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.

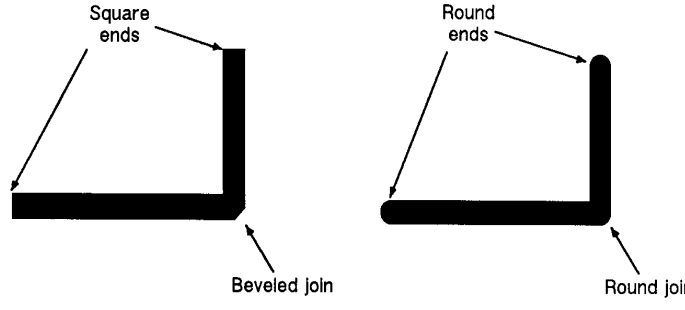

Figure 22-1 Line Ends Attribute

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.

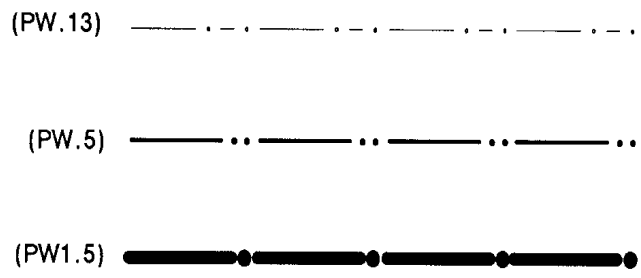

Figure 22-2 Line Types Attribute

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 PD, Pen Down PE, Polyline Encoded PR, Plot Relative RT, Relative Arc Three Point	*The Vector Group*
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.

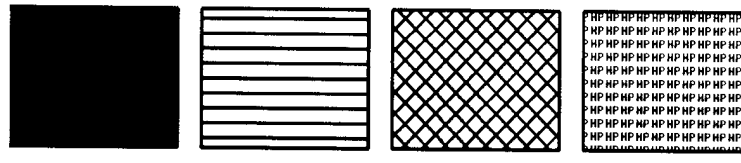

Figure 22-3 Fill Types

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).

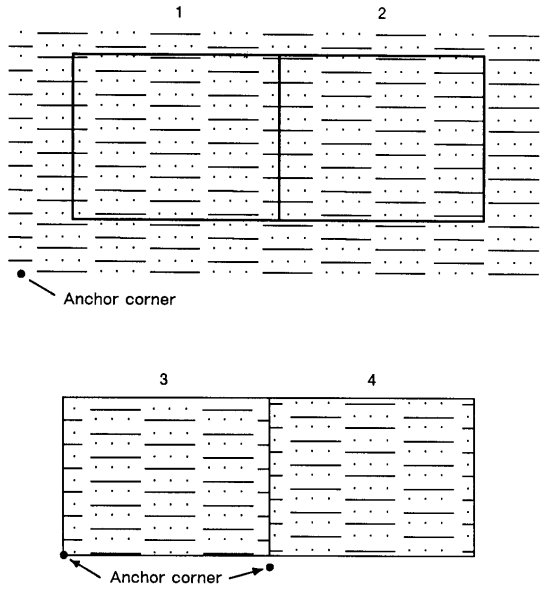

Figure 22-4 Fill Area Anchor Corner

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.

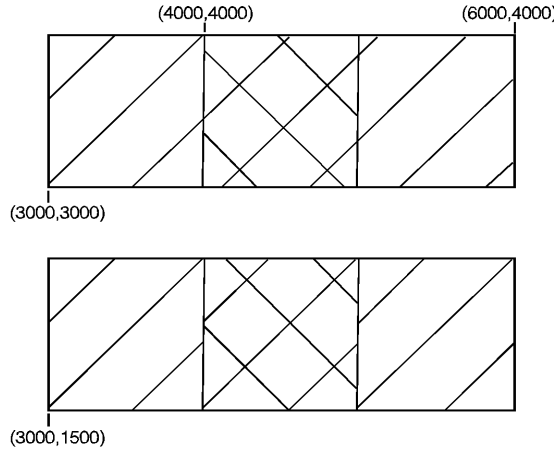

Figure 22-5

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.

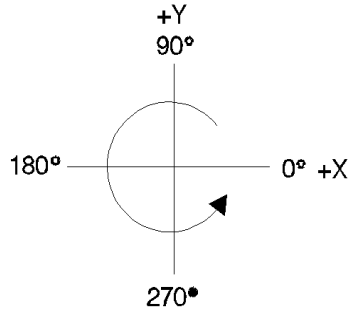

Figure 22-6 Positive Angle of Rotation

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.

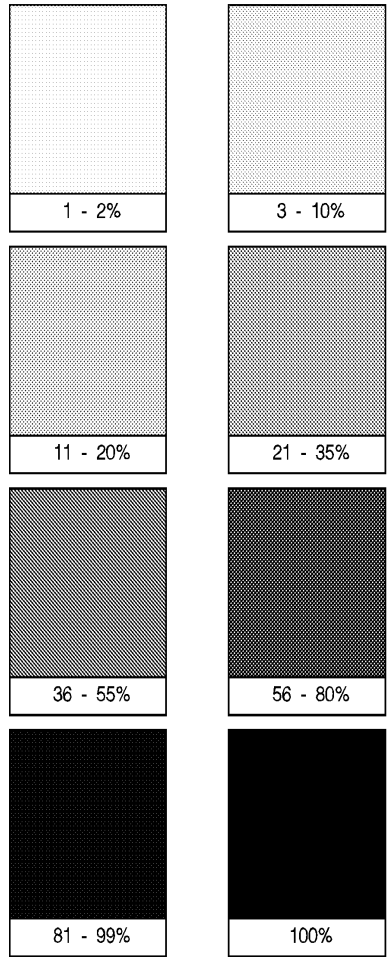

Figure 22-7 HP-Defined Shading Patterns

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.

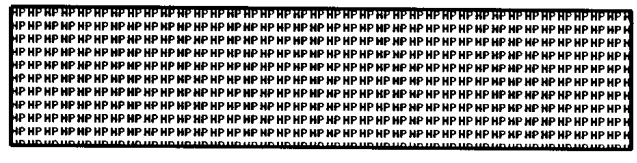

Figure 22-8 HP-GL/2 User-Defined Pattern

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.

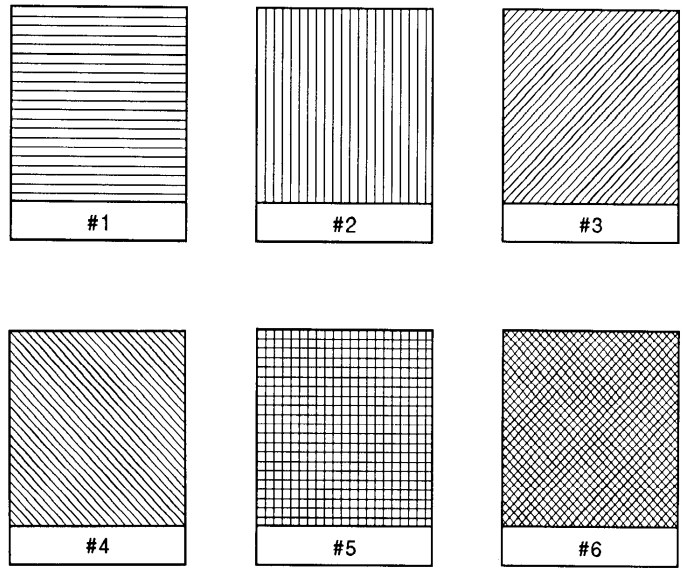

Figure 22-9 PCL Cross-Hatch Patterns

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.

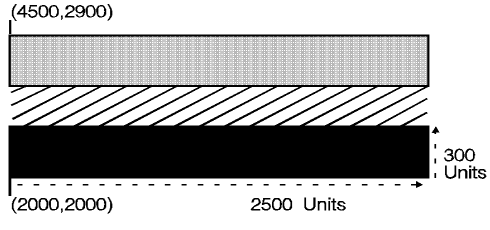

Figure 22-10

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.

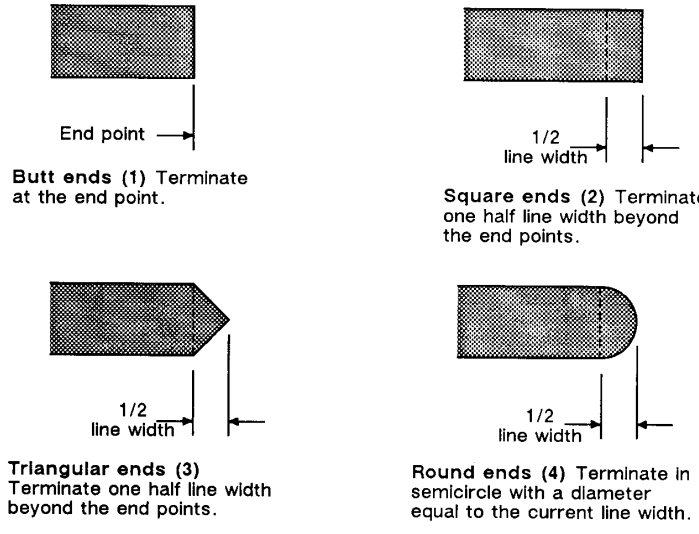

Figure 22-11 Four Line Ends

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.

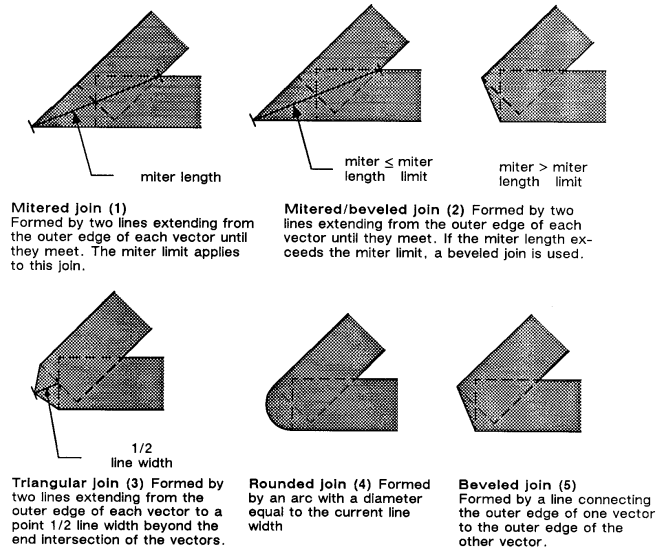

Figure 22-12 Five Line Joins

When you select ‘no join’ (LA2,6;), the currently selected line ends for the two lines merely overlap. Refer to the following illustration.

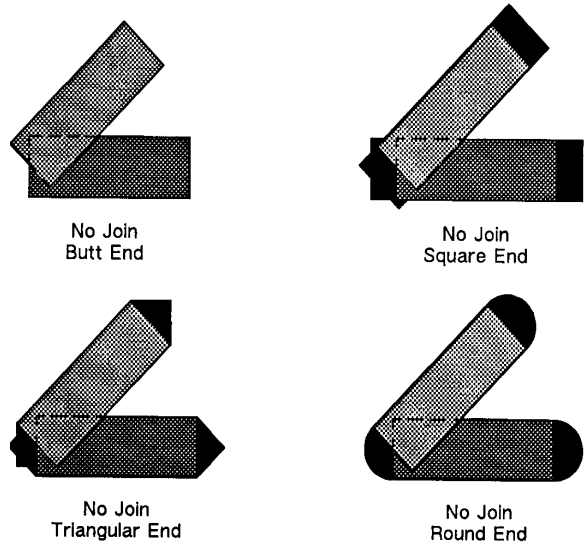

Figure 22-13 Overlapping Line Ends without Line Join Selection

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.

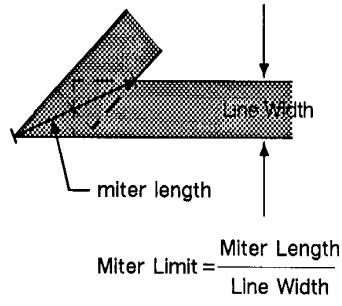

Figure 22-14 Miter Limit

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.

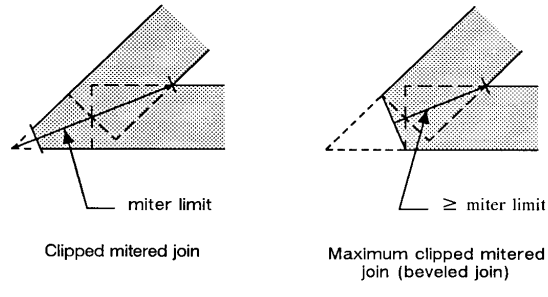

Figure 22-15 Miter Limit Clipping

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.

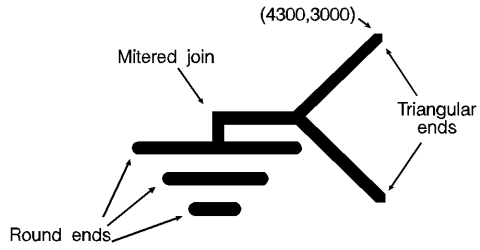

Figure 22-16

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	*The Line and Fill*
LA,Line Attributes	*Attributes Group*
LT,Line Type	
(except (LT) and (LT99))	
PW,Pen Width	
RF,Raster Fill Definition	

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).

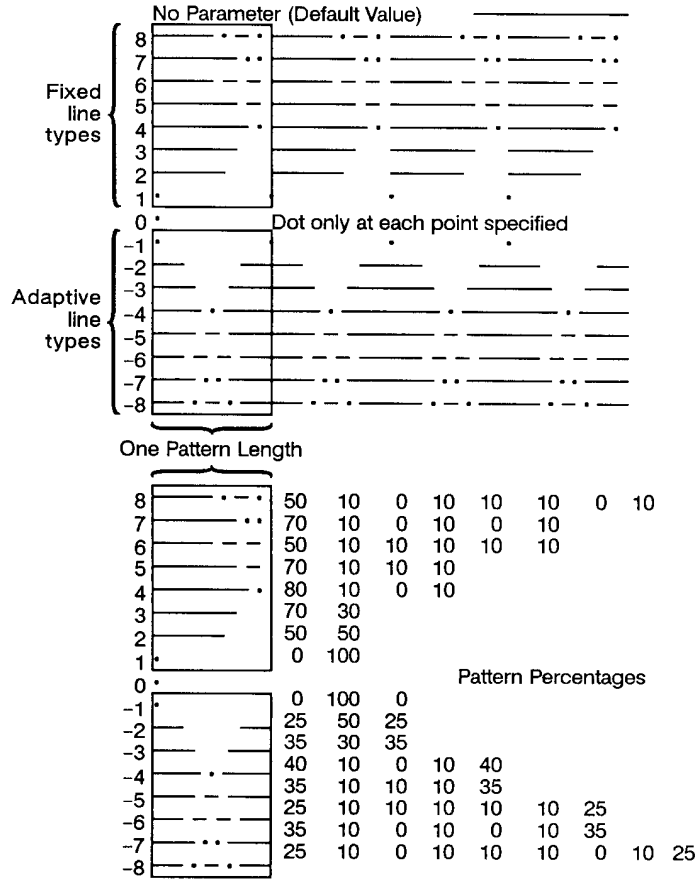

Figure 22-17 Line Type Patterns and Pattern Percentages

- **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.

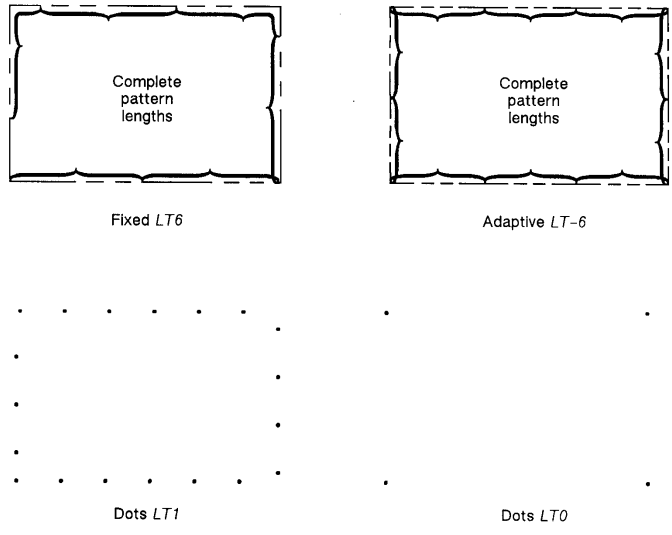

Figure 22-18 Fixed and Adaptive Line Types

Table 22-13

Related Commands	Group
FT,Fill Type	*The Line and Fill*
PW,Pen Width	*Attributes Group*
UL,User-Defined Line Type	

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.

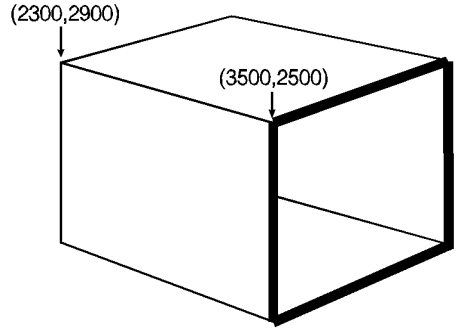

Figure 22-19

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.

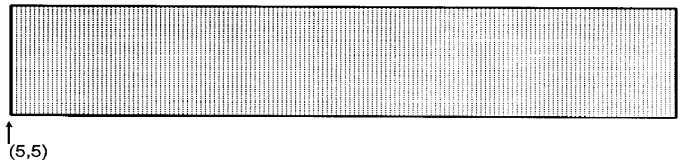

Figure 22-20

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.

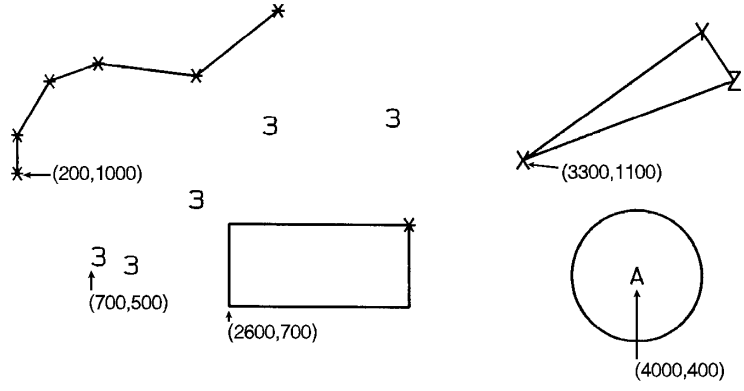

Figure 22-21

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.

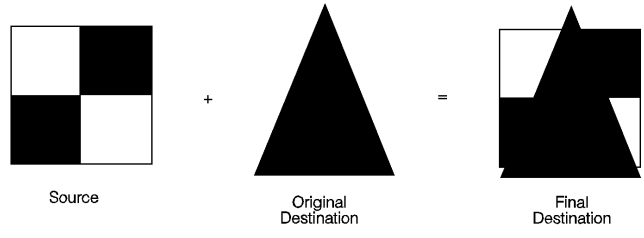

Figure 22-22 Transparency Mode = ON

When transparency mode is off, all source pixels are written to the destination, obscuring any underlying images.

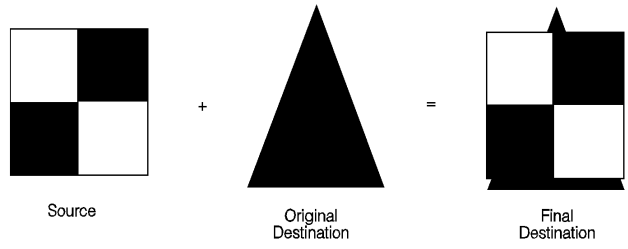

Figure 22-23 Transparency Mode = OFF

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*