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.

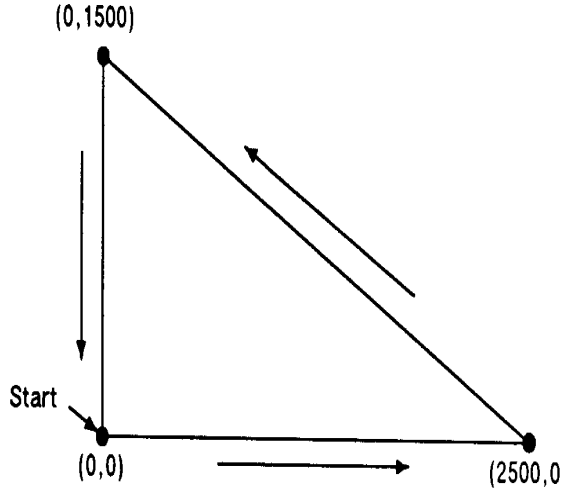

Figure 20-1 Drawing lines

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.

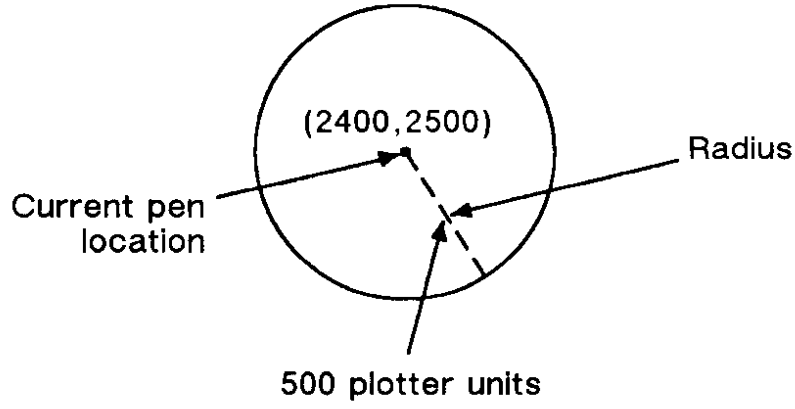

Figure 20-2 Drawing circles

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.

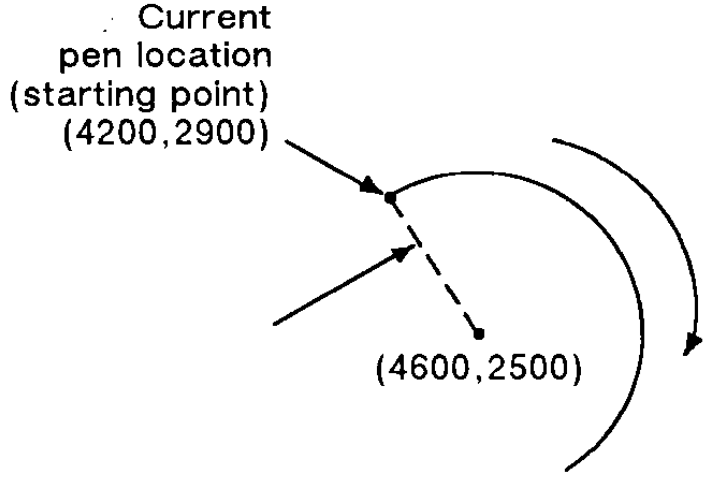

Figure 20-3 Drawing arcs (1 of 3)

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.

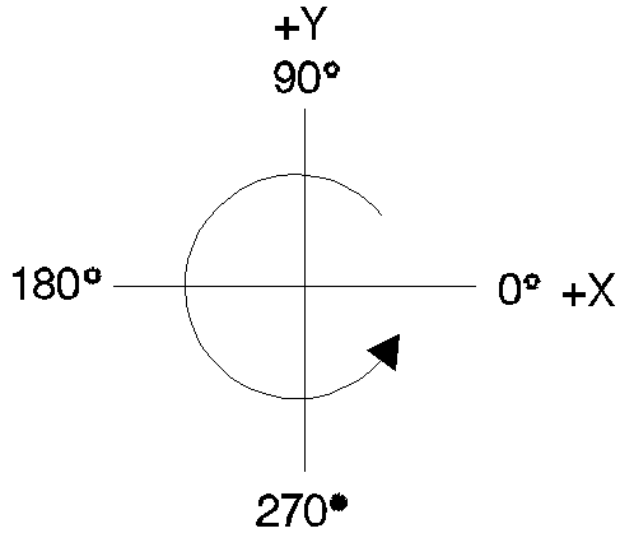

Figure 20-4 Drawing arcs (2 of 3)

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.

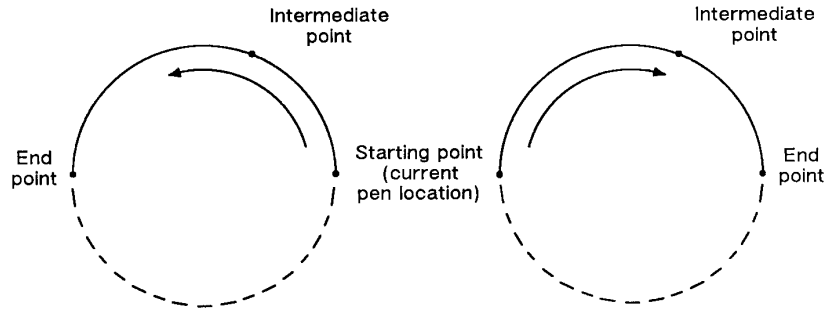

Figure 20-5 Drawing arcs (3 of 3)

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.

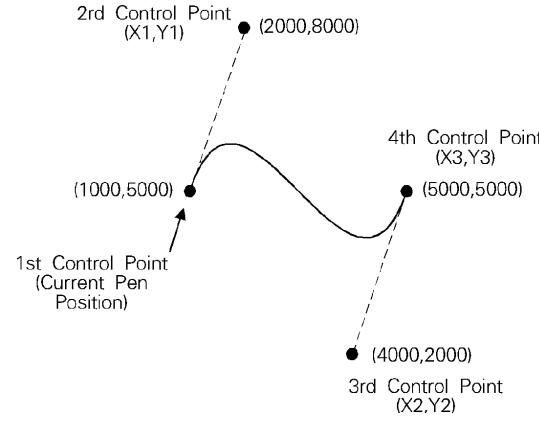

Figure 20-6 Bezier Curves

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.

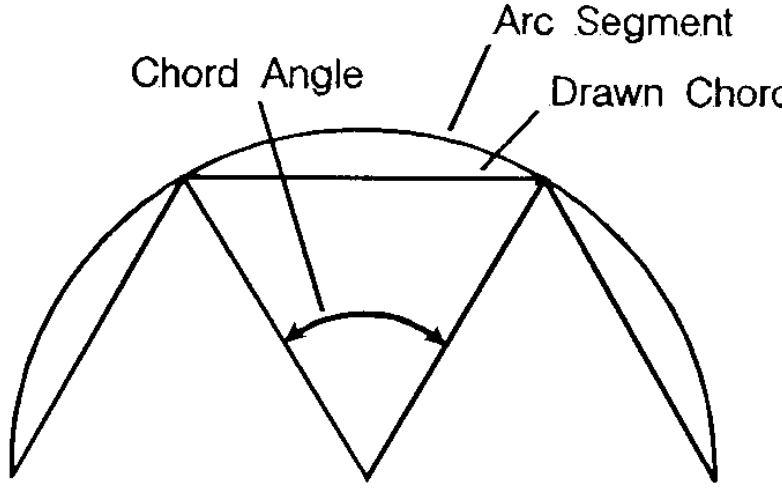

Figure 20-7 Chord Angle

- 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).

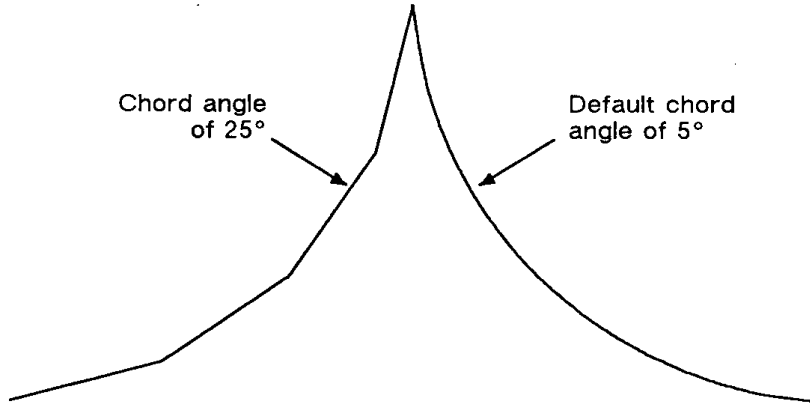

Figure 20-8 Changing Arc Smoothness with the Chord Angle

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.

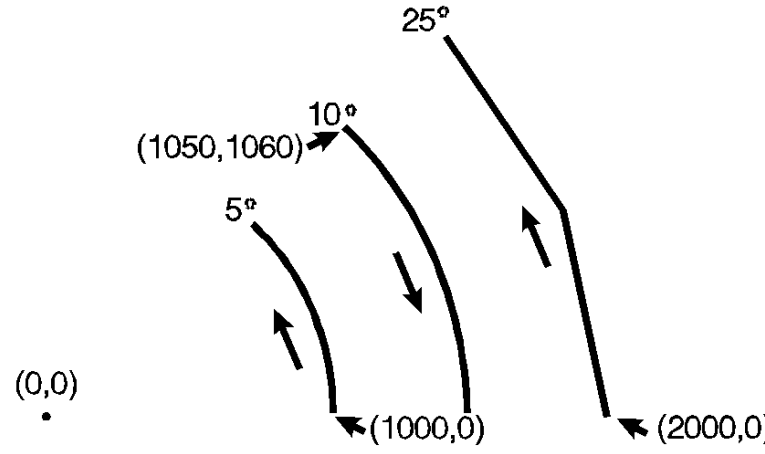

Figure 20-9

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 $X_{increment}$,$Y_{increment}$,*sweep angle[,chord angle;]*

Parameter	Format	Functional Range	Default
$X_{increment}$,$Y_{increment}$	current units	-2^{30} to $2^{30} - 1$	no default
sweep angle	clamped real	-32768 to 32767	no default
chord angle	clamped real	0.5° to 180°	5°

The AR command draws the arc starting at the current pen location using the current pen up/down status, line type, and attributes. After drawing the arc, the pen location remains at the end of the arc.

Note

Do *not* use an adaptive line type when drawing arcs with small chord angles. The printer attempts to draw the complete pattern in every chord (there are 72 chords in a circle using the default chord angle).

- **$X_{Increment}$, $Y_{Increment}$** — Specify the center of the arc relative to the current location. (The center of the arc is the center of the circle that would be drawn if the arc 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.

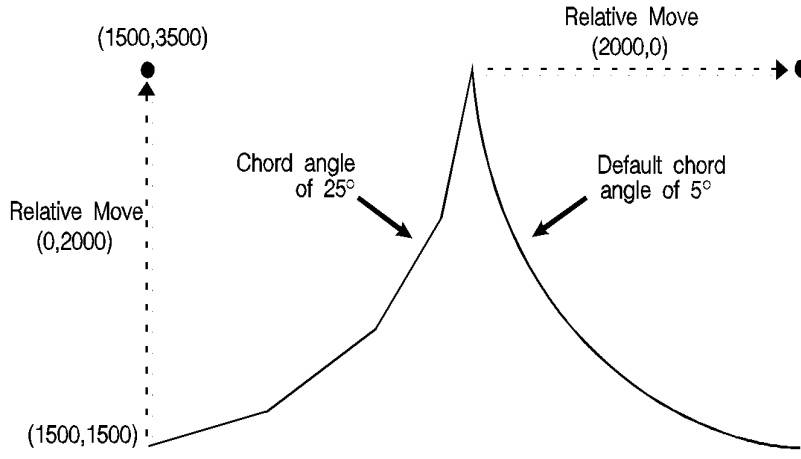

Figure 20-10

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.

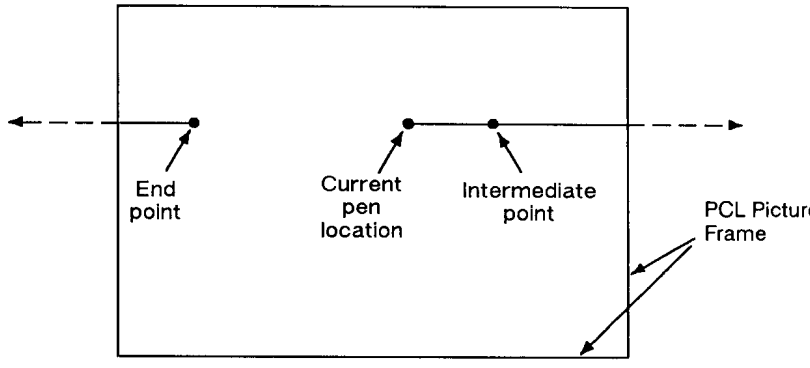

Figure 20-11

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_CE	Send a reset to end the job and eject the page.

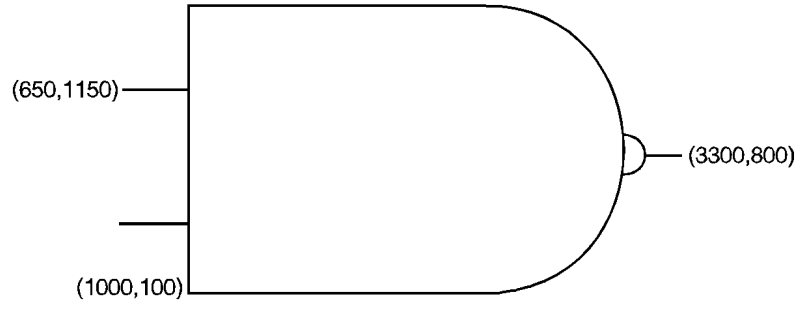

Figure 20-12

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.

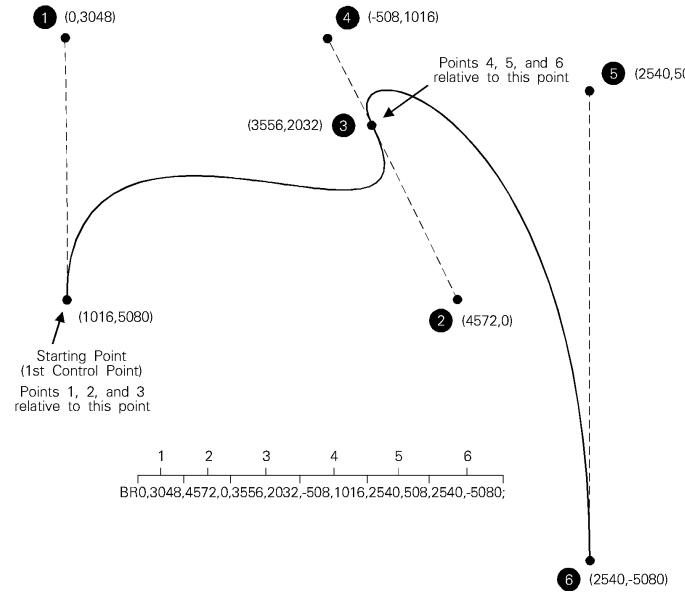

Figure 20-13

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.

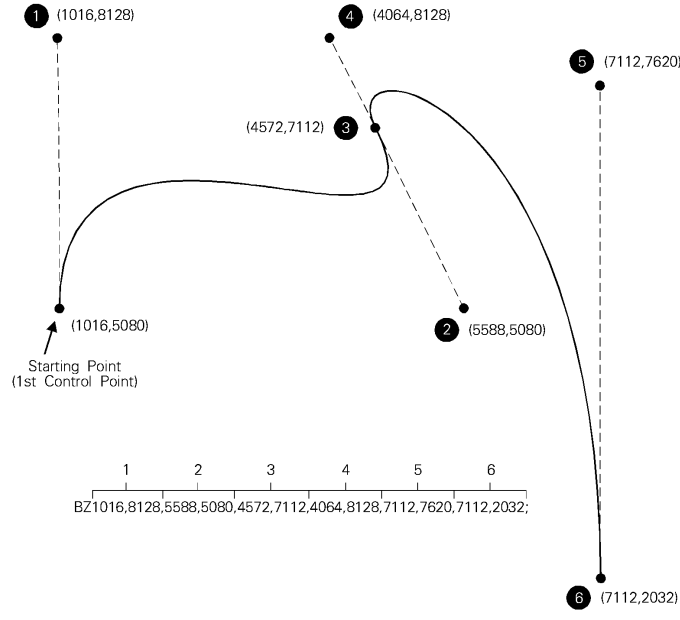

Figure 20-14

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.

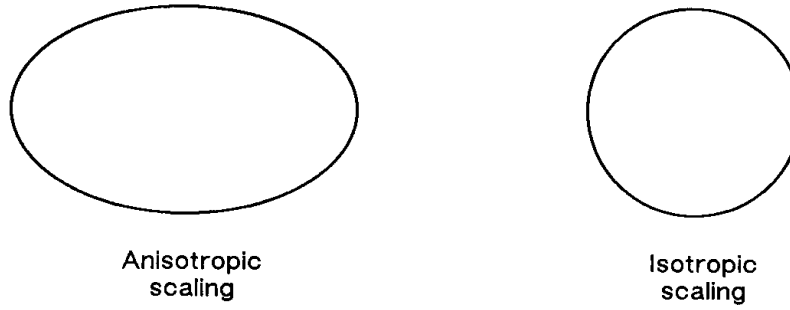

Figure 20-15

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_CE	Send a reset to end the job and eject the page.

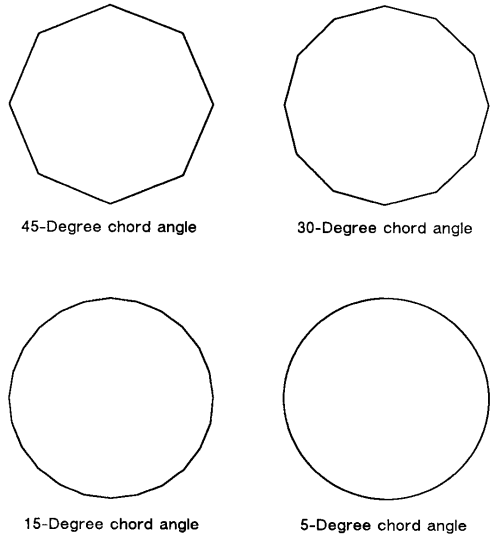

Figure 20-16

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.

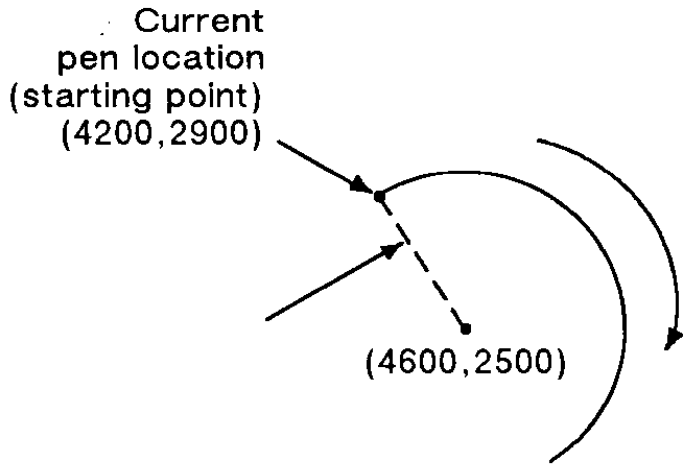

Figure 20-17

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.

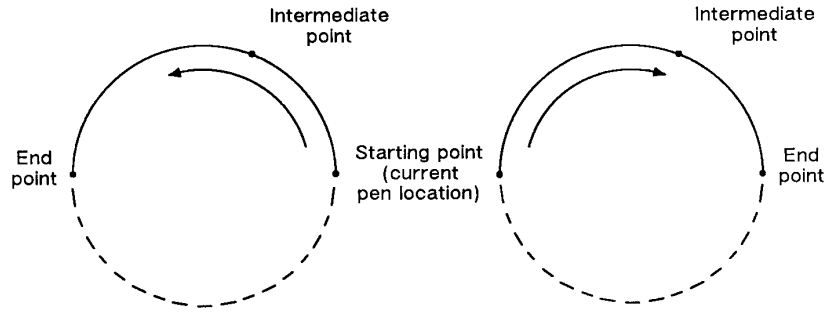

Figure 20-18

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 ''
```

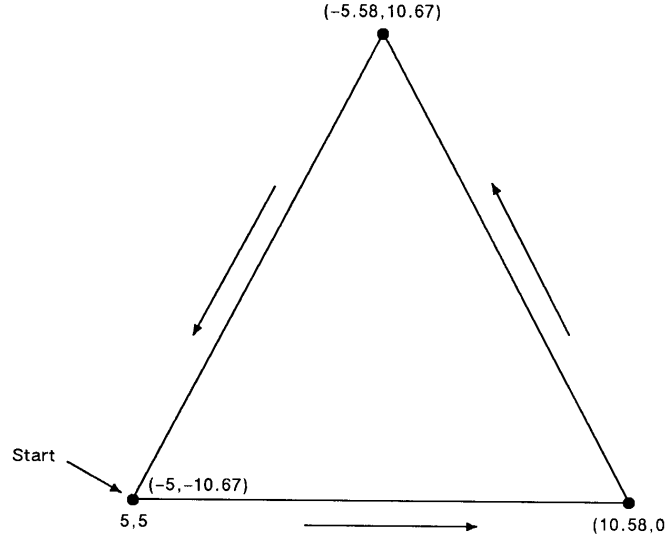

Figure 20-19

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.

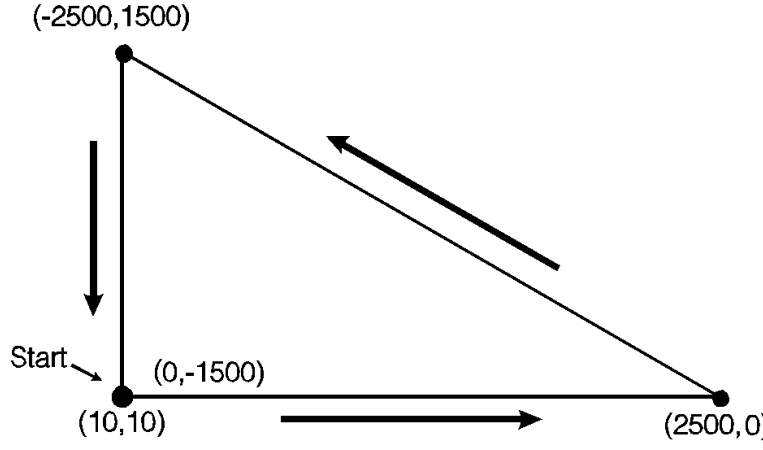

Figure 20-20

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.

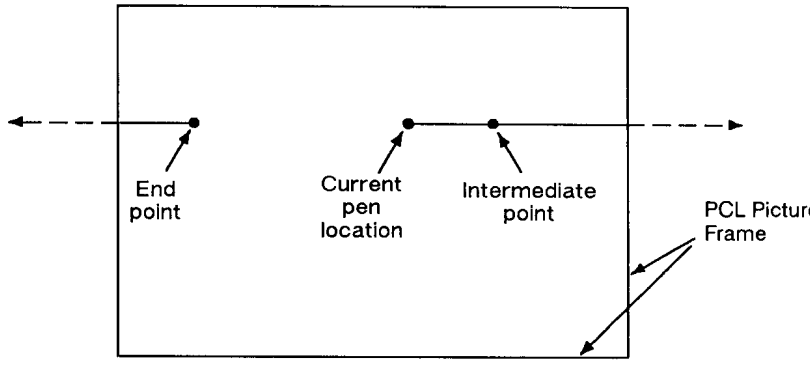

Figure 20-21

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.

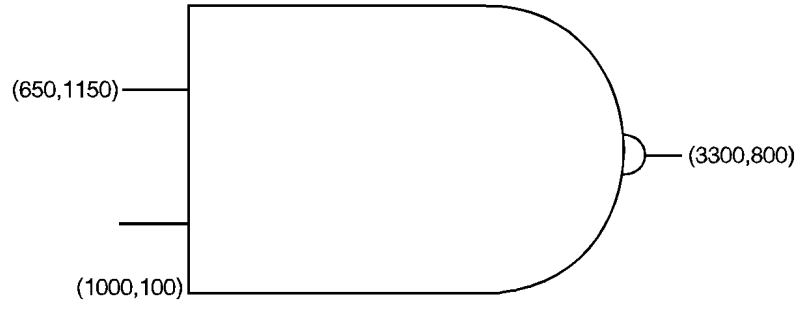

Figure 20-22

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*