HEWLETT® PACKARD

Expanding Possibilities

HP PCL/PJL Reference

PCL 5 Printer Language Technical Reference Manual

PCL 5 Printer LanguageTechnical Reference Manual

HP Part No. 5961-0509
Printed in USA
First Edition - October 1992

Notice

Printing History

This manual was created using *HP Tag/Vectra* software on an HP Vectra Personal Computer. The body text is printed in *Helvetica* fonts. The camera-ready copy was printed on an HP LaserJet IIISi printer with Resolution Enhancement technology (REt) and was then reproduced using standard offset printing.

First Edition – October 1992

NOTICE

This document is the current edition of the technical reference manual for PCL 5 and earlier printers. It replaces the September 1990 edition of the *HP PCL 5 Printer Language Technical Reference Manual* (p/n 33459-90903). If you have ordered another PCL Technical Reference document, this manual and the *PCL 5 Comparison Guide* are the updated replacement documents.

Trademark Credits

Intellifont and *Garth Graphic* are U.S. registered trademarks of Agfa Division, Miles Inc. *CG Triumvirate* and *Shannon* are trademarks of Agfa Division, Miles Inc. *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 Division, Miles Inc. *CG Times*, a product of Agfa Division, Miles Inc., is based on *Times New Roman*, a U.S. registered trademark of Monotype Corporation plc. *PCL*, and *Vectra* are U.S. registered trademarks of Hewlett-Packard Company. *Resolution Enhancement* is a trademark of Hewlett-Packard Company. *IBM* is a registered trademark of International Business Machines Corporation. *Microsoft*, *Windows*, and *MS-DOS* are U.S. registered trademarks of Microsoft Corporation. *TrueType* and *Macintosh* are registered trademarks of Apple Computer, Inc. *PostScript* is a registered trademark of Adobe Systems, Inc. *Centronics* is a U.S. registered trademark of Centronics Corporation. *ITC Avant Garde Gothic*, *ITC Benguiat*, *ITC Bookman*, *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. *Arial* and *Gill Sans* are registered trademarks of The Monotype Corporation plc.

Inside This Manual

What You Can Learn From This Manual

Hewlett-Packard has developed a standard set of printer features for use in all HP printers. Printer features are accessed through the corresponding commands of Hewlett-Packard's PCL language. This manual describes the PCL 5 printer language. This includes descriptions of the commands available for Hewlett-Packard PCL 5 LaserJet printers and the basic requirements of PCL language programming. With the release of new LaserJet family printers there are new features added which supplement the existing PCL base set. Features of future printer releases are not covered in this document. The new features are described in the latest version of the *PCL 5 Comparison Guide*. Programmers should familiarize themselves with the information provided in the *PCL 5 Comparison Guide* in addition to the information in this document.

Experienced Users

This manual was written for people with some programming experience. Many of the concept discussions assume some programming knowledge.

When writing a PCL language program, you should know the PCL language concepts and commands presented in this manual, and should be aware of the differences in implementation of the PCL 5 printer language for the various HP LaserJet printers, as described in the *PCL 5 Comparison Guide*.

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 PCL 5 LaserJet printers. These commands enable you to take advantage of the LaserJet printer's advanced feature set.

Note Since actual implementation of printer commands within software applications varies from package to package, specific examples are not given. For examples of printer command usage with many popular software packages, refer to HP's *Software Application Notes*, provided with the printer. The most current versions of software application notes can be obtained through the HP Forum on CompuServe, by fax using the HP FIRST fax service, or through HP's literature distribution. Refer to Appendix A for more information.

Chapter Summaries

A brief description of each chapter is provided below.

Chapter 1 - Introduction to HP PCL

This chapter gives a brief history of the development of the PCL language, describes the PCL language levels (architecture), and describes the PCL command structure (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 coordinate system and the HP-GL/2 picture frame.

Chapter - The Print Environment

This chapter introduces the printer's feature settings, collectively, as the print environment. It includes descriptions of the factory default environment, user default environment, and the modified print environment. The effect of printer reset functions is also described.

Chapter 4 - PCL Job Control Commands

This chapter describes the commands which provide job control. Job control commands are usually grouped together and sent at the beginning of a job. Job control includes restoration of the User Default Environment, selection of the number of copies of each page to be printed, duplex print commands, and unit of measure specification.

Chapter 5 - Page Control Commands

This chapter describes the commands providing page format control. Page format control allows you to select 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 - PCL 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 the chapter.

Chapter 9 - Font Management

This chapter describes font management which provides mechanisms for downloading and manipulating soft fonts.

Chapter 10 - User-Defined Symbol Sets

This chapter describes the capability of some PCL 5 printers to enable users to define their own symbol sets for special needs.

Chapter 11 - Soft Font Creation

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

Chapter 12 - Macros

This chapter describes macro commands which store a block of PCL commands and data which can be used repeatedly without redefining the block. The macro function reduces the number of commands that must be sent to the printer.

Chapter 13 - The PCL Print Model

This chapter describes the PCL print model which allows for special effects when printing.

Chapter 14 - PCL Rectangular Area Fill Graphics

This chapter describes how to define and fill a rectangular area with one of the predefined PCL patterns, or with a user-defined pattern.

Chapter 15 - 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 16 - Status Readback

This chapter describes the PCL status readback features. Status readback enables you to obtain PCL status information from the printer, such as: available printer (user) memory, a list of fonts and symbol sets, and the ID numbers of macros and user-defined patterns.

Chapter 17 - An Introduction to HP-GL/2 Vector Graphics

This chapter introduces basic information for HP-GL/2. It lists the vector graphics commands, and describes the HP-GL/2 command syntax. An overview of several important topics is also provided, such as the PCL Picture Frame concept, scaling, pen status and location, and absolute vs. relative pen movement.

Chapter 18 - 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 19 - The Configuration and Status Group

This chapter 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 20 - The Vector Group

This chapter provides information about pen movement and drawing lines, arcs, and circles. It also covers a way to encode coordinates for increased print speed.

Chapter 21 - 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 described in this chapter.

Chapter 22 - The Line and Fill Attributes Group

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

Chapter 23 - The Character Group

This chapter 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 almost any size, slant and direction using proportional or fixed-spaced scalable fonts.

Chapter 24 - 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 HP LaserJet printers, including their features and functions.

PCL 5 Comparison Guide

This document contains supplemental information for programming PCL 5 LaserJet printers. It identifies how different HP PCL 5 LaserJet printers implement the commands described in the *HP PCL 5 Printer Language Technical Reference Manual*. It provides printer-specific information on feature sets, paper handling, fonts, and the printer's control panel.

Intellifont Scalable Typeface Format

This document provides information for designing scalable fonts using Agfa's Font Access Interchange Standard (FAIS). This document can be obtained from Agfa Division, Miles Inc. by writing to the address below or by phone.

Agfa Division, Miles Inc.
Typographic Systems
OEM Technical Support
90 Industrial Way
Wilmington, MA 01887
(508) 658-5600

TrueType Font Files

This document, which provides information for designing scalable fonts using Microsoft Corporation's TrueType font scaling technology has been made available in downloadable form on both CompuServe and Internet. Contact Microsoft Corporation for details.

Contents

Introduction to HP PCL

The Page

The Print Environment

PCL Job Control Commands

Page Control Commands

Cursor Positioning

Fonts

PCL Font Selection

Font Management

User-Defined Symbol Sets

Soft Font Creation

Macros

The PCL Print Model

PCL Rectangular Area Fill Graphics

Raster Graphics

Status Readback

An Introduction to HP-GL/2 Vector Graphics

The Picture Frame

The Configuration and Status Group

The Vector Group

The Polygon Group

The Line and Fill Attributes Group

The Character Group

Programming Hints

Customer Support

Index

1 Introduction to HP PCL

PCL PRINTER LANGUAGE HISTORY

Hewlett-Packard created the PCL printer language (simply referred to as “PCL” elsewhere in this manual) 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 PCL to provide the optimal price and performance balance. PCL 5 represents a new breakthrough 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 to deliver powerful technology advances.

PCL commands are compact escape sequence codes that are embedded in the print job data stream. This approach minimizes both data transmission and command decoding overhead. HP PCL 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 functions provided 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 PCL printer language model succeeds because the following points are observed:

- All HP LaserJet 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 **printer commands** provide access to printer features. There are four general types of HP printer language commands:

- control codes
- PCL commands
- HP-GL/2 commands
- PJL commands

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.

PCL Commands

PCL commands provide access to the printer's PCL control structure. The PCL structure controls all of the printer's features except those used for vector graphics, which are controlled by the HP-GL/2 commands.

PCL printer commands consist of two or more characters. The first character is always the ASCII escape character, identified by the ^{E}C symbol. ^{E}C 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 "looks" for this character. When this character appears, the printer reads it and its associated characters as a command to perform and not as data to print.

Note PCL printer commands (other than single-character control codes) are also referred to as **escape sequences**. The terms *printer command* and *escape sequence* are used interchangeably throughout this manual.

Once a PCL command sets a parameter, that parameter remains 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 prints 3 lines/inch until the printer receives a different Line Spacing command, or the printer is reset.

HP-GL/2 Commands

HP-GL/2, vector graphic commands are two letter mnemonic codes designed to remind you of the function name (such as **IN** for **I**nitialize). Following the two letter mnemonic may be one or more parameters, which identify details of how to process the command. For additional information on HP-GL/2 commands, refer to Chapters 17 through 23.

PJL Commands

PJL (Printer Job Language) commands provide a different type of printer control. Unlike PCL and HP-GL/2, which control the placement of dots on the printed page, PJL supplies job-level control. One of the main features PJL offers is the ability to switch printer languages (personalities) between jobs. For example, applications supporting PJL can print one job using PCL, and then print the next job using PostScript or another printer language, without any operator intervention.

PJL also provides two-way communications with the printer. For example, PJL can request information from the printer such as printer model, configuration, printer status, and job status. PJL also can be used to change the printer's control panel settings and modify the message displayed on the control panel.

The PJL language is designed to be used by application developers and technical support personnel only.

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:

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

where "*X*" is a character that defines the operation to be performed. "*X*" may be any character from the ASCII table within the range 48-126 decimal ("0" through "~" - see Appendix A). For a list of the two-character escape sequences supported by the printer, refer to the "PCL Feature Support Matrix" in Chapter 1 of the ***PCL 5 Comparison Guide***.

Following are examples of two-character escape sequences:

$^{E}_{C}$ **E**	a two-character escape sequence used for resetting the printer.
$^{E}_{C}$ **9**	a two-character escape sequence used for resetting the left and right margins to the printer's default settings.

Parameterized Escape Sequences

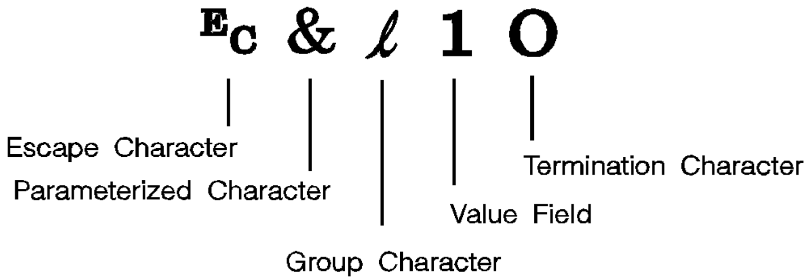
Parameterized escape sequences have the following form:

^{E}C *X y z1 # z2 # z3 ... # Zn[data]*

where *y, #, zi* (*z1, z2, z3...*) 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 " **~** ") that 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") that 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 65535. If an escape sequence requires a value field and a value is not specified, a value of zero 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.

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

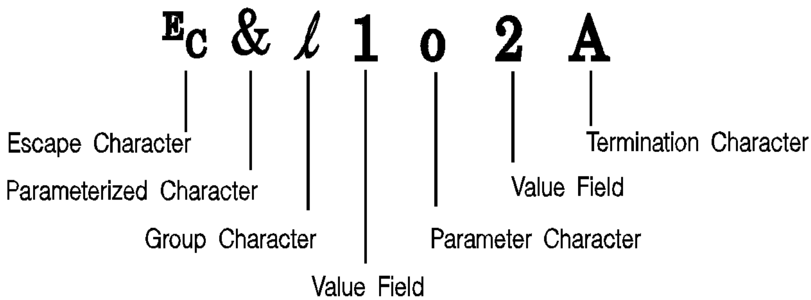


Notes

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.

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&ℓ1O and Ec&ℓ2A):



Notice that the “Ec”and the “&ℓ”are dropped from the second printer command when the two commands 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 to be combined. In the example above, these are "&" and "ℓ".

2 All alphabetic characters within the combined printer command are 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 and the printable area; it introduces the HP-GL/2 (vector graphics) picture 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 Position of the cursor (also referred to as the **CAP**). 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 (see Chapter 6, *Cursor Positioning*). The PCL cursor cannot be moved outside of the logical page bounds.

The size of the logical page for the media (paper, transparencies, labels, etc.) is defined in Table 2-1 and Table 2-2.

Printed Dots

The high quality output achieved by HP LaserJet printers is due in part to the ability to lay down a fine grid of “dots” on the page. The density of this grid is referred to as the printer’s **resolution.** From the first HP LaserJet (the “LaserJet Classic”) until recently, all HP LaserJet family printers printed at a resolution of 300 dots-per-inch. In a one inch square, the printer could print a dot anywhere in a grid of up to 300 dots horizontally by 300 dots vertically, for a total of 90,000 possible dot locations per square inch (300 × 300 = 90,000).

The LaserJet 4 printer is capable of printing at either 300 or 600 dpi resolution. At 600 dots-per-inch, it becomes possible to print up to 360,000 dots per square inch (600 x 600 = 360,000). Print resolution of LaserJet 4 is selectable and can be specified either from the printer’s control panel or programmed through PJL commands.

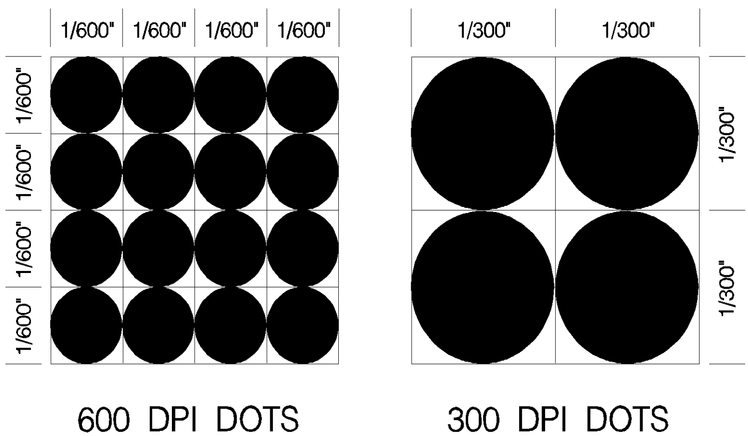


Figure 2-1 300 vs 600 DPI Dot Sizes

Note

Refer to Appendix E of the *PCL 5 Comparison Guide* or the printer *User’s Manual* to determine the default print resolution for a specific HP LaserJet printer.

The printer’s physical dot size has no direct bearing on the size of “PCL Units” used in cursor movements. PCL Units were previously referred to as “PCL dots”, but **should not be confused with the printer’s physically printed dots.** The size of PCL Units can also be specified (see the *Unit of Measure Command* in Chapter 4 for more information).

PCL Coordinate System

The PCL coordinate system is defined as shown in Figure 2-2.

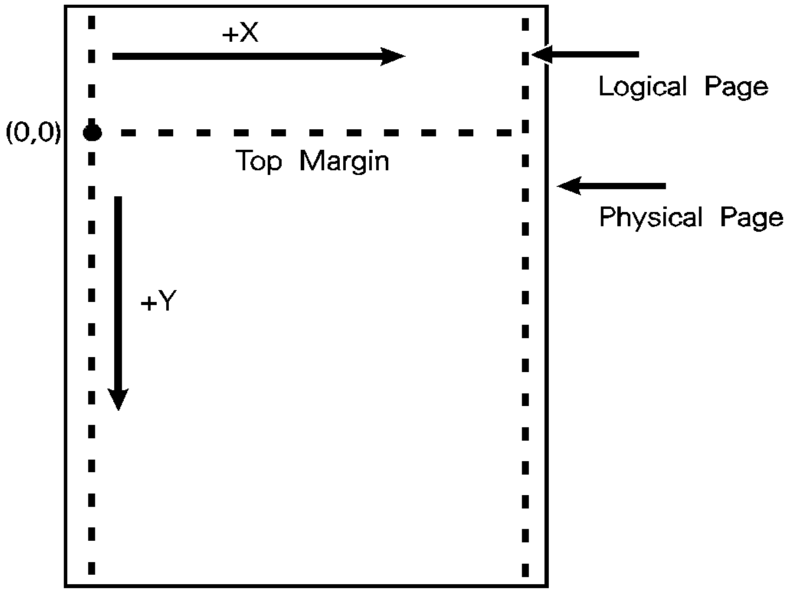


Figure 2-2 X,Y PCL Coordinates

The point (0,0) is at the intersection of the left edge of the logical page and the current top margin position.

Note

Since the point (0,0) is always at the intersection of the left edge of the **logical page** and the **current top margin** position, it moves if the top margin is changed, and rotates around the page if the orientation is changed.

Units of the PCL Coordinate System

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

PCL Units

These are user-definable units of measure which are used in PCL commands affecting various PCL cursor moves. The number of units-per-inch used in PCL cursor moves is determined by the current setting of the **Unit of Measure** command (see “Unit of Measure Command” in Chapter 4).

Note PCL Units were formerly referred to as “PCL Dots”. They were renamed “PCL Units” to prevent confusion with the printer’s physically printed “dots”, which are determined by the printer’s resolution.

Decipoints

In PCL terminology, a decipoint is 1/720 inch or one-tenth of a PCL point (a PCL point is 1/72 inch as opposed to a typographic point which is 1/72 inch).

Columns & Rows

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*.

Printer Internal Units

Internally, the printer uses a different unit of measure. It maps PCL Units, decipoints, and columns and rows to this unit of measure. This internal unit is 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 2-3). 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 17, *An Introduction to HP-GL/2 Vector Graphics*, and Chapter 18, *The Picture Frame*.

Note

If no HP-GL/2 picture frame size is specified (using the commands described in Chapter 18), then the default HP-GL/2 picture frame is used. The default HP-GL/2 picture frame is the current top and bottom margins and the left and right edges of the logical page. The HP-GL/2 picture frame rotates with the PCL page orientation, but is not affected by the PCL print direction.

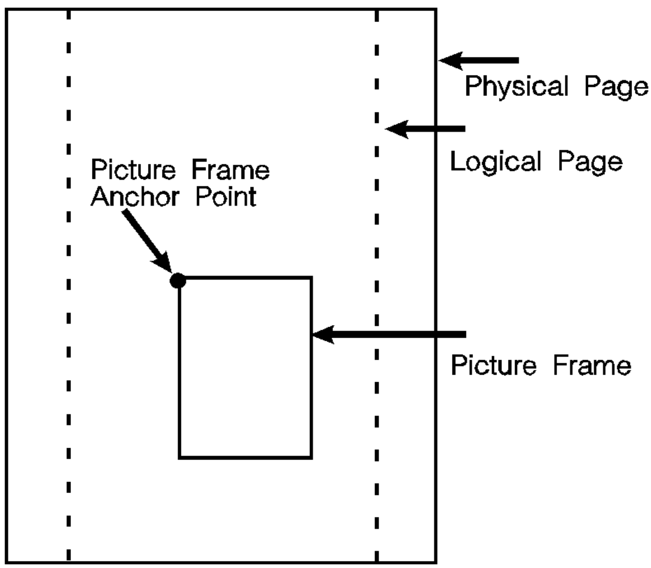


Figure 2-3 PCL Logical Page with HP-GL/2 Picture Frame

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 (letter, legal, etc.) installed in the printer.

The relationship between physical page, logical page, default picture frame, and printable area is defined in Table 2-1 and Table 2-2.

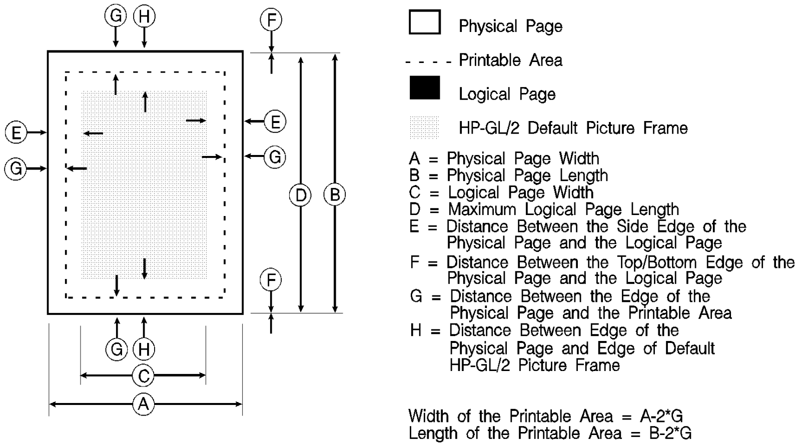


Table 2-1 Portrait Logical Page & Printable Area Boundaries

	DIMENSIONS (at 300 DPI - double for 600 DPI)							
PAPER SIZE	A	B	C	D	E	F	G	H
LETTER	2550	3300	2400	3300	75	0	50	150
Legal List 1	2550	4200	2400	4200	75	0	50	150
LEDGER	3300	5100	3150	5100	75	0	50	150
EXECUTIVE	2175	3150	2025	3150	75	0	50	150
A4	2480	3507	2338	3507	71	0	50	150
A3	3507	4960	3365	4960	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
B5	2078	2952	1936	2952	71	0	50	150
DL	1299	2598	1157	2598	71	0	50	150

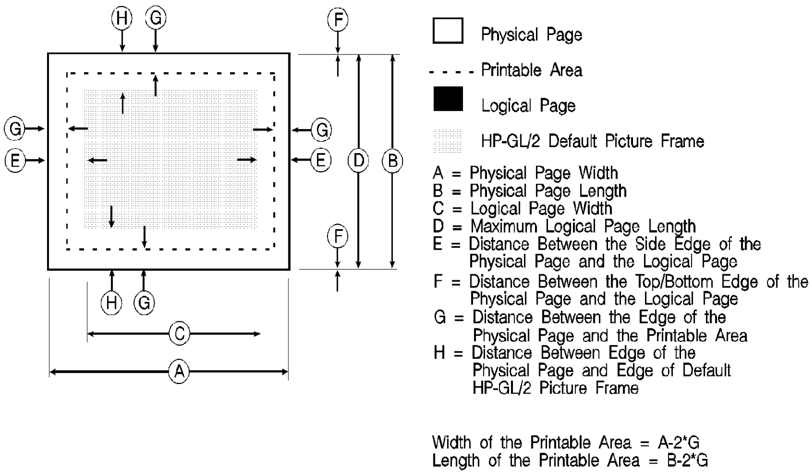


Table 2-2 Landscape Logical Page & Printable Area Boundaries

	DIMENSIONS (at 300 DPI - double for 600 DPI)							
PAPER SIZE	A	B	C	D	E	F	G	H
LETTER	3300	2550	3180	2550	60	0	50	150
Legal List 1	4200	2550	4080	2550	60	0	50	150
LEDGER	5100	3300	4980	3300	60	0	50	150
EXECUTIVE	3150	2175	3030	2175	60	0	50	150
A4	3507	2480	3389	2480	59	0	50	150
A3	4960	3507	4842	3507	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
B5	2952	2078	2834	2078	59	0	50	150
DL	2598	1299	2480	1299	59	0	50	150

The HP LaserJet printers perform pixel-level clipping. 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 is clipped (see Figure 2-4).

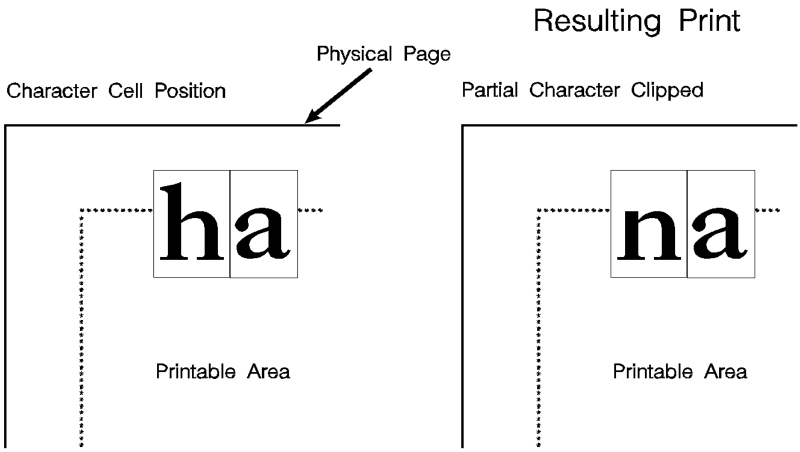


Figure 2-4 Printable Area Character Cell Positioning

Notes

Pixel level clipping can also occur at the logical page for PCL when the page is positioned using the Left Registration command.

Pixel level clipping also occurs at the picture frame for HP-GL/2.

Characters are clipped if they fall across a margin (left, right, top, and bottom). Refer to “Text Area” in Chapter 5 for additional information.

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 12, *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 prints, the job-specific feature settings are longer be required, since the next job is likely to 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 known base set, and vary only those settings that are needed. Starting with the default environment at the beginning of each print job eliminates the need to set every feature each time a job is run.

Note The print environment features presented in this chapter are for a variety of HP LaserJet printers. Not all of the features are applicable to every printer. To identify variations and default settings for specific printers, refer to Chapter 3 of the *PCL 5 Comparison Guide*.

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 settings 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 print environment features are separated, for convenience, into two lists or contexts: PCL and HP-GL/2. Table 3-1 lists typical PCL print environment features, and Table 3-2 lists typical HP-GL/2 print environment features.

Note he factory default settings for the printer features are not shown here, since they differ depending on the printer model. To identify variations and default settings for specific printers, refer to Chapter 3 of the *PCL 5 Comparison Guide*.

Table 3-1 Factory Default Print Environment Features – PCL Context

JOB CONTROL	FONTS[1]
Number of Copies[2]	Symbol Set[2]
Duplex[2]	Spacing
Binding[2, 3]	Pitch[4]
Registration	Height[5]
Tray[2]	Style
Manual Feed[2]	Stroke Weight
User-defined Units	Typeface
	Underlining Mode

1. 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 printer's control panel or from a font cartridge containing a default font.
2. User default values may be selected by the user from the printer's control panel for these items.
3. Selectable from the printer control panel if duplex is selected.
4. Selectable from the printer's control panel if a fixed-space scalable font has been selected as the user default.
5. Selectable from the printer's control panel if a proportional scalable font has been selected as the user default.

Table 3-1 Factory Default Print Environment Features – PCL Context *(continued)*

PAGE CONTROL	FONT MANAGEMENT
Print Direction	Font ID
Orientation[2]	Character Code
Page Size[2]	Symbol Set ID
Paper Source	**RASTER GRAPHICS**
Vertical Motion Index[2]	Left Graphics Margin
Horizontal Motion Index[2]	Resolution
Top Margin	Compression Mode
Text Length	Raster Height
Left Margin	Raster Width
Right Margin	Raster Graphics Presentation Mode
Perforation Skip	**PICTURE FRAME**
Line Termination	Picture Frame Width
PRINT MODEL	Picture Frame Height
Current Pattern	Picture Frame Anchor Point
Source Transparency Mode	HP-GL/2 plot Horizontal Size
Pattern Transparency Mode	HP-GL/2 Plot Vertical Size
Pattern Reference Point	**MACRO**
Pattern Rotation	Macro ID

1. 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 printer's control panel or from a font cartridge containing a default font.
2. User default values may be selected by the user from the printer's control panel for these items.
3. Selectable from the printer control panel if duplex is selected.
4. Selectable from the printer's control panel if a fixed-space scalable font has been selected as the user default.
5. Selectable from the printer's control panel if a proportional scalable font has been selected as the user default.

Table 3-1 Factory Default Print Environment Features – PCL Context *(continued)*

RECTANGULAR AREA FILL	TROUBLESHOOTING
Horizontal Rectangle Size	End-of-Line Wrap
Vertical Rectangle Size	Display Functions
Pattern (Area Fill) ID	
STATUS READBACK	
Current Location Type	
Current Location Unit	

1. 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 printer's control panel or from a font cartridge containing a default font.
2. User default values may be selected by the user from the printer's control panel for these items.
3. Selectable from the printer control panel if duplex is selected.
4. Selectable from the printer's control panel if a fixed-space scalable font has been selected as the user default.
5. Selectable from the printer's control panel if a proportional scalable font has been selected as the user default.

Table 3-2 Factory Default Print Environment Features – HP-GL/2 Context

CHARACTER GROUP	POLYGON GROUP
Symbol Set	Polygon Buffer
Font Spacing	Polygon Mode
Pitch	**LINE AND FILL ATTRIBUTE GROUP**
Height	Line Type
Posture	Line Type Repeat Length
Stroke Weight	Line Cap
Typeface	Line Join
Character Direction	Miter Limit
Character Direction Mode	Pen Turret
Character Size Mode	Pen Width
Character Width	Pen Width Selection Mode
Character Height	Selected Pen
Character Slant	Symbol Mode
Extra Horizontal Space	Fill Type
Extra Vertical Space	User-defined Line Type
Character Fill Mode	Anchor Corner
Label Origin	User-defined Fill Types
Label Terminator	**PALETTE EXTENSION**
Transparent Data Mode	Number of Pens
Primary Font ID	Transparency Mode
Secondary Font ID	Screened Vector
Scalable or Bitmap Font	**CONFIGURATION & STATUS GROUP**
VECTOR GROUP	Scale Mode
Plotting Mode	Window
Pen State	Coordinate System Orientation
	P1, P2

User Default Environment

There are several PCL features in the printer for which user defaults may be selected from the printer's control panel. User default settings are stored in the User Default Environment and are retained even if the printer is turned OFF. Some of these features are listed below (for a complete set of the control panel user default features refer to Chapter 3 of the *PCL 5 Comparison Guide*.)

- Number of Copies
- Font Selection (Font Source, Font Number, Pitch[1] or Point Size[1])
- Duplex/Simplex
- Binding Edge[2]
- Tray
- Paper (Page Size: Paper and Envelopes)
- Manual Feed
- Orientation
- Symbol Set

Notes Refer to "*Horizontal Motion Index (HMI) Command*" in Chapter 5 for the implications of setting the user default font (source, number, pitch or point size).

Refer to the printer *User's Manual* for instructions on how to select these user defaults from the control panel.

The PJL (Printer Job Language) "SET" command overrides the PCL user default environment for the duration of a PJL job. If PJL is not active, then the PCL user default environment has precedence. Refer to "PCL Commands" in Chapter 1 for more information.

1. For scalable typefaces: fixed-space typefaces are selected only by pitch; and proportionally-spaced typefaces are selected only by point size.
2. Selectable only if duplex is On.

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.

A Modified Print Environment consists of the current settings for the items listed in Table 3-1 and Table 3-2, with the exception of the items listed in Table 3-3, below.

Table 3-3 Items Not Included in Modified Print Environment

PCL Context	HP-GL/2 Context
Overlay environment	HP-GL/2 overlay environment
Current cursor position	Duplex registration
Cursor position stack	Polygon buffer
Downloaded fonts/macros	
User-defined patterns	

Note Not all of the Modified Print Environment features are applicable to every printer. To identify variations and default settings for specific printers, refer to the *PCL 5 Comparison Guide*.

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.

Printer Reset

A Printer Reset restores the User Default Environment and deletes temporary fonts, macros, user-defined symbol sets, and patterns. A Printer Reset is performed by sending the $^{E}{}_{C}$**E** command, or through the printer's control panel (see the printer *User's Manual*). The Printer Reset command is described in Chapter 4, *PCL Job Control Commands*.

The $^{E}{}_{C}$**E** command prints any partial pages of data that 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 19, *The Configuration and Status Group*, for additional information).

Notes

Hewlett-Packard strongly recommends the use of both the $^{E}{}_{C}$**E** command and the $^{E}{}_{C}$**%–12345X** command (Universal Exit Language/Start of PJL — also referred to as the **UEL Command**) at the beginning and end of each job. (The order of these commands is critical. Refer to Table 4-1 for an example of their usage.)

The UEL Command ($^{E}{}_{C}$**%–12345X**) has the same effect as the $^{E}{}_{C}$**E** command, and also enters PJL Mode of operation for printers that support PJL (refer to "Universal Exit Language Command" in Chapter 4 for more information). The $^{E}{}_{C}$**E** command should be included to ensure backward compatibility (the UEL command is ignored if received by a printer that does not support PJL).

Cold Reset

A Cold Reset restores the Factory Default Environment which includes resetting the control panel items to their factory default settings. A Cold Reset is performed by power cycling the printer while holding [ON LINE] until a **08 COLD RESET** is displayed.

4 PCL Job Control Commands

Introduction

A job typically consists of three parts:

- Commands providing job control.
- Commands providing page control.
- Print data.

Table 4-1 Structure of a Typical Job

${}^{E}{}_{C}$**%–12345X**	UEL Command (exit language)
${}^{E}{}_{C}$**E**	Printer Reset Command.
Preamble	Job Control Commands.
Page 1	Page Control Commands.
	Data
Page 2	Page Control Commands.[1]
	Data.
•	•
•	•
•	•
Page n	Page Control Commands.
	Data.
${}^{E}{}_{C}$**E**	Printer Reset Command.
${}^{E}{}_{C}$**%–12345X**	UEL Command (exit language).

1. 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.

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:

- Printer Reset.
- Universal End of Language/Start of PJL.
- Number of Copies.
- Simplex/Duplex Print.
- Left and Top Offset Registration.
- Duplex Page Side Selection.
- Job Separation.
- Output Bin Selection.
- Unit of Measure.

Printer Reset Command

Receipt of the Printer Reset command restores the User Default Environment, deletes temporary fonts, macros, user-defined symbol sets and patterns. It also prints any partial pages of data which may have been received.

EC **E**

Notes Hewlett-Packard strongly recommends the use of both the EC E command and the EC**%–12345X** command (Universal Exit Language/Start of PJL — also referred to as the **UEL Command**) at the beginning and end of each job. (The order of these commands is critical. Refer to Table 4-1 for an example.)

The UEL Command (EC**%–12345X**) has the same effect as the EC E command, and also enters PJL Mode of operation for printers that support PJL (refer to the next section, "“Universal Exit Language Command” for more information). The EC E command should be included to ensure backward compatibility (the UEL command is ignored if received by a printer that does not support PJL).

Universal Exit Language Command

The Universal Exit Language (**UEL**) command causes the PCL printer language to shut down and exit. Control is then returned to the Printer Job Language (PJL). Both PCL 5 and HP-GL/2 recognize this command.

EC % – 1 2 3 4 5 X

Default = N/A

Range = –12345

This command performs the following actions:

- Prints all data received before the Exit Language command.
- Performs a printer reset (same effect as EC E).
- Shuts down the PCL 5 printer language processor.
- Turns control over to PJL.

Notes

Hewlett-Packard strongly recommends the use of both EC E (printer reset) and EC**%–12345X** (UEL command) at the beginning and end of each job. (The order of these commands is critical. Refer to Structure of a Typical JobTable 4-1 for an example.)

The UEL Command (EC**%–12345X**) has the same effect as the EC E command, and also enters PJL Mode of operation for printers that support PJL. The EC E command should be included to ensure backward compatibility (the UEL command is ignored if received by a printer that does not support PJL).

Number of Copies Command

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

EC & ℓ # X

\#   =   Number of copies (1 to 32767 maximum)

Default **=** 1 (Configurable from control panel)

Range **=** 1-32767
(Values 32767 execute as 32767 values 1 are ignored.
Maximum number of copies=99 for LaserJet II, IIP, III, IIID, IIIP and earlier LaserJet printers.)

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

Example

To print 3 copies of a page, send:

EC&ℓ3X

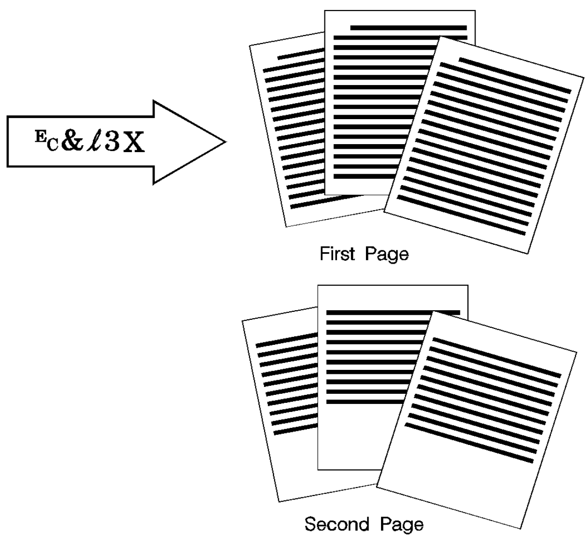


Figure 4-1 Number of Copies

Note The HP-GL/2 Replot (RP) command is inactive for PCL 5 printers; use the Number of Copies command for multiple HP-GL/2 plots. To be effective, the Number of Copies command must be issued from PCL prior to closing the page on which the plot is defined.

Simplex/Duplex Print Command

This command designates either simplex or duplex printing mode for duplex printers. Simplex mode prints an image on only one side of a sheet (page). Duplex mode prints images on both sides of a sheet.

^{E}C & ℓ # S

\# = 0 - Simplex
1 - Duplex, Long-Edge Binding
2 - Duplex, Short-Edge Binding

Default = 0

Range = 0-2 (Other values ignored)

Long-Edge bound duplexed pages are bound along the length of the physical page (see Figure 4-2). Short-edge bound duplexed pages are bound along the width of the physical page (see Figure 4-3).

Selecting long-edge binding usually results in font rotation. This may be a concern if available user memory is critical.

Note If this command is received by a printer which does not contain the duplex feature, it is ignored. Printers which do not contain the duplex feature print in simplex mode (front side of sheet) only.

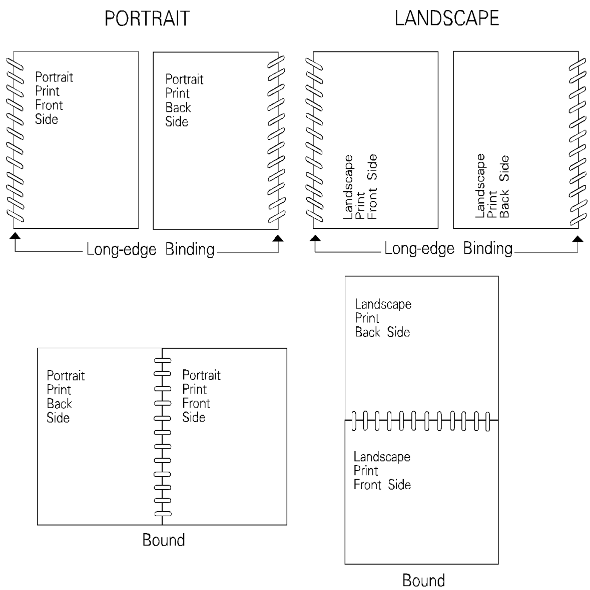


Figure 4-2 Long-Edge Binding Mode

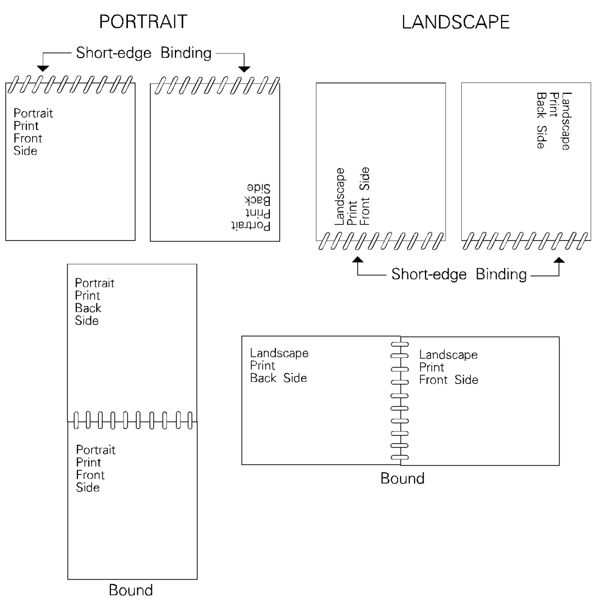


Figure 4-3 Short-Edge Binding Mode

Left Offset Registration Command

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 (1/720 inch)

Default = 0

Range = –32767 to 32767

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, except on the back side (duplex print) of sheets printed in long-edge binding duplex mode, where positive values cause it to move left (refer to Figure 4-4 and Figure 4-5).

Negative values cause the logical page, regardless of orientation, to move left along the width of the physical page, except on the back side of sheets printed in long-edge binding duplex mode, where negative values cause it to move right (refer to Figure 4-4 and Figure 4-5).

Notes

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.

The registration commands may cause data loss by moving the logical page outside the printable area.

This command has the same effect regardless of orientation.

This command can be used in both simplex and duplex modes.

Top Offset Registration Command

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 (1/720 inch)

Default = 0

Range = –32767 to 32767

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, except on the backside of sheets printed in short-edge binding duplex mode, where positive values cause it to move up (refer to Figure 4-4 and Figure 4-5).

Negative values cause the logical page, regardless of orientation, to move up, along the length of the physical page, except on the backside of sheets printed in short-edge binding duplex mode, where negative values cause it to move down (refer to Figure 4-4 and Figure 4-5).

Notes

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.

The registration command may cause data loss by moving the logical page outside the printable area.

This command has the same effect regardless of orientation.

This command can be used in both simplex and duplex modes.

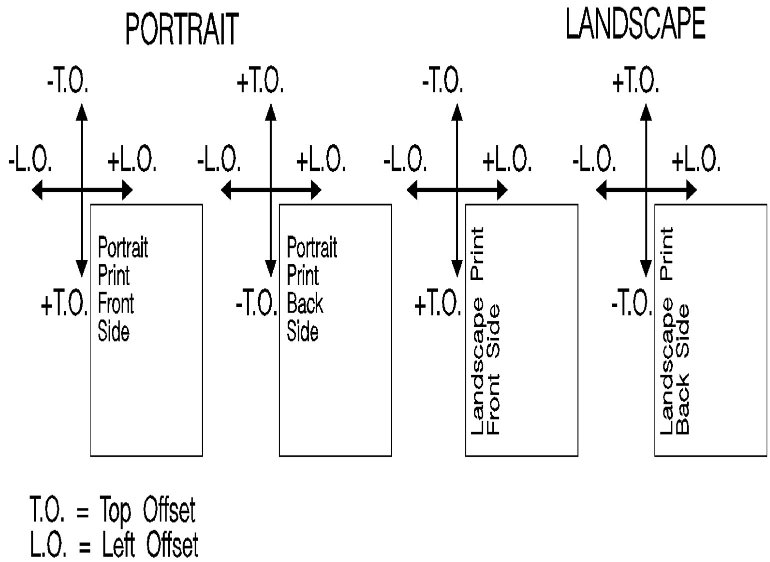


Figure 4-4 Short-Edge Binding Mode Offsets

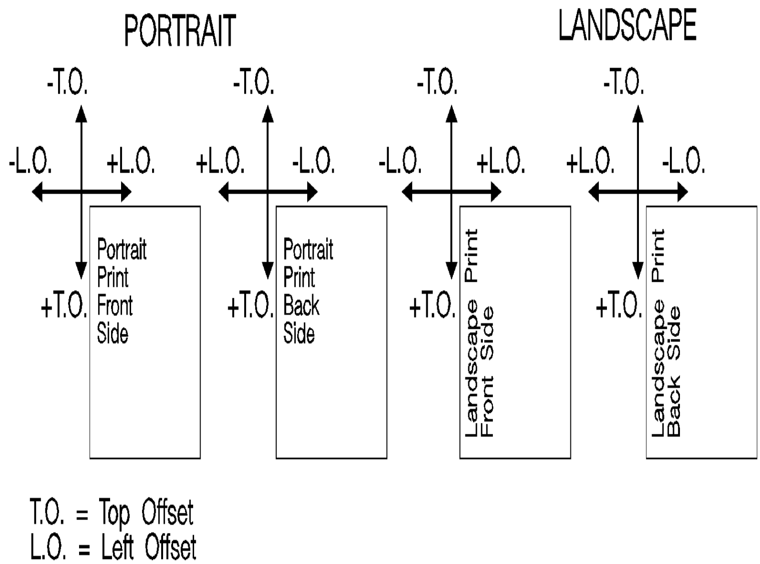


Figure 4-5 Long-Edge Binding Mode Offsets

Duplex Page Side Selection Command

The Duplex Page Side Selection command causes a Form Feed and designates which side of the sheet to print.

The ability to skip a page while duplexing may be required at certain locations in a document. For example, a chapter typically begins on the front side of a page.

^{E}C**&a#G**

\# = 0 - Select next side
1 - Select front side
2 - Select back side

Default = 0

Range = 0-2 (All other values ignored)

If this command is received by a printer which does not have duplex or if duplexing is not enabled, these commands just eject the current page (sheet), positioning the cursor at the default position on the next page.

Example

To print on the front side of a page, regardless of the current side, send the following:

^{E}C**&a1G**

In this example, if the printer is currently formatting a front side, it will stop formatting, eject that page (sheet, skipping the back side), and begin printing on the next front page.

Job Separation Command

Job separation provides a means of identifying one print job from others in the printer's output tray. It usually does this by physically offsetting one print job from the next.

The Job Separation command toggles the printer's separation mechanism. This command must be sent between each job to enable the separation mechanism.

$^{E}{}_{C}$ & ℓ 1 T

HP recommends that the Job Separation command be included at the end of each job, just before the Printer Reset command. HP also recommends that this command be included in the programs even though printers with job separation are not currently being used. This ensures that if a printer with job separation is eventually added, job separation will be performed.

If this command is received by a printer which does not have job separation, the command is ignored.

Note It is possible to perform job offset in printers which do not have a mechanical offset mechanism but have dual paper trays. In dual bin printers, job offset can be performed by placing colored paper in the second tray and using Paper Source command to select the tray to feed a blank sheet of colored paper at the end of a job. This method should only be used in special cases where the end user can control its use, for example, the program should only be available for a dual bin printer which can always contain colored paper in one tray.

Output Bin Selection Command

The **Output Bin Selection** command selects either of the two output paper bins (upper or lower [rear]) for paper output.

EC & ℓ # G

\# = 1 - Upper Output Bin
2 - Lower (Rear) Output Bin

Default = Upper Output Bin

Range = 1, 2

Note If this command is received by a printer which does not contain the dual output bin feature, it is ignored.

Unit of Measure Command

The Unit of Measure command establishes the unit of measure for **PCL Unit** cursor movements.

EC & u # D

\# =Number of units-per-inch

Default = 300

Range = 96, 100, 120, 144, 150, 160, 180, 200, 225, 240, 288, 300, 360, 400, 450, 480, 600, 720, 800, 900, 1200, 1440, 1800, 2400, 3600, 7200.

The value field defines the number of units-per-inch used in the following commands:

- Vertical Cursor Position (PCL Units).
- Horizontal Cursor Position (PCL Units).
- Vertical Rectangle Size (PCL Units).
- Horizontal Rectangle Size (PCL Units).

In addition, the current unit of measure setting affects the HMI setting, which in turn determines how cursor movement values are rounded. This affects the result of the following commands:

- Horizontal Cursor Position (Columns).
- Horizontal Tab (HT control code).
- Space (SP control code).
- Backspace (BS control code).
- Bitmap Character Delta X ("Delta X (SI)," Chapter 11).

For example, if the unit of measure is set to 96 (one PCL Unit = 1/96 inch), then the HMI is rounded to the nearest 1/96 inch. If the unit of measure is set to 300 (one PCL Unit = 1/300 inch), the HMI is rounded to the nearest 1/300 inch.

Note HMI is set either as a result of font selection or through the use of the HMI command. The rounding behavior just described only applies when the HMI is at its default setting (derived from the currently selected font). If the HMI Command was used to override the HMI setting, the rounding behavior described above does not apply. (See "Horizontal Motion Index (HMI) Command" in Chapter 5 for more information.)

The current unit of measure setting affects all PCL Unit moves, horizontal and vertical rectangle size, bitmap and scalable font metrics (how the cursor moves after printing a character). The Unit of Measure command does not affect the interpretation of binary raster data (bitmap fonts, raster graphics or patterns).

Once the units of measure is changed, it stays in effect until another is selected or the printer is reset. A control panel or $^{E}{}_{C}$ **E** reset returns the current unit of measure setting back to the device default setting (300).

The units value is part of the modified print environment. As such, it is saved and restored whenever a macro is called or an overlay invoked, and defaulted when establishing the overlay environment in preparation for an overlay.

Note Values out of range are mapped to the supported value with the minimum relative error. For example, a unit selection of 4801 would be mapped to 7200, since the relative error (0.3332) is less than the relative error when mapped to 3600 (0.3336):

$$\frac{|14801 - 7200|}{7200} = 0.3332 < \frac{|4801 - 3600|}{3600} = 0.3336$$

{|4801-7200| over 7200}=0.3332 < {| 4801-3600|over 3600}=0.3336

Figure 4-6 compares a 4-unit vertical and horizontal cursor move with a unit of measure setting of 100 versus 200 units-per-inch. Note that the cursor move distance is halved when the Units per inch is doubled.

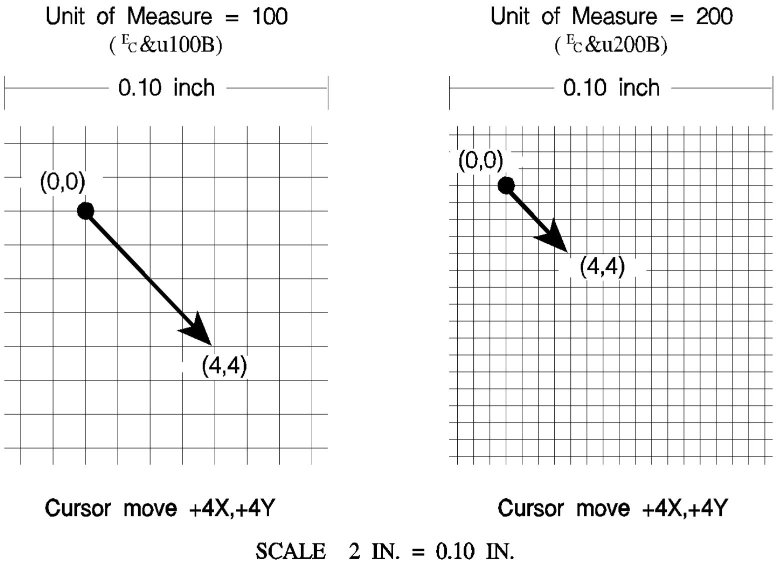


Figure 4-6 Cursor Moves at Different Unit of Measure Settings

The printer's physical **dot size** has **no direct bearing** on the size of **PCL Units** used in cursor movements. In addition, PCL Units are **not affected by the current control panel or PJL resolution setting.**

Note If no other unit of measure value has been specified, then the default is one Unit equals 1/300 inch. In this case, a cursor movement of 450 Units moves the cursor 1.5 inches, whether printed at 300 or 600 dpi print resolution.

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 be sent only once for that group of pages. Remember, once a PCL command is set, it remains in effect until changed by another command.

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 (7¼ x 10½ in.)
2 - Letter (8½ x 11 in.)
3 - Legal (8½ x 14 in.)
6 - Ledger (11 x 17 in.)
26 - A4 (210mm x 297mm)
27 - A3 (297mm x 420mm)

ENVELOPES:

= 80 - Monarch (Letter - 3 7/8 x 7½ in.)
81 - Com-10 (Business - 4 1/8 x 9½ in.)
90 - International DL (110mm x 220mm)
91 - International C5 (162mm x 229mm)
100 - International B5 (176mm x 250mm)

Default = 2 (Configurable from Control Panel)

Range = 1, 2, 3, 6, 26, 27, 80, 81, 90, 91, 100 (Other values ignored)

Note Refer to the "PCL Feature Support Matrix" in Chapter 1 of the *PCL 5 Comparison Guide* or the printer *User's Manual* for lists of supported paper and/or envelope sizes on specific printers.

Upon receipt of this command any unprinted pages are printed, the top margin, text length, and left and right margins are set to their user defaults, and any automatic macro overlay is disabled. The cursor is moved to the left edge of the logical page at the top margin on the following page (see Figure 5-5). Also, certain HP-GL/2 state variables are reset (refer to Table 5-1, 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 and the requested page size is not currently available in another non-secure source, then 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 **HP LaserJet**,, **LaserJet+**, or the **LaserJet 500**+ **printers**.

Example

To select a legal size page, send:

^{E}C & ℓ3A

If the current source paper tray is “LETTER” and the requested page size is not currently available in another non-secure source the following attendance message is displayed:

xx [1] “LOAD LEGAL’’

1 *xx* = A two-letter mnemonic depending on the printer.

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

PAPER SOURCE COMMAND

The Paper Source command designates the location to feed paper, or it prints the current page.

EC & ℓ # H

#	=	0 - Print the current page (paper source remains unchanged).
		1 - Feed paper from the a printer-specific tray.
		2 - Feed paper from manual input.
		3 - Feed envelope from manual input.
		4 - Feed paper from lower tray.
		5 - Feed from optional paper source.
		6 - Feed envelope from optional envelope. feeder[1]

1 Must be used in conjunction with Page Size command, envelope selection.

Default = Printer Dependent (Configurable from Control Panel)

Range = Printer Dependent

Note Not all HP LaserJet printers support all possible paper sources. The implementation of paper source locations varies slightly from printer to printer. Refer to the “PCL Feature Support Matrix” in Chapter 1 of the *PCL 5 Comparison Guide* or the printer *User’s Manual* for paper source feature implementation details for specific HP LaserJet printers.

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 for the next page (see Figure 5-5).

Example

To feed paper from the manual feed slot, send:

EC&ℓ2H

If the selection requires operator action (such as manually feeding paper), a printer message appears in the display, prompting for the appropriate action (see the printer *User’s Manual* for specific behavior).

Logical Page Orientation Command

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

EC & ℓ # O

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

Default = 0

Range = 0-3 (Other values ignored)

Notes

This command can be used only once per page. To print multiple directions per page use the Print Direction command.

This command affects the HP-GL/2 environment (refer to Table 5-1 and the ***“HP-GL/2 and PCL Orientation Interaction” section in Chapter 15 for additional information).

The Orientation command causes the page length, top margin, text length, left and right margins, horizontal motion index (HMI), and vertical motion index (VMI) to return to their user default values, and disables the automatic macro overlay. All data received prior to this command is 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 HP LaserJet 2000, LaserJet IID, LaserJet IIP and all PCL 5 printers automatically rotate all fonts to the current orientation.

Table 5-1 shows how changing certain PCL features (such as a reset, orientation, page size or page length) or changing the HP-GL/2 picture presentation directives (picture frame width or height, horizontal or vertical plot size, or picture frame anchor point) affect the HP-GL/2 state variables.

Table 5-1 HP-GL/2 State Variables

ECE **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 Page Size 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 horizontal and/or vertical 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 Picture Frame 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.

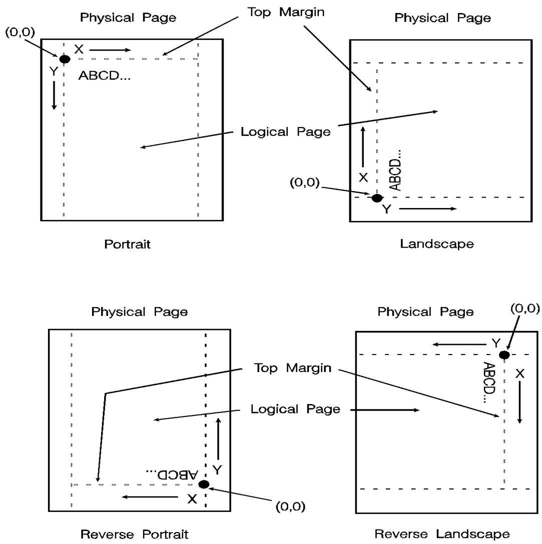


Figure 5-1 Page Orientation With Default Print Direction

The orientation of the HP-GL/2 picture is also affected by the logical page orientation. Figure 5-2 illustrates the effect 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 (they are not affected by PCL mode). However, certain changes to the PCL state can affect the HP-GL/2 state (see Table 5-1).

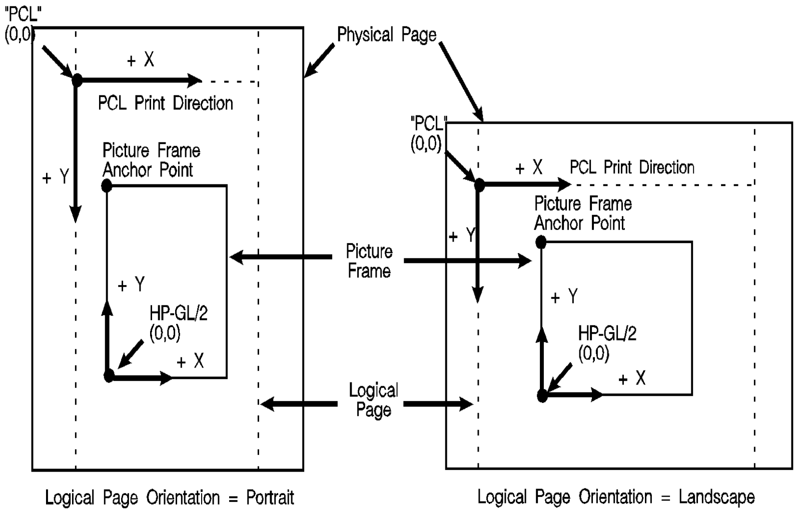


Figure 5-2 HP-GL/2 Picture Orientation with Respect to Logical Page Orientation

Print Direction Command

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

Ec & a # P

= 0 - 0° rotation.
90 - 90° ccw rotation.
180 - 180° ccw rotation.
270 - 270° ccw rotation.

Default = 0

Range = 0, 90, 180, 270 (Other values ignored)

Changing the print direction causes the following:

- The print origin moves with the logical page rotation. 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 (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.
- Print Direction does not default HMI.

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 (Ec**&ℓ#O**) or the HP-GL/2 “RO” command.

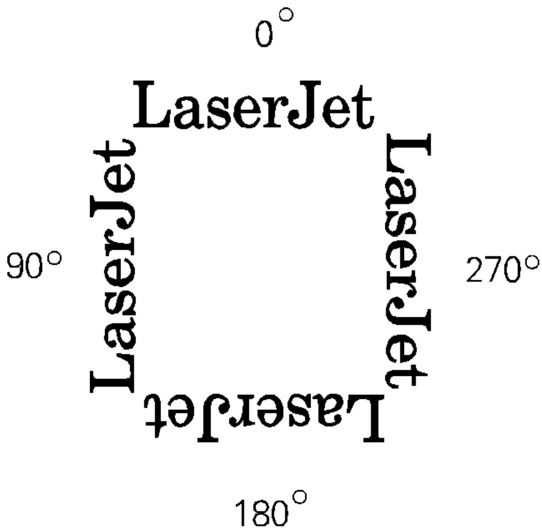


Figure 5-3 Changing Print Direction on a Page

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 region is the distance from the bottom of the text area to the top of the text area (top margin) on the next page. The text area is shown in Figure 5-4.

In general, characters are 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 are printed outside the text area if a cursor move escape sequence positions the cursor outside the text area (but within the printable area). Characters that fall on (or outside) a margin as a result of printing a character string, are clipped (not printed).

Notes

Attempting to print characters across a margin results in the characters being discarded.

The default text area and the default HP-GL/2 picture frame are the same.

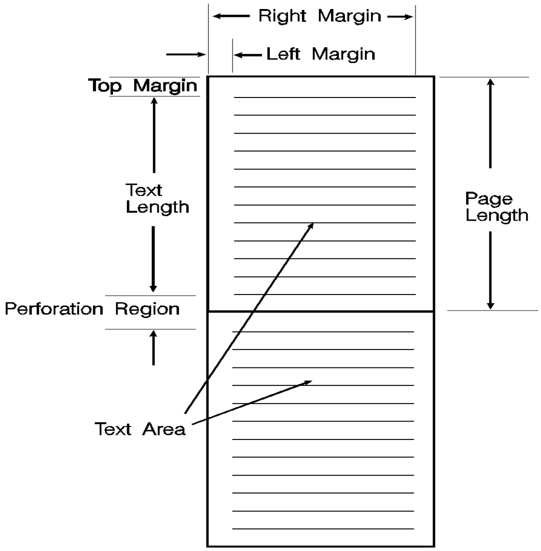


Figure 5-4 Text Area Within the Page

Left Margin Command

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

EC & a # L

= Column number

Default = Column 0 (Left bound of logical page)

Range = 0 - Right margin

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 is moved to the new left margin.

Example

To set the left margin to column 5, send:

EC&a5L

Right Margin Command

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

$^E{}_C$ & a # M

\# = Column number

Default = Logical Page right bound

Range = Current left margin - Logical page right bound

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 is moved to the new right margin.

Example

To set the right margin to column 45, send:

$^E{}_C$&a45M

Clear Horizontal Margins Command

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**

Top Margin Command

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

Default = 1/2 inch down from top of logical page[1]

Range = 0 - Length of logical page (Other values ignored)

1 If logical page length is <½inch, then the top margin is set to top of logical page.

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:

Text Length = (logical page length in inches) - (top margin in inches + 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 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)

Note The default cursor position is not located at the intersection of the top margin and the left bound of the logical page (refer to Figure 5-5). The cursor is actually positioned down 75% of the VMI distance (0.75 × VMI) from the top margin. This positions the cursor at the relative base line position of a character cell for correct character positioning.

Example

To set the top margin to line 4, send:

^{E}C&ℓ4E

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

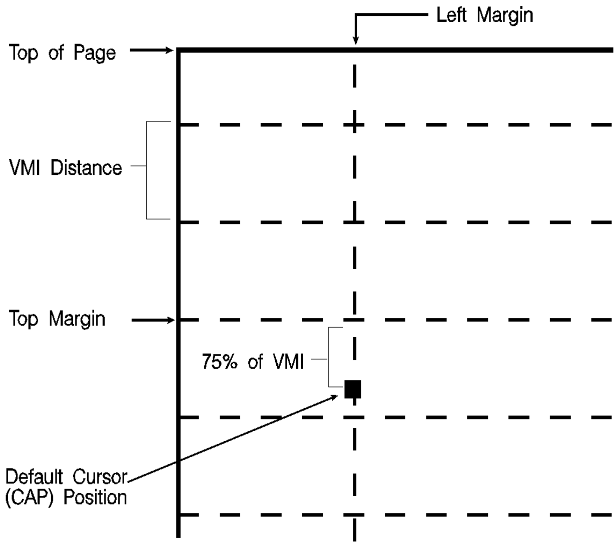


Figure 5-5 Margin Cursor Positioning

Text Length Command

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

Default = 1/2 inch less than maximum text length1

Range = Logical page length minus top margin

1 Maximum text length = INT(logical page length - top margin). However, if the max text length is less than ½inch, the text length is set to the maximum allowable.

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:

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

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

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

Example

To select a text length of 60 lines, send:

^{E}C&ℓ6ØF

Perforation Skip Command

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, which 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 allows the cursor to move to the next line or half-line in the perforation region, allowing printing to continue there.

EC & ℓ # L

\# = 0 - Disable
1 - Enable

Default = 1

Range = 0-1 (Other values ignored)

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 can 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 (HMI) Command

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

EC & k # H

\# = Number of 1/120 inch increments.

Default = Determined by the pitch value in the default font header.

Range = 0 - 32767 (valid to four decimal places)

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 reset to match the new font when any of the font characteristics are changed and when switching between primary and secondary fonts with Shift In and Shift Out.

HMI is equal to the pitch value in the font header. The factory default font's HMI is 12 (12/120 = 1/10 inch per character, or 10 characters per inch).

Note When HMI is not specifically set using the HMI command, PCL cursor moves are rounded to the nearest full increment determined by the current unit of measure setting. For example, if the unit of measure is set to 96 (one PCL Unit = 1/96 inch), then the HMI is rounded to the nearest 1/96 inch. If the unit of measure is set to 300 (one PCL Unit = 1/300 inch), the HMI is rounded to the nearest 1/300 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:

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

Each character then occupies 6.76/120 inch or 1/17.75 inch.

To use Courier 12 point (10 cpi) and print 80 characters across A4 paper, requires adjusting the HMI value. The HMI value is calculated as follows:

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

* This value was obtained from Figure 2-3 which identifies the page sizes (in 300 dpi dots).

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

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

Vertical Motion Index (VMI) Command

The Vertical Motion Index (VMI) command designates the height of the rows. (The vertical distance the cursor moves for a Line Feed operation.)

^{E}C & ℓ # C

\# = number of 1/48 inch increments between rows.

Default = 8

Range = 0 - Current logical page length up to a maximum of 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 Ø 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 printer *User's Manual* for additional information).

Example

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

^{E}C&ℓ6C (6/48 = 1/8 inch/line)

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

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

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 Command

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

EC & 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

Default = 6

Range = 0,1,2,3,4,6,8,12,16,24,48 (Other values are ignored)

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:

EC&ℓ12D

Note Once a PCL command sets a parameter, that parameter remains in effect until another command changes it. 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 PCL cursor position refers to the **Current Active Position (CAP)**, like the blinking underline character (cursor) used on most computers. This “cursor” identifies the current position on the page; the pointer, where a printing command begins laying out page data. 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 cursor commands positioning the cursor, the cursor is automatically positioned after certain operations, such as printing characters and graphics. After printing a character, the cursor is positioned to the right, at a distance equal to the width of that character. This is controlled by the character design described under “Character Width” in Chapter 10, and allows printing characters without requiring a cursor position command for each character printed. When printing graphics, the cursor can also be positioned at a new location. These new positions are identified in the graphics sections.

HP-GL/2 vector graphics has its own HP-GL/2 cursor (referred to as the “pen”) that can be positioned within the HP-GL/2 addressable area. For additional information on HP-GL/2 pen positioning refer to Chapter 17, *An Introduction to HP-GL/2 Vector Graphics*.

Absolute vs. 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 position* (CAP) (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* (CAP) (see Figure 6-1). A signed (+/-) value field in a cursor position command indicates relative cursor movement.

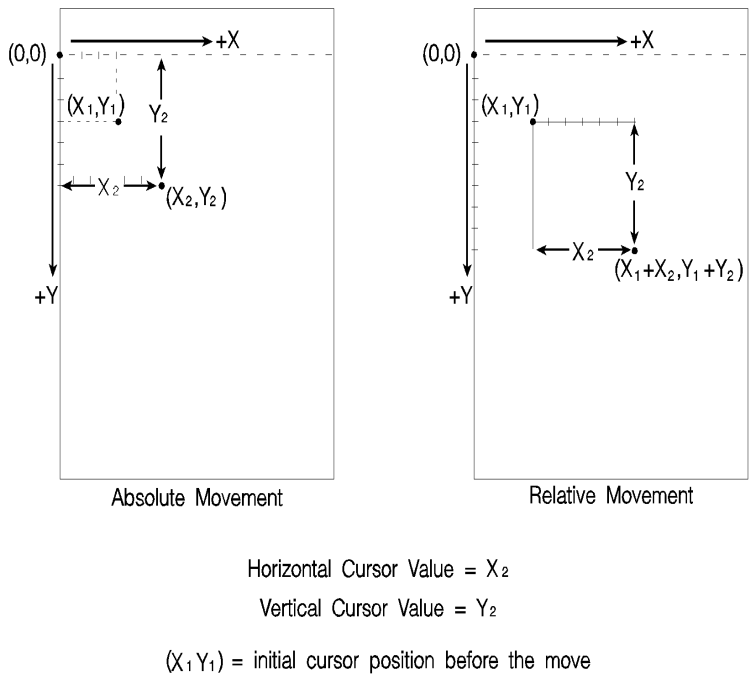


Figure 6-1 Absolute and Relative Cursor Positioning

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

PCL Units

The current unit size used in PCL Unit moves is determined by the value specified in the Unit of Measure command, defining the number of units-per-inch used in the following commands:

- Vertical Cursor Position (PCL Units).
- Horizontal Cursor Position (PCL Units).
- Vertical Rectangle Size (PCL Units).
- Horizontal Rectangle Size (PCL Units).

In addition, the current unit of measure setting affects how cursor movement values are rounded, in turn affecting the result of the following commands:

- Horizontal Cursor Position (Columns).
- Horizontal Tab (HT control code).
- Space (SP control code).
- Backspace (BS control code).
- Bitmap Character Delta X (Delta X (SI), Chapter 11).

For more information, refer to the next section, "*Horizontal Cursor Positioning (Columns) Command*."

If no unit of measure value is specified, the default number of units-per-inch for PCL Unit moves (horizontal and vertical rectangle size, etc.) is one Unit equals 1/300 inch. This is true even when a different resolution (such as 600 dpi) is selected on the printer.

Decipoints

In PCL terminology, a decipoint is 1/720 inch or one-tenth of a PCL point (a PCL point is *exactly* 1/72 inch as opposed to a typographic point which is *approximately* 1/72 inch).

Columns & Rows

The width of a column is defined by the current horizontal motion index (HMI), as described under "Horizontal Motion Index (HMI) Command" in Chapter 5. The distance between rows is defined by the current vertical motion index (VMI), as described under "Vertical Motion Index (VMI) Command" in Chapter 5. 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 17, *An Introduction to HP-GL/2 Vector Graphics*.

Horizontal Cursor Positioning (Columns) Command

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

EC & a # C

= Number of Columns

Default = NA

Range = 0 - logical page right bound (valid to 4 decimal places)

The width of a column is defined by the current HMI.

Note The current unit of measure setting affects how HMI values are rounded. For example, if the unit of measure is set to 96 (one PCL Unit = 1/96 inch), then the HMI is rounded to the nearest 1/96 inch. If the unit of measure is set to 300 (one PCL Unit = 1/300 inch), the HMI is rounded to the nearest 1/300 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 first column within a line is column 0. This sequence ignores margins and can therefore be used to set the current active position (CAP) to any location along the current line.

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

Horizontal Cursor Positioning (Decipoints) Command

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

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

\# = Number of Decipoints (1/720 inch)

Default = NA

Range = 0 - logical page right bound (rounded to the first decimal place)

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 (CAP) is moved to the appropriate logical page limit.

The value field is valid to two decimal places.

Horizontal Cursor Positioning (PCL Units) Command

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

^{E}C * p # X

= Number of PCL Units

Default = NA

Range = 0 - logical page right bound

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 (CAP) is moved to the appropriate logical page limit.

Note The current unit size used in PCL Unit moves is determined by the value specified in the Unit of Measure command. If no other value is specified, the number of units-per-inch for PCL Unit moves is one unit equals 1/300 inch.

Horizontal Cursor Positioning Control Codes

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

Note The distance which the cursor is moved by the Space (SP), Backspace (BS), and Horizontal Tab (HT) control codes is defined by the current HMI value. The current unit of measure setting affects how HMI values are rounded. For example, if the unit of measure is set to 96 (one PCL Unit = 1/96 inch), then the HMI is rounded to the nearest 1/96 inch. If the unit of measure is set to 300 (one PCL Unit = 1/300 inch), the HMI is rounded to the nearest 1/300 inch.

CR - Carriage Return

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

SP - Space

Moves the current active position (CAP) 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 moves the cursor by the current HMI value; however, a printable space moves the cursor the width of the character. For fixed pitch fonts, a space, whether control code or printable, moves the cursor according to the HMI value.

BS - Backspace

Moves the current active position (CAP) 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. If the cursor is currently beyond the right margin, BS positions the cursor just to the left of the right margin. When using fixed pitch fonts, the Backspace distance is defined by the current print pitch (HMI setting).

When using proportionally-spaced fonts, a single Backspace moves back to center the overstrike character. After printing the overstriking character, the cursor returns to its position prior to 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 (CAP) 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) Command

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

^{E}C **& a # R**

\# = Number of Rows

Default = NA

Range = –32767 to 32767 (valid to 4 decimal places)

A value field (#) with a plus sign (+) indicates the new position is downward from and relative to the current cursor position; 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 affects the cursor position on the page.

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

Vertical Cursor Positioning (Decipoints) Command

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

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

\# = Number of Decipoints (1/720 inch)

Default = NA

Range = –32767 to 32767 (rounded to the first decimal place)

A value field (#) with a plus sign (+) indicates the new position is downward from and relative to the current cursor position; 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 affects the cursor position on the page.

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

Vertical Cursor Positioning (PCL Units) Command

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

EC * p # Y

\# = Number of PCL Units

Default = NA

Range = –32767 to 32767

A value field (#) with a plus sign (+) indicates the new position is downward from and relative to the current cursor position; 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 affects the cursor position on the page.

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

Note The current unit size used in PCL Unit moves is determined by the value specified in the Unit of Measure command. If no other value is specified, the number of units-per-inch for PCL unit moves is one unit equals 1/300 inch.

Half-Line Feed Command

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).

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

Vertical Cursor Positioning Control Codes

Two control codes can be used to position the cursor vertically. These control codes are explained below.

LF - Line Feed

Advances the current active position (CAP) 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 “Line Termination Command” later in this chapter.)

FF - Form Feed

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

Line Termination Command

The Line Termination command controls the way the printer interprets CR, LF, and FF control characters. All CR, LF and FF control characters received after the Line Termination Command are interpreted as shown below.

^{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

Default = 0

Range = 0-3

For example, if a value field of 1 is sent, the printer interprets each Carriage Return (CR) received as a **Carriage Return (CR) and Line Feed (LF)** control code. A Line Feed or Form Feed would be sent as is.

If a value of 3 is sent, the printer interprets each Carriage Return (CR) received as a **Carriage Return (CR) and Line Feed (LF)**; it interprets each Line Feed (LF) received as a **Carriage Return (CR) and Line Feed (LF)**; and it interprets each Form Feed (FF) received as a **Carriage Return (CR) and Form Feed (FF)**.

Push/Pop Cursor Position Command

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)

Default = 0

Range = 0, 1 (Values outside range are ignored)

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 you try to save more than 20 positions, the command is ignored. If you try 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. Therefore, the positions are relative to the top left corner of the current orientation. Also, a position pushed in one orientation and popped in another 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 logical page 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**, **typeface** and **orientation**.

A typical document is printed using several fonts. 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. Examples of different fonts are shown in Figure 7-1.

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

A font must be selected for printing by the user. One font is selected at a time. It is selected by identifying the specific characteristics of the font. Font selection commands identify font characteristics to the printer (refer to *Summary of Font Selection by Characteristic* for detailed font selection information).

PCL 5 printers feature scalable fonts. With the addition of this feature, the printer has two font formats available: bitmap and scalable. A bitmap font is available in its one, defined size only. A scalable font, on the other hand, can be selected (scaled) for a range of sizes (refer to “Bitmap Fonts and Scalable Typefaces” later in this chapter for additional information).

Font Sources

A number of fonts (and typefaces, as described later) are supplied with the printer. These fonts reside in permanent ROM (read only memory), and are referred to as **internal fonts**. Additional fonts can be added easily by inserting font cartridges or SIMM modules into the printer, or downloading them from the host computer.

A **cartridge font** plugs into a font cartridge slot on the printer. **SIMM font** modules plug into a printed circuit board inside the printer. These ROM-based fonts are always available (as long as the cartridge or SIMM module is installed). A variety of font products may be purchased from Hewlett-Packard or other vendors. Refer to your Hewlett-Packard Accessories and Supplies Brochure for a list of HP’s font products.

Soft fonts are supplied as files on flexible disk transferred (downloaded) into the printer’s user (RAM) memory. Once a soft font has been downloaded into the printer’s RAM, it may be selected for printing.

Symbol Set

Symbol set identifies the specific collection 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 figure shows two 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, while the Roman-8 set contains European characters not contained in the PC-8 symbol set.

Note User-defined symbol sets are supported by some HP LaserJet printers. See Chapter 10 for more information.

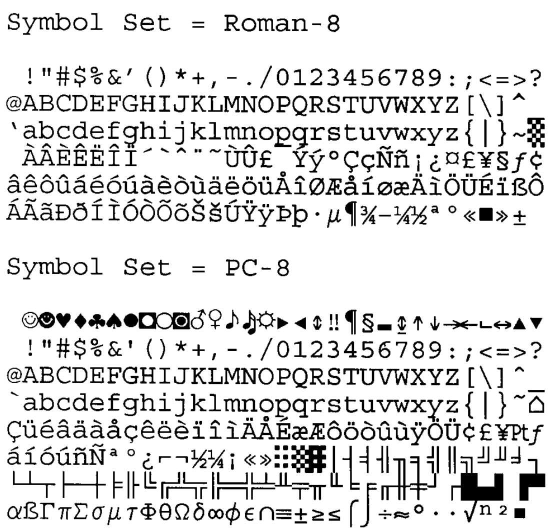


Figure 7-2 Symbol Sets

Spacing

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

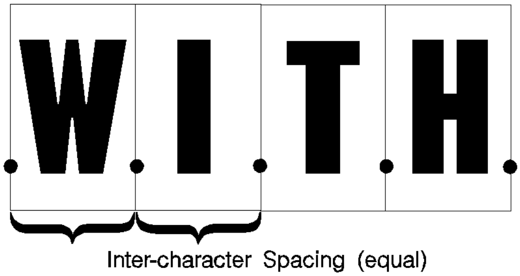


Figure 7-3 Fixed Spacing

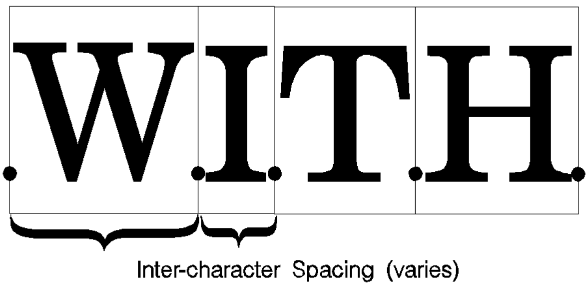


Figure 7-4 Proportional Spacing

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.

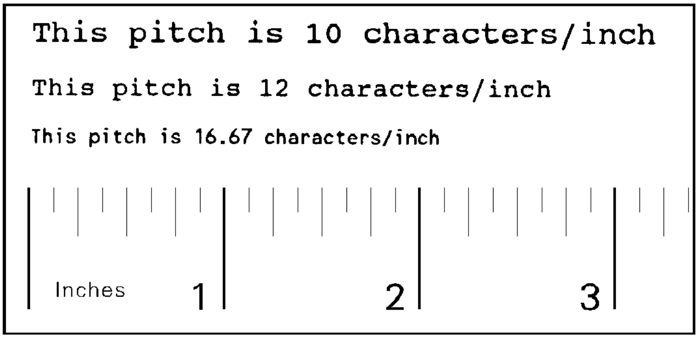


Figure 7-5 Pitch

Height

The height of a font is the measurement of the body of the type in PCL points. A PCL point is 1/72 inch in bitmap fonts, and approximately 1/72 inch in scalable fonts. 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.

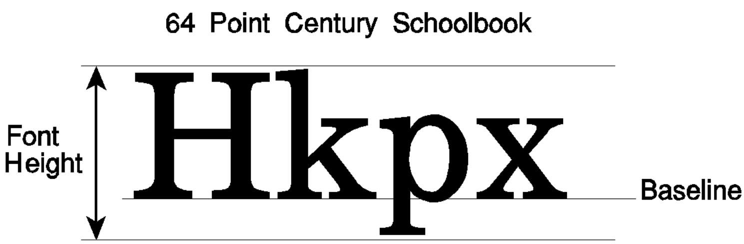


Figure 7-6 Height

This loose measure from near the bottom of a descender to just above the top of an unaccented capital letter is sometimes referred to as the “Em.”

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

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

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 with respect to the physical page as shown in Figure 7-10.

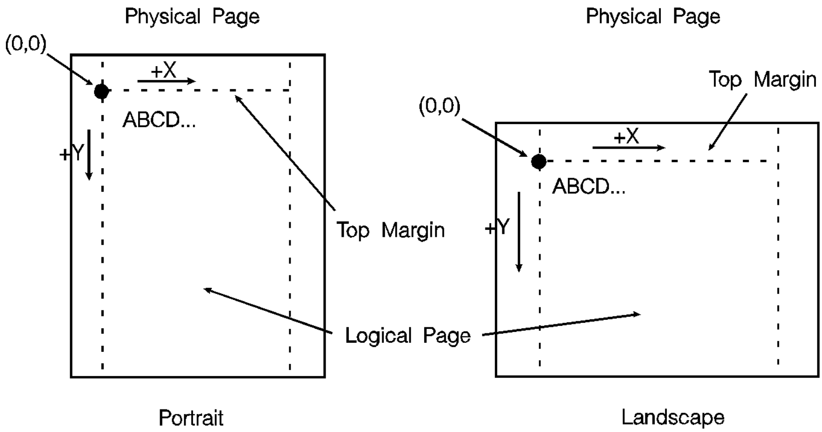


Figure 7-10 Orientation

The HP LaserJet IID, IIP, 2000, and all PCL 5 LaserJet printers automatically rotate fonts to the current orientation (all fonts are available in all four orientations). (Earlier printers required fonts in the orientation which matched the orientation of the page. Thus, orientation is not as important as it once was.)

The orientation of a font is still a consideration when the amount of user memory (RAM) is a concern. Internal and other ROM-based fonts consume very little user memory. On some printers, downloaded fonts, scaled fonts, and rotated fonts are stored entirely in RAM. For bitmap fonts, selecting a font with the current logical page orientation saves RAM space on some printers.

Bitmap Fonts and Scalable Typefaces

There are two basic formats of fonts used by HP PCL 5 printers: bitmap (Figure 7-11) and scalable (Figure 7-12). Earlier HP LaserJet printers supported only bitmap fonts. Bitmap fonts have a fixed bit-pattern for each character. The size of the character is fixed, depending on the bit-pattern. Scalable typefaces, on the other hand, provide an “outline” for the characters. This “outline” can be scaled by the PCL 5 printers to produce a large range of character sizes.

There is a difference, between a scalable typeface and a scalable font. A bound, **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, and size is variable (since it is scalable). A s**calable 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 size are variable.

Note Scalable fonts and scalable typefaces are selected for printing in the same manner as bitmap fonts; no additional selection is required (refer to Summary of Font Selection by Characteristic for font selection information).

Some scalable typefaces are provided with the printer (for example: CG Times and Univers). Additional scalable typefaces can be obtained on disk, cartridge or SIMM modules.

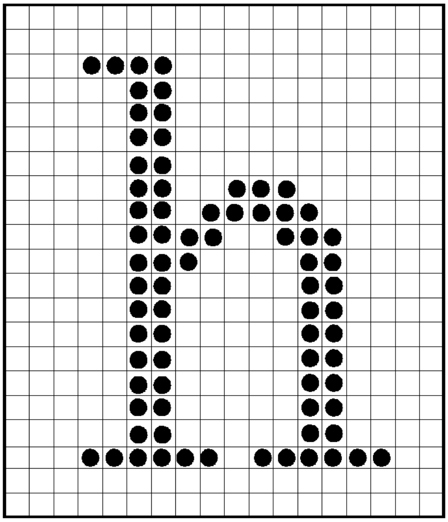


Figure 7-11 Bitmap Character

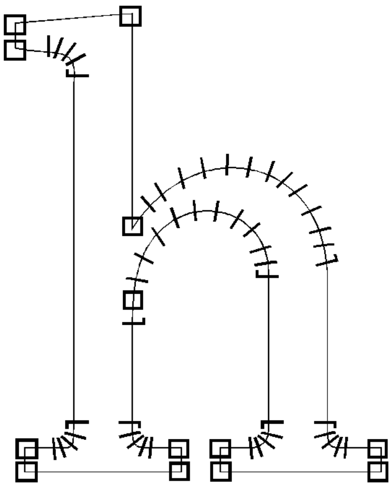


Figure 7-12 Scalable Character

Internal Fonts

Internal fonts are those fonts that are provided with the printer. Both internal bitmap and scalable font formats are provided. Internal bitmap and scalable fonts and symbol sets for current models of HP LaserJet family printers are listed in Chapter 2 of the *PCL 5 Comparison Guide*. Font and symbol set listings for earlier printer models can be found in the *User's Manual* for each printer.

Special Effects

HP PCL 5 printers allow you to create special effects when printing characters. These effects are achieved through the use of the print model feature, or through the use of HP-GL/2 vector graphics (refer to Chapter 13, *The PCL Print Model* or to the HP-GL/2 information in Chapters 17-23).

The print model provides a simple means for printing patterned or shaded characters using the printer's predefined cross-hatch/shading patterns, or user-defined patterns. HP-GL/2 vector graphics provide the additional ability to print characters in any direction (angle) on a page, and to print outlined characters. HP-GL/2 also allows anisotropic (non-linear) scaling of scalable fonts which produces characters that are stretched in one direction.

8 PCL Font Selection

Introduction

Several characteristics identify a font (as described in **Chapter 7**, *Fonts*). Font characteristic selection commands, described in this chapter, are used to specify the desired font characteristics for printing. Commands are included for the following characteristics: symbol set, spacing, pitch, height, style, stroke weight, and typeface family.

The printer maintains a **font select table** in its operating code that contains the characteristic values of the current font. Whenever the printer receives a font select command (escape sequence) specifying a new characteristic value, the printer records that characteristic in the table. After the table is updated (receives new characteristic values), and text is ready to be printed, the printer performs a **font select**. The printer searches the available fonts and scalable typefaces to select one that matches (or most closely matches) the characteristics as listed in the font select table.

Note **A font must be in the printer to be selected for printing!**

Font Selection Priority

The printer selects a font based on a prioritization of its design characteristics, then its resolution, then its physical location in the printer, and finally, its orientation. Font selection priority considerations are shown in the following list:

Font Priority Considerations	
Symbol Set	highest
Spacing	|
Pitch	|
Height	|
Style	|
Stroke Weight	|
Typeface Family	|
Resolution[1]	|
Location[2]	|
Orientation	lowest

1. Bitmap fonts designed at 600 dpi are not available for selection at 300 dpi. In 600 dpi mode, font priority is as follows: 600 dpi bitmap, scalable, 300 dpi bitmap.
2. Although location is not a font characteristic, it is a font selection consideration.

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 design characteristics, more than one font still remains, then the resolution and location are considered.

There are four locations where a font may be stored: printer ROM (Read Only Memory), SIMM module ROM, cartridge ROM, and printer RAM (random access memory; user memory). These font locations are shown below, listed from the highest to lowest priority. The font that matches the characteristics is selected from the highest priority location.

Priority of Locations	
Soft Font (Lowest ID first)	Highest
Cartridge Font[1]	|
SIMM Font	|
Internal Font	Lowest

1. In printers with two cartridge slots, one slot has priority over the other. Refer to Appendix E of the *PCL 5 Comparison Guide* for cartridge slot priority information for the different HP LaserJet printers.

Note

In 600 dpi mode: A 600 dpi font has priority over a 300 dpi font. For example, a 600 dpi bitmap soft font is highest, then a scalable soft font, followed by a 300 dpi bitmapped soft font.

Finally, for bitmap fonts, the orientation of a font is considered. If there are two fonts which are similar in all the above characteristics and which reside 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 rotates the font to the orientation of the page. (“Summary of Font Selection by Characteristic” on page 23, later in this chapter, 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 appears 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 one aspect, only the single characteristic must be specified. For example, to select a font differing only in stroke weight (in this case, medium rather than bold), the printer’s font select table could be changed as follows:

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

At a minimum, 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, **HP recommends that all of the characteristics be sent to ensure that the correct font is selected**.

Note PCL 5 printers 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) is used to designate **primary** and “SO’’ (Shift Out; ASCII 14) is used to designate **secondary.**

The factory default state is **primary** font designated.

Font Resolution

With the introduction of the LaserJet 4 printer, fonts can be printed at 600 dpi resolution. All scalable fonts automatically print at either 300 or 600 dpi resolution. A bitmapped font which was designed at 300 dots-per-inch can be printed on the LaserJet 4 printer at 600 dpi. However, a bitmapped font which was designed at 600 dpi is not available for selection at 300 dpi resolution.

Symbol Set Command

The Symbol Set command identifies the specific set of symbols in a font. “Symbols” are the alphanumeric, punctuation, or any other printable characters or symbols which may be included.

$^{E}{}_{C}$ **(ID** Primary Symbol Set Command

ID = Symbol Set ID value (see Appendix C in the *PCL 5 Comparison Guide*)

$^{E}{}_{C}$ **) ID** Secondary Symbol Set Command

ID = Symbol Set ID value (see Appendix C in the *PCL 5 Comparison Guide*).

Default = 8U

Range = N/A

If the specified symbol set does not exist, Roman-8 is selected (However, the specified symbol set is written into the font select table.)

Notes

The factory default primary and secondary symbol set is Roman-8. However, you may select a user default symbol set from the printer control panel (see the printer *User’s Manual*).

If the font is a scalable typeface, symbol set is determined from the values contained in the printer’s font selection table. To specify a different symbol set, send a symbol set selection command **prior** to the Font Selection ID command. (Also see “Font Selection by ID Command,” later in this chapter.)

A few symbol sets are listed below. For a more complete list, refer to Appendix C in the *PCL 5 Comparison Guide*.

Typical Symbol Set Values	
Symbol Set Name	**Symbol Set ID**
ISO 69: French	1F
ISO 8859-1 Latin 1 (ECMA-94)	0N
ISO 6:ASCII	0U
Legal	1U
Roman-8	8U
PC-8	10U
3 of 9 Barcode	0Y
Windows 3.1 Latin 1 (ANSI)	19U

Note User-defined symbol sets are supported in some HP LaserJet printers. To specify a user-defined symbol set, use the symbol set ID value as defined by the **Symbol Set ID Code Command**. See Chapter 10 for more information.

Example

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

$^{E}{}_{C}$(ØU

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

$^{E}{}_{C}$)8U

7-bit ISO Symbol Sets

The HP LaserJet printers provide several 7-bit ISO (International Organization for Standardization) or “keyboard” symbol sets to support European languages. Each ISO symbol set is a unique ordering of symbols contained within the Roman-8 symbol set (see Appendix B in the *PCL 5 Comparison Guide*). The printer automatically generates the requested ISO font from an HP Roman-8 font.

Spacing Command

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

Default = 0

Range = 0, 1 (values outside the range are ignored)

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 is selected. If fixed spacing is specified but is not available, a proportional-spaced font is selected and the pitch characteristic is ignored.

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 printer's control panel (refer to the 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 Command

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 a fixed-spaced font is selected.

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

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

\#   = # = Pitch in characters/inch

Default = 10

Range = 0.00

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

If a pitch is specified that is not available, the next greater available pitch is selected. If no greater value is available, the closest available lesser value is 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 users default font from the printer's control panel (refer to the printer *User's Manual*).

The range of valid pitch selections for a fixed-spaced scalable font is 576 to .10 characters/inch, however, not all valid pitches are available, since the pitch value is actually converted to a corresponding point size (height) value which is scaled by the printer. The effective pitch ranges are thus limited by height constraints.

The lower end of the pitch range is limited as a result of the font height limitation of 999.75 points. For example, the smallest available pitch for the internal Courier typeface would be about 0.12.

The upper end of the pitch range is similarly limited by the minimum recommended font height of 4 points. For Courier, this translates to a maximum recommended pitch of 30 (30 cpi), while for Letter Gothic the maximum recommended pitch is 36. When requested pitch values are outside of HP's recommended limits, unsatisfactory results can occur.

The following formula can be used to as a rule of thumb for computing a maximum recommended pitch:

$$\frac{1}{\begin{array}{l}\text{Contour Width} \\ \text{(percent of Em)}\end{array} \times 4 \text{ (points)} \div 72 \text{ (points/inch)}}$$

The character (“contour”) width in the above formula is expressed as a percentage of an Em. For example, the width of characters in Courier is very close to 60% of an Em, and $30 = 1 \div (0.64 \div 72)$. (The width of characters in Letter Gothic is approximately 50% of an Em. For other fonts, refer to the font metric data supplied by the font vendor.)

Note If a scalable fixed-space font is selected using an ID number, send the Pitch command to specify the size; otherwise, the size is determined by the pitch characteristic value of the former font (as listed in the font select table) See “Font Selection by ID Command” later in this chapter for more information.

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 Command

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 bitmap font or a proportionally-spaced scalable font is selected.

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

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

\# = Height in points

Default = 12

Range = 0.25 - 999.75

The value field (#) is valid to two decimal places. If the requested height is unavailable, the closest height is 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 (values are rounded to the nearest quarter point).

The factory default primary and secondary heights are 12 point. In PCL bitmap fonts, a point is 1/172 (0.01389) inch. For scalable fonts, the definition of a point varies in TrueType a point is 1/172 inch, while Intellifont fonts have 72.307 points to the inch.

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

Note If a proportional-spaced scalable font is selected using an ID number, send the Height command to specify the point size otherwise, the size is determined by the height characteristic value of the former font (as listed in the font select table) See “Font Selection by ID Command” later in this chapter for more information.

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 Command

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

Default = 0

Range = 0 - 32767 (values greater than 32767 are set to 32767)

Style values for the most common typefaces are listed in Table 8-1. Additional style values may also be obtained from the related font documentation provided with HP's font products.

Table 8-1 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

Notes

With the introduction of the HP LaserJet IID printer, Hewlett-Packard expanded the style values (in the Font Header style value field) from a one-byte to a two-byte value field, expanding the style range from 0-255 to 0-32767. This expansion allows for additional styles.

Style values can be obtained by calculating the "Style Word" as described under "Style MSB" in Chapter 11.

For selecting 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

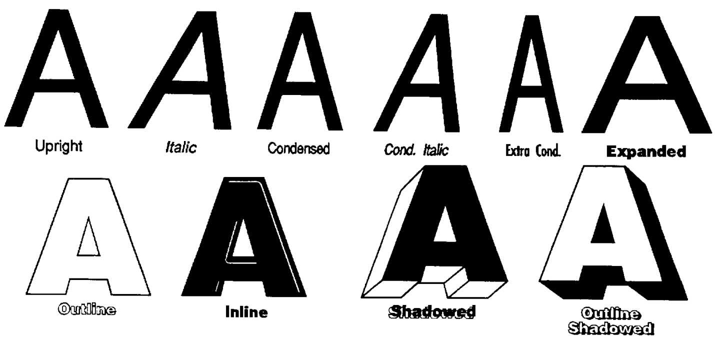


Figure 8-1 Common Font Styles

Stroke Weight Command

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

Default = 0

Range = - 7 to 7 (less than -7 maps to -7; greater than 7 maps to 7)

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 8-2 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 is selected. If no thicker stroke weight is available, the closest available thinner stroke weight is selected.

If the specified stroke weight is less than zero and is not available, the next thinner available stroke weight is selected. If no thinner stroke weight is available, the closest available thicker stroke weight is 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 printer's control panel (refer to the 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 0. This weight value may be assigned to "book" or "text" treatment instead.

Typeface Family Command

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 Appendix C in the *PCL 5 Comparison Guide* for typeface values).

Default = [1]4099, Body Text

Range = [1]0 - 65535 (values greater than 65535 are set to 65535)

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 printer's control panel (refer to the printer *User's Manual*).

There is some variation in how font selection occurs between HP LaserJet models. The typeface selection compatibility for two types of values is identified for various HP LaserJet printers in Chapter 2 of the *PCL 5 Comparison Guide*.

Note Use the typeface family values, listed in Appendix C in the *PCL 5 Comparison Guide*, for future typeface selection.

1. These values are not applicable to all HP LaserJet family printers. See the *PCL 5 Comparison Guide* for specifics.

Some typeface (two-byte) family values are listed below. For a complete listing of typeface family and base values, refer to Appendix C in the *PCL 5 Comparison Guide*.

Sample Typeface Values	
FamilyValue	**Typeface Family**
0	Line Printer
16602	Arial
4168	Antique Olive
4127	ITC Avant Garde
4119	CG Century Schoolbook
4101	CG Times
4148	Univers

Example

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

$^{E}{}_{C}$**)s4101T**

To specify Line Printer as the typeface family for the secondary font, send:

$^{E}{}_{C}$**)s0T**

Orientation

The Orientation command (**$^{E}{}_{C}$&l#O**) designates the position of the logical page with respect to the physical page. Earlier printers could only print bitmap fonts and raster graphics in the orientation for which they were designed. However, the HP LaserJet IID, IIP, 2000, and all PCL 5 HP LaserJet printers have the capability to automatically rotate bitmap fonts and raster graphics to match the page orientation; therefore, all fonts are available in all four page orientations and print directions. Whenever a scalable font is selected, it is created in the current orientation for printing. Refer to "Logical Page Orientation Command" and "Print Direction Command" in Chapter 5 for more information.

Font Selection Examples

Bitmap, Fixed-Spaced Font

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

Table 8-3

CHARACTERISTIC	VALUE	ESCAPE SEQUENCE
Symbol set	ASCII	${}^{E}_{C}$**(0U**
Spacing	Fixed	${}^{E}_{C}$**(s0P**
Pitch	16.66 cpi	${}^{E}_{C}$**(s16.66H**
Height	8.5 point	${}^{E}_{C}$**(s8.5V**
Style	Upright	${}^{E}_{C}$**(s0S**
Stroke weight	Medium	${}^{E}_{C}$**(s0B**
Typeface family	Line Printer	${}^{E}_{C}$**(s0T**

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

${}^{E}_{C}$**(0U**${}^{E}_{C}$**(s0P**${}^{E}_{C}$**(s16.66H**${}^{E}_{C}$**(s8.5V**${}^{E}_{C}$**(s0S**${}^{E}_{C}$**(s0B**${}^{E}_{C}$**(s0T**

The previous sequence can be shortened by combining sequences that have the same two characters following the ${}^{E}_{C}$ character:

${}^{E}_{C}$**(0U**${}^{E}_{C}$**(s0p16.66h8.5v0s0b0T**

Scalable, Proportional-Spaced Font

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	**$^{E}{}_{C}$(0U**
Spacing	Proportional	**$^{E}{}_{C}$(s1P**
Height	14.25 point	**$^{E}{}_{C}$(s14.25V**
Style	Upright	**$^{E}{}_{C}$(s0S**
Stroke weight	Bold	**$^{E}{}_{C}$(s3B**
Typeface family	CG Times	**$^{E}{}_{C}$(s4101T**

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

$^{E}{}_{C}$(0U$^{E}{}_{C}$(s1P$^{E}{}_{C}$(s14.25V$^{E}{}_{C}$(s0S$^{E}{}_{C}$(s3B$^{E}{}_{C}$(s4101T

Combining the above sequences results in:

$^{E}{}_{C}$(0U$^{E}{}_{C}$(s1p14.25v0s3b4101T

Notes

If an escape sequence does not contain a value field, the printer assumes a value of zero; therefore, the command **$^{E}{}_{C}$(sB** can be sent to the printer instead of **$^{E}{}_{C}$(s0B**.

Sending shortened font selection commands can result in selection of an unexpected font. This is due to failure to track 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. Selection by characteristic is an elimination process. The nine steps are performed in the following order:

Note When the printer is in 300 dpi mode, any 600 dpi bitmaps are eliminated before the selection process begins.

1 **Symbol Set** - if the specified symbol set exists, that symbol set is selected; otherwise, Roman-8 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 PCL 5 printers, 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.

   Bitmap Fonts: For a fixed-space bitmap font, 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.

   Scalable Fonts: For a fixed-spaced scalable font, the pitch is used to calculate the appropriate height. The Height selection command is not required. The printer calculates the appropriate height to correspond to the pitch. The user's height request is recorded in the printer's font select table for later font selections, but is ignored for this selection.

4 **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.

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 calculated from the requested pitch.

5 **Style** - if the specified style is available in the remaining fonts, that style is selected; otherwise, this characteristic is ignored.

6 **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 is selected. If no thicker stroke weight is available, the closest available thinner stroke weight is selected.

If the specified stroke weight is less than 0 and is not available, the next thinner available stroke weight is selected. If no thinner stroke weight is available, the closest available thicker stroke weight is selected.

7 **Typeface Family** - if the requested typeface is available in the remaining fonts, that typeface is selected; otherwise, this characteristic is ignored.

8 **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:

Priority of Locations	
Soft Font (Lowest ID first)	Highest
Cartridge Font[1]	|
SIMM Font	|
Internal Font	Lowest

1. In printers with two cartridge slots, one slot has priority over the other. Refer to Appendix E of the *PCL 5 Comparison Guide* for cartridge slot priority information for the different HP LaserJet printers.

9 **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 is selected.

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 is selected and rotated.

Font Selectionby ID Command

Soft fonts can be specified using their associated ID numbers. (ID numbers are assigned to soft fonts 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

Default = 0

Range = 0 - 32767

If the designated font is present, the font is selected as the primary/secondary font and all primary/secondary font characteristics in the printer's Font Select Table 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.

Notes

If a scalable font is selected using an ID number, send the Height or Pitch command (Height for proportional, Pitch for fixed) to specify the height or pitch; otherwise, the characteristic is determined by the value of the former font (as listed in the font select table).

If the font is a scalable typeface, symbol set is determined from the values contained in the printer's font selection table. To specify a different symbol set, send a symbol set selection command **prior** to the Font Selection ID command.

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

Examples

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 is not affected by the default font command.

HP-GL/2 Font Selection

In addition to selecting fonts using the PCL font selection commands, fonts can also be selected and printed in HP-GL/2 mode using the HP-GL/2 label commands (refer to Chapter 23, *Character Group*). The HP-GL/2 font selection commands allow you to label vector graphic images and to create some special effects with fonts not otherwise available. These special effects include printing outline fonts from fonts which are not outline style, 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 this font scaling method is rather program intensive and not the recommended method (refer to "HP-GL/2 Vector Graphics" in Chapter 25 for additional information).

Transparent Print Data Command

The Transparent Print Data command provides printing access to those characters which 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.

Default = N/A

Range = 0 - 32767

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 musical notes (decimal code 14):

$^{E}{}_{C}$**&p1X** *[ASCII 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 exists), however, in the PC-8 symbol set, decimal code 14 is also the musical notes character (printable from transparency mode). Refer to Appendix A for character codes for the various symbol sets.

Underline Command

The Underline command controls automatic text underlining.

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

\# = 0 - Fixed position
3 - Floating position

Default **=** 0

Range **=** 0, 3 (values outside range are ignored)

$^{E}{}_{C}$ **& 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 the dot row on which all of the characters in a given line appear to stand, see Chapter 11.) 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 for a font is defined in the font header, see Chapter 11.)

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

9 Font Management

Introduction

Font management provides mechanisms for manipulating soft fonts. It provides the means for controlling which soft fonts are saved in user memory (RAM) or deleted. This is accomplished by assigning a font as either temporary or permanent, or deleting a soft font. In addition, font management includes the command for assigning ID numbers to RAM fonts. It also provides a mechanism for copying ROM fonts (internal, cartridge, or SIMM) to RAM for the purpose of assigning ID numbers.

Downloading Soft Fonts

The process of transferring soft fonts from a host computer to the printer's user memory (RAM) is called downloading. Designate a unique identification (ID) number 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 is deleted during the download.

Several commands are required to define a font before downloading it to the printer. These commands are described in detail in Chapter 11. Hewlett-Packard font files include the necessary commands that define the symbols of a font. Assigning a font ID number and then copying the font file to the printer downloads the font. Scalable fonts and typefaces may be prepared by font management software such as HP's Type Director. Once prepared, scalable fonts are downloaded in much the same manner as bitmap fonts.

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 vs. Permanent Fonts

Once downloaded, a font is automatically designated as temporary. A temporary soft font is deleted from user memory during a printer reset or when a Typeface List, a Font Printout or a self-test 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 referencing its ID number and using the Font Control command (refer to "Font Control Command" later in this chapter).

Note Both temporary and permanent fonts are deleted from user memory whenever the printer's power is turned off.

Switching printer languages ("personalities"), changing resolution, or changing the Page Protection setting also deletes temporary and permanent fonts from user memory in some printers (refer to the appropriate printer *User's Manual* for specifics).

An existing font is deleted when a new font with the same ID number is downloaded. The new font replaces the existing font (whether temporary or permanent).

Deleting Fonts

There are several mechanisms provided by PCL font management that delete 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 ID and the Font Control commands described on the following pages).

Font ID Command

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 “Font Selection by ID” in Chapter 8).

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

= ID number

Default = 0

Range = 0 - 32767

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

The factory default font ID is 0 (if no Font ID command is sent, an ID of 0 is assigned).

Note The font number assigned by the printer and used from the printer’s control panel is not the same as the ID number assigned using the Font ID Command.

Example

To specify a font ID number of 1, send:

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

Font Control Command

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)

Default = N/A

Range = 0 - 6 (values outside range are ignored)

Note If the primary or secondary font is deleted, a new primary or secondary font is selected automatically 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 a bitmap or bound scalable font with an ID of 1, send:

$^{E}{}_{C}$ ***c1d112e3F**

(A space is printed in place of the deleted character. Also, the $^{E}{}_{C}$***c#E** Character Code command used in the above sequence “...112e...,” is described in Chapter 11.)

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.

Note When the currently selected font is a scalable TrueType ROM font, $^{E}{}_{C}$*c#d6F **assigns** a font ID number, but makes **no copy** of the font in RAM. Any attempts to download or delete characters within the font are ignored. An attempt to delete the font merely results in the loss of the ID number.

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 disk.

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

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

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

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

4 Designate the permanent soft font as primary:

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

Unbound Scalable Fonts

Prior to introduction of the HP LaserJet IIIP printer, a downloaded scalable font was restricted to a single symbol set. Now scalable fonts with no symbol set affiliation can be downloaded. These new fonts are called unbound fonts.

To download unbound fonts, the "PCL Font Header for Intellifont Unbound Scalable Fonts" or the "Format 15 Font Header for Scalable Fonts" (TrueType) must be used (see Chapter 11).

Bound and Unbound Fonts

The terms "bound" and "unbound" refer to the symbol set capacity of a font. A bound font identifies a font which is restricted (bound) to a single symbol set. An unbound font (or unbound *typeface*) indicates the capacity to be bound to a set of symbols selected from a complementary **symbol index** (such as the Master Symbol List (**MSL**), or the **Unicode** symbol index).

Font Selection and Unbound Fonts

When a font is requested for printing, the printer selects a font which most closely matches the current font selection characteristics (symbol set, spacing, pitch, height, style, stroke weight, and typeface). Refer to "Summary of Font Selection by Characteristics" in Chapter 8 for detailed font characteristic selection information.

Since symbol set is the highest font selection priority and typeface is the lowest, the printer searches for the symbol set first. A list of all fonts that match the requested symbol set is made. This includes bitmap, bound, and unbound fonts. Since bitmap and bound scalable fonts contain only one symbol set, they can be easily identified. However, determining which unbound fonts match a symbol set is more complex. Symbol set compatibility for unbound fonts is determined by identification of groups of symbols referred to as symbol collections.

Symbol Collections

The symbols in an unbound font (typeface) can be divided into symbol collections. These symbol collections identify the symbols according to some language basis or special application usage. Some symbol collections include: Basic Latin, East European, Turkish, Math, Semi-Graphic, and Dingbats. If a symbol collection is included in an unbound font, all of the symbols of that collection are included.

Note See Appendix D in the *PCL 5 Comparison Guide* to identify symbols in the various collections.

The symbols within a symbol collection do not change from one unbound font to the next. For example, the Basic Latin collection always contains the same symbols. Different fonts may contain different symbol collections. For example, the internal Univers typeface contains the Latin, Math, and Semi-Graphic collections (these collections contain all the symbols required for the 35 symbol sets that Univers supports). The ITC Zapf Dingbats typeface, on the other hand, contains only the Dingbats collection, which includes all the symbols required for the five supported symbol sets.

When searching unbound scalable fonts (during font selection) for those that match the requested symbol set, the printer actually searches for symbol collections. To identify symbol collections which meet the needs of the requested symbol set, the printer uses two numbers: the **Character Requirements** number and the **Character Complement** number.

Character Complement Numbers

The “Intellifont Unbound Scalable Font Header” (header) includes a 64 bit field (bytes 78-85) which contains the Character Complement number. For TrueType fonts, in the “Format 15 Font Header for Scalable Fonts” (unbound), the Character Complement number is included in the accompanying “Segmented Font Data” section of the header.

The Character Complement number identifies the symbol collections in the font. Each bit in this field corresponds to a symbol collection (not all bits are currently defined; refer to Appendix D in the *PCL 5 Comparison Guide*).

Intellifont example: If bits 63 and 34 are cleared (set to zero) it indicates that the unbound font contains the Basic Latin (bit 63) and Math (bit 34) symbol collections and that the character index is in HP’s MSL numbers (bit 0).

TrueType example: If bits 31, 30, and 0 are cleared (set to zero), it indicates that the unbound font contains ASCII, Latin 1 extensions and is based on Unicode numbers.

Character Requirements Number

The other number the printer uses to determine symbol set compatibility, the Character Requirements number, is provided as part of the information contained in the symbol set. The Character Requirements number is a 64-bit number analogous to the Character Complement number; however, it identifies the symbol collections needed by the symbol set.

Intellifont example: If a symbol set based on HP’s MSL numbers requires one or more characters from the standard Latin collection and some of the characters from the Math collection then bits 63 and 34 are set to one (refer to Appendix D in the *PCL 5 Comparison Guide* for information regarding the various symbol collections).

TrueType example: If a symbol set based on Unicode numbers requires one or more characters from the standard ASCII collection and some of the characters from the Latin 5 collection, then bits 31, 28 and 0 are set to one (refer to Appendix D in the *PCL 5 Comparison Guide* for information regarding the various symbol collections).

As stated above, to determine which unbound scalable fonts contain the symbols for the specific symbol set, the printer must identify those unbound fonts that contain the symbol collections of the requested symbol set. To do this, the printer accesses the Character Requirements number for the requested symbol set. If, for example, the Roman-8 symbol set was requested, the printer would access the Character Requirements number from the Roman-8 symbol set information in the printer. This number is then compared with the Character Complement number of each unbound font in the printer. If any matches are found, those unbound fonts are included in the list of potential fonts for selection.

Final Font Selection

After the process above is complete, the printer contains a list of all fonts (bitmap, bound, and unbound) which support the requested symbol set. (If no fonts are found for the specified symbol set, Roman-8 is used. If more than one font remains, the printer continues comparing font selection characteristics, eliminating fonts, until only one remains. Whenever only one font remains, it is selected for printing.

Symbol Set Mapping Table

The printer receives character codes in the range 0-255 which, depending on the selected symbol set, identify the symbols to print or control codes to execute.

There are hundreds of symbols available in unbound fonts in HP LaserJet printers, more than can be identified by the character code range (0 - 255). A list of these symbols is provided in the **symbol indexes**, such as the Master Symbol List (MSL) and the Unicode list In Appendix D of the *PCL 5 Comparison Guide*). Each symbol in the list is identified by a unique MSL or Unicode number. Symbols in unbound fonts are identified by this number.

Since the printer identifies symbols by their symbol index number (range from 0 to 65535), but receives character codes (range 0-255), a relation must be made between the character codes and the larger range of symbol index numbers. This relation is defined by the symbol set mapping table.

The printer contains a symbol set mapping table for each available symbol set. These tables list the character code range and corresponding list of symbol index numbers. Using this mapping the printer identifies which indexed character is printed for the character code in the current symbol set.

A partial symbol set mapping table is shown in Table 9-1 for the Roman-8 symbol set.

Table 9-1 Roman-8 Symbol Index Mapping

Character Code	MSL Index (decimal)	Unicode Index (hexadecimal)
32	0	
33	1	0021
34	2	0022
35	3	0023
36	4	0024
37	5	0025
38	6	0026
39	8	2019
40	9	0028
41	10	0029
⋮	⋮	⋮
252	189	25a0
253	190	00bb
254	191	00b1

Printing a Character

When an unbound font is selected for printing and a character code is received, the printer accesses the requested symbol set mapping table to identify the MSL or Unicode number. For example, if the Roman-8 symbol set is selected and the printer receives character code 254, the printer accesses the Roman-8 symbol set mapping table (Table 9-1). In the Roman-8 mapping table, character code 254 is mapped to MSL number 191 or Unicode number 00b1 (plus-over-minus symbol). Thus, to print character code 254, the printer searches the selected unbound font for the correct MSL or Unicode number and prints that character.

10 User-Defined Symbol Sets

Introduction

User-defined symbol sets are used with unbound scalable fonts. Three new commands provide for the implementation of user-defined symbol sets:

Symbol Set ID Code - $^{E}_{C}$*c#R

Define Symbol Set - $^{E}_{C}$**(f#W [symbol set data]**

Symbol Set Control - $^{E}_{C}$*c#S

To define a symbol set, you must first designate a symbol set ID code. Next, use the Define Symbol Set command to download the list of characters (character codes and related symbol index numbers) for the symbol set. Once this is accomplished, you may select the symbol set for printing in the same manner as any symbol set using the symbol set selection sequence: $^{E}_{C}$**(ID**

Once a user-defined symbol set is downloaded, the Symbol Set Control command can be used to assign symbol sets as either temporary or permanent and to delete them.

Symbol Set ID Code Command

The Symbol Set ID Code command assigns a symbol set ID code to a user-defined symbol set. This ID code is used by the Symbol Set Control command for symbol set management.

The ID code corresponds to the symbol set ID selection value which is used to identify the symbol set during font selection.

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

\# = Symbol Set ID Code (decimal)

Default = 0

Range = 0 - 32,767 (larger values are outside the legal range)

When downloading a symbol set, the symbol set ID value must match the Encoded Symbol Set Designator field in the user-defined symbol set header.

As mentioned above, the symbol set ID code is related to a symbol set ID value. The relationship between the ID code and the symbol set ID selection value is shown by the following formula:

Symbol Set ID code = (# * 32) + (ID - 64)

where: “#” represents the number portion of the ID selection value which may range from 0-1023; and, “ID” represents the ordinal (decimal) value of the ID character. (Symbol set ID selection values consist of a number and a letter, such as 8U for Roman-8 or 7J for DeskTop etc.)

For example:

Assume the ID selection value selected for this symbol set is 17Q, then:

(17 * 32) + (81 - 64) = 561

The symbol set ID code is 561.

When selecting an ID code, select one which is not being used currently. (If an ID code is selected which is already being used in the printer, that symbol set is redefined.) The first step in selecting an ID code is to determine an ID selection value. Since it may be difficult to determine which ID selection values are being used, it is best to select one which has not been assigned. Refer to Appendix C in the *PCL 5 Comparison Guide* to select a number/letter (ID selection value) combination which has not been assigned.

After the ID selection value has been determined, use the conversion formula (shown above) to convert the ID value to an ID code.

To create a user-defined symbol set:

1 Identify the symbols (symbol index numbers) for the symbol set from the MSL or Unicode list in Appendix D of the *PCL 5 Comparison Guide*. List them in the appropriate character code order.

2 Identify the symbol collections (and Character Requirement bits) that contain the symbols (Appendix D of the *PCL 5 Comparison Guide*).

3 Identify the Define Symbol Set command header information.

4 Identify a symbol set ID selection value and convert it into its symbol set ID code.

5 Designate the ID code using the Symbol Set ID Code command.

6 Download the symbol set header data and MSL or Unicode numbers using the Define Symbol Set command.

To print using the symbol set, it must be selected using the Select Symbol Set command - $^{E}{}_{C}$**(ID**, where **ID** is the symbol set ID selection value used to calculate the symbol set ID code.

Define Symbol Set

This command defines the characters and character mapping for a user-defined symbol set.

$^E{}_C$ (f # W [symbol set definition data]

\# = Number of bytes in symbol set definition

Default = n/a
Range = 0 - 32767

If a user-defined symbol set is already present in the printer and a new, valid symbol set is downloaded with the same Symbol Set ID Code, then the old symbol set is deleted. If an internal symbol set with the same ID code exists, it is overridden by the new symbol set. If the symbol set definition is invalid, the command is ignored. If there is insufficient memory to create the symbol set, the symbol set is discarded.

Note Send the Symbol Set ID Code command prior to the Define Symbol Set command to assign an ID code for the user-defined symbol set. If the Symbol Set ID Code command is not sent, the last code sent is used. If none have been sent, then the default (0) is assigned.

The data format for the user-defined symbol set is shown in Table 10-1.

Table 10-1 User-Defined Symbol Set Defintion Format

Byte	15 - MSB8	7LSB - 0
0	Header Size (18)	
2	Encoded Symbol Set Designator	
4	Format	Symbol Set Type
6	First Code	
8	Last Code	
10	Character Requirements	
Hdr Size	Symbol Map [Last Code — First Code + 1] ⋮	

The following abbreviations are used to define the data type of each field in the symbol set header:

Font Header 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}-1)
(SLI)	: Signed Long Integer	(-2^{31} . . 2^{31}-1)
(ASCxx)	: ASCII string	array (0 . . xx-1) of characters

Header Size (UI)

Set the header size to the size of the header data — the number of bytes from Header Size (byte 0) to the last byte just before the beginning of the Symbol Map data bytes. This value is 18 or greater.

Encoded Symbol Set Designator (UI)

This field must match the ID code in the Symbol Set ID code command.

This field contains the symbol set ID code. The symbol set ID code is calculated from a symbol set ID selection value using the following formula:

Symbol Set ID Code = (# * 32) + (ID - 64)

where # is the decimal number (0 to 1023) and ID is the ASCII character code of the letter.

For example:

Assume the ID selection value selected for this symbol set is 17Q, then:

(17 * 32) + (81 - 64) = 561

The symbol set ID code is 561.

Format (UB)

Set this field to 1 for MSL (Intellifont) or 3 for Unicode (TrueType).

Unrecognized values cause the symbol set definition to be ignored.

Symbol Set Type (UB)

This field defines the printable and unprintable codes for the symbol set.

Bit Field	Designated Use
0	7-bit, 32-127 are printable.
1	8-bit, 32-127 and 160-255 are printable.
2	8-bit, 0 - 255 character codes are printable, however, to print codes 0, 7-15, and 27, the printer must be in transparency mode.

First Code (UI)

Specifies the first character code in the set.

Last Code (UI)

The Last Code specifies the last character code in the set.

Together, the First Code through the Last Code identify the range of character codes which map to the symbol index numbers (characters) in the Symbol Map field.

Character Requirements (Array of UB) and character requirement

This 8-byte field works in conjunction with the Character Complement field in the header of a type 10 or 11 (unbound) font to determine the compatibility of a symbol set with an unbound font. These two fields identify the unbound fonts in the printer which contain the symbol collections required to build a symbol set. Refer to “Unbound Scalable Fonts” in Chapter 9, for a description of symbol collections and unbound fonts.

Each bit in the field represents a specific collection. Setting a bit to 1 indicates that collection is required; setting the bit to 0 indicates that collection is not required. (Bit 63 refers to the most significant bit of the first byte, and bit 0 refers to the least significant bit of the eight byte field.) The bit representations for the collections are shown below. (The symbols for each collection are shown in Appendix D of the *PCL 5 Comparison Guide*.)

MSL Symbol Index Character Requirements		
Bit	**Value**	**Designated Use**
63	1	Basic Latin required (such as ISO 8859/1 Latin 1)
	0	Basic Latin not required
62	1	East European Latin required (such as ISO 8859/2 Latin 2).
	0	East European Latin not required
61	1	Turkish required (such as ISO 8859/9 Latin 5)
	0	Turkish not required
34	1	Math required (such as Math-8)
	0	Math not required
33	1	Semi-graphic required (such as PC-8 D/N)
	0	Semi-graphic not required
32	1	Dingbats required (such as ITC Zapf Dingbats series 100, series 200, etc.)
	0	Dingbats not required
2,1,0	000	MSL Symbol Index

Unicode Symbol Index Character Requirements Bits (numbers/values)		
Bit	**Value**	**Designated Use**
31	1	ASCII required (such as ISO 6 ASCII)
	0	ASCII not required.
30	1	West Europe extensions required (such as ISO 69 French).
	0	West Europe extensions not required.
29	1	East Europe extensions required (such as ISO 8859/2 Latin 2).
	0	East Europe extensions not required.
28	1	Turkish extensions required (such as ISO 8859/9 Latin 5).
	0	Turkish extensions not required.
27	1	Desktop Publishing extensions required (such as Windows 3.1).
	0	Desktop Publishing extensions not required.
26	1	Accent extensions required (such as ISO 8859/1 Latin 1).
	0	Accent extensions not required.
25	1	PCL extensions required (such as Roman-8).
	0	PCL extensions not required.
24	1	Macintosh extensions required (such as MC Text).
	0	Macintosh extensions not required.
23	1	PostScript extensions required (such as PS Text).
	0	PostScript extensions not required.
22	1	Code Page extensions required (such as PC-8).
	0	Code Page extensions not required.
2,1,0	001	Unicode Symbol Index

Examples of values for the field include:

Bit Field	Designated Use
Value (Hex)	**Meaning**
0000000000000000	Default requirement (MSL); symbol set can be used with any typeface indexed bu MSL.
8000000000000000	Symbol set (MSL) requires only the Basic Latin Symbol Collection (such as Roman-8)
0000000100000000	Symbol set (MSL) requires only the Dingbat Collection.
0000000000000001	Default requirement (Unicode); symbol set can be used with any typeface indexed bu Unicode.
00000000A0000001	Symbol set (Unicode) requires the ASCII and East Europe Collections (such as ISO 8859/2).
0000000088000001	Symbol set (Unicode) requires the ASCII and Desktop Publishing Collections (such as Ventura US).

Symbol Map (Array of UI)

The symbol map contains a list of symbol index numbers. This list identifies symbols for the symbol set. (Refer to Appendix D in the *PCL 5 Comparison Guide* for a MSL and Unicode symbol indexes.) The symbol map pairs (maps) a character code to a symbol index number. The range of character code numbers (paired with symbol index numbers) is the range from the First Code through the Last Code fields in the header. The first symbol index number in the Symbol Map field is mapped to the character code whose value is that of the First Code field; the second symbol index number is mapped to the “First Code + 1” character code; the third symbol index number is mapped to the “First Code + 2,” etc., through the last symbol index number, which is mapped to the value in the Last Code field. The number of symbol index characters in the array must match the number of character codes in the range, First Code through Last Code.

If no printable symbol (symbol index number) is associated with a given character code (as with codes 128 through 160 of Roman-8), the corresponding entry in the Symbol Map should be 65535 (FFFF Hex).

Symbol Set Control Command

This command provides a means for making user-defined symbol sets permanent or temporary, and for deleting them.

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

\# = 0 - Delete all temporary and permanent user-defined symbol sets.
1 - Delete all temporary user-defined symbol sets.
2 - Delete current user-defined symbol set (last symbol set ID code specified).
4 - Make current user-defined symbol set temporary.
5 - Make current user-defined symbol set permanent.

Default = n/a
Range = 0-2, 4, 5 (other values ignored)

Downloaded symbol sets default to temporary.

Internal symbol sets cannot be deleted or made temporary.

User-Defined Symbol Set Examples

The following two examples illustrate the concept of user-defined symbol sets. They create symbol sets for PC-8 in MSL and Unicode symbol indexes. The necessary escape sequences are shown in each example.

Unicode Symbol Index Example

Symbol Map Data:	
$^{E}{}_{C}$*c341R	PCL Symbol Set #IDs: 10U
$^{E}{}_{C}$(f526W	Symbol Set 526 bytes in length
00 12	Header Size 18 bytes
01 55	ID code 341 decimal: 10U
03	Format 3 (Unicode Symbol Index)
02	Font Type 2
00 01	First code = 1
00 fe	Last code = 254
00 00 00 00 c0 40 00 01	ASCII, Latin 1, and PC Characters required
26 3a (character code 1)	Open Happy Face
26 3b (character code 2)	Solid Happy Face
26 65 (character code 3)	Solid Heart, Card Suit
26 40 (character code 4)	Solid Diamond, Card Suit
26 63 (character code 5)	Solid Spade, Card Suit
⋮	⋮
25 bc (character code 31	Down Solid Arrowhead
ff ff (character code 32)	Space Code (no character)
00 21 (character code 33)	Exclamation Mark
⋮	⋮

Symbol Map Data: ***(continued)***	
00 41 (character code 65)	Uppercase A
⋮	⋮
00 61 (character code 97)	Lowercase A
⋮	⋮
20 7f (character code 252)	Superior Lowercase N
00 b2 (character code 253)	Superior Numeral 2
25 a0 (character code 254)	Small Solid Square Box
$^{E}_{C}$*c341r5S	PCL Symbol Set #ID: 10U, Make this symbol set permanent.

MSL Symbol Index Example

Symbol Map Data:	
$^{E}_{C}$*c341R	PCL Symbol Set #ID: 10U
$^{E}_{C}$(f528W	Symbol Set 528 bytes in length
00 12	Header Size 18 bytes
01 55	ID code 341 decimal: 10U
01	Format 1 (MSL Symbol Index)
02	Font Type 2
00 01	First code = 1
00 ff	Last code = 255
80 00 00 02 00 00 00 00	Basic Latin and PC Characters required
00 cb (character code 1)	Open Happy Face
00 cc (character code 2)	Solid Happy Face
00 cd (character code 3)	Solid Heart, Card Suit
00 ce (character code 4)	Solid Diamond, Card Suit

Symbol Map Data: ***(continued)***	
00 cf (character code 5)	Solid Spade, Card Suit
⋮	⋮
00 e7 (character code 31)	Down Solid Arrowhead
00 00 (character code 32)	Space Code
00 01 (character code 33)	Exclamation Mark
⋮	⋮
00 22 (character code 65)	Uppercase A
⋮	⋮
00 43 (character code 97)	Lowercase A
⋮	⋮
01 4c (character code 252)	Superior Lowercase N
00 c5 (character code 253)	Superior Numeral 2
01 31 (character code 254)	Small Solid Square Box
00 00 (character code 255)	No-Break Space
$^{E}{}_{C}$*c341r5S	PCL Symbol Set #ID: 10U,

11 Soft Font Creation

Introduction

A font that is downloaded (transferred) from a computer to a printer is called a soft font. A PCL soft font contains a **font header** and a set of **character definitions**. The font header and character definitions contain all the information needed to format a font for use in the HP LaserJet printers.

Every PCL font header begins with a font descriptor, which 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.

Every PCL character definition contains a character descriptor and a body of character data. Furthermore, the character definition always consists of one or more character data blocks. Each character data block begins with its own character data block header.

The character descriptor is a block of data that identifies the characteristics for a specific character, such as its position, and the cursor position after printing. The character data which follows defines the shape of the character.

This chapter describes the font header and character definition formats for PCL Bitmap fonts, Intellifont scalable and TrueType scalable fonts. By formatting a font consistent with the header format requirements, a user may download this information (the font) to the printer using the Font Header command and the Character Descriptor/Data command. One additional command, the Character Code command, required to identify the ASCII character code assigned to each character, is also described in this chapter.

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

Table 11-1

Font ID Command
Font Header
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 Classifications

There are three basic classifications of fonts accepted by the HP LaserJet printer: **PCL bitmap**, **Intellifont scalable**, and **TrueType scalable**. Several different font header and character descriptor formats are available for the different font classifications. All are presented in this chapter.

Note Not all font classifications are supported in all HP LaserJet Family printers. Refer to the *PCL 5 Comparison Guide* or the printer *User's Manual* for specific information.

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

Intellifont scalable fonts are formatted to use Agfa Scaling Technology. Intellifont scalable fonts are described in detail in the document, *Intellifont Scalable Typeface Format*, available from Agfa Division, Miles Inc. (Refer to *Related Documents*, located in the front of this manual, for information on how to obtain this document.)

TrueType scalable fonts are described in detail in the document, *True Type Font Files*. (Refer to *Related Documents*, located in the front of this manual, for information on how to obtain this document.)

Note The documents, *Intellifont Scalable Typeface Format* and *True Type Font Files* do not contain descriptions of scalable PCL fonts. Instead, they contain descriptions of files from which PCL fonts can be built.

Coordinate System

Both bitmap and scalable characters are designed in an area referred to as a *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 bitmap character cell is illustrated in Figure 11-3, Figure 11-6, and Figure 11-7. 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.

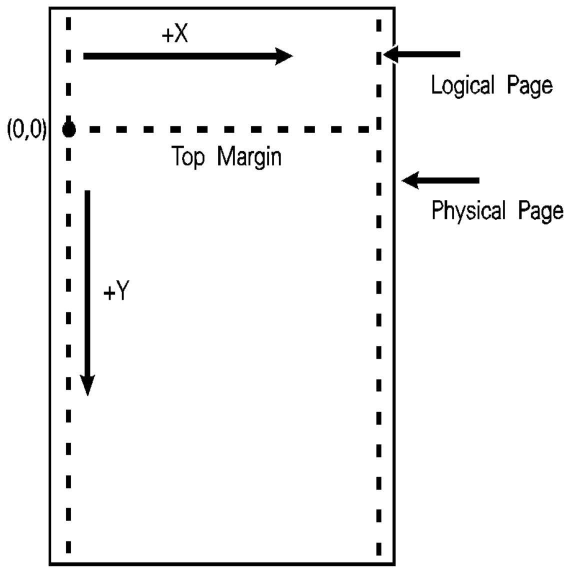


Figure 11-1 Bitmap Physical Coordinate System

Note The LaserJet IID, IIP, 2000, and all LaserJet PCL 5 printers rotate fonts to match the paper's physical coordinate system.

Intellifont Scalable Fonts

Characters of an Intellifont scalable font are designed within a rectangular area known as the Agfa Design Window (Figure 11-2). 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.

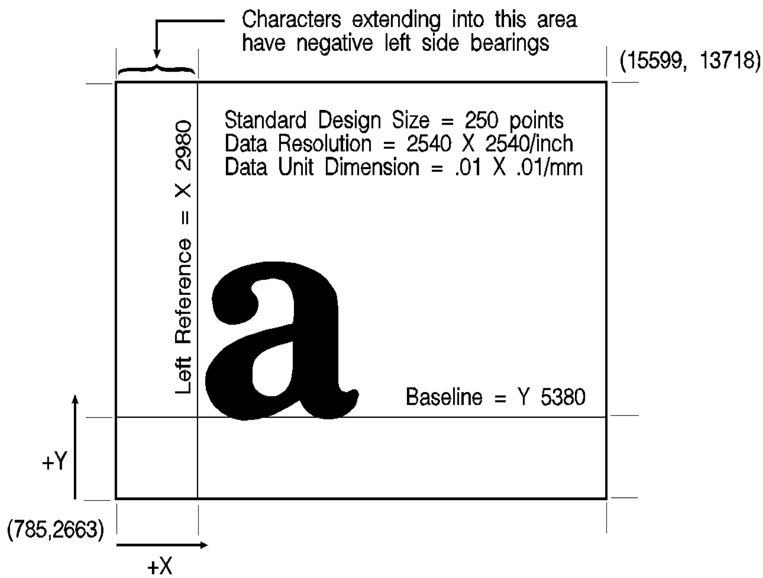


Figure 11-2 Agfa Design Window

TrueType Scalable Fonts

TrueType scalable font character coordinates are typically based on a system of 2048 units per Em. The baseline is defined by y-coordinate=0. The left reference is usually defined by x-coordinate=0 (although there is some variation among fonts). To determine the left reference line for an individual TrueType character, subtract the LSB value found in the hmtx table from the xMin value found in the glyf table. See *True Type Font Files* for more information.

Font Header Command

The Font Header command is used to download font header data to the printer.

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

Default = 0
Range = 0 - 32767

The value field (#) identifies the number of bytes in the font header. The font header fields are described under *Font Header Format*, later in this chapter.

Note Two examples for downloading a Font Header are provided under *Font Header Examples*, after the *Font Header Format* section, later in this chapter.

Font Header Format

The **font header** describes those characteristics of a font which are common to all its characters. Five font headers are included here:

- **Format 0 Font Header for PCL Bitmapped Fonts** - This font header, shown in Table 11-2, is not recommended for LaserJet 4 and later printers. It is included in this manual to maintain backward-compatibility with earlier versions of PCL.
- **Format 20 Font Header for Resolution-Specified Bitmapped Fonts** - This header replaces the previous bitmap header, and has the added capability to specify a font's resolution. This font header is shown in Table 11-3.
- **Format 10 Font Header for Intellifont Bound Scalable Fonts** - For creating Intellifont scalable fonts which are restricted (bound) to a single symbol set. This font header is shown in .
- **Format 11 Font Header for Intellifont Unbound Scalable Fonts** - For creating Intellifont scalable fonts which are not bound to a single symbol set, but are instead composed of a range of compatible symbol collections. This font header is shown in .
- **Format 15 TrueType Scalable Font Header** - This new font header supports TrueType scalable fonts (bound or unbound). This font header is shown in Table 11-6.

Note

Use the Font ID command to designate a unique ID number prior to the download of a font header. If an existing font is already associated with this ID, the existing font is deleted upon the download of the font header. Unless otherwise specified, inappropriate values in a font header field invalidates the font download process; a font is not created and the associated font data is discarded.

Intellifont scalable font formatting also requires the *Intellifont Scalable Typeface Format* document, which supplements the information provided here. For information on how to obtain this document, refer to “Related Documents” in the front of this manual.

The figures that follow illustrate the font header formats for the various font classifications. The individual fields for the font headers are described following the figures.

Notes

Although some LaserJet printer models do not use all of the data in the font header and thus ignore many of the fields, a font creator should use valid values in all of the font header fields. This ensures font compatibility across the LaserJet printer family and with future printers, which may use these fields.

Those font header fields identified as “reserved” should be set to zero.

Table 11-2 Format 0 Font Header (for PCL Bitmapped Fonts)

Byte	15 (MSB) 8	7 (LSB) 0
0	Font Descriptor Size (64)	
2	Header Format (0)	Font Type
4	Style MSB	Reserved
6	Baseline Position	
8	Cell Width	
10	Cell Height	
12	Orientation	Spacing
14	Symbol Set	

Table 11-2 Format 0 Font Header (for PCL Bitmapped Fonts)

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 Position (Distance)	Underline Thickness (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)	

Table 11-3 Format 20 Font Header (for Resolution-Specified Bitmapped)

Byte	15 (MSB) 8	7 (LSB) 0
0	Font Descriptor Size (68)	
2	Header Format (20)	Font Type
4	Style MSB	Reserved
6	Baseline Position	

Table 11-3 Format 20 Font Header (for Resolution-Specified Bitmapped) (continued)

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 Position (Distance)	Underline Thickness (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	X Resolution	
66	Y Resolution	
n	Copyright (optional) ⋮	

Table 11-4 Format 10 Font Header (for Intellifont Bound Scalable)

Byte	15 (MSB) 8	7 (LSB) 0
0	Font Descriptor Size (minimum 80)	
2	Header Format (10)	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 Position (Distance)	Underline Thickness (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 ⋮	

Table 11-4 Format 10 Font Header (for Intellifont Bound Scalable) (continued)

48-63	Font Name ⋮	
64	Scale Factor	
66	X Resolution	
68	Y Resolution	
70	Master Underline Position	
72	Master Underline Thickness (Height)	
74	OR Threshold	
76	Global Italic Angle	
Desc. Size-2	Global Intellifont Data Size	
80	Global Intellifont Data ⋮	
n	Copyright (optional) ⋮	
	Reserved (0)	Checksum

Table 11-5 Format 11 Font Header (for Intellifont Unbound Scalable Fonts)

Byte	**15 (MSB) 8**	**7 (LSB) 0**
0	Font Descriptor Size (minimum 88)	
2	Header Format (11)	Font Type (10)
4	Style MSB	Reserved
6	Baseline Position	
8	Cell Width	
10	Cell Height	
12	Orientation	Spacing
14	Symbol Set	

Table 11-5 Format 11 Font Header (for Intellifont Unbound Scalable Fonts) (continued)

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 Position (Distance)	Underline Thickness
32	Text Height	
34	Text Width	
36	Reserved	
38	Number of Contours (Characters)	
40	Pitch Extended	Height Extended
42	Cap Height	
44-47	Font Number ⋮	
48-63	Font Name ⋮	
64	Scale Factor	
66	X Resolution	
68	Y Resolution	
70	Master Underline Position	
72	Master Underline Thickness	
74	OR Threshold	
76	Global Italic Angle	
78-85	Character Complement	

Table 11-5 Format 11 Font Header (for Intellifont Unbound Scalable Fonts) (continued)

Desc. Size-2	Global Intellifont Data Size	
Desc. Size	Global Intellifont Data ⋮	
n	Copyright (optional) ⋮	
	Reserved (0)	Checksum

Table 11-6 Format 15 Font Header (for TrueType Scalable Fonts)

Byte	15 (MSB) 8	7 (LSB)0
0	Font Descriptor Size (minimum 72)	
2	Header Format (15)	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 Position (Distance)	Underline Thickness

Table 11-6 Format 15 Font Header (for TrueType Scalable Fonts) (continued)

32	Text Height	
34	Text Width	
36	First Code	
38	Last Code/Number of Characters	
40	Pitch Extended	Height Extended
42	Cap Height	
44-47	Font Number ⋮	
48-63	Font Name ⋮	
64	Scale Factor	
66	Master Underline Position	
68	Master Underline Thickness	
70	Font Scaling Technology	Variety
72	*[additional data may be inserted here]* ⋮	
Desc. Size	Segmented Font Data ⋮	
# - 2	Reserved (0)	Checksum

Data Types

In the font header and character descriptor information that follows, the abbreviations shown below are used to define the data type of each field:

Table 11-7 Font Header Field Data Type Notation

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

Table 11-7 Font Header Field Data Type Notation (continued)

(SI)	: Signed Integer	(-32768 . . 32767)
(ULI)	: Unsigned Long Integer	(0 . . 2^{32}-1)
(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. See the font header figure for the appropriate font descriptor size.

Header Format (UB)

The Header Format byte identifies the font to format (see below).

Table 11-8 Header Format Values

Value	Format
0	PCL Bitmap
10	Intellifont Bound Scalable
11	Intellifont Unbound Scalable
15	TrueType Scalable (bound or unbound)
20	Resolution-Specified Bitmap

Font Type (UB)

Font type describes the font's relation to symbol sets.

Table 11-9 Font Type Values

Value	Font Type
0	Bound font. Character codes 32 to 127 [decimal] are printable.
1	Bound font. Character codes 32 to 127 [decimal] and 160 to 255 [decimal] are printable.

Table 11-9 Font Type Values (continued)

2	Bound font. All character codes 0 to 255 are printable, except 0, 7 to 15, and 27 [decimal] (see note below).
10	Unbound font. Character codes correspond to HP MSL numbers (for Intellifont unbound scalable fonts).
11	Unbound font. Character codes correspond to Unicode numbers (for TrueType unbound scalable fonts).

Note

Access to those codes which are unprintable, yet have a character defined, requires the use of the Transparent Print Data command (refer to Chapter 8 for more information).

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.

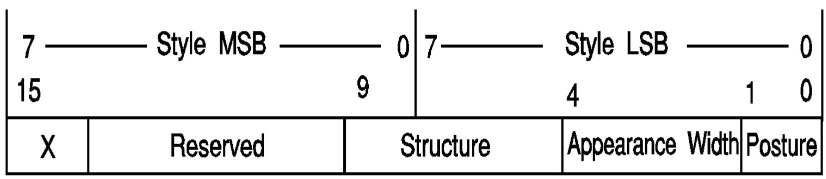


Table 11-10

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

Table 11-11

Value	Appearance 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

Table 11-12

Value	Structure (multiply by 32 for StyleWord partial sum)
0	Solid
1	Outline
2	Inline
3	Contour, Distressed (edge effects)
4	Solid with Shadow
5	Outline with Shadow
6	Inline with Shadow
7	Contour with Shadow
8-11	Patterned (complex patterns, subject to type family)
12-15	Patterned with Shadow
16	Inverse
17	Inverse in Open Border
18-30	Reserved
31	Unknown Structure

Note The reserved bits (15 - 10) should be set to zero.

If a value is requested, and a match not made, the request is ignored and the current font selection process continues as if the parameter was never requested (but it is saved in the attribute table).

Example

Assuming a font style of "italic compressed contour" is desired, the value (#) would be:

$$1 + (2\times4) + (3\times32) = 105$$

Baseline Position (UI)

Bitmap Font - Specifies the distance from the top of the cell to the baseline. The baseline is the dot row on which all of the characters in a given line appear to stand (see). The measurement of this distance is in font resolution dots, as defined in the Resolution Field of a Format 20 font header (default=300 dpi).

Intellifont Scalable - Specifies a Y-coordinate in the design window (refer to Figure 11-2.)

TrueType Scalable - Baseline Position must be set to zero.

Cell Width (UI)

Specifies the width of the cell. The cell must be wide enough to accept the widest character. The cell width range is 1 to 65535.

Bitmap Font - Specified in PCL coordinate system dots.

Scalable Font - Specified in design units.

Cell Height (UI)

Specifies the height of the cell. The design cell for a font must be tall enough to accept the tallest character and greatest descender. The legal range is 1 to 65535.

Bitmap Font - Specified in PCL coordinate system dots.

Scalable Font - Specified in design units.

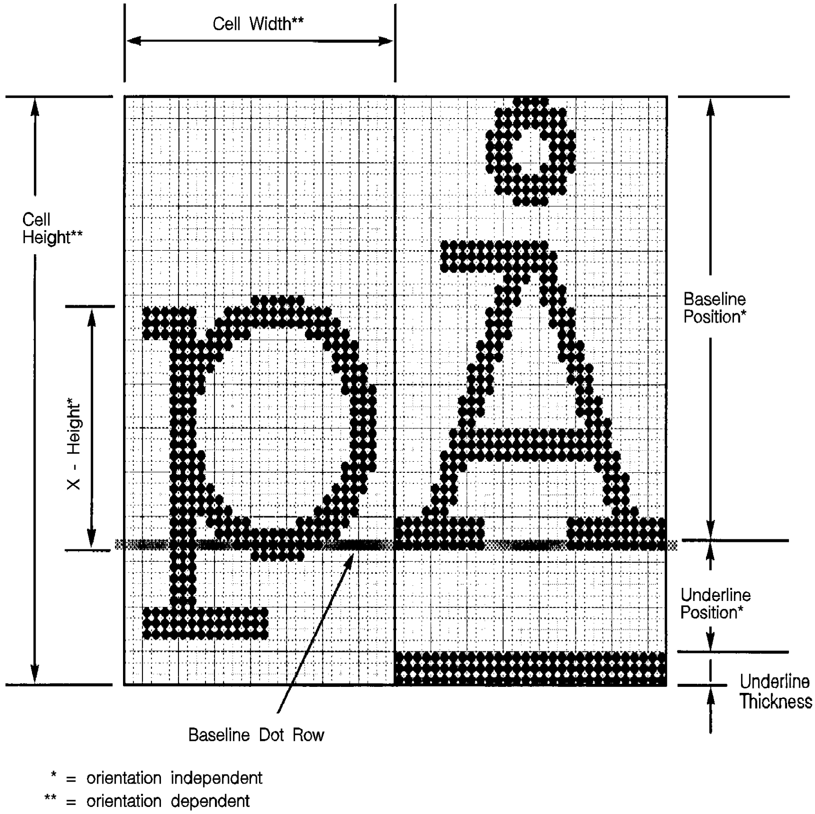


Figure 11-3 Character Cell - Bitmap

Orientation (UB)

Specifies the orientation of the font. All characters within the font must have the same orientation as those specified in the font header; otherwise they are 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.

Scalable Font - set to zero.

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, IIP, 2000, and PCL 5 LaserJet printers rotate the fonts to match the paper's physical coordinate system for the various paper sizes.

Spacing (B)

Specifies the spacing of the font. A value of zero (0) specifies fixed spacing and one (1) 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 decimal (ASCII) value of the termination character (the symbol set ID character value) of the escape sequence, and subtracting 64.

$$\text{Font Descriptor Symbol Set Value} = \left(\begin{array}{l}\text{Escape Sequence}\\ \text{Value Field Value X 32}\end{array}\right) + \left(\begin{array}{l}\text{Decimal Value of Escape Sequence}\\ \text{Termination Character} - 64\end{array}\right)$$

For example, to compute the value for the ASCII (ISO-6) symbol set (Value = **0**, ID = U):

0U = (0×32) + (85–64) = 21

The legal range of symbol set escape sequence field values is 0 to 2047. Refer to Appendix C in the *PCL 5 Comparison Guide* for the HP defined symbol set values for use in the font header.

HP reserves the right to define the symbol set escape sequence value field 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 “Z.” “Q” is reserved for use with HP “Specials” symbol sets and is not recommended for general use.

Notes

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

This field must have a value of 56 for a type 10 or 11 font (unbound Intellifont scalable) to be valid.

Pitch (UI)

Bitmap Font - Specifies the pitch of the font in quarter dots (four quarter-dot units, also known as radix dots, equal one dot). 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, a a 17 cpi font designed at 300 dpi has a pitch value of 70 radix dots as calculated:

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

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

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

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

Note

For a proportional font, the width “printed” for a control code Space is determined by the pitch value, unless an HMI command is received following the selection of the font.

Scalable Fonts - Contains the master design space width (escapement) of the font in design units.

Height (UI)

Bitmap Font - Specifies the design height of the font in quarter-dots (radix dots). 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 (fonts designed at 300 dpi).

For example, a 10 point font at 300 dpi has a height of 166 quarter-dots (radix 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. A typical value for this field is 2000.

TrueType Scalable - Set the Height field to zero.

xHeight (UI)

Bitmap Font - Specifies the height of the lower case “x” in quarter-dots (radix dots).

Scalable Fonts - Specifies the distance from the baseline to the lower case “x” height in design units.

Width Type (SB)

Specifies the proportionate width of characters in the font.

Table 11-13 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.

Table 11-14 Stroke Weight Values

Value	Stroke Weight
-7	Ultra Thin
-6	Extra Thin
-5	Thin
-4	Extra Light

Table 11-14 Stroke Weight Values (continued)

-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 (UB)

This field specifies the HP typeface number of the font. The current version of this field, supported by the &payette; printer, is described first. Then a previous field, supported in earlier printers, is described.

Current Usage

In the LaserJet 4 printer version of this field, an unsigned short integer is assembled from the two unsigned bytes of data. Printers, when seeking to match a typeface request with available font resources, may treat the typeface number as a single value. If an exact match cannot be made, the request may be ignored (for selection purposes, however, the font select table is updated).

The procedure for allocating typeface numbers for the font products of various vendors, however, will consider the typeface number to be composed of two distinct fields: a vendor field (consisting of the four most significant bits) and a typeface family field (consisting of the 12 least significant bits). The following diagram illustrates this scheme:

Table 11-15 Typeface Family Value (Current)

15 12	11 0
Vendor	Typeface Family

Vendor Number - Bits 15 - 12. This value is assigned by HP and is between decimal values 0 and 15.

Table 11-16 Current Vendor Number Values

Value	Vendor
= 0	Reserved
= 1	Agfa Division, Miles Inc.
= 2	Bitstream Inc.
= 3	Linotype Company
= 4	The Monotype Corporation plc
= 5	Adobe Systems Inc.
= 6-15	(Reserved)

Typeface Family Number - Bits 11 - 0 This value is between 0 and 4095. See Appendix C in the *PCL 5 Comparison Guide*.

Typeface Family Values are calculated according to the following formula:

$$\begin{array}{c}\text{Typeface}\\\text{Base Value}\end{array} + \left(\begin{array}{c}\text{Vendor}\\\text{Value}\end{array} \times 4096\right) = \begin{array}{c}\text{Typeface}\\\text{Family}\end{array}$$

Example

The HP typeface number for Agfa Dom Casual typeface is 4157 (vendor value=1, and typeface value=61):

61 + (**1** × 4096) = 4157

Previous Usage

The previous treatment of the Typeface field supported the LaserJet IIP, IID and LaserJet III family printers. It consisted of the Typeface Least Significant Byte (LSB; the original, one-byte typeface value used prior to the LaserJet IID printer) and the Typeface Most Significant Byte (MSB) in the font header.

The previous typeface family value field is shown below. It included a 4-bit field to specify the vendor number, a 2-bit field for the version number, and a 9-bit field which contained the typeface base number. The most significant bit of the MSB was always zero.

Table 11-17 Typeface Family Value (Previous)

15	14	10	8 0
0	Vendor	Version	Typeface Base Value

Table 11-18 Previous Vendor Number Values

Value	Vendor
0,1	Reserved
2	Agfa Division, Miles Inc.
4	Bitstream Inc.
6	Linotype Company
8	The Monotype Corporation plc
10	Adobe Systems Inc.
3,5,7,9,11-15	(Reserved)

Vendor-Version The Vendor-version (bits 10 and 9) value was from 0 to 3. It changed when the vendor changed the width or design of the characters in a font.

Typeface Base Value The Typeface Base Number (bits 0 through 8) ranged from 0 to 511. Some of these values referred to the styles that vary by structure and appearance width (such as Helvetica Condensed, Helvetica Outline, etc.). Do not use these values in new designs since they are being deleted. Refer to Appendix C in the *PCL 5 Comparison Guide* for a list of typeface families and their typeface base values.

Note For future compatibility, use the two-byte (typeface MSB/LSB) typeface family value. All scalable fonts use the larger typeface family value. Older bitmap fonts use the smaller typeface base value.

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 6 and 7) are used by a 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.

Table 11-19 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

Table 11-19 Serif Style Values (continued)

11	Script Calligraphic
12	Script Broken Letter
13-63	Reserved
Values for bits 6 & 7	
64	Sans Serif
128	Serif
192	Reserved

Quality (UB)

This field specifies the quality of the font.

Table 11-20 Quality Values

Value	Quality
0	Data processing (draft)
1	Near Letter Quality
2	Letter Quality

Placement (SB)

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

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

Table 11-21 Bitmap Font Placement Values

Value	Placement
1	Superior
0	Normal
-1	Inferior

Scalable Font - Set the Placement field to zero.

Underline Position (Distance) (SB)

Bitmap Font - Specifies the distance from the baseline to the top dot row of the underline in font design 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.

Scalable Font - Set Underline Position to zero. The Master Underline Position field (see below) identifies this information for scalable fonts.

Underline Thickness (UB)

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

Bitmap Font - A bitmap font prints three-dot thick underlines at 300 dpi (six-dot thick at 600 dpi).

Scalable Font **-** Set Underline Thickness to zero. The Master Underline Thickness field (see below) identifies this information for scalable fonts.

Text Height (UI)

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

Bitmap Font - Specified in quarter-dots (radix dots).

Scalable Fonts - Specified in design units.

Text Width (UI)

Specifies the font's average lowercase character width. (This average width may be weighted on the basis of relative frequency.)

Bitmap Font - Specified in quarter-dots (radix dots).

Scalable Font - Specified in design units.

First Code (UI)

First Code specifies the character code of the first printable character in the font. This value is 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. Currently, PCL 5 LaserJet printers use the Font Type field to determine the first and last codes of the symbol set, as shown below:

Table 11-22

Font Type	First Code../..Last Code
0	32/127
1	32/127 - 160/255
2	0/255
10	Set to 0 (for unbound font)
11	Set to 0 (for unbound font)

Last Code / Number of Characters (UI)

Bound Font: 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).

Unbound Font: For an unbound font (type 10 or 11), this field specifies the maximum number of characters that can be downloaded into the font.

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 font design units. For example, a 17 pitch font designed at 300 dpi has 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.

Scalable Font - Set Pitch Extended field 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 font design units. For example, a 10 point font designed at 300 dpi 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.

Scalable Font - Set The Height Extended field 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, uppercase letter, such as an "H") to the baseline.

Bitmap Font - Fonts containing a 0 in this field are assumed to have a cap height percentage of 70.87% of Em (Em being a measure, in points, of the height of the body of the font.

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

$$0.7087 \times 65535 = 46{,}445$$

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

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

Scalable Font - Contains the cap height in design units.

Font Number (ULI)

The Font Number field uses four bytes (byte 44, 45, 46, and 47). The lower three bytes (45, 46, and 47) contain the font number in hexadecimal. This is the number the vendor assigns to their typeface. The most significant byte (byte 44) 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 (this is assigned by Hewlett-Packard). The following initials have been assigned:

Table 11-23

Initial	HexValue	Vendor Name
A	41	Adobe Systems Inc.
B	42	Bitstream Inc.
C	43	&AGFA;
H	48	Bigelow && Holmes
L	4C	Linotype Company
M	4D	Monotype Corporation plc

For example, the number that Agfa assigns for a CG Times Bold Italic, native format, font is 92505. This number is converted to hexadecimal and used for the lower three bytes of the Font Number. Bit 8 of byte 44 is 0, since the native format is used and the lower seven bits are the ASCII value for "C" (C for Compugraphic; 0100 0011). This process is summarized below.

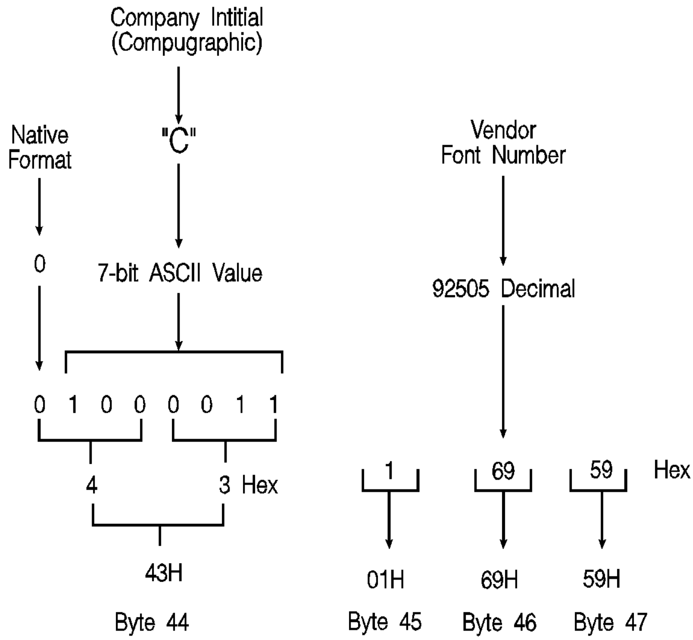


Figure 11-4

This field is ignored by the printer for bitmap fonts.

Font Name (ASC16)

This is a 16 character ASCII field to which you may assign a font name. The font name is used in the Typeface List (or Font List printout), under **Name** or **Typeface** (if the printer does not have a name string assigned to the typeface family code in its font selection table).

X Resolution (UI)

The X Resolution field is the pixel resolution in the X scan direction at which the font was designed.

Note

This field is not present in the Format 15 Font Header and is not necessary for TrueType fonts.

Y Resolution (UI)

The Y Resolution field is the pixel resolution in the Y scan direction at which the font was designed.

Note This field is not present in the Format 15 Font Header and is not necessary for TrueType fonts.

Scale Factor (UI)

The Scale Factor field indicates the number of design units per Em, and is the unit used for all scalable metrics in the font header. It is used for TrueType and Intellifont scalable soft fonts.

Master Underline Position (SI)

The Master Underline Position is the top of the PCL floating underline with respect to the baseline in design units.

Note For scalable fonts, the Master Underline Position field replaces the 1-byte Underline Position field.

Master Underline Thickness (Height) (UI)

The Master Underline Thickness field defines thickness of the floating underline in design units.

Font Scaling Technology (UB)

For scalable fonts, this field species the technology to be used for font scaling.

Table 11-24

Value	Font Scaling Technology
0	Intellifont
1	TrueType

Variety (UB)

The interpretation of this field depends on the value of the preceding (Font Scaling Technology) byte. For TrueType fonts, this field must be set to zero.

OR Threshold (UI)

Formerly called the “LRE Threshold,” this is the pixel size in design units above which the missing pixel recovery process is switched on in Intellifont scaling and rasterization.

Note The size of a pixel (in design units) increases as point size and device resolution decrease.

Global Italic Angle (SI)

The Global Italic Angle field contains the tangent of the italic angle times 2^{15} (relative to the vertical). Set this field to zero for upright fonts. For detailed information on Global Italic Angle, refer to *Intellifont Scalable Typeface Format*.

Global Intellifont Data Size (UI)

The Global Intellifont Data Size identifies the size of the Global Intellifont data block. For detailed information about Global Intellifont Data Size, refer to *Intellifont Scalable Typeface Format*.

Global Intellifont Data

For detailed information on Global Intellifont Data refer to *Intellifont Scalable Typeface Format*.

Character Complement (Array of UB)

This 8-byte field qualifies the compatibility of a type 10 or 11 font with various character sets. Each bit is independently interpreted with the exception of the least significant three bits. (Bit 63 refers to the most significant bit of the first byte, and bit 0 refers to the least significant bit of the eighth byte.)

Note In the Format 15 Font Header for TrueType Scalable Fonts, the data in this field is contained in the “CC” (Character Complement) field in the Segmented Font Data section immediately following the descriptor data. See “Segmented Font Data” later in this chapter

.

Table 11-25 MSL Symbol Index

Bit Field	Designated Use
58-63	Reserved for Latin fonts.
55-57	Reserved for Cyrillic fonts.
52-54	Reserved for Arabic fonts.
50-51	Reserved for Greek fonts.
48-49	Reserved for Hebrew fonts.
3-47	Miscellaneous uses (South Asian, Armenian, other alphabets, bar codes, OCR, Math, PC Semi-graphics, etc.).
0-2	Symbol Index field. 111 - MSL Symbol Index

Table 11-26 Unicode Symbol Index

Bit Field	Designated Use
32-63	Miscellaneous uses (South Asian, Armenian, other alphabets, bar codes, OCR, Math, etc.).
28-31	Reserved for Latin fonts.
22-27	Reserved for platform/application variant fonts.
3-21	Reserved for Cyrillic, Arabic, Greek and Hebrew fonts.
0-2	Symbol Index field. 110 - Unicode Symbol Index

Individually defined bits are shown in the following two tables:

Table 11-27 MSL Symbol Index Character Complement Bits

Bit	Value
63	0 if font is compatible with standard Latin character sets (e.g., Roman-8, ISO 8859-1 Latin 1); 1 otherwise.
62	0 if font is compatible with East European Latin character sets (e.g., ISO 8859-2 Latin 2); 1 otherwise.
61	0 if font contains Turkish character sets (e.g., ISO 8859/9 Latin 5); 1 otherwise.
34	0 if font has access to the math characters of the Math-8, PS Math and Ventura Math character sets; 1 otherwise.
33	0 if font has access to the semi-graphic characters of the PC-8, PC-850, etc. character sets; 1 otherwise.
32	0 if font is compatible with ITC Zapf Dingbats series 100, 200, etc.; 1 otherwise.
2, 1, 0	111 if font is arranged in MSL Symbol Index order.

Table 11-28 Unicode Symbol Index Character Complement Bits

Bit	Value
31	0 if font is compatible with 7-bit ASCII; 1 otherwise.
30	0 if font is compatible with ISO 8859/1 Latin 1 (West Europe) character sets; 1 otherwise.
29	0 if font is compatible with ISO 8859/2 Latin 2 (East Europe) character sets; 1 otherwise.
28	0 if font is compatible with Latin 5 (Turkish) character sets (e.g., ISO 8859/9 Latin 5, PC-Turkish); 1 otherwise.
27	0 if font is compatible with Desktop Publishing character sets (e.g., Windows 3.1 Latin 1, DeskTop, MC Text); 1 otherwise.

Table 11-28 Unicode Symbol Index Character Complement Bits

26	0 if font is compatible with character sets requiring a wider selection of accents (e.g., MC Text, ISO 8859/1 Latin 1); 1 otherwise.
25	0 if font is compatible with traditional PCL character sets (e.g., Roman-8, Legal, ISO 4 United Kingdom); 1 otherwise.
24	0 if font is compatible with the Macintosh character set (MC Text); 1 otherwise.
23	0 if font is compatible with PostScript Standard Encoding (PS Text); 1 otherwise.
22	0 if font is compatible with Code Pages (e.g., PC-8, PC 850, PC-Turk, etc.); 1 otherwise.
2,1,0	110 if font is arranged in Unicode Symbol Index order.

There are no invalid Character Complement field values. Examples of values for the field include:

Table 11-29

Bit Field	**Designated Use**
Value (hex)	**Meaning**
MSL:	
"`0000000000000000`"	Default complement; font is compatible with any character set.
"`7fffffffffffffff`"	Font is indexed in MSL and is compatible only with standard West Latin character sets.
"`ffffffffeffffffff`"	Font is indexed in MSL and is compatible only with ITC Zapf Dingbat character sets.
Unicode:	
"`ffffffff3ffffffe`"	Font is indexed in Unicode and is compatible only with standard West Latin character sets.

Table 11-29 (continued)

"`ffffffff5ffffffe`"	Font indexed in Unicode and is compatible only with East Europe Latin character sets.

Checksum

The Checksum field is over bytes 64 through the end of the header. The checksum should contain a value which, when added to the sum of byte 64 through the reserved byte, equals a value which, when divided by 256 (modulo 256 arithmetic), results in a remainder of 0. For example, if the sum = 10,234 then, 10,234 mod 256 = 250. Therefore, the checksum should = 6 (since 250+6 = 256 which would produce 0 [mod 256]).

Note In the Format 15 Font Header for TrueType Scalable Fonts, this field is located at the end of the Segmented Font Data section immediately following the descriptor data. See "Segmented Font Data" later in this chapter.

Copyright

This field contains ASCII data and is optional.

Note In the Format 15 Font Header for TrueType Scalable Fonts, this field is located in the Segmented Font Data section immediately following the descriptor data. See "Segmented Font Data" later in this chapter.

Segmented Font Data (Format 15)

The Segmented Font Data section immediately follows the main body of a Format 15 Header for TrueType Scalable Fonts. Each segment contains three parts: a **Segment Identifier, Segment Size,** and **Data Segment.**

The Segmented Font Data section is terminated by the Null Segment. (In the deviant case where no Null Segment is encountered prior to the end of the font header &emdash; as defined in the Font Header command &emdash; the font is invalidated. A font also is invalidated in the event that a Null Segment is encountered too soon.)

Table 11-30 below shows the structure of the Segmented Font Data section.

Table 11-30 Segmented Font Data

Byte	15 (MSB) 8	7 (LSB) 0
x + 0	First segment, Segment Identifier	
x + 2	First segment, Segment Size	
x + 4 ⋮	First segment, Data Segment ⋮	
x + 4 + 1st seg size	Second segment: Segment Identifier, Size, Data Segment ⋮	
⋮	⋮	
# – 6	Null Segment Identifier (FFFF - hex)	
# – 4	Null Segment Size (0)	
# – 2	Reserved	Checksum
x = Font Descriptor Size. *#* = Font header length (as defined in Font Header command).		

Segment Identifier (UI)

Each entry in the Segmented Font Data Section has its own unique identification number. The following values are defined:

Table 11-31

Value	Mnemonic	Data Segment
17219	CC	Character Complement
17232	CP	Copyright
18260	GT	Global TrueType Data
18758	IF	Intellifont Face Data
20545	PA	PANOSE Description
22618	XW	XWindows Font Name
65535		Null Segment

Data segments with an unrecognized identifier are ignored.

Segment Size (UI)

For each entry in the Segmented Font Data section, the Segment Size indicates the number of bytes in the immediately following Data Segment. The size for the Null Segment is 0.

Formats of Data Segments

AP (Application Support Segment) The definition of this segment is reserved.

CC (Character Complement) This field has the same form (*i.e.,* 8 unsigned bytes) and function as does the Character Complement of Format 11 fonts. The Character Complement field should be present with type 10 and 11 (unbound) fonts, but has no role to play in type 0, 1 and 2 (bound) fonts.

CP, copyright This field will consist of ASCII data and is optional.

GI (Global Intellifont Data) Reserved for future use.

GT (Global TrueType Data) This data segment contains first a Table Directory, then five or more tables used by the TrueType font scaler. Every TrueType font needs to have this segment.

The Table Directory is patterned after the initial segment of the TrueType font file as described in *True Type Font Files*. The Table Directory has a 12-byte header and 16 bytes per entry in the Table Directory. The Table Directory is organized in alphabetical order by the 4-byte table names. For each entry, there is an offset relative to the beginning of the soft font's Global TrueType Data Segment.

The **Global TrueType Data** for every TrueType font entity must contain a **head, hhea, hmtx** and **maxp** table.

Another required table is the **gdir** table. When the font header is downloaded, the **gdir** table should have a size of 0 and an offset of 0. The **gdir** table is then built in RAM to accommodate the maximum number of glyphs to be downloaded to the given font — with 2 or 4 bytes of offset and 2 bytes of length per glyph. This maximum number of glyphs is obtained from the numGlyphs field of the **maxp** table. Entries in the **gdir** table are filled in by the TrueType rasterizer as characters are downloaded.

The optional **cvt, fpgm** and **prep** tables, as defined in *True Type Font Files*, typically appear in the Global TrueType Data Segments of hinted TrueType soft fonts, but should not appear in unhinted fonts.

IF (Intellifont Face Data) Reserved for future use.

PA (PANOSE Description) This data segment of variable length may be used for the purpose of font selection and substitution. Its definition continues to evolve. A 10-field (10-byte) version sufficient for the description of most Latin fonts appears under the OS/2 table in *True Type Font Files*.

PF (PS-Compatible Font Name) Reserved for future use.

XW (x-windows font name) This ASCII field contains standard X-Windows font names.

Checksum

The value of this byte, when added to the sum of all of the bytes from byte 64 of the descriptor through the Reserved byte, should equal 0 in modulo 256 arithmetic.

Font Header Examples

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

Bitmap Example

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

$^{E}{}_{C}$***c1D** (set Font ID to 1)

$^{E}{}_{C}$**)s#W** (# = 64 bytes of font descriptor data + *x* bytes of optional data)

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

Table 11-32

FIELD NAME	VALUE	DESCRIPTION
Font Descriptor Size	64	Bytes
Header 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

Table 11-32 (continued)

Style LSB	0	Upright, Normal Width, Solid (0,0,0)
Stroke Weight	0	Medium
Typeface LSB	3	Body Text
Typeface MSB	0	No Font Vendor ID
Serif Style	2	Serif Line
Quality	0	∅
Placement	0	∅
Underline Position	-10	∅
Underline Thickness	3	∅
Text Height	200	Quarter dots (50.00 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) }= *x* bytes added to header data		
....Application Support ....(optional) }= *x* bytes added to header data		

Intellifont Scalable Example

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

$^{E}{}_{C}$*c1D (set Font ID to 1)

$^{E}{}_{C}$)s#W (# = 80 bytes of font descriptor data + *x* bytes of Global Intellifont data + *x* bytes of optional data)

Table 11-33

FIELD NAME	VALUE	DESCRIPTION
Descriptor Size	80	Bytes
Header 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 Intellifont
Cell Height	0	..not defined for Intellifont
Orientation	0	..not defined for scalable fonts
Spacing	1	Proportional
Symbol Set	277	8U: Roman-8
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
Serif Style	134	Serif, Bracketed (2,6)
Quality	0	..not defined for scalable fonts

Table 11-33 (continued)

Placement	0	..not defined for scalable fonts
Underline Position	0	..not defined for scalable fonts
Underline Thickness	0	..not defined for scalable fonts
Text Height	0	..not defined for Intellifont
Text Width	4391	Width of En Space
First code	33	
Last Code	273	Compound Pieces Present (n255)
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, CG Times (0,C,92500)
Font Name	“CG Times ”	(16 character ACSII field)
Scale Factor	8782	
X Resolution	2540	
Y Resolution	2540	
Master Underline Position	-1747	
Master Underline Thickness	449	
OR Threshold	176	
Global Italic Angle	0	
Global Intellifont Data Size	112	

Table 11-33 (continued)

....Global Intellifont Data		}= 112 bytes added to header data
....Copyright Statement (optional)		}= *x* bytes added to header data
....Application Support (optional)		}= *x* bytes added to header data

Character Definitions

Following the font header, the individual characters must be defined. Every PCL character definition contains a character descriptor and a body of character data. The character definition always consists of one or more character data blocks. Each character data block begins with its own header. The character data block header always has a size of 2 bytes.

The first data block of a character definition must always have a character descriptor immediately after its 2-byte header.

Character descriptor/data is downloaded using the Character Definition command preceding every character (see *Character Definition Command*).

Notes

A unique character code, using the Character Code command, 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 is deleted during the download of the character descriptor and data.

Unless otherwise specified, inappropriate values in a character descriptor field invalidates the character download process; a character is not created, and the associated descriptor and data are 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 result in the execution of a Space control code.

Character descriptor fields identified as “reserved” should be set to zero.

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.

Character Code Command

The Character Code command establishes the decimal code that is associated with the next character downloaded. This value is used to reference the character for printing.

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

\# =character code

Default **=** 0
Range **=** 0 - 65535

Notes For unbound fonts, the character code for a given character equals its symbol index value.

For TrueType fonts, a special code must be used to download glyphs which never stand alone as characters. FFFF (hex) should be used for this purpose.

Example

To designate the character code for an ASCII lower-case “p”, send:

$^{E}_{C}$***c112E**

Character Definition Command

The Character Descriptor and Data command is used to download character data blocks to the printer for both bitmap and scalable fonts.

$^{E}{}_{C}$ **(s # W** [character descriptor and data]

Default **=** N/A
Range **=** 0 - 32767

The value field (#) identifies the number of bytes in the immediately following character data block. The maximum number is 32767.

For a detailed description of the Character Descriptor fields for bitmap fonts refer to *Character Descriptor and Data Format for PCL Bitmap Fonts.* For Intellifont scalables, refer to “Character Descriptor and Data Format for Intellifont Scalable Fonts.” For TrueType fonts, refer to “Character Descriptor and Data Format for TrueType Fonts.”

Note Examples for defining a bitmapped portrait and landscape character are provided under *Character Definition Examples*, after the *Character Descriptor Formats* section, later in this chapter.

Character Descriptor Formats

Character definition formats for PCL Bitmap, Intellifont Scalable and TrueType Scalable fonts are shown on the following pages.

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

Table 11-34 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)

Character Descriptor and Data Format for PCL Bitmap Fonts

The descriptor of a PCL bitmap character is at least 14 bytes long and contains information such as the character's width and height.

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

Table 11-35 shows the format of the bitmap character descriptor and data.

Table 11-35 PCL Bitmap Character Descriptor and Data Format

Byte	15 (MSB) 8	7 (LSB) 0
0	Format (4)	Continuation (0)
2	Descriptor Size (14)	Class (1)
4	Orientation	Reserved (0)

Table 11-35 PCL Bitmap Character Descriptor and Data Format (continued)

6	Left Offset	
8	Top Offset	
10	Character Width	
12	Character Height	
14	Delta X	
16	Raster Character Data: (in bytes) ⋮	

Table 11-36 PCL Bitmap Continuation Character Descriptor and Data Format

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

Format (UB)

This is the first byte of every character data block header. It specifies the format of the character descriptor and data. The format number used for bitmap fonts is 4. This format must match that of the Font Header.

Table 11-37

Value	Format
4	LaserJet Family (Raster)
10*	Intellifont Scalable
15*	TrueType Scalable
* These are described later in this chapter.	

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

Continuation (B)

This is the second (and last) byte of every character data block header. It specifies whether the following data is the first (0) data block of a new character definition, or a continuation (1) block for a character definition which has already been received by the printer. Because the value field in a Character Definition command is limited to 32767 bytes, characters whose byte count exceed this must be sent in two or more blocks.

Descriptor Size (UB)

This is the first byte of the character descriptor. It specifies the size of the character descriptor in bytes. The descriptor size used by the HP LaserJet printer family for bitmap fonts is 14.

Class (UB)

Specifies the format of the character data. For bitmap fonts only values 1 and 2 are used, as described below.

Table 11-38

Value	Class
1	Bitmap
2	Compressed Bitmap
3*	Contour (Intellifont Scalable)
4*	Compound Contour (Intellifont Scalable)
15*	TrueType Scalable
* These are described later in this chapter.	

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 is 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

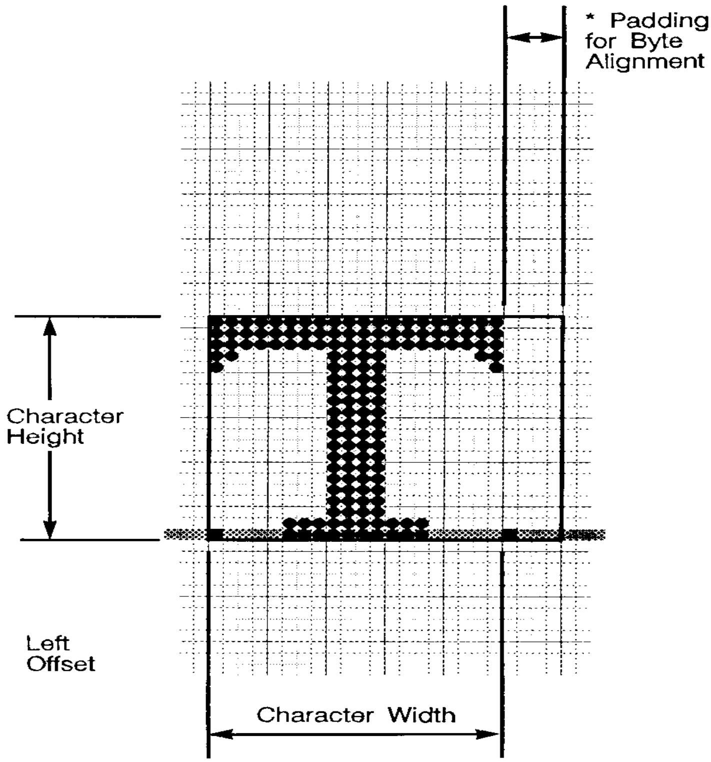
data is received, it is discarded; if less data is received, the character consists of only the data downloaded.

Class 2 - Compressed Bitmap Data

For a compressed bitmap character, the data is composed of a string of bytes using a run-length encoding with line repetition compressed format (see Figure 11-2). 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) is 0. If there are more than 255 pixels in a row of the same type, there is 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 11-5, the cell width 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 11-5 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.

Table 11-39

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 header, 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 (this value is orientation dependent). The left and top offsets locate the character reference point about the cursor position (see Figure 11-6 and Figure 11-7).

PCL 5 printers support 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 (this value is orientation dependent.) The left and top offsets locate the character reference point about the cursor position (see Figure 11-6 and Figure 11-7). 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.

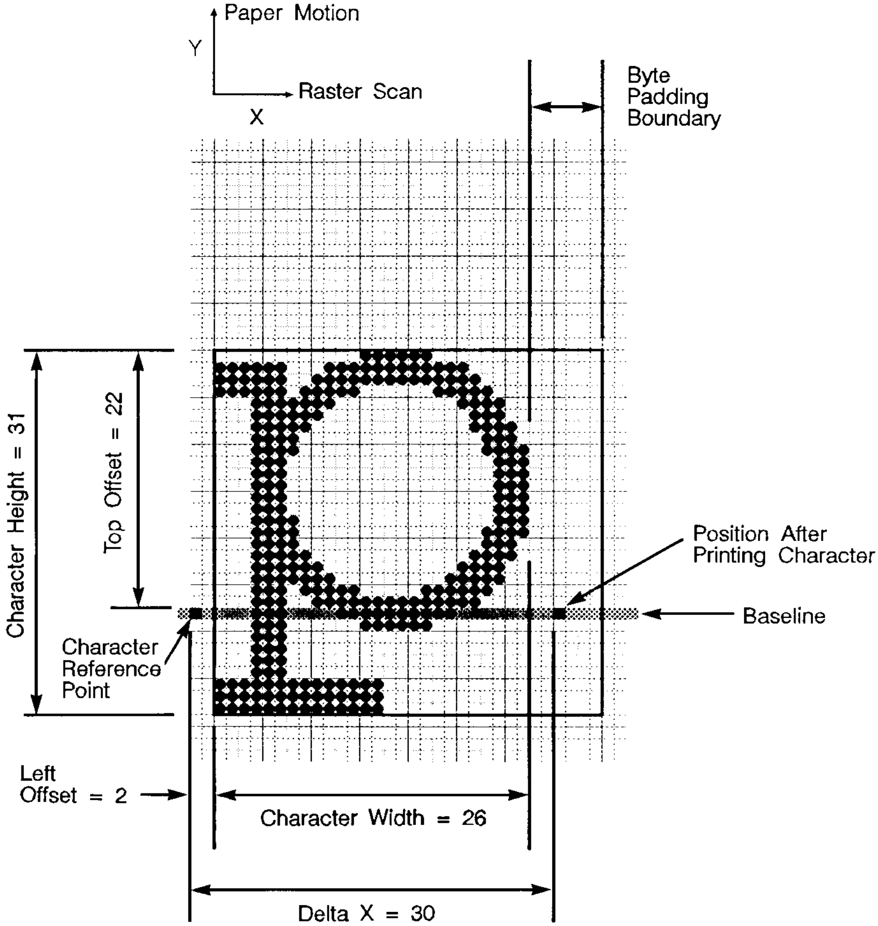
Delta X (SI)

Delta X specifies the number of quarter dots (radix dots) by which the horizontal position within the logical page coordinate system is 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 –32768 to 32767 quarter units.

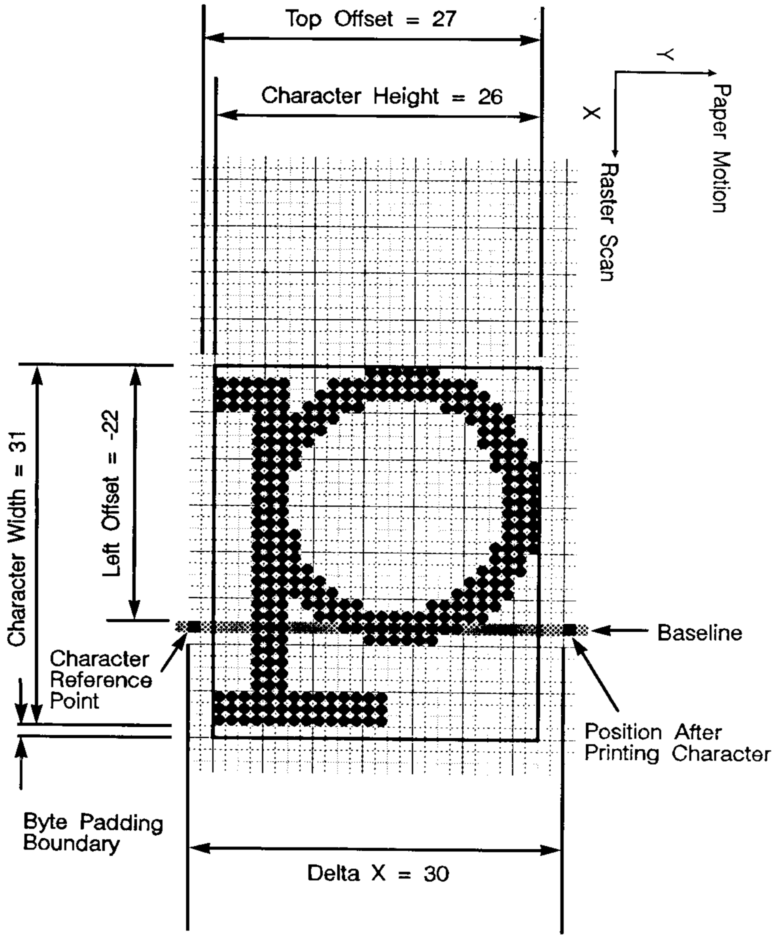
Character Data

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



All values are in dots.

Figure 11-6 Portrait Character Example



All values are in dots.

Figure 11-7 Landscape Character Example

Character Descriptor and Data Format for Intellifont Scalable Fonts

The character header contains a block of bytes that identify character outline data. Table 11-40 and Table 11-41 show the format of the Intellifont scalable character descriptor and data

.

Table 11-40 Intellifont Scalable Character Descriptor and Data Format

Byte	15 (MSB) 8	7 (LSB) 0
0	Format (10)	Continuation (0)[1]
2	Descriptor Size	Class (3)
4	Contour Character Data: (in bytes) ⋮ see Table 11-41 for Contour Character Data	
#–2	Reserved (0)	Checksum[2]

1. Continuation is supported for classes 1, 2, 3 and 15 only.
2. These bytes appear only on the last continuation.

Table 11-41 Intellifont Scalable Contour 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 ⋮	

Table 11-41 Intellifont Scalable Contour Data Format

	Contour Tree Data ⋮
	XY Coordinate Data ⋮

Table 11-42 Intellifont Scalable Character Descriptors/Data Continuation Block

Byte	15 (MSB) 8	7 (LSB) 0
0	Format (10)	Continuation (1)[1]
2	Contour Character Data, resumed: (in bytes, see Table 11-41. ⋮	
#–2	Reserved	Checksum[2]

1. Continuation is supported for Intellifont scalable fonts for class 3 only.
2. This byte appears only on the last continuation.

Table 11-43 Intellifont Scalable Compound Character Descriptor and Data Format

Byte	15 (MSB) 8	7 (LSB) 0
0	Format (10)	Continuation (0)
2	Descriptor Size	Class (4)
4	Compound Character Escapement	
6	Number of Components	
8	Component List ⋮ see Table 11-46 for Component List Data	
–2	Reserved	Checksum

Format (UB)

This is the first byte of every character data block header. It specifies the format of the character descriptor and data. The format number for Intellifont scalable fonts is 10.

Table 11-44

Value	Format
4*	LaserJet Family (Raster)
10	Intellifont Scalable
15*	TrueType Scalable
* These are described elsewhere in this chapter.	

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

Continuation (B)

This is the second (and last) byte of every character data block header. It specifies whether the following data is the first (0) data block of a new character definition, or a continuation (1) block for a character definition which has already been received by the printer. Because the value field in a Character Definition command is limited to 32767 bytes, characters whose byte count exceed this must be sent in two or more blocks. Table 11-42 shows the continuation block for an Intellifont Scalable font.

Descriptor Size (UB)

This is the first byte of the character descriptor. It specifies the size of the character descriptor in bytes. The typical descriptor size for Intellifont scalable fonts is 2.

Class (UB)

Specifies the format of the character data. For Intellifont scalable fonts values 3 and 4 are used, as described below.

Table 11-45

Value	Class
1*	Bitmap
2*	Compressed Bitmap
3	Contour (Intellifont Scalable)
4	Compound Contour (Intellifont Scalable)
15*	TrueType Scalable
* These are described elsewhere in this chapter.	

Class 3 -Intellifont Scalable Character Contour Data

Class 3 is for Intellifont scalable contour character data. The contour character data is organized as described in Table 11-41. 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 composition data is organized as described in Table 11-43. 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 *Intellifont Scalable Typeface Format*.

Metric Data Offset (SI)

The offset to the Metric Data relative to the address of the Contour Data Size field.

Character Intellifont Data Offset (SI)

The offset to the Character Intellifont Data relative to the address of the Contour Data Size field.

Contour Tree Offset (SI)

The offset to the contour Tree Data relative to the address of the Contour Data Size field.

XY Data Offset (SI)

The offset to the XY data relative to the address of the Contour Data Size field.

Metric Data

For information about Metric Data refer to the *Intellifont Scalable Typeface Format* document.

Character Intellifont Scalable Data

For information about Character Intellifont Scalable Data, refer to *Intellifont Scalable Typeface Format*.

Contour Tree Data

For information about Contour Tree Data, refer to *Intellifont Scalable Typeface Format*.

XY Coordinate Data

For information about XY Coordinate Data, refer to *Intellifont Scalable Typeface Format*.

Note For information on obtaining the *Intellifont Scalable Typeface Format* document, refer to *Related Documents* in the front of this manual.

Checksum

This is a checksum of all the contour character data. The checksum value is contained only in the last character data block.

Compound Character Escapement (SI)

The escapement in design units of a compound character.

Number of Components (UB)

The number of components of a compound character.

Component List

This is a list of component descriptions. The list contains Number of Components elements. Each component descriptor consists of 6 bytes as described in Table 11-46 below.

Table 11-46 Component Descriptor

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

The Character Code is the character code number of a component of a compound character. X-offset is the offset of that component from the reference point (origin) in the x direction in design units. Y-offset is the offset in the y direction of a component from the reference point (origin) in design 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 Descriptor and Data Format for TrueType Fonts

Table 11-47 shows the format of the TrueType character descriptor and data when a **continuation block is not required**. Table 11-49 (next page) shows the format of the TrueType character descriptor and data with **multiple character data blocks**.

Table 11-47 TrueType Character Descriptor (no continuation block required)

Byte	15 (MSB) 8	7 (LSB) 0
0	Format (15)	Continuation (0)
2	Descriptor Size	Class (15)
4	*[additional descriptor data may be inserted here]*	
2 + Desc Size	Character Data Size	
4 + Desc Size	Glyph ID	
6 + Desc Size	TrueType Glyph Data ⋮	
# – 2	Reserved	Checksum
# = Character data block size as defined in Character Definition command.		

Table 11-48

Byte	15 (MSB) 8	7 (LSB) 0
0	Format (15)	Continuation (0)
2	Descriptor Size	Class (15)
4	*[additional descriptor data may be inserted here]*	
2 + Desc Size	Character Data Size	
4 + Desc Size	Glyph ID	

Table 11-48 (continued)

6 + Desc Size	beginning of TrueType Glyph Data ⋮

Table 11-49 TrueType Character Descriptor (multiple character data blocks)

Byte	15 (MSB) 8	7 (LSB) 0
0	Format (15)	Continuation (1)
2	conclusion of TrueType Glyph Data ⋮	
# – 2	Reserved	Checksum
# = Character data block size as defined in Character Definition command.		

Format (UB)

This is the first byte of every character data block header. It specifies the format for character downloading. The number 15 designates the TrueType character format.

Table 11-50

Value	Format
4*	LaserJet Family (Raster)
10*	Intellifont Scalable
15	TrueType Scalable
* These are described elsewhere in this chapter.	

Continuation (B)

This is the second (and last) byte of every character data block header. It specifies whether the following data is the first (0) data block of a new character definition, or a continuation (1) block for a character definition which has already been received by the printer. Because the value field in a Character Definition command is limited to 32767 bytes, characters whose byte count exceed this must be sent in two or more blocks.

Descriptor Size (UB)

This is the first byte of the character descriptor. It specifies the size of the character descriptor in bytes. The character descriptor includes everything that is both after the continuation byte and prior to the Character Data Size field. The TrueType character descriptor includes this Descriptor Size byte plus the following Class byte. The minimum value for Descriptor Size is therefore 2. (Additional descriptor information, if any, can be added immediately after the Class byte.)

Class (UB)

This field is used to distinguish different character data types within a given character format. (For instance, among Intellifont characters of format 10, the Class byte is used to distinguish compound characters from simple Intellifont contour characters.) All TrueType scalable characters are handed to the TrueType font scaler in the same format, consequently, the Class byte does not provide vital new information. For TrueType, set the Class value to 15.

Table 11-51

Value	Class
1*	Bitmap
2*	Compressed Bitmap
3*	Contour (Intellifont Scalable)
4*	Compound Contour (Intellifont Scalable)
15	TrueType Scalable
* These are described elsewhere in this chapter.	

Character Data Size (UI)

The value of the Character Data Size should equal the sum of the sizes of the Character Data Size, Glyph ID, and TrueType Glyph Data fields. This value alerts the PCL interpreter when a continuation block is needed. The minimum possible value is 4. The value of Character Data Size plus Descriptor Size plus 4 (for the Format, Continuation, Reserved and Checksum bytes) will never be less than the value # given in the character download command. If the sum is exactly equal to #, then no continuation block is to be expected for the given character. However, if the sum exceeds #, then a continuation block is needed. A condition for the validity of a downloaded scalable TrueType character is that the sum of the # values for all of that character’s data blocks equals the sum of the Descriptor Size and Character Data Size and 2 (for Reserved and Checksum), plus 2 times the number of character data blocks (for Format and Continuation bytes).

Glyph ID (UI)

This field is used by the TrueType font scaler as an ID number for the glyph data associated with the given character.

TrueType Glyph Data

This field contains the data segment associated with the given character as found in the **glyf** table of the original TrueType font file. See the description in *True Type Font Files*.

Checksum (UB)

The value of this byte, when added to the sum of all of the bytes in the Character Data Size, Glyph ID, and TrueType Glyph Data fields, should equal 0 in modulo 256 arithmetic. The Checksum is found only in the last character data block associated with a given character.

Character Definition Examples

Bitmap Portrait Character Example

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]

Note Notice that the **140** appearing in the Character Definition Command accounts for 2 bytes of the Character Data Block Header, 14 bytes of Character Descriptor, and 124 bytes of Character Data. Since the Character Width is 26 dots, 4 bytes are needed per raster row. Also, since the Character Height is 31 dots, 124 bytes of Character Data for a Class 1 character is needed (4 × 31 = 124). No continuation block is to be expected.

Table 11-52 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)

Table 11-53 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

Table 11-53 Portrait Character Data Example (continued)

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

Bitmap Landscape Character Example

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]

Table 11-54 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)

Table 11-55 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

Table 11-55 Landscape Character Data Example (continued)

25	01110000 00000000 00000000 00001110	112	0	0	14
26	01110000 00000000 00000000 00001110	112	0	0	14

12 Macros

Introduction

A Macro is a group of PCL and H”P-GL/2 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 invoked upon request (using the assigned macro ID number), using a single command. When printing letters, for example, which include a company letterhead, the letterhead is repeated for each letter. This letterhead can 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 command sequence to print the letterhead.

Note HP-GL/2 commands are not supported within macros on all HP LaserJet printers. Refer to the “PCL Feature Support Matrix” in Chapter 1 of the *PCL 5 Comparison Guide* for specifics.

Macros eliminate the need to download the same information repeatedly, 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 ROM (read only memory), such as font-type cartridges or SIMM modules. When ROM-based macros are installed in the printer, they become available for selection. There is no need 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

Designate a unique identification (ID) number 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 is 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

Table 12-1

Assign ID Number	Macro ID command ($^{E}_{C}$&f14Y) assigns a unique identification number (14) to the macro.
Start Macro Definition	Macro Control command, $^{E}_{C}$&f0X, indicates the following commands and data are to be stored as a macro.
Macro data • • • Macro data	Escape sequences, control codes, HP-GL/2 commands and text required to perform the desired operation.
Stop MacroDefinition	Macro Control command, $^{E}_{C}$&f1X, identifies the end of the macro data (definition).

To invoke 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 performs 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 **called,** it begins performing its commands using the current modified print environment. Before the macro is performed, the current modified print environment is saved. 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 is 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 HP-GL/2 commands are not supported within macros on all HP LaserJet printers. Refer to the "PCL Feature Support Matrix" in Chapter 1 of the *PCL 5 Comparison Guide* for specifics.

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:

Table 12-2

PCL CONTEXT:	
Page length	**Paper source**
Page size	**Number of copies**
Orientation	**Cursor position stack**
Registration	
HP-GL/2 CONTEXT:	
Current Pen Position	**Scaling Points**
Hard Clip Limits	**Soft Clip Window**
Logical Page Boundaries	**Fill Attributes**
Line Attributes	

Refer to Chapter 3 for descriptions of environments.

Note The current active position (CAP, or cursor 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 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

Default **=** 0
Range **=** 0 - 32767

This number is 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

Table 12-3

# =	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)

Notes

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 ($^{E}{}_{C}$E or UEL) is not allowed in a macro.

HP-GL/2 commands are not supported within macros on all HP LaserJet printers. Refer to the “PCL Feature Support Matrix” in Chapter 1 of the &cguide; for specifics. HP-GL/2 commands as well as the PCL command “Enter HP-GL/2 mode” ($^{E}{}_{C}$%#B) and the PCL picture frame directives are not recommended within a macro.

PCL macro control commands are not allowed while in HP-GL/2 context.

ROM-Based Macros

Macros can be supplied in ROM (read only memory), such as custom macro cartridges or on SIMM modules. The following considerations apply to all ROM-based macros.

- ROM-based macros include the macro ID numbers for their macros. These numbers cannot be changed. It is possible for a downloaded macro to be assigned the same ID number as a ROM macro. If this occurs, the downloaded macro has precedence. To access the ROM macro, the downloaded macro must be deleted.
- The ID numbers for ROM-based macros range from 0-32767.
- In case of conflicting ID numbers in ROM-based macros, the following priorities apply:
  1. Cartridge macros. (In printers that have two cartridge slots, one cartridge has priority over the other. This priority depends on the printer. Refer to Appendix E of the *PCL 5 Comparison Guide* for the macro cartridge priority.)
  2. SIMM macros. SIMM 1=highest, then SIMM 2, etc.

Example

To define a macro with an ID of 7, send:

> $^{E}{}_{C}$**&f7y0X**
>
> •
>
> •
>
> •
>
> *escape sequences, control codes, and data*
>
> •
>
> •
>
> •

To stop the macro definition, send:

> $^{E}{}_{C}$**&f1X**

To make the macro with an ID of 7 permanent, send:

> $^{E}{}_{C}$**&f7y10X**

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.

Table 12-4

$^{E}_{C}$**&f1Y**	Specify the Macro ID as one.
$^{E}_{C}$**&f0X**	Start Macro Definition.
$^{E}_{C}$**&a540h360V**	Position logo at (540, 360) decipoints in the PCL coordinate system.
$^{E}_{C}$***t150R**	Set graphics resolution to
150 dots-per-inch.	
$^{E}_{C}$***r1A**	Start raster image of logo.
$^{E}_{C}$***b60W [Raster data]**	Send the first raster line.
•	•
•	•
•	•
$^{E}_{C}$***b60W [Raster data]**	Send the last raster line.
$^{E}_{C}$***rC**	Stop raster graphics.
$^{E}_{C}$**&a540h780V**	Position for lettering at (540, 780) decipoints.
$^{E}_{C}$**(1X**	Select font with ID of 1.
ABC Corp.	Text
Post Office Box 15	Text

Table 12-4 (continued)

Fred, Texas 83707	Text
$^{E}_{C}$**&a540h960V**	Position first rule at (540, 960) decipoints**.**
$^{E}_{C}$***c10v4680H**	Set rule height and width.
$^{E}_{C}$***c0P**	Print the first rule.
$^{E}_{C}$**&a540h980V**	Position second rule at (540, 980) decipoint**s.**
$^{E}_{C}$***c&zero;P**	Print second rule.
$^{E}_{C}$**&a54&zero;h12&zero;&zero;V**	Position for first line of text at (540, 1200) decipoints.
$^{E}_{C}$**&f1X**	Stop Macro Definition.

This macro now can be **executed**, **called,** or **enabled** for automatic **overlay**.

13 The PCL 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, or with a user-defined pattern. Images include any raster graphic, such as one created with PCL raster graphics commands (as described in Chapter 15, *Raster Graphics*); a rectangular fill area (as described in Chapter 14, *PCL 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 a resulting image that is a combination of the others. The print model features, listed below, are illustrated in Figure 13-1 and Figure 13-2, and described on the following pages.

- Pattern
- Source Image
- Destination Image
- Source Transparency Mode
- Pattern Transparency Mode

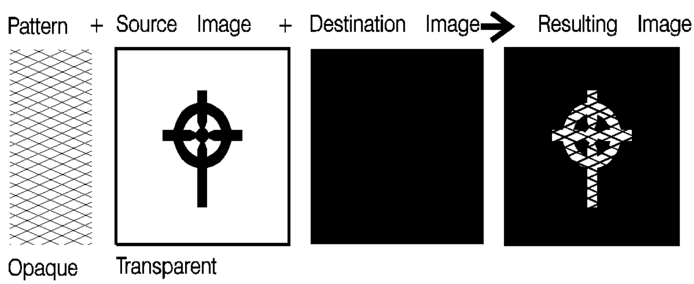


Figure 13-1 Print Model Imaging

Pattern

The design which is "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 13-4) or one of the six cross-hatch patterns (see Figure 13-5), or a user-defined pattern.

Notes

When printing a page, text and raster images are printed using the **current pattern**. The default current pattern is 100% black. The print model allows the current pattern to be changed to white, to one of the six predefined cross-hatch patterns, to one of the eight shading patterns, or to a user-defined pattern. 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 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 "Transparency Mode and Rectangular Area Fills" at the end of this chapter for additional information.

Source Image

An image in which the black ("1" bits) are replaced by the specified pattern. This is like 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) applies the source image's white pixels to the destination image; with a setting of 0 (transparent), these pixels 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 of the source pattern to the destination.

Figure 13-2 Opaque and Transparency Modes

Figure 13-3 illustrates the effects of the source and pattern transparency modes on the final image.

In the first example (1a), the transparency mode for both the source image and the pattern is transparent. Since the source mode is “transparent,” only the black-pixeled region (the circle) of the source image is 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 (1b), 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 (1c), 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 (1d), both source and pattern modes are “opaque.” The entire source image is overlaid onto the destination, and the entire circle is patterned.

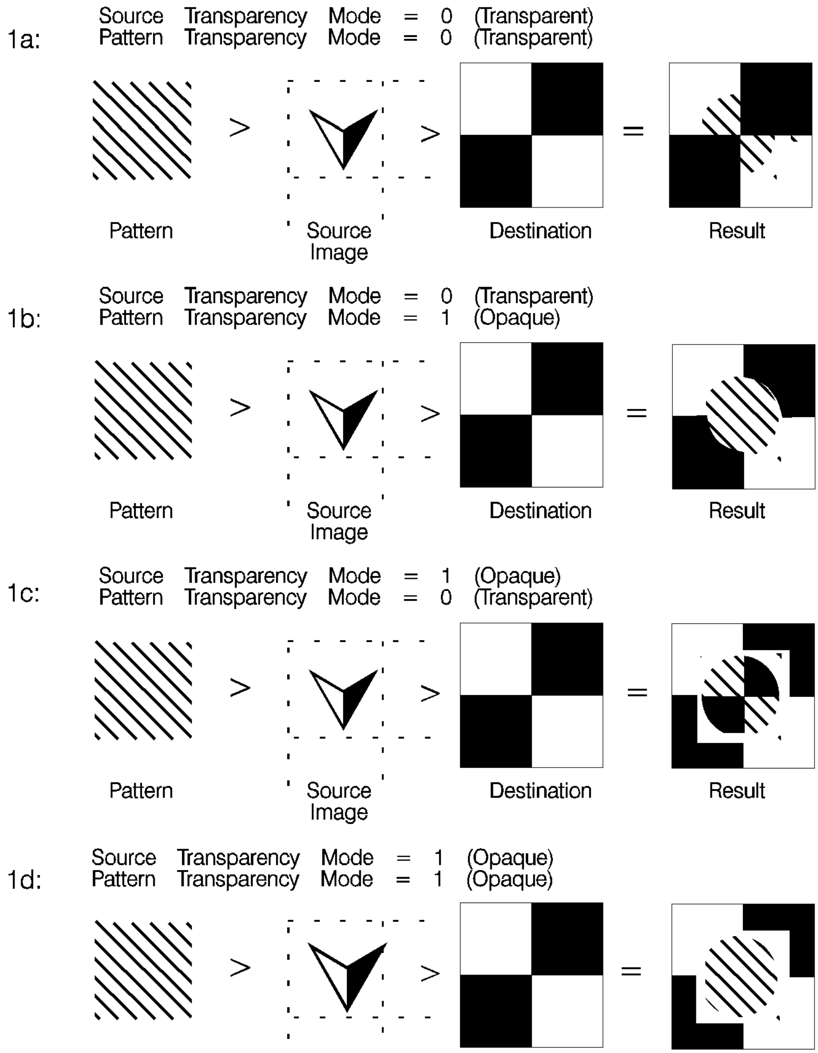


Figure 13-3 Effect of Transparency Modes on Images

Command Sequence

The following illustration shows the Print Model Command Sequence for selecting a current pattern and using it to fill a destination image.

Table 13-1

Operation	Comments
•	
•	
Download Page Data	Prior raster and character data downloaded to the page is considered destination image.
•	
•	
Select Transparency Modes	$^{E}{}_{C}$*v#N and/or $^{E}{}_{C}$*v#O
Select Specific Pattern ID	Pattern ID $^{E}{}_{C}$*c#G
and	
Select Pattern	$^{E}{}_{C}$*v#T (redefines current pattern)
Download Page Data (Source Image 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 modes selected).
•	
•	
Download remaining page data	Transfer data for regular printing, or the above process may be repeated to produce another print model effect.

Table 13-1 (continued)

•	
•	
End of Page Data	

Source Transparency Mode Command

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

Default **=** 0
Range **=** 0, 1 (other values cause the command to be ignored)

With a transparency mode of "0" (transparent), the white regions of the source image are not be copied onto the destination. With a transparency mode of "1" (opaque), the white pixels in the source are applied directly onto the destination.

Refer to the preceding definitions and the discussion of Figure 13-3 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

Default **=** 0
Range **=** 0, 1 (other values cause the command to be ignored)

A transparency mode of "0" (transparent) means that the white regions of the pattern image are not copied onto the destination. A transparency mode of "1" (opaque) means that the white pixels in the pattern are applied directly onto the destination.

Note When printing white rules, the pattern transparency is treated as if it were "opaque"; white rules erase black rules regardless of the transparency mode.

Refer to the preceding definitions and the discussion of Figure 13-3 and Figure 14-3 for an explanation of the effects of transparency.

Pattern ID (Area Fill ID) Command

The Pattern ID command (formerly called Area Fill ID) identifies the specific shading, cross-hatch, or user-defined pattern. (This command is also used for rectangular area fill. Refer to Chapter 14, *PCL Rectangular Area Fill Graphics*.)

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

Table 13-2

Selecting Shaded patterns		**Selecting Cross-Hatch patterns:**	
# =	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		
Selecting User-Defined patterns:[1]			
# = ID number of user-defined pattern			

1. Not supported on all LaserJet family printers. Refer to the "PCL Feature Support Matrix" in Chapter 1 of the *PCL 5 Comparison Guide* for specifics.

=ID number of user-defined pattern

Default **=** 0 (no pattern)
Range **=** 0 - 32767 (values outside the range 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.

Figure 13-4 and Figure 13-5 illustrate the HP-defined shading patterns and cross-hatched patterns, respectively.

Notes

This command is used for both the Select Pattern and Area Fill graphics (it is also described in Chapter 14, *PCL Rectangular Area Fill Graphics*). It is duplicated here for convenience.

For user-defined patterns, this command, sent prior to downloading a user-defined pattern, assigns an ID pattern number to the downloaded pattern. (For more information, see “User- Defined Graphics,” later in this chapter.)

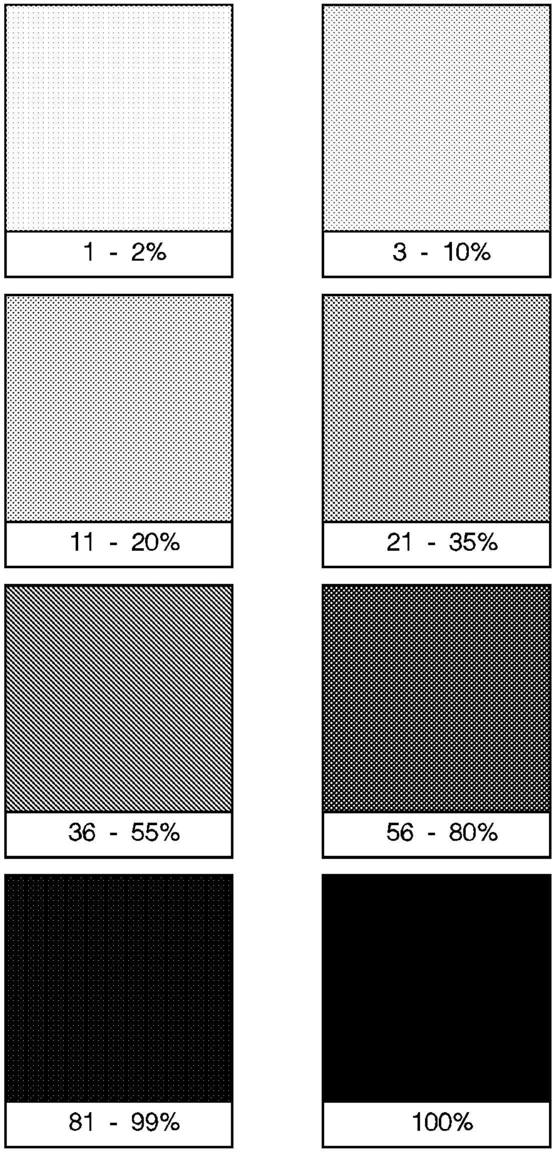


Figure 13-4 Shading Patterns

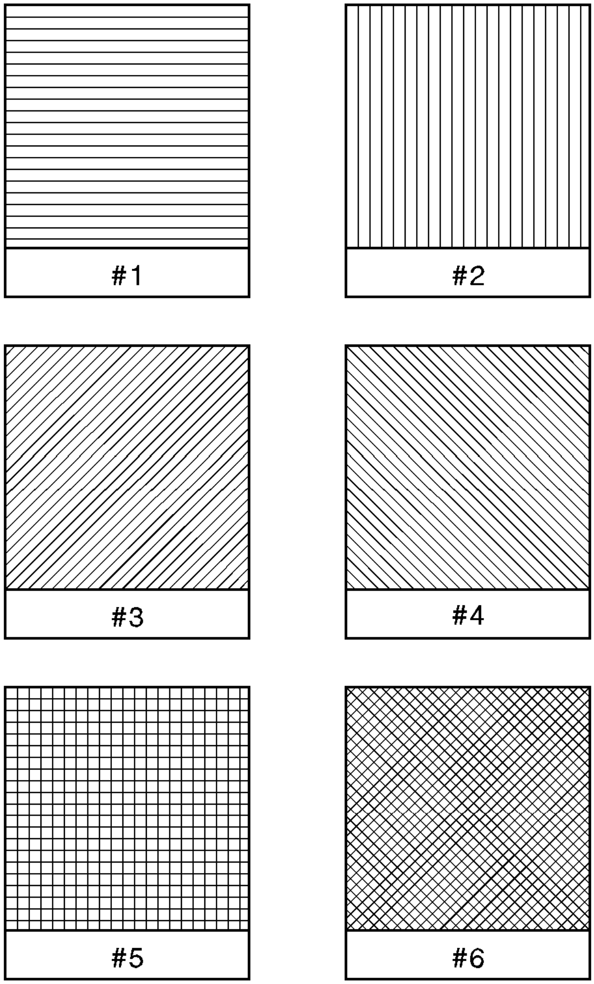


Figure 13-5 Cross-Hatch Patterns

Select Current Pattern Command

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 - Shading pattern
 3 - Cross-hatch pattern
 4 - User-defined pattern

Default **=** 0
Range **=** 0 - 4 (values outside of range are ignored)

This command selects which *type* of pattern is applied. For values 2, 3, and 4, the shading level (Figure 13-4), cross-hatch pattern (Figure 13-5), or user-defined pattern number is identified by the Pattern ID command described earlier in this chapter.

Notes

For selecting or changing the current pattern, the Select Current Pattern ($^{E}{}_{C}$*v#T) and the Pattern ID ($^{E}{}_{C}$*c#G) commands work together. **Sending the current pattern** (Select Current Pattern command) **alone does not change the current pattern; the Pattern 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.

Once a current pattern is selected, that pattern applies to all images placed on the page until a new pattern is selected.

User-Defined Pattern Graphics

In addition to the eight shading patterns and six cross-hatch patterns, users can design their own patterns (area fill). These **user-defined patterns** are downloaded to the printer and controlled using three new commands:

- User-Defined Pattern ${}^{E}{}_{C}$*c#W [data]
- Set Pattern Reference Point ${}^{E}{}_{C}$*p#R
- Pattern Control ${}^{E}{}_{C}$*p#Q <Unknown> <list> >

User-Defined Pattern Implementation

To create a user pattern, a user defines a binary raster data image as a base pattern. This base pattern is downloaded to the printer using the User-Defined Pattern command. Prior to downloading the pattern, a Pattern ID command is sent to assign the user pattern an ID number. This ID number is used to select the pattern for printing and for pattern management.

To apply the pattern to an image, the printer duplicates or tiles (like placing ceramic tiles) the pattern across and down the page. This pattern can be applied to any image, or used as rectangular area fill.

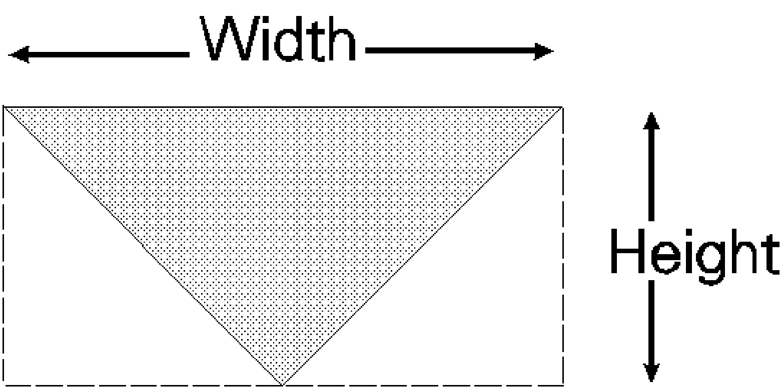


Figure 13-6 User-Defined Base Pattern Example

A user-defined pattern may be applied to any image in the same manner as the internal (cross-hatch or shade) patterns.

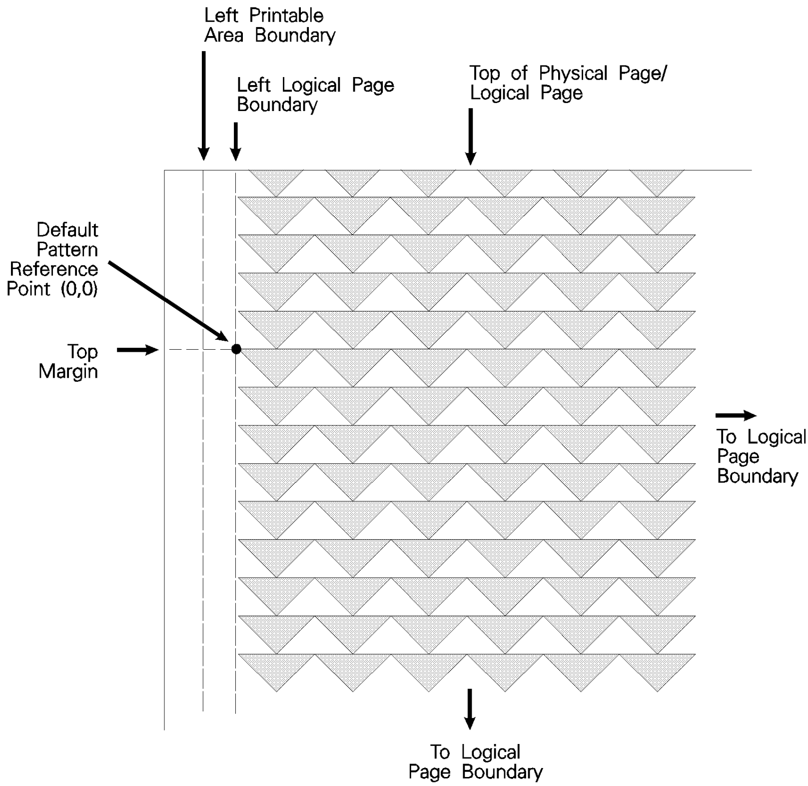


Figure 13-7 Pattern Layout Across the Printable Area

Pattern Reference Point

The pattern reference point is a position on the logical page at which the base pattern is positioned for tiling. The upper left corner of the base pattern is positioned at this point (see). The default pattern reference point is position 0,0. However, it is possible to set the pattern reference point to the current cursor position. This allows the pattern to be positioned or adjusted for fill areas. The pattern reference point may be shifted more than once for as many fill areas as there are on a page (the area must be filled before the tile point is moved for the next fill area).

Figure 13-8 shows two areas filled with the pattern reference point fixed at the default (0,0) position. The lower portion of the illustration shows two areas in which the pattern reference point was moved to the upper left corner of each area and the area filled separately.

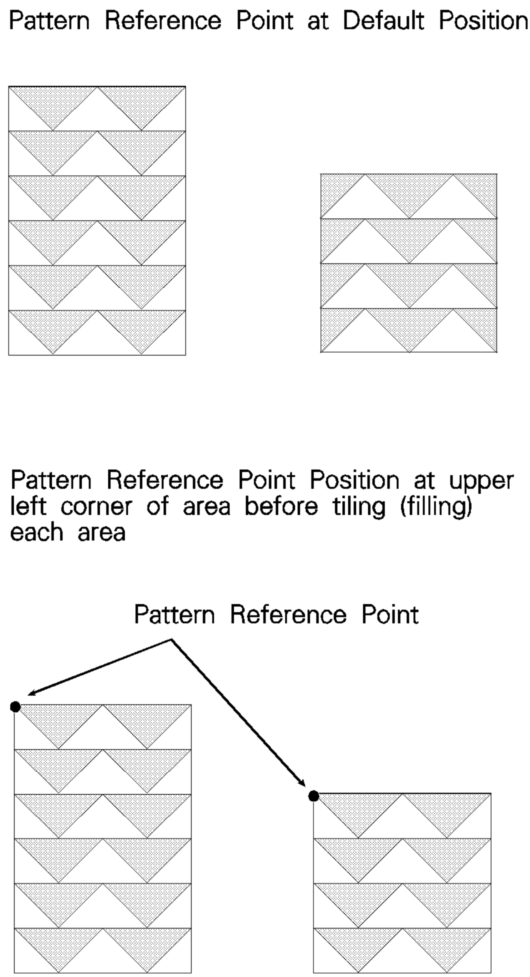


Figure 13-8 Moving Pattern Reference Point for Pattern Filling

User-Defined Pattern Command

The User-Defined Pattern command provides the means for downloading the binary pattern data that defines the user pattern.

$^{E}{}_{C}$ * c # W [pattern data]

\# =Number of pattern data bytes

Default **=** 0
Range **=** 0 - 32767 (values outside the range are ignored)

The value field (#) identifies the number of pattern data bytes that follow the User-Defined Pattern command. In addition to the binary pattern data, there are eight bytes of pattern descriptor (header) information included in this pattern data. The format for a 300 dpi resolution header is shown in Table 13-3, below.

Table 13-3 User-Defined Pattern Header (300 dpi resolution)

Byte	15 - MSB 8	7 LSB-0
0	Format (0)	Continuation (0)
2	Pixel Encoding (1)	Reserved (0)
4	Height in Pixels	
6	Width in Pixels	
8	Pattern image ⋮	

With the introduction of the LaserJet 4 printer, user-defined patterns can be printed either 300 or 600 dpi resolution. X Resolution and Y Resolution fields have been added to the header information included in the previous header. The format for the new header is shown in Table 13-4, below.

Table 13-4 Resolution-Specified User-Defined Pattern Header

Byte	15 - MSB 8	7 LSB-0
0	Format (0)	Continuation (0)
2	Pixel Encoding (1)	Reserved (0)

Table 13-4 Resolution-Specified User-Defined Pattern Header

4	Height in Pixels	
6	Width in Pixels	
8	X Resolution	
10	Y Resolution	
12	Pattern image ⋮	

Notes

The Master X and Master Y Resolution fields can be used to specify 600 dpi resolution for a pattern originally designed at 300 dpi. However, a pattern which was designed at 600 dpi is not available for selection at 300 dpi resolution.

Patterns are identified by some value (ID number). This is the current pattern ID number.

If the Pattern ID command is not used to assign an ID number to the user pattern, the existing (current) pattern ID value is used. If a pattern is already associated with the ID, that pattern is replaced with the new pattern.

Format (Byte 0)

This field, byte 0, must be set to “0.”

Continuation (Byte 1)

This field, byte 1, must be set to “0.” (This byte is for future printer support and does not currently provide any continuation operation.)

Pixel Encoding (Byte 2)

This field, byte 2, should be set to “1.” (This byte is reserved for future printer operation.)

Reserved (Byte 3)

This field, byte 3, is not currently used and must be set to 0.

Height in Pixels (Bytes 4 and 5)

This field, bytes 4 and 5, identifies the number of rows (height) of the pattern.

Width in Pixels (Bytes 6 and 7)

This field, bytes 6 and 7, identifies the number of pixels (width) of the pattern.

Pattern Image

This field contains the raster data for the pattern.

Master X Resolution (UI)

The Master X Resolution field is the pixel resolution in the X scan direction at which the pattern was designed.

Master Y Resolution (UI)

The Master Y Resolution field is the pixel resolution in the Y scan direction at which the pattern was designed.

User-defined Pattern Example

This example shows how the user-defined pattern command is used to create a user-defined patterns. For this example, a pattern of triangles is used. The first step is to design the base pattern triangle (in this case, using 64 bytes of data). The base pattern binary data is shown below:

```
11111111111111111111111111111111
01111111111111111111111111111110
00111111111111111111111111111100
00011111111111111111111111111000
00001111111111111111111111110000
00000111111111111111111111100000
00000011111111111111111111000000
00000001111111111111111110000000
00000000111111111111111100000000
00000000011111111111111000000000
00000000001111111111110000000000
00000000000111111111100000000000
00000000000011111111000000000000
00000000000001111110000000000000
00000000000000111100000000000000
00000000000000011000000000000000
```

This translates into the following 64 bytes in hexadecimal values:

Table 13-5

FF	FF	FF	FF
7F	FF	FF	FE
3F	FF	FF	FC
1F	FF	FF	F8
0F	FF	FF	F0
07	FF	FF	E0
03	FF	FF	C0
01	FF	FF	80
00	FF	FF	00
00	7F	FE	00
00	3F	FC	00
00	1F	F8	00
00	0F	F0	00
00	07	E0	00
00	03	C0	00
00	01	80	00

When using the 300 dpi User-Defined Pattern header (see Table 13-3). Set the eight bytes of header information to the following values:

Byte 0 - Format = 0 (00 hex)

Byte 1 - Continuation = 0 (00 hex)

Byte 2 - Pixel Encoding = 1 (01 hex)

Byte 3 - Reserved = 0 (00 hex)

Byte 4/5 - Height in Pixels = 0 / 16 (00 / 10 hex)

Byte 6/7 - Width in Pixels = 0 / 32 (00 / 20 hex)

Byte eight begins the first bytes of binary data.

The PCL code below downloads the user-defined pattern and assigns it an ID number of 3.

1 Specify the pattern ID number:

$^{E}{}_{C}$*c3G

Assigns an ID number of 3 to the pattern data which follows.

2 Send the User-defined Pattern command:

$^{E}{}_{C}$*c72W

Specifies that 72 bytes are to follow (8 bytes for header plus 64 bytes of pattern data).

3 Send the pattern header and binary data:

Table 13-6

```
00 00 01 00 00 10 00 20
FF FF FF FF
7F FF FF FE
3F FF FF FC
1F FF FF F8
0F FF FF F0
07 FF FF E0
03 FF FF C0
01 FF FF 80
00 FF FF 00
00 7F FE 00
00 3F FC 00
00 1F F8 00
00 0F F0 00
00 07 E0 00
00 03 C0 00
00 01 80 00
```

Notes

There must be an even number of bytes in user-defined pattern data, hence the trailing zeros ("padding") in the last eight data rows above.

The user-defined pattern downloaded in the previous example is printed within a rectangular area in Chapter 14 under "Rectangular Area Fill Examples."

In the previous example, the raster data code is presented in hexadecimal, however, the numbers in the escape sequences are decimal.

Set Pattern Reference Point Command

The Set Pattern Reference Point command causes the printer to tile patterns with respect to the current cursor position. This command also specifies whether the pattern rotates with the print direction or remains fixed.

$^{E}{}_{C}$ * p # R

=0 - Rotate patterns with print direction
1 - Keep patterns fixed

Default **=** 0
Range **=** 0,1 (values outside the range are ignored)

A value field of 0 rotates the patterns with changes in the print direction (see Print Direction command). For a value field of 1, patterns remain fixed for changes in print direction.

The default pattern reference point is the upper left corner of the logical page at the top margin (position 0,0). If the Set Pattern Reference Point command is not set, the pattern is tiled with respect to the default reference point.

Notes

All patterns are rotated for changes in orientation (refer to “Logical Page Orientation Command” in Chapter 5 of this manual).

This command applies to user-defined, shading, and cross-hatch patterns.

Pattern Control Command

The Pattern Control command provides a means for manipulating user-defined patterns.

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

=0 - Delete all patterns (temporary & permanent)
1 - Delete all temporary patterns
2 - Delete pattern (last ID # specified)
3 - Reserved
4 - Make pattern temporary (last ID # specified)
5 - Make pattern permanent (last ID # specified)

Default **=** 0
Range **=** 0 - 5 (values outside the range are ignored)

For value fields 2, 4, and 5, the Pattern ID ($^{E}{}_{C}$***c#G**) command is sent prior to the Pattern Control command to identify the specific pattern for the Pattern Control command action.

14 PCL Rectangular Area Fill Graphics

Introduction

The PCL language includes commands for filling or shading rectangular areas on the page with pre-defined patterns, and allows creation and use of user-defined patterns. Pre-defined patterns include eight shading patterns and six cross-hatch patterns.

Note User-defined patterns are not supported on all LaserJet family printers. Refer to the “PCL Feature Support Matrix” in the *PCL 5 Comparison Guide*.

The first step in filling an area, if using a user-defined pattern, is to download the pattern (see Chapter 13). Next, position the cursor (using cursor move commands) and specify the dimension of the area (using the horizontal and vertical rectangle size commands). The cursor identifies the upper left corner of the rectangular fill area. Once the rectangle size and position are identified, select the specific pattern (**shading level** (Figure 14-1), **cross-hatch pattern** (Figure 14-2), or **user-defined pattern**), to be used for filling the rectangular area. Finally the command is issued to fill the defined rectangular area. Once a user-defined pattern has been downloaded, the fill procedure can be repeated as often as required.

Rectangular Area Fill Procedure

1. *For user-defined patterns:* if you have not done so already, download the binary pattern data (User-Defined Pattern Command - $^{E}{}_{C}$***c#W** - Chapter 13).

2. Position the cursor (choice of various cursor commands - Chapter 6).

3 Specify width of rectangle (Horizontal Rectangle Size Command - Decipoints=${}^{E}{}_{C}$*c#H, or PCL Units=${}^{E}{}_{C}$*c#A).

4 Specify height of rectangle (Vertical Rectangle Size Command - Decipoints=${}^{E}{}_{C}$*c#V, or PCL Units=${}^{E}{}_{C}$*c#B).

5 Select specific shade, cross-hatch, or user-defined pattern (Pattern ID Command - ${}^{E}{}_{C}$*c#G - Chapter 13)[1].

6 Fill rectangular area with pattern (Fill Rectangular Area Command - ${}^{E}{}_{C}$c#P).[1] This ends the procedure and prints the patterned area.

Note An area's width extends in the positive X-direction of the PCL coordinate system, and the height extends in the positive Y-direction.

The Pattern Transparency Mode 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 “Pattern Transparency Mode Command” in Chapter 13).

1. White (1), black (0) or current (5) pattern also can be specified using this command.

Horizontal Rectangle Size (Decipoints) Command

This Horizontal Rectangle Size command specifies the rectangle width in decipoints.

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

=Number of decipoints (1/720 inch)

Default **=** 0
Range **=** 0 - 32767 (valid to 4 decimal places)

The printer converts the specified width to printer dots by rounding up to an integral number of dots. For example, 5 decipoints, which corresponds to 2.08 dots in 300 dpi mode, is converted to 3 dots.

Horizontal Rectangle Size (PCL Units) Command

This Horizontal Rectangle Size command specifies the rectangle width in PCL Units.

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

=Number of PCL Units

Default **=** 0
Range **=** 0 - 32767

For example, if the unit of measure is set to 300 units-per-inch, to specify a two-inch wide rectangle, send the command: $^{E}{}_{C}$***c600A**

The same command specifies a one-inch wide rectangle if the unit of measure is set to 600 units-per-inch.

Note The number of units-per-inch used in PCL dot moves is determined by the current setting of the **Unit of Measure** command (see “Unit of Measure Command” in Chapter 4).

Vertical Rectangle Size (Decipoints) Command

This Vertical Rectangle Size command specifies the rectangle height in decipoints.

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

=Number of decipoints (1/720 inch)

Default **=** 0
Range **=** 0 - 32767 valid to 4 decimal places

The printer converts the specified width to printer dots by rounding up to an integral number of dots. For example, 5 decipoints, which corresponds to 2.08 dots in 300 dpi mode, is converted to 3 dots.

Vertical Rectangle Size (PCL Units) Command

This Vertical Rectangle Size command specifies the rectangle height in PCL Units.

$^{E}{}_{C}$ * c # B</BLD

=Number of PCL Units

Default **=** 0
Range **=** 0 - 32767

For example, if the unit of measure is set to 300 units-per-inch, to specify a two-inch high rectangle, send the command: $^{E}{}_{C}$***c600A**

The same command specifies a one-inch high rectangle if the unit of measure is set to 600 units-per-inch.

Note The number of units-per-inch used in PCL dot moves is determined by the current setting of the **Unit of Measure** command (see “Unit of Measure Command” in Chapter 4).

Pattern ID (Area Fill ID) Command

The Pattern ID command (formerly called Area Fill ID) identifies the specific shading, cross-hatch, or user-defined pattern (see Figure 14-2) to be used when filling a rectangular area.

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

Table 14-1

Selecting Shaded Patterns		**Selecting Cross-Hatch patterns:**	
# =	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		
Selecting User-Defined patterns:[1]			
# = ID number of user-defined pattern			

1. Not supported on all LaserJet family printers. Refer to the “PCL Feature Support Matrix” in Chapter 1 of the *PCL 5 Comparison Guide* for specifics.

Default **=** 0 (no pattern)
Range **=** 0 - 32767 (values outside the range are ignored)

The value field (#) identifies the level of shading, the cross-hatch pattern, or the user-defined pattern.

There are eight HP defined shading patterns defined within the PCL language. To specify one of the eight shading patterns, use any value within the value field range for the desired shade. For example, to select the 56-80% shade (shown in Figure 14-1) use a value of 56, or 80, or any value in between such as 73.

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 14-2.

For user-defined patterns, this command, sent prior to downloading a user-defined pattern, assigns an ID pattern number to the downloaded pattern. (For more information, see “User-defined Pattern Graphics,” in Chapter 13.)

Note This command works in conjunction with the Fill Rectangular Area Command (described next in this section) and the Select Current Pattern Command (described in Chapter 13).

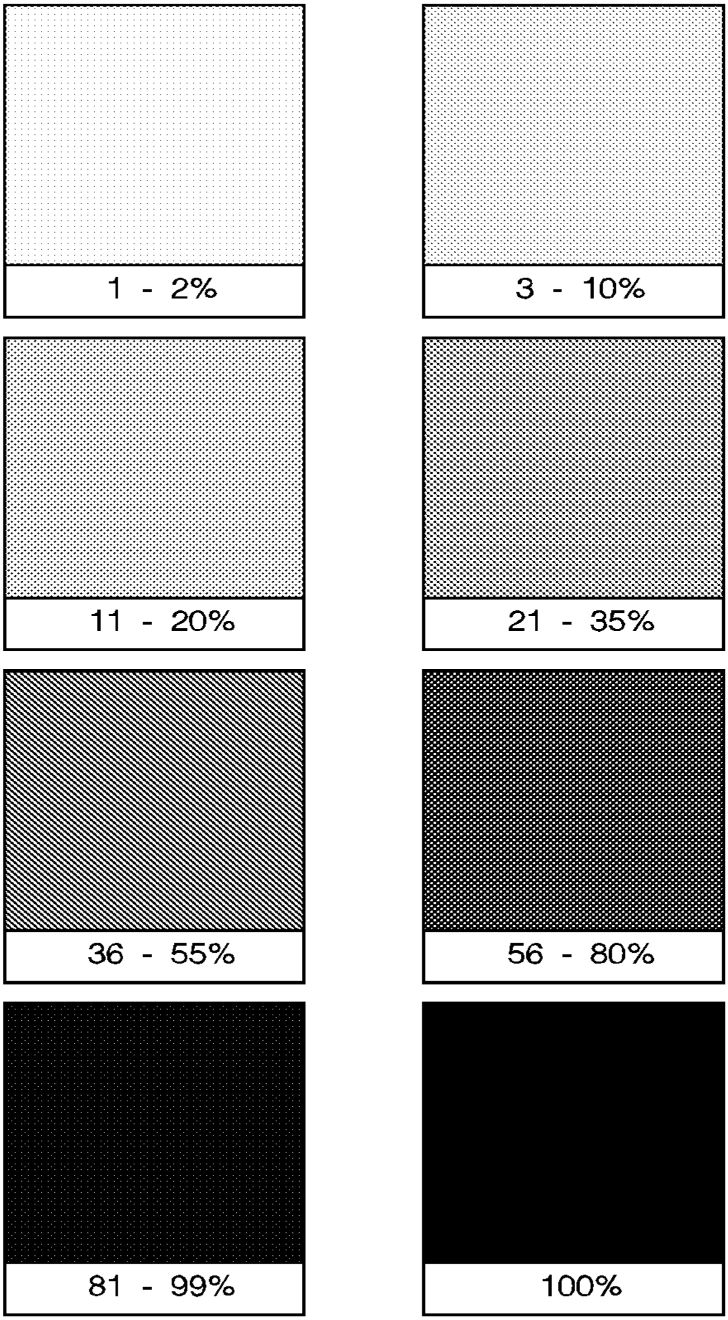


Figure 14-1 Shading Patterns

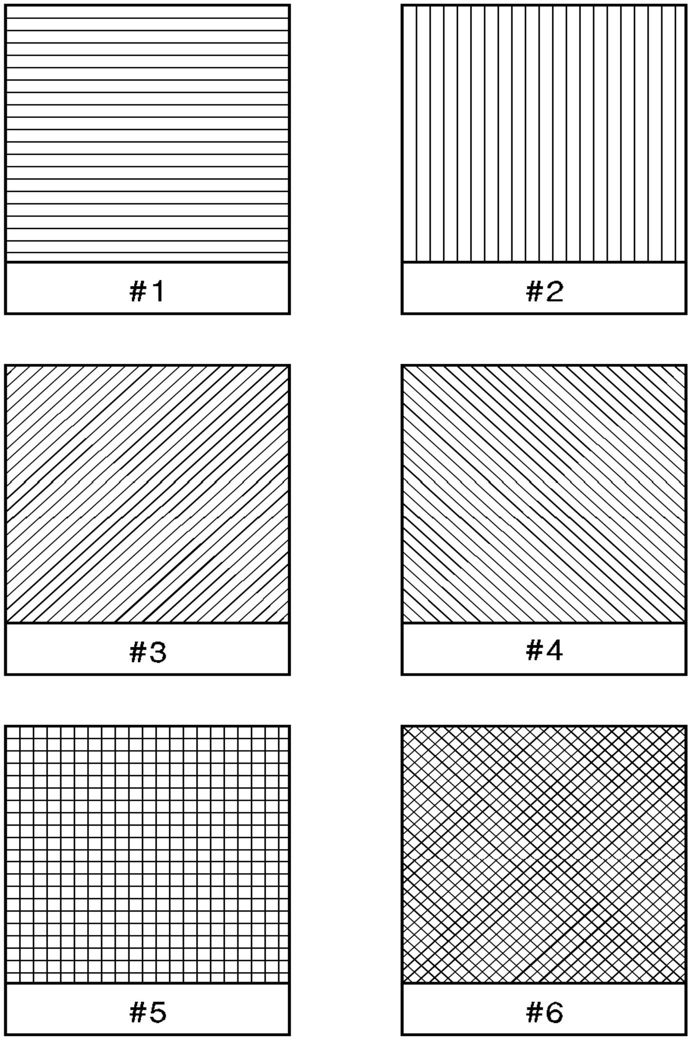


Figure 14-2 Cross-hatch Patterns

Fill Rectangular Area Command

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
4 - User-defined pattern fill
5 - Current pattern fill

Default **=** 0
Range **=** 0 - 5 (values outside the range are ignored)

Black fill — fills the rectangular area with black fill.
White fill — erases any fill in the rectangular area (it fills the rectangular area with white fill).
Shaded fill — fills the rectangular area with one of the eight shading patterns as specified by the Pattern ID command.
Cross-Hatch fill — fills the rectangular area with one of the six cross-hatched patterns as specified by the Pattern ID command.
User-defined fill — fills the rectangular area with custom pattern data as specified by the Pattern ID command and downloaded by the User-Defined Pattern command.
Current Pattern — fills the rectangular area with the current pattern.

Notes

The order in which data (patterns/rules, text, raster) is received is the order in which it is processed during the rasterization of the page.

The current pattern is not 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 13, *The PCL 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 Pattern 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; 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 (rectangles are not clipped at these boundaries). 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 13, 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 is visible.

Pattern Transparency for Rectangular Area Fill

Pattern transparency, described in Chapter 13, under “Pattern Transparency Mode Command,” affects how a pattern is applied to the rectangular fill area. Rectangular areas are special case images for transparency mode. The pattern and pattern type are selected by the Pattern ID command ($^{E}{}_{C}$*c#G) and the Fill Rectangular Area ($^{E}{}_{C}$*c#P) command (described earlier in this chapter).

Note Source transparency has **no effect** on the rectangular fill area since the rectangular area is viewed as 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 the effect white pixels of the pattern 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 (see Figure 14-3). When a value field of 1 (white fill) is used, pattern transparency mode is **always treated as if it were opaque.**

The effect of transparency modes on rectangular areas is illustrated in Figure 14-3. 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.

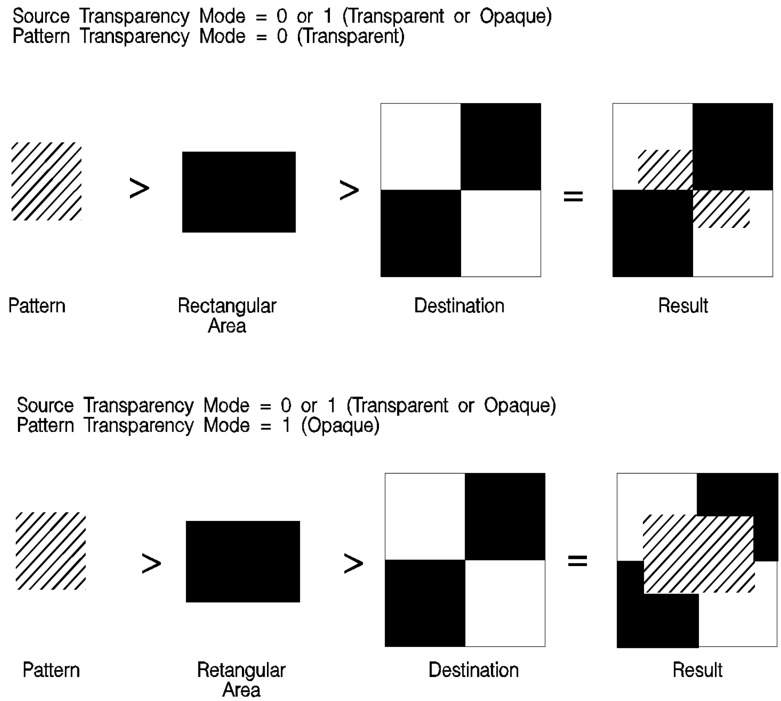


Figure 14-3 Effect of Transparency Modes on Rectangular Areas

Rectangular Area Fill Examples

This section shows example usage of area fill commands to print pre-defined patterns as well as user-defined patterns.

Pre-defined Pattern Examples

Solid Fill (Black/White)

To print a 900 by 1500 Unit black rule (3 inches by 5 inches at 300 units-per-inch), then white fill a small area inside the black rectangle, perform the following steps.

1 1. Position the cursor:

$^{E}{}_{C}$*p300x400Y

This moves the cursor to PCL Unit position (300, 400) within the PCL coordinate system.

2 2. Specify the width of the rule:

$^{E}{}_{C}$*c900A

This sets the rule width to 900 PCL Units (3 inches at 300 units-per-inch).

3 3. Specify the height of the rule:

$^{E}{}_{C}$*c1500B

This sets the rule height to 1500 PCL Units (5 inches at 300 units-per-inch).

4 4. Print the rule:

$^{E}{}_{C}$*c0P

This example prints a black filled rectangular area.

5 5. Position the cursor inside the rectangular area:

$^{E}{}_{C}$*p600x700Y

6 6. Specify the width and height for the smaller white fill rectangular area:

$^{E}{}_{C}$*c300a600B

7 7. Select the white fill and print.

$^{E}{}_{C}$*c1P

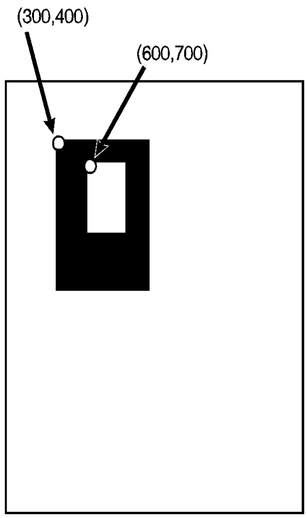


Figure 14-4 Solid Fill Example

Shaded Fill

To print a 900 by 1500 Unit 25% shaded rectangle (3 inches by 5 inches at 300 units-per-inch), perform the following steps.

1 Position the cursor:

$^{E}{}_{C}$*p300x400Y

This moves the cursor to PCL Unit position (300, 400) within the PCL coordinate system.

2 Specify the width of the rectangle:

$^{E}{}_{C}$*c900A

This sets the rectangle width to 900 PCL Units (3 Inches at 300 units-per-inch).

3 Specify the height of the rectangle:

$^{E}{}_{C}$*c1500B

This sets the rectangle to 1500 PCL Units (5 inches at 300 units-per-inch).

4 Specify the Pattern ID:

$^{E}{}_{C}$*c25G

This sets the Pattern ID to 25.

1 Print the rectangular shaded area:

$^{E}{}_{C}$*c2P

This example prints the following:

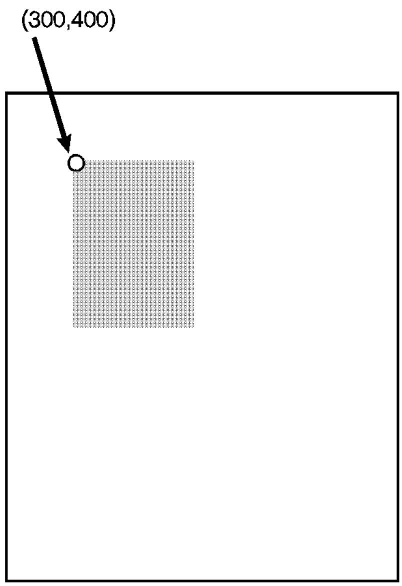


Figure 14-5 Shaded Fill Example

Cross-hatch Fill

To print a 900 by 1500 Unit rectangular area (3 inches by 5 inches at 300 units-per-inch), filled with a horizontal cross-hatch pattern, perform the following steps:

1. Position the cursor:

    $^{E}{}_{C}$*p300x400Y

Moves the cursor to PCL Unit position (300,400) within the PCL coordinate systems.

2. Specify the width of the rectangle:

    $^{E}{}_{C}$*c900A

Sets the rectangle width to 900 PCL Units (3 inches at 300 units-per-inch).

3. Specify the height of the rectangle:

    $^{E}{}_{C}$*c1500B

Sets the rectangle height to 1500 PCL Units (5 inches at 300 units-per-inch).

4. Specify the Pattern ID:

    $^{E}{}_{C}$*c1G

Sets the Pattern ID to 1.

5. Print the rectangular pattern-filled area:

    $^{E}{}_{C}$*c3P

This example prints the following:

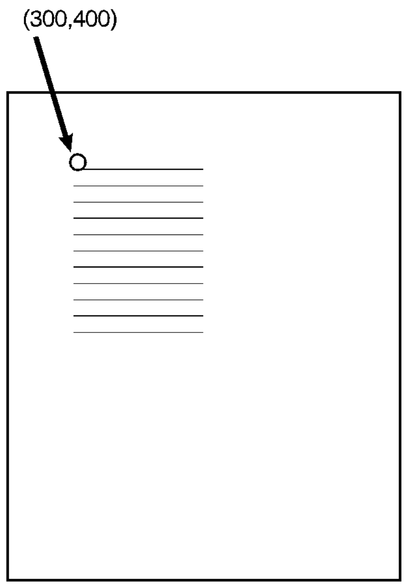


Figure 14-6 Patterned Fill Example

User-defined Pattern Example

This example shows how to print a user-defined pattern which has already been downloaded to the printer. For this example we will print the pattern of triangles which was downloaded in the example in Chapter 13, under "User-Defined Pattern Command."

The following commands define a 600 PCL Unit square rectangular area, select ID number 3, and print the user-defined pattern associated with that ID number.

1 Position the cursor:

$^{E}{}_{C}$*p300x400Y

Moves the cursor to PCL Unit position (300,400) within the PCL coordinate systems.

2 Specify the width and height of the rectangle:

$^{E}{}_{C}$*c600a600B

Sets the rectangle width and height both to 600 PCL Units (2 x 2 inches at 300 Units/inch).

3 Specify the Pattern ID:

$^{E}{}_{C}$*c3G

Sets the Pattern ID to 3.

4 Print the user-defined pattern-filled area:

$^{E}{}_{C}$*c5P

This example prints as shown in Figure 14-7.

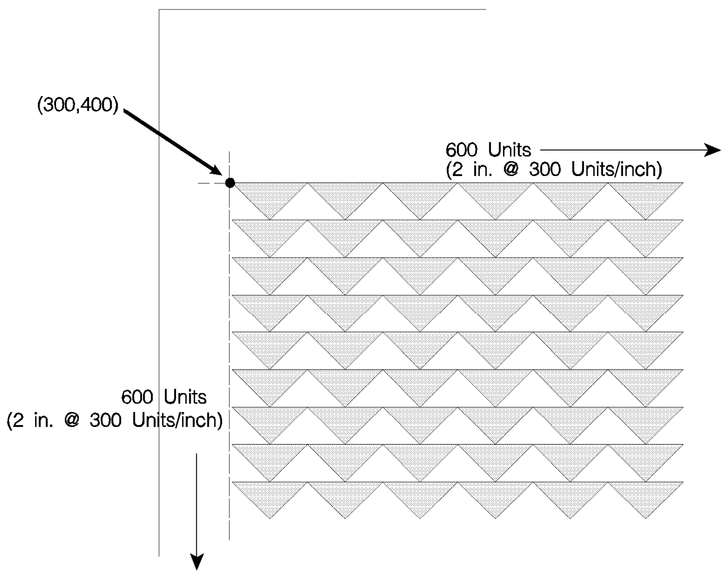


Figure 14-7 User-Defined Pattern Fill Example

15 Raster Graphics

Introduction

A raster image is an image composed of dots. Pictures in newspapers or on television screens (also, a page printed by this printer) are examples of raster images. The PCL language includes commands for printing raster graphic images. These commands enable the LaserJet printer 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. Each dot position within a row is represented by a binary data bit. If a bit in a row is set to one, a dot is printed; if the bit is set to zero, no dot is printed for that position. 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.

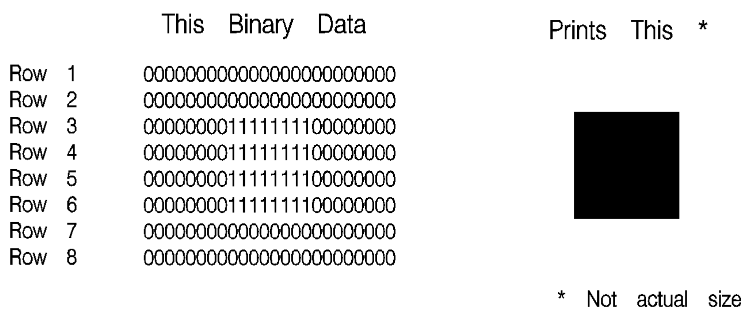


Figure 15-1 Binary Raster Data

Since it takes a considerable amount of data to create even a small raster image, several methods are provided to reduce the amount of data needed to define an image. (Note, that the above illustration creates a rectangle 0.013 by 0.027 inches; a binary “1“ = 1 dot = 1/300 inch.) These reduction techniques include several binary data compression methods, and additional reduction techniques associated with the **raster area** feature (see Figure 15-2).

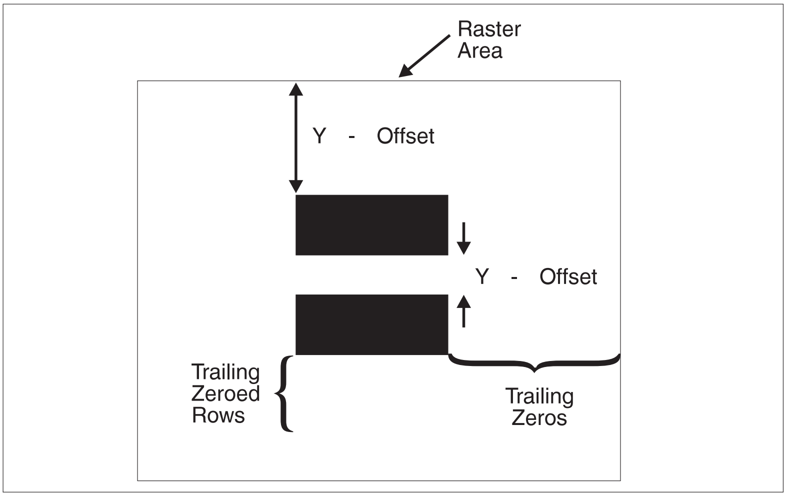


Figure 15-2 Raster Area

Data compression methods include: run-length encoding, tagged image file format (TIFF), delta row, and adaptive compression. These techniques are described in detail later in this section, under the Set Compression Method command.

In addition to the compression methods, the raster area feature provides some other raster reduction techniques which utilize a defined raster area. The raster area is defined by a width and height which are set using the Raster Width and the Raster Height commands.

Zeroed rows at the top and within the raster image can be eliminated by using the Y-offset feature. Y-Offset identifies how many rows to skip (zero fill). The Y-offset command specifies the Y-offset or number of rows for the printer to fill with zeroed rows. This provides a reduction in data for increased efficiency.

Trailing zeroed full rows at the end of the raster image need not be sent. The printer automatically fills 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.

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 zeros following the last “1“ in the raster row to the edge of the picture area need not be sent. The printer automatically fills them. This technique eliminates the need to transmit raster data rows that are all the same length, as required in a raster image which does not use the raster area feature.

The raster area represents a boundary. Within this boundary the printer zero-fills missing rows and fills in short rows to the edge of the raster area. However, in addition to filling to the boundaries of the raster area, the printer also clips any raster line which extends beyond the boundary. Thus, if an image extends beyond the raster area, then that portion of the image is not printed.

When the raster area reduction techniques are used in conjunction with the raster compression techniques, a considerable savings in data can be realized. This results in a saving of host storage and data transmission time. However, these reduction techniques do not reduce the amount of printer memory required for page formatting.

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 is shown below:

Table 15-1

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 previous 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, the entire image is sent during the *start..data..end* sequence, choosing the most effective compression method for each raster row of data.

Raster Presentation, Raster Resolution, Raster Height, Raster Width, and Raster Compression are all true modes. Once specified, the printer remains in that mode unless explicitly changed by issuing the command again, or reset to 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 is 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 determines where raster graphics appear; raster data is clipped to the printable area.

Raster Graphics Resolution Command

Raster graphics can be printed at various resolutions. This command designates the resolution of subsequent raster data transfers in dots-per inch.

$^{E}{}_{C}$ * t # R

= 75 - 75 dots-per-inch
100 - 100 dots-per-inch
150 - 150 dots-per-inch
200 - 200 dots-per-inch[1]
300 - 300 dots-per-inch
600 - 600 dots-per-inch

Default **=** 75
Range **=** 75, 100, 150, 200, 300, 600

This command must be sent prior to the start graphics command. The factory default resolution is 75 dots-per-inch.

Note 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.

When configured for 300 dpi resolution, the printer automatically expands raster graphics transferred at resolutions less than 300 dots-per-inch to 300 dots-per-inch during printing. illustrates how a single bit is translated into the corresponding printed dots in various graphics resolutions when the printer is configured for 300 dpi.

1. Only available if the printer is configured for resolution=600 dpi.

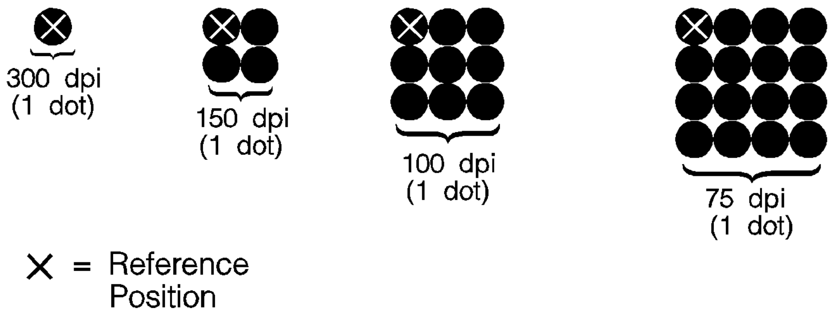


Figure 15-3 Raster Graphics Expansion - at 300 dpi

Note Rectangular area fills and character data are not affected by changes in resolution. Rectangular Area fills and character data always print at the maximum resolution, regardless of the resolution setting.

When configured for 600 dpi resolution, the printer automatically expands raster graphics transferred at resolutions less than 600 dots-per-inch to 600 dots-per-inch during printing. illustrates how a single bit is translated into the corresponding printed dots in various graphics resolutions when the printer is configured for 600 dpi.

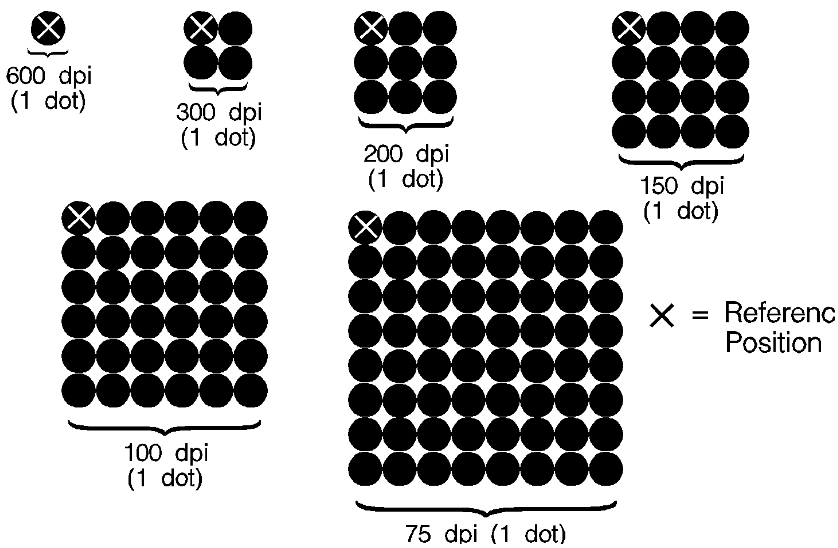


Figure 15-4 Raster Graphics Expansion - at 600 dpi

Raster Graphics Presentation Mode Command

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

Default **=** 3
Range **=** 0, 3

A value of 0 indicates that a raster row ‘will be printed in the positive X-direction of the PCL coordinate system. (The print direction translates the PCL coordinate system.)

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 is printed in the positive X-direction of the PCL coordinate system and a subsequent raster row is printed beginning at the next dot row position in the positive Y-direction. In landscape orientation, a raster row is printed in the positive Y-direction of the PCL coordinate system and a subsequent raster row is printed beginning at the next dot row position in the negative X-direction. Figure 15-5 illustrates presentation mode 0 and 3.

Table 15-2

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 page left bound
3	portrait	logical page left bound
3	reverse portrait	logical page left bound

Table 15-2 (continued)

3	landscape	50 dots in from the logical page *top* bound
3	reverse landscape	50 dots in from the logical page *top* bound

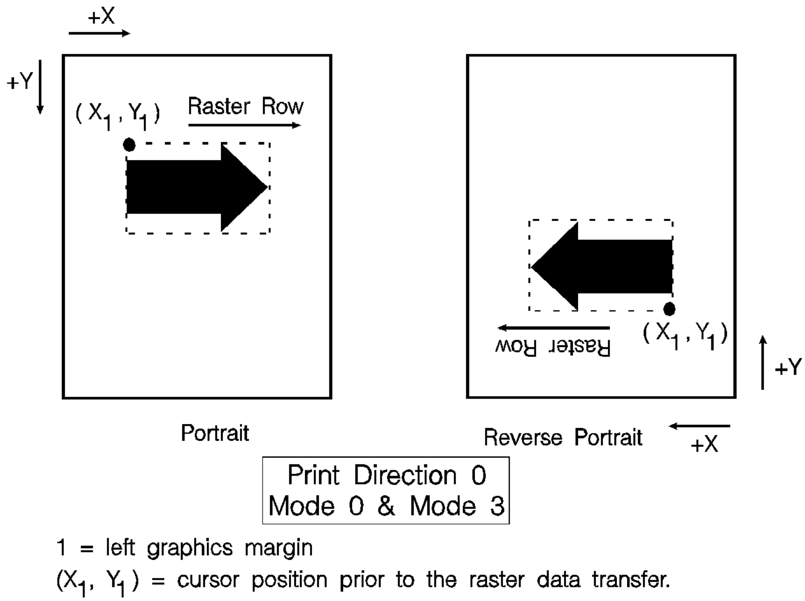


Figure 15-5 Raster Graphics Presentation Mode for Portrait Orientation

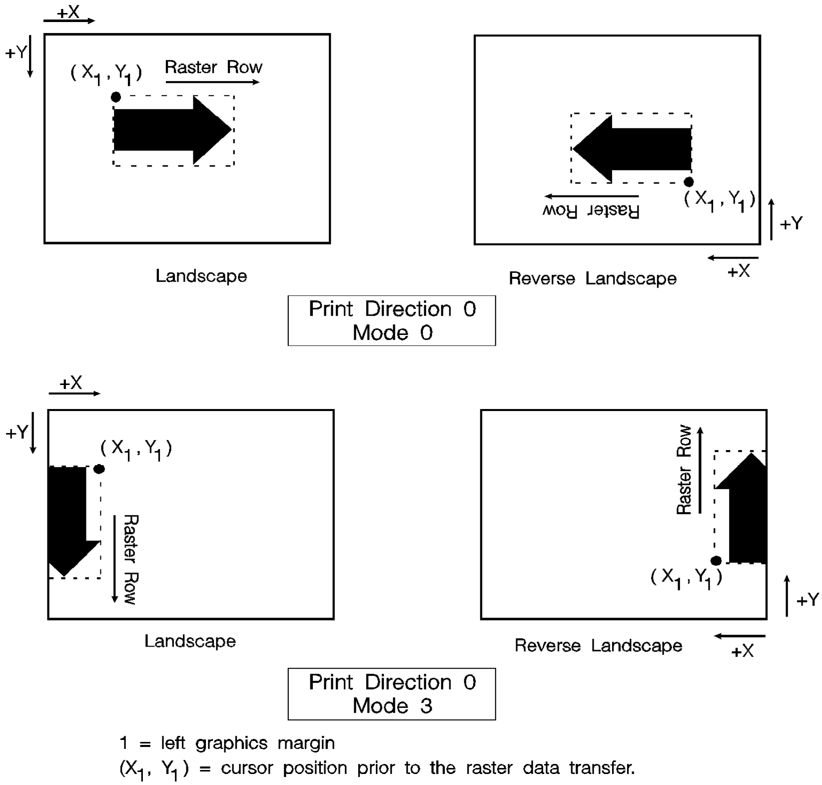


Figure 15-6 Raster Graphics Presentation Mode for Landscape Orientation

Raster Height Command

The Raster Height command specifies the height in raster rows of the raster area. Height is the direction perpendicular to the direction that raster rows are laid down, hence, height is subject to the current raster presentation mode and print direction (see Figure 15-7).

$^{E}{}_{C}$ * r # T

\# = Height in raster rows

Default **=** N/A
Range **=** 0 to (logical page length – current Y-position of the 0,cursor)*

* Greater values default to (logical page length – current Y-position of the cursor)

This command fills the 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 is 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 you have 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 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 raster height is not set, 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 is printed. Data outside the intersection is clipped.

Upon receiving an End Raster Graphics (^{E}C***rC**) command, the cursor position is set to the left graphics margin of the next raster row after the raster height boundary.

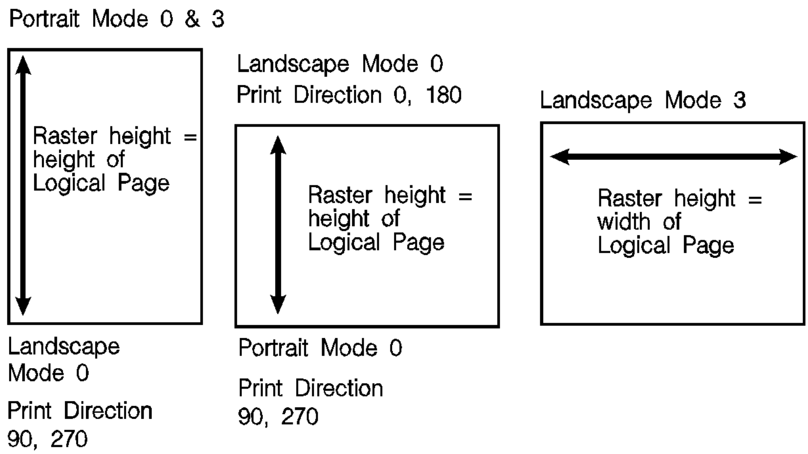


Figure 15-7 Maximum Raster Height

Raster Width Command

The Raster Width command specifies the width in pixels of the raster area. Width is in the direction that the raster rows are laid down, hence, width is subject to the current raster presentation mode and print direction (see Figure 15-8).

$^{E}{}_{C}$* r # S

\# =Width in pixels of the specified resolution

Default	**=**	depends on raster presentation mode - when presentation mode is 0, width = width of logical page - left graphics margin when presentation mode is 3 then width = dimension of logical page along paper length - left graphics margin
Range	**=**	0 to (logical page width – left graphics margin)*

*Greater values default to the (logical page width – left graphics margin).

This command allows you 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 is printed. Data outside the intersection is clipped.

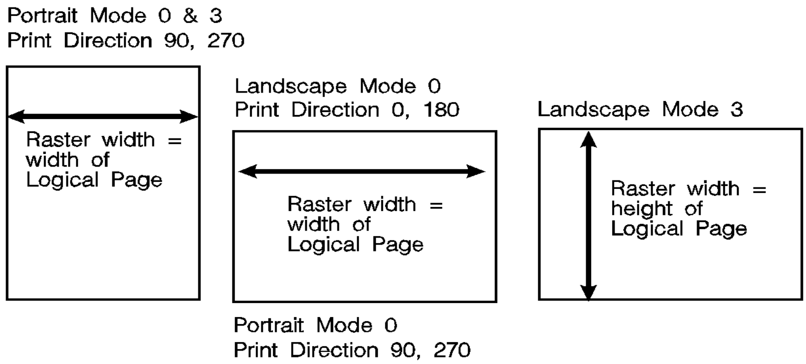


Figure 15-8 Maximum Raster Width

Start Raster Graphics Command

The Start Raster Graphics command identifies the beginning of the raster data and also specifies the left graphics margin.

$^{E}{}_{C}$ * r # A

\# =0- Start graphics at default left graphics margin X-position 0).

1 - Start graphics at current cursor position (current X-position).

Default = 0
Range = 0, 1 (values outside the range default to 0)

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. In presentation mode 3, the location of the left graphics margin varies depending on the orientation.

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 imply an End Raster Graphics ($^{E}{}_{C}$***rC**) except for the following commands:

- Transfer Raster Data
- Set Raster Compression Method
- 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

Notes An implied End Raster Graphics resets the Raster Compression Method 3 seed row, but does not reset the Raster Compression Method nor the left raster graphics margin.

If source and/or transparency modes have been set, frequent start/end graphics commands in an image can result in a memory overflow condition.

Raster Y Offset Command

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

\# =Number of raster lines of vertical movement

Default **=** N/A
Range **=** 0 - 32767

This command is recognized only while in raster graphics mode and only within the raster area.

Set Compression Method Command

The Set Compression Method command allows you to code raster data in one of four compressed formats: Run-length encoding, tagged imaged file format (TIFF) rev. 4.0, delta row compression, and adaptive compression. The choice of compression methods affects 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
4 - Reserved
5 - Adaptive compression

Default **=** 0
Range **=** 0 - 5 (values outside the range are ignored)

Unencoded (Method 0)

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.

Note Compressed data formats allow for efficient transfer of data from the host system to the printer. However, compressed data formats do NOT reduce the amount of printer memory required to produce an image.

Run-length Encoding (Method 1)

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 to be printed.
A repetition count of 0 signifies the pattern in the data byte is not repeated (it occurs only once). A repetition count of 1 signifies the pattern occurs twice. The repetition count can range from 0 to 255 for a repetition of 1 to 256 times.

[(Repetition count byte 0-255)(pattern byte)] . [.] [ ]

Tagged Image File Format Encoding (Method 2)

Tagged image file format encoding interprets raster data as TIFF "Packbits." This format combines features of methods 0 and 1. A **control byte** precedes the raster data (pattern bytes). The control byte identifies whether the pattern byte(s) represent a byte that is to be repeated some number of times (up to 127), or represent some number of bytes (up to 127) which are to be printed as is (literal).

The sign of the number in the control byte identifies whether the byte or bytes that follow represent a literal pattern or byte to be repeated. A positive number (1 to 127) indicates that the bytes are literal. A negative number (-1 to -127), represented by the twos complement, indicates a repeated byte. The value of the number, if positive (literal), identifies the number of pattern bytes which follow the control byte; if negative (repeated), identifies the number of times to repeat the following byte. A pattern byte may be repeated up to 127 times; or up to 127 literal bytes may follow the control byte.

As mentioned, for a byte to be repeated, the control byte must be a negative value as represented by the twos complement. For example, to repeat a pattern three times would require the twos complement of the number 3. The twos complement is computed as follows. The binary of 3 is 00000011. Complement each bit to get 11111100, then add one to this value to produce 11111101, the twos complement. The decimal value of this number, 253, used in the control byte, produces a repetition of 3 bytes for a total of 4 occurrences of the pattern.

The range of numbers for the control byte is shown below.

Table 15-3 Literal Pattern Values

# of Bytes	Binary value	Decimal value
1	0000 0000	1
to	to	to
127	0111 1111	127

Table 15-4 No Operation Value

NOP value	Binary value	Decimal value
128 (-128)	1000 000	128

Table 15-5 Repeated Pattern Values

# of Repetitions	Binary value[1]	Decimal value
1 (-1)	1111 1111	255
to	to	to
127 (-127)	1000 0001	129

1. These negative values are represented by taking the twos complement of the value of the number.

Note Another method to calculate the number needed in the control byte for some number of repetitions is to subtract the number of desired repetitions from 256. For example, the control value for 3 repetitions (4 occurrences) of a byte is 256 minus 3 = 253.

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 that follow. For example, a control byte 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.

Note 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: Run-length and TIFF Compression

The following examples show how a raster row can be coded using run-length and TIFF compression methods. Note that the compression examples use characters to represent the binary data stream.

Table 15-6

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*rC

Run-length Encoding

E_C*r1A

E_C*b1m6W(3)U(0)A(1)T

E_C*rC

TIFF Encoding

$^{E}{}_{C}$*r1A

$^{E}{}_{C}$*b2m6W(-3)U(0)A(-1)T or $^{E}{}_{C}$*b2m6W(-3)U(2)ATT

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

In the TIFF encoding example above, parenthetical expressions are used to identify control bytes. For example, the byte (-3) is shown to represent the control byte for a repetition (minus value) of 3. The actual value for this position is the decimal value 253. Additional "encoded" control bytes in this sequence include: (0) for decimal 0, (-1) for decimal 255, and (2) for decimal 2. The raster data (pattern) bytes are represented as by the ASCII character.

Delta Row Compression (Method 3)

Delta row compression identifies a section of bytes in a row that is 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, 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 the 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.

Table 15-7

Command Byte

7 5	4 0
Number of bytes to replace (1-8)	Relative offset from last untreated byte

If more than eight replacement (delta) bytes are needed, additional command byte/replacement bytes may be added, as shown below:

> $^{E}{}_{C}$*3m#W [(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 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.

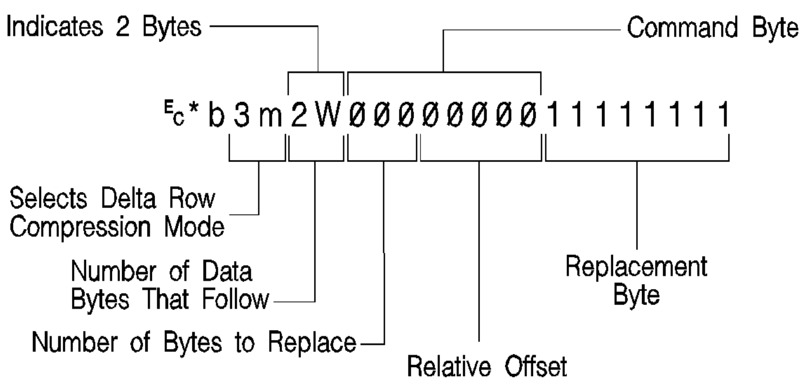


Figure 15-9

As mentioned, the offset is contained in the lower five bits of the command byte allows for offset values 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 are offset from the 1st byte to the 31st byte.
- A value of 31 indicates that the next byte following the command byte is an additional offset byte which adds to the first (32) offset value. 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 then totaled (added). The following example shows an offset larger than 31:

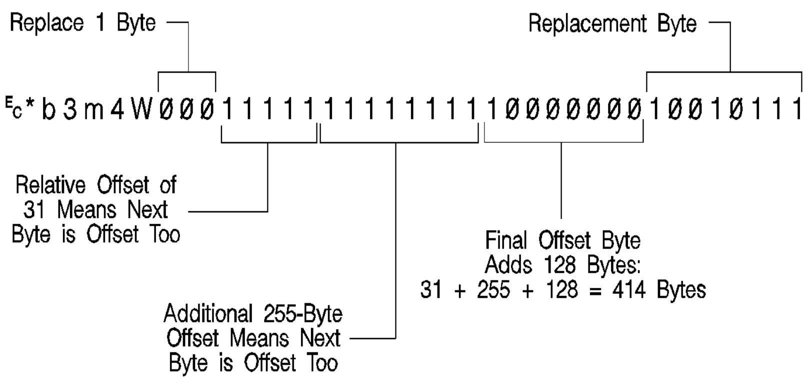


Figure 15-10

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 being printed. It is maintained by the printer for use by delta row compression. The delta compression replacement bytes are applied to the seed row to create the new row. This new data row is printed and becomes the new seed row.

The seed row is updated by every raster graphic transfer, regardless of the compression method. This allows delta compression method to be mixed with other methods to achieve better compression performance.

Repeating a Row

$^{E}{}_{C}$*b0W

When using the delta compression method, 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 is applied to a zeroed seed row.

Other cursor position moves set the seed row 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, **&esc*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 — those bytes that are different from the previous row, the seed row.)

Table 15-8

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 method and the **2W** indicates that 2 bytes of data to 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.

Adaptive Compression (Method 5)

Adaptive compression enables the combined use of any of the four previous compression methods (0 through 3), and it includes the ability to print empty (all zeros) rows or to duplicate rows.

Adaptive compression interprets a raster image as a block of raster data rather than as individual rows. The result of this interpretation is that the Transfer Raster Data (${}^{E}{}_{C}$*b#W) command is sent only once at the beginning of a raster data transfer, and the value field (**#**) identifies the number of bytes in the block (all rows). For the other compression methods, the Transfer Raster Data command is sent at the beginning of each row and the value field (**#**) identifies the number of bytes for that row only.

The size of a block is limited to 32,767 bytes. (32,767 bytes is the number of compressed bytes and not the size of the uncompressed data). To transfer greater than 32,767 bytes, send multiple blocks.

Adaptive compression uses three control bytes at the beginning of each row within the block. The first of these bytes, the command byte, identifies the type of compression for the row. The two following bytes identify the number of bytes or rows involved. The format for adaptive compression raster rows is shown below:

<command byte><# of bytes/rows - upper byte><# of bytes/rows - lower byte> ...
...<first raster row byte>...<last raster row byte>

The command byte designates the compression method, empty row, or row duplication. Command byte values are shown below.

Table 15-9

Value	Compression Operation
0 -	Unencoded
1 -	Run-Length Encoding
2 -	Tagged Image File Format (TIFF) rev 4.0
3 -	Delta row
4 -	Empty row
5 -	Duplicate row

For command byte values 0 - 3, the two **<# of bytes/rows>** bytes specify the number of bytes (row length) for the row. For command byte values 4 and 5, these bytes identify the number of empty or duplicate rows to print. The maximum value for these two bytes is 65,535; however, the image is clipped to the logical page. Thus, the value of these bytes should not exceed the maximum number of bytes/rows that can be printed on the current logical page size.

If an out of range command byte is encountered, the remainder of the block is skipped, the cursor is not updated, and the seed row is cleared.

Compression methods 0 - 3 are the compression methods used by the Set Compression Method command. Value fields 4 and 5 are features for the adaptive compression method and are explained below.

Empty Row

A command byte of 4, empty row, causes a row of zero's to be printed. The number of rows printed depends on the value contained in the two **<# of bytes/rows>** bytes following the command byte. The empty row operation resets the seed row to zero and updates the cursor position.

Duplicate Row

A command byte of 5, duplicate row, causes the previous row to be printed again. The row can be duplicated the number of times indicated by the value contained in the **<# of bytes/row>** byte. Duplicate Row updates the cursor position but does not change the seed row.

Adaptive Compression Operation Hints

Note Some HP LaserJet printers perform internal compression techniques to support full-page graphics. Refer to Chapter 1 of the *PCL 5 Comparison Guide* for specifics.

- The compression methods cannot be mixed within one raster row. A raster row must be compressed using only one method.
- The cursor position is updated with each row of the raster block. The cursor position is also incremented when a block count of less than 3 is sent.
- A Raster Y-Offset command moves the entire block of raster data and initializes the seed row to zeros. The seed row is set to zero even if the y-offset is zero.
- **B**lock size takes precedence over row length. If the row length of any line exceeds the block size, the row length is truncated to the block size.
- For duplicate and empty rows a row length value of zero does not update the cursor, however, the seed row is initialized to zero.
- If an unsupported command byte for a raster row is encountered, the remaining bytes for the block are skipped, the seed row is cleared, and the cursor is not incremented.
- For method 1, run length encoded, if the row length is odd, the cursor is incremented and the row data is skipped (thrown away), and the seed row is left unchanged.
- For method 1, a row length value of zero increments the cursor and zero fills the seed row.
- For method 2, TIFF, if row length terminates the data before the control byte value is satisfied (literal byte count greater than row length), the data following the control byte (if any) is printed as text. The cursor is incremented.
- For method 2 - If row length is equal to one, the one byte is consumed from the I/O and the cursor is incremented. The data is ignored and the seed row is zeroed.
- For method 3 - delta row compression, within an adaptive compression block, the seed row is updated by every raster compression method or type of row. For example, a row compressed with method 2, TIFF, updates the seed row, while the effect of an empty row initializes the seed row to zeros. Maintaining the seed row allows method 3 to be mixed with other methods to achieve optimal compression performance.

- For method 3 - Since delta row compression requires that the seed row be available whenever raster graphics mode is entered, the seed row is initialized to zeros upon raster graphics mode entry ($^{E}{}_{C}$*r#A). The seed row is also initialized upon receipt and completion of each raster block.
- For method 3 - If the row length terminates the data before the control byte value is satisfied (literal byte count greater than row length), the data following the control byte (if any) is printed as text. The cursor is incremented.
- For method 3 - if the row length is equal to one, the current row is duplicated, and the cursor is incremented.

Transfer Raster Data Command

The Transfer Raster Data command is used to transfer a row of raster data to the printer.

$^{E}{}_{C}$ * b # W [*raster data*]

Default **=** N/A
Range **=** 0 - 32767

The value field (#) identifies the number of bytes in the raster row. These bytes are interpreted as one row of raster graphics data that is 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 is 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 – 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.

Note 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 method=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.

Notes If the last byte indicated by the value field in the Transfer Raster Data command is a control byte, that byte is ignored.

If a Transfer Raster Data command is received without an accompanying Start Raster Graphics command, any preceding start raster values are used (such as left graphics margin, raster height and width, etc.).

End Raster Graphics Command

The **End Raster Graphics** command signifies the end of a raster graphic data transfer.

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

- Receipt of this command causes 5 operations:
- Resets the raster compression seed row to zeros.
- Moves the cursor to the raster row immediately following the end of the raster area (if a source raster height was specified).
- Allows raster commands which were previously locked out to be processed.
- Sets compression mode to 0 (no compression)
- Defaults the left graphics margin to X-position 0.

Notes This command is a modified version of the $^{E}{}_{C}$***rB End Raster Graphic**s command. This new version ($^{E}{}_{C}$*rC) performs two additional operations: 1) it resets the compression mode to 0, and 2), it defaults the left graphics margin to 0.

This command ($^{E}{}_{C}$*rC) is not supported by the HP LaserJet III or the HP LaserJet IIID printers. Use the $^{E}{}_{C}$***rB End Raster Graphics** command to terminate raster graphic data transfers for these printers.

Refer to the “PCL Feature Support Matrix” in Chapter 1 of the *PCL 5 Comparison Guide* for specific printers which support these commands.

Raster Graphics Example

To transfer an unencoded raster graphic image (see Figure 15-11) in the shape of an arrow, perform the following steps:

Table 15-10

1. Position the cursor:

$^{E}_{C}$*p300x400Y	This moves the cursor to PCL Unit 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 method:

$^{E}_{C}$*r0F	This specifies that the raster graphics is 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:

$^{E}_{C}$***rC**	This example prints the arrow as shown in Figure 15-11.

Table 15-11 Example of Raster Graphic Image Data

	Raster Image Data				Command Data
Dot Row	**byte 1**	**byte 2**	**byte 3**	**byte 4**	**Decimal Equivalent**
1	00000000	00000000	10000000	00000000	$^{E}_{C}$*b4W[0, 0,128, 0]
2	00000000	00000000	11000000	00000000	$^{E}_{C}$*b4W[0, 0,192, 0]
3	00000000	00000000	11100000	00000000	$^{E}_{C}$*b4W[0, 0,224, 0]
4	00000000	00000000	11110000	00000000	$^{E}_{C}$*b4W[0, 0,240, 0]
5	00000000	00000000	11111000	00000000	$^{E}_{C}$*b4W[0, 0,248, 0]

Table 15-11 Example of Raster Graphic Image Data (continued)

6	00000000	00000000	11111100	00000000	E_C*b4W[0, 0,252, 0]
7	00000000	00000000	11111110	00000000	E_C*b4W[0, 0,254, 0]
8	00000000	00000000	11111111	00000000	E_C*b4W[0, 0,255, 0]
9	00000000	00000000	11111111	10000000	E_C*b4W[0, 0,255,128]
10	11111111	11111111	11111111	11000000	E_C*b4W[255,255,255,192]
11	11111111	11111111	11111111	11100000	E_C*b4W[255,255,255,224]
12	11111111	11111111	11111111	11110000	E_C*b4W[255,255,255,240]
13	11111111	11111111	11111111	11111000	E_C*b4W[255,255,255,248]
14	11111111	11111111	11111111	11111100	E_C*b4W[255,255,255,252]
15	11111111	11111111	11111111	11111110	E_C*b4W[255,255,255,254]
16	11111111	11111111	11111111	11111111	E_C*b4W[255,255,255,255]
17	11111111	11111111	11111111	11111111	E_C*b4W[255,255,255,255]
18	11111111	11111111	11111111	11111110	E_C*b4W[255,255,255,254]
19	11111111	11111111	11111111	11111100	E_C*b4W[255,255,255,252]
20	11111111	11111111	11111111	11111000	E_C*b4W[255,255,255,248]
21	11111111	11111111	11111111	11110000	E_C*b4W[255,255,255,240]
22	11111111	11111111	11111111	11100000	E_C*b4W[255,255,255,224]
23	11111111	11111111	11111111	11000000	E_C*b4W[255,255,255,192]
24	00000000	00000000	11111111	10000000	E_C*b4W[0, 0,255,128]
25	00000000	00000000	11111111	00000000	E_C*b4W[0, 0,255, 0]
26	00000000	00000000	11111110	00000000	E_C*b4W[0, 0,254, 0]
27	00000000	00000000	11111100	00000000	E_C*b4W[0, 0,252, 0]
28	00000000	00000000	11111000	00000000	E_C*b4W[0, 0,248, 0]
29	00000000	00000000	11110000	00000000	E_C*b4W[0, 0,240, 0]
30	00000000	00000000	11100000	00000000	E_C*b4W[0, 0,224, 0]
31	00000000	00000000	11000000	00000000	E_C*b4W[0, 0,192, 0]
32	00000000	00000000	10000000	00000000	E_C*b4W[0, 0,128, 0]

The brackets and commas are not part of the raster data command; they are used only to delineate the data.

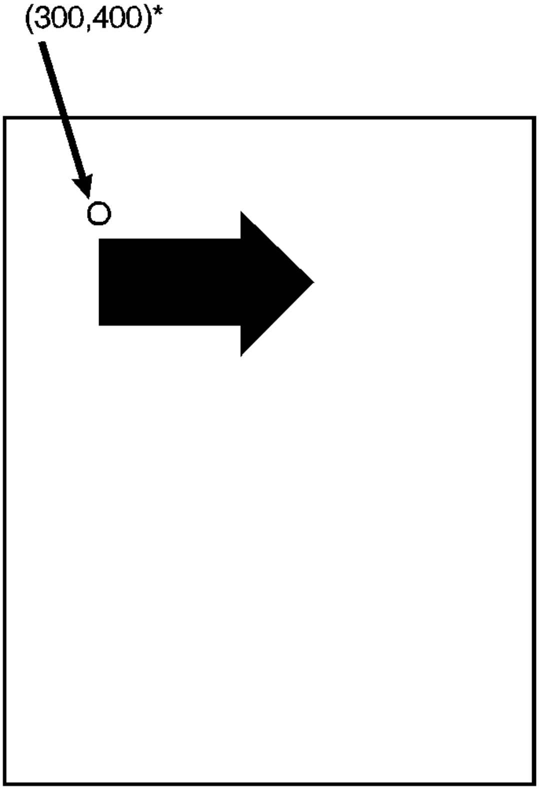


Figure 15-11 Example of Raster Graphic Image Data

16 Status Readback

Introduction

This chapter describes the PCL status readback features. PCL status is requested from the printer with the commands described in this chapter. Following a status request, the printer generates a status response. This response consists of ASCII data which is sent directly from the printer, through the I/O, back to the host. Status readback allows you to obtain information from the printer such as: available printer (user) memory, current available fonts and symbol sets, and the ID numbers of downloaded macros and user-defined patterns to verify their presence.

The contents of this chapter are listed below:

- Flush All Pages Command
- Echo Command
- Status Readback Programming Hints

For status readback to work, the host system must contain a bi-directional driver to receive status response data. In network operations, some printing environments do not support bi-directional communication, such as many printer sharing devices which spool data, and some network operating systems. Applications designed to incorporate PCL status readback should be designed to function correctly in situations where no response is possible.

Note For the stand-alone DOS personal computer, bi-directional driver/applications are required to access the parallel/serial I/O communication data for not only sending to the printer but also receiving data (status) back from the printer.

FTo obtain status information you must initiate a request by sending either a request for memory status or a request for an entity status, as described on the following pages.

Memory Status Request

It is possible to identify the amount of available user memory using the memory status request. Being able to identify the available memory enables a user to determine whether sufficient memory is available for the entity being downloaded, potentially avoiding a printer memory overflow condition (control panel error 20, memory overflow).

An example memory request with its associated response is shown below.

Table 16-1 Memory Status Request Example

Description	I/O Data
Memory request (Free Space command) sent to printer from host	$^{E}{}_{C}$*s1M

Table 16-1 Memory Status Request Example (continued)

Status response sent from printer to host	PCL INFO MEMORY TOTAL=100000 LARGEST=25000

Entity Status

It is possible to request status for the printer's entities. An **entity** is a font, symbol set, macro, or user-defined pattern stored in the printer. Each individual entity request is limited to one specific entity, and is further limited to a specific location. To request entity status, you must send the entity status readback commands to identify a **location type** and a **location unit**, and then send the entity request command.

Location type refers to the memory locations which store entities. These memory locations include internal ROM, RAM (for downloaded entities), cartridges, user-installable ROMs (SIMMs), and one additional location identified as "currently selected." Currently selected identifies the entity which is active, such as the font or user-defined pattern last selected. (Currently selected does not apply to macros or symbol sets).

Location unit refers to a specific location (or device) within the location type. For example, location unit "1" for location type "cartridge," identifies the left cartridge on a printer with two cartridges; or, unit "1" for location type "downloaded," identifies the temporary fonts (as opposed to permanent).

The location type and unit are described in detail under the location type and unit status readback command descriptions provided later in this chapter.

Once the location type and unit are specified, the status can be requested using the Inquire Status Readback Entity command. This command identifies the entity (font, symbol set, macro, or user-defined pattern) and causes the printer to send the response.

A basic entity status request is shown in the example below. This example identifies a status request for downloaded permanent fonts. The example also includes a status readback response at the bottom. Note that this example shows only one possible request/response; for more detailed information, refer to the status readback command descriptions provided later in this chapter.

Table 16-2 Entity Status Request Example

Operation	Example PCL Command	Comments
Set location type	$^{E}{}_{C}$*s4T	This Set Location Type command sets the location type to "downloaded."
Set location unit	$^{E}{}_{C}$*s2U	This Set Location Unit command sets the location unit to "permanent."
Identify entity which initiates status readback (Inquire Entity)	$^{E}{}_{C}$*s0I	The Inquire Status Readback Entity command selects status for "fonts" and causes the printer to buffer the response.

Table 16-3

Printer status res-ponse	PCL INFO FONTS SELECT="<Esc>(8U<Esc>(s1p__v0s0b4120T <Esc>(7X" SELECT="<Esc>(10U<Esc> __v0s0b4157T<Esc>(21X"	Two permanent downloaded fonts exist in the printer: University Roman (4120T) and Dom Casual (4157T).

In addition to the normal status responses, if an invalid request is made, the printer returns an error response. Error responses are described under the Inquire Status Readback Entity command, later in this chapter.

Status Response

When the printer receives a status request (command), it processes that request and forms the response data. This data is then stored in an I/O status buffer. The response is saved in this buffer until it is either read (by any user) or the printer is turned off.

In addition to clearing the status buffer by reading the status response or by turning off the printer, status responses are cleared if one the following settings are changed:

- Printer resolution (600/300)
- Page protection
- Language personality

Status requests and their associated response are processed in the order in which they are received.

The number of responses the printer can buffer varies, depending on internal printer operations. When requesting status, especially in the case where multiple applications or users are sharing one printer, HP recommends that you request one item, and then read its response prior to making another request.

Note Since the printer may contain a status response requested by a previous application's operation, it is important to use the Echo command (described later in this chapter) to synchronize your application's request with the printer's responses. Refer to the Echo command description and to the "Programming Hints" section at the back of this chapter for additional information.

Note The number of status responses a printer can buffer varies from printer to printer. The HP LaserJet 4 printer can store 5 responses. Refer to the *PCL 5 Comparison Guide* for printer specific information.

A status response is returned to the printer I/O port from which it was requested.

Status Response Syntax

All status responses start with the letters "PCL" followed by a Carriage Return control code (decimal 13; <CR>) and a Line Feed control code (decimal 10; <LF>). In addition, each remaining line of the response is terminated by a Carriage Return and Line Feed control code. Finally, status responses are terminated by a Form Feed control code (decimal 12; <FF>). The basic syntax for the status response is shown below.

```
PCL<CR><LF>
INFO TITLE<CR><LF>
KEYWORDn=DATAn<CR><LF>
KEYWORDn=DATAn<CR><LF>
  ⋮
<FF>
```

TITLE, *KEYWORDn*, and *DATAn* are strings that vary depending on the particular status readback command being executed. Each status readback response has one or more keyword lines associated with it. A slight variation of this is the Echo command response. This response is shown below.

```
PCL<CR><LF>
ECHO ValueField<CR><LF>
<FF>
```

ValueField is the decimal number taken from the Echo command value field.

Note Keywords may be added for future printers that are not documented here. Applications that use status readback should be designed to ignore lines with keywords they do not recognize.

Two example status responses are shown below.

```
PCL<CR><LF>
INFO MEMORY<CR><LF>
TOTAL=100000<CR><LF>
LARGEST=25000<CR><LF>
<FF>
```

```
PCL<CR><LF>
INFO FONTS<CR><LF>
SELECT="<Esc>(8U<Esc>(s0p10.00h12.00v0s0b3T"<CR><LF>
SELECT="<Esc>(0N<Esc>(s0p16.67h8.5v0s0b0T"<CR><LF>
SELECT="<Esc>(s1p__v1s0b4101T<Esc>(78X"<CR><LF>
SYMBOLSETS="0D,0I,0N,0S,0U,1E,1F,1G,..."<CR><LF>
SELECT="<Esc>(8U<Esc>(s1p__v0s3b4148T"<CR><LF>
<FF>
```

Notes

In the example listings, "<CR>," "<LF>," and "<FF>" identify the Carriage Return (decimal 13), Line Feed (decimal 10), and Form Feed (decimal 12) control codes. The "<Esc>" following the "SELECT=" keyword is a five character representation (the printable characters: "<," "E," "s," "c," and ">") and does not identify an escape control code (decimal 27).

The examples in the remainder of this chapter do not show the status response line termination ("<CR><LF>") control codes, or the termination ("<FF>") control code.

Example responses in this chapter for "SYMBOLSETS=" do not list the complete list of internal available symbol sets, only a partial list: "0D,0I,0N,0S,0U,1E,1F,1G,..." The internal symbol sets are printer dependent and may vary from printer to printer. Refer to the *PCL 5 Comparison Guide* for printer specific information.

Set Status Readback Location Type Command

The Set Location Type command sets the status location type to the specified value. Location type is used in conjunction with the location unit to identify an entity location for a status request (Inquire Status Readback Entity command).

$^{E}{}_{C}$ * s # T

\# =0- Invalid location
1 - Currently selected
2 - All Locations
3 - Internal
4 - Downloaded Entity
5 - Cartridge
7 - User-installable ROM device (SIMMs)

Default **=** 0
Range **=** 0 - 5, 7

If a value outside the range is received, the location type is set to 0.

When the location type is 0 and an Inquire Entity command is received, an error response is generated (refer to the “Status Response Error Codes” section later in this section for additional information).

A printer reset returns the location type setting to 0.

The printer retains the location type setting. If the Set Status Readback Location Type command is not sent to change the setting for an entity request, then the existing location type setting is used.

Set Status Readback Location Unit Command

The Set Location Unit command sets the status location unit to the specified value. Location unit is used in conjunction with the location type to identify an entity location for a status request (Inquire Status Readback Entity command). Note that the unit value is interpreted differently, depending on the location type specified.

$^{E}{}_{C}$ * s # U

Table 16-4 Set Status Readback Location Unit Command

Location Type		Location Unit		
0	#	=	*	Invalid location
1		=	*	Currently selected
2		=	*	All Locations
3		=	0	All internal
4		=	0	All downloaded
		=	1	Temporary downloaded
		=	2	Permanent downloaded
5		=	0	All cartridges
		=	1	Highest priority cartridge
			⋮	⋮
			n	Lowest priority cartridge
7		=	0	All SIMMs
		=	1	Highest priority SIMM
			⋮	⋮
			n	Lowest priority SIMM

Default **=** 0
Range **=** 0 through n, where n is printer dependent. Refer to the *PCL 5 Comparison Guide*.

* - For location type values 0, 1 and 2, the unit value is ignored; it may be any value.

A value of 0 indicates all units of the location type.

A printer reset ($^{E}{}_{C}$E) returns the location unit to its default value, 0.

The printer retains the location unit setting. If this command is not sent to change the setting for an entity request, then the existing location unit setting is used.

Note The location type and unit may be set in any order. Invalid combinations are not determined until the Inquire Entity command is received. Therefore, even if the unit value is out of range, the unit is set to that value so that an appropriate error response is sent when the Inquire Entity command is received.

Inquire Status Readback Entity Command

The Inquire Entity command identifies the entity type and causes the printer to create a status response for the entity specified in the status readback location (type and unit).

$^{E}{}_{C}$ * s # I

\# =0- Font
1 - Macro
2 - User-defined pattern
3 - Symbol Set (for unbound scalable fonts)
4 - Font Extended

Default **=** NA
Range **=** 0 - 4

The entity status responses for the value field parameters vary depending on the setting of the location type and location unit (refer to the Set Location Type and Set Location Unit commands described on the preceding pages).

The entity status and error responses are described on the following pages.

Entity Status Responses

The status response for an Inquire Status Readback Entity command varies depending on the type of entity requested. The status responses for font, font extended, macro, user-defined pattern, and symbol set are described below.

Font Response

The status response information returned for font (inquire entity value field 0) varies. Depending on whether the printer's font is a bitmap, unbound scalable, or bound scalable, different keywords are returned. The response is also somewhat different if the location type is set to 1 (currently selected, as explained in more detail later). The list of possible keywords for a font request is shown below.

SELECT=
SYMBOLSETS=
LOCTYPE=
LOCUNIT=

An example of an inquire entity font (entity type 0) status response is shown below. Notice the variation in the keyword lines for the three fonts, listed in order below:

Internal, bitmap, Line Printer
Internal, unbound scalable, CG Times italic
Downloaded, bound scalable, (CG Palacio)

Font status:

```
PCL
INFO FONTS
SELECT="<Esc>(8U<Esc>(s0p16.67h8.5v0s0b0T"
SELECT="<Esc>(s1p__v1s0b4101T"
SYMBOLSETS="0D,0I,0N,0S,0U,1E,1F,1G,..."
SELECT="<Esc>(1U<Esc>(s1p__v0s0b4111T<Esc>(21X"
  ⋮
```

In a font status response, individual fonts are identified by the "SELECT=" keyword line, as shown in the example above. This line identifies the font by specifying the font selection characteristics (symbol set, spacing, pitch, height, style, stroke weight, and typeface). The characteristics are listed as they would be sent to the printer to select the font (in priority order, highest priority to lowest). "SELECT=" is returned for all font types.

As mentioned, variations in the font response occur as a result of the font being a bitmap, bound scalable, unbound scalable, soft (downloaded) font, or the location type set to 1 (currently selected). These variations include slight differences in the information included in the “SELECT=” line, with the addition of different keywords (“SYMBOLSETS=” “LOCTYPE=” and “LOCUNIT=”). These variations are described in detail in the following paragraphs.

Notes

In the status response, an escape character is represented by the five characters: “**&**”.

Keywords which follow a “SELECT=” keyword apply to the font identified by that “SELECT=” keyword.

Bitmap Fonts

For bitmap fonts, the “SELECT=” line is returned (which identifies the font selection characteristics as described above). For example, the printer’s internal, bitmap, Roman-8 Line Printer font would be returned as shown below.

```
PCL
INFO FONTS
SELECT="<Esc>(8U<Esc>(s0p16.67h8.5v0s0b0T"
```

Also see soft font description below.

Scalable Fonts

For bound scalable fonts, two underscores, “...s 1 p __ v 0 s...,” in the “SELECT=” line indicate that the font is a bound scalable. In addition, only the relevant characteristics are listed. Depending on whether the font is proportional or fixed spaced, only either height or pitch is listed. For example, the printer’s internal scalable Symbol font (proportionally spaced) would be returned as shown below.

```
PCL
INFO FONTS
SELECT="<Esc>(19M<Esc>(s1p__v0s0b16686T"
```

Also see the soft font description below.

Unbound Scalable Fonts

For unbound fonts, since multiple symbol sets can be associated with an unbound font, the “SYMBOLSETS=” keyword is added to list the available symbol sets and the symbol set sequence is no longer present in the “SELECT=” line. For example, the printer’s internal unbound scalable Courier (medium, fixed spaced) font and CG Times (bold italic, proportional spaced) fonts would be returned as shown below.

```
PCL
INFO FONTS
SELECT=“<Esc>(s0p__h0s0b4099T”
SYMBOLSETS=“0D,0I,0N,0S,0U,1E,1F,1G,...
SELECT=“<Esc>(s1p__v1s3b4101T”
SYMBOLSETS=“0D,0I,0N,0S,0U,1E,1F,1G,...”
```

Soft Fonts

For soft fonts (bitmap, bound scalable or unbound scalable), the font ID number is also included at the end (a font downloaded with an ID of 27 would be presented as “ ...<Esc>(27X ”). For example, a downloaded bitmap Courier with a font ID of 39 and a downloaded, unbound scalable, Dom Casual typeface with a font ID of 78 would be returned as shown below.

```
PCL
INFO FONTS
SELECT=“<Esc>(8U<Esc>(s0p10.00h12.0v0s0b3T<Esc>(39X”
SELECT=“<Esc>(s1p__v1s0b4148T<Esc>(78X”
SYMBOLSETS=“0D,0I,0N,0S,0U,1E,1F,1G,...”
```

Location Type 1 (Currently Selected) Font

For a status location type 1 (currently selected) font, only a single font, the printer’s currently selected font, is returned. The keywords and data returned are described as follows.

- “LOCTYPE=” and “LOCUNIT=” are returned after the “SELECT=” line for each font.
- “SELECT=” line changes for bound and unbound scalable fonts.
  - For all scalable fonts, the actual size (either height or pitch) is listed in place of the underscores.
  - For unbound scalable fonts, the symbol set currently bound to the font is listed.

- For all fonts, if the font is a secondary font, then the “(“ characters are replaced by ”)” characters in the “SELECT=” line.

“LOCTYPE=” identifies the location type of the currently selected font. The value returned corresponds to the value field of the Set Status Readback Type command.

“LOCUNIT=” identifies the location unit of the currently selected font. The value returned corresponds to the value field of the Set Status Readback Unit command.

For example, if the printer’s currently selected font is a bold 14 point Presentation bitmap font selected from a cartridge, and a font entity request with the location type set to 1 is made, the response would be returned as shown below.

```
PCL
INFO FONTS
SELECT=“<Esc>(1U<Esc>(s0p10.00h14.0v0s3b11T
LOCTYPE=5
LOCUNIT=1
```

For example, assume the printer’s currently selected font is unbound scalable Dom Casual font with the following characteristics:

- downloaded (font ID of 78)
- temporary
- Roman-8 (specified for printing)
- secondary font
- 18 point

If an entity request is made with the location type set to 1 (currently selected), the following response is returned.

```
PCL
INFO FONTS
SELECT=“<Esc>)8U<Esc>)s1p18.00v1s0b4148T<Esc>)78X”
LOCTYPE=4
LOCUNIT=1
```

Font Extended Response

The font extended response (inquire entity value field 4) provides a way to return the name and internal ID number of the font, as well as the “SELECT=” line. It is the same as a font status response (inquire entity value field 1), in that “SELECT=,” “SYMBOLSETS=,” “LOCTYPE=,” and “LOCUNIT=” are returned in the same manner. They are not re-described here; refer to the “Font Response” section for a description of their operation. However, for a font extended request, two additional keywords, “DEFID=” and “NAME=” are returned as described below.

“**DEFID=**” identifies the font’s internal ID number. This is the number which appears on the font printout. It is the number used to select the font as the default font from either the printer’s control panel or from PJL (refer to the *Printer Job Language Technical Reference Manual* for information on PJL font selection). The “DEFID=” number consists of two parts, a location and an ID number, such as “I 21,” where “I” is the location and “21” is the font’s internal ID number. The possible locations are listed below:

Table 16-5

I	-	Internal
C	-	Cartridge - single cartridge printers
Cn	-	Cartridge - multiple cartridge printers where n is printer specific
S	-	Permanent soft fonts
Mn	-	SIMMs where n is the number of the SIMM slot for example: M2 is SIMM in #2 slot.
NONE	-	Temporary soft fonts

Note

The cartridge (Cn) and SIMMs (Mn) location identifiers are printer specific. Refer to Chapter 1 of the *PCL 5 Comparison Guide* for printer-specific values for “n.”

Since temporary soft fonts do not have an internal ID number (they cannot be selected as the default from the control panel or PJL), NONE is returned as their “DEFID=NONE”.

The font’s internal ID number is assigned to fonts by the printer. This number is different than the soft font download ID number assigned to a downloaded font using the Font ID ($^{E}{}_{C}$*c#D) command.

"**NAME=**" is returned for font extended status requests only. It identifies the name of the font, such as, Courier, Times Roman, Univers, etc., and its treatment (such as BdIt - bold italic) as listed in the font printout.

For example, the font extended response for the printer's internal bitmap Line Printer font and a downloaded unbound CG Palacio temporary font would be returned as shown below.

```
PCL
INFO FONTS EXTENDED
SELECT="<Esc>(8U<Esc>(s0p10.00h12.0v0s0b0T"
DEFID="I 45"
NAME="Line Printer"
SELECT="<Esc>(s1p__v1s3b4111T<Esc>(7X"
SYMBOLSETS="0D,0I,0N,0S,0U,1E,1F,1G,..."
DEFID=NONE
NAME="CG Palacio   BdIt"
SELECT="...
⋮
```

Or, for example, a font extended response with the location type set to 1 (currently selected) where the currently selected font is the internal CG Times (18 point specified for printing) bold, the response would be returned as shown below.

```
PCL
INFO FONTS EXTENDED
SELECT="<Esc>(8U<Esc>(s0p18.00h0s3b4101T"
DEFID="I 002"
NAME="CG Times   Bd"
LOCTYPE=3
LOCUNIT=1
```

Macro Response

The status response for macros (inquire entity value field 1) lists all of the macro IDs ("IDLIST=") for the macros in the specified location.

Note Status location type 1 (currently selected) is an invalid location for macros and returns an error ("ERROR=NONE").

A macro status response might appear as shown below.

```
PCL
INFO MACROS
IDLIST="1,3,8,29,32"
```

User-Defined Pattern Response

The status response for user-defined patterns (inquire entity value field 2) lists all of the user-defined pattern IDs ("IDLIST=") for the patterns in the specified location.

A user-defined pattern response might appear as shown below.

```
PCL
INFO PATTERNS
IDLIST="1,2,9,13,27,456"
```

If the location type is set to 1 (currently selected), then "LOCTYPE=" and "LOCUNIT=" lines are added.

"LOCTYPE=" is returned for a status location type 1 request only. It identifies the location type of the currently selected pattern.

"LOCUNIT=" is returned for a status location type 1 request only. It identifies the location unit of the currently selected pattern.

A user-defined pattern response for the currently selected pattern might appear as shown below.

```
PCL
INFO PATTERNS
IDLIST="88"
LOCTYPE=4
LOCUNIT=2
```

If the current pattern is set to one of the internal HP-defined patterns (no pattern ID number assigned), then no number is available and the response, "ERROR=NONE" is returned.

```
PCL
INFO PATTERNS
ERROR=NONE
```

Symbol Set Response

The response for symbol sets (inquire entity value field 3) lists all of the symbol set IDs (“IDLIST=”) for all of the symbol sets that can be bound to unbound scalable fonts in the specified location (type and unit).

A symbol set response might appear as shown below.

```
PCL
INFO SYMBOLSETS
IDLIST=“0U,2K,8M,8U,11U”
```

Notes

Status location type 1 (currently selected) is an invalid location for unbound font symbol sets and returns an error (“ERROR=NONE”).

Example responses in this chapter for “SYMBOLSETS=” do not list the complete list of internal available symbol sets, only a partial list: “0D,0I,0N,0S,0U,1E,1F,1G,...” The internal symbol sets are printer dependent and may vary from printer to printer; refer to the *PCL 5 Comparison Guide* for printer specific information.

Entity Error Codes

If you request out-of-range values in the command value fields, or if the entity is unsupported or does not exist, or if the request is inappropriate, the printer responds with one of four possible errors:

- **Invalid Entity**
- **Invalid Location**
- **None**
- **Internal Error**

ERROR=INVALID ENTITY

If the entity type specified in the escape sequence is out of range or unsupported, an invalid entity error is returned. For example, if the Inquire Entity command contained an out of range value of 8 ($^E{}_C$***s8I**), the following error response would be generated.

```
PCL
INFO ENTITY
ERROR=INVALID ENTITY
```

ERROR=INVALID LOCATION

If the entity type is valid but the location (either the type, the unit, or the combination) is invalid or if the specified device is not installed, an invalid location error is returned. For example, if you requested a status for a cartridge type but identified an out of range location unit of 9 ($^E{}_C$***s5t9U**), the following error response would be generated:

```
PCL
INFO FONTS
ERROR=INVALID LOCATION
```

ERROR=NONE

If the entity type and location are valid, but there are no entities of the specified type in that location, or if the type is inappropriate for the specified entity (internal user-defined pattern or currently selected macro), then an error response is generated. For example, if you request the downloaded symbol sets and there are no downloaded symbol sets, the following error response would be generated:

```
PCL
INFO SYMBOLSETS
ERROR=NONE
```

ERROR=INTERNAL ERROR

The status response for some requests can be fairly large (such as for fonts). In processing status responses, if the printer runs out of memory, an internal error is returned, as shown below:

```
PCL
INFO SYMBOLSETS
ERROR=INTERNAL ERROR
```

Note The error conditions described above are the only conditions for which an error response is generated. If you make a syntax error in the escape sequence, or send a command which the printer cannot interpret, the printer ignores the command and no error response is given.

Free Space Command

The Free Space command returns the amount of available memory. This response returns two values: the total available memory, and the largest available block of memory (refer to the “Memory Status Response” section later in this chapter for additional information).

$^{E}{}_{C}$ * s 1 M

If a value other than 1 is sent, this command returns an error (“ERROR = INVALID UNIT,” refer to “Memory Error Response” section later in this chapter for additional information).

To identify whether the printer has enough memory available for a job, you can send the Free Space command to compare the space available with that needed. You can also identify how much memory an entity or any other data uses by checking the amount of free memory prior to downloading the data, then downloading the data, and checking memory again. The difference in these values represents the approximate memory needed.

Note Many conditions can cause the available memory to change or appear different. Some of these conditions are listed below.

The actual printer memory required to store an item varies slightly based on printer memory fragmentation and other internal printer conditions.

Different printer models use different methods to store data. Thus, the amount of memory required to store the same amount of data may be slightly different in different printers.

While the printer is processing page data, the available memory is constantly changing due to the printer receiving new data, processing existing data, and adding new characters to the font cache, etc. Under these conditions, the available memory may change by the time the memory response is returned.

If a PostScript SIMM is installed in the printer, some memory is not reported for a Free Space command response. This memory is not reported as part of the free memory for a PCL status readback response, however, this memory is available for PCL use. Thus, it is possible for all or part of the downloaded data to be stored in this section of unreported memory and not change the memory response size.

If you determine there is insufficient memory to hold the data to be downloaded, some action is required. One method to make more memory available is to send the Flush All Pages command. This causes the printer to clear (process) the current page data from memory without accepting any new data for processing (refer to the "Flush All Pages Command" described later in this section). Another, more comprehensive method to clear memory is to send the Printer Reset ($^{E}{}_{C}$E) command. This not only removes data (deletes all temporary entities and the font cache) but also restores the User Default Environment settings (refer to the Printer Reset command in Chapter 4, "Job Control Commands").

Note To print characters from a scalable font, the printer converts the scalable character outlines into sized bitmaps. These bitmapped characters are created on a character-by-character basis as they are needed for printing and are stored in memory. As more pages are printed using more fonts, the bitmaps consume more memory. The bitmap characters used on the first page of a job can remain in memory until the end of a job. These stored bitmap characters are referred to as the font cache.

Note When an HP LaserJet 4 printer (or later) reaches a memory low condition it automatically deletes all of the font cache. It is possible to delete the cache immediately using a Printer Reset command. A Printer Reset clears the font cache, clears temporary entities, and restores the user default environment.

Memory Status Response

A Free Space status response returns two values:

```
TOTAL=
LARGEST=
```

"TOTAL=" identifies the total available user memory (in bytes). This value includes the largest block available and all smaller blocks.

Note Data downloaded to the printer is stored in a block (continuous section of free memory). If the printer does not have a large enough block to store the data, then the data is discarded and a memory error results.

"LARGEST=" identifies the largest continuous block of available memory (in bytes).

An example response is shown below:

```
PCL
INFO MEMORY
TOTAL=100000
LARGEST=25000
```

The above example indicates that the printer has 100,000 bytes of available memory and the largest continuous block is 25,000 bytes.

Memory Error Response

If the Free Memory command value field is out of range (not 1), then the memory status response returns an invalid unit error. For example, if the Free Space command with a value of 2 ($^{E}{}_{C}$***s2M**) were sent, the following error would be returned:

```
PCL
INFO MEMORY
ERROR=INVALID UNIT
```

Flush All Pages Command

The Flush All Pages command suspends accepting input data until all pages currently in the printer are printed. This gives the printer time to clear some memory.

$^{E}{}_{C}$ & r # F

\# =0- Flush all complete pages
1 - Flush all pages

Default **=** 0
Range **=** 0 - 1

A value of 0 indicates that only complete pages are to be processed. If a partial page exists, it is not processed. A value of 1 indicates that all page data including the partial page will be processed.

For example, if the printer contains two complete pages (page “A” and page “B”) and one partial page (page “C”), and receives a Flush All Pages command (value field 0 - all complete pages), it ejects pages “A” and “B” and retains page “C.” If the printer received the flush all pages (value field 1) it processes and ejects pages “A,” “B,” and “C.”

The printer resumes receiving (processing) data when the last page is processed and ejected from the paper path.

Notes

Using the Flush All Pages command significantly reduces printing performance. If possible, applications should use the Free Space command to check for available memory without using the Flush All Pages command. If the memory status readback response indicates sufficient memory available to process a job, the Flush All Pages command does need not be used. If the memory response indicates insufficient memory available to run the job, then the application should use the Flush All Pages command to make memory available, and then check available memory a second time.

When possible, use the Flush All Pages command only at the beginning of a print job, prior to the receipt and processing of any data. This minimized, to minimize performance reduction.

Echo Command

The Echo command echoes its value field (in ASCII format) back to the host.

$^{E}{}_{C}$ * s # X

\# =Echo value (ASCII)

Default **=** 0
Range **=** –32767 to 32767

If multiple users are requesting status, it can be difficult to distinguish one user's status response from another. The Echo command provides the means to label status responses. Since the user-selected value for the value field is returned, this command can be used as a user identification mark or "place holder." Sending the Echo command, with a specific user-selected value, at the beginning of a status request enables users to identify their status response data.

Notes

Status readback requests are processed in the order they are received.

Status readback responses are returned to the printer port from which they were received.

When selecting an echo value, it is important to select a number which is not likely to be used by another user, such as a random number.

This example illustrates why using the Echo command with a random number is important. Assume an application uses a fixed number each time the Echo command is sent. Further, assume the printer running the application was turned off after the application sent the Echo command followed by a Free Space command. The printer generates the status readback responses to the Echo command and Free Space commands. Since the host is not accepting data, the data will be in the printer waiting for the host to accept it. Now, assume the host computer is turned on and the application is again executed.

If the application sends the Echo command and Free Space command, the printer returns the response to the first Echo command and Free Space command, along with the response to the second request. The application will assume that the response received is the response to its last request. If the application uses random numbers in the Echo command, this type of mix-up will not occur.

Echo Response

The Echo command returns the following response:

```
PCL
ECHO ValueField
```

where “`ValueField`” is the Echo command value field value that was selected (within the range –32767 to 32767).

For example, if the Echo command, $^{E}{}_{C}$*s–999X was sent the status response would be:

```
PCL
ECHO –999
```

Status Readback Programming Hints

The following hints can assist in using the status readback feature.

- PCL status readback is useful during the development of applications. Status readback allows you to determine that fonts, macros, user-defined patterns, and symbol set resources you have downloaded were accepted by the printer.
- If the printer does not contain sufficient memory to accept a downloaded entity, the printer discards the data. Status readback can be used to determine if the printer accepted a downloaded entity.
- Status responses are directed to the printer's I/O port from which the request is received. If the status is not read and the printer switches to another I/O port, the status response is not directed to that port. The status response returns if the printer switches back to the original port (see note on following page).
- Your application should work correctly when an unexpected status response is received. For example, when requesting a PCL status, it is possible that PJL could return an unsolicited status response, if PJL is enabled.
  - All PCL status responses begin with the "PCL" header and end with the <FF> control code. When reading PCL status responses, your application should be able to read all the data between the "PCL" header and the <FF> control code. It should ignore any other status response syntax.
  - Lines within the PCL status response begin with a specific keyword (those described in this chapter) and end with the <CR> and <LF> control codes. Future printers may support new keywords in the PCL status response. Your application should be designed to ignore those lines which it does not understand.
- The first PCL status readback command an application should send is the PCL Echo command. A random number should be generated for the value field each time the command is sent. Your application should ignore all printer status readback data until the PCL Echo status readback response is received, echoing the number the application sent.
- To clear any possible unread status responses from previous applications, an application, upon starting up, may want to read any pending responses until they are cleared from the printer.

17 An Introduction to HP-GL/2 Vector Graphics

The PCL 5 printer provides the ability to print vector graphics using the HP-GL/2 graphics language. HP-GL/2 graphics 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 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 usually prints faster using HP-GL/2.

Printing with HP-GL/2 requires leaving the PCL printer language mode and entering HP-GL/2 mode. Switching between modes involves only a few commands, and software applications easily switch between the two modes as needed.

Learning HP-GL/2

Read through this chapter and Chapter 18 for a general overview of the HP-GL/2 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 help converting the generic commands shown in the examples to a programming language, see "Using HP-GL/2 with Programming Languages" later in this chapter.

As you see unfamiliar commands, find the page number of the command description in the index and read about the command. Think of an application that you would like to program and then look for an example that uses some of the elements you desire. After trying some examples and seeing how the commands interact, you should be well on your way to learning the HP-GL/2 language.

This chapter describes the interaction between the PCL printer language and HP-GL/2 modes and introduces the following topics:

- HP-GL/2 Commands and Syntax
- Using HP-GL/2 with Programming Languages
- The HP-GL/2 Coordinate System
- HP-GL/2 and PCL Orientation Interactions
- The Vector Graphics Limits
- Units of Measure
- Pen Status and Location
- Defining the Image Area (PCL Picture Frame)
- Scaling
- Automatically Adjusting Image Size
- Absolute and Relative Pen Movement

Chapter 18 covers more HP-GL/2 fundamentals, and Chapters 19 through 23 discuss 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 the name implies, the *PCL printer language commands* are used when in the PCL printer language mode. They define the area on the page where HP-GL/2 graphics are printed and provide a means to enter HP-GL/2 mode. The *HP-GL/2 commands* are used within HP-GL/2 mode. They define the image that is 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.

The vector graphics commands have been grouped into functional categories. The categories are designated as shown in Table 17-1 through . Each of the command categories is discussed in its own chapter, beginning with Chapter 19, *The Configuration and Status Group*.

Table 17-1 The HP-GL/2 Commands by Group (1 of 5)

CONFIGURATION GROUP	
CO	Comment
DF	Default Values
IN	Initialize
IP	Input P1 and P2
IR	Input Relative P1 and P2
IW	Input Window
PG[1]	Advance Page
RO	Rotate Coordinate System
RP[1]	Replot
SC	Scale

1. Ignored by HP LaserJet printers.

Table 17-2 The HP-GL/2 Commands by Group (2 of 5)

VECTOR GROUP	
AA	Arc Absolute
AR	Arc Relative
AT	Absolute Arc Three Point
BR	Bezier Relative
BZ	Bezier Absolute
CI	Circle
PA	Plot Absolute
PD	Pen Down
PE	Polyline Encoded
PR	Plot Relative
PU	Pen Up
RT	Relative Arc Three Point

Table 17-3 The HP-GL/2 Commands by Group (3 of 5)

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 17-4 The HP-GL/2 Commands by Group (4 of 5)

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[1]	Select Primary Font
FN[1]	Select Secondary Font
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

1. These commands are part of HP-GL/2's Dual Context Extensions.

Table 17-5 The HP-GL/2 Commands by Group (5 of 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[1]	Screened Vectors
TR[1]	Transparency Mode
UL	User-defined Line Type
WU	Pen Width Unit Selection

1. These commands are part of the Palette Extensions to HP-GL/2.

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.

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.

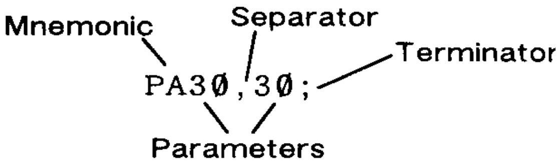


Figure 17-1 Typical HP-GL/2 Command

- **Mnemonic**--The two-letter mnemonic reminds you of the command's function. The mnemonic can be uppercase or lowercase.
- **Parameter(s)**--Some commands have no parameters; for those commands which have 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. Most HP-GL/2 commands are terminated by a semicolon or the first letter of the next mnemonic, a white space, or a tab (exceptions: LB uses a user-defined terminator; PE cannot use 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 method shown on the left is recommended in most instances. 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.)

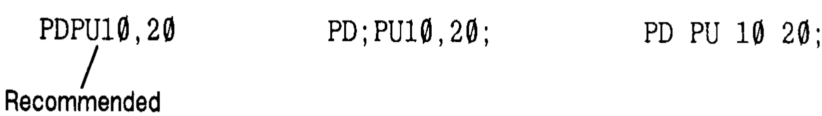


Figure 17-2 Illustration of Syntax Flexibility

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 a range of ASCII characters, such as in the Label (LB) command.

(....)

Indicates that you can use a range of the previous parameter; however, all X coordinates must have a corresponding Y coordinate.

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.

;

iCommand terminator. In most HP-GL/2 commands, a semicolon is optional, and is shown in parentheses in most command syntax.

Notes

Three exceptions to the optional use of the semicolon as a command terminator occur in the following commands: Polyline Encoded (PE), Label (LB), and Comment (CO).

PE must be terminated by a semicolon. LB is terminated by the non-printing end-of-text character (ETX - decimal 3), or a user-defined character. The comment string of the CO command must be delimited by double quotes.

A semicolon terminator is **always required** following the last command prior to leaving HP-GL/2 mode.

,

A comma is always shown as the separator between parameters. A space, +, or - is also valid (although not preferred). (A + or - is a valid separator only for numeric parameters.)

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:

LT6

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.

For example, if you send the following command (omitting the second parameter), the printer interprets the "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 –1,073,741,823 ($-2^{30}+1$) to 1,073,741,823 ($2^{30}-1$). The printer automatically rounds fractional parameters to the nearest integer within the range. Sending a number outside the parameter range may produce unexpected results.

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 above 32,767 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 with an integer portion from –1,073,741,823 ($-2^{30}+1$) 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. Sending a number outside the parameter range may produce unexpected results.

4 *Clamped Real*—A number with an integer portion 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. 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 above 32,767 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.

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 23 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 under “The Vector Graphics Limits.”

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 (described under “Units of Measure” later in this chapter).

Notes 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.

Parameter values less than the range maximum are passed by the parser; these values may subsequently be unscaled into resolution units (e.g. 7200 units-per-inch) that exceed the device-dependent internally representable number range. If this occurs, the device enters a LOST mode; all relative drawing commands are ignored until a command is received which specifies an absolute move to a point within the internally representable number range.

Notes

When LOST mode is entered, the pen is raised and the following commands are ignored: AA, AR, AT, CI, CP, EA, ER, EW, LB, PE, PM, PR, RA, RR, RT, and WG.

The commands allowed in LOST mode are: AC, AD, CF, CO, DF, DI, DR, DT, DV, ES, FT, IN, IP, IR, IW, LA, LO, LT, PA, PD, PG, PU, PW, RF, RO, RP, SA, SB, SC, SD, SI, SL, SM, SP, SR, SS, TD, UL, WU, and the PM1/PM2 forms of PM.

The commands IN, PG, RP, and PA, with in-range parameters, clear LOST mode, PD and PU in absolute plotting mode, with in-range parameters, also clear LOST mode. When PD clears LOST mode, a line is drawn from the last valid current position to the first point in the PD parameter sequence. If PA clears LOST mode, the pen will not go down until a PD command is received.

Using HP-GL/2 With Programming Languages

The HP-GL/2 examples included in this manual are given in a “generic” format (they 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 print three lines forming a simple triangle (shown below).

```
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 “SP1PA10,10”; :REM Select Pen & move to 10,10
50 LPRINT “PD2500,10,10,1500,10,10;”; :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
```

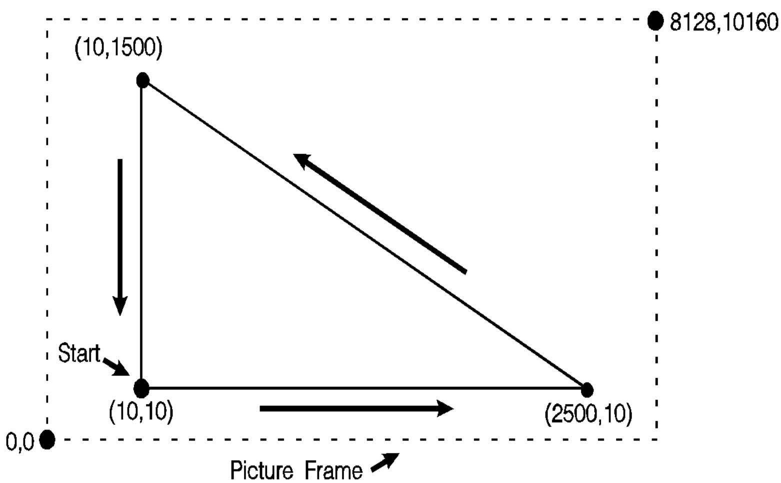


Figure 17-3

Example:C Programming Language

This example uses the C programming language to print the same three lines shown on the previous page.

Table 17-6

```
#include <stdio.h>
main()
{
FILE *prn;
prn = fopen(“PRN”,“wb”);                  /* open the printer */
fprintf(prn,“033E”);                      /* EC E to reset printer */
fprintf(prn,“033%%>0B”);                  /* Enter HP-GL/2 */
fprintf(prn,“IN”);                        /* Initialize HP-GL/2 Mode */
fprintf(prn,“SP1PA10,10”);                /* Select pen 1 & move to 10,10 */
fprintf(prn,“PD2500,10,10,1500,10,10;”);  /* Pen down & draw */
fprintf(prn,“033%%0A”);                   /* enter PCL at previous CAP */
fprintf(prn,“033E”);                      /* Reset to end job/eject page */
}
```

The HP-GL/2 Coordinate System

Both PCL and HP-GL/2 use a Cartesian Coordinate System. The Cartesian coordinate system is a grid formed by two perpendicular axes, usually called the X-axis and Y-axis (refer to Figure 17-4). The intersection of the axes is called the origin of the system and has a location of (0,0). The default HP-GL/2 coordinate system is different than the PCL coordinate system; +Y is down in PCL and up in HP-GL/2. In addition, the default origin is at the lower left in HP-GL/2 and at the upper left in PCL.

Note

The HP-GL/2 coordinate system can be set up to match the PCL coordinate system. See the example entitled “Adapting the HP-GL/2 Coordinate System to Match the PCL System” in Chapter 19.

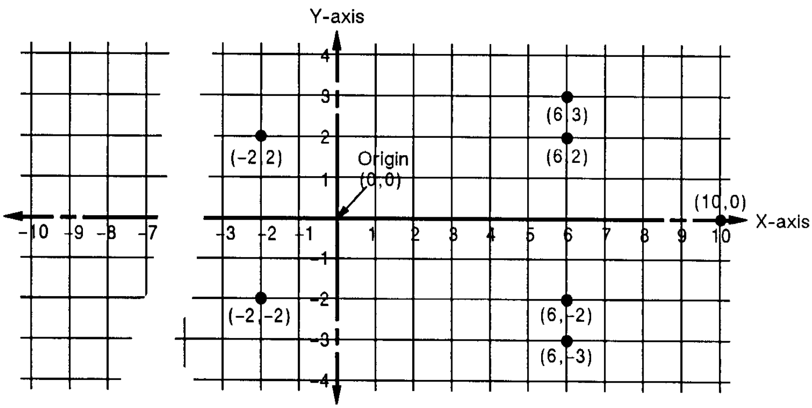


Figure 17-4 The HP-GL/2 Coordinate System

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 matches a coordinate location. Each point is designated by the combination of its X-coordinate and Y-coordinate, known as an X,Y coordinate pair. In , positive X values are plotted to the right of the origin, and positive Y values are plotted above the origin.

Study Figure 17-4 to locate these points: (0,0); (-2,2); (6,2); (6,3); (10,0); (6,-3); (6,-2); (-2,-2); (0,0). Draw a straight line between each point in the order listed. (You should have drawn an arrow.) This is a simple demonstration of defining a vector image 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. Do not use parentheses in your command sequence.

Using the default HP-GL/2 coordinate system, the origin is in the lower left corner of the PCL Picture Frame, as shown in Figure 17-5. Using the IP or IR commands, you can move the origin to other locations. Then, using the SC command, you can define practically any unit coordinate system. (This process is discussed in more detail later in this chapter under “Scaling,” and also in Chapter 19.)

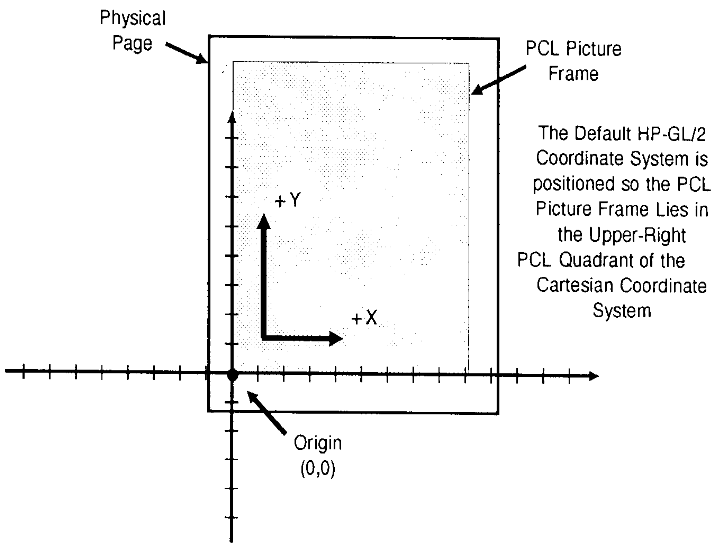


Figure 17-5 The Default HP-GL/2 Coordinate System

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 17-6 illustrates this relationship for the default HP-GL/2 orientation (RO 0) and the PCL logical page orientation. As shown in the illustration, in the default HP-GL/2 orientation, 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.

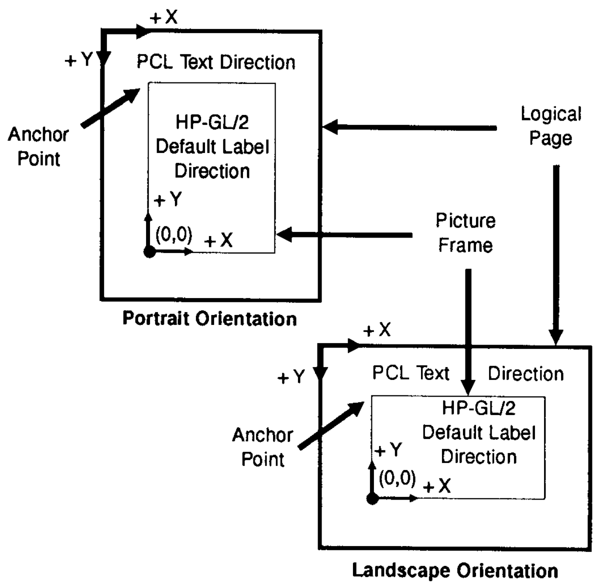


Figure 17-6 Orientation Interactions Between PCL and HP-GL/2

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 (which matches the PCL orientation). Figure 17-7 shows how the RO command modifies the default HP-GL/2 orientation.

Note

A change in PCL print direction has no effect on the HP-GL/2 orientation, the physical position of the picture frame, or the picture frame anchor point.

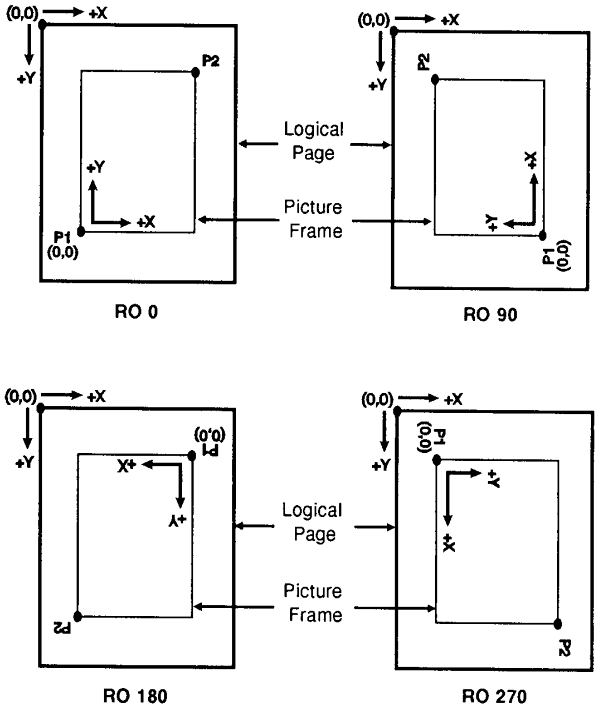


Figure 17-7 Modifying HP-GL/2 Orientation on a Portrait Page

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 Window
- PCL 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 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. The intersection of all these areas is the *effective window.* An HP-GL/2 graphic appears on the page only if it falls within the effective window.

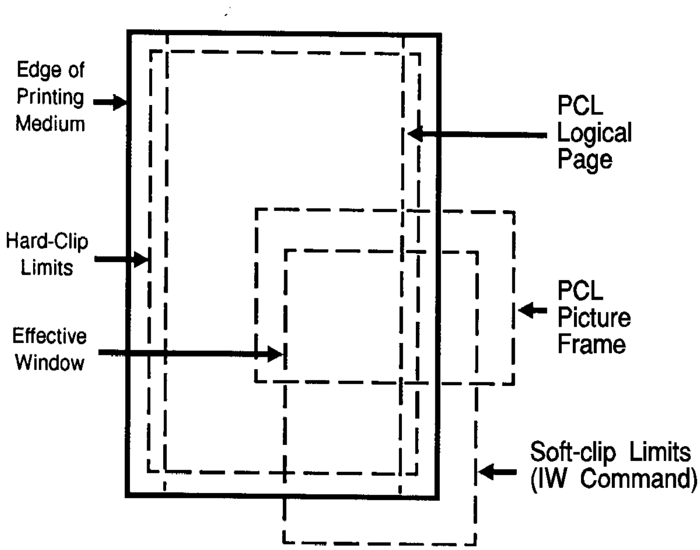


Figure 17-8 The Effective Window

Note For more information on the PCL coordinate system and the PCL 5 printer's printable limits, see Chapter 2.

HP-GL/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

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 17-7

PlotterUnits	**EquivalentValue**
1 plu =	0.025 mm (≈ 0.00098 in.)
40 plu =	1 mm
1016 plu =	1 in.
3.39 plu =	1 dot @ 300 dpi

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 represent any value. 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 give the coordinate (25,12) rather than calculating the exact location in plotter units.

Before printing, the printer internally converts user-units to dot locations.

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 HP-GL/2 cursor, 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 first specified X,Y coordinate.

Upon entering HP-GL/2 mode for the first time following a reset ($^{E}{}_{C}$E) command, no pen has been selected and the pen is up. *This means that no lines are drawn when HP-GL commands are given until a pen is selected.* This can be done using the Select Pen (SP) command.

Most drawing commands require that the pen be lowered to produce marks on the page. Once 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 command a pen-up move to the initial starting position. This ensures that a pen is selected and 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 table 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 17-8 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*

Notes

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.

Only the portion of the pen falling within the effective window is printed. The pen is centered on a line between the beginning and end points, with half of the pen width falling on either side of this line.

The definition of each command tells you whether it has an automatic pen down. If you find that part of your image is not drawn, make sure your command sequence uses the PD command before the affected commands.

Pen Location

Pen location refers to the X,Y coordinates of the current active position (CAP — the point at which the next HP-GL/2 command begins). 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 should 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 (*user-units*) to dot positions for placing the image on the page. *Scaling* allows control of the printer using units that 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 100 squares rather than plotter units. Here is another example of scaling: since 400 plotter units equals 1 centimeter, you can establish this scale to print in user-units equal to 1 centimeter each.

Scaling begins with the scaling points, P1 and P2. P1 and P2 act 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 have accepted the default, use this imaginary rectangle to set up scaling for your drawing. With the Scale (SC) command you specify how many sections the rectangle divides into horizontally (the X-axis) and how many sections the rectangle divides into vertically (the Y-axis). With this process you have created your user-units.

Scaling 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 19.)

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. This method allows you to scale an image while maintaining the aspect ratio of all elements (including fonts). The Scale command does not affect the size of fonts.

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 Figure 17-9, 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.

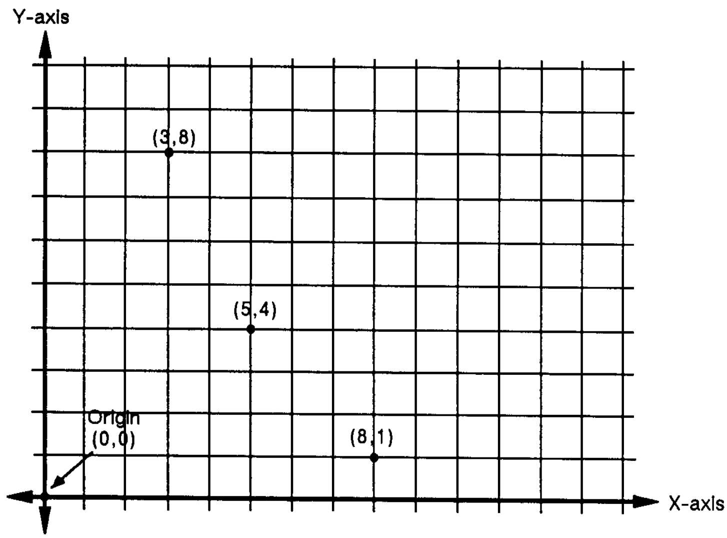


Figure 17-9 Absolute Coordinates

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 17-10 for example, assume that the pen is currently at the origin (0,0). To move to the absolute points shown in Figure 17-9 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).

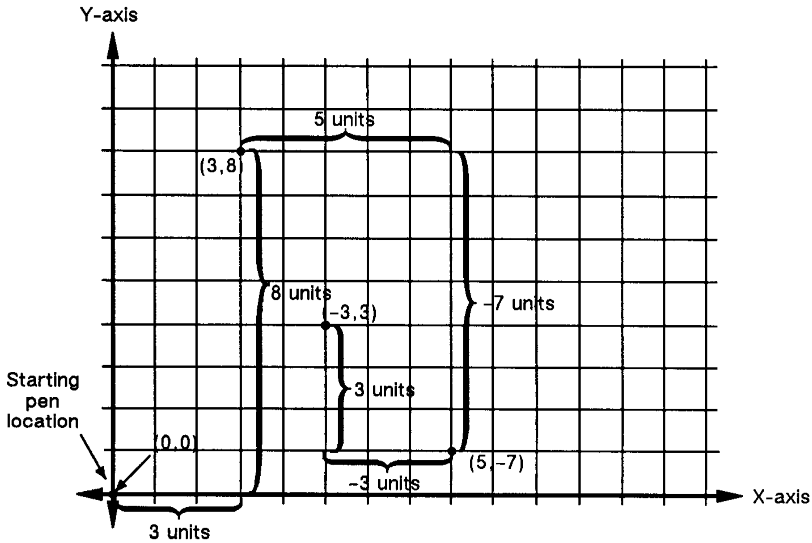


Figure 17-10 Relative Coordinates

Relative movement is useful in many applications where you know the dimensions of the shape you want, but do not want to calculate the absolute coordinates. For example, if you want a box 4 X-units by 8 Y-units, you can 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 pen movement 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 limits your print speed, since relative coordinates are generally smaller numbers and therefore transmit less data over the I/O.

18 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 PCL commands.

The following terms are used in this discussion:

Picture presentation directives are a group of PCL commands which:

- Provide the means to enter and exit HP-GL/2 context.
- Define a delimiting rectangle for the graphic image.
- Specify a scaling factor so existing HP-GL/2 graphics can be scaled and placed anywhere on the PCL logical page.

Picture frame refers to the destination rectangle when transferring HP-GL/2 graphics into the PCL logical page. The PCL picture frame size commands specify the size of the destination rectangle.

Picture frame scaling factor is the ratio of the size of the picture frame to the size of the source HP-GL/2 plot. There may actually be two scaling factors, one for the *x* direction and one for the *y* direction.

Picture frame anchor point refers to the upper left corner of the picture frame, which is set to the current active position (CAP) in the PCL environment at the time the picture frame anchor point command is executed.

Defining the Image Area(PCL Picture Frame)

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 the *Picture Presentation Directives* and are used to define a bounding rectangle to contain the HP-GL/2 image.

Figure 18-1 illustrates the Picture Presentation Directives. The rectangular area surrounding the image is the *PCL Picture Frame* and the location on the page of the PCL Picture Frame is determined by the *picture frame anchor point*. Refer to Figures 2-3 and 2-4 for the default picture frame size.

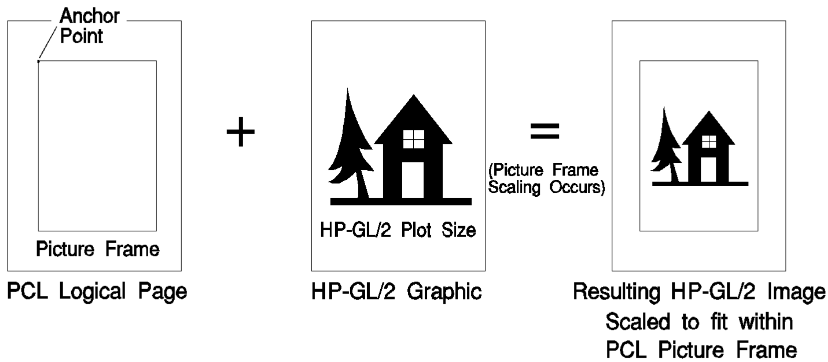


Figure 18-1 The Picture Presentation Directives

Automatically Adjusting Image Size to Fit the PCL Picture Frame

FrameImported HP-GL/2 drawings can be adjusted automatically to fit the size of the PCL Picture Frame without changing the locations of P1 and P2 (in Scale mode, as described earlier). This is called *picture frame scaling*.

When using picture frame scaling, specify the HP-GL/2 plot size 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; the drawing and the picture frame are assumed to be the same size. If a drawing *is* page size-independent, it automatically enlarges or reduces 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 is adjusted automatically to fit different page sizes without specifying the HP-GL/2 plot size. 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.
- Scalable fonts are used exclusively.
- The default window is used, or the window is specified in user-units.
- The DR command (relative direction) is used for label direction (*not* DI — absolute direction).

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 to accomplish the desired scaling. If it is not specified, the image is clipped to the effective window and no scaling occurs.

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 (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). See Chapter 19 to specify an HP-GL/2 plot size.

Typical HP-GL/2 PlotCommand Sequence

Before we discuss the actual commands and how they operate, we will demonstrate the general sequence in which these commands are used to print HP-GL/2 files.

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.
- Specify the *picture frame anchor point* using the $^{E}_{C}$*c0T (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. Receipt of this command establishes the PCL picture frame anchor point at the PCL current cursor position.
- If importing an existing plot, defined in absolute units, specify the HP-GL/2 plot size using the $^{E}_{C}$$^{E}_{C}$*c#K (Horizontal HP-GL/2 Plot Size) and $^{E}_{C}$*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 HP-GL/2 mode using the $^{E}_{C}$%#B command.
- Send HP-GL/2 commands (IN;SP1;. . .).
- Exit HP-GL/2 mode by sending the $^{E}_{C}$%#A (Enter PCL Mode) command.
- Send more PCL commands if desired or issue an $^{E}_{C}$E command to end the job and eject the page.

Note Whenever a printer reset ($^{E}_{C}$E) is sent at the beginning of a job, precede it with a UEL ($^{E}_{C}$%–12345X) command; whenever a printer reset is sent at the end of a job, follow it with a UEL command.

Table 18-1 Example: Creating and Using a PCL Picture Frame

${}^{E}_{C}$**E**	Reset the printer.
${}^{E}_{C}$&l2A	Set the page size to letter.
${}^{E}_{C}$&l0O	Specify portrait orientation.
${}^{E}_{C}$*c3060x3960Y	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).
${}^{E}_{C}$*p565x600Y	Move the cursor to the point you desire as the picture frame anchor point.
${}^{E}_{C}$*c0T	Set the picture frame anchor point to the current cursor position.
${}^{E}_{C}$*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, do not send this command.*)
${}^{E}_{C}$%1B	Enter HP-GL/2 mode with the pen (HP-GL/2 cursor) at the PCL cursor position. In this example, the cursor would be at the picture frame anchor point (600 PCL Units down from the top of the logical page and 565 PCL Units to the right of the left logical page boundary).

Table 18-1 Example: Creating and Using a PCL Picture Frame

IN;SP1;PU50,50;	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.

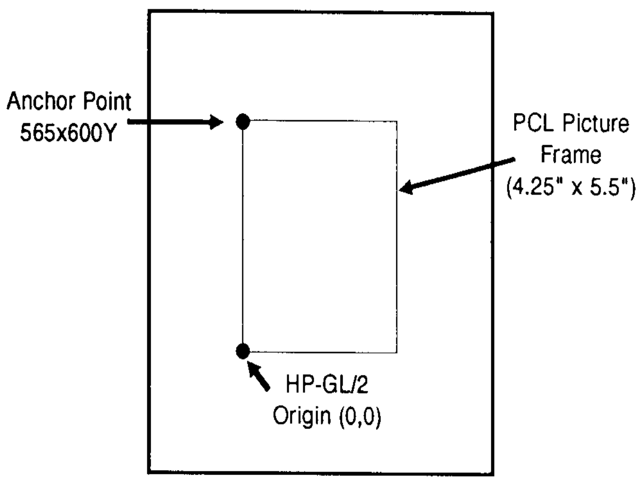


Figure 18-2

The previous example provides an idea of the commands 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 HP-GL/2 mode.

Note If you have a page size-independent HP-GL/2 image, there is no need to set plot size, otherwise it is good practice to set plot size.

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

This PCL 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 **=** 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 HP-GL/2 pen 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 0 or the PCL *reset*, *UE*L, *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 PCL command specifies the vertical dimension of the window 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 sets the location of the PCL Picture Frame anchor point to the PCL cursor position.

$^{E}{}_{C}$ * c 0 T

Default = 0
Range = 0

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 for which X and Y coordinates are minimized when the print direction is 0.

A parameter value of zero ($^{E}{}_{C}$*c0T) specifies that the picture frame anchor point should be set to the cursor position. 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 do not send a Set Picture Frame Anchor command, the printer defaults the anchor point to the left edge of the logical page and the default top margin.

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, resets the soft-clip window to the PCL Picture Frame boundaries, clears the polygon buffer, and updates the HP-GL/2 pen position to the lower left corner of the picture frame (if entered with $^{E}{}_{C}$%0B), 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$^{E}{}_{C}$*c0T

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 $^{E}{}_{C}$*c0T command sets the picture frame anchor point to that location.

HP-GL/2 Plot Horizontal Size

This command specifies the horizontal size of the HP-GL/2 drawing being imported.

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

=The horizontal size in inches

Default	**=**	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

This command specifies the vertical size of the HP-GL/2 drawing being imported.

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

\#   =The vertical size in inches

Default **=** 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:

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

\# =0— Position pen at previous HP-GL/2 pen position
1 — Position pen at current PCL cursor position

Default **=** 0
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, $^{E}{}_{C}$E, or UEL command, or until the printer power is switched off and on. (For information on the effect of PCL settings on HP-GL/2 mode, see “Default Settings” later in this chapter.)

The value field (#) determines the cursor position once HP-GL/2 mode is entered.

0— This parameter option ($^{E}{}_{C}$%0B) sets the pen position to the previous HP-GL/2 position; if this is the first time HP-GL/2 mode is entered in the present print job (assuming an $^{E}{}_{C}$E 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 HP-GL/2 mode.

$^{E}{}_{C}$ % # A

\# =0— Position cursor at previous PCL cursor position.
1 — Position cursor at current HP-GL/2 pen position.

Default **=** 0
Range **=** 0, 1 (even values are mapped to 0; 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.

0— A 0 parameter ($^{E}{}_{C}$%0A) sets the pen position to the previous PCL position (the cursor position before entering HP-GL/2 mode).

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:

$^{E}{}_{C}$%0A

Default Settings

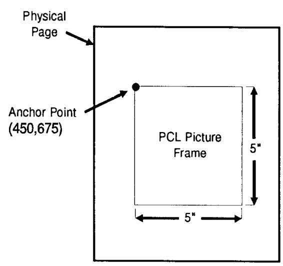
When you enter HP-GL/2 mode, most vector graphics variables retain their previous HP-GL/2 value. However, the following changes in the PCL environment can affect the HP-GL/2 environment:

- Resetting the printer ($^{E}{}_{C}E$ 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
- 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)
  - Resets the soft-clip window to the PCL Picture Frame boundaries (IW command)
  - Clears the polygon buffer (PM0,PM2)
  - Updates the cursor to the lower-left corner of the picture frame (P1).
- Redefining the PCL Picture Frame:
  - Defaults P1 and P2 (IP,IR commands)
  - Resets the soft-clip window (IW) to the PCL Picture Frame boundaries.
  - Clears the polygon buffer (PM0,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)
  - Resets the soft-clip window to the PCL Picture Frame boundaries (IW command)
  - Clears the polygon buffer (PM0,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).

Table 18-2 Example: Creating a Simple Drawing

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$&&l2A	Set the page size to letter.
$^{E}_{C}$&&l0O	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.



$^{E}_{C}$*c0T	Set the picture frame anchor point to the cursor position.

Table 18-2 Example: Creating a Simple Drawing (continued)

$^{E}_{C}$%1B	Enter HP-GL/2 mode with the cursor (pen) at the PCL cursor position. In this example, the cursor is 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 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.

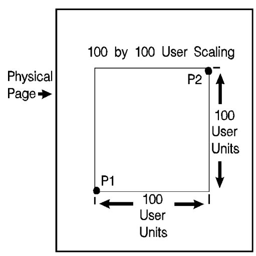
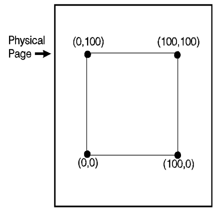
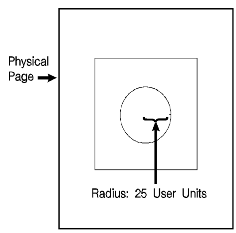


Table 18-2 Example: Creating a Simple Drawing (continued)



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.



Note Any line drawn along the border of the effective window will cause the line to be clipped, producing a line width one-half of the defined pen width. For example, all the lines drawn in the above example are half the width of the other lines since they are clipped at the window borders.

19 The Configuration and Status Group

Introduction

The configuration and status group commands help you:

- Establish default conditions and values for HP-GL/2 features.
- Scale images in the dimensional units you want to use.
- Enlarge/reduce images for different media sizes.
- Establish a window (soft-clip limits).
- Draw equal-sized and mirror-imaged drawings.
- Rotate the HP-GL/2 coordinate system.
- Add comments to your HP-GL/2 command sequence.

Table 19-1 lists the commands described in this chapter.

Table 19-1 The Configuration and Status Group Commands

Command	Summary
CO, Comment	Allows comments to be included in an HP-GL/2 command sequence.
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.[1]
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.

1. These commands, useful in plotter applications, are not the optimal solution for PCL 5 printers. Other PCL commands perform similar functions (see the Number of Copies and Form Feed command descriptions).

Establishing Default Conditions

Whether you are using 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 user-selected defaults. This process is called initialization. The reset command ($^{E}{}_{C}E$) executes an Initialize (IN) command automatically, so if a reset was sent at the beginning of your print job, HP-GL/2 command parameters are at their user-selected default state when 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 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 HP-GL/2 mode, immediately sending an IN command ensures that 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 allows you to 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, and the Y-axis into 10 units, 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 use these units (see Figure 19-1). If you command the printer to move to the point (3,4), the printer moves to the location equivalent to (3,4) user-units (*not* (3,4) plotter units).

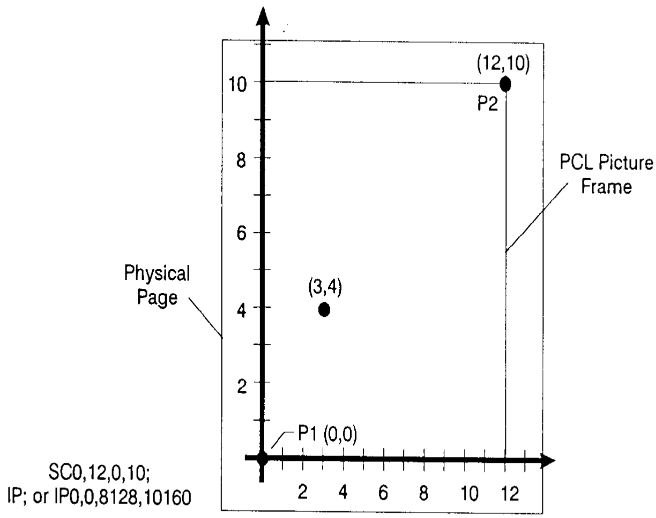


Figure 19-1 User-Unit Scaling with Default P1 and P2

If you move the locations of P1 and P2, the size of the user-units changes. Assume that 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 Figure 19-2, 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.

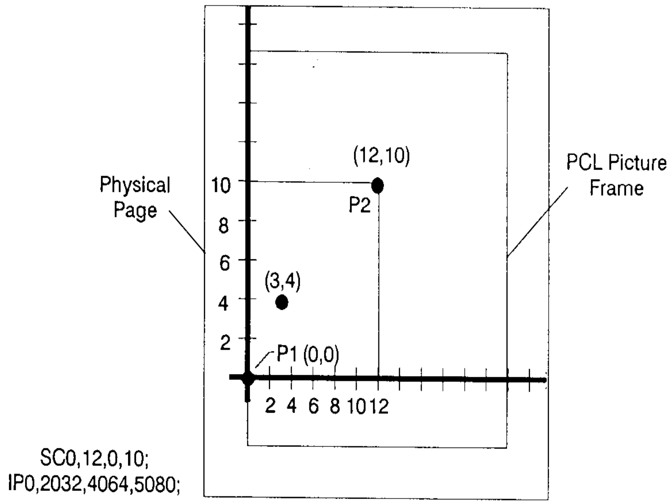


Figure 19-2 Same User-Unit Scaling with New P1 and P2

To further illustrate the flexibility of user-unit scaling, Figure 19-3 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. In Figure 19-3, P1 is in the -X and -Y quadrant.

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 is 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 is printed.

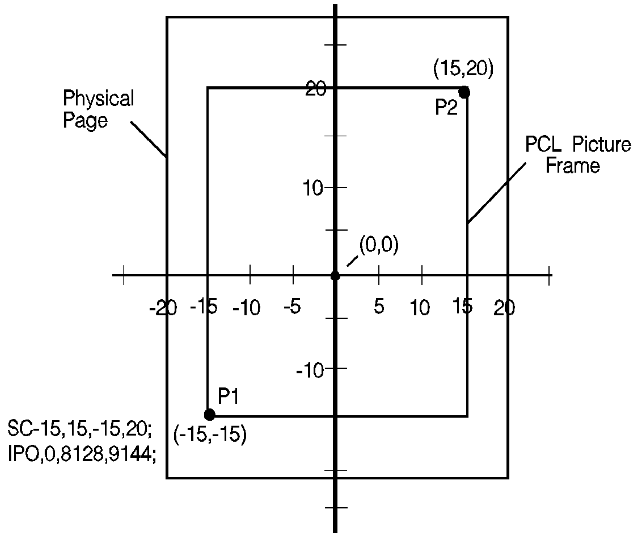


Figure 19-3 New P1 and P2 User-Unit Scaling with Negative Values

Refer to the Scale (SC) command at the end of this chapter for more information on scaling drawings.

Using Scaling Effectively

The following sections describe 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 to define a smaller or larger area. This is especially useful when you want 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 (see "Automatically Adjusting the Image Size" in Chapter 18).

To maintain the proportions of scaled plots, set P1 and P2 to define an area with the sameaspect 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 square area that maintains the 1:1 ratio. Note that the circle printed in the new area is smaller but is proportionately identical.

Table 19-2 Example: Changing the Size of a Drawing

$^{E}{}_{C}$%0B	Enter HP-GL/2 mode, using the default picture frame size and anchor point.
IN;	Initialize HP-GL/2 mode.
IP0,0,2000,2000;	Set P1 to be (0,0) and P2 to be (2000,2000).
SC0,10,0,10;	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 to enable printing.
PA5,5;	Begin absolute plotting from the center of the square (5,5).
CI3;	Print a circle with a radius of 3 user-units.
IP2500,500,3500,1500;	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.
$^{E}{}_{C}$%0A	Enter PCL Mode.
$^{E}{}_{C}$E	Reset the printer to complete the job and eject the page.

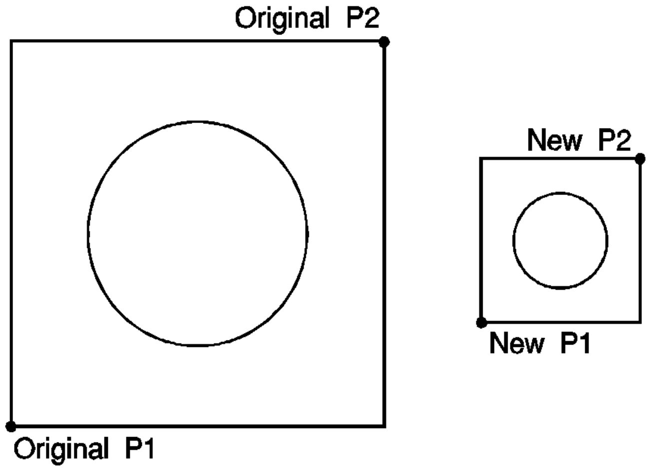


Figure 19-4 Changing the size of a drawing

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 feature. 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.

Table 19-3 Example: Drawing Equal-Size Pictures on a Page

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$&l1O	Select landscape orientation.
$^{E}_{C}$%0B	Enter HP-GL/2 mode, using the default picture frame size and anchor point.
IN;	Initialize HP-GL/2 mode.
IP500,500,5450,7500;	Set P1 to be (500,500) and P2 to be (5450,7500).
SC0,10,0,15;	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 to enable printing.
PA0,0;	Begin absolute plotting from the origin (0,0).
PD10,0,10,15,0,15,0,0;PU;	Pen Down and print from (0,0) to (10,0) to (10,15) to (0,15) to (0,0); then Pen Up.
IP5550,500	Input a new P1 and allow P2 to automatically track it.
PA0,0;	Begin absolute plotting from the new origin.
PD10,0,10,15,0,15,0,0;PU;	Pen Down and print from (0,0) to (10,0) to (10,15) to (0,15) to (0,0); then Pen Up.
$^{E}_{C}$%0A	Enter PCL Mode.
$^{E}_{C}$E	Reset the printer to complete the job and eject the page.

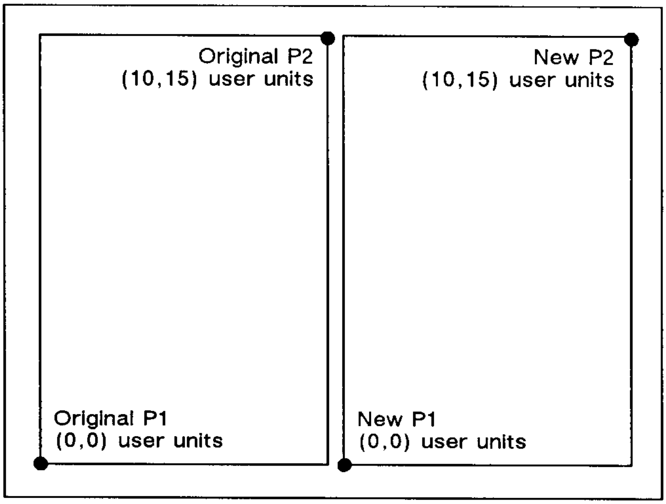


Figure 19-5 Drawing equal-size pictures on a page

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, or changing the coordinate system by using SC. You can mirror-image labels using the Absolute Direction and Relative Direction (DI and DR) commands, the Relative Character Size (SR) command, or using the Absolute Character Size (SI) command. (The DI, DR, and SR commands are discussed in Chapter 23, *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.)

Table 19-4 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.

Table 19-4 Example: Creating a Mirror-Image (continued)

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 on the next page

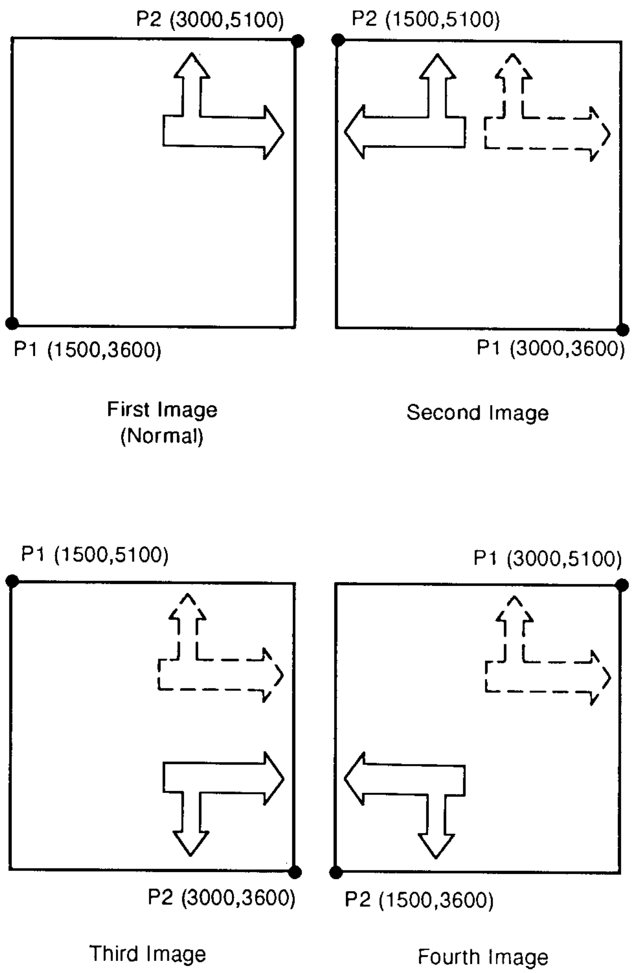


Figure 19-6 Creating a mirror-image

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 to match 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).

Notes

Sending an IN (Initialize) or DF (Default) command causes the coordinate system to revert to the HP-GL/2 default.

Since this example is based on the default top margin and text length, changing the top margin or the text length moves the two coordinate systems out of alignment.

Table 19-5 Example: Adapting the HP-GL/2 Coordinate System to Match the PCL System in Portrait Orientation

$^{E}{}_{C}$E	Reset the printer.
$^{E}{}_{C}$&l2A	Set the page size to letter.
$^{E}{}_{C}$&l0O	Specify portrait orientation.
$^{E}{}_{C}$&l0E	Set top margin to 0.
$^{E}{}_{C}$*p0x0Y	Move to position (0,0).
$^{E}{}_{C}$*c5760x7920Y	Set picture frame to 8’’ x 11’’ (size of logical page).
$^{E}{}_{C}$*c0T	Set picture frame anchor point to current PCL cursor position (0,0).
$^{E}{}_{C}$%1B	Enter HP-GL/2 mode with the HP-GL/2 cursor or pen at the PCL cursor position.

Table 19-5 Example: Adapting the HP-GL/2 Coordinate System to Match the PCL System in Portrait Orientation

IN;SP1;	Initialize 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.)
SC0,3.3867,0,-3.3867,2	Set-up a user scale with a user-unit equal to 1/300 inch. Scale command type 2, the scale is the ratio of plotter units/user-units (1016 plotter units-per-inch/300 dots-per-inch = 3.3867). The minus 2 Y-value changes the HP-GL/2 Y direction to match that of the PCL coordinate system.
IR0,100,0,100	Place P1 (point 0,0) at the top of the PCL picture frame.
PU0,0;	Lift the pen and move to (0,0) (upper left corner — since HP-GL/2 coordinate system now matches PCL coordinate system). Every subsequent 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 draws a line at a 45° angle down from the starting point.
$^{E}{}_{C}$%1A	Enter the PCL mode with HP-GL/2's pen position being inherited as PCL's. CAP=(600,600).
$^{E}{}_{C}$*c300a4b0P	Draw a horizontal line (rule) that is 300 PCL units wide by 4 PCL units. (Note that the cursor position after a rule is printed is at the beginning of the rule — in this case, (600,600).)

Table 19-5 Example: Adapting the HP-GL/2 Coordinate System to Match the PCL System in Portrait Orientation

$^{E}{}_{C}$%1BPU;PR300,0; PD;PR0,500;	Enter HP-GL/2 mode (inheriting PCL's CAP) 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.
$^{E}{}_{C}$%1A	Enter the PCL mode with the CAP at the current HP-GL/2 pen position.
$^{E}{}_{C}$E	Reset the printer to end the job and eject a page.

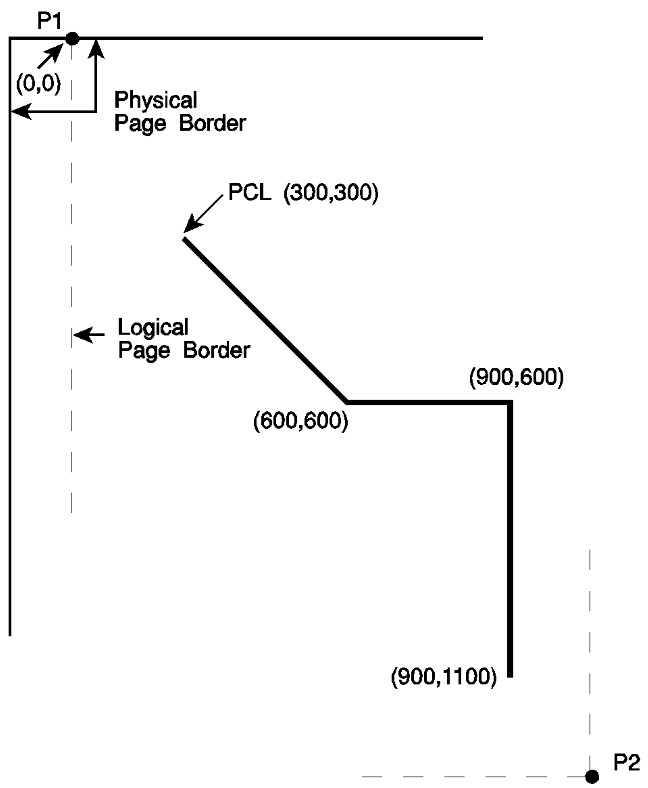


Figure 19-7 Adapting the HP-GL/2 coordinate system to match the PCL system in portrait orientation

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 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 19-6 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

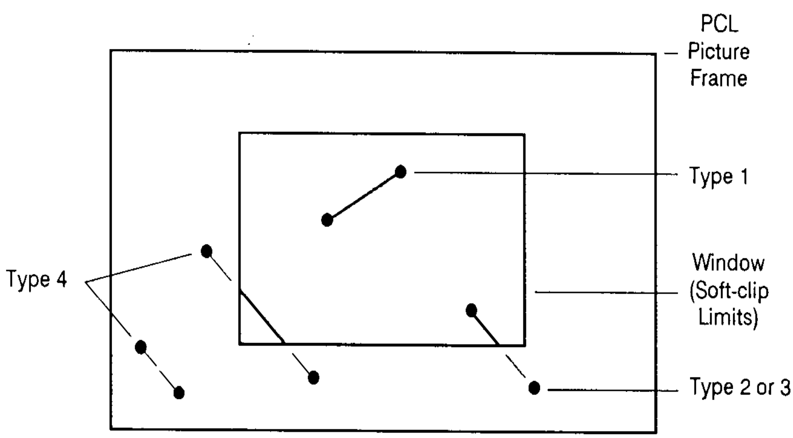


Figure 19-8 The four types of line segments

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 “The Vector Graphic Limits” in Chapter 17, and the IW command description later in this chapter.

CO, Comment

This command allows comments to be inserted within an HP-GL/2 command sequence. The comment string of the CO command must be delimited by double quotes.

CO “*text ... text*”

HP-GL/2 comments are ignored by the printer.

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 command sequence, graphics parameters such as character size, slant, or scaling are defaulted.

DF [;]

The DF command resets the printer to the conditions listed in Table 19-7.

Table 19-7 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.

Table 19-7 Default Conditions (continued)

Absolute Direction	DI1,0	Character direction parallel to X-axis.
Define Label Terminator	DT	**ETX** and non-printing 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	PM	Polygon buffer cleared.
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	Turns off symbol mode.
Select Standard Font	SS	Standard font selected.

Table 19-7 Default Conditions (continued)

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 23, *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.

Table 19-8 Related commands

Related Commands	Group
IN, Initialize	The Configuration/Status Group

IN, Initialize

This command resets all programmable HP-GL/2 functions to their default settings. Use the IN command to return the printer to a known HP-GL/2 state and to cancel settings that may have been changed by a previous command sequence. (The $^{E}{}_{C}$E Reset issues an automatic IN command.)

IN *[;]*

Notes

In this manual, all command sequence examples begin with IN to clear unwanted conditions from the previous command sequence, even though an $^{E}{}_{C}$E command automatically executes an IN command.

Once HP-GL/2 mode is entered and commands are issued, the HP-GL/2 conditions are no longer initialized. To place HP-GL/2 into the default state, send the IN command.

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]).

Table 19-9

Affected Commands	Group
DF, RO, IP	Configuration/Status Group
PD, PU,	Vector Group
WU, PW	Line and Fill Attributes Group

Table 19-10

Related Commands	Group
DF, Default Values	Configuration/Status Group

IP, Input P1 and P2

This command 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 (see the previous discussion in this chapter).

IP $X_{P1}, Y_{P1}[,X_{P2}, Y_{P2};]$ or

IP *[;]*

Parameter	Format	Functional Range	Default
$X_{P1}Y_{P1}[,X_{P2},Y_{P2};]$	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 Figure 19-9. (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.)

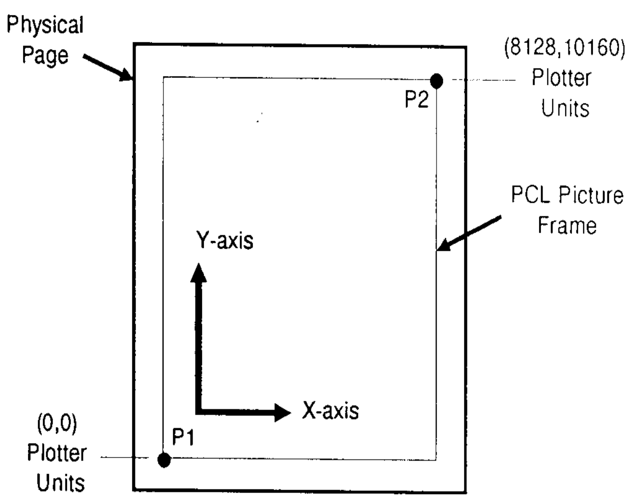


Figure 19-9 The Default P1/P2 Locations

- **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 are rotated with the RO command, P1 and P2 locations change to reflect the rotation. 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.

- **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 locate P2 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 corres-ponding coordinate of P2, the coordinate of P2 is incremented by 1 plotter unit.

The locations of P1 and P2 interact with the following commands:

Table 19-11 Commands Affected by P1/P2

Command	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.

Table 19-12

Related Commands	Group
IR, Input Relative P1 and P2	*The Configuration/Status Group*
IW, Input Window	
RO, Rotate Coordinate System	
SC, Scale	

IR, Input Relative P1 and P2

This command 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 $X_{P1}, Y_{P1}, [X_{P2}, Y_{P2};]$ or

IR *[;]*

Parameter	Format	Functional Range	Default
$X_{P1}Y_{P1}[X_{P2}Y_{P2};]$	clamped real	0 to 100%	0,0,100,100%

When P1 and P2 are set using IR, the scaled area is page size-independent. 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 locate 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.

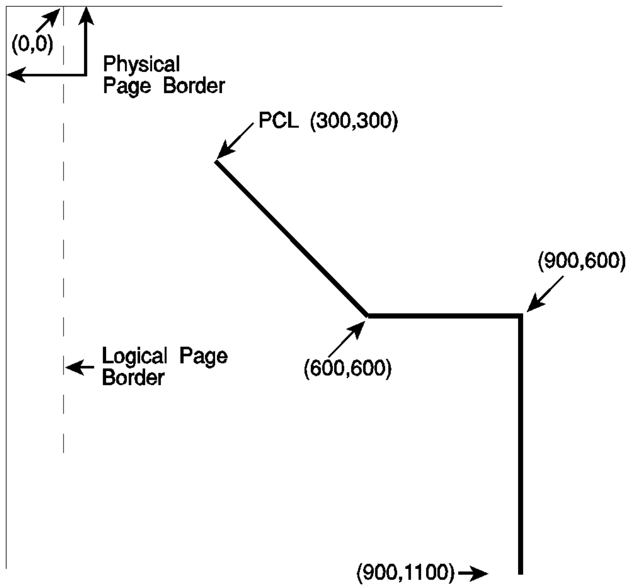


Figure 19-10 Example: P1 and P2 command

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.

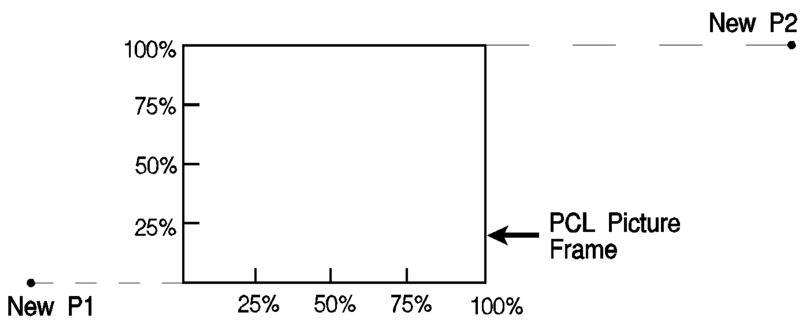


Figure 19-11 Example: P1 and P2 command

If you specify P1 and P2 beyond the PCL Picture Frame, your drawing is scaled with respect to those locations; however, only the portion of the drawing fitting within the effective window is drawn.

Note The specified P1/P2 percentages are converted to the equivalent plotter unit coordinates. If the coordinate system orientation subsequently changes (for example, by sending an RO command), the plotter unit position is maintained with respect to the new orientation. 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.

The locations of P1 and P2 interact with the following commands:

Table 19-13 Commands Affected by P1/P2

Command	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.

Table 19-14

Related Commands	**Group**
IP, Input P1 and P2 IW, Input Window RO, Rotate Coordinate System SC, Scale	*The Configuration/Status Group*

IW, Input Window

This command 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** — Resets 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 move the window 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 does not change with any subsequent IP or IR commands.

When you turn on the printer, 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 cannot print vector graphics beyond the effective window. 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.

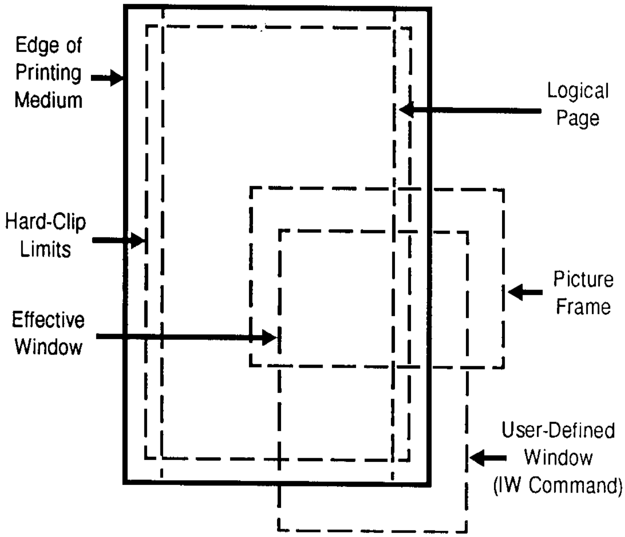


Figure 19-12 The Effective Window

If the window falls entirely outside of the PCL Picture Frame, no image is 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 is established, but not before.

Table 19-15 Example: The IW Command

$^{E}{}_{C}$E	Reset the printer.
$^{E}{}_{C}$%1B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.

Table 19-15 Example: The IW Command (continued)

SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used to enable printing.
SI.2,.35;	Set Absolute Character Size to .2 x .35 cm.
PA2000,3200;	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). (The label on the left is shown on two lines —with a Carriage Return in the middle of the text— for convenience in this example. In an actual command sequence, this label text should be all on one line to print as shown in the plot at the end of this example.)
IW3000,1300,4500,3700;	Specify a soft-clip window (in plotter units).
PD2000,1700	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). (This label should not contain carriage returns to print as shown in the plot for this example.)
PU3000,1300;	Pen Up and move to position (3000,1300).
PD4500,1300,4500,3700;	Pen Down and begin drawing box indicating the soft-clip window.
PD3000,3700,3000,1300;	Finish drawing the soft-clip window box
PU;	Pen Up
$^{E}{}_{C}$%0A	Enter PCL Mode.
$^{E}{}_{C}$E	Reset the printer to end the job and eject the page.

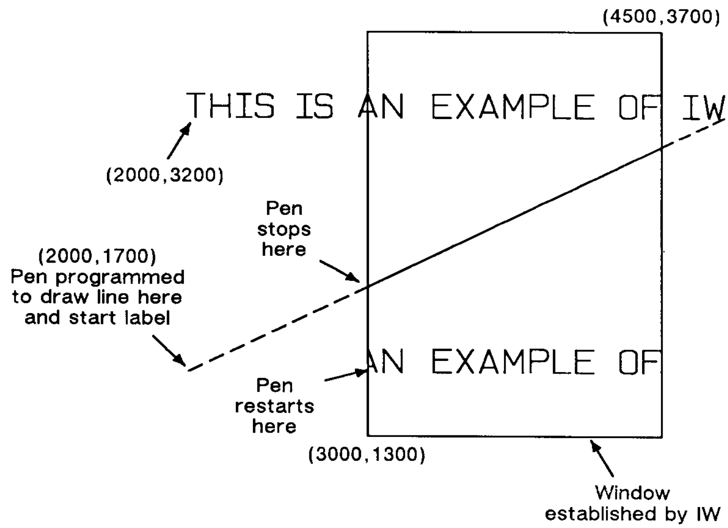


Figure 19-13 Example: IW command

Table 19-16

Related Commands	Group
IP, Input P1 and P2 IR, Input Relative P1 and P2 RO, Rotate Coordinate System SC, Scale	*The Configuration/Status Group*

PG, Advance Full Page

This HP-GL/2 command is ignored by the printer since it could cause undesirable results when importing plots. A page eject can be accomplished only from the PCL printer language mode.

The following PCL commands cause a conditional page eject, meaning that a page is ejected if there is any printable data in the print buffer:

- $^{E}{}_{C}$E Reset
- UEL (Universal Exit Language)
- Flush All Pages
- 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 from PCL 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 pen position is not affected by a Form Feed; it occupies the same position on the next page.

RO, Rotate Coordinate System

This command rotates the printer's coordinate system relative to the default HP-GL/2 coordinate system, in the following increments of rotation: 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°. Equivalent to *(RO0)*. This is the same as PCL's current orientation.
- **Angle** — Specifies the degree of rotation:

  0 Sets the orientation to PCL's current orientation.

  90 Rotates and shifts the coordinate system 90 degrees in a positive angle of rotation from PCL's current orientation.

  180 Rotates and shifts the coordinate system 180 degrees in a positive angle of rotation from PCL's current orientation.

  270 Rotates and shifts the coordinate system 270 degrees in a positive angle of rotation from PCL's current orientation.

Angle of Rotation

Note

A *positive angle* of rotation is in the direction of the +X-axis to the +Y-axis as shown below. (A *negative angle* of rotation is not allowed in the RO command.)

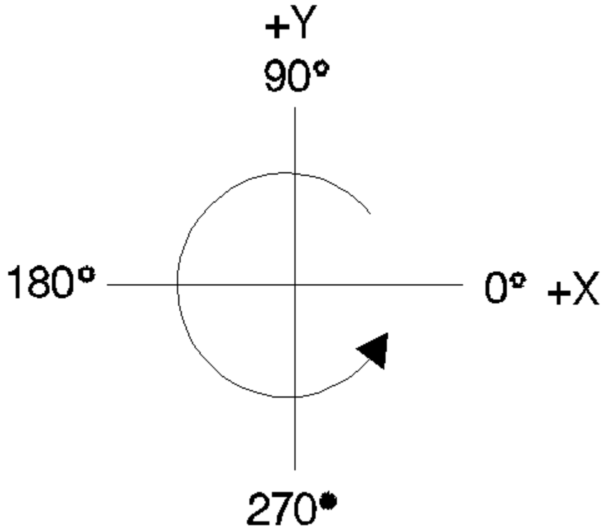


Figure 19-14 Angle of rotations

Note The relationship of the X-axis to Y-axis can change as a result of the scaling point or scaling factor changes, thus changing the direction of a positive angle of rotation.

The physical location of the pen does not change when you rotate the coordinate system. 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, if defined, 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 (see Figure 19-17).

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.

Figure 19-15 shows the default orientation and the result of rotating the orientation without relocating P1 and P2.

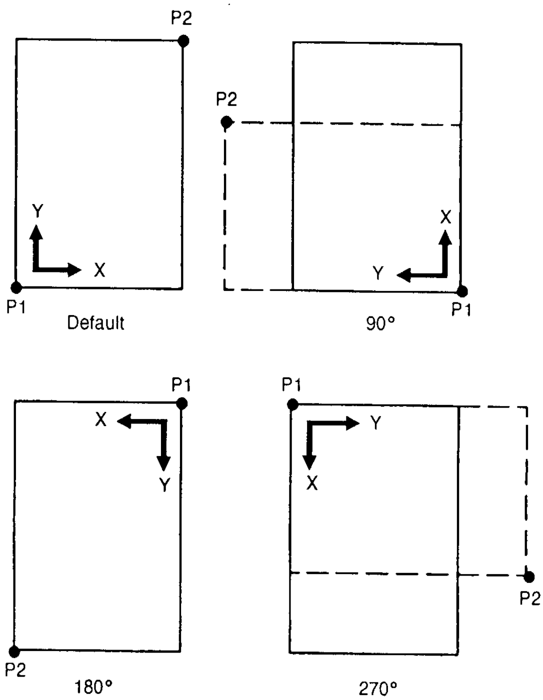


Figure 19-15 Using the RO Command Without Using the IP Command

Figure 19-16 shows the locations of P1 and P2 when you follow the rotation with the IP command.

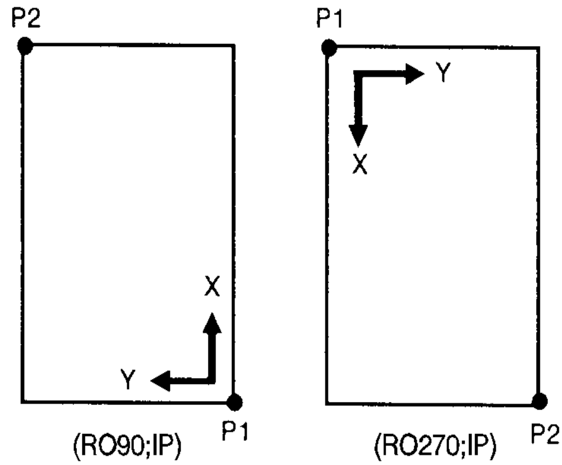


Figure 19-16 Using IP after the RO Command

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.

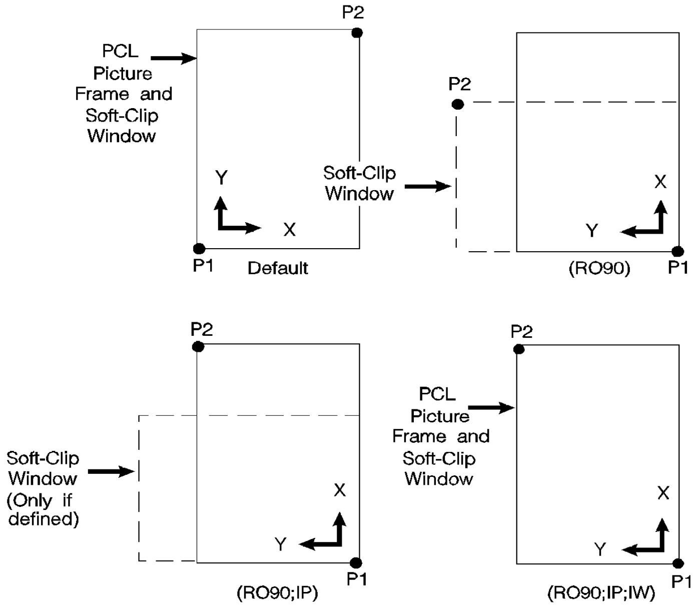


Figure 19-17 Using IP and IW after the RO Command

Table 19-17

Related Commands	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 printer; to eject a page, the printer must be in PCL printer language mode. The following commands cause a conditional page eject; a page is ejected if there is any printable data in the print buffer:

- $^{E}{}_{C}E$ Reset
- UEL (Universal Exit Language)
- Flush All Pages
- Page Length
- Page Size
- Orientation
- Paper Source

The PCL Form Feed control code causes an unconditional page eject and advances the cursor position to the top of form on the next page.

Note A page eject caused by any of the above commands except Paper Source defaults the HP-GL/2 pen position.

To print more than one plot, use the Number of Copies command. For information about printing more than one copy of an HP-GL/2 illustration, see “Number of Copies Command” in Chapter 4.

SC, Scale

This command establishes a user-unit coordinate system by mapping user-defined coordinate values onto the scaling points P1 and P2.

SC *XMIN,XMAX,YMIN,YMAX [,type[,left,bottom;]]* or

SC *XMIN,XFACTOR,YMIN,YFACTOR,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 more information about the basic concept of scaling, refer to “The Scale Command” 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.

Table 19-18

Scaling Form	Type	Description
Anisotropic	0	Establishes standard user-unit scaling allowing different unit size on X-axis and Y-axis.
Isotropic	1	Establishes standard user-unit scaling with same unit size on X-axis and Y-axis.
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).

Table 19-19

Scaling Form	Type	Syntax
Anisotropic	0	SC*XMIN,XMAX,YMIN,YMAX[,type;]*
Isotropic	1	SC%%X_{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 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}.

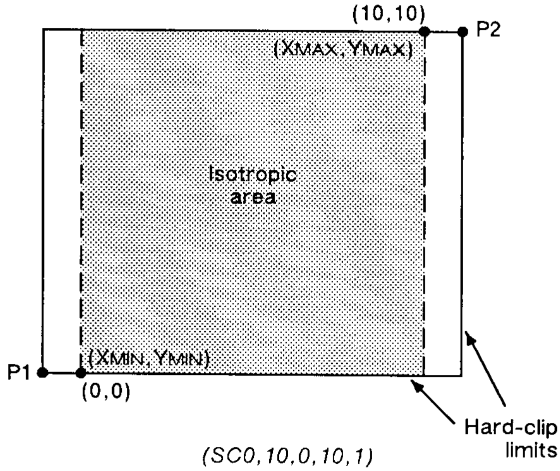
As their names suggest, you will normally want to specify X_{MIN} smaller than X_{MAX}, and Y_{MIN} smaller than Y_{MAX}. If you specify X_{MIN} larger than X_{MAX} and Y_{MIN} larger than Y_{MAX}, your illustration is drawn as a mirror-image, reversed and/or upside down, depending on the relative positions 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.

Table 19-20

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 anisotropic 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 (XMIN,YMIN) and (XMAX,YMAX) 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.)



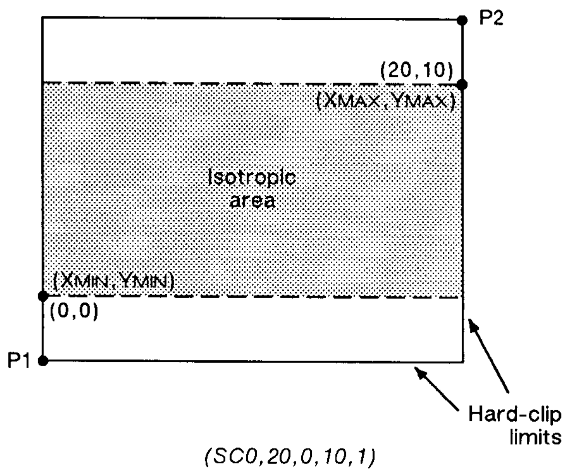


Figure 19-18 Isotropic Scaling

- **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%.

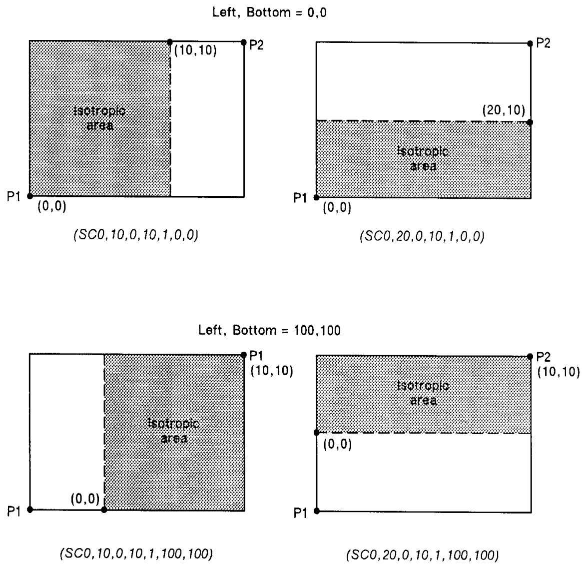


Figure 19-19 The Left and Bottom Parameters

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.

Table 19-21

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 initialized or set to default conditions.

Examples: The following examples explain the effect of several parameter selections.

(SC0,40,0,40,2) allows scaling in millimeters since 1 millimeter = 40 plotter units. Each user-unit is 1 millimeter.

(SC0,1.016,0,1.016,2) allows scaling in thousandths of an inch since 1 inch = 1016 plotter units.

While scaling is on (after any 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 be issued only 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.)

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.

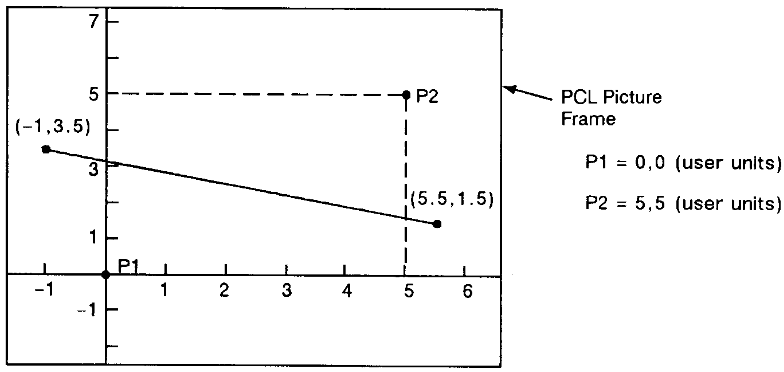


Figure 19-20 Example: Printing point-to-point

Table 19-22

Related Commands	Group
IP, Input P1 and P2 IR, Input Relative P1 and P2 IW, Input Window	The Configuration/Status Group

Table 19-23 Possible Error Conditions for SC

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

20 The Vector Group

Introduction

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, bezier curves, and circles.
- Encode coordinates to increase your printer's throughput.

The following commands are described in this chapter.

Table 20-1 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.
BR, Bezier Relative	Draws a bezier curve using relative coordinates as control points.
BZ, Bezier Absolute	Draws a bezier curve using absolute coordinates as control points.
CI, Circle	Draws a circle with a specified radius.

Table 20-1 The Vector Group Commands (continued)

PA, Plot Absolute	Enables movement to absolute coordinate locations (with respect to the origin [0,0]).
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 a serial 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.

Table 20-2 Example: Drawing Lines

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1 (black). 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.

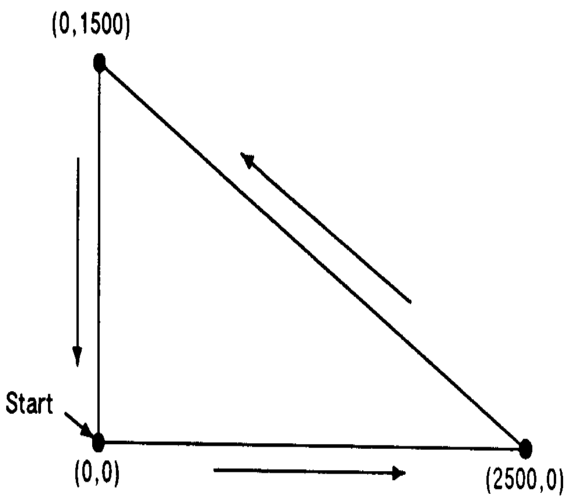


Figure 20-1 Drawing lines

Note Any line drawn along the border of the effective window causes the line to be clipped, producing a line width of one-half of what it should be. For example, in the above plot, the lines from (0,0) to (0,1500), and (0,0) to (2500,0) is clipped.

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 command sequence using CI to draw a circle with a radius of 500 plotter units.

Table 20-3 Example: Drawing Circles

$^{E}{}_{C}$E	Reset the printer.
$^{E}{}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2.
SP1;	Select pen number 1. The SP command must be used to enable printing.
PA2400,2500;	Specify absolute plotting and move to position (2400,2500).
CI500;	Draw a circle with a radius of 500 plu (plotter units); 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.

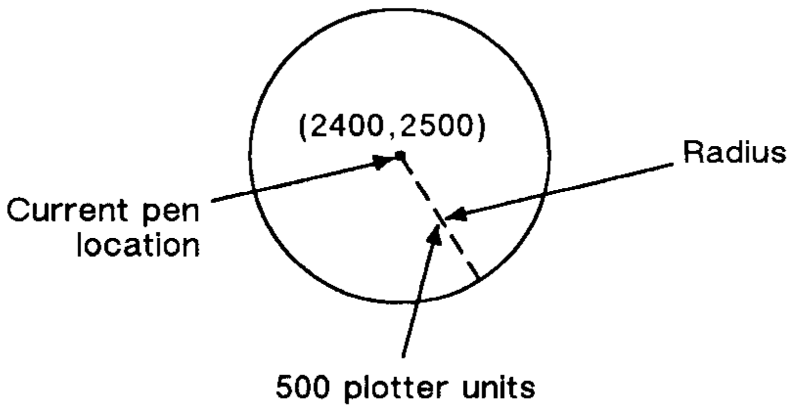


Figure 20-2 Drawing circles

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 command sequence using the AA command to draw a circle and an arc:

Table 20-4 Example: Drawing Arcs

$^{E}{}_{C}$E	Reset the printer.
$^{E}{}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2.
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used to enable printing.
PA4200,2900;PD;	Set starting point to (4200,2900) and set pen down.

Table 20-4 Example: Drawing Arcs

AA4600,2500,-180;	Using the Arc Absolute command, specify the pivot point of the arc, thereby setting the radius; draw the arc for 180° in a *negative* angle of rotation.
$^{E}{}_{C}$%ØA	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

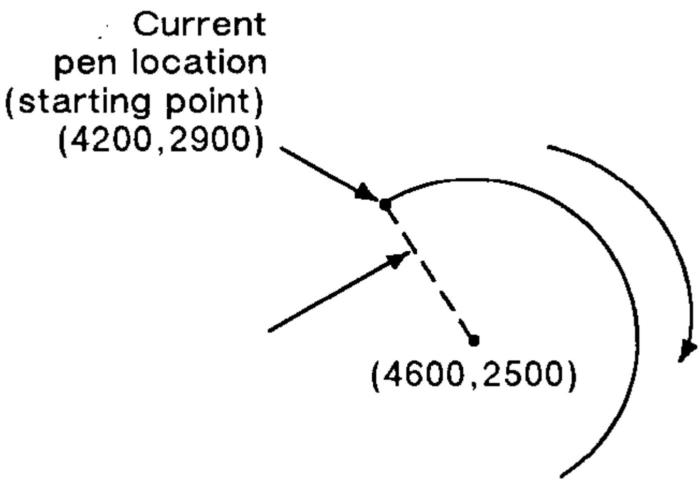


Figure 20-3 Drawing arcs (1 of 3)

Angle of Rotation

NoteS

A *positive angle* of rotation is in the direction of the +X-axis to the +Y-axis as shown below.

A *negative angle* of rotation is in the direction of the +X-axis to the −Y-axis.

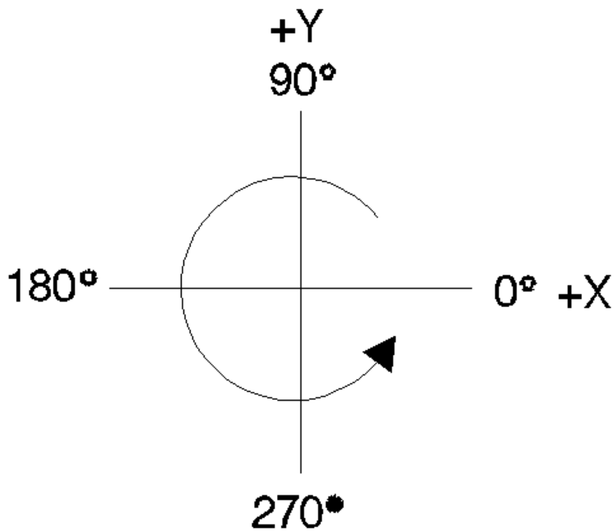


Figure 20-4 Drawing arcs (2 of 3)

Note

The relationship of the +X-axis to +Y-axis (and -Y-axis) can change as a result of the scaling point or scaling factor changes, thus, changing the direction of a positive (or negative) angle of rotation.

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 with a positive angle of rotation, so that it passes through the intermediate point before the end point. Refer to the following illustration.

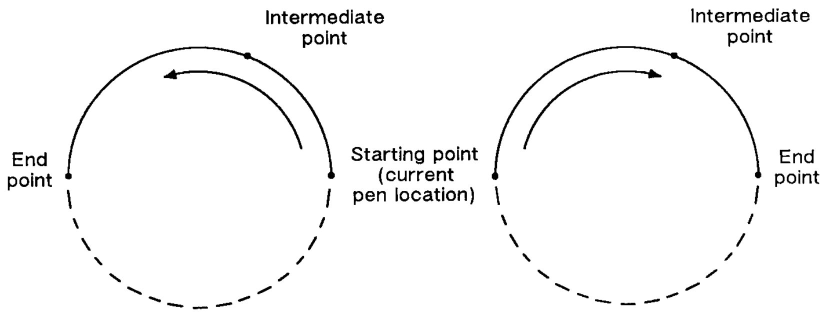


Figure 20-5 Drawing arcs (3 of 3)

Drawing Bezier Curves

The Bezier Absolute (BZ) and Bezier Relative (BR) commands use your current pen position as the first control point in the Bezier curve. You specify the second, third, and fourth control points. If you are drawing more than one curve, the fourth control point of the first curve (X_3, Y_3) becomes the first control point of the next curve.

The following example shows a simple command sequence using BZ to draw a Bezier Curve in the shape of a sine wave (shown in the figure following the example).

Table 20-5 Example: Drawing Bezier Curves

$^{E}{}_{C}$E	Reset the printer.
$^{E}{}_{C}$%ØB	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2.
SP1;	Select pen number 1. The SP command must be used to enable printing.
PA1000,5000;PD;	Specify absolute plotting and move to position (1000,5000); pen down.
BZ2000,8000, 4000,2000,5000,5000;	Draw a Bezier curve with (1000,5000) as the starting point (first control point). Specify (2000,8000), (4000,2000), and (5000,5000) as the second, third, and fourth control points.
$^{E}{}_{C}$%ØA	Enter the PCL mode.

Table 20-5 Example: Drawing Bezier Curves (continued)

$^{E}{}_{C}E$	Send a reset to end the job and eject the page.

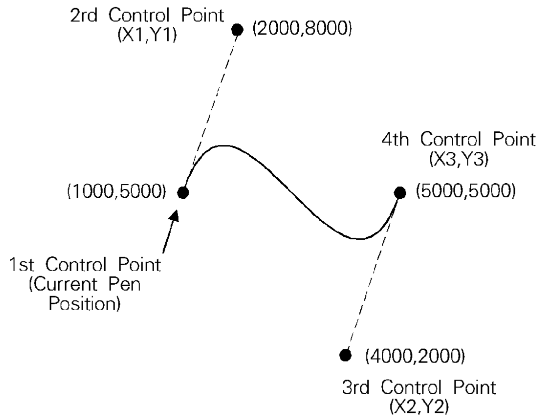


Figure 20-6 Bezier Curves

AA, Arc Absolute

This command 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 attempts to draw the complete pattern in every chord (there are 72 chords in a circle using the default chord angle).

- **XCenter, YCenter** — 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 was 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 in a positive direction (angle of rotation); a negative angle is drawn in the negative direction.
- **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.

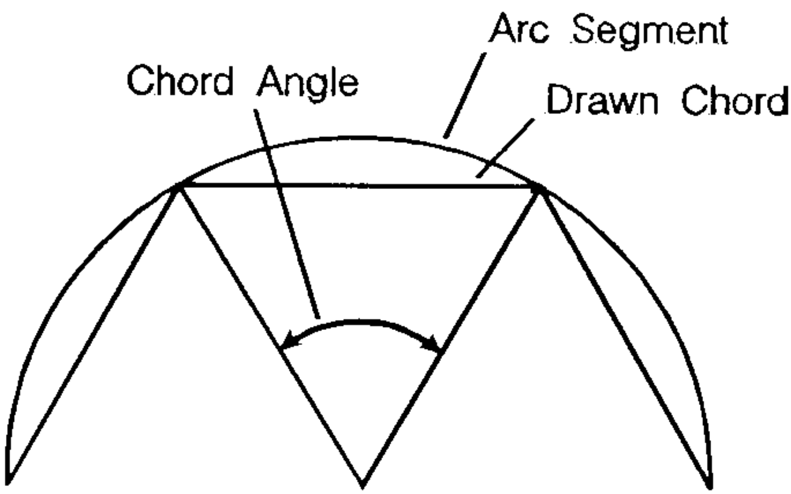


Figure 20-7 Chord Angle

- For a specific chord angle, a circle or arc always has 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 with the same chord angle; setting the chord angle to a smaller number will help large circles or arcs appear more smooth (see Figure 20-8).

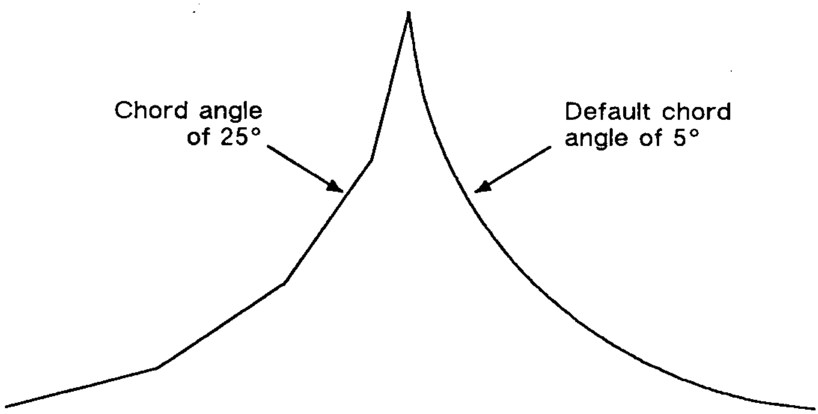


Figure 20-8 Changing Arc Smoothness with the Chord Angle

Table 20-6 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 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 (positive angle) 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 (negative angle) using the same center point as the first arc, but with a 10° chord angle.

Table 20-6 Example: Varying the Chord Angle (continued)

PU1000,0;	Lift the pen and move to (1000,0).
PD;AA0,0,45;	With the pen down, draw another 45° arc (positive angle) 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.

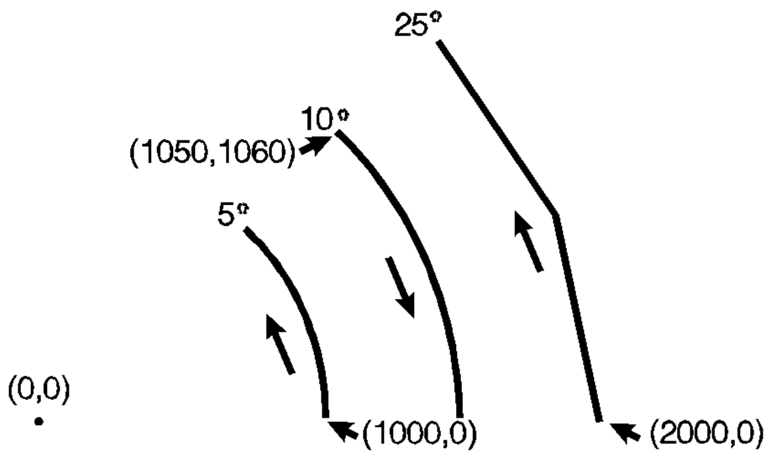


Figure 20-9

Table 20-7

Related Commands	**Group**
AT, Absolute Arc Three Point	*The Vector Group*
BR, Bezier Relative	
BZ, Bezier Absolute	
AR, Arc Relative	
CI, Circle	
RT, Relative Arc Three Point	

Table 20-7

LA, Line Attributes	*The Line and Fill Attributes Group*
LT, Line Type	
PW, Pen Width	

AR, Arc Relative

This command draws an arc, using relative coordinates, which starts at the current pen location and pivots around the specified center point.

AR $X_{\text{increment}}$,$Y_{\text{increment}}$,*sweep angle[,chord angle;]*

Parameter	Format	Functional Range	Default
$X_{\text{increment}}$,$Y_{\text{increment}}$	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 attempts to draw the complete pattern in every chord (there are 72 chords in a circle using the default chord angle).

- **$X_{\text{Increment}}$, $Y_{\text{Increment}}$** — 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 was 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 an angle in the positive direction (angle of rotation); a negative angle draws the angle in the negative direction.
- **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.

Table 20-8 Example: Using Arc Relative to Draw Arcs

$^{E}{}_{C}$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 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° (positive angle), 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° (positive angle), with a 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.

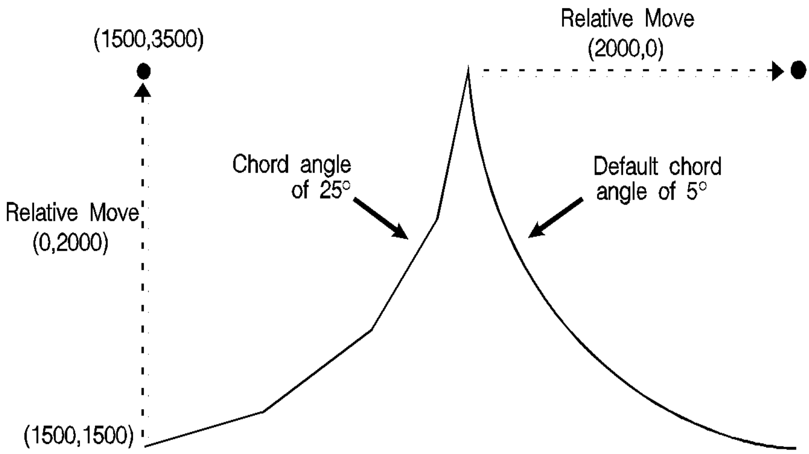


Figure 20-10

Table 20-9

Related Commands	Group
AA, Arc Absolute AT, Absolute Arc Three Point BR, Bezier Relative BZ, Bezier Absolute 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*

AT, Absolute Arc Three Point

This command 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 *Xinter,Yinter, Xend,Yend[,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 in a positive or negative angle of rotation, 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, and the three points are collinear, 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.

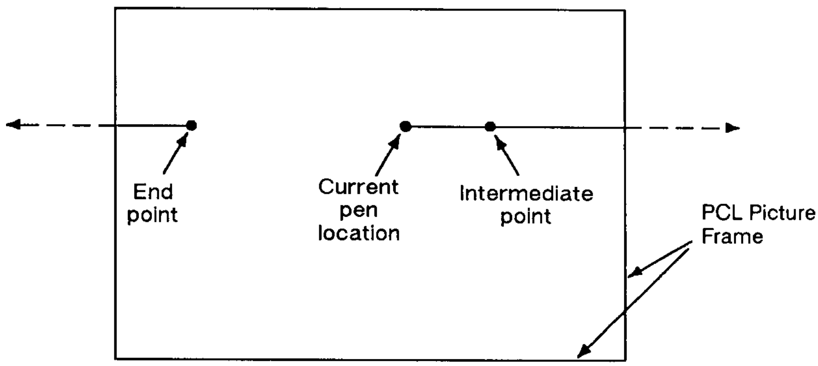


Figure 20-11

Table 20-10 Example: Using the AT 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).
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).

Table 20-10 Example: Using the AT Command (continued)

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.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

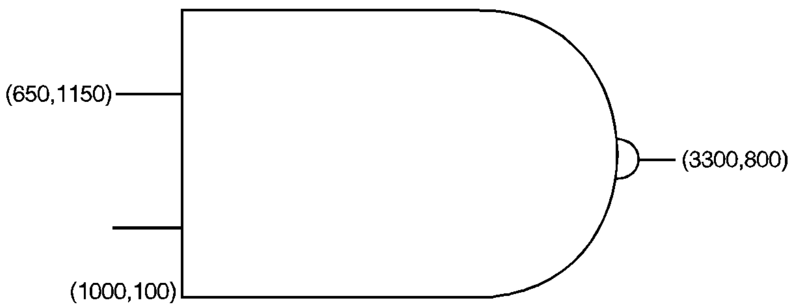


Figure 20-12

Table 20-11

Related Commands	Group
AA, Arc Absolute AR, Arc Relative BR, Bezier Relative BZ, Bezier Absolute 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*

BR, Bezier Relative

This command draws bezier curves using relative coordinates. This command uses the current pen position as the first control point, and specifies the other three control points as relative increments from the first point.

BR *X1,Y1, X2,Y2,X3,Y3,...[X1,Y1, X2,Y2,X3,Y3]]*

Parameter	Format	Functional Range	Default
X_1, Y_1... (control points)	current units	-2^{23} to 2^{23} - 1	no default

The BR command uses the current pen location and three specified control points to draw a bezier curve. After each new Bezier, the last control point of the previous curve becomes the first control point of the next Bezier. All curve control points are relative to the first control point of that curve. For example, points 1, 2, and 3 of the example are relative to the starting point, while points 4, 5, and 6 are relative to point 3.

Bezier curves are drawn with the current pen, line type, current line attributes, and pen-state (up/down). The curve is clipped to the hard-clip limits and the soft-clip window. Following the command execution, the current pen position is updated to the end point of the curve.

The BR command is allowed in Polygon Mode. (The first chord after PM1 is not treated as a pen-up move.)

- **X_1, Y_1...** — Specify the location of the second (X_1, Y_1), third (X_2, Y_2), and fourth (X_3, Y_3) control points, in relative increments (relative to the first control point).

Table 20-12 Example: Using the BR Command (Bezier Relative)

$^{E}{}_{C}$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 to enable printing.
PA1016,5080;	Specify the absolute point (1016,5080) as the starting location.
PR;PD;	Specify relative plotting and pen down.
BR0,3048,4572,0, 3556,2032,-508,1016, 2540,508,2540,-5080;	Draw a Bezier using the current position (1016,5080) as the first control point. The specified control points for the first curve are (0,3048), (4572,0), and (3556,2032). The second curve uses the last control point of the previous curve as the first control point (3556,2032). The other three control points for the second curve are (-508,1016), (2540,508), and (2540,-5080).
$^{E}{}_{C}$%ØA	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

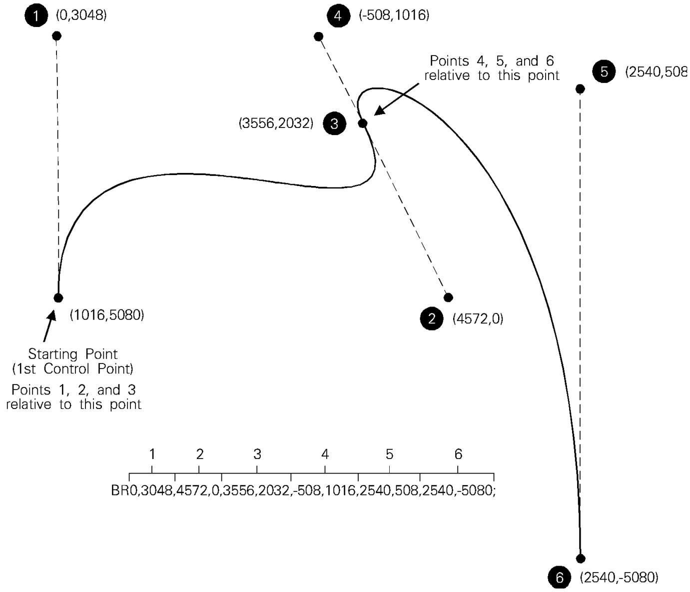


Figure 20-13

Table 20-13

Related Commands	Group
AA, Arc Absolute BZ, Bezier Absolute AR, Arc Relative AT, Absolute Arc Three Point 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*

BZ, Bezier Absolute

This command draws bezier curves using absolute coordinates. The BZ command uses the current pen position as the first control point, and specifies the other three control points as absolute coordinates.

BZ $X_1,Y_1, X_2,Y_2,X_3,Y_3,...[X_1,Y_1, X_2,Y_2,X_3,Y_3]]$

Parameter	Format	Functional Range	Default
X_1, Y_1... (control points)	current units	-2^{23} to 2^{23} - 1	no default

The BZ command uses the current pen location and three specified control points to draw a bezier curve. After each new Bezier, the last control point of the previous curve becomes the first control point of the next Bezier. All curve control points are specified as absolute coordinates.

Bezier curves are drawn with the current pen, line type, current line attributes, and pen-state (up/down). The curve is clipped to the hard-clip limits and the soft-clip window. Following the command execution, the current pen position is updated to the end point of the curve.

The BZ command is allowed in Polygon Mode. (The first chord after PM1 is not treated as a pen-up move.)

- **X_1, Y_1...** — Specify the location of the second (X_1, Y_1), third (X_2, Y_2), and fourth (X_3, Y_3) control points, as absolute coordinates.

Table 20-14 Example: Using the BZ Command (Bezier Absolute)

$^E{}_C$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 to enable printing.

Table 20-14 Example: Using the BZ Command (Bezier Absolute)

PA1016,5080;	Specify the absolute point (1016,5080) as the starting location.
PR;PD;	Specify relative plotting and pen down.
BZ1016,8128,5588,5080,	
4572,7112,4064,8128,	
7112,7620,7112,2032;	Draw a Bezier using the current position (1016,5080) as the first control point. The specified control points for the first curve are (1016,8128), (5588,5080), and (4572,7112). The second curve uses the last control point of the previous curve as the first control point (4572,7112). The other three control points for the second curve are (4064,8128), (7112,7620), and (7112,2032).
$^{E}{}_{C}$%ØA	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

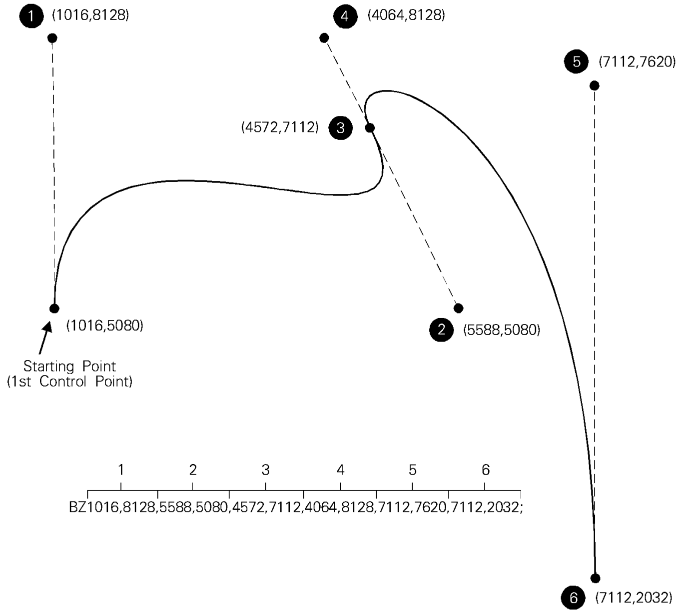


Figure 20-14

Table 20-15

Related Commands	Group
AA, Arc Absolute BR, Bezier Relative AR, Arc Relative AT, Absolute Arc Three Point 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*

CI, Circle

This command 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.

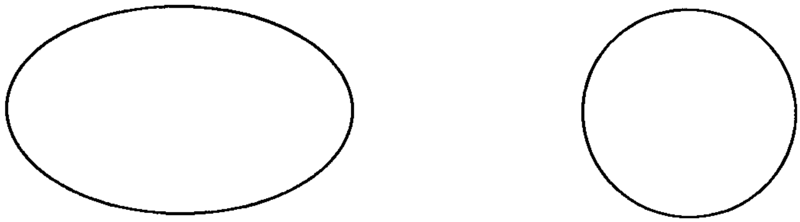
CI *radius[,chord angle;]*

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 22, *The Line and Fill Attributes Group,* for more information.) Do not use an adaptive (negative) line type to draw a circle, as the printer attempts 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 "stretch" with aspect ratio changes of the drawing (anisotropic scaling may produce an ellipse). For more information, refer to Chapter 19 for a scaling discussion and for the Scale (SC) command description.



Anisotropic scaling

Isotropic scaling

Figure 20-15

Table 20-16 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°.

Table 20-16 Example: Effects of Chord Angle on Circle Smoothness (continued)

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.

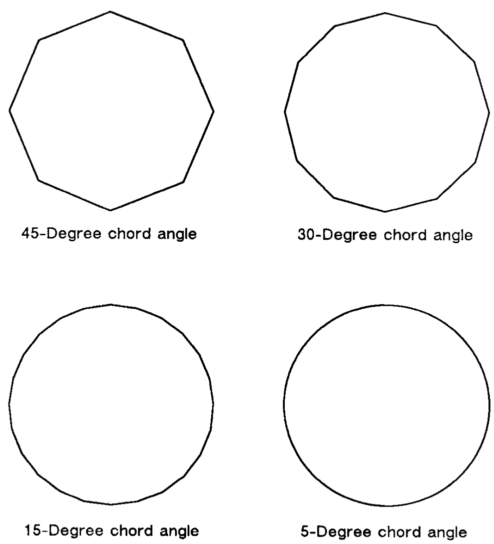


Figure 20-16

Table 20-17 Example: Drawing Circles with Different Radii and Line 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 (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 starting at the 180° point).
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.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

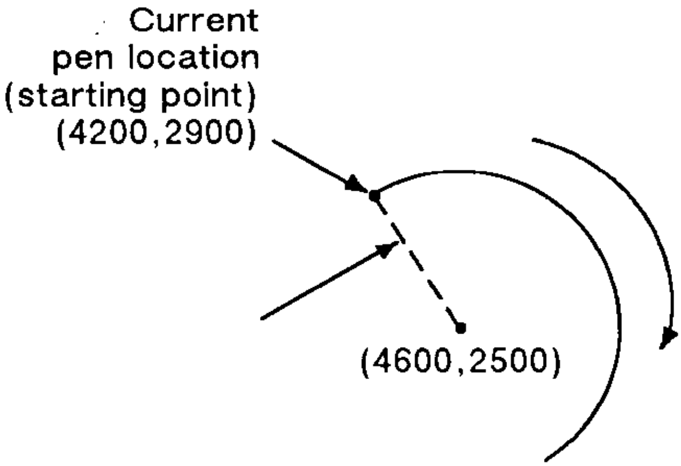


Figure 20-17

Table 20-18

Related Commands	Group
EW, Edge Wedge WG, Fill Wedge	*The Polygon Group*
SC, Scale	*The Configuration/Status Group*
AA, Arc Absolute AR, Arc Relative 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*

PA, Plot Absolute

This command 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.

Table 20-19

Related Commands	Group
PE, Polyline Encoded PR, Plot Relative PD, Pen Down PU, Pen Up	*The Vector Group*
LA, Line Attributes LT, Line Type PW, Pen Width SM, Symbol Mode	*Line and Fill Attributes Group*

PD, Pen Down

This command 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 no PA or PR command is issued, 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).

Table 20-20 Example: Using the Pen Down 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 to enable printing.
PA10,10;	Begin absolute plotting from coordinate (10,10).
PD2500,10,10,1500,10,10;	Set the Pen Down and draw lines between the specified points.
$^{E}{}_{C}$%ØA	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

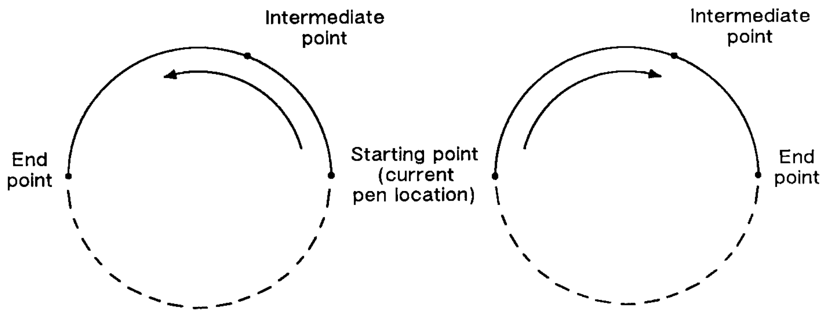


Figure 20-18

Note If an odd number of coordinates is specified (an X coordinate without a corresponding Y coordinate), the printer ignores the last unmatched coordinate

.

Table 20-21

Related Commands	Group
PA, Plot Absolute PE, Polyline Encoded PR, Plot Relative PU, Pen Up	*The Vector Group*
LA, Line Attributes LT, Line Type PW, Pen Width SM, Symbol Mode	*Line and Fill Attributes Group*

PE, Polyline Encoded

This command 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 remains 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, control characters, as well as ASCII characters 128-160 and 255 are ignored.

- **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 (fro example, a character code of 61 and a character code of 189 both send a '=' [the absolute flag]).

Table 20-22

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 are 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. Flag values are encoded in the same manner as coordinate data. Instructions for encoding flag values follow the parameter descriptions.
- *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).

Table 20-23

Value	Format	Range[1]
pen number	integer	0 to 1
number of fractional binary bits	integer	-26 to 26

1. 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.

- **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 22, *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 21, *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).

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.

Note When converting numbers to base 32 or 64 (step 4 in the following instructions), note that highest order digits are always in the high range, all other digits are in the low range. Therefore, if there is only one digit in a number, it is in the high range.

Table 20-24 Procedure to encode a number

STEPS	EXAMPLE
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.	x = 82.83
a. Multiply the number of decimal places contained in the data by 3.33.	2 × 3.33 = 6.66
b. Round that number up to the next integer to get integer n.	
n = round (decimal places × 3.33)	n = 7
x = x × 2^n	x = 82.83 × 2^7 = 10,525.42

Table 20-24 Procedure to encode a number (continued)

2. Round to an integer. Round the results of step 1 to the nearest integer.	
x = round (x)	x = round (10,525.42) = 10,525
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 ≥ 0)	
x = 2 × x	x = 2 × 10,525 = 21,050
else	
x = 2 × 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 non-terminator characters, followed by a terminator character. A character is a non-terminator or terminator depending on the range it is in; refer to the following table. For example, in base 64 there are 64 non-terminator and 64 terminator characters. Either kind represents a "digit."	

Table 20-25 Terminator and non-terminator characters

Range Type	Non-terminator	Terminator
8-bit Range (base 64)	63-126	191-254
7-bit Range (base 32)	63-94	95-126

Note Values following the fractional data or select pen flag also must be encoded.

```
while n &geq; 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)
```

Table 20-26 Procedure for determining base range

STEPS	EXAMPLE
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$(F) ” CHR$(63 + i).| Encode the highest order digit (or the single digit in a one-digit number) into the range 191 to 254.	21,050 ÷ 4096 = 5 remainder 570 570 ÷ 64 = 8 remainder 58 5 - 4096ths place 58 - 1's place
	Low order digit: 1's place (63-126) 63 + 58 = 121 CHR$ (121)

Table 20-26 Procedure for determining base range (continued)

	Next order digit: 64ths place (63-126) 63 + 8 = 71 CHR$ (71)
	High order digit: 4096ths place (191-254) 191 + 5 = 196 CHR$ (196)
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$(63 + i).| Encode the highest order digit (or the single digit in a one-digit number) into the range 95 to 126.	21,050 ÷ 1024 = 20 remainder 570 570 ÷ 32 = 17 remainder 26 20 - 1024ths place 17 - 32nds place 26 - 1's place
	Low order digit: 1's (range 63-94) 63 + 26 = 89 CHR$(89)
	Next order digit: 32's place (63-94) 63 + 17 = 80 CHR$ (80)
	High order digit: 1024ths place (95-126) 95 + 20 = 115 CHR$ (115)

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, follow these steps.

1 Create a flag called "lost" in your program.

2 After labeling (or any command which updates the current pen location), 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.

```
``10 LPRINT CHR$(27);"E"; 'Reset the Printer.''
``20 LPRINT CHR$(27);"%0B"; 'Enter HP-GL/2 Mode.''
``30 LPRINT "IN;SC1,20,1,20,1;SP1;PU5,5;";''
``40 PRINT "Input number of fractional decimal places in data" ''
``50 INPUT F   'In this example, 2 decimal places (line 290).''
``60 'Calculate Number of Fractional Binary Bits ''
``70 F = F * 3.33 ''
``80 F = INT(F) ''
``90 A = F ''
``100 IF F >= 0 THEN F = 2*ABS(F) ELSE F = 2*ABS(F)+1 ''
``110 F = 191+F ''
``120 LPRINT #1, "PE>"+CHR$(F) ''
```

```
''130 'Convert coordinate data to base 64 ''
''140 FOR J = 1 to 6 ''
''150 READ C ''
''160 C = C * (2^A) ''
''170 C = INT(C) ''
''180 IF C = 0 THEN C = 2*C ELSE C = 2*ABS(C)+1 ''
''190 WHILE C = 64 ''
''200 LPRINT CHR$(63+(C MOD 64)) ''
''210 C = C64 ''
''220 WEND ''
''230 C = 191+C ''
''240 LPRINT CHR$(C) ''
''250 NEXT J ''
''260 LPRINT ";"; ''
''270 LPRINT CHR$(27);"%0A"; 'Enter PCL Mode ''
''280 LPRINT CHR$(27);"E"; 'Reset to eject page.''
''290 DATA 10.58,0,-5.58,10.67,-5,-10.67 ''
''300 END ''
```

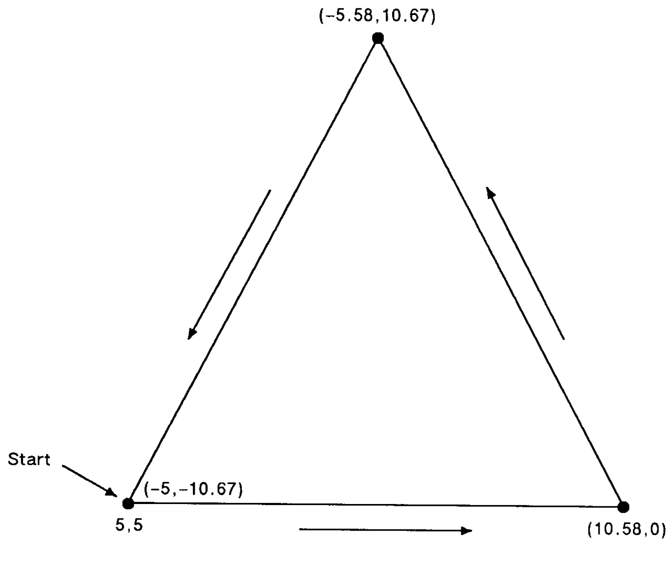


Figure 20-19

Table 20-27

Related Commands	Group
PA, Plot Absolute PD, Pen Down PR, Plot Relative PU, Pen Up	*The Vector Group*
LA, Line Attributes LT, Line Type PW, Pen Width SM, Symbol Mode	*Line and Fill Attributes Group*

PR, Plot Relative

This command 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.

Table 20-28 Example: Using the PR 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. The SP command must be used to enable printing.
PA10,10;PD;	Move to absolute position (10,10) and put the pen down.
PR2500,0,-2500, 1500,0,-1500;	Specify relative plotting and draw lines beginning at (10,10) and then moving the relative coordinate distances indicated.
$^{E}{}_{C}$%ØA	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

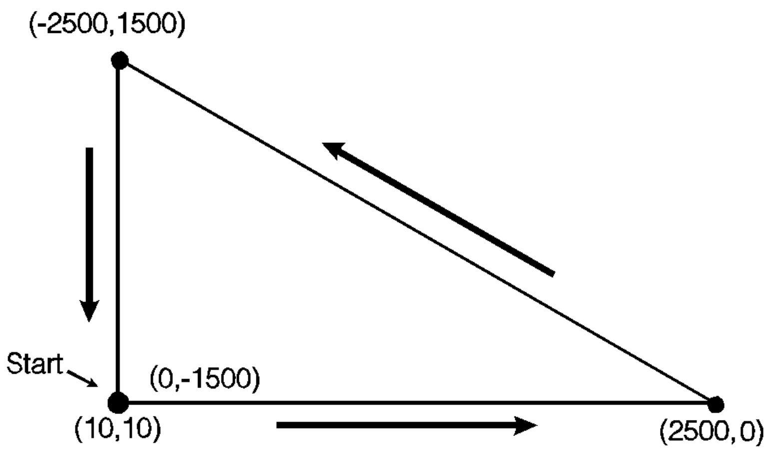


Figure 20-20

Note

If an odd number of coordinates is specified (an X coordinate without a corresponding Y coordinate), the printer ignores the last unmatched coordinate.

Table 20-29

Related Commands	Group
PA, Plot Absolute PD, Pen Down PE, Polyline Encoded	*The Vector Group*
LA, Line Attributes LT, Line Type PW, Pen Width SM, Symbol Mode	*Line and Fill Attributes Group*

U, Pen Up

This command 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

The PU 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, PU 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.

Table 20-30

Related Commands	**Group**
PA, Plot Absolute PD, Pen Down PE, Polyline Encoded PR, Plot Relative	*The Vector Group*
SM, Symbol Mode	*Line and Fill Attributes Group*

RT, Relative Arc Three Point

This command 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,Yincr inter, X\incr end\,Yincr 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 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.

- **$X_{Incr\ Inter}$, $Y_{Incr\ Inter}$** — Specify the location of an intermediate point of the arc in relative increments (relative to the current pen location). The arc is drawn in a negative or positive direction, 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, and the three points are collinear, 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.

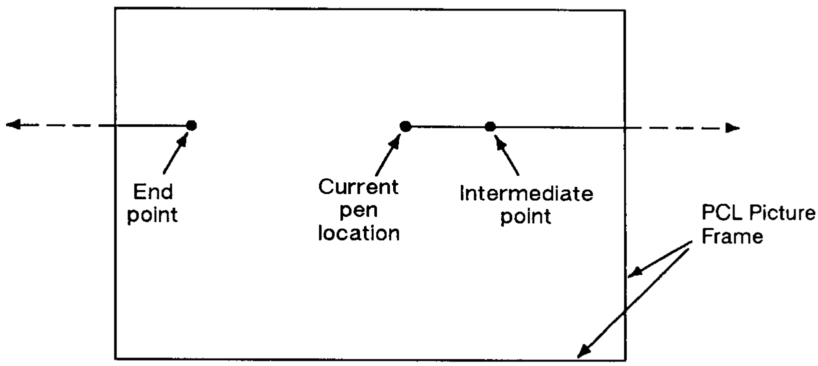


Figure 20-21

Table 20-31 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.

Table 20-31 Example: Using the RT Command (Relative Arc Three Point) (continued)

SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used 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.

Table 20-31 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.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

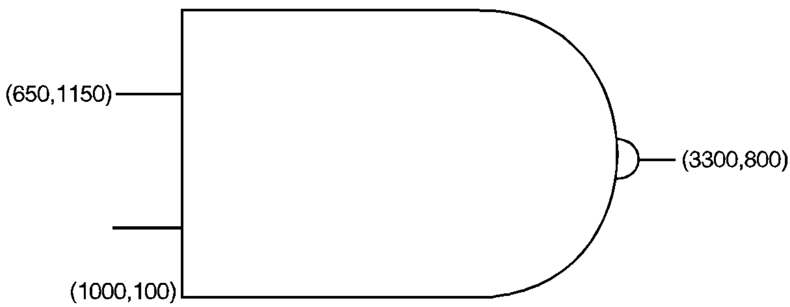


Figure 20-22

Table 20-32

Related Commands	Group
AA, Arc Absolute AR, Arc Relative AT, Absolute Arc Three Point BR, Bezier Relative BZ, Bezier Absolute CI, Circle	*The Vector Group*
LA, Line Attributes LT, Line Type PW,Pen Width	*The Line and Fill Attributes Group*

21 The Polygon Group

Introduction

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 21-1 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.

Table 21-1 The Polygon Group Commands (continued)

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 want 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 allow you to enter polygon mode first.

Table 21-2

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

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.

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 command sequence uses EA to draw a rectangle.

Table 21-3

Example: Drawing Rectangles	
?E	Reset the printer.
?%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.
PA10,10;	Specify absolute plotting and move to (10,10).
EA2500,1500;	Draw the outline of a rectangle, with the lower left corner being the current pen location (10,10) and the upper right corner being (2500,1500).
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

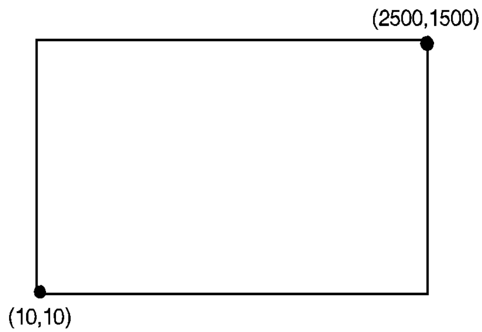


Figure 21-1

The Fill Rectangle Absolute (RA) and Fill Rectangle Relative (RR) commands, both discussed later in this chapter, fill their rectangles with the default or current fill pattern. You may also want to edge (or outline) the rectangle for better image definition with some fill types. The following command sequence draws two filled rectangles: one edged and one not.

Table 21-4 Example: Filled Rectangles

?E	Reset the printer.
?%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 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.

Table 21-4 Example: Filled Rectangles (continued)

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 do not 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.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

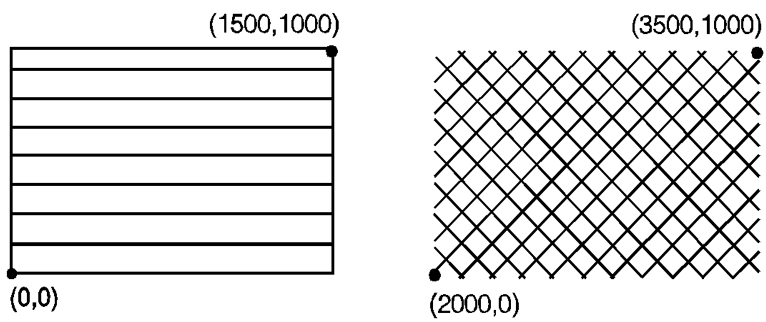


Figure 21-2

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. Figure 21-4 shows the different parameters of a wedge with a positive radius.

Note A *positive angle* of rotation is in the direction of the +X-axis to the +Y-axis as shown below. A *negative angle* of rotation is in the direction of the +X-axis to the –Y-axis.

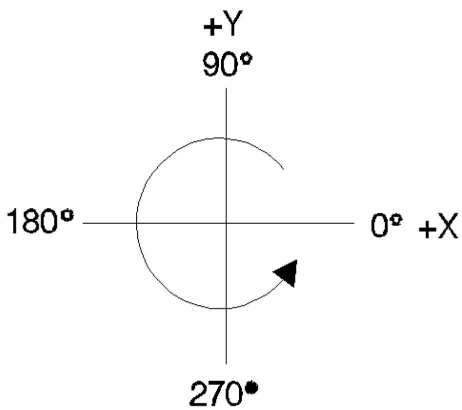


Figure 21-3

Note The relationship of the +X-axis to +Y-axis (and –Y-axis) can change as a result of the scaling point or scaling factor changes, thus, changing the direction of a positive (or negative) angle of rotation.

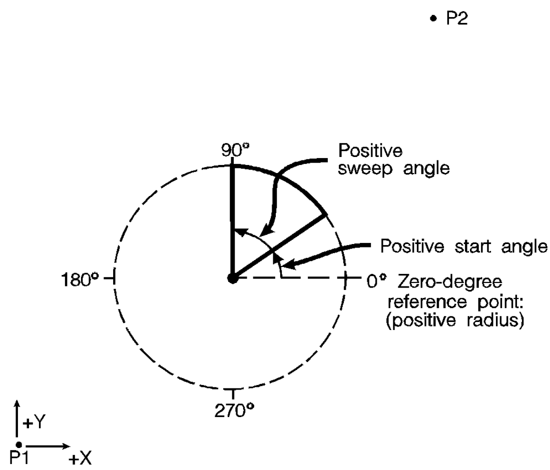


Figure 21-4 Drawing Wedges

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°.

Note

In the example plots, some reference points are added which are not part of the example plot. These reference points are added for clarification.

Table 21-5 Example: Drawing Wedges

?E	Reset the printer.
?%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 to enable printing.
PA2500,3500;	Specify absolute plotting and move to location (2500,3500).

Table 21-5 Example: Drawing Wedges (continued)

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°.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

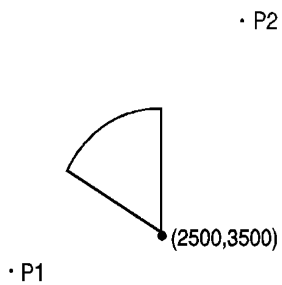


Figure 21-5

The following example uses different fill types with wedges and circles.

Table 21-6 Example: Filling Wedges and Circles

?E	Reset the printer.
?%0B	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 is black (solid black is the default fill type).

Table 21-6 Example: Filling Wedges and Circles (continued)

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°.
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).
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

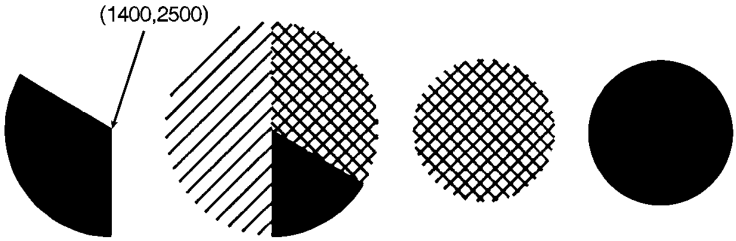


Figure 21-6

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.

Table 21-7

Polygon Definition Commands	Group
AA, Arc Absolute AR, Arc Relative AT, Absolute Arc Three Point BR, Bezier Relative BZ, Bezier Absolute CI, Circle PA, Plot Absolute PD, Pen Down PE, Polyline Encoded	*The Vector Group*

Table 21-7 (continued)

PR, Plot Relative PU, Pen Up RT, Relative Arc Three Point	
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.'

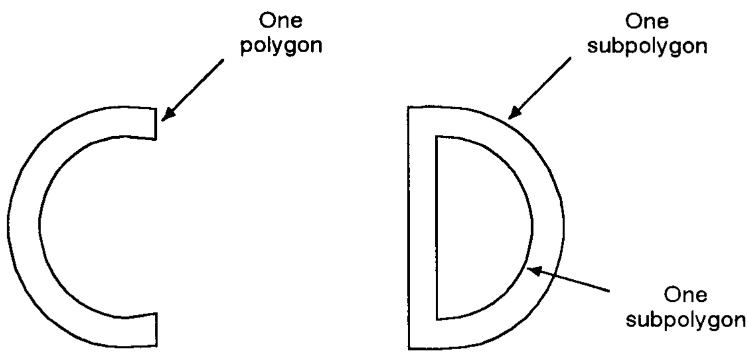


Figure 21-7 Drawing Subpolygons

To create one polygon, for example, 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, for example, 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 discussed in 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 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 are two methods which can be selected for filling polygons: the **even/odd** fill method and the **non-zero winding** fill method.

Even/Odd Fill Method

There is a simple way to determine which portions of a single polygon or series of subpolygons is filled when you send a Fill Polygon (FP) command using the default method 0, (fill using even/odd rule):

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 edges of the polygon an odd number of times. Figure 21-8 illustrates this ‘odd-even’ rule.

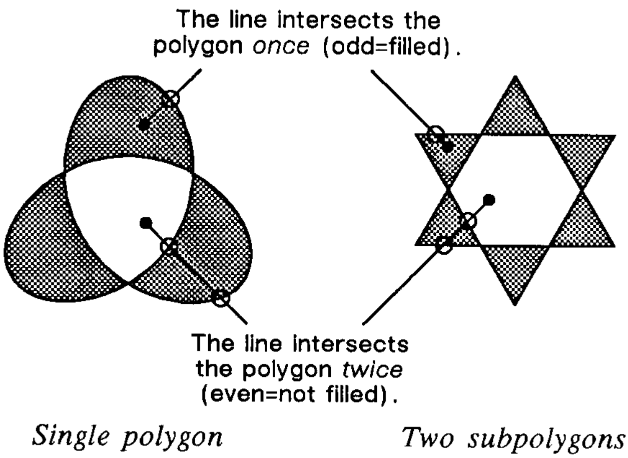


Figure 21-8 Filling Polygons: Even/Odd Fill Method

Non-Zero Winding Fill Method

The *non-zero* winding fill algorithm (fill method 1) determines whether a point is inside a region enclosed by a line path using the following steps:

1 Draw a ray from the point across the path segment.

2 Add 1 every time the line segment crosses the ray from left to right or bottom to top.

3 Subtract 1 every time the segment crosses the ray from right to left or top to bottom.

4 FP fills the enclosed area in question if the sum of steps 2 and 3 is non-zero. Figure 21-9 illustrates the non-zero winding fill concept.

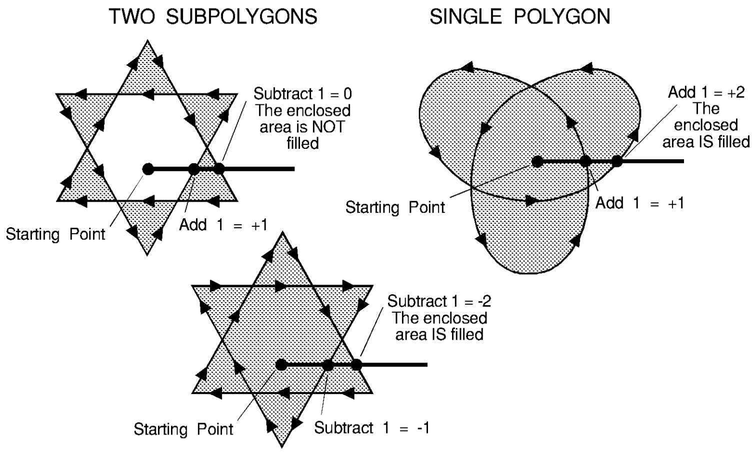


Figure 21-9 Filling Polygons: Non-Zero Winding Fill Method

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 did not close your first polygon completely 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.

`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 the 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:

number 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.

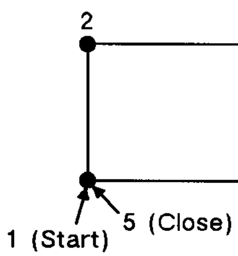


Figure 21-10

The following shape has seven points.

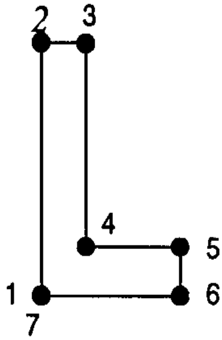


Figure 21-11

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. There is always one more point than the number of chords, because the starting location is counted again as the ending location. Use the following formula to determine the number of points used to draw a circle or arc:

$$\#\text{ of Points} = \frac{\text{Arc Angle (degrees)}}{\text{Chord Angle (degrees)}} + 1$$

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).

Notes

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.

In polygon mode, the smaller a circle's chord angle, the more chords will be stored in the polygon buffer to draw it.

EA, Edge Rectangle Absolute

This command 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 performs 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.

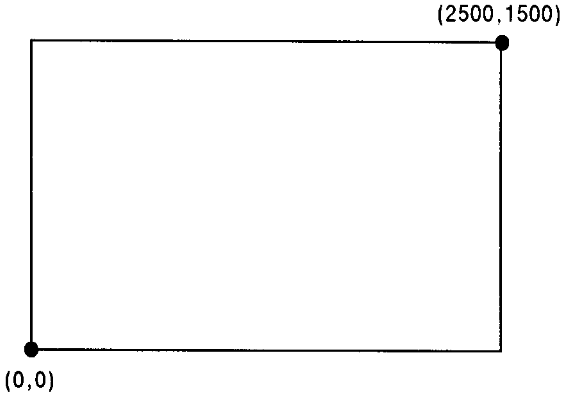


Figure 21-12

Note Any line drawn along the border of the effective window causes the line to be clipped, producing a line width one-half of the defined pen width. For example, all the lines drawn in the above example are half the width of the other lines since they are clipped at the window borders.

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).

Table 21-8 Example: Using EA to Draw Rectangles

?E	Reset the printer.
?%0B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.

Table 21-8 Example: Using EA to Draw Rectangles (continued)

SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used 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 a 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).
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

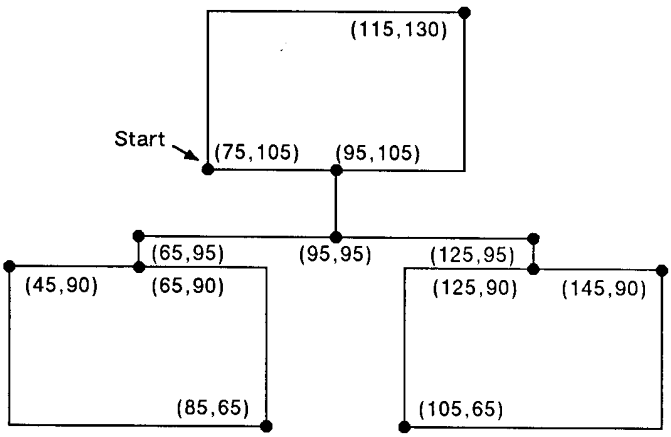


Figure 21-13

Table 21-9

Related Commands	**Group**
EP, Edge Polygon ER, Edge Rectangle Relative FP, Fill Polygon RA, Fill Rectangle Absolute RR, Fill Rectangle Relative	*The Polygon Group*
LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

EP, Edge Polygon

This command 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.

Table 21-10 Example: Using the EP Command

?E	Reset the printer.
?%0B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1 (black).
PA2000,10;	Specify absolute plotting and move to position (2000,10).
PM0;PD10,2000,10,10, 2000,10;PM1;	Enter polygon mode, store a pen down command, and then store points (10,2000), (10,10), and (2000,10). Close the polygon.
PU610,610; CI500;PM2;	While still in polygon mode, lift the pen and move to (610,610). Draw a circle with a diameter of 500 plu, then close the current subpolygon and exit polygon mode.

Table 21-10 Example: Using the EP Command (continued)

EP;	Outline the polygon that was just stored in the polygon buffer.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

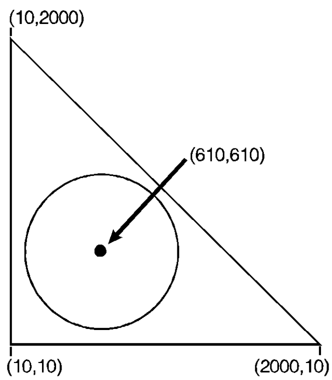


Figure 21-14

Table 21-11

Related Commands	**Group**
EA, Edge Rectangle Absolute ER, Edge Rectangle Relative EW, Edge Wedge PM, Polygon Mode RA, Fill Rectangle Absolute RR, Fill Rectangle Relative WG, Fill Wedge	*The Polygon Group*
LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

ER, Edge Rectangle Relative

This command 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.

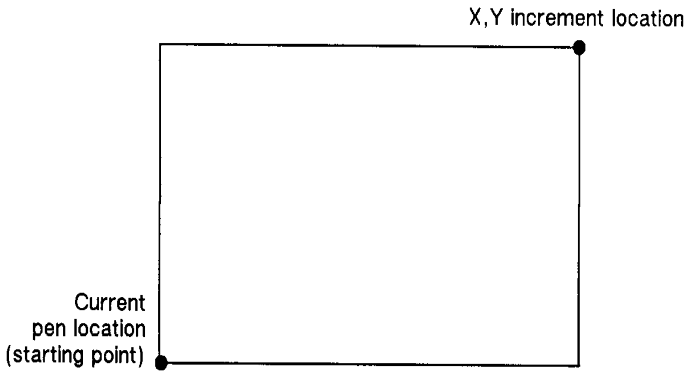


Figure 21-15 Edge Relative Rectangle Command

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.

Table 21-12 Example: Using ER to Draw Rectangles

?E	Reset the printer.
?%0B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. The SP command must be used 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.

Table 21-12 Example: Using ER to Draw Rectangles (continued)

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.
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.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

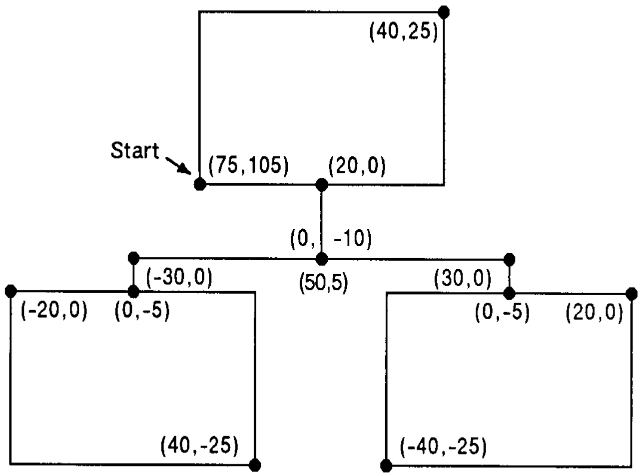


Figure 21-16

Table 21-13

Related Commands	**Group**
EA, Edge Rectangle Absolute EP, Edge Polygon FP, Fill Polygon RA, Fill Rectangle Absolute RR, Fill Rectangle Relative	*The Polygon Group*
LA, Line Attributes LT, Line Type PW, Pen Width	*The Line and Fill Attributes Group*

EW, Edge Wedge

This command 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	no default
		modulo 360	
sweep angle	clamped real	±360°	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 “stretch” 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 19.

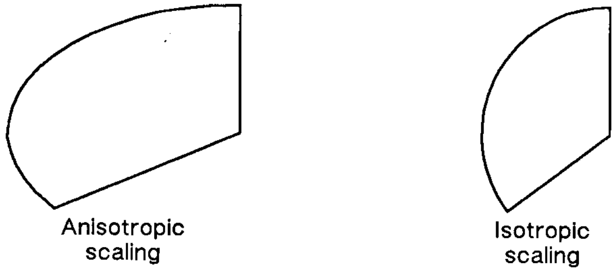


Figure 21-17 Anisotropic and Isotropic Scaling

- **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.

- **Sweep Angle** — Specifies the number of degrees through which the arc is drawn. A positive sweep angle is in the direction of the +X-axis to the +Y-axis; a negative sweep angle is in the direction of the +X-axis to the –Y-axis. However, the relative position of the +X-axis to the +Y-axis can change as a result of scaling point or scaling factor changes, thus, changing the direction of the sweep angle. Also, if you specify a start angle greater than 360°, a start angle equal to the remainder of the start angle/360° 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 20 for further information on chords and chord angles.

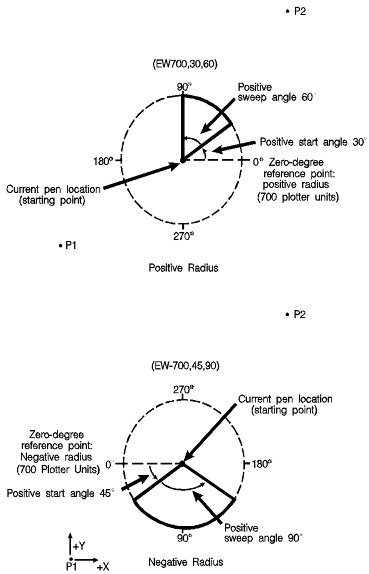


Figure 21-18

Table 21-14 Example: Using EW to Draw a Pie Chart

?E	Reset the printer.
?%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 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.

Table 21-14 Example: Using EW to Draw a Pie Chart

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°.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

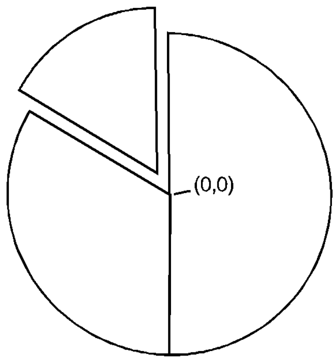


Figure 21-19

Table 21-15

Related Commands	**Group**
EP, Edge Polygon FP, Fill Polygon WG, Fill Wedge	*The Polygon Group*
SC, Scale	*The Configuration/Status Group*
CI, Circle	*The Vector Group*
LA, Line Attributes	*The Line and Fill Attributes Group*

Table 21-15 (continued)

LT, Line Type PW, Pen Width	

Table 21-16 Possible Error Conditions

Condition	Printer Response
polygon buffer overflow	edges contents of buffer

FP, Fill Polygon

This command 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, EW, RA, RR, or WG).

FP *fill method [;]*

or

FP *[;]*

Parameter	Format	Functional Range	Default
fill method	clamped integer	0 or 1	0 (odd-even fill)

- **Fill Method** — Specifies the algorithm used to determine which portions of the polygon are “inside” the polygon and therefore are to be filled:
  - 0 -- Even/odd fill algorithm (default)
  - 1 -- Non-zero winding fill algorithm

Note

Even/odd (method 0) and **Non-zero** (method 1) winding fill methods are described in detail under “Filling Polygons,” earlier in this chapter.

The FP command fills any polygon that is currently in the polygon buffer. 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 raster). 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 example on the next page creates a polygon composed of two subpolygons. In this case, the FP command fills alternating areas, beginning with the outside area.

Table 21-17 Example

?E	Reset the printer.
?%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 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.
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;	Using even-odd fill method, fill the polygon currently in the polygon buffer with the line and fill types just specified.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

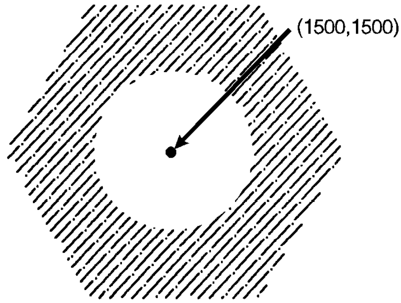


Figure 21-20

Table 21-18

Related Commands	Group
EA, Edge Rectangle Absolute ER, Edge Rectangle Relative EW, Edge Wedge 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*

PM, Polygon Mode Command

This 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, only certain commands are allowed. The following list contains these commands:

Table 21-19

Polygon Mode Allowable Commands	**Group**
DF, Default Values IN, Initialize	*The Configuration/Status Group*
AA, Arc Absolute AR, Arc Relative AT, Absolute Arc Three Point BR, Bezier Relative BZ, Bezier Absolute 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 a polygon, the pen location before the *PM0* command 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 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 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 adds 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 always moves 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 Status and Location” in Chapter 17, *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.

Table 21-20 Example: Using the PM Command

?E	Reset the printer.
?%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 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.
PD2080,2160,2480, 2160, 2480,2340, 2080,2340,2080, 2160;	Store 5 pen-down locations for a subpolygon.
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.

Table 21-20 Example: Using the PM Command (continued)

PD2920,2340,2920, 2660,2720,2660;	Begin a third subpolygon that draws 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 polygon mode. Fill (even/odd), then edge the polygon and subpolygons currently stored in the buffer.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

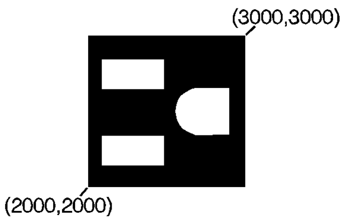


Figure 21-21

Table 21-21

Related Commands	Group
EP, Edge Polygon FP, Fill Polygon	*The Polygon Group*

RA, Fill Rectangle Absolute

This command 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.

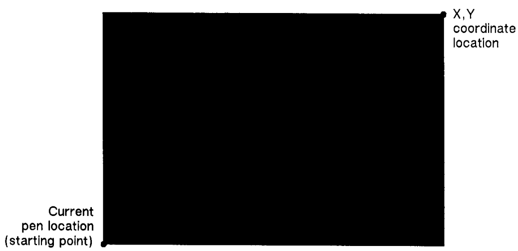


Figure 21-22 Fill Rectangle Absolute

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 bar 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 22.)

Table 21-22 Example: Using the RA Command with Different Fill Types

?E	Reset the printer.
?%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 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.

Table 21-22 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.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

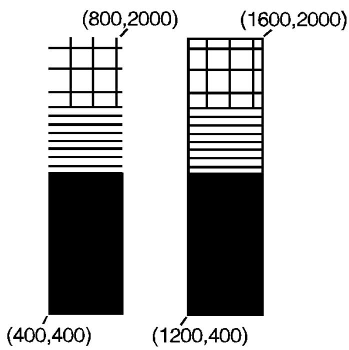


Figure 21-23

Table 21-23

Related Commands	Group
EA, Edge Rectangle Absolute EP, Edge Polygon ER, Edge Rectangle Relative FP, Fill Polygon RR, Fill Rectangle Relative	*The Polygon Group*

Table 21-23 (continued)

FT, Fill Type LT, Line Type RF, Raster Fill Definition	*The Line and Fill Attributes Group*

RR, Fill Rectangle Relative

This command 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.

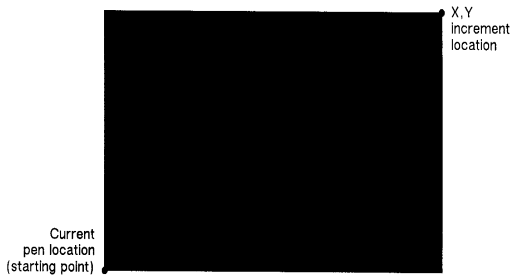


Figure 21-24 Fill Rectangle Relative

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.

Table 21-24 Example: Using the RR Command with Different Fill Types

?E	Reset the printer.
?%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 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.

Table 21-24 Example: Using the RR Command with Different Fill Types (continued)

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.
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.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

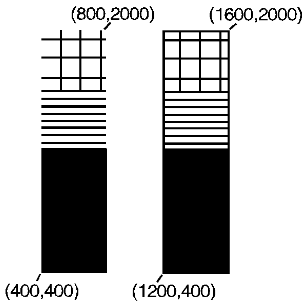


Figure 21-25

Table 21-25

Related Commands	Group
EA, Edge Rectangle Absolute EP, Edge Polygon ER, Edge Rectangle Relative FP, Fill Polygon RA, Fill Rectangle Absolute	*The Polygon Group*

WG, Fill Wedge

This command 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	±360°	—
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.)

Figure 21-26 Fill Wedge with Scaling

- **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 in the positive direction (the direction from the +X-axis toward the +Y-axis) from the zero-degree reference point; a negative start angle positions the radius in a negative direction 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.

- **Sweep Angle** — Specifies in degrees the angle through which the arc is drawn. A positive angle draws the angle in the positive direction (angle of rotation - +X-axis to the +Y-axis); a negative angle draws the angle in the negative direction (+X-axis to the –Y-axis). (Note, the relation of the +X-axis to the +Y-axis/–Y-axis can change as a result of scaling point or scaling factor changes.) If a sweep angle greater than 360 degrees is specified, 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 20) for information on setting the chord angle.

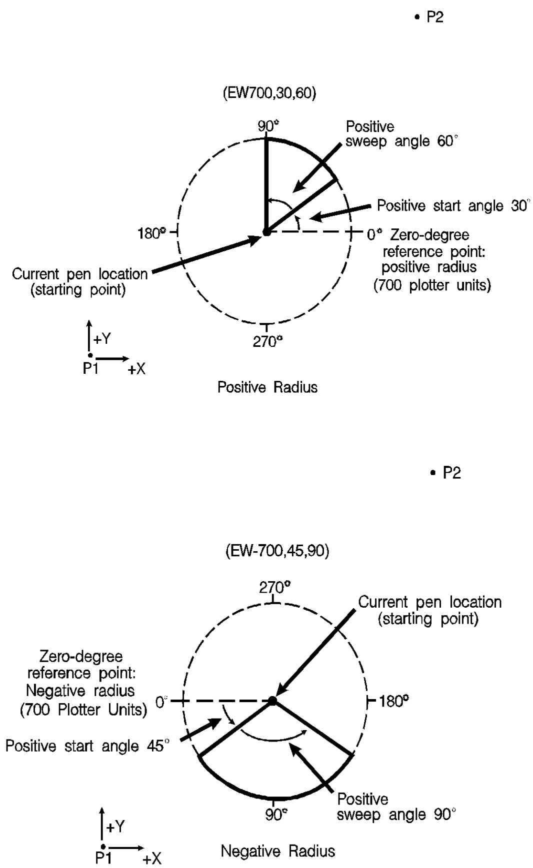


Figure 21-27

Table 21-26 Example: Filling then Edging vs. Edging then Filling Chart

?E	Reset the printer.
?%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 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°.
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.

Table 21-26 Example: Filling then Edging vs. Edging then Filling Chart (continued)

?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

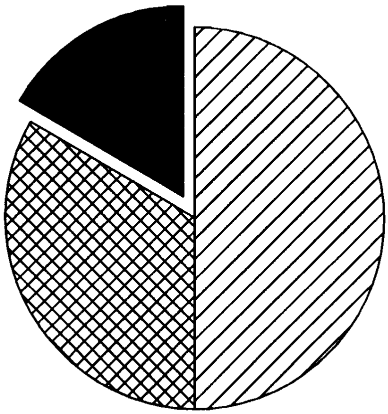


Figure 21-28

The center point of the above circle is located at (0,0).

Note When transparency mode (TR command) is opaque, filling then edging an object may produce different results from edging and then filling. This is especially true when large pen widths are used. The following example illustrates this.

Table 21-27 Example:

?E	Reset the printer.
?%0B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select printer logical pen number 1.
TR0;	Set transparency mode OFF (opaque)
PU4000,6000;	Position pen.

Table 21-27 Example: (continued)

PW5;	Select pen width of 5 units.
PM0;	Enter polygon mode.
CI1000;	Draw a circle with a radius of 1000 units.
PM2;	Close polygon and exit polygon mode.
FT10,30;	Select 30% shading fill type.
FP;EP;	Fill then Edge polygon.
PU4000,3000;	Select pen position (4000, 3000) for second circle.
PM0;	Enter polygon mode.
CI1000;	Draw another circle with a radius of 1000 units.
PM2;	Close polygon and exit polygon mode.
EP;FP;	Edge then fill polygon (circle).
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

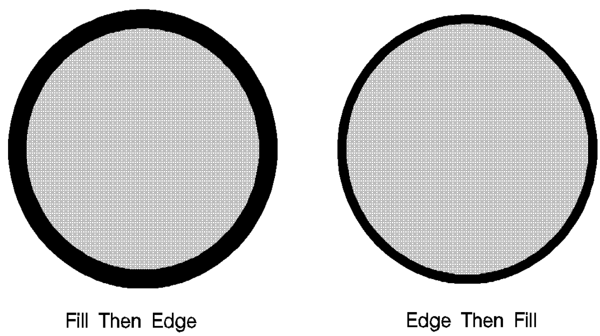


Figure 21-29

The center of the left circle is located at (4000,3000). The center of the right circle is located at (4000,6000).

Table 21-28

Related Commands	Group
EP, Edge Polygon EW,Edge Wedge	*The Polygon Group*
SC, Scale	*The Configuration/Status Group*
CI, Circle	*The Vector Group*
FP, Fill Polygon	*The Polygon Group*
FT, Fill Type	*The Line and Fill Attributes Group*

22 The Line and Fill Attributes Group

Introduction

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 22-1 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.

Table 22-1 The Line and Fill Attribute Commands

SV, Screened Vectors	Selects the type of area fill to be applied to vectors (lines, cross-hatch 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.

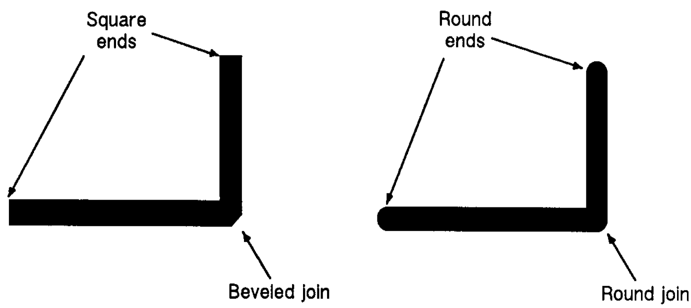


Figure 22-1 Line Ends Attribute

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.

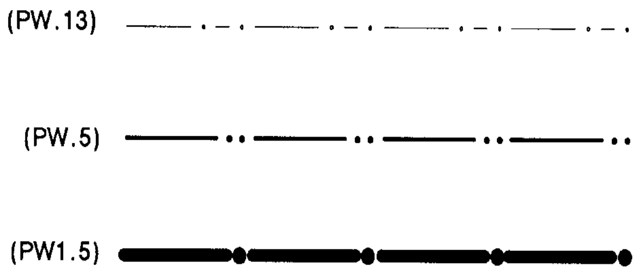


Figure 22-2 Line Types Attribute

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.

Table 22-2 Commands Affectedby Line Types

Command	Group
AA, Arc Absolute	
AR, Arc Relative	
AT, Absolute Arc Three Point	
BR,.Bezier Relative	
BZ,.Bezier Absolute	
PA, Plot Absolute	*The Vector Group*
PD, Pen Down	
PE, Polyline Encoded	
PR, Plot Relative	
RT, Relative Arc Three Point	
CI, Circle	
EA, Edge Rectangle Absolute	
EP, Edge Polygon	
ER, Edge Rectangle Relative	*The Polygon Group*

Table 22-2 Commands Affectedby Line Types (continued)

EW, Edge Wedge FP, Fill Polygon RA, Fill Rectangle Absolute RR, Fill Rectangle Relative WG, Fill Wedge	

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), FP (Fill Polygon) commands, and CF (Character Fill) commands. PCL 5 printers support **solid, parallel line,** (hatching), **HP-GL/2 cross-hatch, raster fill** (shading is a special type of raster fill), and **PCL cross hatch** and **PCL user-defined** fills. Figure 22-3 shows the first four types. The **user-defined** fill type shown on the right can be printed using the HP-GL/2 RF (raster fill) command. User-defined fills can also be selected with the FT (Fill Type) command after having been created in PCL context (see "User-Defined Raster Graphics" in Chapter 13.

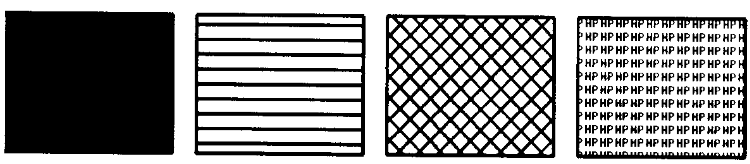


Figure 22-3 Fill Types

When you use HP-GL/2 hatching or cross-hatch 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 is 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 plus X-directions and plus 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).

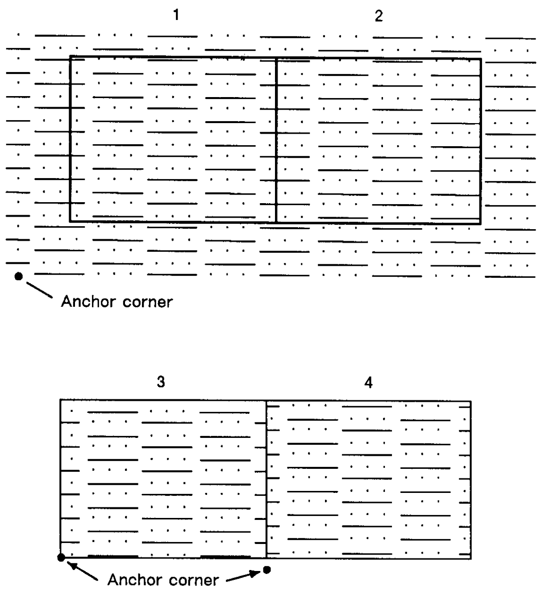


Figure 22-4 Fill Area Anchor Corner

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 printer does not 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 is 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 is 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 with fill patterns 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.

Table 22-3 Example: Changing the Anchor Corner

?E	Reset the printer.
?%0B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.

Table 22-3 Example: Changing the Anchor Corner (continued)

SP1;	Select pen number 1. The SP command must be used 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-hatch); create a rectangle the same size as the first one, fill it with cross-hatch, 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-hatch); fill and edge another rectangle.
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.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

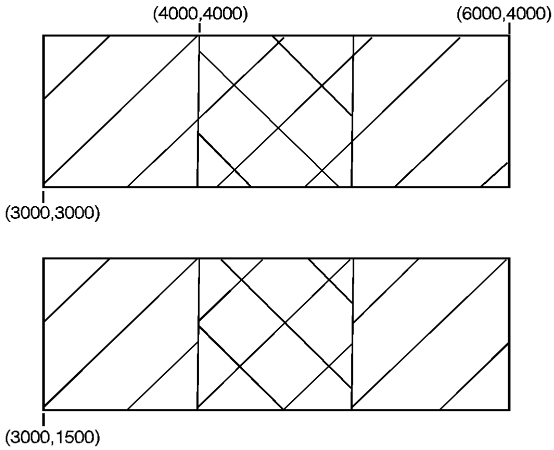


Figure 22-5

Table 22-4

Related Commands	**Group**
FT, Fill Type RF, Raster Fill Definition SV, Screened Vectors	*The Line and Fill Attributes Group*
FP, Fill Polygon RA, Fill Rectangle Absolute RR, Fill Rectangle Relative WG, Fill Wedge	*The Polygon Group*

FT, Fill Type

This command selects the shading pattern used to fill polygons (FP), rectangles (RA or RR), wedges (WG), or characters (CF). Use FT to enhance drawings using solid fill, shaded fill, parallel lines (hatching), cross-hatch, patterned (raster) fill, or PCL user-defined patterns.

FT *fill type[,option1[,option2;]]*

or

FT *[;]*

Parameter	Format	Functional Range	Default
fill type	clamped integer	1—4, 10, 11, 21, 22	1
option1, option2	clamped real	type dependent*	type dependent*

*Refer to the table following the parameter descriptions.

There are eight forms of fill types as shown above. 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.

Table 22-5

Fill Type	Description	Option1	Option2
1 and 2	solid black	ignored	ignored
3	hatching (parallel lines)	spacing of lines	angle of lines

Table 22-5 (continued)

4	cross-hatch	spacing of lines	angle of lines
10	shading	shading level	ignored
11	HP-GL/2 user-defined	raster-fill index	ignored
21	PCL cross-hatch patterns	pattern type	ignored
22	PCL user-defined	pattern ID	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 (an SC command is in effect).

For fill types 3 and 4, the *option2* parameter specifies an angle, in degrees, for the lines of the fill. This angle is a positive angle referenced 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 are drawn at the specified angle and the next set are drawn at that angle plus 90 degrees.

Note

A positive angle is an angle rotated from the +X-axis to the +Y-axis as shown below. A negative angle of rotation is in the direction of the +X-axis to the –Y-axis.

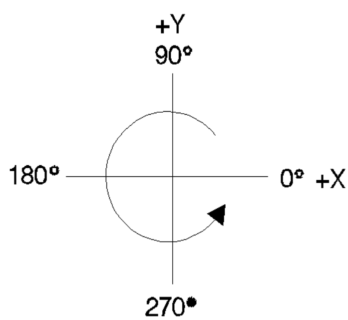


Figure 22-6 Positive Angle of Rotation

Note The relationship of the +X-axis to the +Y-axis (and the -Y-axis) can be changed as a result of scaling point or scaling factor changes, thus changing the direction of a positive (and negative) angle of rotation.

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 HP-GL/2 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.

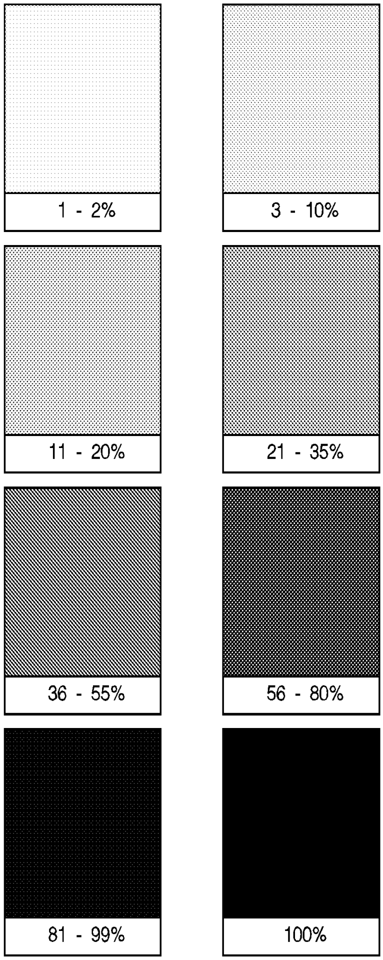


Figure 22-7 HP-Defined Shading Patterns

For fill type 11, the option1 parameter selects the corresponding HP-GL/2 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 uses solid fill.

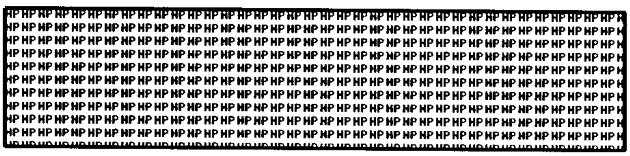


Figure 22-8 HP-GL/2 User-Defined Pattern

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.

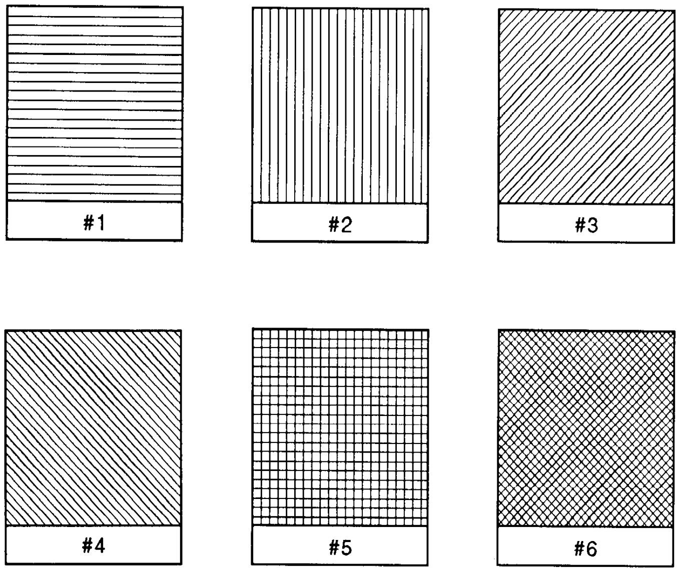


Figure 22-9 PCL Cross-Hatch Patterns

For fill type 22, the optional parameter selects the corresponding PCL user-defined pattern specified by way of the **?*c#W** command. Option1 specifies the pattern associated with the user-defined fill pattern. Option2 is ignored if present. See "User-Defined Pattern Graphics" in Chapter 13 for a discussion of PCL user-defined patterns.

Table 22-6 Example: Using the FT Command

?E	Reset the printer.
?%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 to enable printing.

Table 22-6 Example: Using the FT Command (continued)

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.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

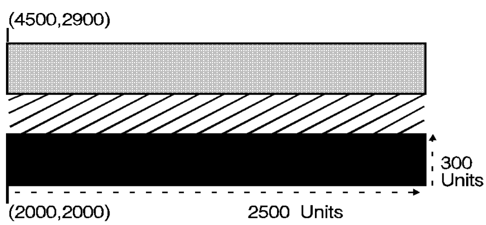


Figure 22-10

Table 22-7

Related Commands	Group
LA, Line Attributes LT,Line Type PW,Pen Width RF,Raster Fill Definition	*The Line and Fill Attributes Group*
FP, Fill Polygon RA, Fill Rectangle Absolute RR, Fill Rectangle Relative WG, Fill Wedge	*The Polygon Group*
CF, Character Fill Mode	*The Character Group*
SV, Screened Vectors	*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 specified by the kind parameter. The available values are listed in the following table and described under each attribute.

Table 22-8

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.

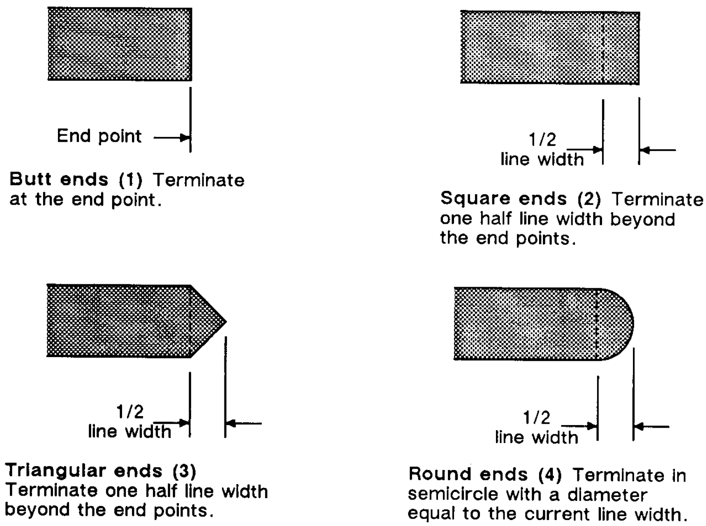


Figure 22-11 Four Line Ends

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.

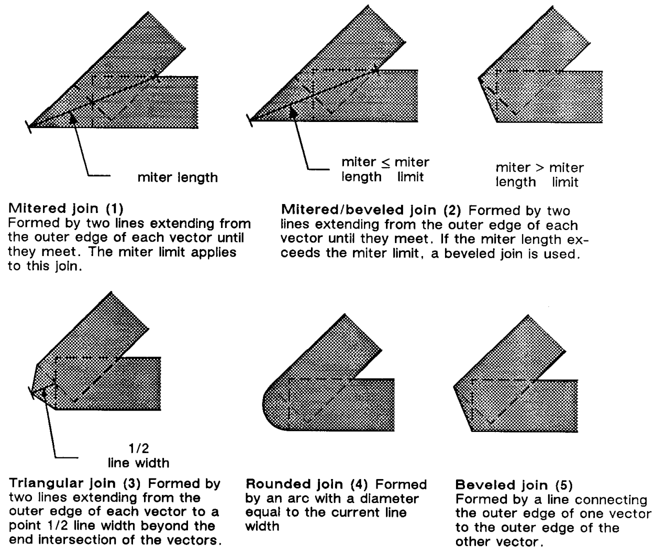


Figure 22-12 Five Line Joins

When you select 'no join' (LA2,6;), the currently selected line ends for the two lines merely overlap. Refer to the following illustration.

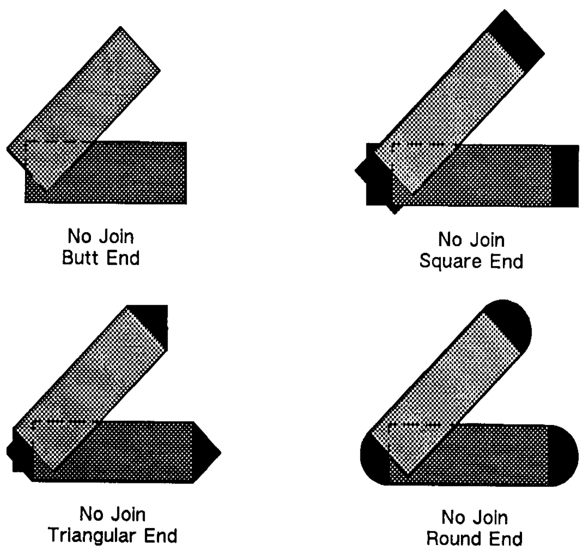


Figure 22-13 Overlapping Line Ends without Line Join Selection

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.

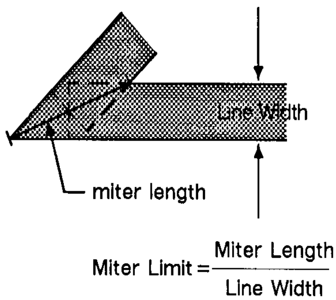


Figure 22-14 Miter Limit

When the miter length 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.

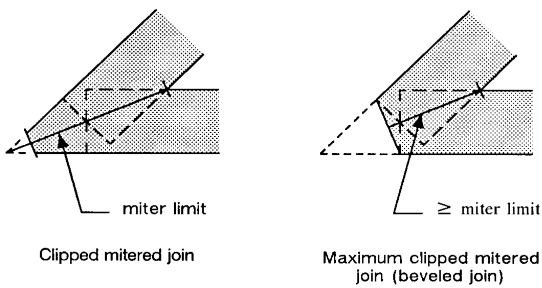


Figure 22-15 Miter Limit Clipping

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.

Table 22-9 Example: Using the LA Command

?E	Reset the printer.
?%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 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).
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

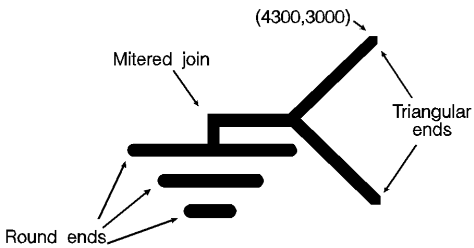


Figure 22-16

Table 22-10

Related Commands	Group
FT, Fill Type LT, Line 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 BR, Bezier Relative BZ, Bezier Absolute CI, Circle 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*

LT, Line Type

This command 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 these HP-GL/2 commands.
- The following commands clear current residue and vector end points:

Table 22-11 Commands that Affect LT1 - LT8

Command	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).

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:

Table 22-12 Commands that Affect LT99

Command	Group
AC,Anchor Corner LA,Line Attributes LT,Line Type (except (LT) and (LT99)) PW,Pen Width RF,Raster Fill Definition	*The Line and Fill* *Attributes Group*

Table 22-12 Commands that Affect LT99 (continued)

SP,Select Pen TR,Transparency Mode UL,User-Defined Line Type WU,Pen Width Unit Selection	
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*

Figure 22-17 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 attempts to draw the complete pattern in every chord (there are 72 chords in a circle using the default chord angle).

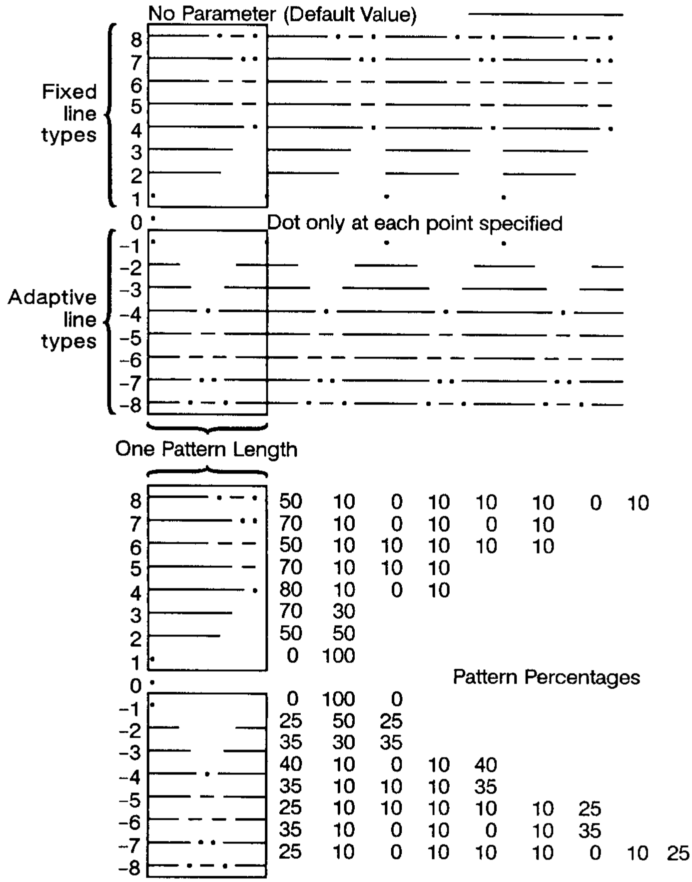


Figure 22-17 Line Type Patterns and Pattern Percentages

- **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 do not specify a length, the printer uses the last value specified.
- **Mode**- Specifies how the values of the pattern length parameter are interpreted. If you do not 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.

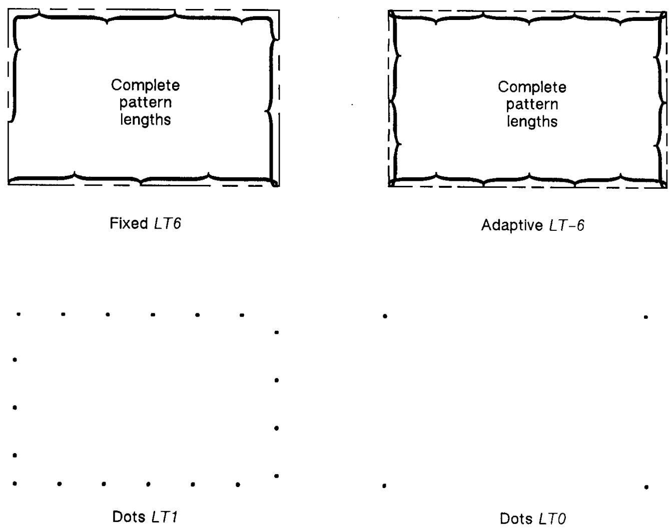


Figure 22-18 Fixed and Adaptive Line Types

Table 22-13

Related Commands	Group
FT,Fill Type PW,Pen Width UL,User-Defined Line Type	*The Line and Fill Attributes Group*

Table 22-13

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

This command 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[1]
pen	integer	0 or 1	1 (Black)

1. 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;” sets 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/Arc fonts 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.

Table 22-14 Example: Using the PW Command

?E	Reset the printer.
?%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 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).
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).

Table 22-14 Example: Using the PW Command (continued)

?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

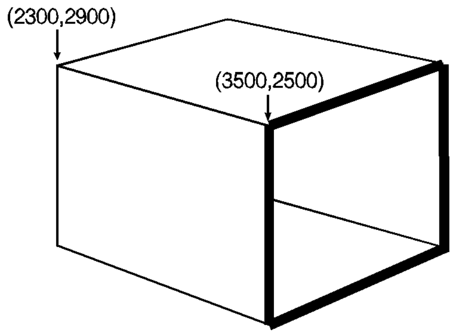


Figure 22-19

Table 22-15

Related Commands	**Group**
SP, Select Pen SV, Screened Vectors WU, Pen Width Unit Selection	*The Line and Fill Attributes Group*

RF, Raster Fill Definition

This command defines a rectangular pattern that may be used as area fill and for screened vectors (see the SV command). 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, [FT11,3] 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 at the current printer resolution.

- **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.

Table 22-16 Example: Creating and Printing a Fill Pattern

?E	Reset the printer.
?%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 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.
FT11,2;	Select the user-defined pattern having an index number of 2.

Table 22-16 Example: Creating and Printing a Fill Pattern

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.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

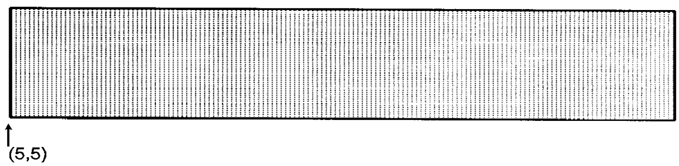


Figure 22-20

Table 22-17

Related Commands	**Group**
AC, Anchor Corner FT, Fill Type SV, Screened Vectors	*The Line and Fill Attributes Group*

SM, Symbol Mode

This command 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 symbol 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 non-printing 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.

Table 22-18 Example: Using the Symbol Mode Command

?E	Reset the printer.
?%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 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.
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.

Table 22-18 Example: Using the Symbol Mode Command

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.
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

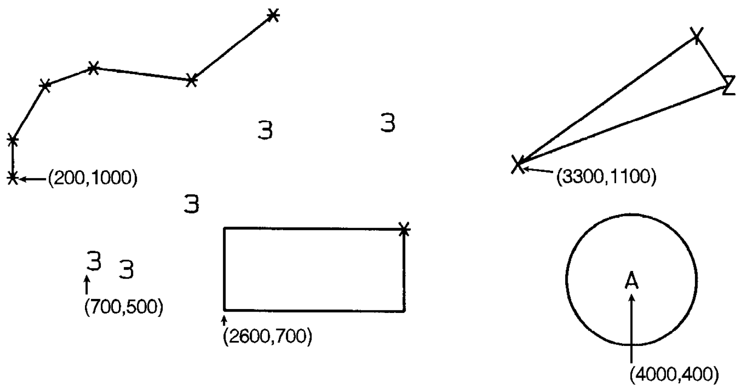


Figure 22-21

Table 22-19

Related Commands	Group
PA, Plot Absolute PD, Pen Down PE, Polyline Encoded PR, Plot Relative PU, Pen Up	*The Vector Group*

SP, Select Pen

This command selects the printer's 'logical' pen for subsequent plotting. An SP command must be included at the beginning of each command sequence to enable the printer to draw.

SP *pen number[;]*

or

SP *[;]*

Parameter	Format	Functional Range	Default
pen number	integer	0 or 1	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. To see a white pen on a non-white background you must set transparency mode to OFF (TR0;).
- **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. For more information on the Transparency Mode command, see the TR command description later in this chapter.

Table 22-20

Related Commands	**Group**
PW, Pen Width WU, Pen Width Unit Selection TR, Transparency Mode	*The Line and Fill Attributes Group*

SV, Screened Vectors

This command selects the type of screening (area fill) to be applied to vectors. Options include lines, hatching patterns (fill types 3 and 4), arcs, circles, edges of polygons, rectangles, wedges and PCL user-defined patterns. SV does not affect solid fill types, stroked characters, or edges of characters.

SV *[screen_type [,option1 [,option2]]][;]*

or

SV *[;]*

Parameter	**Format**	**Functional Range**	**Default**
screen_type	clamped integer	0, 1, 2, 21, 22	No screening (solid)
option1, option2	clamped integer	type dependent*	type dependent

* Refer to the table following the parameter descriptions.

There are four types of screen fill: shaded fill, HP-GL/2 user-defined raster fill, predefined PCL cross-hatch patterns, and PCL user-defined 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**— HP-GL/2 User-defined raster fill (RF command)
  - **21**— Predefined PCL cross-hatch patterns
  - **22**— PCL user-defined raster fill (RF command)
  - **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.

Table 22-21

Screen/Type	Description	Option1	Option2
1	Shaded Fill	% Shading (0 to 100)	Ignored
2	HP-GL/2 User-defined Raster Fill	Pattern Index	0—Pen 1 1—Current Pen
21	PCL Cross-hatch	1 - 6	Ignored
22	PCL User-defined Pattern Fill	Pattern ID	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 (option2 = **0** parameter) or the current pen (option2 = **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.

For Type 22, the optional parameter selects the corresponding PCL user-defined pattern specified by way of the **?*c#W** command. Option1 specifies the pattern associated with the user-defined fill pattern. Option2 is ignored if present. See “User-Defined Pattern Graphics” in Chapter 13 for a discussion of PCL user-defined patterns.

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 Reset, the defaults are assumed.

All screening patterns use the current anchor corner (see the AC command description).

Table 22-22

Related Commands	Group
AC, Anchor Corner FT, Fill Type PW, Pen Width RF, Raster Fill Definition WU, Pen Width Unit Selection	*The Line and Fill Attributes Group*

Table 22-23 POSSIBLE ERROR CONDITIONS:

Condition	Printer Response
1 or more parameters	ignores parameter

TR, Transparency Mode

This command 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; whatever was already written to the page “shows through” the white areas in the new image.

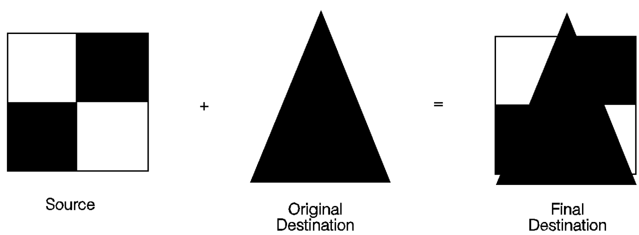


Figure 22-22 Transparency Mode = ON

When transparency mode is off, all source pixels are written to the destination, obscuring any underlying images.

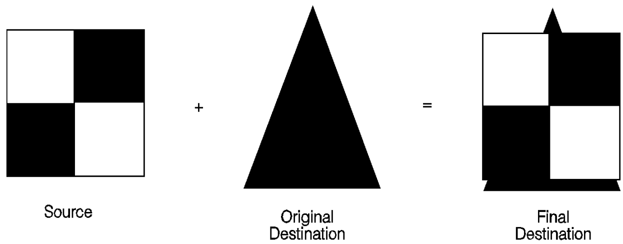


Figure 22-23 Transparency Mode = OFF

The transparency mode is defaulted by the ?E Reset, IN, or DF commands.

Note For more information on the transparency mode, see the discussion of the “Source Transparency Mode” in Chapter 13, *The PCL Print Mode*l.

UL, User-Defined Line Type

This command 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 have 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.

Table 22-24 Example: Using the UL Command

?E	Reset the printer.
?%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 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).
?%0A	Enter the PCL mode.
?E	Send a reset to end the job and eject the page.

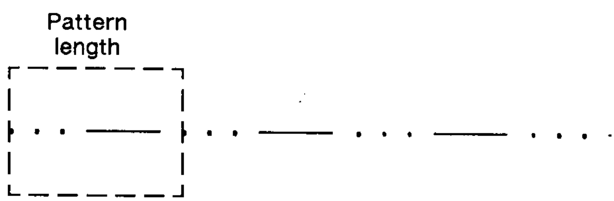


Figure 22-24

Table 22-25

Related Commands	**Group**
LA, Line Attributes LT, Line Type	*The Line and Fill Attributes Group*

Table 22-26 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

This command 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, 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.

Table 22-27

Related Commands	Group
PW, Pen Width SP, Select Pen	*The Line and Fill Attributes Group*

23 The Character Group

Introduction

When you create 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 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 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 23-1 The Character Group Commands

Command	**Summary**
AD, Alternate Font Definition	Specifies an alternate font for labeling.
CF,Character Fill Mode	Specifies how outline fonts are 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.

Table 23-1 The Character Group Commands (continued)

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.
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.

Table 23-1 The Character Group Commands (continued)

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. You can follow the LB (Label) command with virtually any characters, including non-printing control codes, such as a Line Feed or Carriage Return.

Note Symbol mode is a special case of a Label.

At the end of a label, you must use a special label terminator to signify the end of text. The default terminator is the ASCII end-of-text character ETX (decimal code 03), or you can define a terminator using the DT command. Without the label terminator in place, your printer continues to label your picture with all subsequent 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.

Note In the examples in this chapter, the left column identifies the command sequence data for the plot. If the label command text is too wide for the column width, is it continued on a second line (which might indicate a Carriage Return in the text). In actual use, the text should be presented on one line, with no carriage-returns. If a Carriage Return is required in the example, it is indicated as "*CR-LF*."

Table 23-2 Example: Printing Labels

$^{E}{}_{C}$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 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.
SS;	Select the standard font.
LBThis is Univers Italic*;	Print the next line of text in the newly specified font.
$^{E}{}_{C}$%0A	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

Figure 23-1

Moving to the Carriage Return Point

When you begin labeling, the current pen location is the Carriage Return point (the beginning of your line of text is the point at which the pen is “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 control code 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:

Table 23-3 Commands Updating Carriage Return Point to Current Location

Mnemonic	Command Name[1]
AA	Arc Absolute
AR	Arc Relative
AT	Absolute Arc (Three Point)
BZ	Bezier Absolute
BR	Bezier Relative
DF	Default Values
DI	Absolute Direction
DR	Relative Direction

Table 23-3 Commands Updating Carriage Return Point to Current Location (continued)

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)

1. 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.

Table 23-4 Commands Updating Carriage Return Point to Current Location

Control Code	DecimalCode
Backspace	8
Horizontal tab	9
Line feed	10
Carriage return	13
Shift Out[1]	14

Table 23-4 Commands Updating Carriage Return Point to Current Location (continued)

Shift In[2]	15
Space	32

1. Equivalent to Select Alternate Font (SA) command.
2. 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 (LO1). 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** — Solid fill, 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 nominal character width and CAP height 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 nominal character width and CAP height 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 with the SR command. Changing the character size changes the size of the CP (Character Plot) 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 font 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 (Character Plot) cell. The CP cell is not altered.

Character Spaces and Text Lines

You can use the Extra Space (ES) command to automatically increase or decrease spaces between all characters or lines. For example, ES can be used to increase space between every character in a label such as, M E M O R A N D U M), or to increase or decrease space between every line of text (such as double-spacing).

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. 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.

Figure 23-2 Label Orientation and Direction

Note Bit map characters are always printed orthogonally to the page (refer to Figure 23-17). Scalable characters print in the direction specified.

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.

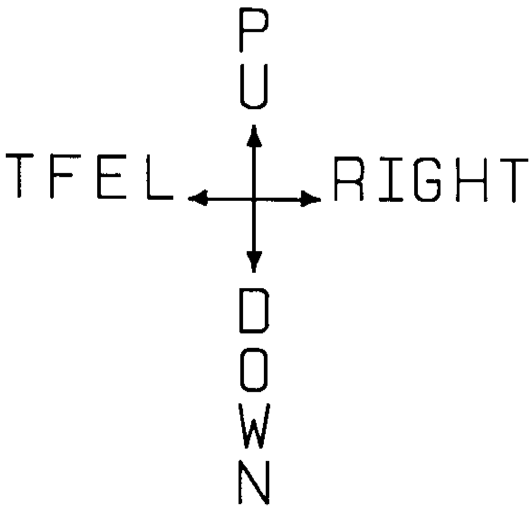


Figure 23-3 Define Variable Text Path Command

The Label Origin (LO) command 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.

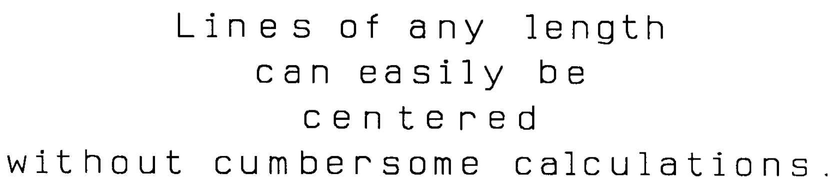


Figure 23-4 Label Origin Command

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 (Character Plot) cells, dividing by two, and using the CP command to ‘Backspace’ the required number of cells. The LO command saves 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 the special ‘print label terminator mode’ 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 non-printing ASCII end-of-text character ETX (decimal code 3). You must use the label terminator, or the printer prints 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 Figure 23-5.

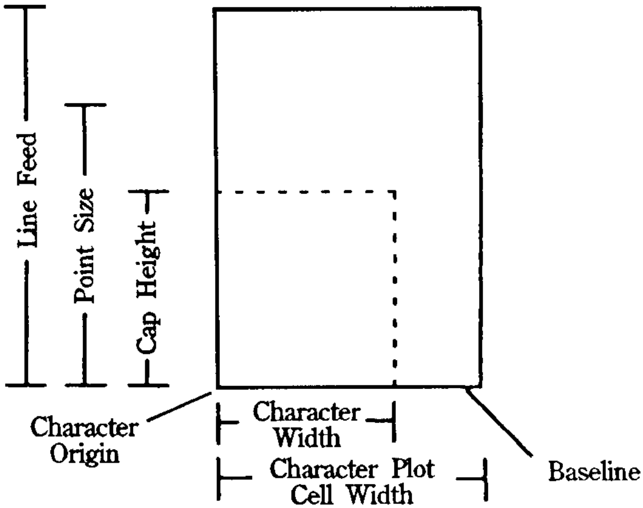


Figure 23-5 The Character Cell and HP-GL/2

Table 23-5

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.

Table 23-5 (continued)

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 Plot (CP) Cell Width	The distance from the left edge of one character to the beginning of the next character.
Character Plot (CP) 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 printer implements the following different types of fonts:

- Scalable outline font
- Bitmap font
- HP-GL/2 Stick and Arc font

These are described in more detail in “Using Fonts” later in this chapter. Figure 23-6 and Figure 23-7 show 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.

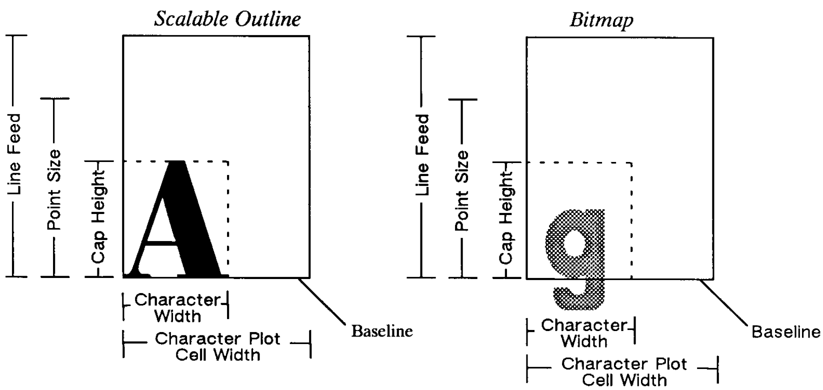


Figure 23-6 Scalable and Bitmap Character Cell

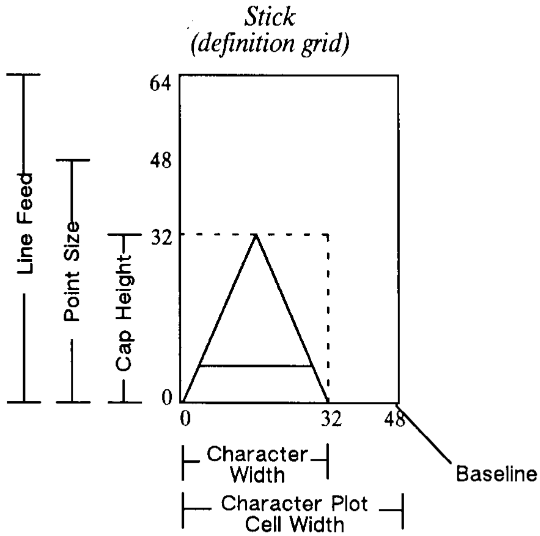


Figure 23-7 Stick Font Character Cell

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 (Character Plot) cell.

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 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 SI, SR, or SL, but they can be used with all of the other commands in this chapter (see the SB command). Bitmap characters are always placed in an orthogonal direction (to the PCL page) closest to the print direction established using the DI and DR commands (see Figure 23-17).
- **Stick and Arc fonts** — 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 Stick font is fixed-spaced, and the Arc font is proportional.

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.

Figure 23-8 and Figure 23-9 show the difference between fixed-spaced and proportional fonts.

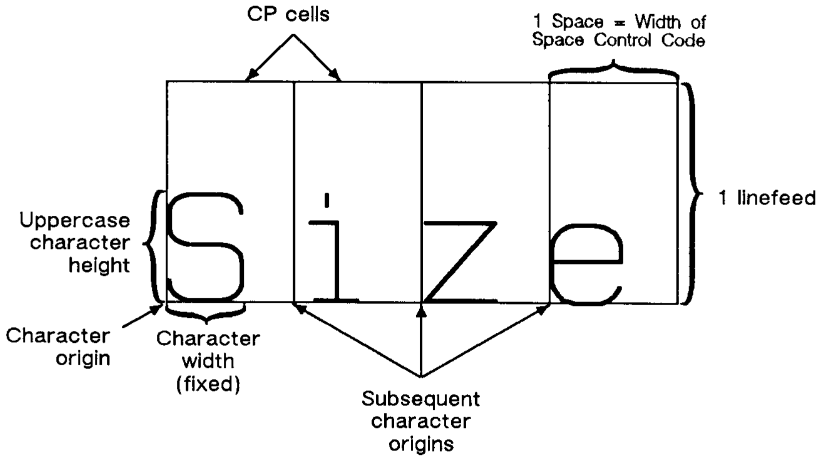


Figure 23-8 Fixed-Spaced Font

With proportional fonts, the actual space occupied by each character varies according to the character's width (Figure 23-9).

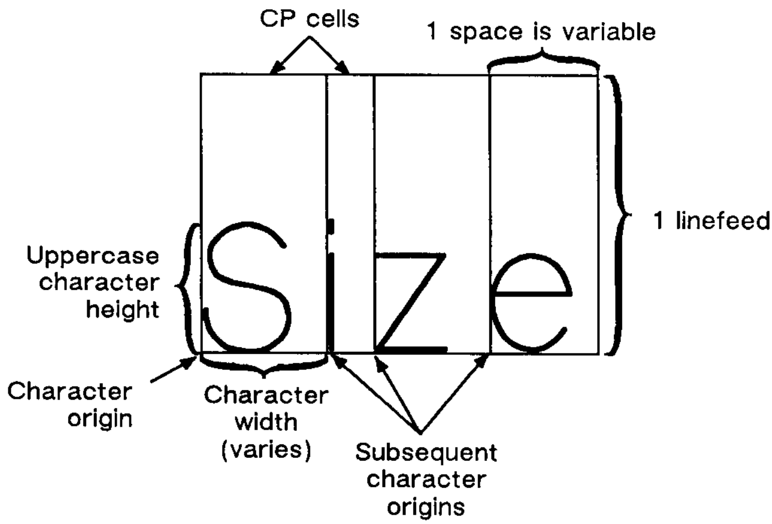


Figure 23-9 Proportional Font

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 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

This command is similar to the Standard Font Definition (SD) command that defines the primary HP-GL/2 font. In addition the AD command defines an alternate HP-GL/2 font and its characteristics: font spacing, pitch, height, posture, stroke weight, and typeface. It allows the font characteristics to be assigned to the secondary (alternate) font definition. 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 allows you to define another font and its font characteristics.

- **No Parameters** — Defaults the alternate font characteristics to that of the Stick font (see the following table).
- **Kind** — Specifies the characteristic for which you are setting a value (see the following table).

Table 23-6

Kind	Characteristic	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

Table 23-6 (continued)

6	Stroke Weight	0	medium
7	Typeface	48	Stick (fixed vector)

- **Value** — Defines the properties of the characteristic specified by the *kind* parameter.

Note

When selecting fonts, the different characteristics (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 characteristics, see the “Font Selection by Characteristic” discussion in Chapter 8.

Note

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):

$$\text{AD}\underbrace{1,21}_{\text{Symbol Set}},\underbrace{2,1}_{\text{Font Spacing}},\underbrace{4,30}_{\text{Height}},\underbrace{5,1}_{\text{Posture}},\underbrace{6,3}_{\text{Stroke Weight}},\underbrace{7,4101}_{\text{Typeface}}$$

Note that the *pitch* parameter is missing in the above command because the designated font is proportionally spaced.

Table 23-7

Related Commands	**Group**
FI, Select Primary Font FN, Select Secondary Font LB, Label	*The Character Group*

Table 23-7 (continued)

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 TD, Transparent Data	

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 specified by the FT command (shading, hatching, cross-hatch, 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 renders 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 Characteristics 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 Characteristics 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 is used to edge the character (black or white).
- **0**—No 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 hatch is selected using the PW (Pen Width) command. Due to the way hatching and cross-hatch lines are drawn, they may extend beyond the character outline by up to 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).

Figure 23-10 Character Fill Overflowing

Table 23-8 Example: Using the CF 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 (black).
SD1,21,2,1,4,140, 5,0,6,3,7,4148;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.

Table 23-8 Example: Using the CF Command (continued)

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”.
$^{E}{}_{C}$%0A	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

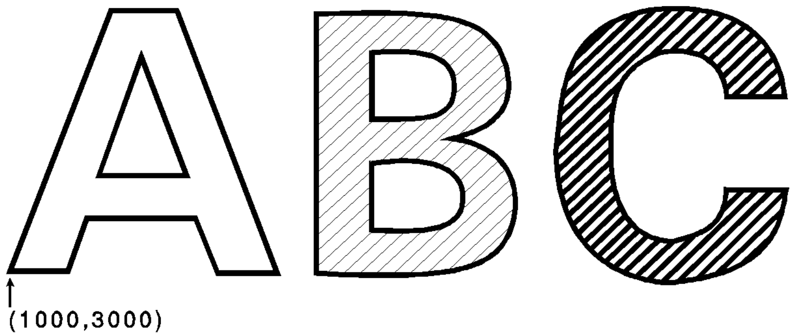


Figure 23-11

Table 23-9

Related Commands	**Groups**
DI, Absolute Direction DR, Relative Direction SB, Scalable or Bitmap Fonts	*The Character Group*
FT, Fill Type	*The Line and Fill Characteristics Group*

CP, Character Plot

This command 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 (Character Plot) 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 does not 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 moves 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 is used.

- **Lines** — Specifies the number of lines the pen moves relative to the current pen location. Positive values specify the number of lines the pen moves 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.

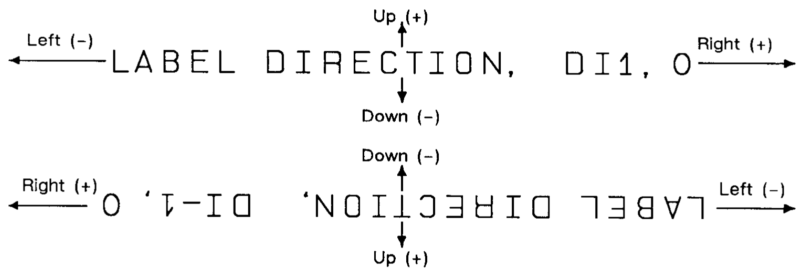


Figure 23-12 Interaction of Label Direction and Parameter Sign

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).

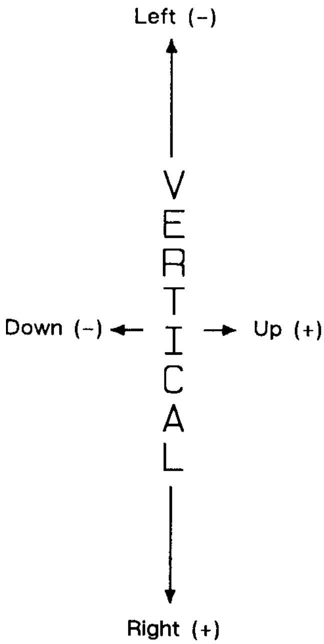


Figure 23-13 Labeling with a Vertical Text Path

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 using a CP command without parameters to emulate a CR-LF.

Table 23-10 Example: Using the CP 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 (black).

Table 23-10 Example: Using the CP Command

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 is placed just above the line.
DT$,1;	Define a label terminator ($) and specify that it does not print.
SD1,21,2,1,4,14,5, 0,6,3,7,4148;SS;	Designate a 14-point Univers Bold font and select it.
LBABOVE THE LINE$;	Print the first line of text. The label text is shown on two lines due to the column width restriction. When coding a single line label, it should all be placed on one line.
PA2500,2500; WG20,0,360;	Move the pen to (2500,2500) and draw a dot marking the new Carriage Return point (360° black-filled wedge with a diameter of 20 plu).
CP0,-.95LBBELOW THE LINE*CR-LF* WITH A NEAT$;	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.

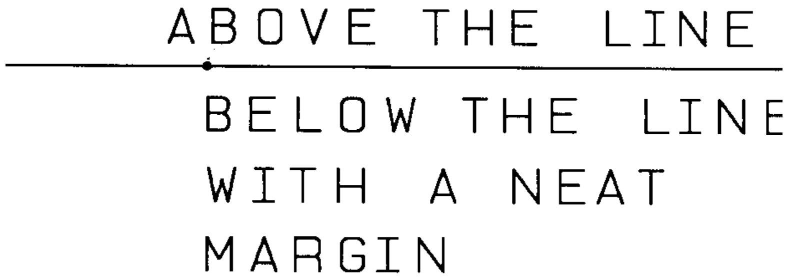


Figure 23-14

Table 23-11

Related Commands	Group
DI, Absolute Direction	*The Character Group*
DR, Relative Direction	
DV, Define Variable Text Path	
ES, Extra Space	
LB, Label	
LO, Label Origin	
SB, Scalable or Bitmap Fonts	
SI, Absolute Character Size	
SR, Relative Character Size	

DI, Absolute Direction

This command specifies the slope or direction at which characters 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 *[;]*

Table 23-12

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.

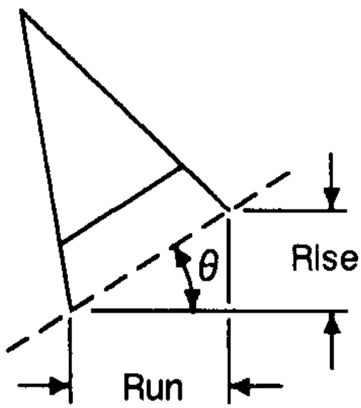


Figure 23-15 Character Slope Rise and Run

When plotting in horizontal mode (you have not 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.

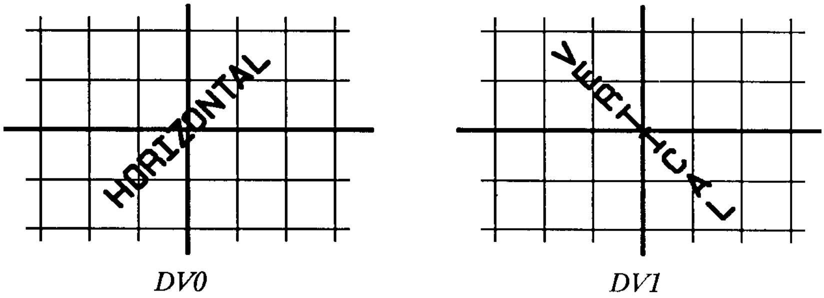


Figure 23-16 Effect of Horizontal and Vertical Text Paths

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.

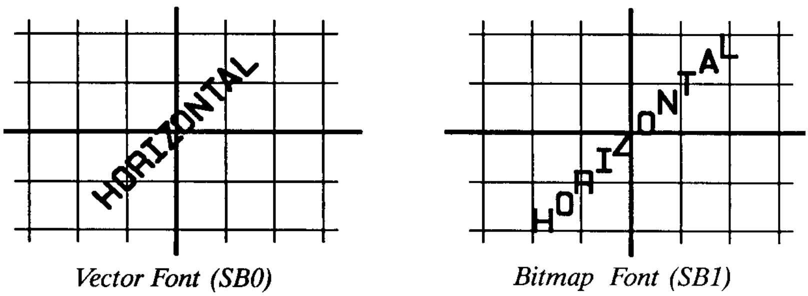


Figure 23-17 Scalable Versus Bitmap Variable Text Path Printing

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.

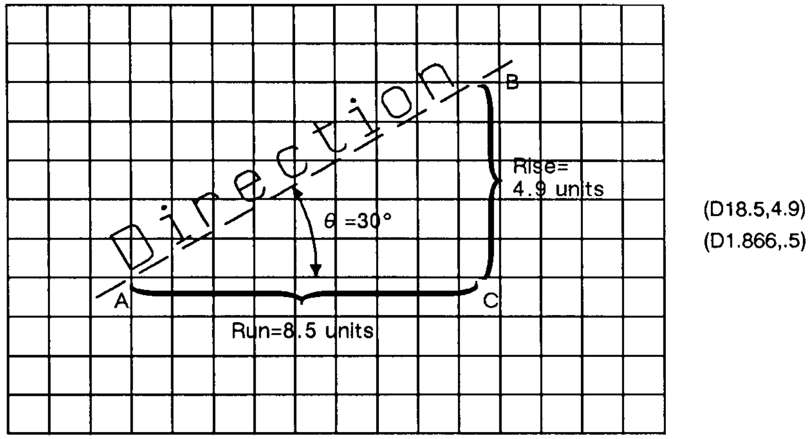


Figure 23-18 Label Print Direction Rise and Run

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 is (DI8.5,4.9).

If you know the angle (θ), you can use the trigonometric functions sine (sin) and cosine (cos). In this example, θ = 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 is drawn in the same direction as shown in the previous illustration.

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.

Table 23-13

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 is in.

Table 23-14 Example: Using the DI 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 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.

Table 23-14 Example: Using the DI Command (continued)

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.
$^{E}{}_{C}$%0A	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

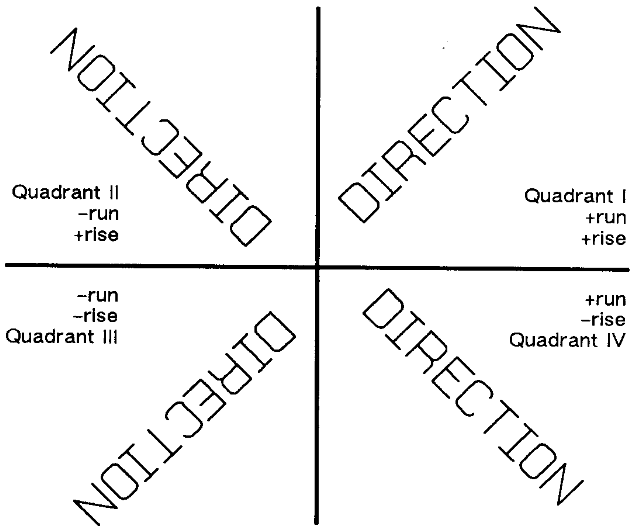


Figure 23-19 Varying Print Direction with DI Command Parameter Sign

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.

Table 23-15 Example: Another DI Example

$^{E}{}_{C}$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 to enable printing.
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; LB1993#;	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.
$^{E}{}_{C}$%0A	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

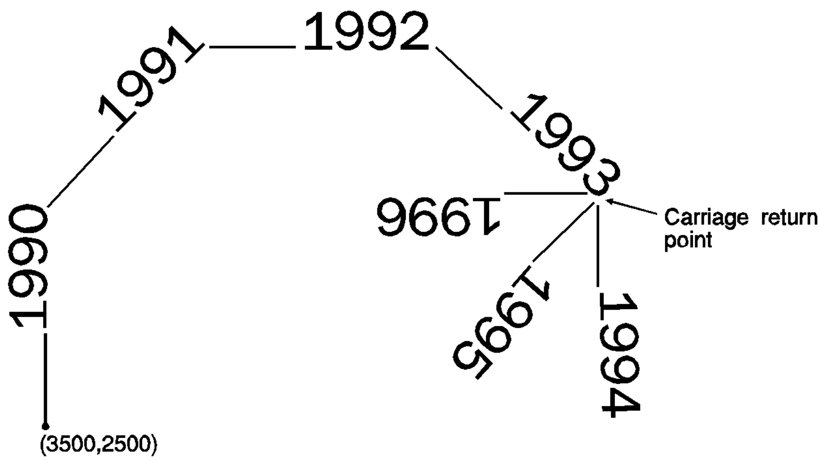


Figure 23-20

Table 23-16

Related Commands	Group
CF, Character Fill Mode CP, Character Plot DR, Relative Direction DV, Define Variable Text Path LB, Label SB, Scalable or Bitmap Fonts SI, Absolute Character Size SL, Character Slant SR, Relative Character Size	*The Character Group*

Table 23-17 POSSIBLE ERROR CONDITIONS

Error Condition	Printer Response
both parameters = 0 or number out of range	ignores command

DR, Relative Direction

This command 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 *[;]*

Table 23-18

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:

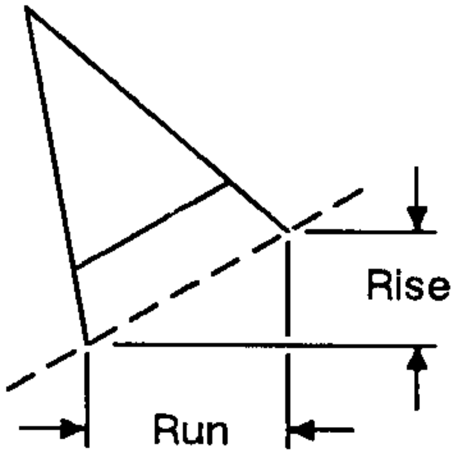


Figure 23-21 Rise and Run Parameters

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 ÷ 100 × ($P2_X$ – $P1_X$)

actual rise = rise parameter ÷ 100 × ($P2_Y$ – $P1_Y$)

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.

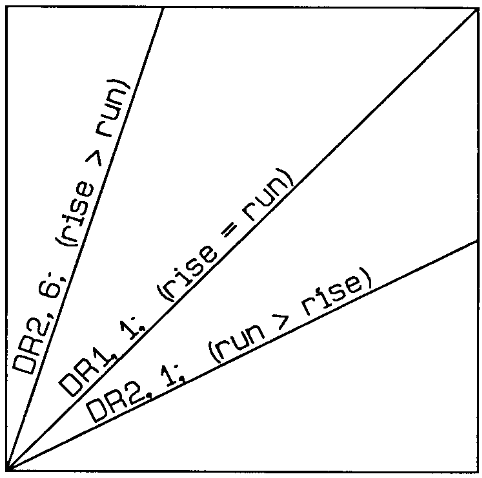


Figure 23-22 Effects of Different Rise/Run Parameters

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 remains parallel to an imaginary line running from P1 to P2 (see illustration below).

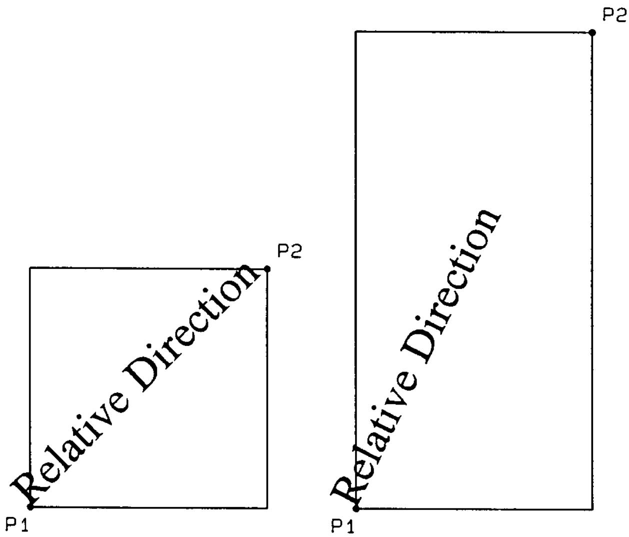


Figure 23-23 Effects of Scaling on Label Direction

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.

Table 23-19

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 is in.

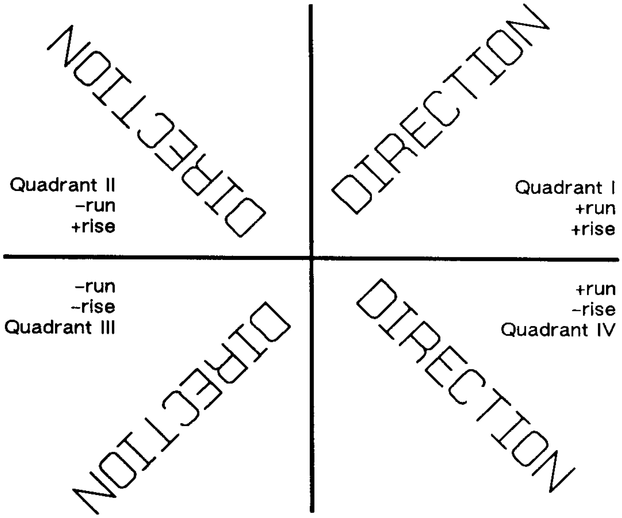


Figure 23-24 Varying Print Direction with DR Command Parameter Sign

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 are drawn parallel to the directional line, not necessarily on it.

Table 23-20 Example: Using the DR 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 (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.
${}^{E}{}_{C}$%0A	Enter the PCL mode.
${}^{E}{}_{C}$E	Send a reset to end the job and eject the page.

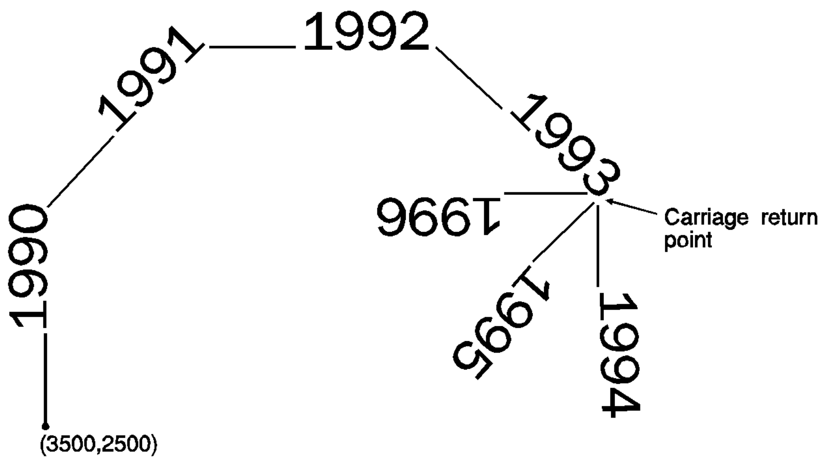


Figure 23-25

Table 23-21

Related Commands	Group
CF, Character Fill Mode CP, Character Plot DI, Absolute Direction DV, Define Variable Text Path LB, Label SB, Scalable or Bitmap Fonts SI, Absolute Character Size SL, Character Slant SR, Relative Character Size	*The Character Group*
IP, Input P1 and P2 IR, Input Relative P1 and P2	*The Configuration/Status Group*

Table 23-22 POSSIBLE ERROR CONDITIONS:

Error Condition	Printer Response
both parameters = 0 or number out of range	ignores command

DT, Define Label Terminator

This command 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 (non-printing)

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 terminator to ETX (not a semicolon) and the mode to non-printing (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.

Table 23-23

Related Commands	**Group**
LB, Label TD, Transparent Data	*The Character Group*

DV, Define Variable Text Path

This command 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) Within a label, 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) Within a label, each character begins below the previous character. This is a vertical text path (unless altered by DI or DR).
  - **2 — –180 degrees.**(Left) Within a label, 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) Within a label, 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.

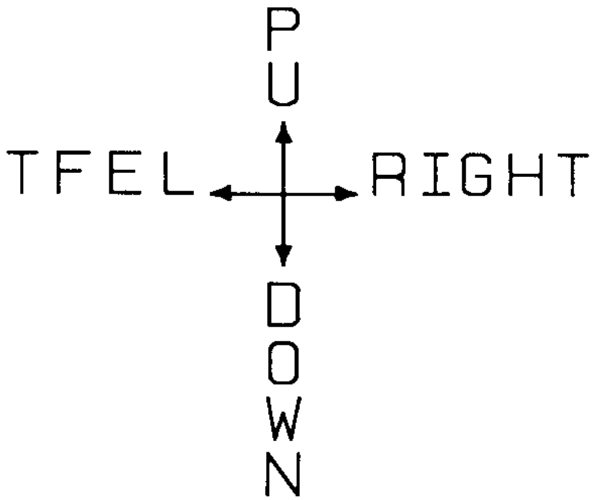


Figure 23-26 Four Text Paths

- **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.

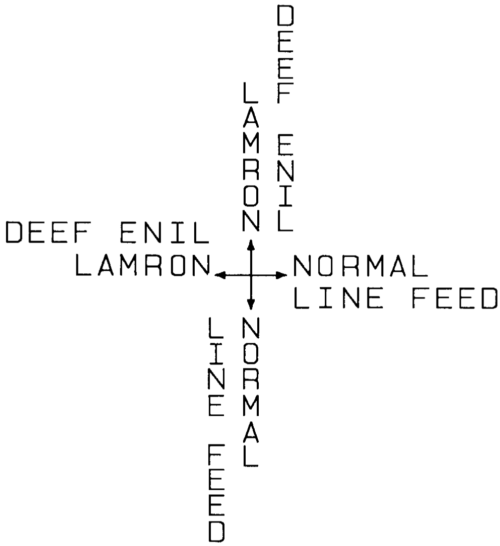


Figure 23-27 DV Command Character Position for Normal (0) Parameter

- **0 — +90 degrees.**(Reverse Line Feed) Sets the direction of Line Feeds +90 degrees with respect to the text path.

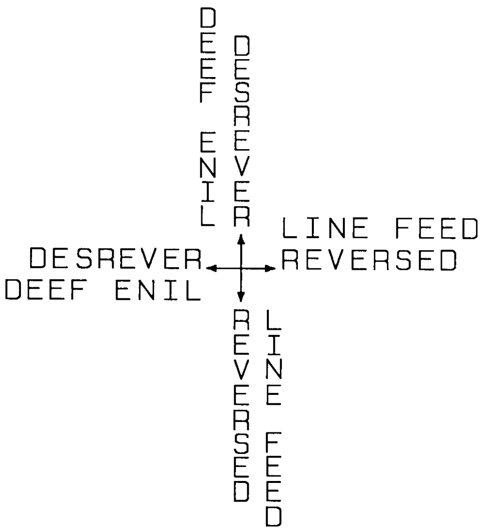


Figure 23-28 DV Command Character Position for Normal (90) Parameter

Example:Using theDV Command

The following example illustrates how Line Feeds and Carriage Returns affect vertical labels. Horizontal labels are shown for comparison.

Table 23-24 Example: Using the DV 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 to enable printing.
PA2000,3000;DV1;	Specify absolute plotting and move to (2000,3000). 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 *LF@*;	Print GHI, followed by a Line Feed.
LO3;	Change the label Origin to 3 (the default LO1 was used prior to this).
LBJKL*@*	Print JKL.
LO1;	Return to the default label Origin (LO1).
PA4000,3000;DV0;	Move to (4000,3000) 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).

Table 23-24 Example: Using the DV Command (continued)

${}^{E}{}_{C}$%0A	Enter the PCL mode.
${}^{E}{}_{C}$E	Send a reset to end the job and eject the page.

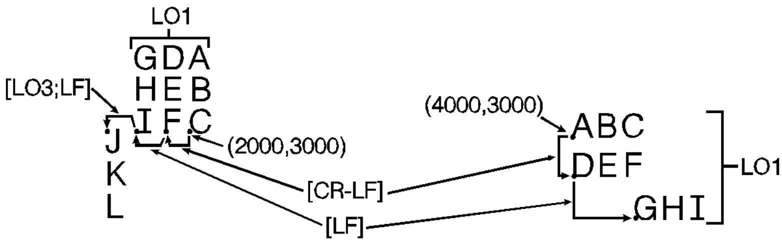


Figure 23-29

Table 23-25

Related Commands	**Group**
CP, Character Plot DI, Absolute Direction DR, Relative Direction LB, Label LO, Label Origin	*The Character Group*

Note Used with specific LO (Label Origin) settings, labels can be concatenated (see LO command description, later in this chapter).

ES, Extra Space

This command 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.

Table 23-26 Example: Using the ES 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 to enable printing.

Table 23-26 Example: Using the ES Command (continued)

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.

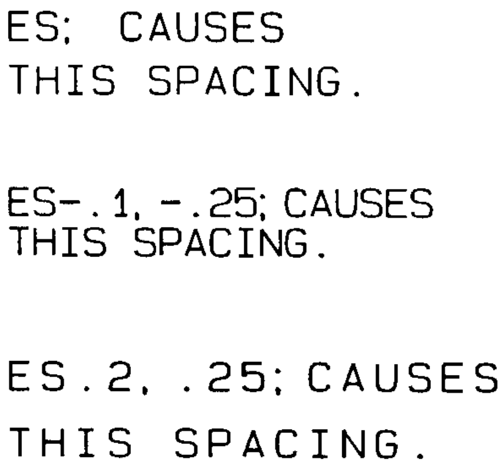


Table 23-27

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 (the font characteristics are assigned to the 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. 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 requested font is present, the primary font characteristics are set to those of the requested font. If the selected font is proportionally spaced, the pitch characteristic is not changed.

Notes

This command does not select the font for label printing if you are currently using the alternate font.

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. This affects the performance of certain HP-GL/2 commands. Refer to SB command later in this chapter.

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.

Table 23-28 Example: Using the FI Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$*c15D	Specify a font ID number of 15.
$^{E}_{C}$(s1p18v0s3b4148T	Select an 18-point Univers Bold font as the primary font.
$^{E}_{C}$*c6F	Assign the currently selected font as a temporary font with the current ID number (15).
$^{E}_{C}$%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 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. (Note, label text should not contain carriage-returns or any control codes unless specifically desired for plotting. It is shown here on two lines (with a Carriage Return) for convenience only.
SD4,18;FI15;SS:	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. Then select the primary font for printing.
LBLaserJetPrinters#;	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.

Figure 23-30

Table 23-29

Related Commands	Group
AD, Alternate Font Definition LB, Label SA, Select Alternate Font SD, Standard Font Definition SS, Select Standard Font	*The Character Group*
$^{E}{}_{C}$(#X, Select Primary Font by ID # $^{E}{}_{C}$)#X, Select Secondary Font by ID # $^{E}{}_{C}$)*c#D, Assign Font ID $^{E}{}_{C}$)*c6F, Font Control, Copy Assign	*PCL Commands*

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 characteristics are assigned to the secondary font). The font must be accessible to the printer as either a resident font, a downloaded font, or a loaded cartridge font. 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 requested font is present, the secondary font characteristics are set to those of the requested font. If the selected font is proportionally spaced, the pitch characteristic is not changed.

Notes This command does not select the font for label printing if you are currently using the standard font.

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. This affects the performance of certain HP-GL/2 commands. Refer to SB command later in this chapter.

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.

Table 23-30 Example: Using the FN Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$*c28D	Specify a font ID number of 28.
$^{E}_{C}$(s1p18v0s3b4148T	Select an 18-point Univers Bold font as the primary font.
$^{E}_{C}$*c6F	Assign the currently selected font as a temporary font with the current ID number (28).
$^{E}_{C}$%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 to enable printing.
PA1500,1500;	Move to location (1500,1500).
DT#;	Define “#” as a label terminator (non-printing).

Table 23-30 Example: Using the FN Command

LBLaserJetPrinters *CR-LF*#;	Print “LaserJet Printers” in the currently selected font, which is the default Stick font; Carriage Return/Line Feed.
AD4,18;FN28;SA;	Use the AD command to designate an 18-point font from within HP-GL/2 mode; then assign the PCL font with font ID number of 28 as the secondary font. Then select the font.
LBLaserJetPrinters#;	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.

Figure 23-31

Table 23-31

Related Commands	Group
AD, Alternate Font Definition LB, Label SA, Select Alternate Font SD, Standard Font Definition SS, Select Standard Font	*The Character Group*

Table 23-31

$^{E}{}_{C}$*c#D, Font ID (assign) $^{E}{}_{C}$*c6F, Font Control, Copy Assign $^{E}{}_{C}$(#X, Designate Font # as Primary $^{E}{}_{C}$)#X, Designate Font # as Secondary	*PCL Commands*

LB, Label

This command 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**— ASCII 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 non-printing 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 Appendixes A and B of the *PCL 5 Comparison Guide* 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 the label mode. If you do not use the label terminator, everything following the LB mnemonic is printed in the label, including other commands. The default label terminator is the non-printing end-of-text character ETX (decimal code 3). You can define a different terminator using the DT command.

Table 23-32 Example: Printing Text with the LB 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 to enable printing.
PA2500,2500;	Move to absolute location (2500,2500).
DT*;	Specify the asterisk (*) as the label terminator.
SD1,21,2,1,4,25,5,0,6,3,7,4148;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.

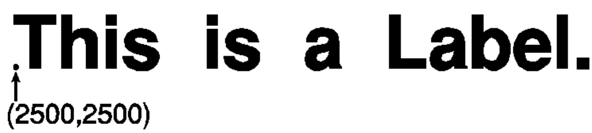


Figure 23-32

Table 23-33

Related Commands	**Group**
AD, Alternate Font Definition 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 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	*The Character Group*

LO, Label Origin

This command 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 11 to 19 21	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.

The label position 21 provides a PCL-compatible label origin. The character(s) are printed at the same location as in PCL.

Notes

Label origins do not change text path. To change the text path, use the Define Variable Text Path (DV) command.

Label position 21 is not shown in Figure 23-33 because the exact location is dependent on the PCL position.

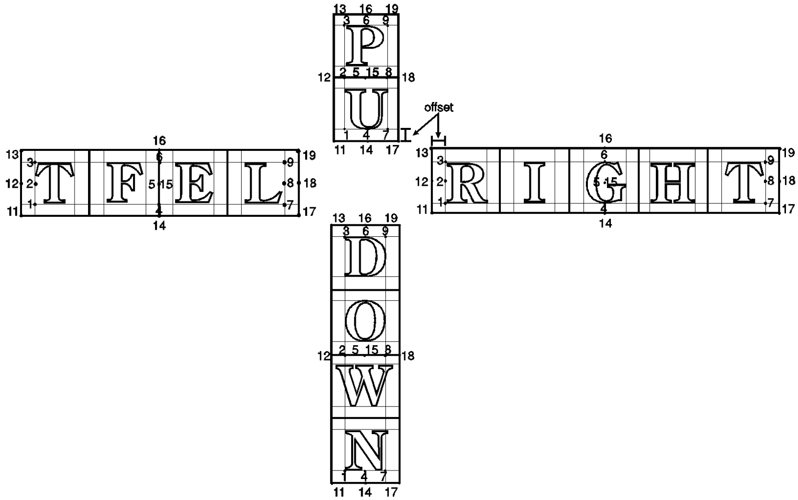


Figure 23-33 Label Origin Positioning

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.

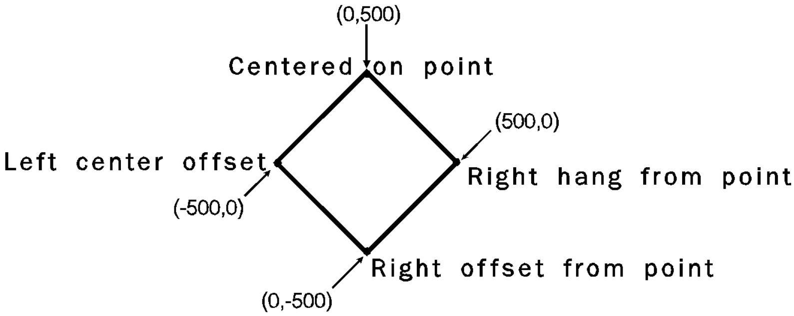
An LO command remains in effect until another LO command is executed, or the printer is initialized or set to default conditions.

Table 23-34 Example: Using the LO Command

$^{E}{}_{C}$E	Reset the printer.
$^{E}{}_{C}$%0B	Enter HP-GL/2 mode.
IN;	Initialize 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.

Table 23-34 Example: Using the LO Command (continued)

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, “Right hang from point”.
$^{E}{}_{C}$%0A	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.



The pen position at the end of the label string depends on whether two successive LB commands concatenate together as though only one label was given. The DV/LO combinations which permit concatenation are:

Table 23-35

Text Path	Label Origin
DV0 (right)	LO's 1,2,3, and 11,12,13,21
DV1 (down)	LO's 3,6,9, and 13,16,19
DV2 (left)	LO's 7,8,9, and 17,18,19
DV3 (up)	LO's 1,4,7, and 11,14,17,21

The following two rules determine where the pen is positioned after a label string is drawn. Rule 1 is for DV/LO combinations which permit concatenation; rule 2 clarifies other DV/LO combinations:

1 If a concatenation combination is specified, the pen position is updated to give the normal delta X space between the last character of the first label, and the first character of the second label.

Note For proportional fonts that use a pair-wise spacing table, the pen position is updated using an average delta X space.

2 If a non-concatenation combination is specified, the pen position that existed immediately prior to the LB command is restored.

Table 23-36

Related Commands	Group
CP, Character Plot DV, Define Variable Text Path LB, Label	*The Character Group*

SA, Select Alternate Font

This command 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 symbol 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 symbol 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.

Table 23-37

Related Commands	Group
AD, Alternate Font Definition DT, Define Label Terminator 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 are used for labeling commands. It allows you to restrict font selection to only scalable fonts and the Stick and Arc fonts, 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 bitmapped 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:

Table 23-38 AffectedCommands

Command	Limitation
CF	Bitmapped characters cannot be edged.
DI,DR	Bitmapped characters can be printed only with orthogonal directions (0°, 90°, 180°, or 270°).
SI,SR	Sizes of bitmapped fonts are approximate only.
SL	The Slant command is ignored for bitmapped fonts.
AD,SD,CP,LB	

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 characteristics: 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 characteristics.
- **Kind**— Specifies the characteristic for which you are setting a value.

Table 23-39

Kind	Characteristic	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 properties of the characteristic specified by the *kind* parameter.

Note When selecting fonts, the different characteristics (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 characteristics, see the “Font Selection by Characteristic” 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 characteristic defines the set of characters to be used in the alternate font. For a complete list of symbol set values, refer to Appendix C of the *PCL 5 Comparison Guide*.

Note

Stick font is available only in ASCII, Roman-8, and Roman Extension symbol sets.

Kind 2: Font Spacing

The font spacing characteristic 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.

Table 23-40 Kind 2: Font Spacing Values

Font SpacingValue	Description
0	fixed spacing (default)
1	proportional spacing

Kind 3: Pitch

The pitch characteristic is a horizontal measurement defining the number of characters-per-inch for fixed-spaced fonts.

Note

When selecting proportional fonts, do not include pitch in the font definition command (SD or AD).

Table 23-41 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 SD and 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 characteristic defines the font point size (the height of the character cell). (Fixed-spaced fonts ignore height; the point size is calculated using the font pitch.) There are approximately 72 points in an inch. Note that with the font definition command (SD or AD)., you cannot create tall, skinny characters or short, wide characters; the character aspect ratio is preserved.

Table 23-42 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.

Table 23-43 Kind 5: Posture Values

Posture Values	Description
0	Upright (Default)
1	Italic
2	Alternate Italic

Kind 6: Stroke Weight

The stroke weight characteristic 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. If the aspect ratio of the P1/P2 rectangle is maintained as P1 and P2 are moved, a medium stroke weight font still looks "medium" after it is enlarged or reduced.

Note Available stroke weights are the same as those available within PCL.

Table 23-44 Kind 6: Stroke Weight Values

Stroke WeightValue	Description
-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
9999	Stick font only[1]

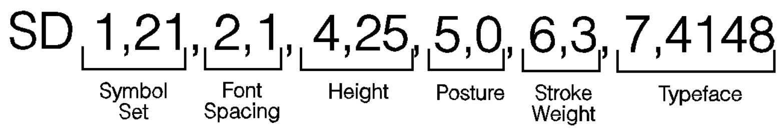
1. When the Stick font (typeface 48) is selected, the value 9999 renders it using the current pen width.

Kind 7: Typeface

The typeface characteristic selects the font's design style, which gives the font its distinctiveness. Typefaces can only be printed if the printer has access to them; if they are internal fonts, are soft fonts that are downloaded to the printer, or if they reside in a font cartridge or SIMM that is plugged into the printer. PCL 5 LaserJet printers have at least three internal scalable typefaces: Univers (4148), CG Times (4101), and the Stick font (48). (For more information about the printer's internal fonts, refer to Chapter 2 of the *PCL 5 Comparison Guide*.)

Example:Using the SD Command

The following example shows the SD 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):



Note that the *pitch* parameter is missing in the above command because the designated font is proportionally spaced.

Table 23-45

Related Commands	**Group**
AD, Alternate Font Definition DT, Define Label Terminator 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

This command 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.

Notes

If the (SB1;) command is in effect, an SI command may not be executed accurately. Labels are 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).

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.

Table 23-46 Example: Using the SI 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 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, 5,0,6,0,7,4148;SS;	Designate a 12-point Univers font and select it.

Table 23-46 Example: Using the SI Command (continued)

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”.
$^{E}{}_{C}$%0A	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

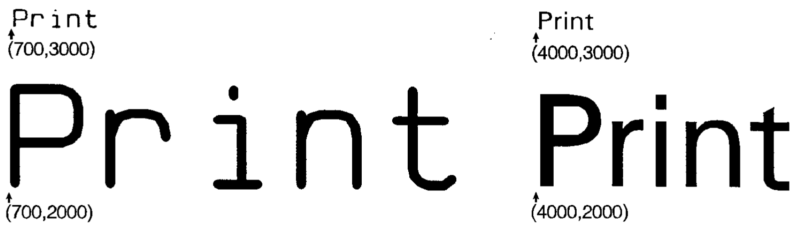


Figure 23-34

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#;

Figure 23-35

A negative height parameter mirrors labels in the top-to-bottom direction.

SI.6,-.9;LBPrint#;

Figure 23-36

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#;

Figure 23-37

Table 23-47

Related Commands	**Group**
AD, Alternate Font Definition	*The Character Group*
CP, Character Plot	
DI, Absolute Direction	
DR, Relative Direction	
LB, Label	
SB, Scalable or Bitmap Fonts	
SD, Standard Font Definition	
SR, Relative Character Size	

SL, Character Slant

This command specifies the slant at which labels are drawn. Use SL to create slanted text for emphasis, or to re-establish 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 *[;]*

Table 23-48

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.

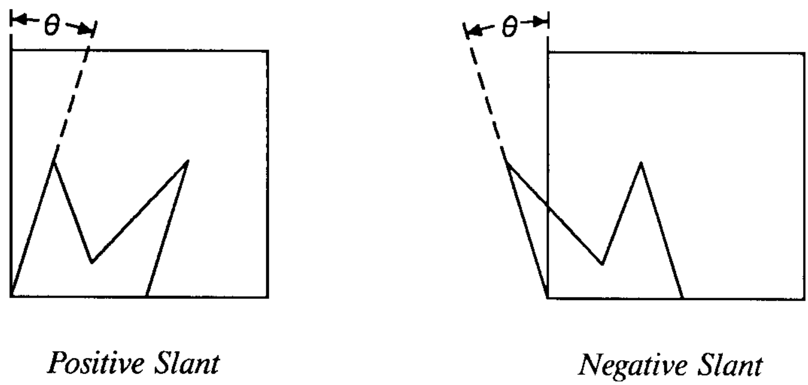


Figure 23-38 Character Slant

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.

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 Many languages require that tangents be calculated in radians. Consult your programming language documentation if you are not familiar with your language's tangent function.

Table 23-49 Example: Using the SL 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 to enable printing.
SD1,21,2,1,4,25, 5,0,6,0,7,4101;	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 (#).
SL.36;LBSlant#;	Set the slant angle for 20° from vertical (forward slant), and print "Slant."

Table 23-49 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.”
$^{E}{}_{C}$%0A	Enter the PCL mode.
$^{E}{}_{C}$E	Send a reset to end the job and eject the page.

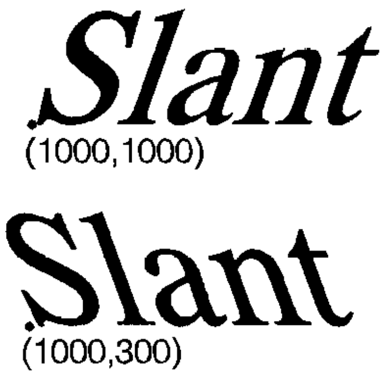


Figure 23-39

Table 23-50

Related Commands	**Group**
SB, Scalable or Bitmap Fonts DI, Absolute Direction DR, Relative Direction LB, Label	*The Character Group*

SR, Relative Character Size

This command 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:

actual width = (width parameter/100) x ($P2_X – P1_X$)

actual height = (height parameter/100) x ($P2_Y – P1_Y$)

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:

width = || (2/100) x (6956 – (–6956)) = 278.24 plu or 0.695 cm

height = (3.5/100) x (4388 – (–4388)) = 307.16 plu or 0.768 cm

If you changed P1 and P2 settings to (100,100) and (5000,5000), but did not change the SR parameters, the character size would change as follows:

width = (2/100) x (5000 – 100) = || 98 plu or 0.245 cm

height = (3.5/100) x (5000 – 100) = 171.5 plu or 0.429 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 produces 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.

Table 23-51 Example: Using the SR 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 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 SRm INSTRUCTION@;CP ;	Print “NEW SR INSTRUCTION” and send CP for Carriage Return/Line Feed.
LBCHANGES LABEL SIZE@;	Print “CHANGES LABEL SIZE.”
${}^{E}{}_{C}$%0A	Enter the PCL mode.
${}^{E}{}_{C}$E	Send a reset to end the job and eject the page.

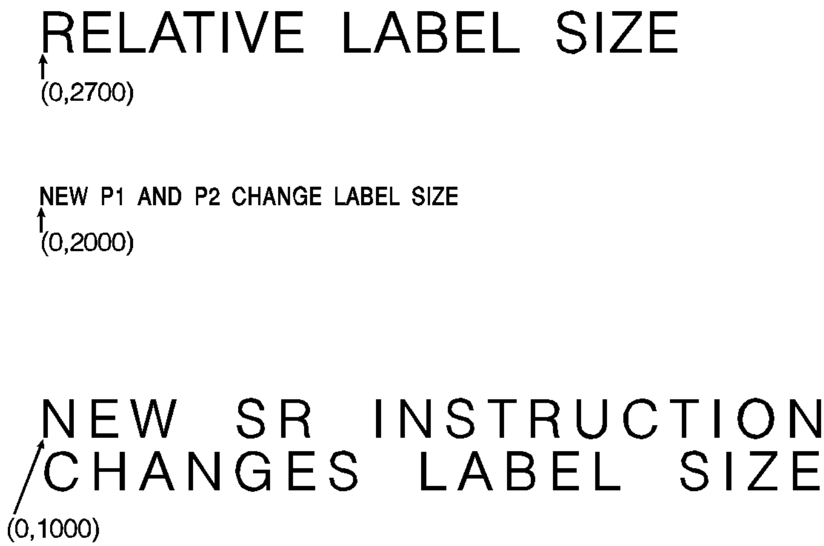


Figure 23-40

Table 23-52

Related Commands	Group
CP, Character Plot 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

This command 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 symbol 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.

Table 23-53

Related Commands	Group
AD, Alternate Font Definition DT,Define Label Terminator FI, Select Primary Font FN, Select Secondary Font LB, Label SA, Select Alternate Symbol set SD, Standard Font Definition	*The Character Group*

TD, Transparent Data

This command 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 *[;]*

Table 23-54

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 B of the *PCL 5 Comparison Guide*.
- **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 non-printing or undefined characters.

Transparent data mode must be enabled to access printable characters which have character codes with an associated functionality in normal mode. For example, the left arrow in the PC-8 symbol 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 prints a left arrow.

Table 23-55

Related Commands	Group
AD, Alternate Font Definition DT, Define Label Terminator LB, Label SA, Select Alternate Font SD, Standard Font Definition SS, Select Standard Font	*The Character Group*

24 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 Duplex Print command has no effect on the HP LaserJet III, IIIP or LaserJet 4 printers, since these are non-duplexing printers. However, on printers which support duplex printing (such as the HP LaserJet IIID and LaserJet IIISi), the job is printed in duplex mode.

Job Control

Printer Reset

Hewlett-Packard strongly recommends the use of both the $^{E}{}_{C}$**E** command and the $^{E}{}_{C}$**%–12345X** command (Universal Exit Language/Start of PJL — also referred to as the **UEL Command**) at the beginning and end of each job. (The order of these commands is critical; refer to Table 24-1 for an example.) This allows the next job to start with the default settings as a known base. Starting with the default environment at the beginning of each print job eliminates the need to set every feature each time a job is run.

Table 24-1 Structure of a Typical Job

$^{E}{}_{C}$%–12345X	UEL Command (exit language).
$^{E}{}_{C}$E	Printer Reset Command.
Preamble	Job Control Commands.
Page 1	Page Control Commands.
	Data
⋮	⋮
Page *n*	Page Control[1] Commands.
	Data.
$^{E}{}_{C}$E	Printer Reset Command.
$^{E}{}_{C}$%–12345X	UEL Command (exit language).

1. 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.

Note

The UEL Command ($^{E}{}_{C}$**%–12345X**) has the same effect as the $^{E}{}_{C}$**E** command, and also enters PJL Mode of operation for printers that support PJL. The $^{E}{}_{C}$**E** command should be included to ensure backward compatibility (the UEL command is ignored if received by a printer that does not support PJL).

Do not perform a printer reset *within* a job.

PCL Page Control 1

Paper Source

The primary use for the paper source command is to allow access to "locked out" (secured) paper trays.

Page Size

This command 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 (the last VMI or lpi commands).

Specifying the text length establishes the bottom margin.

When using both the Top Margin and Text Length commands, send the Top Margin command 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 (refer to the printer *User's Manual*).

HMI

When a font is selected, HMI is set automatically to correspond to the pitch of the selected font if fixed-pitch, or the recommended (default) word space if proportional. Therefore, when using a non-standard HMI value, the value must be re-specified following each font selection.

PCL Cursor Positioning

Horizontal (decipoint, dot and column) positioning ignores margins, and therefore can be used to move the cursor anywhere along the present line.

When performing cursor positioning with decipoints, PCL Units, 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.

The current active position (CAP) is the reference point for *relative* vertical and horizontal positioning.

Refer to Chapter 6 for more information on cursor 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 soft font using Hewlett-Packard's **Type Director 2.0** (and later). AutoFont support for Hewlett-Packard's newer font cartridge products are furnished as 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 FontLoad Utility, HP product number 33407B.

Since line spacing is independent of font height, line spacing may require adjustment following font selection to ensure proper vertical alignment of text.

To ensure 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 Space control code is executed when an attempt is made to print a non-existent character.

Using an ID number which has not been associated with a font results in no font change.

Font designers should not define the space character. Use the printer's Space control code should be used for character spacing. Defining the space character in the font results in a significant reduction in performance and inhibits the HMI command with proportional fonts.

Note Refer to "HP-GL/2 Vector Graphics" later in the chapter for hints on using HP-GL/2 text.

PCL 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.

Set resolution 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.

Set presentation mode 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 ("$^{E}{}_{C}E$" "UEL" or control panel), or the page length, page size or orientation is changed.

When the modified print environment is restored (upon exiting a called or overlaid macro), if the page length, page size, or the orientation has changed, or the primary or secondary font has been deleted, the following occurs:

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 supported within a macro on some printers (refer to the "PCL Feature Support Matrix" in Chapter 1 of the *PCL 5 Comparison Guide*. HP-GL/2 implementation within macros matches that of PCL.

Macro problems can often be avoided by first ensuring that the data formats 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 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
- When using text, if you want the character to be printed at the same location as it would in PCL, use label origin position 21 (see “Label Origin” command, in Chapter 23).
- 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, use a command that was designed to draw that shape. For example, to draw a rectangle, use the ER command to produce it, instead of stroking the shape line by line.
- When drawing arcs or circles, use the Bezier commands to eliminate the need to compute the chord angle, thus resulting in better quality and efficiency.
- To Scale text, use the HP-GL/2 font selection commands, such as SD or AD, that use Intellifont or TrueType 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 HP LaserJet “Page Protection” feature.

Performance

PCL Commands

Since PCL printers are command driven devices and each command takes a finite amount of time to process, pages 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.

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, some pages 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, an error number “21’’ (`ERROR 21` - print overrun) is displayed on the printer’s control panel. A page causing this error can be printed by setting the printer’s page protection feature to ON (see next section).

Page Protection

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.

Note

The page protection feature is available only with additional optional memory on many HP LaserJet printers. (One exception is the LaserJet 4 printer, which supports page protection for letter-size paper **in 300 dpi mode** with the standard 2 Mbytes memory.) Refer to the appropriate *User's Manual* for specific memory requirements.

The Page Protection feature can be used to prevent possible `ERROR 21` conditions. `ERROR 21` is reported when data is too complex for the printer to process concurrent with actual physical printing. A frequent cause of `ERROR 21` when printing graphics is that the program sends commands to print a single point many times during the page run.

Page protection can be set for letter, A4, or 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.

Troubleshooting Commands

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 moves the cursor to the right of the right margin executes a CR-LF (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 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, or be given a Transparent Print command.

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 Space control code is printed while in display functions mode. The PC symbol sets do have printable characters defined in this range.

Auto Continue Mode

Automatic error clearing (refer to the 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 displays a message for 10 seconds, and then attempts 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 (hardware handshake or Xon/Xoff handshake) correspond and that your cable is correct for your host/printer configuration.

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 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 printer *User’s Manual*.

Customer Support

Support services are available to help you in case you have a question about your HP LaserJet printer. Following are some places to turn for this support.

Help From Your Organization

If you organization has many HP printers, the best source of assistance may be within your own company. Many organizations designate central support personnel to help when you have any problems with your computer system or when you need consumable items such as toner cartridges or paper. These support personnel, in turn, can call special resources within HP when necessary.

Help From Your Dealer

If you purchased your printer from an HP dealer or system vendor, your dealer is the best source of assistance. Your salesperson should be familiar with your needs, equipment, configuration and software and should be able to provide you with the information you need. Your dealer can also access special support resources and programs within HP. Contact your dealer for details on available support options.

Help from HP

The CompuServe HP Forum

The HP Forum on CompuServe is a fast and easy way to get drivers and updated application notes for HP LaserJet printers. As soon as printer drivers and notes are available, they are uploaded to HP Forum for instant access by CompuServe members.

If you are not a member of CompuServe, but would like to join, call CompuServe at 1-800-848-8199 (operator #51) and take advantage of the Free Introductory Membership, which includes:

- A $15 introductory usage credit to CompuServe.
- A private User ID number and Password.
- A complimentary subscription to CompuServe's monthly publication, *CompuServe Magazine.*

HP Distribution

Software drivers and application notes are also available through HP Distribution by calling at 303-353-7650 (materials are mailed at no charge).

HP FIRST Faxback support

Hewlett-Packard has installed a "faxback" service called HP FIRST (Fax Information Retrieval Support Technology). A wealth of information on HP peripherals, including the full line of HP LaserJet printers, is available to anyone with access to a group 3 fax machine. The phone number for the HP FIRST service is:

208-344-4809

HP's Personal Peripherals Assist Line

If your organization's support personnel or your dealer are unable to answer your question, 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.

(208) 323-2551

Before you call the Personal Peripherals Assist Line, do the following:

1. Check the "Troubleshooting Checklist" section of your printer *User's Manual.*

2. Use the printer's control panel to print self-test, if possible.

3. Check with you software vendor for help if you suspect a software problem.

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 names and versions you are currently using.

Glossary

Auto-Continue

Auto-Continue mode can be configured using the printer's control panel (refer to the printer *User's Manual*).

Aspect Ratio

The ratio of the width to height of an image.

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.

Bound and Unbound Fonts

A bound font is a font which contains a pre-specified set of symbols, such as Roman-8, PC-8, etc. An unbound font (or more accurately, unbound *typeface*) has the capacity to be bound to a set of symbols selected from a complementary **Symbol Index** (such as HP's Master Symbol List **- MSL**, or the **Unicode** symbol list). See Chapter 10, "User-Defined Symbol Set" for more information.

CAP (Current Active Position)

The PCL cursor position refers to the **Current Active Position (CAP),** like the blinking underline character (cursor) used on most computers. This "cursor" identifies the current position on the page; the pointer, where a printing command begins laying out page data. The cursor can be moved anywhere within the logical page using a combination of horizontal and vertical cursor positioning commands and control codes (see Chapter 6, *Cursor Positioning*).

Centronics I/O

An industry standard parallel input/output (I/O) interface. (Also see *Parallel I/O.*)

Character Descriptor

The character descriptor is a block of data that identifies the characteristics for a specific character, such as its position, and the cursor position after printing. The character data which follows, defines the shape of the character. Chapter 11 describes the character definition and descriptor formats for PCL bitmap fonts, as well as Intellifont and TrueType scalable fonts.

Column

The width of a column is defined by the current Horizontal Motion Index (HMI).

Compression (raster graphics)

Raster graphics compression methods reduce the amount of code needed to generate a raster graphic image and improve the efficiency with which the image is printed. The Set Compression Method command allows you to code raster data in one of four compressed formats: Run-length encoding, tagged imaged file format (TIFF) rev. 4.0, delta row compression, and adaptive compression. These techniques are described in detail under “Set Compression Method Command” in Chapter 15.

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.

Configuration Menu

Identifies printer features which are set from the printer’s Operator Control Panel. Configuration menu selections include such features as Auto-Continue, I/O configuration, and Resolution Enhancement setting. The configuration menu includes features which are not part of the print environment (features which can not be selected with printer commands).

Control Code

A control code is a type of PCL language command that initiates a printer function, for example CR (Carriage Return), LF (Line Feed), and FF (Form Feed).

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 (CAP)

See CAP.

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 1/720th of an inch.

Default

A value used instead 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 which is selectable via the control panel.

Dot

The dot is the smallest printable unit. On HP LaserJet printers, one dot can equal either 1/300th or 1/600 inch. The number of dots printed per inch is referred to as the printer's resolution.

Downloading

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.

Escape Character

The first character of a PCL command (or "escape sequence") is identified by the **?** 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 (or "PCL Command")

PCL escape sequences consist of two or more characters. The first character is always the escape character, which is identified by the **?** 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. (Also see *PCL commands.*)

Factory Default

These are 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 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 Helvetica; 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.

Font Header

The font header and character definitions contain all the information needed to format a font for use in the HP LaserJet printers.

Every PCL font header begins with a font descriptor, which 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. Chapter 11 describes the font header and character definition formats for PCL bitmap fonts, as well as Intellifont and TrueType scalable fonts.

Height

The height of a font is the measurement of the body of the type in points. A PCL point is 1/72nd inch. The body of the type is slightly greater than the distance from the bottom of a descender (such as the tail of lower-case "p") to the top of an unaccented capital letter.

Horizontal Motion Index (HMI)

HMI defines the distance between columns in 1/120 inch 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 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 12/120 = 1/10 inch per character or 10 characters per inch).

HP-GL/2

PCL 5 printers provide the ability to print vector graphics using the HP-GL/2 graphics language commands. HP-GL/2 graphics 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. Advantages include faster I/O transfer of large images and smaller storage requirements. See Chapter 17 for more information.

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 printer's internal random access memory (RAM) where PCL commands and data are stored.

Interface Connector

The LaserJet 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. (Also see *Parallel I/O* or *Serial I/O*.)

Internal Fonts

Internal fonts are the fonts resident in the printer when shipped.

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 (CAP). In other words, the location of the “cursor” is the position on the logical page where the next character is 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 (such as “Copies”); a “value” is an “item’s” particular configuration (such as “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.

MSL (Master Symbol List)

This is a group of symbols (a **symbol index**). An unbound font has the capacity to be bound to a set of symbols selected from a complementary symbol index (such as the MSL or Unicode symbol indexes). Each symbol in the index is identified by a unique MSL number. Appendix D of the *PCL 5 Comparison Guide* contains the MSL symbol index.

Negative angle of rotation

An angle used to create a plot in HP-GL/2 which is rotated in the direction of the +X-axis to the –Y-axis. Note that the relationship of the +X-axis to the –Y-axis can change as a result of scaling point or scaling factor changes, thus changing the direction of a negative angle of rotation. See “Drawing Arcs” in Chapter 20 for more information.

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 printer 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: Paper source, Page size, Number of copies, Orientation, Cursor position stack.

Parallel I/O

An input/output (I/O) interface that transmits more than one bit of information simultaneously (in a “parallel” mode). Centronics is an industry-wide parallel interface standard. (Also see *Serial I/O*.)

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, or the printer is reset. There are three types of PCL commands: control codes, two-character escape sequences, and parameterized escape sequences. (Also see *escape sequences.*)

PCL Coordination 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 may be dots, decipoints, or rows.

PCL Units

These are user-definable units of measure which are used in PCL commands affecting various PCL cursor moves. The number of units-per-inch used in PCL cursor moves is determined by the current setting of the **Unit of Measure** command (see “Unit of Measure Command” in Chapter 4).

Note PCL Units were previously referred to as “PCL dots,” but *should not be confused with the printer’s physically printed dots.*

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.

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.

PJL

PJL (Printer Job Language) commands provide job-level control, such as the ability to switch printer languages (or “personalities” - such as PCL to PostScript) between jobs. PJL also provides two-way communications with the printer. PJL can also be used to change the printer’s control panel settings and modify the message displayed on the control panel.

Point

A PCL point is a unit of measurement that equals 1/72nd inch. Font height is measured in points.

Positive angle of rotation

An angle used to create a plot in HP-GL/2 which is rotated in the direction from the +X-axis to the +Y-axis. Note that the relationship of the +X-axis to the +Y-axis can change as a result of scaling point or scaling factor changes, thus changing the direction of a positive angle of rotation. See “Drawing Arcs” in Chapter 20 for more information.

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 identifies four levels of changes of this print environment: the factory default environment, the user default environment, the modified print environment and the overlay environment.

Printer Commands

See PCL Commands and HP-GL/2.

Printing Menu

Identifies a few printer features which can be selected from the printer's Operator Control Panel, [[Menu]] key. Print menu features select the user default items, which are included in the print environment (features which can be selected with printer 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.

Reset

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, macros, user-defined symbol sets and patterns. A Printer Reset is performed by sending the **?E** command or through the printer's control panel (see the printer *User's Manual*).

Resolution

The high quality output achieved by HP LaserJet printers is due in part to the ability to lay down a fine grid of “dots” on the page. The density of this grid is referred to as the printer’s **resolution.** Resolution is expressed as a value of dots-per-inch. Until recently, all HP LaserJet family printers printed at a resolution of 300 dots-per-inch. In a one inch square, the printer could print a dot anywhere in a grid of up to 300 dots horizontally by 300 dots vertically, for a total of 90,000 possible dot locations per square inch (300 × 300 = 90,000).

The LaserJet 4 printer is capable of printing at either 300 or 600 dpi resolution. At 600 dots-per-inch, it becomes possible to print up to 360,000 dots per square inch (600 × 600 = 360,000).

Robust-Xon

The configuration of ROBUST-XON determines the method by which Xon signals are generated on the interface. If ROBUST-XON is ON, an Xon is transmitted from the printer to the host computer when the printer’s 1 Kbyte I/O buffer has less than 128 data bytes remaining (896 bytes empty). The printer must be in the on-line state and not busy. If no data is received, additional Xon’s are transmitted at one second intervals.

If ROBUST-XON is OFF, the printer sends one Xon signal when the printer is in the on-line state, and is not busy. The printer does not send additional Xon signals.

Row

The distance between rows is defined by the current vertical motion index (VMI).

Rule

A solid-filled rectangular area.

Scalable

PCL 5 printers can use either bitmap or scalable fonts. A bitmap font is available in its one, defined size only. Scalable fonts, on the other hand, provide an “outline” for each character which can be scaled by the PCL 5 printers to produce a large range of character sizes.

Serial I/O

An input/output (I/O) interface that transmits information bit-by-bit (in “serial” mode). RS-232 is an industry-wide standard form of a serial interface.

Soft Font

Soft fonts are fonts stored on 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. In proportionally-spaced fonts, 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, italic, and condensed are examples of font styles.

Symbol Index

This is a grouping of symbols. An unbound font has the capacity to be bound to a set of symbols selected from a complementary Symbol Index (such as the Unicode or the MSL symbol indexes). Each symbol in the index is identified by a unique symbol index number. Appendix D of the *PCL 5 Comparison Guide* contains lists of MSL and Unicode symbol index characters and their numbers (also see *Unicode* or *MSL*).

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.

Treatment

Treatment is the combination of font style and/or weight. For example, some treatments of Times Roman font include: upright, or bold, or italic.

Typeface

Typeface is a generic name for graphics symbols having common design features. Each typeface has unique and distinguishing characteristics.

UEL (Universal Exit Language) Command

The Universal Exit Language (**UEL**) command (**?%–12345X**) causes the PCL printer language to shut down and exit. Control is then returned to the Printer Job Language (PJL). Both PCL 5 and HP-GL/2 recognize this command.

The UEL Command has the same effect as the **?E** command, and also enters PJL Mode of operation for printers that support PJL (refer to the section, “Universal Exit Language Command” in Chapter 4 for more information).

Unicode

This is a grouping of symbols (a **symbol index**) used by TrueType fonts. An unbound font has the capacity to be bound to a set of symbols selected from a complementary symbol index (such as the Unicode or MSL symbol indexes). Each symbol in the index is identified by a unique Unicode number. Appendix D of the *PCL 5 Comparison Guide* contains the Unicode symbol index.

Unit of Measure

The number of units-per-inch used in PCL cursor moves is determined by the current setting of the **Unit of Measure** command. The current unit of measure setting affects all PCL Unit moves, horizontal and vertical rectangle size, bitmap and scalable font metrics (how the cursor moves after printing a character). See “Unit of Measure Command” in Chapter 4.

User Default

A default selectable through the printer’s control panel. For example, user defaults may be selected for number of copies, manual feed mode, fonts, and vertical form length (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.

User-Defined Pattern

In addition to the eight shading patterns and six cross-hatch patterns, users can design their own patterns (area fill). These **user-defined pattern**s are downloaded to the printer and used in subsequent area fills. See “User-Defined Pattern Graphics” in Chapter 13.

User-Defined Symbol Sets

User-defined symbol sets are supported in some HP LaserJet printers. Symbols are user-selected from a Symbol Index, (such as Unicode or MSL). To specify a user-defined symbol set, use the symbol set ID value as defined by the *Symbol Set ID Code Command.* See Chapter 10 for more information.

Vector Graphics

A method of drawing lines, area fills and other objects which is generally more efficient than “raster graphics.“ Also see “HP-GL/2.”

Vertical Motion Index (VMI)

VMI (vertical motion index)

VMI defines the distance between rows in 1/48th 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.

Index

Symbols

Numerics

A

B

C

E

F

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z

HEWLETT® PACKARD

Expanding Possibilities

Printed on Recycled Paper