier in this chapter for additional information.)

22 ERROR This error indicates an I/O protocol problem between the printer and the host system. Make sure the printer and the host system protocol (i.e., hardware handshake or Xon/Xoff handshake) correspond and that your cable is correct for your host/printer configuration. (Refer to Appendix C for interface information.)

40 ERROR An error occurred while transferring data from the computer to the printer. This error occurs if the computer is turned ON and OFF while the printer is on-line or if the printer's baud rate, parity, or data character size are not the same as the computer's. To clear the error message press CONTINUE/RESET (refer to the LaserJet III Printer User's Manual). Make sure the printer is set to the same baud rate as the computer and that your host I/O has been configured for your printer. If the error continues, call your HP Service Representative.

For additional printer errors refer to the LaserJet III Printer User's Manual.

A

Symbol Sets

Symbol Set Tables

This section includes symbol set tables showing character locations and decimal addresses. Individual tables are provided for the following symbol sets:

Roman-8	Ventura US
ECMA-94 Latin 1	PS Math
PC-8	PS Text
PC-8 D/N	Math-8
PC-850	Pi Font
Legal	Microsoft Publishing
Ventura Math	Windows
Ventura International	DeskTop

The shaded areas in these tables denote printer control code areas. Refer to your computer or software manuals for information on printing the characters shown in the right half of the tables.

The International Standards Organization (ISO) symbol sets and the HP German and HP Spanish symbol sets are represented by a character substitution table (see page A-18).

Roman-8 Symbol Set

Includes ASCII and Roman Extension Symbol Sets

NUL 0	DLE 16	32	0 48	@ 64	P 80	‘ 96	p 112	128	144	160	¯ 176	â 192	Å 208	Á 224	Þ 240
SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113	129	145	À 161	Ý 177	ê 193	î 209	Ã 225	þ 241
STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114	130	146	Â 162	ý 178	ô 194	Ø 210	ã 226	· 242
ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115	131	147	È 163	° 179	û 195	Æ 211	Đ 227	µ 243
EOT 4	DC4 20	$ 36	4 52	D 68	T 84	d 100	t 116	132	148	Ê 164	Ç 180	á 196	å 212	ð 228	¶ 244
ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117	133	149	Ë 165	ç 181	é 197	í 213	Í 229	¾ 245
ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118	134	150	Î 166	Ñ 182	ó 198	ø 214	Ì 230	— 246
BEL 7	ETB 23	’ 39	7 55	G 71	W 87	g 103	w 119	135	151	Ï 167	ñ 183	ú 199	æ 215	Ó 231	¼ 247
BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120	136	152	´ 168	¡ 184	à 200	Ä 216	Ò 232	½ 248
HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121	137	153	` 169	¿ 185	è 201	ì 217	Õ 233	ª 249
LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122	138	154	ˆ 170	¤ 186	ò 202	Ö 218	õ 234	º 250
VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123	139	155	¨ 171	£ 187	ù 203	Ü 219	Š 235	« 251
FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	| 124	140	156	˜ 172	¥ 188	ä 204	É 220	š 236	■ 252
CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125	141	157	Ù 173	§ 189	ë 205	ï 221	Ú 237	» 253
SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126	142	158	Û 174	ƒ 190	ö 206	ß 222	Ÿ 238	± 254
SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	▒ 127	143	159	£ 175	¢ 191	ü 207	Ô 223	ÿ 239	255

NUL 0	DLE 16	32	0 48	@ 64	P 80	` 96	p 112	128	144	160	° 176	À 192	Ð 208	à 224	ð 240
SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113	129	145	¡ 161	± 177	Á 193	Ñ 209	á 225	ñ 241
STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114	130	146	¢ 162	² 178	Â 194	Ò 210	â 226	ò 242
ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115	131	147	£ 163	³ 179	Ã 195	Ó 211	ã 227	ó 243
EOT 4	DC4 20	$ 36	4 52	D 68	T 84	d 100	t 116	132	148	¤ 164	´ 180	Ä 196	Ô 212	ä 228	ô 244
ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117	133	149	¥ 165	µ 181	Å 197	Õ 213	å 229	õ 245
ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118	134	150	¦ 166	¶ 182	Æ 198	Ö 214	æ 230	ö 246
BEL 7	ETB 23	' 39	7 55	G 71	W 87	g 103	w 119	135	151	§ 167	· 183	Ç 199	× 215	ç 231	÷ 247
BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120	136	152	¨ 168	¸ 184	È 200	Ø 216	è 232	ø 248
HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121	137	153	© 169	¹ 185	É 201	Ù 217	é 233	ù 249
LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122	138	154	ª 170	º 186	Ê 202	Ú 218	ê 234	ú 250
VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123	139	155	« 171	» 187	Ë 203	Û 219	ë 235	û 251
FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108		124	140	156	¬ 172	¼ 188	Ì 204	Ü 220	ì 236	ü 252
CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125	141	157	- 173	½ 189	Í 205	Ý 221	í 237	ý 253
SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126	142	158	® 174	¾ 190	Î 206	Þ 222	î 238	þ 254
SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	▒ 127	143	159	¯ 175	¿ 191	Ï 207	ß 223	ï 239	ÿ 255

A Symbol Sets

PC-8 Symbol Set

NUL 0	► 16	32	0 48	@ 64	P 80	` 96	p 112	Ç 128	É 144	á 160	░ 176	└ 192	╨ 208	α 224	≡ 240
☺ 1	◄ 17	! 33	1 49	A 65	Q 81	a 97	q 113	ü 129	æ 145	í 161	▒ 177	┴ 193	╤ 209	ß 225	± 241
☻ 2	↕ 18	" 34	2 50	B 66	R 82	b 98	r 114	é 130	Æ 146	ó 162	▓ 178	┬ 194	╥ 210	Γ 226	≥ 242
♥ 3	‼ 19	# 35	3 51	C 67	S 83	c 99	s 115	â 131	ô 147	ú 163	│ 179	├ 195	╙ 211	π 227	≤ 243
♦ 4	¶ 20	$ 36	4 52	D 68	T 84	d 100	t 116	ä 132	ö 148	ñ 164	┤ 180	─ 196	╘ 212	Σ 228	⌠ 244
♣ 5	§ 21	% 37	5 53	E 69	U 85	e 101	u 117	à 133	ò 149	Ñ 165	╡ 181	┼ 197	╒ 213	σ 229	⌡ 245
♠ 6	▬ 22	& 38	6 54	F 70	V 86	f 102	v 118	å 134	û 150	ª 166	╢ 182	╞ 198	╓ 214	µ 230	÷ 246
• 7	↨ 23	' 39	7 55	G 71	W 87	g 103	w 119	ç 135	ù 151	º 167	╖ 183	╟ 199	╫ 215	τ 231	≈ 247
◘ 8	↑ 24	(40	8 56	H 72	X 88	h 104	x 120	ê 136	ÿ 152	¿ 168	╕ 184	╚ 200	╪ 216	Φ 232	° 248
○ 9	↓ 25	) 41	9 57	I 73	Y 89	i 105	y 121	ë 137	Ö 153	⌐ 169	╣ 185	╔ 201	┘ 217	Θ 233	· 249
◙ 10	→ 26	* 42	: 58	J 74	Z 90	j 106	z 122	è 138	Ü 154	¬ 170	║ 186	╩ 202	┌ 218	Ω 234	· 250
♂ 11	← 27	+ 43	; 59	K 75	[91	k 107	{ 123	ï 139	¢ 155	½ 171	╗ 187	╦ 203	█ 219	δ 235	√ 251
♀ 12	∟ 28	, 44	< 60	L 76	\ 92	l 108	| 124	î 140	£ 156	¼ 172	╝ 188	╠ 204	▄ 220	∞ 236	n 252
♪ 13	↔ 29	- 45	= 61	M 77	] 93	m 109	} 125	ì 141	¥ 157	¡ 173	╜ 189	═ 205	▌ 221	φ 237	2 253
♫ 14	▲ 30	. 46	> 62	N 78	^ 94	n 110	~ 126	Ä 142	Pt 158	« 174	╛ 190	╬ 206	▐ 222	ε 238	■ 254
☼ 15	▼ 31	/ 47	? 63	O 79	_ 95	o 111	⌂ 127	Å 143	ƒ 159	» 175	┐ 191	╧ 207	▀ 223	∩ 239	255

PC-8 D/N (Danish/Norwegian) Symbol Set

NUL 0	► 16	32	0 48	@ 64	P 80	` 96	p 112	Ç 128	É 144	á 160	░ 176	└ 192	╨ 208	α 224	≡ 240
☺ 1	◄ 17	! 33	1 49	A 65	Q 81	a 97	q 113	ü 129	æ 145	í 161	▒ 177	┴ 193	╤ 209	ß 225	± 241
☻ 2	↕ 18	" 34	2 50	B 66	R 82	b 98	r 114	é 130	Æ 146	ó 162	▓ 178	┬ 194	╥ 210	Γ 226	≥ 242
♥ 3	‼ 19	# 35	3 51	C 67	S 83	c 99	s 115	â 131	ô 147	ú 163	│ 179	├ 195	╙ 211	π 227	≤ 243
♦ 4	¶ 20	$ 36	4 52	D 68	T 84	d 100	t 116	ä 132	ö 148	ñ 164	┤ 180	─ 196	╘ 212	Σ 228	⌠ 244
♣ 5	§ 21	% 37	5 53	E 69	U 85	e 101	u 117	à 133	ò 149	Ñ 165	╡ 181	┼ 197	╒ 213	σ 229	⌡ 245
♠ 6	▬ 22	& 38	6 54	F 70	V 86	f 102	v 118	å 134	û 150	õ 166	╢ 182	╞ 198	╓ 214	μ 230	÷ 246
• 7	↨ 23	' 39	7 55	G 71	W 87	g 103	w 119	ç 135	ù 151	Õ 167	╖ 183	╟ 199	╫ 215	τ 231	≈ 247
◘ 8	↑ 24	(40	8 56	H 72	X 88	h 104	x 120	ê 136	ÿ 152	¿ 168	╕ 184	╚ 200	╪ 216	Φ 232	° 248
○ 9	↓ 25	) 41	9 57	I 73	Y 89	i 105	y 121	ë 137	Ö 153	ã 169	╣ 185	╔ 201	┘ 217	Θ 233	· 249
◙ 10	→ 26	* 42	: 58	J 74	Z 90	j 106	z 122	è 138	Ü 154	Ã 170	║ 186	╩ 202	┌ 218	Ω 234	· 250
♂ 11	← 27	+ 43	; 59	K 75	[91	k 107	{ 123	ï 139	ø 155	ℓ 171	╗ 187	╦ 203	█ 219	δ 235	√ 251
♀ 12	∟ 28	, 44	< 60	L 76	\ 92	l 108	| 124	î 140	£ 156	ŉ 172	╝ 188	╠ 204	▄ 220	∞ 236	^{n} 252
♪ 13	↔ 29	- 45	= 61	M 77	] 93	m 109	} 125	ì 141	Ø 157	¡ 173	╜ 189	═ 205	▌ 221	φ 237	^{2} 253
♫ 14	▲ 30	. 46	> 62	N 78	^ 94	n 110	~ 126	Ä 142	Ŀ 158	^{3} 174	╛ 190	╬ 206	▐ 222	ε 238	■ 254
☼ 15	▼ 31	/ 47	? 63	O 79	_ 95	o 111	⌂ 127	Å 143	ŀ 159	¤ 175	┐ 191	╧ 207	▀ 223	∩ 239	255

A Symbol Sets

PC-850 Symbol Set

NUL 0	► 16	32	0 48	@ 64	P 80	` 96	p 112	Ç 128	É 144	á 160	░ 176	└ 192	ð 208	Ó 224	- 240
☺ 1	◄ 17	! 33	1 49	A 65	Q 81	a 97	q 113	ü 129	æ 145	í 161	▒ 177	┴ 193	Đ 209	ß 225	± 241
☻ 2	↕ 18	" 34	2 50	B 66	R 82	b 98	r 114	é 130	Æ 146	ó 162	▓ 178	┬ 194	Ê 210	Ô 226	‗ 242
♥ 3	‼ 19	# 35	3 51	C 67	S 83	c 99	s 115	â 131	ô 147	ú 163	│ 179	├ 195	Ë 211	Ò 227	¾ 243
♦ 4	¶ 20	$ 36	4 52	D 68	T 84	d 100	t 116	ä 132	ö 148	ñ 164	┤ 180	─ 196	È 212	õ 228	¶ 244
♣ 5	§ 21	% 37	5 53	E 69	U 85	e 101	u 117	à 133	ò 149	Ñ 165	Á 181	┼ 197	ı 213	Õ 229	§ 245
♠ 6	▬ 22	& 38	6 54	F 70	V 86	f 102	v 118	å 134	û 150	ª 166	Â 182	ã 198	Í 214	µ 230	÷ 246
• 7	↨ 23	' 39	7 55	G 71	W 87	g 103	w 119	ç 135	ù 151	º 167	À 183	Ã 199	Î 215	þ 231	¸ 247
◘ 8	↑ 24	(40	8 56	H 72	X 88	h 104	x 120	ê 136	ÿ 152	¿ 168	© 184	╚ 200	Ï 216	Þ 232	° 248
○ 9	↓ 25	) 41	9 57	I 73	Y 89	i 105	y 121	ë 137	Ö 153	® 169	╣ 185	╔ 201	┘ 217	Ú 233	¨ 249
◙ 10	→ 26	* 42	: 58	J 74	Z 90	j 106	z 122	è 138	Ü 154	¬ 170	║ 186	╩ 202	┌ 218	Û 234	· 250
♂ 11	← 27	+ 43	; 59	K 75	[91	k 107	{ 123	ï 139	ø 155	½ 171	╗ 187	╦ 203	█ 219	Ù 235	¹ 251
♀ 12	∟ 28	, 44	< 60	L 76	\ 92	l 108	| 124	î 140	£ 156	¼ 172	╝ 188	╠ 204	▄ 220	ý 236	³ 252
♪ 13	↔ 29	- 45	= 61	M 77	] 93	m 109	} 125	ì 141	Ø 157	¡ 173	¢ 189	═ 205	¦ 221	Ý 237	² 253
♫ 14	▲ 30	. 46	> 62	N 78	^ 94	n 110	~ 126	Ä 142	× 158	« 174	¥ 190	╬ 206	Ì 222	¯ 238	■ 254
☼ 15	▼ 31	/ 47	? 63	O 79	_ 95	o 111	⌂ 127	Å 143	ƒ 159	» 175	┐ 191	¤ 207	▀ 223	´ 239	255

Legal Symbol Set

NUL 0	DLE 16	32	0 48	@ 64	P 80	° 96	p 112	128	144	160	176	192	208	224	240
SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113	129	145	161	177	193	209	225	241
STX 2	DC2 18	″ 34	2 50	B 66	R 82	b 98	r 114	130	146	162	178	194	210	226	242
ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115	131	147	163	179	195	211	227	243
EOT 4	DC4 20	$ 36	4 52	D 68	T 84	d 100	t 116	132	148	164	180	196	212	228	244
ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117	133	149	165	181	197	213	229	245
ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118	134	150	166	182	198	214	230	246
BEL 7	ETB 23	′ 39	7 55	G 71	W 87	g 103	w 119	135	151	167	183	199	215	231	247
BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120	136	152	168	184	200	216	232	248
HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121	137	153	169	185	201	217	233	249
LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122	138	154	170	186	202	218	234	250
VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	§ 123	139	155	171	187	203	219	235	251
FF 12	FS 28	, 44	‗ 60	L 76	® 92	l 108	¶ 124	140	156	172	188	204	220	236	252
CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	† 125	141	157	173	189	205	221	237	253
SO 14	RS 30	. 46	¢ 62	N 78	© 94	n 110	™ 126	142	158	174	190	206	222	238	254
SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	▒ 127	143	159	175	191	207	223	239	255

Ventura Math Symbol Set

NUL 0	DLE 16	32	0 48	≅ 64	Π 80	‾ 96	π 112	128	144	◇ 160	® 176	≤ 192	↓ 208	⎪ 224	⎡ 240
SOH 1	DC1 17	! 33	1 49	A 65	Θ 81	α 97	θ 113	129	145	√ 161	⊃ 177	♦ 193	← 209	· 225	TM 241
STX 2	DC2 18	∀ 34	2 50	B 66	P 82	β 98	ρ 114	130	146	⎝ 162	⊇ 178	≥ 194	® 210	∠ 226	⇐ 242
ETX 3	DC3 19	# 35	3 51	X 67	Σ 83	χ 99	σ 115	131	147	⎡ 163	⌠ 179	∂ 195	″ 211	⌡ 227	⇔ 243
EOT 4	DC4 20	∃ 36	4 52	Δ 68	T 84	δ 100	τ 116	132	148	⎢ 164	180	ℵ 196	ƒ 212	228	∨ 244
ENQ 5	NAK 21	% 37	5 53	E 69	Y 85	ε 101	υ 117	133	149	⎣ 165	♣ 181	′ 197	ℑ 213	⎨ 229	∑ 245
ACK 6	SYN 22	& 38	6 54	Φ 70	ς 86	ϕ 102	ϖ 118	134	150	⎝ 166	⊕ 182	ℜ 198	© 214	⌠ 230	TM 246
BEL 7	ETB 23	∍ 39	7 55	Γ 71	Ω 87	γ 103	ω 119	135	151	⎢ 167	⊗ 183	℘ 199	± 215	〉 231	⎢ 247
BS 8	CAN 24	(40	8 56	H 72	Ξ 88	η 104	ξ 120	136	152	⇑ 168	⊆ 184	∞ 200	→ 216	232	⎦ 248
HT 9	EM 25	) 41	9 57	I 73	Ψ 89	ι 105	ψ 121	137	153	⇒ 169	∪ 185	♠ 201	↑ 217	¬ 233	∅ 249
LF 10	SUB 26	* 42	: 58	ϑ 74	Z 90	φ 106	ζ 122	138	154	⇓ 170	— 186	∝ 202	≠ 218	∇ 234	∩ 250
VT 11	ESC 27	+ 43	; 59	K 75	[91	κ 107	{ 123	139	155	⊄ 171	… 187	• 203	≡ 219	⌠ 235	∈ 251
FF 12	FS 28	, 44	< 60	Λ 76	∴ 92	λ 108	| 124	140	156	⊂ 172	⎪ 188	/ 204	° 220	⎮ 236	© 252
CR 13	GS 29	− 45	= 61	M 77	] 93	μ 109	} 125	141	157	⌡ 173	∧ 189	♥ 205	↔ 221	⎫ 237	∉ 253
SO 14	RS 30	. 46	> 62	N 78	⊥ 94	ν 110	~ 126	142	158	⎪ 174	↵ 190	× 206	⎤ 222	⌡ 238	⎫ 254
SI 15	US 31	/ 47	? 63	O 79	_ 95	ο 111	127	143	159	} 175	≈ 191	ϒ 207	∫ 223	÷ 239	〈 255

Ventura International Symbol Set

NUL 0	DLE 16	32	0 48	@ 64	P 80	‘ 96	p 112	128	144	„ 160	‰ 176	â 192	Å 208	Á 224	Œ 240
SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113	129	145	À 161	“ 177	ê 193	î 209	Ã 225	œ 241
STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114	130	146	Â 162	” 178	ô 194	Ø 210	ã 226	¶ 242
ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115	131	147	È 163	° 179	û 195	Æ 211	227	† 243
EOT 4	DC4 20	$ 36	4 52	D 68	T 84	d 100	t 116	132	148	Ê 164	Ç 180	á 196	å 212	228	‡ 244
ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117	133	149	Ë 165	ç 181	é 197	í 213	Í 229	— 245
ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118	134	150	Î 166	Ñ 182	ó 198	ø 214	Ì 230	– 246
BEL 7	ETB 23	’ 39	7 55	G 71	W 87	g 103	w 119	135	151	Ï 167	ñ 183	ú 199	æ 215	Ó 231	247
BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120	136	152	© 168	¡ 184	à 200	Ä 216	Ò 232	248
HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121	137	153	® 169	¿ 185	è 201	ì 217	Õ 233	ª 249
LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122	138	154	™ 170	¤ 186	ò 202	Ö 218	õ 234	º 250
VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123	139	155	‹ 171	£ 187	ù 203	Ü 219	Š 235	« 251
FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	| 124	140	156	› 172	¥ 188	ä 204	É 220	š 236	• 252
CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125	141	157	Ù 173	§ 189	ë 205	ï 221	Ú 237	» 253
SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126	142	158	Û 174	ƒ 190	ö 206	ß 222	Ÿ 238	254
SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	127	143	159	175	¢ 191	ü 207	Ô 223	ÿ 239	… 255

Ventura US Symbol Set

NUL 0	DLE 16	32	0 48	@ 64	P 80	‘ 96	p 112	128	144	„ 160	‰ 176	192	208	224	240
SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113	129	145	161	“ 177	193	209	225	241
STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114	130	146	162	” 178	194	210	226	¶ 242
ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115	131	147	163	° 179	195	211	227	† 243
EOT 4	DC4 20	$ 36	4 52	D 68	T 84	d 100	t 116	132	148	164	180	196	212	228	‡ 244
ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117	133	149	165	181	197	213	229	— 245
ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118	134	150	166	182	198	214	230	– 246
BEL 7	ETB 23	’ 39	7 55	G 71	W 87	g 103	w 119	135	151	167	183	199	215	231	247
BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120	136	152	© 168	184	200	216	232	248
HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121	137	153	® 169	185	201	217	233	249
LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122	138	154	™ 170	186	202	218	234	250
VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123	139	155	171	187	203	219	235	251
FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	| 124	140	156	172	188	204	220	236	• 252
CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125	141	157	173	§ 189	205	221	237	253
SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126	142	158	174	190	206	222	238	254
SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	127	143	159	175	¢ 191	207	223	239	… 255

PS Math Symbol Set

NUL 0	DLE 16	32	0 48	≅ 64	Π 80	‾ 96	π 112	128	144	160	° 176	ℵ 192	∠ 208	◊ 224	240
SOH 1	DC1 17	! 33	1 49	Α 65	Θ 81	α 97	θ 113	129	145	ϒ 161	± 177	ℑ 193	∇ 209	〈 225	〉 241
STX 2	DC2 18	∀ 34	2 50	Β 66	Ρ 82	β 98	ρ 114	130	146	′ 162	″ 178	ℜ 194	® 210	® 226	∫ 242
ETX 3	DC3 19	# 35	3 51	Χ 67	Σ 83	χ 99	σ 115	131	147	≤ 163	≥ 179	℘ 195	© 211	© 227	⌠ 243
EOT 4	DC4 20	∃ 36	4 52	Δ 68	Τ 84	δ 100	τ 116	132	148	/ 164	× 180	⊗ 196	™ 212	™ 228	⎮ 244
ENQ 5	NAK 21	% 37	5 53	Ε 69	Υ 85	ε 101	υ 117	133	149	∞ 165	∝ 181	⊕ 197	∏ 213	∑ 229	⌡ 245
ACK 6	SYN 22	& 38	6 54	Φ 70	ς 86	ϕ 102	ϖ 118	134	150	ƒ 166	∂ 182	∅ 198	√ 214	⎛ 230	⎞ 246
BEL 7	ETB 23	∋ 39	7 55	Γ 71	Ω 87	γ 103	ω 119	135	151	♣ 167	• 183	∩ 199	· 215	⎜ 231	⎟ 247
BS 8	CAN 24	(40	8 56	Η 72	Ξ 88	η 104	ξ 120	136	152	♦ 168	÷ 184	∪ 200	¬ 216	⎝ 232	⎠ 248
HT 9	EM 25	) 41	9 57	Ι 73	Ψ 89	ι 105	ψ 121	137	153	♥ 169	≠ 185	⊃ 201	∧ 217	⎡ 233	⎤ 249
LF 10	SUB 26	* 42	: 58	ϑ 74	Ζ 90	φ 106	ζ 122	138	154	♠ 170	≡ 186	⊇ 202	∨ 218	⎢ 234	⎥ 250
VT 11	ESC 27	+ 43	; 59	Κ 75	[91	κ 107	{ 123	139	155	↔ 171	≈ 187	⊄ 203	⇔ 219	⎣ 235	⎦ 251
FF 12	FS 28	, 44	< 60	Λ 76	∴ 92	λ 108	| 124	140	156	← 172	… 188	⊂ 204	⇐ 220	⎧ 236	⎫ 252
CR 13	GS 29	− 45	= 61	Μ 77	] 93	μ 109	} 125	141	157	↑ 173	⏐ 189	⊆ 205	⇑ 221	⎨ 237	⎬ 253
SO 14	RS 30	. 46	> 62	Ν 78	⊥ 94	ν 110	~ 126	142	158	→ 174	⎯ 190	∈ 206	⇒ 222	⎩ 238	⎭ 254
SI 15	US 31	/ 47	? 63	Ο 79	_ 95	ο 111	127	143	159	↓ 175	↵ 191	∉ 207	⇓ 223	⎪ 239	255

PS Text Symbol Set

NUL 0	DLE 16	32	0 48	@ 64	P 80	‘ 96	p 112	128	144	160	176	192	— 208	224	240
SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113	129	145	¡ 161	– 177	` 193	209	Æ 225	æ 241
STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114	130	146	¢ 162	† 178	´ 194	210	226	242
ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115	131	147	£ 163	‡ 179	ˆ 195	211	ª 227	243
EOT 4	DC4 20	$ 36	4 52	D 68	T 84	d 100	t 116	132	148	/ 164	· 180	˜ 196	212	228	244
ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117	133	149	¥ 165	181	¯ 197	213	229	ı 245
ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118	134	150	ƒ 166	¶ 182	˘ 198	214	230	246
BEL 7	ETB 23	’ 39	7 55	G 71	W 87	g 103	w 119	135	151	§ 167	• 183	˙ 199	215	231	247
BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120	136	152	¤ 168	‚ 184	¨ 200	216	Ł 232	ł 248
HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121	137	153	' 169	„ 185	201	217	Ø 233	ø 249
LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122	138	154	“ 170	” 186	˚ 202	218	Œ 234	œ 250
VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123	139	155	« 171	» 187	¸ 203	219	º 235	ß 251
FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	| 124	140	156	‹ 172	… 188	204	220	236	252
CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125	141	157	› 173	‰ 189	˝ 205	221	237	253
SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126	142	158	ﬁ 174	190	˛ 206	222	238	254
SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	127	143	159	ﬂ 175	¿ 191	ˇ 207	223	239	255

Math-8 Symbol Set

NUL 0	DLE 16	32	0 48	∴ 64	Π 80	∵ 96	π 112	128	144	160	‾ 176	⊕ 192	Å 208	⎡ 224	⎤ 240
SOH 1	DC1 17	√ 33	1 49	A 65	P 81	α 97	ρ 113	129	145	↑ 161	∀ 177	⊙ 193	⊣ 209	⎣ 225	⎦ 241
STX 2	DC2 18	″ 34	2 50	B 66	Σ 82	β 98	σ 114	130	146	→ 162	∃ 178	⊗ 194	⊢ 210	⎧ 226	⎫ 242
ETX 3	DC3 19	° 35	3 51	Γ 67	T 83	γ 99	τ 115	131	147	↓ 163	⊤ 179	⊖ 195	∟ 211	⎨ 227	⎬ 243
EOT 4	DC4 20	∞ 36	4 52	Δ 68	Υ 84	δ 100	υ 116	132	148	← 164	⊥ 180	⊘ 196	∍ 212	⎩ 228	⎭ 244
ENQ 5	NAK 21	÷ 37	5 53	E 69	Φ 85	ϵ 101	ϕ 117	133	149	⇑ 165	∪ 181	∧ 197	∫ 213	⌠ 229	⎪ 245
ACK 6	SYN 22	∝ 38	6 54	Z 70	X 86	ζ 102	χ 118	134	150	⇒ 166	∩ 182	∨ 198	∮ 214	⌽ 230	⎪ 246
BEL 7	ETB 23	′ 39	7 55	H 71	Ψ 87	η 103	ψ 119	135	151	⇓ 167	∈ 183	⊻ 199	∠ 215	⌡ 231	⎷ 247
BS 8	CAN 24	(40	8 56	Θ 72	Ω 88	θ 104	ω 120	136	152	⇐ 168	∋ 184	¬ 200	∅ 216	⟍ 232	⌝ 248
HT 9	EM 25	) 41	9 57	I 73	∇ 89	ι 105	ϑ 121	137	153	↕ 169	∉ 185	∘ 201	ℵ 217	‖ 233	〉 249
LF 10	SUB 26	× 42	e 58	K 74	∂ 90	κ 106	φ 122	138	154	↔ 170	⊂ 186	· 202	ℶ 218	∠ 234	⌟ 250
VT 11	ESC 27	+ 43	ε 59	Λ 75	ς 91	λ 107	ϖ 123	139	155	⇕ 171	⊃ 187	• 203	ℷ 219	╱ 235	╲ 251
FF 12	FS 28	, 44	< 60	M 76	≤ 92	μ 108	≃ 124	140	156	⇔ 172	⊄ 188	● 204	ℭ 220	— 236	〈 252
CR 13	GS 29	− 45	= 61	N 77	≠ 93	ν 109	≡ 125	141	157	⇄ 173	⊅ 189	○ 205	ℑ 221	= 237	∓ 253
SO 14	RS 30	. 46	> 62	Ξ 78	≥ 94	ξ 110	≢ 126	142	158	⇆ 174	⊆ 190	† 206	ℜ 222	∗ 238	± 254
SI 15	US 31	/ 47	≈ 63	O 79	_ 95	ο 111	▒ 127	143	159	‾ 175	⊇ 191	‡ 207	ℨ 223	≅ 239	255

A Symbol Sets

Pi Font Symbol Set

NUL 0	DLE 16	32	¯ 48	∷ 64	𝒫 80	┌ 96	┐ 112	128	144	160	176	192	208	224	240
SOH 1	DC1 17	33	˘ 49	≜ 65	℘ 81	└ 97	┘ 113	129	145	161	177	193	209	225	241
STX 2	DC2 18	„ 34	ˇ 50	66	℞ 82	╭ 98	╮ 114	130	146	162	178	194	210	226	242
ETX 3	DC3 19	‚ 35	˙ 51	67	∑ 83	╰ 99	╯ 115	131	147	163	179	195	211	227	243
EOT 4	DC4 20	“ 36	↗ 52	68	84	┼ 100	┬ 116	132	148	164	180	196	212	228	244
ENQ 5	NAK 21	” 37	↘ 53	69	85	├ 101	┤ 117	133	149	165	181	197	213	229	245
ACK 6	SYN 22	‘ 38	↙ 54	ƒ 70	86	─ 102	┴ 118	134	150	166	182	198	214	230	246
BEL 7	ETB 23	’ 39	↖ 55	71	87	║ 103	│ 119	135	151	167	183	199	215	231	247
BS 8	CAN 24	⟨ 40	△ 56	ℏ 72	88	∪ 104	⊔ 120	136	152	168	184	200	216	232	248
HT 9	EM 25	⟩ 41	▷ 57	73	89	∩ 105	⊓ 121	137	153	169	185	201	217	233	249
LF 10	SUB 26	™ 42	▽ 58	74	90	╔ 106	╗ 122	138	154	170	186	202	218	234	250
VT 11	ESC 27	℠ 43	◁ 59	75	⟦ 91	╚ 107	╝ 123	139	155	171	187	203	219	235	251
FF 12	FS 28	® 44	≪ 60	ℒ 76	‖ 92	□ 108	■ 124	140	156	172	188	204	220	236	252
CR 13	GS 29	© 45	§ 61	ℓ 77	⟧ 93	◇ 109	◆ 125	141	157	173	189	205	221	237	253
SO 14	RS 30	Ⓜ 46	≫ 62	78	‹ 94	110	126	142	158	174	190	206	222	238	254
SI 15	US 31	47	¶ 63	79	› 95	111	▒ 127	143	159	175	191	207	223	239	255

Microsoft Publishing Symbol Set

NUL 0	16	32	48	2 64	80	‘ 96	112	128	144	160	° 176	192	208	Ω 224	240
1	17	1 33	49	65	81	97	113	129	145	′ 161	● 177	` 193	` 209	225	241
2	18	” 34	50	66	℞ 82	98	114	130	146	″ 162	● 178	´ 194	´ 210	226	242
3	19	3 35	51	67	Š 83	℅ 99	š 115	131	147	^ 163	● 179	^ 195	^ 211	227	243
4	20	4 36	52	68	™ 84	100	Thin Space 116	132	148	~ 164	○ 180	~ 196	~ 212	228	244
5	21	5 37	53	69	85	101	117	133	149	165	○ 181	¯ 197	¯ 213	229	ı 245
6	22	7 38	54	70	86	102	118	134	150	166	○ 182	˘ 198	˘ 214	Ĳ 230	ĳ 246
BEL 7	23	’ 39	55	71	87	103	119	135	151	167	■ 183	˙ 199	˙ 215	Ŀ 231	ŀ 247
BS 8	24	9 40	56	72	88	104	120	136	152	168	■ 184	¨ 200	¨ 216	Ł 232	ł 248
HT 9	25	0 41	57	73	Ÿ 89	105	121	137	153	ﬁ 169	■ 185	201	217	233	249
LF 10	26	8 42	58	74	Ž 90	106	ž 122	138	154	ﬂ 170	□ 186	˚ 202	˚ 218	234	250
VT 11	ESC 27	† 43	59	75	91	107	123	139	155	ﬀ 171	□ 187	¸ 203	¸ 219	235	251
FF 12	28	, 44	„ 60	76	92	ℓ 108	124	140	156	ﬃ 172	□ 188	204	220	236	252
CR 13	29	— 45	‡ 61	— 77	93	Em Space 109	125	141	157	ﬄ 173	‰ 189	˝ 205	˝ 221	237	253
SO 14	30	… 46	62	– 78	6 94	En Space 110	“ 126	142	Pt 158	‹ 174	◆ 190	˛ 206	˛ 222	238	254
SI 15	31	/ 47	63	Œ 79	‗ 95	œ 111	127	143	ƒ 159	› 175	◇ 191	ˇ 207	ˇ 223	ŉ 239	255

Windows Symbol Set

NUL 0	16	32	0 48	@ 64	P 80	` 96	p 112	128	144	160	° 176	À 192	Đ 208	à 224	ð 240
1	17	! 33	1 49	A 65	Q 81	a 97	q 113	129	‘ 145	¡ 161	± 177	Á 193	Ñ 209	á 225	ñ 241
2	18	" 34	2 50	B 66	R 82	b 98	r 114	130	’ 146	¢ 162	² 178	Â 194	Ò 210	â 226	ò 242
3	19	# 35	3 51	C 67	S 83	c 99	s 115	131	147	£ 163	³ 179	Ã 195	Ó 211	ã 227	ó 243
4	20	$ 36	4 52	D 68	T 84	d 100	t 116	132	148	¤ 164	´ 180	Ä 196	Ô 212	ä 228	ô 244
5	21	% 37	5 53	E 69	U 85	e 101	u 117	133	149	¥ 165	µ 181	Å 197	Õ 213	å 229	õ 245
6	22	& 38	6 54	F 70	V 86	f 102	v 118	134	150	¦ 166	¶ 182	Æ 198	Ö 214	æ 230	ö 246
BEL 7	23	' 39	7 55	G 71	W 87	g 103	w 119	135	151	§ 167	· 183	Ç 199	× 215	ç 231	÷ 247
BS 8	24	(40	8 56	H 72	X 88	h 104	x 120	136	152	¨ 168	¸ 184	È 200	Ø 216	è 232	ø 248
HT 9	25	) 41	9 57	I 73	Y 89	i 105	y 121	137	153	© 169	¹ 185	É 201	Ù 217	é 233	ù 249
LF 10	26	* 42	: 58	J 74	Z 90	j 106	z 122	138	154	ª 170	º 186	Ê 202	Ú 218	ê 234	ú 250
VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123	139	155	« 171	» 187	Ë 203	Û 219	ë 235	û 251
FF 12	28	, 44	< 60	L 76	\ 92	l 108	| 124	140	156	¬ 172	¼ 188	Ì 204	Ü 220	ì 236	ü 252
CR 13	29	- 45	= 61	M 77	] 93	m 109	} 125	141	157	- 173	½ 189	Í 205	Ý 221	í 237	ý 253
SO 14	30	. 46	> 62	N 78	^ 94	n 110	~ 126	142	158	® 174	¾ 190	Î 206	Þ 222	î 238	þ 254
SI 15	31	/ 47	? 63	O 79	_ 95	o 111	▒ 127	143	159	¯ 175	¿ 191	Ï 207	ß 223	ï 239	ÿ 255

DeskTop Symbol Set

NUL 0	DLE 16	32	0 48	@ 64	P 80	‘ 96	p 112	128	144	160	“ 176	— 192	‹ 208	a 224	´ 240
SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113	129	145	¶ 161	” 177	± 193	› 209	o 225	` 241
STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114	130	146	§ 162	μ 178	× 194	« 210	æ 226	ˆ 242
ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115	131	147	† 163	‰ 179	÷ 195	» 211	Æ 227	¨ 243
EOT 4	DC4 20	$ 36	4 52	D 68	T 84	d 100	t 116	132	148	‡ 164	• 180	° 196	‚ 212	ð 228	˜ 244
ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117	133	149	© 165	● 181	′ 197	„ 213	Đ 229	ˇ 245
ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118	134	150	® 166	◦ 182	″ 198	· 214	ij 230	˘ 246
BEL 7	ETB 23	’ 39	7 55	G 71	W 87	g 103	w 119	135	151	™ 167	○ 183	¼ 199	¡ 215	IJ 231	˝ 247
BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120	136	152	℅ 168	▪ 184	½ 200	¿ 216	ł 232	˚ 248
HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121	137	153	¢ 169	■ 185	¾ 201	Pt 217	Ł 233	˙ 249
LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122	138	154	– 170	▫ 186	¹ 202	ℓ 218	œ 234	¯ 250
VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123	139	155	— 171	□ 187	² 203	£ 219	Œ 235	¸ 251
FF 12	FS 28	, 44	< 60	L 76	\ 92	l 108	| 124	140	156	… 172	' 188	³ 204	¥ 220	ø 236	˛ 252
CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125	141	157	ﬁ 173	¬ 189	⁄ 205	¤ 221	Ø 237	· 253
SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126	142	158	ﬂ 174	¦ 190	206	ƒ 222	þ 238	ı 254
SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	▒ 127	143	159	175	‗ 191	207	ß 223	Þ 239	255

ISO Substitution Table

This table provides a quick reference for the values of special characters contained in ISO (International Standards Organization) symbol sets. ISO symbol sets contain the same characters and the ASCII symbol set, except for the character positions listed in this table. For example, the ISO 4 (United Kingdom) symbol set, the British pound sign (£) replaces the # sign used in decimal position 35 of the ASCII symbol set.

<table>
<tr><th></th><th></th><th></th><th colspan="12">DECIMAL CHARACTER EQUIVALENTS</th></tr>
<tr><th>ISO</th><th>Name</th><th>ID</th><th>35</th><th>36</th><th>64</th><th>91</th><th>92</th><th>93</th><th>94</th><th>96</th><th>123</th><th>124</th><th>125</th><th>126</th></tr>
<tr><td>6</td><td>ASCII</td><td>0U</td><td>#</td><td>$</td><td>@</td><td>[</td><td>\</td><td>]</td><td>^</td><td>‘</td><td>{</td><td>|</td><td>}</td><td>~</td></tr>
<tr><td>2</td><td>ISO IRV *</td><td>2U</td><td>#</td><td>¤</td><td>@</td><td>[</td><td>\</td><td>]</td><td>ˆ</td><td>`</td><td>{</td><td>|</td><td>}</td><td>‾</td></tr>
<tr><td>4</td><td>ISO United Kingdom</td><td>1E</td><td>£</td><td>$</td><td>@</td><td>[</td><td>\</td><td>]</td><td>ˆ</td><td>`</td><td>{</td><td>|</td><td>}</td><td>‾</td></tr>
<tr><td>25</td><td>ISO French *</td><td>0F</td><td>£</td><td>$</td><td>à</td><td>°</td><td>ç</td><td>§</td><td>ˆ</td><td>`</td><td>é</td><td>ù</td><td>è</td><td>¨</td></tr>
<tr><td>69</td><td>ISO French</td><td>1F</td><td>£</td><td>$</td><td>à</td><td>°</td><td>ç</td><td>§</td><td>ˆ</td><td>µ</td><td>é</td><td>ù</td><td>è</td><td>¨</td></tr>
<tr><td></td><td>German *</td><td>0G</td><td>£</td><td>$</td><td>§</td><td>Ä</td><td>Ö</td><td>Ü</td><td>ˆ</td><td>`</td><td>ä</td><td>ö</td><td>ü</td><td>ß</td></tr>
<tr><td>21</td><td>ISO German</td><td>1G</td><td>#</td><td>$</td><td>§</td><td>Ä</td><td>Ö</td><td>Ü</td><td>ˆ</td><td>`</td><td>ä</td><td>ö</td><td>ü</td><td>ß</td></tr>
<tr><td>15</td><td>ISO Italian</td><td>0I</td><td>£</td><td>$</td><td>§</td><td>°</td><td>ç</td><td>é</td><td>ˆ</td><td>ù</td><td>à</td><td>ò</td><td>è</td><td>ì</td></tr>
<tr><td>14</td><td>JIS ASCII *</td><td>0K</td><td>#</td><td>$</td><td>@</td><td>[</td><td>¥</td><td>]</td><td>ˆ</td><td>`</td><td>{</td><td>|</td><td>}</td><td>‾</td></tr>
<tr><td>57</td><td>ISO Chinese *</td><td>2K</td><td>#</td><td>¥</td><td>@</td><td>[</td><td>\</td><td>]</td><td>ˆ</td><td>`</td><td>{</td><td>|</td><td>}</td><td>‾</td></tr>
<tr><td>10</td><td>ISO Swedish *</td><td>3S</td><td>#</td><td>¤</td><td>@</td><td>Ä</td><td>Ö</td><td>Å</td><td>ˆ</td><td>`</td><td>ä</td><td>ö</td><td>å</td><td>‾</td></tr>
<tr><td>11</td><td>ISO Swedish names</td><td>0S</td><td>#</td><td>¤</td><td>É</td><td>Ä</td><td>Ö</td><td>Å</td><td>Ü</td><td>é</td><td>ä</td><td>ö</td><td>å</td><td>ü</td></tr>
<tr><td></td><td>Spanish *</td><td>1S</td><td>#</td><td>$</td><td>@</td><td>¡</td><td>Ñ</td><td>¿</td><td>°</td><td>`</td><td>{</td><td>ñ</td><td>}</td><td>˜</td></tr>
<tr><td>17</td><td>ISO Spanish</td><td>2S</td><td>£</td><td>$</td><td>§</td><td>¡</td><td>Ñ</td><td>¿</td><td>ˆ</td><td>`</td><td>°</td><td>ñ</td><td>ç</td><td>˜</td></tr>
<tr><td>85</td><td>ISO Spanish: *</td><td>6S</td><td>#</td><td>$</td><td>·</td><td>¡</td><td>Ñ</td><td>Ç</td><td>¿</td><td>`</td><td>´</td><td>ñ</td><td>ç</td><td>¨</td></tr>
<tr><td>16</td><td>ISO Portuguese *</td><td>4S</td><td>#</td><td>$</td><td>§</td><td>Ã</td><td>Ç</td><td>Õ</td><td>ˆ</td><td>`</td><td>ã</td><td>ç</td><td>õ</td><td>°</td></tr>
<tr><td>84</td><td>ISO Portuguese: *</td><td>5S</td><td>#</td><td>$</td><td>´</td><td>Ã</td><td>Ç</td><td>Õ</td><td>ˆ</td><td>`</td><td>ã</td><td>ç</td><td>õ</td><td>˜</td></tr>
<tr><td>60</td><td>ISO Norwegian v1</td><td>0D</td><td>#</td><td>$</td><td>@</td><td>Æ</td><td>Ø</td><td>Å</td><td>ˆ</td><td>`</td><td>æ</td><td>ø</td><td>å</td><td>‾</td></tr>
<tr><td>61</td><td>ISO Norwegian v2 *</td><td>1D</td><td>§</td><td>$</td><td>@</td><td>Æ</td><td>Ø</td><td>Å</td><td>ˆ</td><td>`</td><td>æ</td><td>ø</td><td>å</td><td>|</td></tr>
</table>

* Not recommended for future use.

Conversion Table

Table A-1 gives the hexadecimal, decimal, and octal equivalent of each character in the Roman-8 symbol set (see page A-2). Use this table when your software requires you to enter hexadecimal, decimal, or octal values in place of your printer command characters.

Table A-1. Roman-8 Character Conversion Table

Graphic	Hex	Dec	Oct	Description
	00	0	000	NUL (null)
	01	1	001	SOH (start of heading)
	02	2	002	STX (start of text)
	03	3	003	ETX (end of text)
	04	4	004	EOT (end of transmission)
	05	5	005	ENQ (enquiry)
	06	6	006	ACK (acknowledge)
	07	7	007	BEL (bell)
	08	8	010	BS (backspace)
	09	9	011	HT (horizontal tabulation)
	0A	10	012	LF (line feed)
	0B	11	013	VT (vertical tabulation)
	0C	12	014	FF (form feed)
	0D	13	015	CR (carriage return)
	0E	14	016	SO (shift out)
	0F	15	017	SI (shift in)
	10	16	020	DLE (data link escape)
	11	17	021	DC1 (device control 1 or X-ON)
	12	18	022	DC2 (device control 2)
	13	19	023	DC3 (device control 3 or X-OFF)
	14	20	024	DC4 (device control 4)
	15	21	025	NAK (negative acknowledge)
	16	22	026	SYN (synchronous idle)
	17	23	027	ETB (end of transmission block)
	18	24	030	CAN (cancel)
	19	25	031	EM (end of medium)
	1A	26	032	SUB (substitute)
	1B	27	033	ESC (escape)
	1C	28	034	FS (file separator)
	1D	29	035	GS (group separator)
	1E	30	036	RS (record separator)
	1F	31	037	US (unit separator)
	20	32	040	SP (space)
!	21	33	041	Exclamation point
"	22	34	042	Quotation mark
#	23	35	043	Number sign
$	24	36	044	Dollar sign
%	25	37	045	Percent sign
&	26	38	046	Ampersand
'	27	39	047	Closing single quote (apostrophe)

Table A-1. Roman-8 Character Conversion Table (continued)

Graphic	Hex	Dec	Oct	Description
(	28	40	050	Opening parenthesis
)	29	41	051	Closing parenthesis
*	2A	42	052	Asterisk
+	2B	43	053	Plus
,	2C	44	054	Comma
-	2D	45	055	Hyphen
.	2E	46	056	Period (point)
/	2F	47	057	Slant (solidus)
0	30	48	060	Zero
1	31	49	061	One
2	32	50	062	Two
3	33	51	063	Three
4	34	52	064	Four
5	35	53	065	Five
6	36	54	066	Six
7	37	55	067	Seven
8	38	56	070	Eight
9	39	57	071	Nine
:	3A	58	072	Colon
;	3B	59	073	Semicolon
<	3C	60	074	Less than sign
=	3D	61	075	Equals sign
>	3E	62	076	Greater than sign
?	3F	63	077	Question mark
@	40	64	100	Commercial At
A	41	65	101	Uppercase A
B	42	66	102	Uppercase B
C	43	67	103	Uppercase C
D	44	68	104	Uppercase D
E	45	69	105	Uppercase E
F	46	70	106	Uppercase F
G	47	71	107	Uppercase G
H	48	72	110	Uppercase H
I	49	73	111	Uppercase I
J	4A	74	112	Uppercase J
K	4B	75	113	Uppercase K
L	4C	76	114	Uppercase L
M	4D	77	115	Uppercase M
N	4E	78	116	Uppercase N
O	4F	79	117	Uppercase O

Table A-1. Roman-8 Character Conversion Table (continued)

Graphic	Hex	Dec	Oct	Description
P	50	80	120	Uppercase P
Q	51	81	121	Uppercase Q
R	52	82	122	Uppercase R
S	53	83	123	Uppercase S
T	54	84	124	Uppercase T
U	55	85	125	Uppercase U
V	56	86	126	Uppercase V
W	57	87	127	Uppercase W
X	58	88	130	Uppercase X
Y	59	89	131	Uppercase Y
Z	5A	90	132	Uppercase Z
[	5B	91	133	Opening square bracket
\	5C	92	134	Reverse slant
]	5D	93	135	Closing bracket
^	5E	94	136	Caret (circumflex)
_	5F	95	137	Underscore (low line)
'	60	96	140	Opening Single Quote
a	61	97	141	Lowercase a
b	62	98	142	Lowercase b
c	63	99	143	Lowercase c
d	64	100	144	Lowercase d
e	65	101	145	Lowercase e
f	66	102	146	Lowercase f
g	67	103	147	Lowercase g
h	68	104	150	Lowercase h
i	69	105	151	Lowercase i
j	6A	106	152	Lowercase j
k	6B	107	153	Lowercase k
l	6C	108	154	Lowercase l
m	6D	109	155	Lowercase m
n	6E	110	156	Lowercase n
o	6F	111	157	Lowercase o
p	70	112	160	Lowercase p
q	71	113	161	Lowercase q
r	72	114	162	Lowercase r
s	73	115	163	Lowercase s
t	74	116	164	Lowercase t
u	75	117	165	Lowercase u
v	76	118	166	Lowercase v
w	77	119	167	Lowercase w

Table A-1. Roman-8 Character Conversion Table (continued)

Graphic	Hex	Dec	Oct	Description
x	78	120	170	Lowercase x
y	79	121	171	Lowercase y
z	7A	122	172	Lowercase z
{	7B	123	173	Opening brace (curly bracket)
|	7C	124	174	Vertical line
}	7D	125	175	Closing brace (curly bracket)
~	7E	126	176	Approximate (tilde)
▒	7F	127	177	DEL (delete, rubout)
	80	128	200	--undefined control code--
	81	129	201	--undefined control code--
	82	130	202	--undefined control code--
	83	131	203	--undefined control code--
	84	132	204	--undefined control code--
	85	133	205	--undefined control code--
	86	134	206	--undefined control code--
	87	135	207	--undefined control code--
	88	136	210	--undefined control code--
	89	137	211	--undefined control code--
	8A	138	212	--undefined control code--
	8B	139	213	--undefined control code--
	8C	140	214	--undefined control code--
	8D	141	215	--undefined control code--
	8E	142	216	--undefined control code--
	8F	143	217	--undefined control code--
	90	144	220	--undefined control code--
	91	145	221	--undefined control code--
	92	146	222	--undefined control code--
	93	147	223	--undefined control code--
	94	148	224	--undefined control code--
	95	149	225	--undefined control code--
	96	150	226	--undefined control code--
	97	151	227	--undefined control code--
	98	152	230	--undefined control code--
	99	153	231	--undefined control code--
	9A	154	232	--undefined control code--
	9B	155	233	--undefined control code--
	9C	156	234	--undefined control code--
	9D	157	235	--undefined control code--
	9E	158	236	--undefined control code--
	9F	159	237	--undefined control code--

Table A-1. Roman-8 Character Conversion Table (continued)

Graphic	Hex	Dec	Oct	Description
	A0	160	240	--undefined--
À	A1	161	241	Uppercase A grave
Â	A2	162	242	Uppercase A circumflex
È	A3	163	243	Uppercase E grave
Ê	A4	164	244	Uppercase E circumflex
Ë	A5	165	245	Uppercase E dieresis
Î	A6	166	246	Uppercase I circumflex
Ï	A7	167	247	Uppercase I dieresis
´	A8	168	250	Lowercase acute accent
`	A9	169	251	Lowercase grave accent
ˆ	AA	170	252	Lowercase circumflex accent
¨	AB	171	253	Lowercase dieresis accent
˜	AC	172	254	Lowercase tilde accent
Ù	AD	173	255	Uppercase U grave
Û	AE	174	256	Uppercase U circumflex
£	AF	175	257	Italian lira (pound sterling)
‾	B0	176	260	Overscore (high line)
Ý	B1	177	261	Uppercase Y acute
ý	B2	178	262	Lowercase y acute
°	B3	179	263	Degree
Ç	B4	180	264	Uppercase C cedilla
ç	B5	181	265	Lowercase c cedilla
Ñ	B6	182	266	Uppercase N tilde
ñ	B7	183	267	Lowercase n tilde
¡	B8	184	270	Inverted exlamation mark
¿	B9	185	271	Inverted question mark
¤	BA	186	272	General currency symbol
£	BB	187	273	Pound sterling sign
¥	BC	188	274	Yen sign
§	BD	189	275	Section mark
ƒ	BE	190	276	Dutch guilder symbol
¢	BF	191	277	Cent sign
â	C0	192	300	Lowercase a circumflex
ê	C1	193	301	Lowercase e circumflex
ô	C2	194	302	Lowercase o circumflex
û	C3	195	303	Lowercase u circumflex
á	C4	196	304	Lowercase a acute
é	C5	197	305	Lowercase e acute
ó	C6	198	306	Lowercase o acute
ú	C7	199	307	Lowercase u acute

Table A-1. Roman-8 Character Conversion Table (continued)

Graphic	Hex	Dec	Oct	Description
à	C8	200	310	Lowercase a grave
è	C9	201	311	Lowercase e grave
ò	CA	202	312	Lowercase o grave
ù	CB	203	313	Lowercase u grave
ä	CC	204	314	Lowercase a dieresis
ë	CD	205	315	Lowercase e dieresis
ö	CE	206	316	Lowercase o dieresis
ü	CF	207	317	Lowercase u dieresis
Å	D0	208	320	Uppercase A bolle
î	D1	209	321	Lowercase i circumflex
Ø	D2	210	322	Uppercase O oblique
Æ	D3	211	323	Uppercase AE diphthong
å	D4	212	324	Lowercase a bolle
í	D5	213	325	Lowercase i acute
ø	D6	214	326	Lowercase o oblique
æ	D7	215	327	Lowercase ae diphthong
Ä	D8	216	330	Uppercase A dieresis
ì	D9	217	331	Lowercase i grave
Ö	DA	218	332	Uppercase O dieresis
Ü	DB	219	333	Uppercase U dieresis
É	DC	220	334	Uppercase E acute
ï	DD	221	335	Lowercase i dieresis
ß	DE	222	336	Lowercase es-zet ligature
Ô	DF	223	337	Uppercase O circumflex
Á	E0	224	340	Uppercase A acute
Ã	E1	225	341	Uppercase A tilde
ã	E2	226	342	Lowercase a tilde
Đ	E3	227	343	Uppercase Eth
ð	E4	228	344	Lowercase eth Icelandic
Í	E5	229	345	Uppercase I acute
Ì	E6	230	346	Uppercase I grave
Ó	E7	231	347	Uppercase O acute
Ò	E8	232	350	Uppercase O grave
Õ	E9	233	351	Uppercase O tilde
õ	EA	234	352	Lowercase o tilde
Š	EB	235	353	Uppercase S hacek
š	EC	236	354	Lowercase s hacek
Ú	ED	237	355	Uppercase U acute
Ÿ	EE	238	356	Uppercase Y dieresis
ÿ	EF	239	357	Lowercase y dieresis

Table A-1. Roman-8 Character Conversion Table (continued)

Graphic	Hex	Dec	Oct	Description
Þ	F0	240	360	Uppercase Thorn
þ	F1	241	361	Lowercase thorn
·	F2	242	362	Lowercase Catalan middle dot
µ	F3	243	363	Lowercase mu (micro)
¶	F4	244	364	Pilcrow (paragraph sign)
¾	F5	245	365	Vulgar fraction: three fourths
–	F6	246	366	Minus sign
¼	F7	247	367	Vulgar fraction: one fourth
½	F8	248	370	Vulgar fraction: one half
ª	F9	249	371	Female ordinal
º	FA	250	372	Male ordinal
«	FB	251	373	Left pointing guillemets (quotes)
■	FC	252	374	Medium solid box
»	FD	253	375	Right pointing guillemets (quotes)
±	FE	254	376	Plus over minus
	FF	255	377	--undefined--

B

Printer Commands

This appendix lists the LaserJet III printer commands. Table B-1 lists the PCL context printer commands in hierarchical order and gives the decimal and hexadecimal equivalents of each. Table B-2 lists the HP-GL context printer commands. Table B-3 lists the printer control codes.

Table B-1. LaserJet III Printer Commands — PCL Context

FUNCTION	PARAMETER	COMMAND	DECIMAL VALUE	HEXADECIMAL VALUE
JOB CONTROL COMMANDS				
RESET				
RESET	—	EcE	027 069	1B 45
NUMBER OF COPIES	# of Copies (1-99)	Ec&l#X *(x)*	027 038 108 #...# 088 *(120)*	1B 26 6C #...# 58 *(78)*
LONG-EDGE (LEFT) OFFSET REGISTRATION	# of Decipoints (1/720")	Ec&l#U *(u)*	027 038 108 #...# 085 *(117)*	1B 26 6C #...# 55 *(75)*
SHORT-EDGE (TOP) OFFSET REGISTRATION	# of Decipoints (1/720")	Ec&l#Z *(z)*	027 038 108 #...# 090 *(122)*	1B 26 6C #...# 5A *(7A)*
PAGE CONTROL COMMANDS				
PAGE LENGTH and SIZE				
PAPER SOURCE	Eject Page	Ec&l0H *(h)*	027 038 108 048 072 *(104)*	1B 26 6C 30 48 *(68)*
	Paper Tray Auto Feed	Ec&l1H *(h)*	027 038 108 049 072 *(104)*	1B 26 6C 31 48 *(68)*
	Manual Feed	Ec&l2H *(h)*	027 038 108 050 072 *(104)*	1B 26 6C 32 48 *(68)*
	Manual Envelope Feed	Ec&l3H *(h)*	027 038 108 051 072 *(104)*	1B 26 6C 33 48 *(68)*
PAGE SIZE	Executive	Ec&l1A *(a)*	027 038 108 049 065 *(97)*	1B 26 6C 31 41 *(61)*
	Letter	Ec&l2A *(a)*	027 038 108 050 065 *(97)*	1B 26 6C 32 41 *(61)*
	Legal	Ec&l3A *(a)*	027 038 108 051 065 *(97)*	1B 26 6C 33 41 *(61)*
	A4	Ec&l26A *(a)*	027 038 108 050 054 065 *(97)*	1B 26 6C 32 36 41 *(61)*
(Envelopes)	Monarch	Ec&l80A *(a)*	027 038 108 056 048 065 *(97)*	1B 26 6C 38 30 41 *(61)*
	COM 10	Ec&l81A *(a)*	027 038 108 056 049 065 *(97)*	1B 26 6C 38 31 41 *(61)*
	DL	Ec&l90A *(a)*	027 038 108 057 048 065 *(97)*	1B 26 6C 39 30 41 *(61)*
	C5	Ec&l91A *(a)*	027 038 108 057 049 065 *(97)*	1B 26 6C 39 31 41 *(61)*
PAGE LENGTH	# of Lines	Ec&l#P *(p)*	027 038 108 #...# 080 *(112)*	1B 26 6C #...# 50 *(70)*
ORIENTATION				
ORIENTATION	Portrait	Ec&l0O *(o)*	027 038 108 048 079 *(111)*	1B 26 6C 30 4F *(6F)*
	Landscape	Ec&l1O *(o)*	027 038 108 049 079 *(111)*	1B 26 6C 31 4F *(6F)*
	Reverse Portrait	Ec&l2O *(o)*	027 038 108 050 079 *(111)*	1B 26 6C 32 4F *(6F)*
	Reverse Landscape	Ec&l3O *(o)*	027 038 108 051 079 *(111)*	1B 26 6C 33 4F *(6F)*
PRINT DIRECTION	# Degrees of Rotation (counterclockwise, 90° increments only)	Ec&a#P	027 038 097 #...# 080 *(112)*	1B 26 61 #...# 50 *(70)*

Values in the parentheses identify the lower case of the termination character. This value is used if the printer command is combined.

Table B-1. LaserJet III Printer Commands — PCL Context (continued)

FUNCTION	PARAMETER	COMMAND		DECIMAL VALUE		HEXADECIMAL VALUE	
MARGINS and TEXT LENGTH							
TOP MARGIN	# of Lines	Ec&l#E	*(e)*	027 038 108 #...# 069	*(101)*	1B 26 6C #...# 45	*(65)*
TEXT LENGTH	# of Lines	Ec&l#F	*(f)*	027 038 108 #...# 070	*(102)*	1B 26 6C #...# 46	*(66)*
LEFT MARGIN	# of Columns	Ec&a#L	*(l)*	027 038 097 #...# 076	*(108)*	1B 26 61 #...# 4C	*(6C)*
RIGHT MARGIN	# of Columns	Ec&a#M	*(m)*	027 038 097 #...# 077	*(109)*	1B 26 61 #...# 4D	*(6D)*
CLEAR HORIZONTAL MARGINS	—	Ec9		027 057		1B 39	
PERFORATION SKIP MODE							
PERFORATION SKIP	Disable	Ec&l0L	*(l)*	027 038 108 048 076	*(108)*	1B 26 6C 30 4C	*(6C)*
	Enable	Ec&l1L	*(l)*	027 038 108 049 076	*(108)*	1B 26 6C 31 4C	*(6C)*
HORIZONTAL COLUMN SPACING							
HORIZONTAL MOTION INDEX (HMI)	# of 1/120" Increments	Ec&k#H	*(h)*	027 038 107 #...#0 48 072	*(104)*	1B 26 6B #...# 4B	*(68)*
VERTICAL LINE SPACING							
VERTICAL MOTION INDEX (VMI)	# of 1/48" Increments	Ec&l#C	*(c)*	027 038 108 #...# 048 076	*(99)*	1B 26 6C #...# 43	*(63)*
LINE SPACING (Lines per Inch)	1 line/inch	Ec&l1D	*(d)*	027 038 108 049 068	*(100)*	1B 26 6C 31 44	*(64)*
	2 lines/inch	Ec&l2D	*(d)*	027 038 108 050 068	*(100)*	1B 26 6C 32 44	*(64)*
	3 lines/inch	Ec&l3D	*(d)*	027 038 108 051 068	*(100)*	1B 26 6C 33 44	*(64)*
	4 lines/inch	Ec&l4D	*(d)*	027 038 108 052 068	*(100)*	1B 26 6C 34 44	*(64)*
	6 lines/inch	Ec&l6D	*(d)*	027 038 108 054 068	*(100)*	1B 26 6C 36 44	*(64)*
	8 lines/inch	Ec&l8D	*(d)*	027 038 108 056 068	*(100)*	1B 26 6C 38 44	*(64)*
	12 lines/inch	Ec&l12D	*(d)*	027 038 108 049 050 068	*(100)*	1B 26 6C 31 32 44	*(64)*
	16 lines/inch	Ec&l16D	*(d)*	027 038 108 049 054 068	*(100)*	1B 26 6C 31 36 44	*(64)*
	24 lines/inch	Ec&l24D	*(d)*	027 038 108 050 052 068	*(100)*	1B 26 6C 32 34 44	*(64)*
	48 lines/inch	Ec&l48D	*(d)*	027 038 108 052 056 068	*(100)*	1B 26 6C 34 38 44	*(64)*
CURSOR POSITIONING							
VERTICAL and HORIZONTAL							
VERTICAL POSITION	# of Rows	Ec&a#R	*(r)*	027 038 097 #...# 082	*(114)*	1B 26 61 #...# 52	*(72)*
	# of Dots	Ec*p#Y	*(y)*	027 042 112 #...# 089	*(121)*	1B 2A 70 #...# 59	*(79)*
	# of Decipoints	Ec&a#V	*(v)*	027 038 097 #...# 086	*(118)*	1B 26 61 #...# 56	*(76)*
HORIZONTAL POSITION	# of Columns	Ec&a#C	*(c)*	027 038 097 #...# 067	*(99)*	1B 26 61 #...# 43	*(63)*
	# of Dots	Ec*p#X	*(x)*	027 042 112 #...# 088	*(120)*	1B 2A 70 #...# 58	*(78)*
	# of Decipoints	Ec&a#H	*(h)*	027 038 097 #...# 072	*(104)*	1B 26 61 #...# 48	*(68)*
HALF LINE FEED		Ec=		027 061		1B 3D	

Values in the parentheses identify the lower case of the termination character. This value is used if the printer command is combined.

B Printer Commands

FUNCTION	PARAMETER	COMMAND	DECIMAL VALUE	HEXADECIMAL VALUE
END-OF-LINE TERMINATION				
LINE TERMINATION	CR=CR; LF=LF; FF=FF	Ec&kØG (g)	027 038 107 048 071 (103)	1B 26 6B 30 47 (67)
	CR=CR+LF; LF=LF; FF=FF	Ec&k1G (g)	027 038 107 049 071 (103)	1B 26 6B 31 47 (67)
	CR=CR; LF=CR+LF; FF=CR+FF	Ec&k2G (g)	027 038 107 050 071 (103)	1B 26 6B 32 47 (67)
	CR=CR+LF; LF=CR+LF; FF=CR+FF	Ec&k3G (g)	027 038 107 051 071 (103)	1B 26 6B 33 47 (67)
PUSH/POP POSITION				
PUSH/POP POSITION	Push	Ec&fØS (s)	027 038 102 048 083 (115)	1B 26 66 30 53 (73)
	Pop	Ec&f1S (s)	027 038 102 049 083 (115)	1B 26 66 31 53 (73)
FONT SELECTION				
SYMBOL SET SELECTION†				
PRIMARY SYMBOL SET	ISO 60: Norwegian 1	Ec(ØD (d)	027 040 048 068 (100)	1B 28 30 44 (64)
	*ISO 61: Norwegian 2	Ec(1D (d)	027 040 049 068 (100)	1B 28 31 44 (64)
	ISO 4: United Kingdom	Ec(1E (e)	027 040 049 069 (101)	1B 28 31 45 (65)
	*ISO 25: French (obsolete)	Ec(ØF (f)	027 040 048 070 (102)	1B 28 30 46 (66)
	ISO 69: French	Ec(1F (f)	027 040 049 070 (102)	1B 28 31 46 (66)
	*HP German (obsolete)	Ec(ØG (g)	027 040 048 071 (103)	1B 28 30 47 (67)
	ISO 21: German	Ec(1G (g)	027 040 049 071 (103)	1B 28 31 47 (67)
	ISO 15: Italian	Ec(ØI (i)	027 040 048 073 (105)	1B 28 30 49 (69)
	*ISO 14: JIS ASCII	Ec(ØK (k)	027 040 048 075 (107)	1B 28 30 4B (6B)
	*ISO 57: Chinese	Ec(2K (k)	027 040 050 075 (107)	1B 28 32 4B (6B)
	ECMA-94 Latin 1	Ec(ØN (n)	027 040 048 78 (110)	1B 28 30 4E (6E)
	ISO 11: Swedish	Ec(ØS (s)	027 040 048 083 (115)	1B 28 30 53 (73)
	*HP Spanish (obsolete)	Ec(1S (s)	027 040 049 083 (115)	1B 28 31 53 (73)
	ISO 17: Spanish	Ec(2S (s)	027 040 050 083 (115)	1B 28 32 53 (73)
	*ISO 10: Swedish	Ec(3S (s)	027 040 051 083 (115)	1B 28 33 53 (73)
	*ISO 16: Portuguese	Ec(4S (s)	027 040 052 083 (115)	1B 28 34 53 (73)
	*ISO 84: Portuguese	Ec(5S (s)	027 040 053 083 (115)	1B 28 35 53 (73)
	*ISO 85: Spanish	Ec(6S (s)	027 040 054 083 (115)	1B 28 36 53 (73)
	ISO 6: ASCII	Ec(ØU (u)	027 040 048 085 (117)	1B 28 30 55 (75)
	*ISO 2: IRV	Ec(2U (u)	027 040 050 085 (117)	1B 28 32 55 (75)
	Roman8	Ec(8U (u)	027 040 056 85 (117)	1B 28 38 55 (75)
	PC-8	Ec(1ØU (u)	027 040 049 048 085 (117)	1B 28 31 30 55 (75)
	PC-8 D/N	Ec(11U (u)	027 040 049 049 085 (117)	1B 28 31 31 55 (75)
	PC 850	Ec(12U (u)	027 040 049 050 085 (117)	1B 28 31 32 55 (75)

Values in the parentheses identify the lower case of the termination character. This value is used if the printer command is combined.

†Additional symbol sets are supported.

*These symbol sets are becoming low usage sets and are not recommended for future use.

The primary font printer commands in this table can be specified as secondary by replacing the left parenthesis "(" in the command with a right parenthesis ")."

Table B-1. LaserJet III Printer Commands — PCL Context (continued)

FUNCTION	PARAMETER	COMMAND		DECIMAL VALUE		HEXADECIMAL VALUE	
SPACING							
PRIMARY SPACING	Proportional	Ec(s1P	*(p)*	027 040 115 049 080	*(112)*	1B 28 73 31 50	*(70)*
	Fixed	Ec(sØP	*(p)*	027 040 115 048 080	*(112)*	1B 28 73 30 50	*(70)*
PITCH							
PRIMARY PITCH	# Characters/inch	Ec(s#H	*(h)*	027 040 115 #...# 072	*(104)*	1B 28 73 #...# 48	*(68)*
SET PITCH MODE	10.0	Ec&k0S	*(s)*	027 038 107 048 083	*(115)*	1B 26 6B 30 53	*(73)*
	Compressed (16.5-16.7)	Ec&k2S	*(s)*	027 038 107 050 083	*(115)*	1B 26 6B 32 53	*(73)*
	Elite (12.0)	Ec&k4S	*(s)*	027 038 107 052 083	*(115)*	1B 26 6B 34 53	*(73)*
POINT SIZE							
PRIMARY HEIGHT	# Points	Ec(s#V	*(v)*	027 040 115 #...# 086	*(118)*	1B 28 73 #...# 56	*(76)*
STYLE							
PRIMARY STYLE	Upright	Ec(sØS	*(s)*	027 040 115 048 083	*(115)*	1B 28 73 30 53	*(73)*
	Italic	Ec(s1S	*(s)*	027 040 115 049 083	*(115)*	1B 28 73 31 53	*(73)*
The LaserJet III printer allows you to specify complex structures (contours, outlines, shading, etc.) and widths as well as posture.							
STROKE WEIGHT							
PRIMARY FONT STROKE WEIGHT	Ultra Thin	Ec(s-7B		027 040 115 -055 066	*(98)*	1B 28 73 -37 42	*(62)*
	Extra Thin	Ec(s-6B		027 040 115 -054 066	*(98)*	1B 28 73 -36 42	*(62)*
	Thin	Ec(s-5B		027 040 115 -053 066	*(98)*	1B 28 73 -35 42	*(62)*
	Extra Light	Ec(s-4B		027 040 115 -052 066	*(98)*	1B 28 73 -34 42	*(62)*
	Light	Ec(s-3B		027 040 115 -051 066	*(98)*	1B 28 73 -33 42	*(62)*
	Demi Light	Ec(s-2B		027 040 115 -050 066	*(98)*	1B 28 73 -32 42	*(62)*
	Semi Light	Ec(s-1B		027 040 115 -049 066	*(98)*	1B 28 73 -31 42	*(62)*
	Medium (normal)	Ec(s0B		027 040 115 048 066	*(98)*	1B 28 73 30 42	*(62)*
	Semi Bold	Ec(s1B		027 040 115 049 066	*(98)*	1B 28 73 31 42	*(62)*
	Demi Bold	Ec(s2B		027 040 115 050 066	*(98)*	1B 28 73 32 42	*(62)*
	Bold	Ec(s3B		027 040 115 051 066	*(98)*	1B 28 73 33 42	*(62)*
	Extra Bold	Ec(s4B		027 040 115 052 066	*(98)*	1B 28 73 34 42	*(62)*
	Black	Ec(s5B		027 040 115 053 066	*(98)*	1B 28 73 35 42	*(62)*
	Extra Black	Ec(s6B		027 040 115 054 066	*(98)*	1B 28 73 36 42	*(62)*
	Ultra Black	Ec(s7B		027 040 115 055 066	*(98)*	1B 28 73 37 42	*(62)*
PRIMARY TYPEFACE							
TYPEFACE	Courier	Ec(s3T	*(t)*	027 040 115 051 084	*(116)*	1B 28 73 33 54	*(74)*
	Univers	Ec(s4148T	*(t)*	027 040 115 052 084	*(116)*	1B 28 73 34 54	*(74)*
	LinePrinter	Ec(sØT	*(t)*	027 040 115 048 084	*(116)*	1B 28 73 30 54	*(74)*
	CG Times	Ec(s4101T	*(t)*	027 040 115 053 084	*(116)*	1B 28 73 35 54	*(74)*
	Many more typefaces are supported.						

Values in the parentheses identify the lower case of the termination character. This value is used if the printer command is combined.

The primary font printer commands in this table can be specified as secondary by replacing the left parenthesis "(" in the command with a right parenthesis ")".

Table B-1. LaserJet III Printer Commands — PCL Context (continued)

FUNCTION	PARAMETER	COMMAND	DECIMAL VALUE	HEXADECIMAL VALUE
		FONT DEFAULT		
FONT DEFAULT	Primary Font Secondary Font	Ec(3@ Ec)3@	027 040 051 064 027 041 051 064	1B 28 33 40 1B 29 33 40
		UNDERLINE		
UNDERLINE	Enable Fixed Enable Floating Disable	Ec&dØD *(d)* Ec&d3D *(d)* Ec&d@	027 038 100 048 068 *(100)* 027 038 100 051 068 *(100)* 027 038 100 064	1B 26 64 30 44 *(64)* 1B 26 64 33 44 *(64)* 1B 26 64 40
		TRANSPARENT PRINT		
TRANSPARENT PRINT DATA	# of Bytes	Ec&p#X[Data]	027 038 112 #...# 088	1B 26 70 #...# 58
		FONT MANAGEMENT		
ASSIGN FONT ID	Font ID #	Ec*c#D *(d)*	027 042 099 #...# 068 *(100)*	1B 2A 63 #...# 44 *(64)*
FONT AND CHARACTER CONTROL	Delete all Fonts	Ec*cØF *(f)*	027 042 099 048 070 *(102)*	1B 2A 63 30 46 *(66)*
	Delete all Temporary Fonts	Ec*c1F *(f)*	027 042 099 049 070 *(102)*	1B 2A 63 31 46 *(66)*
	Delete Last Font ID Specified	Ec*c2F *(f)*	027 042 099 050 070 *(102)*	1B 2A 63 32 46 *(66)*
	Delete Last Character Specified	Ec*c3F *(f)*	027 042 099 051 070 *(102)*	1B 2A 63 33 46 *(66)*
	Make Font Temporary	Ec*c4F *(f)*	027 042 099 052 070 *(102)*	1B 2A 63 34 46 *(66)*
	Make Font Permanent	Ec*c5F *(f)*	027 042 099 053 070 *(102)*	1B 2A 63 35 46 *(66)*
	Copy / Assign the Currently Invoked Font as Temporary	Ec*c6F *(f)*	027 042 099 054 070 *(102)*	1B 2A 63 36 46 *(66)*
		FONT SELECTION BY ID NUMBER		
SELECT FONT (with ID #)	ID # Primary Font ID # Secondary Font	Ec(#X *(x)* Ec)#X *(x)*	027 040 #...# 088 *(120)* 027 041 #...# 088 *(120)*	1B 28 #...# 58 *(78)* 1B 29 #...# 58 *(78)*
		SOFT FONT CREATION		
FONT DESCRIPTOR (FONT HEADER)	# of Bytes	Ec)s#W[Data]	027 041 115 #...# 087	1B 29 73 #...# 57
DOWNLOAD CHARACTER	# of Bytes	Ec(s#W[Data]	027 040 115 #...# 087	1B 28 73 #...# 57
CHARACTER CODE	Character Code # (decimal)	Ec*c#E *(e)*	027 042 099 #...# 069 *(101)*	1B 2A 63 #...# 45 *(65)*

Values in the parentheses identify the lower case of the termination character. This value is used if the printer command is combined.

Table B-1. LaserJet III Printer Commands — PCL Context (continued)

FUNCTION	PARAMETER	COMMAND	DECIMAL VALUE	HEXADECIMAL VALUE
GRAPHICS				
VECTOR GRAPHICS				
ENTER HP-GL / 2 MODE	Use Previous HP-GL / 2 Pen Position	Ec%0B	027 037 048 066 *(98)*	1B 25 30 42 *(62)*
	Use Current PCL CAP	Ec%1B	027 037 049 066 *(98)*	1B 25 31 42 *(62)*
HP-GL / 2 PLOT HORIZONTAL SIZE	Horizontal Size in Inches	Ec*c#K	027 042 099 #...# 075 *(107)*	1B 2A 63 #...# 4B *(6B)*
HP-GL / 2 PLOT VERTICAL SIZE	Vertical Size in Inches	Ec*c#L	027 042 099 #...# 076 *(108)*	1B 2A 63 #...# 4C *(6C)*
SET PICTURE FRAME ANCHOR POINT	Set Anchor Point to CAP	Ec*c0T	027 042 099 048 084 *(116)*	1B 2A 63 30 54 *(74)*
PICTURE FRAME HORIZONTAL SIZE	Decipoints	Ec*c#X	027 042 99 #...# 088 *(120)*	1B 2A 63 #...# 58 *(78)*
PICTURE FRAME VERTICAL SIZE	Decipoints	Ec*c#Y	027 042 99 #...# 089 *(121)*	1B 2A 63 #...# 59 *(79)*
RASTER GRAPHICS				
RASTER RESOLUTION	75 Dots / inch	Ec*t75R *(r)*	027 042 116 055 053 082 *(114)*	1B 2A 74 37 35 52 *(72)*
	100 Dots / inch	Ec*t100R *(r)*	027 042 116 049 048 048 082 *(114)*	1B 2A 74 31 30 30 52 *(72)*
	150 Dots / inch	Ec*t150R *(r)*	027 042 116 049 053 048 082 *(114)*	1B 2A 74 31 35 30 52 *(72)*
	300 Dots / inch	Ec*t300R *(r)*	027 042 116 051 048 048 082 *(114)*	1B 2A 74 33 30 30 52 *(72)*

Values in the parentheses identify the lower case of the termination character. This value is used if the printer command is combined.

Table B-1. LaserJet III Printer Commands — PCL Context (continued)

FUNCTION	PARAMETER	COMMAND	DECIMAL VALUE	HEXADECIMAL VALUE
RASTER GRAPHICS PRESENTATION				
RASTER GRAPHICS PRESENTATION	Rotate Image	Ec*rØF (f)	027 042 114 048 070 (102)	1B 2A 72 30 46 (66)
	LaserJet Landscape Compatible	Ec*r3F (f)	027 042 114 051 070 (102)	1B 2A 72 33 46 (66)
START RASTER GRAPHICS	Left Raster Graphics Margin	Ec*rØA (a)	027 042 114 048 065 (97)	1B 2A 72 30 41 (61)
	Current Cursor	Ec*r1A (a)	027 042 114 049 065 (97)	1B 2A 72 31 41 (61)
RASTER Y OFFSET	# of Raster Lines of Vertical Movement	Ec*b#Y (y)	027 042 098 #...# 089 (120)	1B 2A 62 #...# 59 (79)
SET RASTER COMPRESSION MODE	Uncoded	Ec*bØM (m)	027 042 098 048 077 (109)	1B 2A 62 30 41 (6D)
	Run-Length Encoded	Ec*b1M (m)	027 042 098 049 077 (109)	1B 2A 62 31 41 (6D)
	Tagged Image File Format	Ec*b2M (m)	027 042 098 050 077 (109)	1B 2A 62 32 41 (6D)
	Delta Row	Ec*b3M (m)	027 042 098 051 077 (109)	1B 2A 72 33 41 (6D)
TRANSFER RASTER DATA	# of Bytes	Ec*b#W[Data]	027 042 098 #...# 087	1B 2A 62 #...# 57
END RASTER GRAPHICS	—	Ec*rB (b)	027 042 114 066 (98)	1B 2A 72 42 (62)
RASTER HEIGHT	# Raster Rows	Ec*r#T (t)	027 042 114 #...# 084 (116)	1B 2A 72 #...# 54 (74)
RASTER WIDTH	# Pixels of the Specified Resolution	Ec*r#S (s)	027 042 114 #...# 083 (115)	1B 2A 72 #...# 53 (73)
THE PRINT MODEL				
IMAGING				
SELECT PATTERN	Solid Black (default)	Ec*v0T	027 042 118 048 084 (116)	1B 2A 76 30 54 (74)
	Solid White	Ec*v1T	027 042 118 049 084 (116)	1B 2A 76 31 54 (74)
	HP-defined Shading Pattern	Ec*v2T	027 042 118 050 084 (116)	1B 2A 76 32 54 (74)
	HP-defined Cross-Hatched Pattern	Ec*v3T	027 042 118 051 084 (116)	1B 2A 76 33 54 (74)
SELECT SOURCE TRANSPARENCY MODE	Transparent	Ec*v0N	027 042 118 048 078 (110)	1B 2A 76 31 42 (6E)
	Opaque	Ec*v1N	027 042 118 049 078 (110)	1B 2A 76 31 42 (6E)
SELECT PATTERN TRANSPARENCY MODE	Transparent	Ec*v0O	027 042 118 048 079 (111)	1B 2A 76 30 43 (6F)
	Opaque	Ec*v1O	027 042 118 049 079 (111)	1B 2A 76 31 43 (6F)
RECTANGLE DIMENSIONS				
RECTANGLE WIDTH (Horizontal Size)	# of Dots	Ec*c#A (a)	027 042 099 #...# 065 (97)	1B 2A 63 #...# 41 (61)
	# of Decipoints	Ec*c#H (h)	027 042 099 #...# 072 (104)	1B 2A 63 #...# 48 (68)
RECTANGLE HEIGHT (Vertical Size)	# of Dots	Ec*c#B (b)	027 042 099 #...# 066 (98)	1B 2A 63 #...# 42 (62)
	# of Decipoints	Ec*c#V (v)	027 042 099 #...# 086 (118)	1B 2A 63 #...# 56 (76)

Values in the parentheses identify the lower case of the termination character. This value is used if the printer command is combined.

Table B-1. LaserJet III Printer Commands — PCL Context (continued)

FUNCTION	PARAMETER	COMMAND		DECIMAL VALUE		HEXADECIMAL VALUE	
RECTANGULAR AREA FILL							
FILL RECTANGULAR AREA	Solid Black	Ec*cOP		027 042 099 048 080	*(112)*	1B 2A 63 30 50	*(70)*
	Erase (Solid White Area Fill)	Ec*1P		027 042 099 049 080	*(112)*	1B 2A 63 31 50	*(70)*
	Shaded Fill	Ec*c2P		027 042 099 050 080	*(112)*	1B 2A 63 32 50	*(70)*
	Cross-hatched Fill	Ec*c3P		027 042 099 051 080	*(112)*	1B 2A 63 33 50	*(70)*
	User Defined	Ec*c4P		027 042 099 052 080	*(112)*	1B 2A 63 34 50	*(70)*
	Current Pattern	Ec*c5P		027 042 099 053 080	*(112)*	1B 2A 63 35 50 (70)	
PATTERN ID	% of Shading or Type of Pattern	Ec*c#G		027 042 099 #...# 071	*(103)*	1B 2A 63 #...# 47	*(67)*
SHADING	2% Gray	Ec*c2G	*(g)*	027 042 099 050 071	*(103)*	1B 2A 63 32 47	*(67)*
	10% Gray	Ec*c10G	*(g)*	027 042 099 049 048 071	*(103)*	1B 2A 63 31 30 47	*(67)*
	15% Gray	Ec*c15G	*(g)*	027 042 099 049 053 071	*(103)*	1B 2A 63 31 35 47	*(67)*
	30% Gray	Ec*c30G	*(g)*	027 042 099 051 048 071	*(103)*	1B 2A 63 33 30 47	*(67)*
	45% Gray	Ec*c45G	*(g)*	027 042 099 052 053 071	*(103)*	1B 2A 63 34 35 47	*(67)*
	70% Gray	Ec*c70G	*(g)*	027 042 099 055 048 071	*(103)*	1B 2A 63 37 30 47	*(67)*
	90% Gray	Ec*c90G	*(g)*	027 042 099 057 048 071	*(103)*	1B 2A 63 39 30 47	*(67)*
	100% Gray	Ec*c100G	*(g)*	027 042 099 049 048 048 071	*(103)*	1B 2A 63 31 30 30 47	*(67)*
PATTERN	1 Horiz. Line	Ec*c1G	*(g)*	027 042 099 049 071	*(103)*	1B 2A 63 31 47	*(67)*
	2 Vert. Lines	Ec*c2G	*(g)*	027 042 099 050 071	*(103)*	1B 2A 63 32 47	*(67)*
	3 Diagonal Lines	Ec*c3G	*(g)*	027 042 099 051 071	*(103)*	1B 2A 63 33 47	*(67)*
	4 Diagonal Lines	Ec*c4G	*(g)*	027 042 099 052 071	*(103)*	1B 2A 63 34 47	*(67)*
	5 Square Grid	Ec*c5G	*(g)*	027 042 099 053 071	*(103)*	1B 2A 63 35 47	*(67)*
	6 Diagonal Grid	Ec*c6G	*(g)*	027 042 099 054 071	*(103)*	1B 2A 63 36 47	*(67)*
MACROS							
MACRO ID	Macro ID #	Ec&f#Y	*(y)*	027 038 102 #...# 089	*(121)*	1B 26 66 #...# 59	*(79)*
MACRO CONTROL	Start Macro Def.	Ec&f0X	*(x)*	027 038 102 048 088	*(120)*	1B 26 66 30 58	*(78)*
	Stop Macro Def.	Ec&f1X	*(x)*	027 038 102 049 088	*(120)*	1B 26 66 31 58	*(78)*
	Excecute Macro	Ec&f2X	*(x)*	027 038 102 050 088	*(120)*	1B 26 66 32 58	*(78)*
	Call Macro	Ec&f3X	*(x)*	027 038 102 051 088	*(120)*	1B 26 66 33 58	*(78)*
	Enable Overlay	Ec&f4X	*(x)*	027 038 102 052 088	*(120)*	1B 26 66 34 58	*(78)*
	Disable Overlay	Ec&f5X	*(x)*	027 038 102 053 088	*(120)*	1B 26 66 35 58	*(78)*
	Delete Macros	Ec&f6X	*(x)*	027 038 102 054 088	*(120)*	1B 26 66 36 58	*(78)*
	Delete All Temp. Macros	Ec&f7X	*(x)*	027 038 102 055 088	*(120)*	1B 26 66 37 58	*(78)*
	Delete Macro ID	Ec&f8X	*(x)*	027 038 102 056 088	*(120)*	1B 26 66 38 58	*(78)*
	Make Temporary	Ec&f9X	*(x)*	027 038 102 057 088	*(120)*	1B 26 66 39 58	*(78)*
	Make Permanent	Ec&f10X	*(x)*	027 038 102 049 048 088	*(120)*	1B 26 66 31 30 58	*(78)*
PROGRAMING HINTS							
DISPLAY FUNCTIONS	ON	EcY		027 089		1B 59	
	OFF	EcZ		027 090		1B 5A	
END-OF-LINE WRAP	Enabled	Ec&s0C	*(c)*	027 038 115 048 067	*(99)*	1B 26 73 30 43	*(63)*
	Disabled	Ec&s1C	*(c)*	027 038 115 049 067	*(99)*	1B 26 73 31 43	*(63)*

Values in the parentheses identify the lower case of the termination character. This value is used if the printer command is combined.

Table B-2. LaserJet III Printer Commands — HP-GL/2 Context

COMMAND	MNEMONIC	PARAMETERS*
DUAL CONTEXT EXTENSIONS		
ENTER PCL MODE	Esc%#A	0 – Retain previous PCL cursor position 1 – Use current HPGL pen position
RESET	EscE	None
PRIMARY FONT	FI	Font_ID
SECONDARY FONT	FN	Font_ID
SCALABLE OR BITMAPPED FONTS	SB	0 – Scalable fonts only 1 – Bitmapped fonts allowed
PALETTE EXTENSIONS		
TRANSPARENCY MODE	TR	0 – Off (opaque) 1 – On (transparent)
SCREENED VECTORS	SV	[screen_type[,shading[,index]]]

HP-GL/2 Kernel		
VECTOR GROUP *Parameters in brackets are optional.		
ARC ABSOLUTE	AA	x_center,y_center,sweep_angle [,chord_angle];
ARC RELATIVE	AR	x_increment,y_increment,sweep_angle [,chord_angle];
ABSOLUTE ARC THREE POINT	AT	x_inter,y_inter,x_end,y_end [,chord_angle];
PLOT ABSOLUTE	PA	[x,y ... [,x,y]];
PLOT RELATIVE	PR	[x,y ... [,x,y]];
PEN DOWN	PD	[x,y ... [,x,y]];
PEN UP	PU	[x,y ... [,x,y]];
RELATIVE ARC THREE POINT	RT	x_incr_inter,y_incr_inter,x_incr_end,y_incr-end [,chord_angle];
POLYLINE ENCODED	PE	[flag[val]|coord_pair ... [flag[val]|coord_pair]];

Table B-2.
LaserJet III Printer Commands — HP-GL/2 Context (continued)

HP-GL/2 Kernel (continued)		
COMMAND	**MNEMONIC**	**PARAMETERS***
POLYGON GROUP *Parameters in brackets are optional.		
CIRCLE	CI	radius [,chord_angle];
FILL RECTANGLE ABSOLUTE	RA	x_coordinate,y_coordinate;
FILL RECTANGLE RELATIVE	RR	x_increment,y_increment;
EDGE RECTANGLE ABSOLUTE	EA	x_coordinate,y_coordinate;
EDGE RECTANGLE RELATIVE	ER	x_increment,y_increment;
FILL WEDGE	WG	radius,start_angle,sweep_angle [,chord_angle];
EDGE WEDGE	EW	radius,start_angle,sweep_angle [,chord_angle];
POLYGON MODE	PM	polygon_definition;
FILL POLYGON	FP	
EDGE POLYGON	EP	

HP-GL/2 Kernel (continued)		
COMMAND	**MNEMONIC**	**PARAMETERS***
CHARACTER GROUP *Parameters in brackets are optional.		
SELECT STANDARD FONT	SS	
SELECT ALTERNATE FONT	SA	
ABSOLUTE DIRECTION	DI	[run,rise];
RELATIVE DIRECTION	DR	[run,rise];
ABSOLUTE CHARACTER SIZE	SI	[width,height];
RELATIVE CHARACTER SIZE	SR	[width,height];
CHARACTER SLANT	SL	[tangent_of_angle];
EXTRA SPACE	ES	[width [,height]]
STANDARD FONT DEFINITION	SD	[kind,value ... [,kind,value]];
ALTERNATE FONT DEFINITION	AD	[kind,value ... [,kind,value]];
CHARACTER FILL MODE	CF	[fill_mode[,edge_pen]];
LABEL ORIGIN	LO	[position];
LABEL	LB	[char ... [char]]1bterm
DEFINE LABEL TERMINATOR	DT	[1bterm[,mode]];
CHARACTER PLOT	CP	[spaces,lines];
TRANSPARENT DATA	TD	[mode];
DEFINE VARIABLE TEXT PATH	DV	[path[,line]];

Table B-2.
LaserJet III Printer Commands — HP-GL/2 Context (continued)

HP-GL/2 Kernel (continued)		
COMMAND	**MNEMONIC**	**PARAMETERS***
LINE AND FILL ATTRIBUTES GROUP *Parameters in brackets are optional.		
LINE TYPE	LT	[line_type[,pattern_length[,mode]]];
LINE ATTRIBUTES	LA	[kind,value ... [,kind,value]];
PEN WIDTH	PW	[width[,pen]];
PEN WIDTH UNIT SELECTION	WU	[type];
SELECT PEN	SP	[pen];
SYMBOL MODE	SM	[char];
FILL TYPE	FT	[fill_type[,option1[,option2]]];
ANCHOR CORNER	AC	[x_coordinate,y_coordinate];
RASTER FILL DEFINITION	RF	[index[,width,height,pen_nbr ... pen_nbr]];
USER DEFINED LINE TYPE	UL	[index[,gap1 ... gapn]];
CONFIGURATION AND STATUS GROUP *Parameters in brackets are optional.		
SCALE	SC	[x1,x2,y1,y2[,type[,left,bottom]]]; or [x1,xfactor,y1,yfactor,2];
INPUT WINDOW	IW	[xLL,yLL,xUR,yUR];
INPUT P1 AND P2	IP	[p1x,p1y[,p2x,p2y]];
INPUT RELATIVE P1 AND P2	IR	[p1x,p1y[,p2x,p2y]];
DEFAULT VALUES	DF	
INITIALIZE	IN	[n];
ROTATE COORDINATE SYSTEM	RO	[angle];
ADVANCE FULL PAGE	PG	[n];
REPLOT	RP	[n];

Table B-3. LaserJet III Control Codes

Backspace	BS	Move one column left unless at left margin in which case no action is taken.
Line Feed	LF	Move to next print line while maintaining current column position.
Form Feed	FF	Move to first line at top of the next page while maintaining current column position.
Carriage Return	CR	Move to the left margin on current print line.
Shift Out	SO	Select characters that follow from the current secondary font until receipt of a Shift In.
Shift In	SI	Select characters that follow from the current primary font until receipt of a Shift Out.
Escape	EC	Indicates the beginning of a special control sequence (escape sequence).
Horizontal Tab	HT	Move to next horizontal tab stop. The tab stops are at the left margin and at every eight columns to the right of the left margin.
Space	SP	Move one column to the right unless at right margin in which case no action is taken.

C

Interfaces

Introduction

The LaserJet III printer supports an RS-232C serial interface, an RS-422 differential serial interface, and a Centronics parallel interface. Two connectors, a parallel and serial connector, are provided at the rear of the printer.

The parallel, RS-232, and RS-422 interfaces are configured using the Operator Control Panel's configuration menu (refer to the *HP LaserJet III Printer User's Manual* for configuration information).

The printer stores the I/O configuration information in non-volatile RAM, thus the configuration is saved even if the printer is powered off.

The printer has three 1024 byte I/O buffers that are common to both the parallel and serial interfaces.

Parallel Interface

Parallel I/O operation is enabled from the printer's Operator Control Panel configuration menu (refer to the *HP LaserJet III Printer User's Manual*). Once parallel operation is enabled, the user can transfer data to the printer using parallel (Centronics) communication protocol. The signals used for parallel communication are listed in Table C-1.

Table C-1.
Parallel Interface Connector Pin Assignments

Signal	Pin	Pin	Signal
–Strobe (Input)	1	19	GND
Data 1 (Input)	2	20	GND
Data 2 (Input)	3	21	GND
Data 3 (Input)	4	22	GND
Data 4 (Input)	5	23	GND
Data 5 (Input)	6	24	GND
Data 6 (Input)	7	25	GND
Data 7 (Input)	8	26	GND
Data 8 (Input)	9	27	GND
–Ack (Output)	10	28	GND
Busy (Output)	11	29	GND
Paper error (Output)	12	30	GND
Select (Output)	13	31	NC
NC	14	32	–fault (Output)
NC	15	33	Auxout1 (Output)
O VDC	16	34	NC
Chassis GND	17	35	Auxout2 (Output)
+5 VDC (Output)	18	36	NC

The "–" in front of the signals indicates that the signal is negative true (active LOW). GND means the connection is a ground. NC indicates that there is no connection for the pin.

Input signals

Data Strobe (Pin 1)

Data Strobe tells the printer when the data on the data lines is valid. The printer latches the data on the falling edge of the strobe and asserts the BUSY signal. BUSY is set high immediately after the Data Strobe signal line is asserted. Refer to Figure C-1.

Data Lines (Pins 2-9)

Eight lines are used for character transfer from the host CPU to the printer. Data line 1 is the least significant bit; data line 8 is the most significant bit.

Output signals

Select line (Pin 13)

This signal indicates that the printer has been placed ON-LINE and that no printer errors or malfunctions exist. The select line is HIGH when the printer is ON-LINE, LOW when the printer is OFF-LINE.

When the printer is changed from OFF-LINE to ON-LINE, this signal changes from the de-select state to the select state, an −Ack pulse is sent to the host CPU and the BUSY signal is set LOW.

When the printer is changed from ON-LINE to OFF-LINE, this signal changes from the select state to the de-select state. If the BUSY signal is HIGH when select changes, BUSY remains HIGH. If the BUSY signal is LOW when select changes, BUSY will change to HIGH to indicate that the printer is no longer ready for data. If no −Ack pulse is generated before select changes, no −Ack pulse will be generated until the printer is put back ON-LINE. The host CPU can catch either the momentary not-BUSY signal or an extraneous −Ack pulse and strobe another character into the printer while it is going OFF-LINE. The printer interface can detect and accept this late-coming character without data loss.

If a malfunction occurs in the printer while in the ON-LINE state, the printer goes OFF-LINE and this signal changes just as it would for a normal ON-LINE to OFF-LINE transition.

The printer is set to a select state at power-on.

Fault line (Pin 32)

–Fault goes LOW when the printer is OFF-LINE or if any malfunction out of paper or any malfunction or error occurs in the printer.

Busy line (Pin 11)

When Busy is LOW, the printer can accept another character from the host. Busy is set HIGH immediately after the Data Strobe signal line is asserted. Busy will stay HIGH (not ready for data) whenever –Fault is LOW and whenever the I/O buffer is full.

Acknowledge line (Pin 10)

–Ack is also used to synchronize the transfer of data from the host CPU to the printer. The –Ack pulse is a "request for data" signal generated by the printer and expects one character in response from the host CPU. During normal data transfer, the leading edge of –Ack signal is generated before the BUSY signal changes from HIGH to LOW (not-BUSY). A –Ack pulse is generated each time the printer changes from OFF-LINE to ON-LINE.

Paper error line (Pin 12)

Normally LOW, this signal changes to HIGH when the printer runs out of paper. In addition to paper errors, this signal responds to any of the following conditions:

- Error 21
- Paper Jams
- Memory Out
- Paper Out
- Incorrect Paper Size

When the Paper Error signal is HIGH, the −Fault signal is always LOW.

O VDC (Pin 16)

Same as logic ground.

Chassis Grounds (Pin 17)

Same as frame ground.

+5 Volts (Pin 18)

This is not +5 VDC directly, but rather it is +5 VDC with a 464 ohm in-line resistor. This signal is not intended to provide power to any external devices; it is provided only to be compatible with host CPUs that may test this pin for a logic HIGH before attempting data transfers.

Auxout1 (Pin 33)

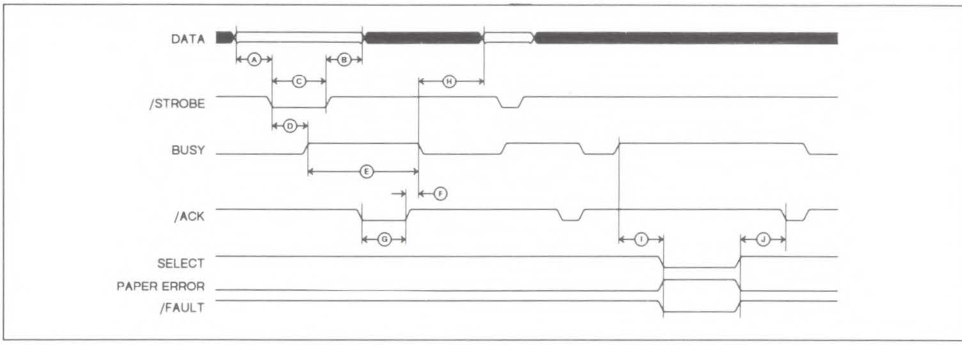
This signal is always HIGH while the printer is powered on.

Auxout2 (Pin 35)

This signal is always HIGH while the printer is powered on.

Handshake Timing

The timing specifications for parallel plug-compatible interfaces are described in the following figure.



Timing specification Description		VALUE		
		minimum	typical	maximum
A:	DATA setup time before $\overline{\text{STROBE}}$ TRUE	$0.5\mu S$	—	—
B:	DATA hold time after $\overline{\text{STROBE}}$ FALSE	$0.5\mu S$	—	—
C:	$\overline{\text{STROBE}}$-TRUE pulse width	$1.0\mu S$	—	$500\mu S$
D:	$\overline{\text{STROBE}}$-TRUE to BUSY-TRUE	—	$0.05\mu S$	$0.1\mu S$
E:	BUSY-TRUE duration when receiving data	$10\mu S$	$200\mu S$	—
F:	$\overline{\text{ACK}}$-FALSE to BUSY-FALSE	$-0.2\mu S$	$0.0\mu S$	—
G:	$\overline{\text{ACK}}$-TRUE pulse width	$2.5\mu S$	—	$10\mu S$
H:	BUSY-FALSE to start of next cycle	$0.0\mu S$	—	—
I:	BUSY-TRE is before $\overline{\text{FAULT}}$ set TRUE SELECT set FALSE PE set TRUE	$1.0\mu S$	—	—
J:	$\overline{\text{ACK}}$-TRUE is after $\overline{\text{FAULT}}$ set FALSE SELECT set TRUE PE set FALSE	$1.0\mu S$	—	—

Hardware

Connector

The receptacle installed in the printer is the Amphenol 850-57FE-403600-20 36-pin connector, or equivalent.

Cable

The external cable connecting the host CPU to the printer is supplied by the user. The plug required for the user's cable must be compatible with the Amphenol 57-30360 36-pin connector.

Note The parallel interface is designed to work with properly shielded cables shorter than ten feet.

Line Driver Circuitry

Each output signal from the printer (−Ack, Busy, Paper Error, Select, Auxout1, Auxout2, and −Fault) is driven onto the interface cable line with an 7406 (or equivalent) open-collector buffer with an output pull-up resistor of 1K ohms to +5 VDC. The −Ack and Busy signals have a "return" line associated with them; this is simply logic ground

Line Receiver Circuitry

Each Data input signal to the printer is received off the interface cable with an 74HCT374 with an input pull-up 1K ohm resistor to +5 VDC. The "return" signal associated with each data line is simply logic ground.

The Strobe input signal to the printer is received off the interface cable with an input pull-up 619 ohm resistor to +5 VDC and a 180pF capacitor to ground. The "return" signal associated with the Strobe line is simply logic ground. The "return" signal associated with the Strobe line is simply logic ground.

Serial Interface

Serial I/O operation is enabled from the printer's Operator Control Panel Menu (refer to the LaserJet III Printer User's Manual). When serial operation is enabled, the user can transfer data to the printer using either RS-232C or RS-422 protocol. RS-232C and RS-422 operation is configured from the printer's Operator Control Panel (refer to the user's manual).

The signals used by the printer for serial communication are listed in Table C-2.

Table C-2. RS-232C/422 Signals; Connector Pin Assignments

Pin Number	Description	RS232	RS422	I/O
1	Protective/Sheild ground	*	*	
2	Transmitted data (data from printer)	*		Output
3	Received data (received from printer)	*		Input
	Received data inverted (RDA) (received by printer)		*	Input
4	Request to send. This signal is HIGH when unit is powered on	*		Output
7	Signal ground	*	*	
9	Send data inverted (SDA)		*	Output
10	Send data noninverted (SDB)		*	Output
18	Receive data noninverted (RDB)		*	Input
20	Data terminal ready	*		Output

The asterisks identify signals used.

Serial Data Format

Transmission is asynchronous, with one start bit, eight data bits and one stop bit. Parity is not used.

Serial Data Communication Throughput

Unlike the parallel interface, the selected baud rate of the serial interface limits the rate at which data passes through the machine. The LaserJet III printer supports the following baud rates:

300	600
1200	2400
4800	9600
19,200	

The baud rate is configured via the configuration menu on the operator control panel (refer to the LaserJet III Printer User's Manual for configuration information).

Serial Interface Protocol

Two handshake methods are always available for controlling data transfer between the host and the printer. For RS-232C operation, Xon/Xoff and a hardware handshake protocol are available. (The Data Terminal Ready signal, pin 20, is available for hardware handshake.) Only Xon/Xoff operation is available for RS-422 operation.

Xon/Xoff

Xon/Xoff is a data stream handshake protocol which sends Xon (DC1; 11 Hex) to the computer when the printer is able to accept data and sends Xoff (DC3; 13 Hex) when the printer is not ready for data.

The printer transmits an Xon when it is ready to accept more data from the host. The printer requests data when the following three conditions exist (each time any one becomes TRUE, making all three true again):

1. when the I/O buffer has more than 64 empty bytes
2. when it is ON-LINE,
3. when it is NOT BUSY.

If no data is received within approximately one second of the transmission of an Xon, the printer may be configured so that it sends additional Xon's at one second intervals until data is received. The ROBUST-XON Operator Control Panel configuration menu item is used to select whether additional Xon's should be transmitted. If ROBUST-XON is set to ON, additional Xon's will be transmitted at one second intervals until data is received. If ROBUST-XON is set to OFF, additional Xon's are not transmitted. The factory setting is ROBUST-XON set to ON.

Xoff's are transmitted by the printer to the computer to indicate that the printer is not ready to accept data. An Xoff is transmitted when any one of the following conditions exist:

- The I/O buffer has 64 or fewer bytes empty,
- the printer is OFF-LINE, or
- the printer is BUSY.

If additional data bytes are received from the host after the Xoff is transmitted, additional Xoff characters are transmitted when the buffer has 32, 16, 8, 4, 2, 1, and 0 bytes empty. Also, an Xoff is transmitted as soon as state "05 SELF TEST,"changes to "02 WARMING UP" when the printer is powered ON.

Data Terminal Ready (RS-232C - pin 20)

A hardware handshake is also available with the printer. The Data Terminal Ready (DTR) signal line is available for hardware handshake at pin 20 of the serial connector. This signal line is always operating; it does not require enabling.

The DTR signal line indicates whether the printer is "ready" or "not ready" for data. When the printer is ready for data, the DTR signal switches to a HIGH (or a LOW, if the DTR line is set for inverted operation). The printer will request data when the following three conditions exist:

1. when the I/O buffer has more than 64 empty bytes
2. when it is ON-LINE, and
3. when it is not BUSY.

The DTR signal goes LOW (HIGH, if the DTR line is set for inverted operation) when the printer is not ready to accept data. Data will not be accepted by the printer when any one of the following conditions exist:

- the I/O buffer has 64 or fewer bytes empty,
- it is OFF-LINE, or
- it is in a BUSY state (such as performing Self-Test).

Transitions on the line correspond to the transmissions of Xon (asserted) and Xoff (not-asserted).

The signal logic or "sense" of the DTR signal line can be switched to either active high or active low from the printer's Operator Control Panel. To select the DTR line for active high signal polarity select DTR POLARITY=HI* (default) using the printer's Operator Control Panel, configuration menu; to select active low signal polarity set the configuration menu item to DTR POLARITY=LO.

Hardware

Connector

The common RS-232C/RS-422 connector is a 25-pin, D-subminiature female connector.

Cable

The external cable connecting the host CPU to the printer must be supplied by the user. The plug required for the user's cable must be a male, 25-pin, D-subminiature connector.

Note

The RS-232C interface is designed to work with cables shorter than 15 metres (50 feet). RS-422 is designed for operation with cables up to 1200 metres (4000 feet) in length.

D

Customer Support

Support

Hewlett-Packard has support services available to help you in case you have a question about your LaserJet printer. The following are places to turn for this support.

Your Dealer

If you encounter difficulty, begin by contacting the person who sold you your LaserJet printer. Your salesman is familiar with your needs, equipment and software and should be able to provide you with the information you need.

Hewlett-Packard Personal Peripherals Assist Line

Hewlett-Packard has a Personal Peripherals Assist Line available to you. It is available from 7 AM to 6 PM (Mountain Standard Time), Monday, Tuesday, Thursday, and Friday, and 7 AM to 4 PM (MST) Wednesday. The Personal Peripherals Assist Line staff can help you.

(208) 323-2551

Before you call the Personal Peripherals Assist Line, do the following:

1. Check the "Troubleshooting Checklist" section of the User's Manual.
2. Check with your software vendor for help.

When you call the Personal Peripherals Assist Line, please have the following information available to help us answer your questions:

- Identify which computer you are using.

- Identify any special equipment or software you are using (for example, spoolers, networks, switch boxes, modems or special software drivers).
- Identify the cable you are using and who sold it to you.
- Identify any special interface, I/O, or RAM boards installed in your printer.
- Identify the software name and version you are currently using.
- Have a control panel test print available.

Glossary

Auto-Continue

Auto-Continue mode can be configured using the LaserJet III printer control panel (refer to the LaserJet III Printer User's Manual).

Baud Rate

Baud rate is the rate at which information is transferred between the computer and the printer. To communicate properly, the computer and printer must both be configured to the same baud rate.

Centronics I/O

An industry standard parallel input/output (I/O) interface.

Column

The width of a column is defined by the current horizontal motion index (HMI).

Configuration

Configuration is the process of changing certain printer settings to allow a computer to communicate properly with the printer. For example, interface selection is part of printer configuration. The printer is configured using the control panel configuration menu.

Control Code

A control code is a type of PCL language command. A control code is a character that initiates a printer function, for example CR, LF, and FF.

Control Panel

The combination of keys, LEDs, and a display that allows an operator to communicate with a device and allows the device to communicate with an operator.

Current Active Position

See Cursor.

Cursor

Although the printer does not actually have a cursor, the cursor position refers to the currently active printing position (like the blinking underline character used on most computer terminals). The cursor can be moved anywhere within the logical page using a combination of horizontal and vertical cursor positioning commands and control codes.

Decipoint

A decipoint is a unit of measurement that equals $\frac{1}{720}$th of an inch.

Default

A value used in lieu of a programmatically selected value. A factory default is a value programmed into the device at the factory; this value is stored in read-only memory (ROM) and cannot be changed by a user or operator. A user default is a default that is selectable via the control panel.

Dot

The dot is the smallest printable unit. On the LaserJet III printer, one dot equals $\frac{1}{300}$th inch. The number of dots printed per inch is referred to as the printer's resolution.

Download

The process of transferring soft fonts, macros, or raster data from a host computer to the printer's user memory is called downloading.

DTR Polarity

The configuration of DTR polarity determines whether pin 20, on the serial interface connector, is high or low when the printer is ready. If DTR polarity is HI, pin 20 is high when the printer is ready. If DTR polarity is LO, pin 20 is low when the printer is ready.

GLOSSARY

Escape Character

The first character of a PCL escape sequence is identified by the $^{E}_{C}$ symbol, (ASCII decimal code 27). This character is a control code used specifically by the printer to identify a string of characters as a printer command. As the printer monitors incoming data from a computer, it is "looking" for this character. When this character appears, the printer reads it and its associated characters as a command to be performed, and not data to be printed.

Escape Sequence

PCL escape sequences consist of two or more characters. The first character is always the escape character, which is identified by the $^{E}_{C}$ symbol. This character is a control code used specifically by the printer to identify a string of characters as a printer command. As the printer monitors incoming data from a computer, it is "looking" for this character. When this character appears, the printer reads it and its associated characters as a command to be performed, and not as data to be printed.

Factory Default

Factory default's refer to the settings that are programmed into the printer at the factory. These settings are in use unless you override them using either the control panel or by sending printer commands.

Factory Default Environment

A factory default is a setting programmed into the printer at the factory. The group of all the printer's factory settings is referred to as the factory default environment. The factory default symbol set is selectable from the control panel configuration menu (refer to the LaserJet III Printer User's Manual).

Font

A font is a set of characters that have similar characteristics. A font has an assigned name, typeface, and is further described by its spacing, height, pitch, style, stroke weight, symbol set, and orientation. For example, the name of the font used for this text is Century Schoolbook; its height is 10 point, its style is upright, and its stroke weight is medium.

Font Cartridge

A removable media containing multiple fonts. When a cartridge is plugged into the printer, the printer has access to the fonts contained in the cartridge.

Height

The height of a font is the measurment of the body of the type in points. A PCL point is $\frac{1}{72}$nd inch. The bod of the type is slightly greater than the distance from the bottom of a descender to the top of an unaccented capital letter.

Horizontal Motion Index (HMI)

HMI defines the distance between columns in $\frac{1}{120}$ incl increments. When fixed pitch fonts are selected, all printable characters including the space and backspace characters are affected by HMI. When proportional fonts are selected, the HMI affects only the control space character.

HMI is defaulted when font orientation, symbol set, pitch, spacing or height is specified and when switching between primary and secondary fonts with shift in and shift out.

The default HMI is equal to the pitch value in the font header. The factory default font's HMI is 12 (which is $\frac{12}{120} = \frac{1}{10}$ inch per character or 10 characters per inch.)

I/O

I/O is an acronym for input/output (I/O) and is used in this document when referring to hardware used to interface printers with computers.

I/O Buffer

The area within the device's internal random access memory where PCL commands and data are stored.

Interface Connector

The LaserJet III printer comes with two interface connectors, serial and parallel, located on the lower part of the back panel. The cable that attaches the computer to the printer is connected here.

Internal Fonts

Internal fonts are the fonts resident in the printer when shipped.

ISO Symbol Set

128 symbol sets containing European versions of the Roman alphabet (e.g., ISO-German contains umlaut vowels, ISO-French contains e accent grave, etc.) based on the standards produced by the Internation Standards Organization (ISO).

Landscape

See Orientation

Logical Page

The PCL logical page (also referred to as the addressable area) defines the area in which the cursor can be positioned. Although the printer does not actually have a cursor (like the blinking underline character used on most computer terminals), the cursor position refers to the currently active printing position. In other words, the location of the "cursor" is the position on the logical page where the next character will be positioned. You can move the cursor to different points on the logical page using the cursor positioning commands; however, the cursor cannot be moved outside of the logical page bounds.

Macro

A macro is a collection of escape sequences, control codes, and data downloaded to the printer, whose execution can be initiated using a single command.

Menu

A list of configurable items. In the nomenclature of this document, an "item" is one particular configurable entity(that is, Copies); a "value" is an "item's" particular configuration (this is, Copies=10).

Modified Print Environment

The current printer feature settings constitute the modified print environment. Whenever a feature setting is altered using escape sequences, the new setting is recorded in the modified print environment.

Non-volatile RAM

Random Access Memory whose contents are preserved following a power failure (volatile RAM is memory whose contents are not preserved when the device is powered off). Non-volatile RAM is generally used to preserve configured (vs. programmed) device state information.

Off-line/On-line

On-line is a condition when the printer will accept data from the host computer. When the LaserJet III is on-line, the ON LINE lamp is lit. When off-line, the printer will not accept data from the host.

Orientation

The orientation of characters on a page; if the print is across the width of the page, it is "portrait-oriented"; if the print is across the length of the page, it is "landscape-oriented".

Overlay Environment

The overlay environment consists of the current settings for the following features with the remainder of the environment features set to their user default values: Page length , Paper source, Page size, Number of copies, Orientation , Cursor position stack.

Parallel I/O

An input/output interface that transmits more than one bit of information simultaneously. Centronics is an industry-wide standard form of a parallel interface.

PCL Commands

PCL commands provide access to printer features. Once a PCL command sets a parameter, that parameter remains set until the same PCL command is repeated with a new value of the printer is reset. There are three types of PCL commands: control codes, two-character escape sequences, and parameterized escape sequences.

A control code is a character that initiates a printer function, for example CR, LF, and FF.

PCL escape sequences consist of two or more characters. The first character is always the escape character, identified by the "Ec" symbol. This character is a control code used specifically by the printer to identify a string of characters as a printer command.

As the printer monitors incoming data from a computer, it is "looking" for this character. When this character appears, the printer reads it and its associated characters as a command to be performed and not as data to be printed. (Note, PCL printer commands are also referred to as escape sequences.)

PCL Coordination Systems Units

The units of the X-axis of the PCL coordinate system may be dots, decipoints, or columns. The units of the Y-axis may be dots, decipoints, or rows.

Perforation Region

The perforation region is the distance from the bottom of the text area to the top of the text of the next page. When perforation skip is enabled, a line feed or half-line feed, which would move the cursor beyond the bottom of the text area, moves the cursor to the top of the text area on the next page. When perforation skip is disabled, a line feed or half-line feed moves to the next line or half-line within the perforation region.

Permanent Image

An image (font, macro, etc.) can be designated "permanent" via a PCL escape sequence. A "permanent" image is not cleared from internal memory as a result of either an ␛E or an operator control reset; whereas, a "temporary" one is cleared by either of the aforementioned operations. Both "permanent" and "temporary" images are cleared from internal memory by a power failure.

Pitch

Pitch describes the number of characters printed in a horizontal inch. Pitch only applies to fixed-spaced fonts since the number of characters per inch varies for proportionally-spaced fonts.

Point

A PCL point is a unit of measurement that equals $\frac{1}{72}$nd inch. Font height is measured in points.

Primary (Secondary) Font

A PCL convention whereby two fonts can be defined internally simultaneously. The primary font is accessed via the control code "SI" and the secondary font is accessed via the control code "SO." The factory default state is primary font designated.

Printable Area

The printable area is the area of the physical page in which the printer is able to place a dot. The physical page refers to the size of the media installed in the printer.

The relationship between physical page, logical page, and printable area is defined in Figures 2-2 and 2-3.

Portrait

See Orientation

Print Environment

The group of all the printer's current feature settings, collectively, is referred to as the print environment. The printer maintains four print environments: the factory default environment, the user default environment, the modified print environment and the overlay environment.

Printer Commands

See PCL Commands

Raster Graphics

Images composed of groups of dots are raster images. Pictures in newspapers or on televisions are examples of raster images. PCL includes commands for printing raster images.

Robust-Xon

The configuration of ROBUST-XON determines the method by which Xon's are generated. If ROBUST-XON is ON an Xon is transmitted by the controller to the host system when the controller's 1 Kbyte I/O buffer has less than 128 data bytes remaining (896 bytes empty), the printer is in the on-line state, and the printer is not busy. If no data is received within approximately one second, then additional Xon's are to be transmitted at one second intervals until data is received. If REBUST-XON is OFF, the printer sends on Xon when the printer can accept more data, the printer is in the on-line state, and the printer is not busy. The printer does not send Xon's every second while the printer is on-line and ready for more data.

Row

The distance between rows is defined by the current vertical motion index (VMI).

Rule

A solid-filled rectangular area.

Serial I/O

An input/output (I/O) interface that transmits information bit-by-bit. RS-232 is an industry-wide standard form of a serial interface.

Soft Font

Soft fonts are fonts stored on floppy disks. These fonts can be transferred to the printer's memory and used the same way as cartridge or resident fonts.

Spacing

Fonts have either fixed or proportional spacing. Fixed-spaced fonts are those for which the inter-character spacing is constant. Proportionally-spaced fonts are those the inter-character spacing varies with the natural shape of a character.

Stroke Weight

Stroke weight describes the thickness of the strokes that compose characters. Medium and bold are examples of stroke weights.

Style

Font style is defined by the angularity of the strokes of the characters with respect to the X-axis. Upright and italics are example of font styles.

Symbol Set

A symbol set is a unique ordering of the characters in a font. Each symbol set is defined with a unique set of applications in mind. Symbol sets are created for many purposes, for example the PC-8 symbol set was designed to support US IBM-PC applications.

Typeface

Typeface is a generic name for graphics symbols having common design features. Each typeface has unique and distinguishing characteristics.

User Default

A user default is a default that is selectable via the operator control panel. User defaults may be selected for the following items via the LaserJet III control panel: (1) number of copies, (2) manual feed mode, (3) font, and (4) vertical form length (i.e., VMI).

User Default Environment

The user default environment consists of the user default settings (any user default settings selected from the control panel) with the remainder of the environment features set to the factory default values.

Vertical Motion Index (VMI)

VMI defines the distance between rows in $\frac{1}{48}$th inch increments. This command affects the line feed and half-line feed spacing.

The factory default VMI is eight, which corresponds to six lines per inch. A user default VMI can be selected from the control panel using the FORM menu item.

Sales and Service Offices

Calling for Help

To find an Authorized HP Dealer call:

(800) 367-4772

To find an Authorized HP Service Dealer call:

(800) 835-4747

Or contact one of the regional offices below:

United States:

Hewlett-Packard Company
4 Choke Cherry Road
Rockville, MD 20850
(301) 670-4300

Hewlett-Packard Company
5201 Tollview Drive
Rolling Meadows, IL 60008
(312) 255-9800

Hewlett-Packard Company
5161 Lankershim Blvd.
North Hollywood, CA 91601
(818)505-5600

Hewlett-Packard Company
2015 South Park Place
Atlanta, GA 30339
(404) 955-1500

Canada:
Hewlett-Packard Ltd.
6877 Goreway Drive
Mississauga, Ontario
Canada, L4V 1M8
(416) 678-9430

Europe/Africa/Middle East:
Hewlett-Packard S.A.
Central Mailing Department
P.O. Box 529
1180 AM Amstelveen
The Netherlands
(31) 20/547 9999

Australia/New Zealand:
Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130,
Melborne, Australia
(03) 895-2895

Japan:
Yokogawa-Hewlett-Packard Ltd.
29-21, Takaido-Higashi 3-chome
Suginami-ku, Tokyo 168
(03) 331-6111

Far East Area:

Hewlett-Packard Asia Ltd.
22-30/F., West Tower
Bond Centre
89 Queensway
Central, Hong Kong
(5) 848-7777

Latin America:

Hewlett-Packard Company
Latin American Region Headquarters
Monte Pelvoux Nbr. 111
Lomas de Chapultapec
11000 Mexico, D.F. Mexico
(905) 596-79-33

Index

INDEX

INDEX

INDEX

INDEX

F

INDEX

INDEX

V

W

X

Y

Z

Reader Comment Card

HP LaserJet III Technical Reference Manual

We welcome your evaluation of this manual. Your comments and suggestions help us improve our publications.

Please circle one number for each statement.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
• The manual is well organized.	1	2	3	4	5
• I can find the information I want.	1	2	3	4	5
• The index is thorough.	1	2	3	4	5
• The information is easy to understand.	1	2	3	4	5
• The manual is clearly written.	1	2	3	4	5
• Concepts and vocabulary are easy to understand.	1	2	3	4	5
• Examples are clear and useful.	1	2	3	4	5
• The manual contains enough examples.	1	2	3	4	5
• Illustrations are clear and helpful.	1	2	3	4	5
• The manual contains enough illustrations.	1	2	3	4	5
• Layout and format enhance the manual's usefulness.	1	2	3	4	5
• I like the use of color in the manual.	1	2	3	4	5
• The quality of this manual would influence any repeat purchase decision.	1	2	3	4	5
• The scope of the information in the manual meets my needs.	1	2	3	4	5

Please write additional comments, particularly if you disagree with a statement above. Use additional pages if you wish. The more specific your comments, the more useful they are to us.

Comments: ______________________________

____

____

____

Thanks

Name: ______________________________

Title: ______________________________

Company: ______________________________

Address: ______________________________

City/State/Zip: ______________________________

Phone: ______________________________

HEWLETT PACKARD

TAPE HERE

TAPE HERE

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS MAIL PERMIT NO. 141 BOISE, IDAHO

POSTAGE WILL BE PAID BY ADDRESSEE

Hewlett-Packard Company
Boise Division
Attn: Learning Products M.S. 517
P.O. Box 15
Boise, Idaho 83707-9934

HEWLETT
PACKARD

33449-90903
Edition 1
E0390
Printed in U.S.A. 3/90