19 The Configuration and Status Group

Introduction

The configuration and status group commands help you:

- Establish default conditions and values for HP-GL/2 features.
- Scale images in the dimensional units you want to use.
- Enlarge/reduce images for different media sizes.
- Establish a window (soft-clip limits).
- Draw equal-sized and mirror-imaged drawings.
- Rotate the HP-GL/2 coordinate system.
- Add comments to your HP-GL/2 command sequence.

Table 19-1 lists the commands described in this chapter.

Table 19-1 The Configuration and Status Group Commands

Command	Summary
CO, Comment	Allows comments to be included in an HP-GL/2 command sequence.
DF, Default	Sets most programmable HP-GL/2 features to their default conditions.
IN,Initialize	Sets all programmable HP-GL/2 features to their default conditions.
IP, Input P1 and P2	Establishes new or default locations for the scaling points P1 and P2.
IR, Input Relative P1 and P2	Establishes P1 and P2 locations as a percentage of the PCL Picture Frame.
IW, Input Window	Sets up a window (soft-clip limits).
PG, Advance Full Page	This command is ignored.[1]
RO, Rotate Coordinate System	Rotates the HP-GL/2 coordinate system.
RP, Replot	This command is ignored.
SC, Scale	Establishes a user-unit coordinate system.

1. These commands, useful in plotter applications, are not the optimal solution for PCL 5 printers. Other PCL commands perform similar functions (see the Number of Copies and Form Feed command descriptions).

Establishing Default Conditions

Whether you are using HP-GL/2 mode or strictly the PCL printer language mode, you should establish default conditions at the beginning of each print job to prevent unexpected results due to “leftover” command parameters from a previous job. From within HP-GL/2 mode there are two ways to establish default conditions: using the Initialize (IN) command or using the Default (DF) command.

Using the IN command sets the printer to its user-selected defaults. This process is called initialization. The reset command ($^{E}_{C}$E) executes an Initialize (IN) command automatically, so if a reset was sent at the beginning of your print job, HP-GL/2 command parameters are at their user-selected default state when HP-GL/2 mode is first entered. (See Chapter 3 for a more thorough discussion of the printer environment and how it is affected by the reset command.)

Note

HP-GL/2 command parameters are set to their default values the first time HP-GL/2 mode is entered during a print job (assuming that an $^{E}_{C}$E reset is sent at the beginning of the job). After commands have been sent to modify the current print environment, the command parameters are no longer set to their defaults. When re-entering HP-GL/2 mode, immediately sending an IN command ensures that HP-GL/2 features are set to their default conditions (if that is desired).

The DF command is not as powerful as the IN command. The conditions set by the DF and IN commands are described later in this chapter.

The Scaling Points P1 and P2

When you scale a drawing, you define your own units of measurement, which the printer then converts to plotter units. Scaling relies on the relationship between two points: P1 and P2. These two points are called the scaling points because they take on the user-unit values that you specify with the Scale (SC) command. You can change the locations of P1 and P2 using either the Input P1 and P2 (IP), or Input Relative P1 and P2 (IR) command.

P1 and P2 always represent an absolute location in relation to the PCL Picture Frame, defined in plotter-units. They designate opposite corners of a rectangular printing area within the picture frame. You can change the size of the rectangular printing area and move it anywhere within the picture frame, or even outside the picture frame, depending on the plotter-unit coordinates you specify using the IP or IR commands.

Using the Scale Command

Scaling allows you to establish units of measure with which you are familiar, or which are more logical to your drawing. The Scale command (SC) determines the number of user-units along the X- and Y-axes between P1 and P2. The actual size of the units depends on the locations of P1 and P2 and the range of user-units set up by the SC command.

There are three types of scaling:

- Anisotropic
- Isotropic
- Point-factor

Anisotropic scaling indicates that the size of the units along the X-axis may be different than the size of the units on the Y-axis. **Isotropic scaling,** then, indicates that the units are the same size on both axes. **Point-factor scaling** sets up a ratio of plotter units to user-units.

The Scale command does not change the locations of P1 and P2, only their coordinate values. Also, scaling is not limited to the rectangular area defined by P1 and P2, but extends across the entire printing area within the PCL Picture Frame.

For example, to divide the X-axis into 12 units, and the Y-axis into 10 units, specify the X-axis to scale from 0 to 12, and the Y-axis to scale from 0 to 10. P1 becomes the origin with user-unit coordinate (0,0) and P2 becomes (12,10). The entire plotting area is now divided into the desired units. Subsequent plotting commands use these units (see Figure 19-1). If you command the printer to move to the point (3,4), the printer moves to the location equivalent to (3,4) user-units (*not* (3,4) plotter units).

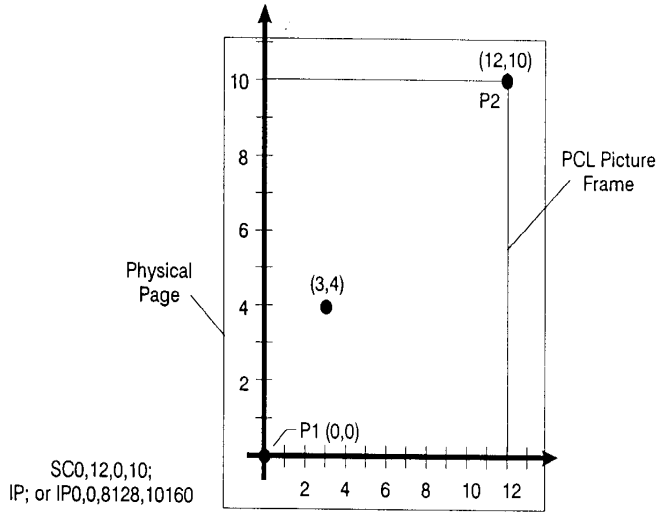


Figure 19-1 User-Unit Scaling with Default P1 and P2

If you move the locations of P1 and P2, the size of the user-units changes. Assume that the previous illustration showed P1 and P2 in their default locations (the lower-left and upper-right corners, respectively, of the PCL Picture Frame). In Figure 19-2, P1 and P2 have the same user-unit values (set with the Scale command [SC]), but their physical locations have been changed (using Input P1 and P2 [IP]). Note that the size of the user-units decreased.

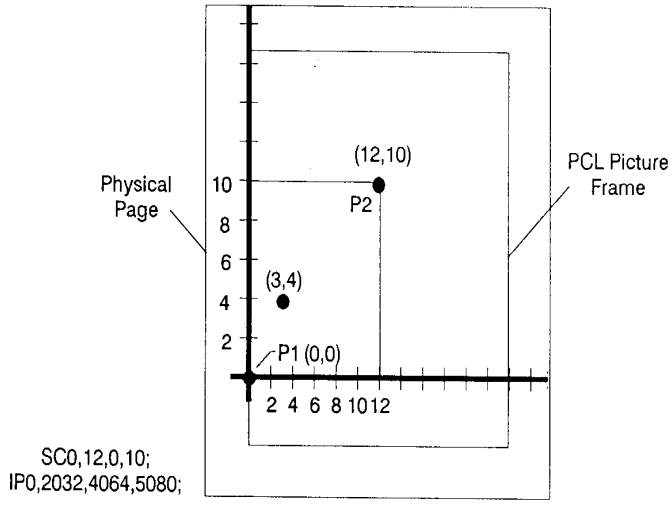


Figure 19-2 Same User-Unit Scaling with New P1 and P2

To further illustrate the flexibility of user-unit scaling, Figure 19-3 shows the P1 and P2 locations with negative user-unit values. Note that the framework set by the scaling points P1 and P2 is *not* a graphics limit. The user-unit coordinate system extends across the entire PCL Picture Frame area. You can print to a point beyond P1 or P2 as long as you are within the PCL Picture Frame. In Figure 19-3, P1 is in the -X and -Y quadrant.

Note

You can use coordinate points that are outside of the PCL Picture Frame boundaries or even off of the page, but only that portion of the vector graphics image that falls within the effective window is printed. For example, you can draw a small portion of the circumference of a circle with a 5-foot radius by moving the pen 5 feet from the page and issuing a CI command (specifying a 5-foot radius); only the portion of the arc that falls within the effective window is printed.

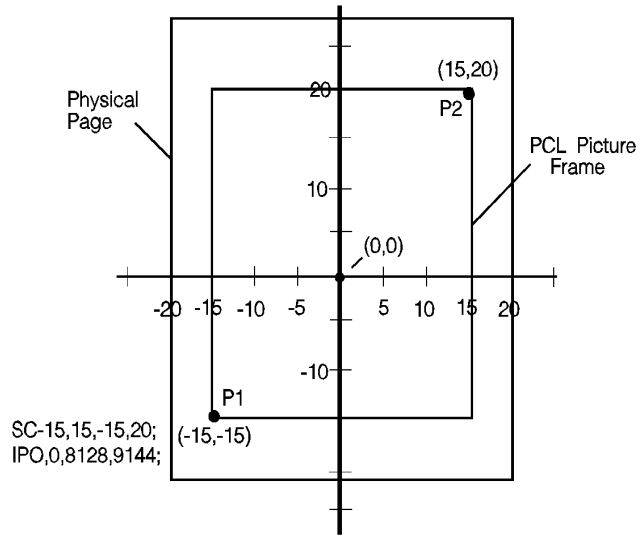


Figure 19-3 New P1 and P2 User-Unit Scaling with Negative Values

Refer to the Scale (SC) command at the end of this chapter for more information on scaling drawings.

Using Scaling Effectively

The following sections describe how to combine scaling and P1/P2 concepts to do the following.

- Enlarge or reduce the size of a drawing
- Draw equal-size pictures on the same page.
- Create mirror-imaged pictures

Enlarging or Reducing a Picture

The basic technique for changing a picture's size is to scale the printing area defined by P1 and P2, then move the locations of P1 and P2 to define a smaller or larger area. This is especially useful when you want to print the picture on any portion of the page.

Note Only scaled drawings (those using the SC command) are enlarged/reduced when the P1/P2 locations change. Use PCL Picture Frame scaling when importing HP-GL/2 images created without the SC command (see "Automatically Adjusting the Image Size" in Chapter 18).

To maintain the proportions of scaled plots, set P1 and P2 to define an area with the sameaspect ratio as the original scaling rectangle. For example, if the area defined by P1 and P2 is 3000 x 2000 plotter units, its aspect ratio is 3:2. To enlarge the plot, set P1 and P2 to define a larger area that maintains a 3:2 ratio.

The following example illustrates this technique using a square P1/P2 scaling rectangle with a scale of 0 to 10 for both axes. By definition, a square always has an aspect ratio of 1:1. After drawing a circle within the scaled area, the locations of P1 and P2 move to form a new square area that maintains the 1:1 ratio. Note that the circle printed in the new area is smaller but is proportionately identical.

Table 19-2 Example: Changing the Size of a Drawing

$^{E}_{C}$%0B	Enter HP-GL/2 mode, using the default picture frame size and anchor point.
IN;	Initialize HP-GL/2 mode.
IP0,0,2000,2000;	Set P1 to be (0,0) and P2 to be (2000,2000).
SC0,10,0,10;	Set up user-unit scaling to range from (0,0) to (10,10).
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used to enable printing.
PA5,5;	Begin absolute plotting from the center of the square (5,5).
CI3;	Print a circle with a radius of 3 user-units.
IP2500,500,3500,1500;	Input a new P1 and P2 position for printing the smaller circle.
PA5,5;	Begin absolute plotting from the center of the new square (5,5).
CI3;	Print the second circle with a radius of 3 user-units.
$^{E}_{C}$%0A	Enter PCL Mode.
$^{E}_{C}$E	Reset the printer to complete the job and eject the page.

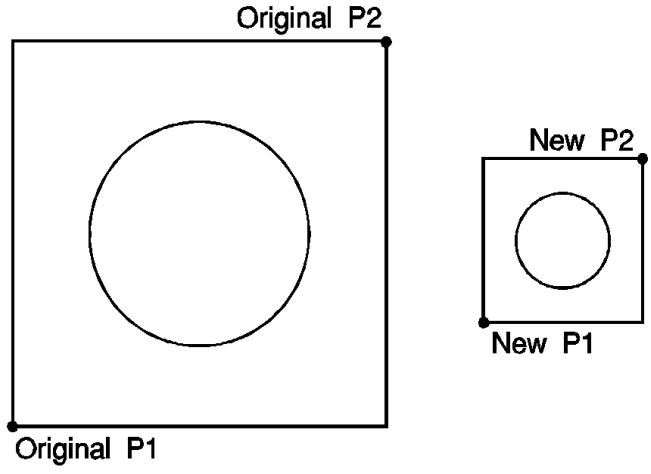


Figure 19-4 Changing the size of a drawing

Drawing Equal-Size Pictures on a Page

You may occasionally want to print more than one drawing on the same page for a side-by-side comparison. This can be useful for comparing parts, assemblies, layouts, or other similar information. The easiest way to draw equal-sized

pictures on one piece of paper is to take advantage of the fact that P2 follows P1 whenever you change the location of P1.

The following example illustrates this feature. The example locates P1 and P2 on the left side of the paper and scales the area for the first image. Then, for the second image, only the P1 location is moved to the right side of the paper; P2 automatically tracks P1, so the printing area retains the same dimensions as the first drawing. The printed rectangle around the second area shows P2 in its new location.

Table 19-3 Example: Drawing Equal-Size Pictures on a Page

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$&l1O	Select landscape orientation.
$^{E}_{C}$%0B	Enter HP-GL/2 mode, using the default picture frame size and anchor point.
IN;	Initialize HP-GL/2 mode.
IP500,500,5450,7500;	Set P1 to be (500,500) and P2 to be (5450,7500).
SC0,10,0,15;	Set up user-unit scaling to range from (0,0) to (10,15).
SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used to enable printing.
PA0,0;	Begin absolute plotting from the origin (0,0).
PD10,0,10,15,0,15,0,0;PU;	Pen Down and print from (0,0) to (10,0) to (10,15) to (0,15) to (0,0); then Pen Up.
IP5550,500	Input a new P1 and allow P2 to automatically track it.
PA0,0;	Begin absolute plotting from the new origin.
PD10,0,10,15,0,15,0,0;PU;	Pen Down and print from (0,0) to (10,0) to (10,15) to (0,15) to (0,0); then Pen Up.
$^{E}_{C}$%0A	Enter PCL Mode.
$^{E}_{C}$E	Reset the printer to complete the job and eject the page.

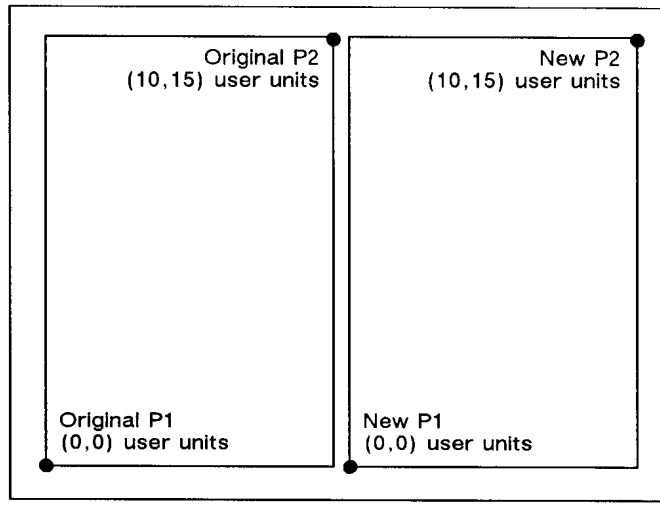


Figure 19-5 Drawing equal-size pictures on a page

Note

The P1/P2 frames are not windows or graphics limits; the pen can print HP-GL/2 images anywhere within the PCL Picture Frame. Note that the new P1 and P2 retain their scaled values. This allows you to use the same coordinates on both halves of the page. In contrast, if you do not assign a scale to P1 and P2, you must calculate the new plotter unit coordinates for the drawing on the second half of the page.

Creating Mirror-Images

For most drawings, you will probably set P1 and P2 so that P1 is in the lower-left corner and P2 is in the upper-right corner of the scaling area. However, you can change the relationship of P1 and P2 to produce a mirror-image effect.

You can “mirror-image” any *scaled* drawing (those drawings using the SC command) by changing the relative locations of P1 and P2, or changing the coordinate system by using SC. You can mirror-image labels using the Absolute Direction and Relative Direction (DI and DR) commands, the Relative Character Size (SR) command, or using the Absolute Character Size (SI) command. (The DI, DR, and SR commands are discussed in Chapter 23, *The Character Group*.)

The following example uses a subroutine to draw the same picture (an arrow) four times. Because the program changes the relative locations of P1 and P2, the direction of the arrow is different in each of the four drawings. The

program sets P1 and P2, draws the plot, then returns to reset P1 and P2 (using the IP command). This continues until all four possible mirror-images are plotted. (The original drawing is shown in each picture so you can compare the orientation of the mirror-image.)

Table 19-4 Example: Creating a Mirror-Image

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%0B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.
SP1;	Select pen number 1. You must use the SP command to enable printing.
IP1500,3600,3000,5100;	Specify the P1/P2 locations for the first arrow figure.
SC-15,15,-10,10;	Set up user scaling: (-15,-10) to (15,10).
(Run subroutine)	Run the subroutine (below) that prints the arrow image.
IP3000,3600,1500,5100;	Change the physical locations of P1 and P2 to flip the image to the left.
(Run subroutine)	Print the second image.
IP1500,5100,3000,3600;	Change the physical locations of P1 and P2 to flip the image down.
(Run subroutine)	Print the third image.
IP3000,5100,1500,3600;	Change P1/P2 locations to flip the image to the left and down.
(Run subroutine)	Print the fourth image.
$^{E}_{C}$%0A	Enter the PCL mode.
$^{E}_{C}$E	Send a reset to end the job and eject the page.

Table 19-4 Example: Creating a Mirror-Image (continued)

SUBROUTINE: PA1,2;PD1,4,3,4,3,7,2,7, 4,9,6,7,5,7,5,4,12,4,12, 5,14,3,12,1,12,2,1,2; PU;	Subroutine that prints the arrow figure on the next page

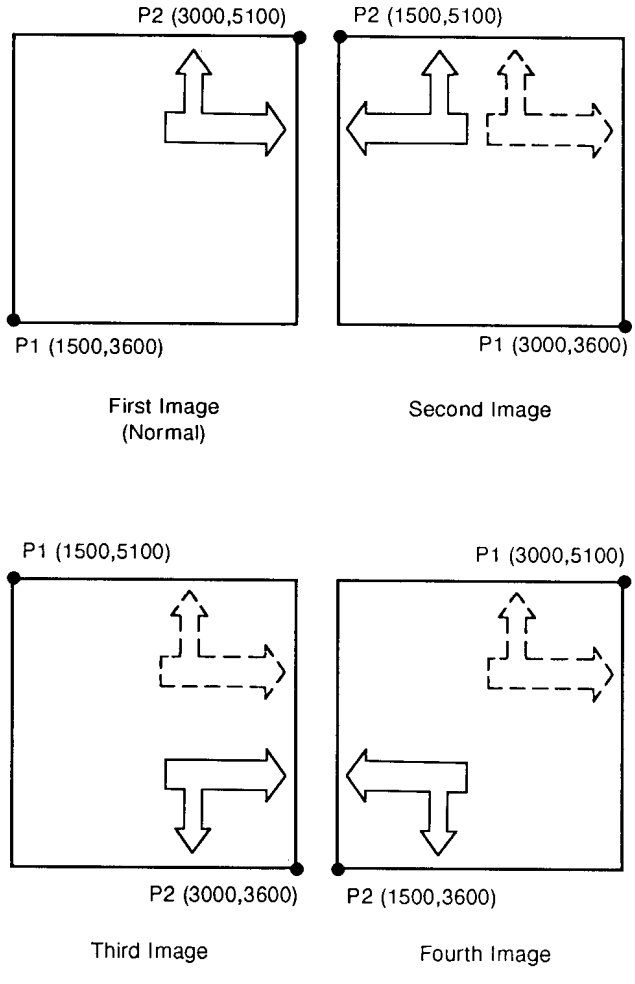


Figure 19-6 Creating a mirror-image

Adapting the HP-GL/2 Coordinate System to Match the PCL System

The following example uses the IP and SC commands to change HP-GL/2 coordinate system to match the default PCL coordinate system. The IP command is used to invert the Y-axis so that the Y values increase as the pen moves down the page. The SC command equates user-units to dot positions (300 dots-per-inch). The example draws a few lines in both PCL and HP-GL/2 modes to demonstrate that the coordinate systems are lined up correctly (the end points of the lines intersect).

Notes

Sending an IN (Initialize) or DF (Default) command causes the coordinate system to revert to the HP-GL/2 default.

Since this example is based on the default top margin and text length, changing the top margin or the text length moves the two coordinate systems out of alignment.

Table 19-5 Example: Adapting the HP-GL/2 Coordinate System to Match the PCL System in Portrait Orientation

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$&l2A	Set the page size to letter.
$^{E}_{C}$&l0O	Specify portrait orientation.
$^{E}_{C}$&l0E	Set top margin to 0.
$^{E}_{C}$*p0x0Y	Move to position (0,0).
$^{E}_{C}$*c5760x7920Y	Set picture frame to 8'' x 11'' (size of logical page).
$^{E}_{C}$*c0T	Set picture frame anchor point to current PCL cursor position (0,0).
$^{E}_{C}$%1B	Enter HP-GL/2 mode with the HP-GL/2 cursor or pen at the PCL cursor position.

Table 19-5 Example: Adapting the HP-GL/2 Coordinate System to Match the PCL System in Portrait Orientation

IN;SP1;	Initialize HP-GL/2 command values and select pen number 1 (black). (The IN command moves the pen position from the anchor point to the HP-GL/2 origin, the lower-left corner of the PCL Picture Frame.)
SC0,3.3867,0,-3.3867,2	Set-up a user scale with a user-unit equal to 1/300 inch. Scale command type 2, the scale is the ratio of plotter units/user-units (1016 plotter units-per-inch/300 dots-per-inch = 3.3867). The minus 2 Y-value changes the HP-GL/2 Y direction to match that of the PCL coordinate system.
IR0,100,0,100	Place P1 (point 0,0) at the top of the PCL picture frame.
PU0,0;	Lift the pen and move to (0,0) (upper left corner — since HP-GL/2 coordinate system now matches PCL coordinate system). Every subsequent pen move can be specified using the same coordinate numbers in either mode. The following commands demonstrate that the grids are synchronized.
PU300,300;PD600,600;	Lift the pen and move it to (300,300); then draw a line to (600,600). This draws a line at a 45° angle down from the starting point.
$^{E}_{C}$%1A	Enter the PCL mode with HP-GL/2's pen position being inherited as PCL's. CAP=(600,600).
$^{E}_{C}$*c300a4b0P	Draw a horizontal line (rule) that is 300 PCL units wide by 4 PCL units. (Note that the cursor position after a rule is printed is at the beginning of the rule — in this case, (600,600).)

Table 19-5 Example: Adapting the HP-GL/2 Coordinate System to Match the PCL System in Portrait Orientation

$^{E}_{C}$%1BPU;PR300,0; PD;PR0,500;	Enter HP-GL/2 mode (inheriting PCL's CAP) and lift the pen; move to a point 300 user-units (dots) to the right; place the pen down and print a line 500 user-units down.
$^{E}_{C}$%1A	Enter the PCL mode with the CAP at the current HP-GL/2 pen position.
$^{E}_{C}$E	Reset the printer to end the job and eject a page.

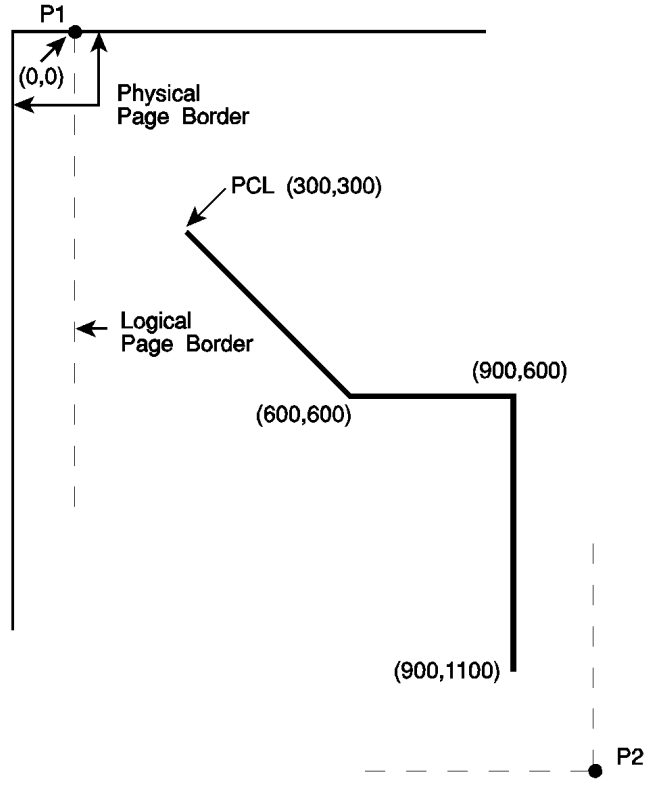


Figure 19-7 Adapting the HP-GL/2 coordinate system to match the PCL system in portrait orientation

Windowing: Setting Up Soft-Clip Limits

Soft-clip limits temporarily restrict pen movement to a rectangular area, or window. When you initialize or set the printer to default conditions, the soft-clip limits are the same as the PCL Picture Frame limits.

To create a window, you use the Input Window (IW) command. The printer does not draw outside the window.

The following illustration shows the four types of line segments you can specify from one point to another.

Table 19-6 The Four Types of Line Segments

Type	From Last Point	To New Point
1	Inside window area	Inside window area
2	Inside window area	Outside window area
3	Outside window area	Inside window area
4	Outside window area	Outside window area

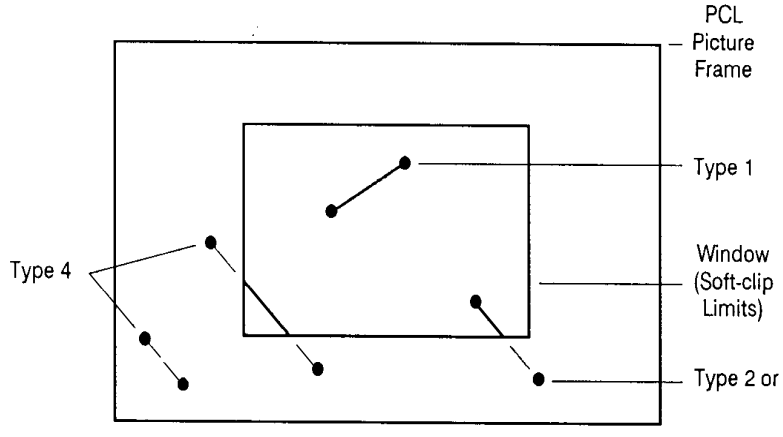


Figure 19-8 The four types of line segments

The IW command lets you control the size of the HP-GL/2 printing area so that you can draw a particular portion of a drawing. You can leave the rest as white space, or use the remaining area for labels, or another drawing. Refer to “The Vector Graphic Limits” in Chapter 17, and the IW command description later in this chapter.

CO, Comment

This command allows comments to be inserted within an HP-GL/2 command sequence. The comment string of the CO command must be delimited by double quotes.

CO “*text ... text*”

HP-GL/2 comments are ignored by the printer.

DF, Default Values

This command returns the printer’s HP-GL/2 settings to the factory default settings. Use the Default Values (DF) command to return the printer to a known state while maintaining the current locations of P1 and P2 (unlike the IN command). When you use DF at the beginning of a command sequence, graphics parameters such as character size, slant, or scaling are defaulted.

DF [;]

The DF command resets the printer to the conditions listed in Table 19-7.

Table 19-7 Default Conditions

Function	Command	Default Condition
Anchor Corner	AC	Anchor corner (not the same as the picture frame anchor point) set to lower-left corner of PCL Picture Frame, relative to the current coordinate system.
Alternate Font Definition	AD	Stick Font (11.5-pt., 9-cpi, upright, medium)
Character Fill Mode	CF	Solid fill, no edging.

Table 19-7 Default Conditions (continued)

Absolute Direction	DI1,0	Character direction parallel to X-axis.
Define Label Terminator	DT	**ETX** and non-printing mode.
Define Variable Text Path	DV	Text printed left to right with normal Line Feed.
Extra Space	ES	No extra space.
Fill Type	FT	Solid fill.
Input Window	IW	Set equal to PCL Picture Frame Window.
Line Attributes	LA	Butt caps, mitered joins, and miter limit=5.
Label Origin	LO1	Standard labeling starting at current location.
Line Type	LT	Solid line, relative mode, pattern length=4% of diagonal distance from P1 to P2.
Plotting Mode	PA	Absolute plotting.
Polygon Mode	PM	Polygon buffer cleared.
Raster Fill	RF	Solid black.
Scalable or Bitmap Fonts	SB0	Scalable fonts only.
Scale	SC	User-unit scaling off.
Screened Vectors	SV	No screening
Standard Font Definition	SD	Stick Font (11.5-pt., 9-cpi, upright, medium)
Absolute Character Size	SI	Turns off size transformation.
Character Slant	SL	No slant.
Symbol Mode	SM	Turns off symbol mode.
Select Standard Font	SS	Standard font selected.

Table 19-7 Default Conditions (continued)

Transparency Mode	TR1	Transparency mode on.
Transparent Data	TD	Normal printing mode.
User-Defined Line Type	UL	Defaults all 8 line types.

In addition, the printer updates the Carriage Return point for labeling to the current pen location. (See Chapter 23, *The Character Group,* for more information on the Carriage Return point.)

The DF command does not affect the following HP-GL/2 conditions.

- Locations of P1 and P2.
- Current pen, its location, width, width unit selection, and up/down
- position.
- HP-GL/2 drawing rotation.

Table 19-8 Related commands

Related Commands	Group
IN, Initialize	The Configuration/Status Group

IN, Initialize

This command resets all programmable HP-GL/2 functions to their default settings. Use the IN command to return the printer to a known HP-GL/2 state and to cancel settings that may have been changed by a previous command sequence. (The $^{E}_{C}$E Reset issues an automatic IN command.)

IN *[;]*

Notes

In this manual, all command sequence examples begin with IN to clear unwanted conditions from the previous command sequence, even though an $^{E}_{C}$E command automatically executes an IN command.

Once HP-GL/2 mode is entered and commands are issued, the HP-GL/2 conditions are no longer initialized. To place HP-GL/2 into the default state, send the IN command.

The IN command sets the printer to the same conditions as the DF command, plus the following:

- Raises the pen (PU).
- Returns the pen location to the lower-left corner of the PCL Picture Frame (PA0,0).
- Cancels drawing rotation (RO).
- Sets P1 and P2 to the lower-left and upper-right corners, respectively, of the PCL Picture Frame (IP).
- Sets pen width mode to metric; units are millimeters (WU).
- Sets the pen width to 0.35 mm (PW).
- Sets number of pens to 2 (black [1] and white [0]).

Table 19-9

Affected Commands	Group
DF, RO, IP	Configuration/Status Group
PD, PU,	Vector Group
WU, PW	Line and Fill Attributes Group

Table 19-10

Related Commands	Group
DF, Default Values	Configuration/Status Group

IP, Input P1 and P2

This command establishes new or default locations for the scaling points P1 and P2. P1 and P2 are used by the Scale (SC) command to establish user-unit scaling. You can also use IP in advanced techniques such as printing mirror-images, enlarging/reducing drawings, and enlarging/reducing relative character size, or changing label direction (see the previous discussion in this chapter).

IP *X_{P1},Y_{P1}[,X_{P2},Y_{P2};]* or

IP *[;]*

Parameter	Format	Functional Range	Default
$X_{P1}Y_{P1}$[,X_{P2},Y_{P2};]	integer	-2^{30} to 2^{30} - 1	(see below)

The default location of P1 is the lower-left corner of the PCL Picture Frame; the default location of P2 is the upper-right corner, as shown in Figure 19-9. (The default picture frame extends from the top margin to the bottom margin, and from the left edge to the right edge of the logical page.)

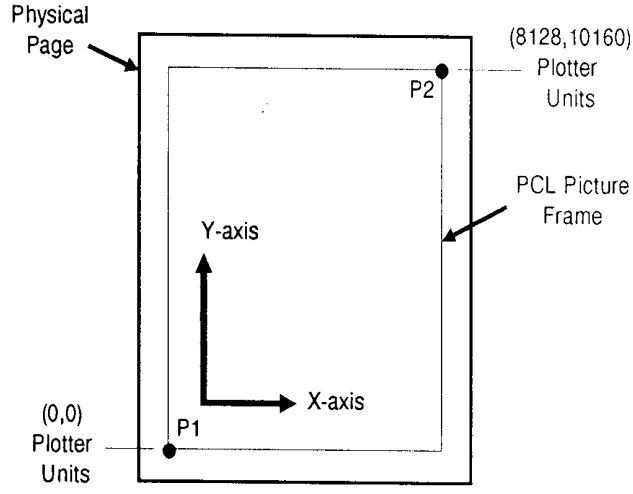


Figure 19-9 The Default P1/P2 Locations

- **No Parameters** — Sets P1 and P2 to their default locations, adjusted by any current axis rotation.

Note

If an IP command without parameters is executed after the axes are rotated with the RO command, P1 and P2 locations change to reflect the rotation. If the coordinate system orientation subsequently changes (e.g., by sending an RO command), the plotter unit position is maintained with respect to the new orientation.

- **X,Y Coordinates** — Specify the location of P1 (and, optionally, P2) in plotter units. Specifying P2 is not required. If P2 is not specified, P2 tracks P1 and its coordinates change so that the X,Y distances between P2 and P1 stay the same. This tracking process can locate P2 outside the effective window. Used carefully, the tracking function can be useful for preparing more than one equal-sized drawing on a page. For an example, refer to "Drawing Equal-Sized Pictures on a Page" earlier in this chapter.
- Neither X,Y coordinate of P1 can equal the corresponding coordinate of P2. If either coordinate of P1 equals the corresponding coordinate of P2, the coordinate of P2 is incremented by 1 plotter unit.

The locations of P1 and P2 interact with the following commands:

Table 19-11 Commands Affected by P1/P2

Command	Group
IW, Input Window RO, Rotate Coordinate System SC, Scale	*The Configuration/Status Group*
FT, Fill Type LT, Line Type PW, Pen Width WU, Pen Width Unit Selection	*The Line and Fill Attributes Group*
DR, Relative Direction LB, Label SR, Relative Character Size	*The Character Group*

An IP command remains in effect until another IP command is executed, an IR command is executed, or the printer is initialized.

Table 19-12

Related Commands	Group
IR, Input Relative P1 and P2	*The Configuration/Status Group*
IW, Input Window	
RO, Rotate Coordinate System	
SC, Scale	

IR, Input Relative P1 and P2

This command establishes new or default locations for the scaling points P1 and P2 relative to the PCL Picture Frame size. P1 and P2 are used by the Scale (SC) command to establish user-unit scaling. IR can also be used in advanced techniques such as printing mirror-images, enlarging/reducing drawings, and enlarging/reducing relative character size, or changing label (text) direction.

IR $X_{P1},Y_{P1},[X_{P2},Y_{P2};]$ or

IR *[;]*

Parameter	Format	Functional Range	Default
$X_{P1}Y_{P1}[X_{P2}Y_{P2};]$	clamped real	0 to 100%	0,0,100,100%

When P1 and P2 are set using IR, the scaled area is page size-independent. As the PCL Picture Frame changes size, P1 and P2 keep the same relative position within the PCL Picture Frame boundaries.

- **No Parameters** — Defaults P1 and P2 to the lower-left and upper-right corners of the PCL Picture Frame, respectively.
- **X,Y Coordinates** — Specify the location of P1 (and, optionally, P2) as percentages of the PCL Picture Frame limits (specifying P2 is not required). If P2 is not specified, P2 tracks P1; the P2 coordinates change so that the distances of X and Y between P1 and P2 remain the same. This tracking process can cause P2 to locate outside the effective window. Used carefully, the tracking function can be useful for preparing more than one equal-sized drawing on a page. For an example, refer to “Drawing Equal-Sized Pictures on a Page” earlier in this chapter.
- Neither X,Y coordinate of P1 can equal the corresponding coordinate of P2. If either coordinate of P1 equals the corresponding coordinate of P2, the coordinate of P2 is incremented by 1 plotter unit.

Sending the command **IR25,25,75,75** establishes new locations for P1 and P2 that create an area half as high and half as wide as the PCL Picture Frame, in the center of the picture frame. Refer to the following illustration.

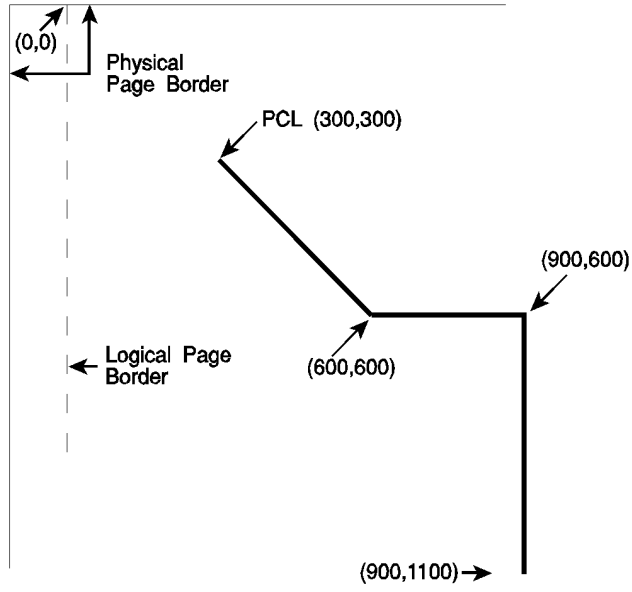


Figure 19-10 Example: P1 and P2 command

P1 or P2 can also be set outside the PCL Picture Frame by specifying parameters less than zero and greater than 100. For example, sending (IR-50,0,200,100) would set P1 and P2 as shown in the following illustration.

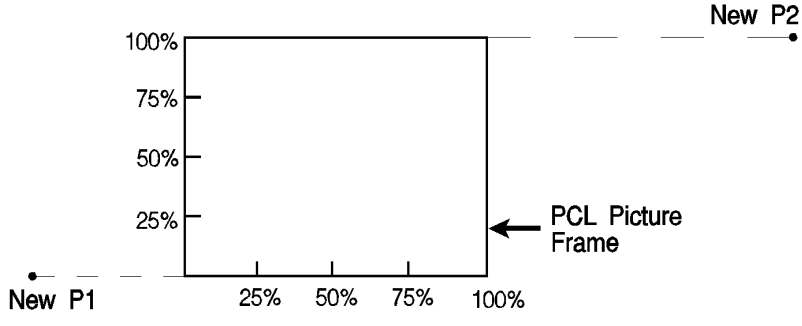


Figure 19-11 Example: P1 and P2 command

If you specify P1 and P2 beyond the PCL Picture Frame, your drawing is scaled with respect to those locations; however, only the portion of the drawing fitting within the effective window is drawn.

Note

The specified P1/P2 percentages are converted to the equivalent plotter unit coordinates. If the coordinate system orientation subsequently changes (for example, by sending an RO command), the plotter unit position is maintained with respect to the new orientation. If an IP command without parameters is executed after the axes have been rotated with the RO command, P1 and P2 locations change to reflect the rotation.

The locations of P1 and P2 interact with the following commands:

Table 19-13 Commands Affected by P1/P2

Command	Group
IW, Input Window RO, Rotate Coordinate System SC, Scale	*The Configuration/Status Group*
FT, Fill Type LT, Line Type PW, Pen Width WU, Pen Width Unit Selection	*The Line and Fill Attributes Group*
DR, Relative Direction LB, Label SR, Relative Character Size	*The Character Group*

An IR command remains in effect until another IR command is executed, an IP command is executed, or the printer is initialized.

Table 19-14

Related Commands	Group
IP, Input P1 and P2 IW, Input Window RO, Rotate Coordinate System SC, Scale	*The Configuration/Status Group*

IW, Input Window

This command defines a rectangular area, or window, that establishes soft-clip limits. Subsequent HP-GL/2 drawing is restricted to this area. Use IW to restrict printing to a specified area on the page.

IW $X_{LL},Y_{LL},X_{UR},Y_{UR}[;]$ or

IW *[;]*

Parameter	Format	Functional Range	Default
$X_{LL},Y_{LL},X_{UR},Y_{UR}$	current units	-2^{30} to $2^{30} - 1$	PCL Picture Frame

The printer interprets the command parameters as follows.

- **No Parameters** — Resets the soft-clip limits to the PCL Picture Frame limits.
- **X,Y Coordinates** — Specify the opposite, diagonal corners of the window area, usually the lower-left (LL) and upper-right (UR) corners. Coordinates are interpreted in the current units: as user-units when scaling is on; as plotter units when scaling is off.

When scaling is on, subsequent changes to P1 and P2 move the window in relation to the physical page, but keep the same user coordinate locations. However, sending a subsequent SC command binds the window to its equivalent plotter units. The window does not change with any subsequent IP or IR commands.

When you turn on the printer, the window is automatically set to the PCL Picture Frame boundaries. You can define a window that extends beyond the picture frame, however the printer cannot print vector graphics beyond the effective window. All programmed pen motion is restricted to this area. For more information, refer to “Windowing: Setting Up Soft-Clip Limits” at the beginning of this chapter.

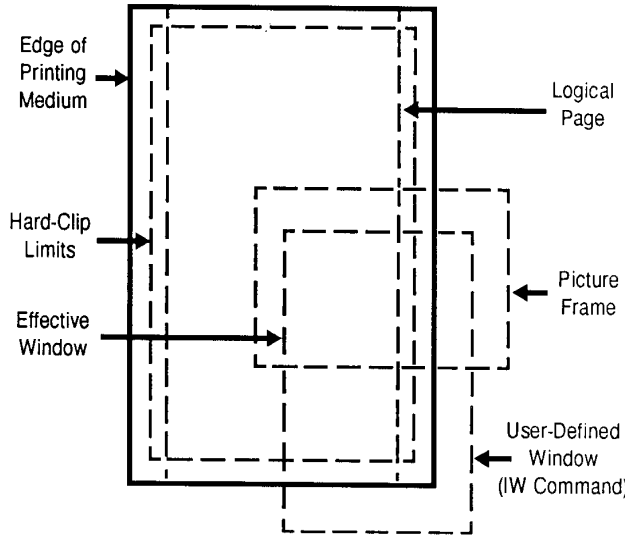


Figure 19-12 The Effective Window

If the window falls entirely outside of the PCL Picture Frame, no image is drawn. The IW command remains in effect until another IW command is executed, or the printer is initialized or set to default conditions.

The following example draws a label, then establishes a window and again draws the label along with a line. Notice how the line and label are clipped after the window is established, but not before.

Table 19-15 Example: The IW Command

$^{E}_{C}$E	Reset the printer.
$^{E}_{C}$%1B	Enter HP-GL/2 mode.
IN;	Initialize HP-GL/2 mode.

Table 19-15 Example: The IW Command (continued)

SP1;	Select pen number 1. Even though there is no physical pen, the SP command must be used to enable printing.
SI.2,.35;	Set Absolute Character Size to .2 x .35 cm.
PA2000,3200;	Specify absolute plotting and move to location (2000,3200) (plotter units).
DT@,1;	Define label terminator to be the “@” character, without printing the character.
LBTHIS IS AN EXAMPLE OF IW@;	Print a label beginning at (2000,3200). (The label on the left is shown on two lines —with a Carriage Return in the middle of the text— for convenience in this example. In an actual command sequence, this label text should be all on one line to print as shown in the plot at the end of this example.)
IW3000,1300,4500,3700;	Specify a soft-clip window (in plotter units).
PD2000,1700	Pen Down; print a line from the current pen position to (2000,1700). Current pen position at start of command is at the letter W baseline.
LBTHIS IS AN EXAMPLE OF IW@;	Print the same label at (2000,1700). (This label should not contain carriage returns to print as shown in the plot for this example.)
PU3000,1300;	Pen Up and move to position (3000,1300).
PD4500,1300,4500,3700;	Pen Down and begin drawing box indicating the soft-clip window.
PD3000,3700,3000,1300;	Finish drawing the soft-clip window box
PU;	Pen Up
$^{E}_{C}$%0A	Enter PCL Mode.
$^{E}_{C}$E	Reset the printer to end the job and eject the page.

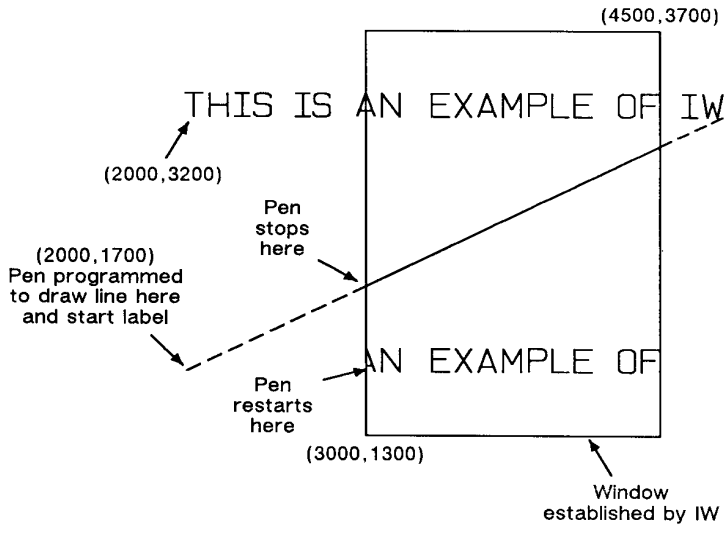


Figure 19-13 Example: IW command

Table 19-16

Related Commands	Group
IP, Input P1 and P2 IR, Input Relative P1 and P2 RO, Rotate Coordinate System SC, Scale	*The Configuration/Status Group*

PG, Advance Full Page

This HP-GL/2 command is ignored by the printer since it could cause undesirable results when importing plots. A page eject can be accomplished only from the PCL printer language mode.

The following PCL commands cause a conditional page eject, meaning that a page is ejected if there is any printable data in the print buffer:

- $^{E}_{C}$E Reset
- UEL (Universal Exit Language)
- Flush All Pages
- Page Length
- Page Size
- Orientation
- Paper Source

When a page is ejected using one of the above commands, the PCL cursor position is set to the top of form on the new page. (The Top of Form is 3/4 of a line below the top margin.)

An alternative method of ejecting a page from PCL is the Form Feed control code. A Form Feed causes an unconditional page eject and advances the current active cursor position to the top of form on the next page. The horizontal cursor position remains the same as before the page eject.

Note The HP-GL/2 pen position is not affected by a Form Feed; it occupies the same position on the next page.

RO, Rotate Coordinate System

This command rotates the printer's coordinate system relative to the default HP-GL/2 coordinate system, in the following increments of rotation: 90°, 180°, and 270°. Use RO to orient your drawing vertically or horizontally, or to reverse the orientation.

RO *angle[;]* or

RO *[;]*

Parameter	Format	Functional Range	Default
angle	clamped integer	0°, 90°, 180°, or 270°	0°

The printer interprets the command parameters as follows:

- **No Parameter** — Defaults the orientation of the coordinate system to 0°. Equivalent to *(RO0)*. This is the same as PCL's current orientation.
- **Angle** — Specifies the degree of rotation:

  0 Sets the orientation to PCL's current orientation.

  90 Rotates and shifts the coordinate system 90 degrees in a positive angle of rotation from PCL's current orientation.

  180 Rotates and shifts the coordinate system 180 degrees in a positive angle of rotation from PCL's current orientation.

  270 Rotates and shifts the coordinate system 270 degrees in a positive angle of rotation from PCL's current orientation.

Angle of Rotation

Note

A *positive angle* of rotation is in the direction of the +X-axis to the +Y-axis as shown below. (A *negative angle* of rotation is not allowed in the RO command.)

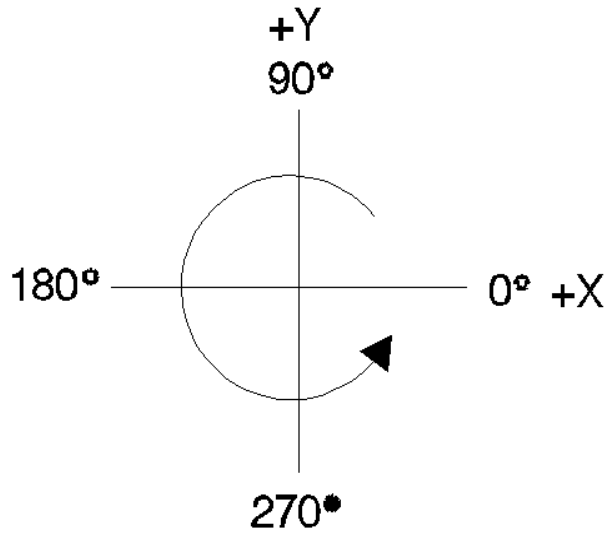


Figure 19-14 Angle of rotations

Note

The relationship of the X-axis to Y-axis can change as a result of the scaling point or scaling factor changes, thus changing the direction of a positive angle of rotation.

The physical location of the pen does not change when you rotate the coordinate system. The printer updates the pen's X,Y coordinate location to reflect the new orientation.

The scaling points P1 and P2 rotate with the coordinate system. However, they maintain the same X,Y coordinate values as before the rotation. This means that P1 and P2 can be located outside of the PCL Picture Frame. Follow the *(RO90)* or *(RO270)* commands with *(IP)* or *(IR)* to relocate points P1 and P2 to the lower-left and upper-right corners of the picture frame.

When the RO command is used, the soft-clip window, if defined, is also rotated, and any portion that is rotated outside of the picture frame is clipped to the picture frame boundaries. The soft-clip window can be set equal to the picture frame by issuing an "IW;" command (see Figure 19-17).

Note The RO command also rotates the contents of the polygon buffer.

The RO command remains in effect until the rotation is changed by another RO command, or the printer is initialized.

Figure 19-15 shows the default orientation and the result of rotating the orientation without relocating P1 and P2.

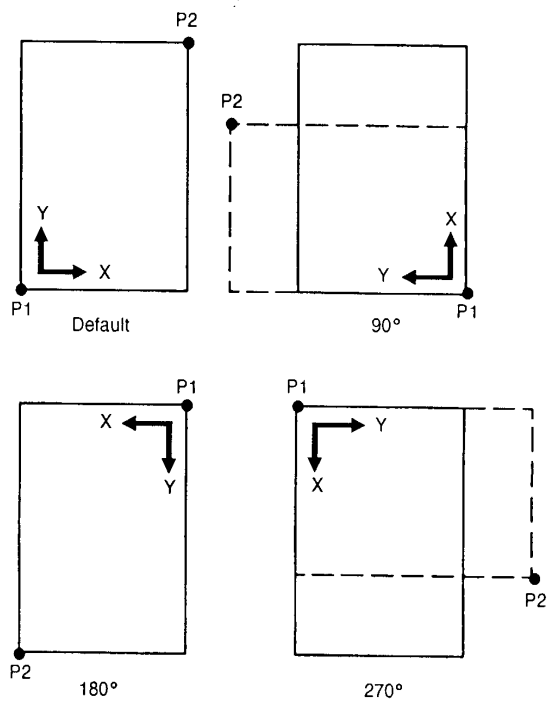


Figure 19-15 Using the RO Command Without Using the IP Command

Figure 19-16 shows the locations of P1 and P2 when you follow the rotation with the IP command.

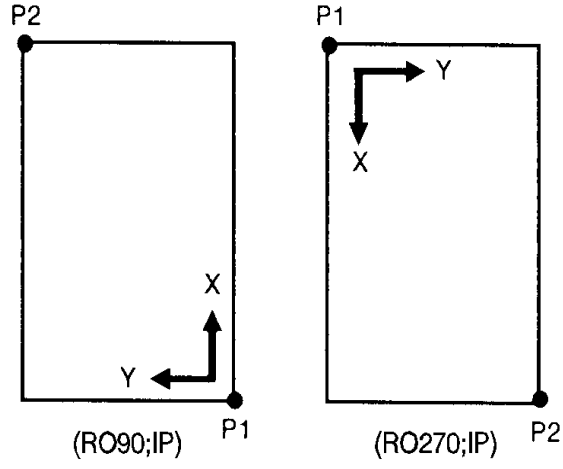


Figure 19-16 Using IP after the RO Command

When you set-up a soft-clip window (see the IW command), RO also rotates the window. If a portion of a window rotates outside the hard-clip limits, it is clipped. Note that *IP* does not affect the window limits. Use *IW* to reset the window to the size of the PCL Picture Frame.

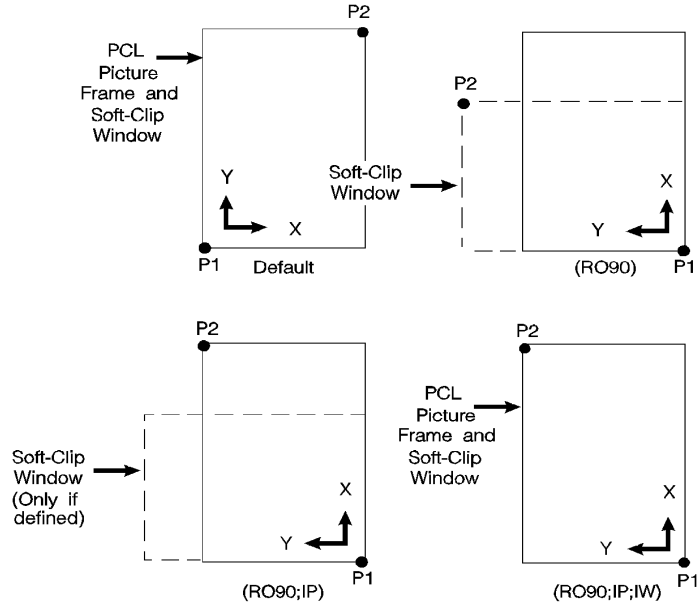


Figure 19-17 Using IP and IW after the RO Command

Table 19-17

Related Commands	Group
IP, Input P1 and P2 IR, Input Relative P1 and P2 IW, Input Window	*The Configuration/Status Group*

RP, Replot

This command is ignored by the printer; to eject a page, the printer must be in PCL printer language mode. The following commands cause a conditional page eject; a page is ejected if there is any printable data in the print buffer:

- $^{E}_{C}E$ Reset
- UEL (Universal Exit Language)
- Flush All Pages
- Page Length
- Page Size
- Orientation
- Paper Source

The PCL Form Feed control code causes an unconditional page eject and advances the cursor position to the top of form on the next page.

Note A page eject caused by any of the above commands except Paper Source defaults the HP-GL/2 pen position.

To print more than one plot, use the Number of Copies command. For information about printing more than one copy of an HP-GL/2 illustration, see “Number of Copies Command” in Chapter 4.

SC, Scale

This command establishes a user-unit coordinate system by mapping user-defined coordinate values onto the scaling points P1 and P2.

SC *XMIN,XMAX,YMIN,YMAX [,type[,left,bottom;]]* or

SC *XMIN,XFACTOR,YMIN,YFACTOR,type[;]* or

SC *[;]*

Parameter	Format	Functional Range	Default
X_{MIN},X_{MAX},	real	-2^{30} to $2^{30} - 1$	no default
Y_{MIN},Y_{MAX}	real	-2^{30} to $2^{30} - 1$	no default
type	clamped integer	0, 1, or 2	0
left	clamped real	0 to 100%	50%
bottom	clamped real	0 to 100%	50%
X_{FACTOR}, Y_{FACTOR}	real	-2^{30} to $2^{30} - 1$	no default

For more information about the basic concept of scaling, refer to “The Scale Command” earlier in this chapter.

There are three forms of scaling: anisotropic, isotropic, and point-factor. The *Type* parameter tells the printer which form you are using. Refer to the following table.

Table 19-18

Scaling Form	Type	Description
Anisotropic	0	Establishes standard user-unit scaling allowing different unit size on X-axis and Y-axis.
Isotropic	1	Establishes standard user-unit scaling with same unit size on X-axis and Y-axis.
Point Factor	2	Establishes P1 user-unit location and a specific ratio of plotter units to user-units.

- **No Parameters** — Turns off scaling; subsequent coordinates are in plotter units.

For Scaling Types 0 and 1:

The following forms of scaling establish a user-unit coordinate system by mapping user-defined coordinate values onto the scaling points P1 and P2. The type parameter selects between anisotropic (Type 0) and isotropic scaling (Type 1).

Table 19-19

Scaling Form	Type	Syntax
Anisotropic	0	SC*XMIN,XMAX,YMIN,YMAX[,type;]*
Isotropic	1	SC%%X_{MIN},X_{MAX},Y_{MIN},Y_{MAX}*[,type[,left,bottom];]*

- X_{MIN}, X_{MAX}, Y_{MIN}, Y_{MAX} — These parameters represent the user-unit X- and Y-axis ranges, respectively. For example, *SC0,15,0,10* indicates 15 user-units along the X-axis and 10 user-units along the Y-axis. As a result, the first and third parameters (X_{MIN} and Y_{MIN}) are the coordinate pair that is mapped onto P1; the second and fourth parameters (X_{MAX} and Y_{MAX}) are the coordinate pair mapped onto P2. Using the same example, the coordinate location of P1 is (0,0) and P2 is (15,10). This is different from the IP command, where the parameters are expressed as X,Y coordinate pairs rather than as ranges.

Note X_{MIN} cannot be set equal to X_{MAX}, and Y_{MIN} cannot be set equal to Y_{MAX}.

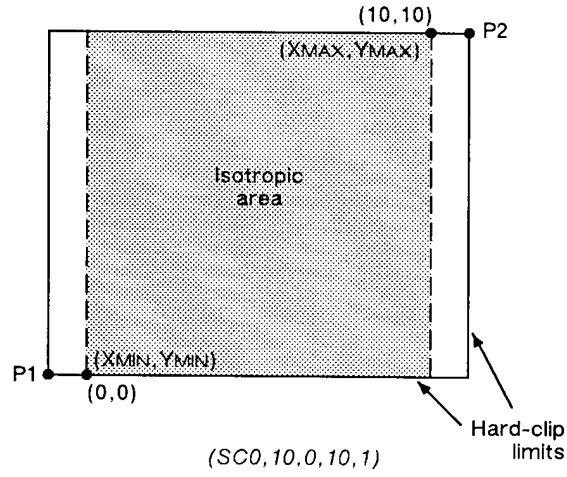
As their names suggest, you will normally want to specify X_{MIN} smaller than X_{MAX}, and Y_{MIN} smaller than Y_{MAX}. If you specify X_{MIN} larger than X_{MAX} and Y_{MIN} larger than Y_{MAX}, your illustration is drawn as a mirror-image, reversed and/or upside down, depending on the relative positions of P1 and P2.

The parameters of the SC command are always mapped onto the current P1 and P2 locations. P1 and P2 retain these new values until scaling is turned off or another SC command redefines the user-unit values. Thus, the size of a user unit could change if any change is made in the relative position and distance between P1 and P2 *after* an SC command is executed.

- **Type** — Specifies anisotropic or isotropic scaling.

Table 19-20

0	**Anisotropic scaling.** Allows a user-unit along the X-axis to be a different size than user-units along the Y-axis. Printed shapes are distorted when you use anisotropic scaling. For example, a circle might be drawn as an ellipse—oval-shaped instead of round. (*Left and bottom* parameters are ignored for anisotropic scaling.
1	**Isotropic scaling.** Produces user-units that are the same size on both the X- and Y-axes. The following illustrations show how the printer adjusts the location of (XMIN,YMIN) and (XMAX,YMAX) to create the largest possible isotropic area within the P1/P2 limits. (Remember, the user-units are always square regardless of the shape of the isotropic area.)



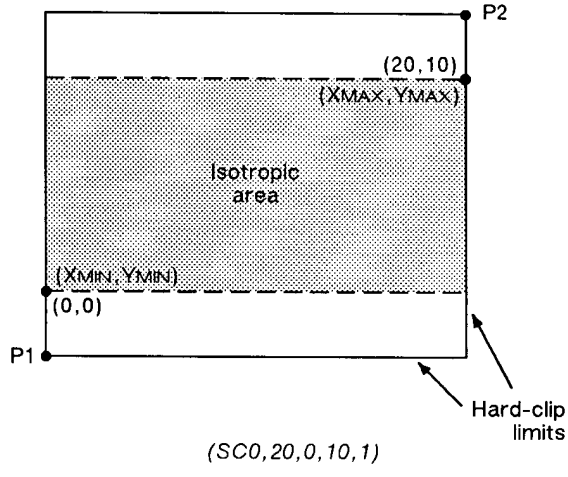


Figure 19-18 Isotropic Scaling

- **Left, Bottom** — Positions the isotropic area in the P1/P2 limits. (These parameters are always specified together and are valid for isotropic scaling only.) The left parameter indicates the percentage of the unused space on the left of the isotropic area; the bottom parameter indicates the percentage of unused space below.
  - The defaults for the left and bottom parameters are each 50%. This centers the isotropic area on the page with the unused space equally divided between left and right or top and bottom, as shown in the previous illustrations.

- Although you **must** specify both parameters, the printer applies only one: the left parameter applies when there is extra horizontal space; the bottom parameter applies when there is extra vertical space. The following examples illustrate left and bottom parameters of 0% and 100%.

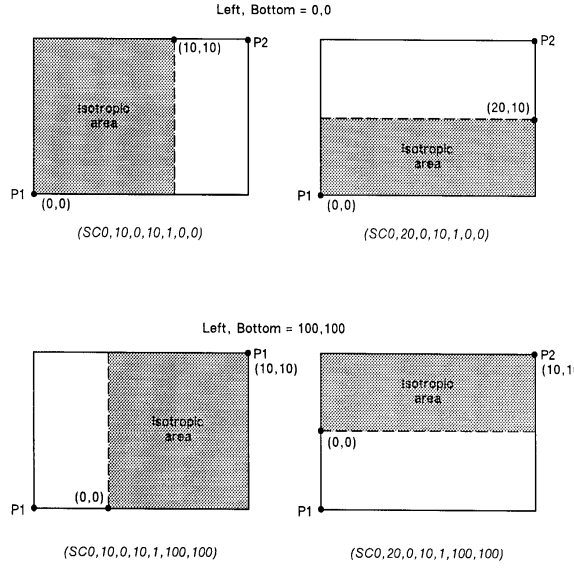


Figure 19-19 The Left and Bottom Parameters

For Scaling Type 2:

The third form of scaling, point-factor scaling, sets a specific ratio of plotter units to user-units, and establishes the user-units coordinate of P1.

Table 19-21

Scaling Form	Type	Syntax
Point Factor	2	SCX_{MIN},X_{FACTOR},Y_{MIN},Y_{FACTOR},*type[;]*

- X_{MIN},X_{FACTOR},Y_{MIN},Y_{FACTOR} — Establish the user-unit coordinates of P1 and the ratio of plotter to user-units. X_{MIN} and Y_{MIN} are the user-unit coordinates of P1. X_{FACTOR} sets the number of plotter units per user-unit on the X-axis; Y_{FACTOR} sets the number of plotter units per user-unit on the Y-axis.
- **Type** — Must be 2 for this type of scaling.

An SC command remains in effect until another SC command is executed, or the printer is initialized or set to default conditions.

Examples: The following examples explain the effect of several parameter selections.

(SC0,40,0,40,2) allows scaling in millimeters since 1 millimeter = 40 plotter units. Each user-unit is 1 millimeter.

(SC0,1.016,0,1.016,2) allows scaling in thousandths of an inch since 1 inch = 1016 plotter units.

While scaling is on (after any form of the SC command has been executed), only those HP-GL/2 commands that can be issued in 'current units' are interpreted as user-units; the commands that can be issued only in plotter units are still interpreted as plotter units. (The command syntax discussion pertaining to each command tells you which kind of units each parameter requires.)

The SC parameters are mapped onto the current locations of P1 and P2. P1 and P2 do *not* represent a graphic limit; therefore, the new user-unit coordinate system extends across the entire range of the plotter-unit coordinate system. Thus, you can print to a point beyond P1 or P2, as long as you are within the effective window. For example, you can print from the point (-1,3.5) to the point (5.5,1.5) as shown in the following illustration.

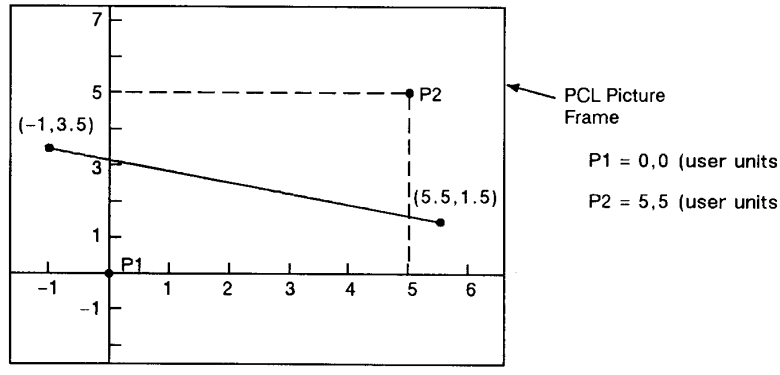


Figure 19-20 Example: Printing point-to-point

Table 19-22

Related Commands	Group
IP, Input P1 and P2 IR, Input Relative P1 and P2 IW, Input Window	The Configuration/Status Group

Table 19-23 Possible Error Conditions for SC

Condition	Printer Response
no parameters	turns scaling off
more than 7 parameters	executes first 7 parameters
for types 0 or 1: 6 parameters or less than 4 parameters	ignores command
for type 2: any more or less than 5 parameters	ignores command
$X_{MIN}=X_{MAX}$ or $Y_{MIN}=Y_{MAX}$ or number out of range	ignores command
$X_{FACTOR}=0$ or $Y_{FACTOR}=0$	ignores command