System 35 Desktop Computer

Plotter ROM Programming

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Plotter ROM Programming

HP 9835A Desktop Computer

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Printing History

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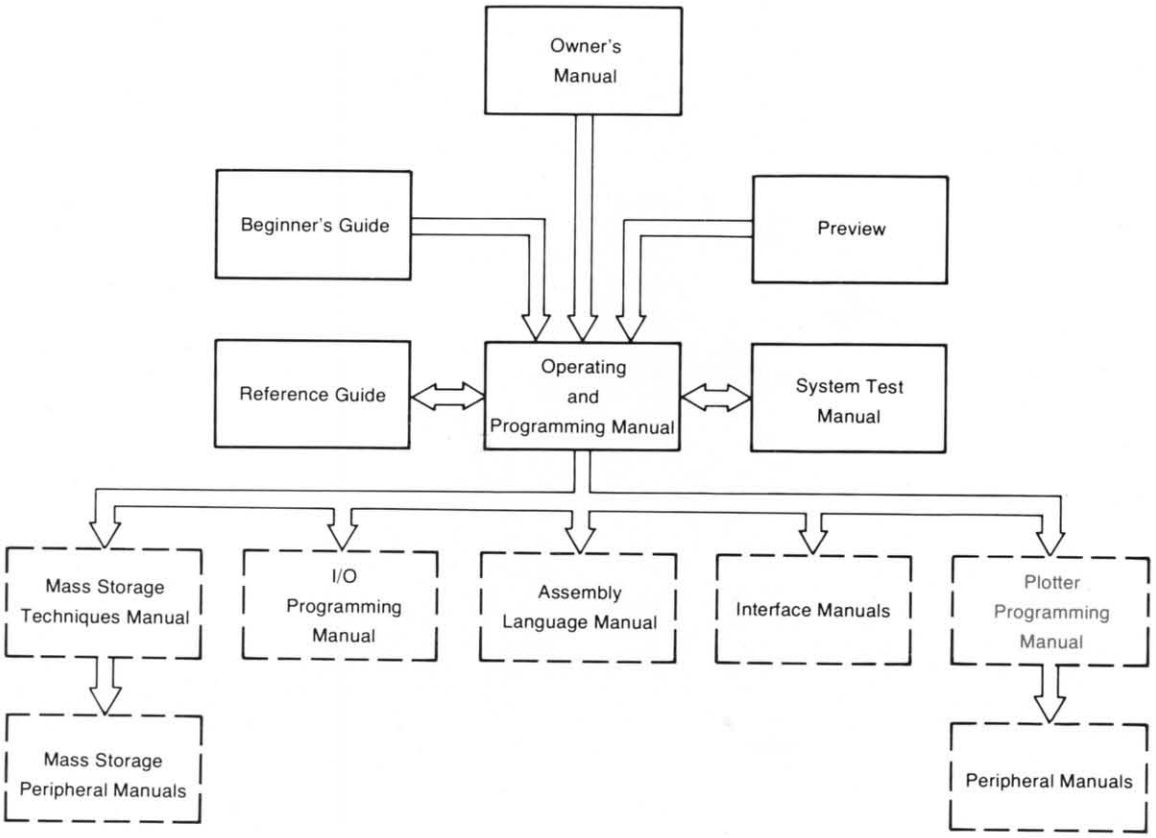
The date on the back cover changes only when each new edition is published. Minor corrections or additions may be made as the manual is reprinted between editions.

First Printing .....August, 1978

System 35 Manual Reference

The following block diagram shows manuals that are included in the System 35 Documentation scheme and suggested progression. Dotted-line borders indicate those manuals are available with specific options; solid borders indicate those manuals that are shipped with every System 35.



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To help us in preparing new manuals, there is a questionnaire in the back of this manual. Your answers to the questions can assist in producing better, more useful manuals. Your feedback is our only way of knowing the validity of our manuals. Please complete the questionnaire and mail it - postage is already paid in the United States. Thank you.

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Chapter 1
General Information

Introduction

The HP System 35 Plotter ROM enables the computer to control the HP 9872A Plotter as well as some incremental plotters. This provides plotter graphic solutions or hard copy illustrations of problems solved by the computer. In addition, digitizing control allows you to retrieve numeric data from a plot or an illustration.

Before attempting to use the plotter and this manual you should be familiar with the basic operation of the HP 9835 Desktop Computer. Refer to the System 35 Operating and Programming Manual (P/N 09835-90000).

Information contained in this manual is directed specifically to the HP 9872A Plotter as the primary plotter unit. However, the information can be helpful when using other external plotting devices.

ROM Installation

The HP 98337 Plotter ROM for the System 35 consists of a plug in ROM package. You can install the Plotter ROM in one of the ROM drawers in the front of the computer. If you are unfamiliar with the procedure for installing a ROM, refer to the System 35 Operating and Programming Manual for the proper procedure.

Factory Installed Plotter ROM

If the 9835 Computer was ordered from the factory with the Plotter ROM, the ROM will already be installed for you.

Plotter Installation

Appendix C contains detailed instructions for connecting the HP 9872A Plotter to the HP 9835 Desktop Computer. Refer also to Appendix C for instructions on how to load the plotter with paper and pens.

For connecting other plotting devices to the 9835, refer to their respective installation manuals.

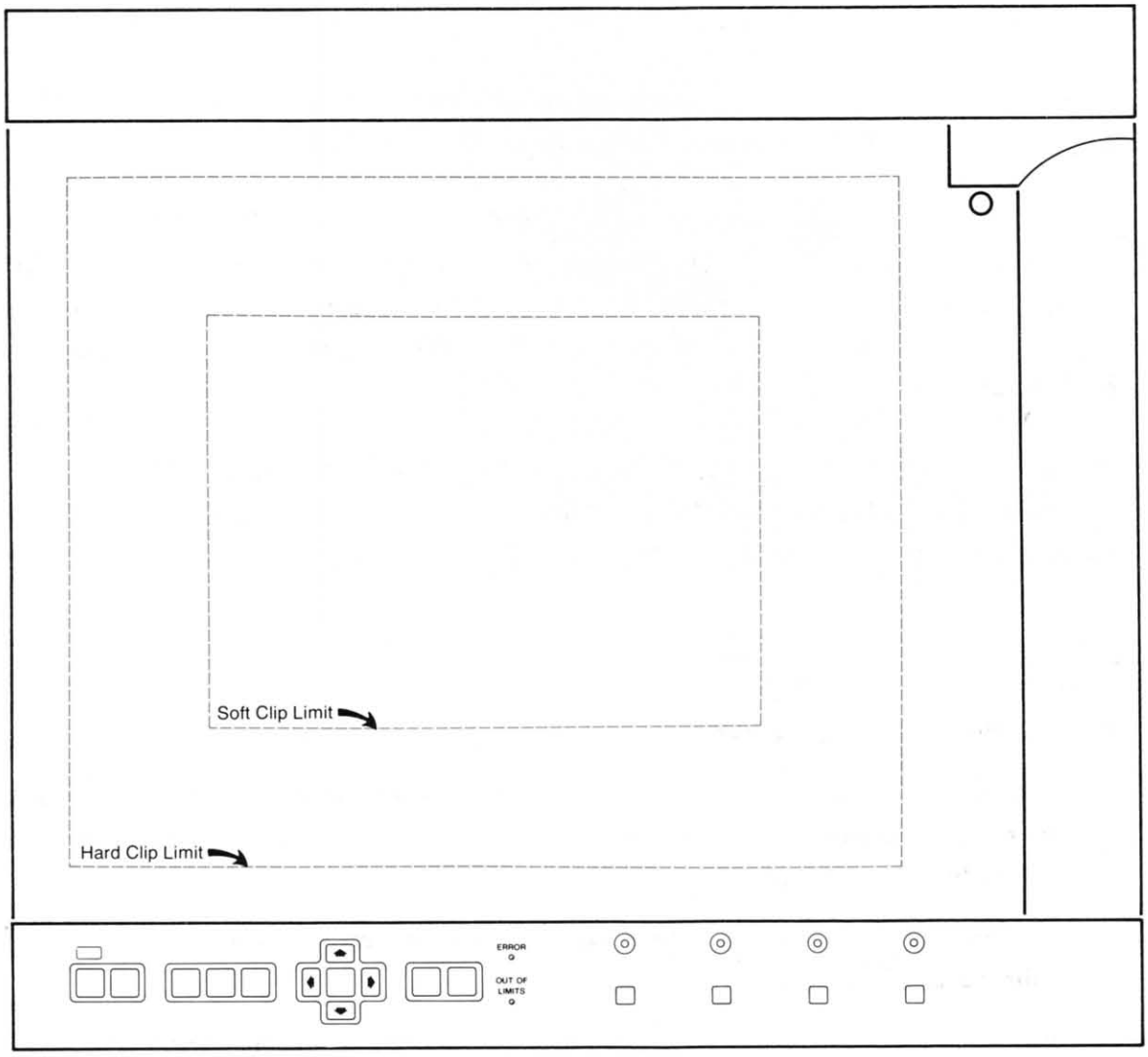
Definition of Terms

Throughout this manual some new terms and mnemonics are used to describe a particular operation. In many cases a term or mnemonic is used before a complete definition can be given. For these cases, the following explanations provide enough information to make each term meaningful without giving complete details. Complete details regarding each term are given later in the manual. The terms and mnemonics to be defined are:

- Plotting Space
  - Hard Clip Limits
  - Soft Clip Limits
- Unit-of-Measure Modes
  - Graphic Display Units (GDU's)
  - User Defined Units (UDU's)
  - Metric Units
  - Current Units
- X,Y Coordinate Reference
  - Absolute
  - Relative
  - Incremental

Plotting Space

Plotting devices have physically-imposed **hard clip limits** (e.g., the 9872A Plotter's platen size) that restrict the pen movement. The default hard clip limits and the resulting plotting area size depend upon the plotting device used (see illustration below). The hard clip limits can be made smaller (e.g., to fit a piece of paper) by program control, or on some plotters, manually. Whether this area is the default size or is specified, it is referred to as the area within the hard clip limits.



Another set of limits that further restrict the pen movement are the **soft clip limits**. The soft clip limits are defaulted to the hard clip limits but can be altered under program control (see illustration above). The soft clip limits restrict the pen movement when the User Defined Units (**UDU's**) mode is set, but not when the Graphic Display Units (**GDU's**) mode is set. As will be seen later, this capability is very useful.

Unit-of-Measure Modes

Program control provides three units-of-measure in which you can plot: Graphic Display Units (GDU's),User Defined Units (UDU's), and Metric Units.

GDU's are defined as being one percent of the length of the shortest side of the plotting area (i.e. the area bounded by the hard clip limits). Thus, the short side is scaled to be 100 GDU's long and the length of the long side is 100 times the ratio of the long to short dimensions. This units mode allows access to the plotter area on a percent of full scale basis.

UDU's are the units defined by the user's application. Functions which operate in the UDU mode can have values for the arguments specified directly in user units. The SCALE, SHOW and MSCALE statements allow you to define the units of measure for a particular application.

The unit of measure in the **Metric** unit mode (MSCALE) is the millimetre. This mode is implemented as a special case of UDU's. Plotting statements executed in this mode will put a line on the plotting area physically scaled to millimetres. This mode is useful where correspondence with physically measurable objects is desirable, as in drafting applications. In some devices, METRIC units are only approximate.

The term "current units" refers to the last unit-of-measure mode that was set. Most of the statements described in this manual interpret their parameters according to current units; other statements will specifically select a particular mode.

X, Y Coordinate Reference

X, Y coordinate data is referenced by most plotting statements in one of three ways:

- Absolute – Coordinate points are referenced to a fixed origin point (0, 0) that is defined for the plotting area. No reference is given to the current location of the pen in determining the location of the point to be plotted.
- Relative – The last point plotted becomes the single origin point for referencing all subsequent plots.
- Incremental – Each incrementally plotted point becomes the origin to which the next point is referenced. In this way, the origin changes with each plot.

Syntax Guidelines

The following general conventions apply to the syntax in this manual.

Dot Matrix - All items appearing in dot matrix must be entered as shown.

[ ] - All items in square brackets are optional and are explained in their respective texts.

ROM Statement Preview

The following is a list of Plotter ROM statements that are used to direct plotter operations. A brief description of each statement is included. The descriptions are intended as a preview and will be dealt with in detail in their respective sections of this manual.

Statement	Description
PLOTTER IS	Specifies the select code and type of plotter being used. (Page 10)
PLOTTER... IS ON	Activates a specific plotter; deactivates all other plotting devices. (Page 13)
PLOTTER... IS OFF	Deactivates a specific plotter. (Page 13)
LIMIT	Defines the physical area in which the plotter can move its pen(s). (Page 14)
LOCATE	Defines the physical plotting area within the LIMIT area that will be scaled by SCALE or SHOW statements. (Page 17)
CLIP	Redefines the soft clip limits and restricts only lines drawn in User Defined Units. (Page 19)
UNCLIP	Redefines the soft clip limits to equal the hard clip limits. (Page 22)
SCALE	Defines the minimum and maximum unit values for the area specified by a LOCATE statement. (Page 24)

SHOW	Defines the minimum and maximum unit values for the area specified by a LOCATE statement for units of measure that are equal in the X and Y directions. (Page 26)
MSCALE	Sets a millimetre unit of measure as the User Defined Unit. (Page 29)
SETGU	Selects Graphic Display Units (GDU's) mode. (Page 31)
SETUU	Selects User Defined Units (UDU's) mode. (Page 31)
GCLEAR	Clears plotted data by advancing plotter roll paper. (Page 32)
RATIO	Returns a value equal to the ratio of the plotting area (hard clip) X dimension divided by the Y dimension. (Page 33)
PLOT	Moves the pen to an absolute X,Y coordinate with optional pen control. (Page 37)
MOVE	Moves to the specified location without drawing or plotting anything. (Page 40)
DRAW	Moves the pen to an absolute X,Y coordinate after first lowering the pen (always draws a line). (Page 41)
RPLOT	Moves the pen to an absolute X,Y coordinate that references the last point plotted by a PLOT, MOVE, DRAW, LABEL, FRAME or IPLOT statement as a local origin (0,0). (Page 42)
IPLOT	Moves the pen an incremental X,Y amount from the last plotted position of the pen. (Page 44)
PEN	Selects a particular pen or returns a pen to its holder. (Page 45)
PENUP	Lifts the pen off the plotter. (Page 47)
PDIR	Sets an angle of rotation to be used for subsequent RPLOT and IPLOT statements. (Page 48)
LINETYPE	Selects the line pattern to be used for plotter operations. (Page 51)
AXES	Draws both X and Y axes with optional tic-marks. (Page 54)

GRID — Draws a full grid over the X and Y axes area. (Page 56)

FRAME — Draws a box around the current clipping area. (Page 58)

LABEL and LABEL USING — Provide formatting for character output. (Page 61)

LORG — Sets the label origin position. (Page 63)

CSIZE — Specifies the size and aspect ratio of characters to be lettered on the plotter. (Page 64)

LDIR — Specifies the angle from horizontal at which lines of characters will be printed. (Page 66)

LETTER — Draws the character that is entered on the keyboard. (Page 69)

DIGITIZE — Stops the program and allows you to re-position the pen (or special digitize sight on the 9872A) via the plotter arm controls. When you press ENTER on the plotter, the X,Y coordinate values along with an optional pen status character are returned to the variables specified in the DIGITIZE statement and the program continues. (Page 72)

POINTER — Using the raised pen as a cursor, it moves the pen to an absolute X,Y coordinate location. This establishes the cursor location but does not affect the pen position for plotting operations. (Page 75)

CURSOR — Returns the X,Y coordinate values and pen status (up or down) for the current cursor position. (Page 76)

WHERE — Returns the X,Y coordinate values and an optional pen status character to the variables specified in the statement for the last plotted or moved to point. (Page 77)

Manual Preview

The remainder of this manual describes Plotter ROM statements and their control of plotter operations. Plotter operations are presented in the following order:

- Set up
- Scaling
- Plotting
- Axes and Labeling
- Digitizing and Cursor Control

Example programs are included in each chapter to demonstrate particular operations. These programs can be used for practice to gain hands-on experience.

Chapter 2
Set-up Operations

Introduction

A program written to plot or draw lines on a plotting device must include some set-up operations to initialize the plotter and define the plotting area. It is not necessary to use each statement in this chapter to initialize a plotting device. The statements given provide sufficient flexibility to accommodate most plotting applications.

Typical set-up operations are shown by the following example program.

```
10   PLOTTER IS 7,5,"9872A"
20   SCALE -10,10,-10,10
30   AXES 1,1,0,0,5,5,5
40   FRAME
50   END
```

Each of these statements is covered individually in the following pages.

PLOTTER IS Statement

The PLOTTER IS statement is used to specify the select code and the type of plotting device to which successive plotter operations are directed. The PLOTTER IS statement must be the first plotting statement executed or no plotting operations can be performed.

More than one plotter can be specified by using several PLOTTER IS statements with the appropriate select codes and device addresses. However, only one plotter can be active at any one time. The active plotter will be the last one described by a PLOTTER IS statement. The computer monitors the status of all inactive plotters so that they can be re-activated at a later time. This status is maintained until SCRATCH A or RESET is executed.

Syntax:

PLOTTER IS [select code [, HP-IB device address],] plotter ID string
[, step size [, # of pens, pen offset, incremental plotter ID]]

Example:

```
10   PLOTTER IS 7,5,"9872A"
20   !   OR
30   PLOTTER IS "9872A"
40   !   AND
50   PLOTTER IS 5,"INCREMENTAL"
60   !   OR
70   PLOTTER IS 5,"INCREMENTAL",254,4,500,2
80   !   OR
90   PLOTTER IS "INCREMENTAL"
```

Statement Parameters

The select code parameter specifies the select code setting of the interface that connects the plotter to the computer. The optional HP-IB device address is specified whenever an HP-IB Plotter is being used. The factory-set select code for the 98034A HP-IB is 7 and the device address for the HP 9872A Plotter is set to 5. All program examples in this manual will assume these settings.

The plotter ID string (string variable or constant) specifies the type of plotting device, and therefore, the proper I/O operations which drive the plotter using the specified select code. The available plotter ID strings and the default select codes that they select are described next.

9872A

The plotter ID string, "9872A", specifies the HP 9872A as the plotter which must be con-

nected to the computer via the HP 98034A HP-IB Interface. Refer to the appendix for basic 98034A and 9872A hookup information.

Incremental

The plotter ID string, "INCREMENTAL", specifies an incremental plotter that must be connected to the computer via the HP 98040A Incremental Plotter Interface. Refer to the appendix and the 98040A Installation and Service Manual (98040-90000) for hookup information.

The last four optional parameters of the PLOTTER IS statement provide a means for you to describe the features of an incremental plotter to the computer so that the plotter can be driven properly. If you are not going to use an incremental plotter, do not use the last four optional parameters.

The default values for these parameters are:

Parameter	Default value
step size	.254 mm (.01 inch)
# of pens	1
pen offset	0 mm
incremental plotter ID	1

The step size parameter must be specified if the other three parameters are to be specified. The assigned value of the step size parameter is plotting device dependent and must be obtained from the plotter's documentation.

If one of the last three parameters is specified, then they ALL must be specified.

The number of pens parameter is used to tell the computer the number of available pens on the plotter.

The pen offset is used to specify the center-to-center distance between pens on multi-pen devices. If the plotter has only one pen, zero offset should be specified.

The plotter ID parameter is used to specify one of several known incremental plotters that will operate with the computer and the 98040A Interface. This parameter can also be used to tell the computer whether the offset is in the X or the Y direction. For more information regarding these last four parameters, refer to HP 98040A Incremental Plotter Interface Installation and Service Manual.

Default Conditions

The PLOTTER IS statement sets the following default conditions when executed:

1. Activates the plotting device specified (PLOTTER ... IS ON).
2. Sets initial units mode to UDU's (User Defined Units).
3. Sets UDU's equal to GDU's (Graphic Display Units).
4. Reads hardware-set hard clip limits from the plotting device (LIMIT).
5. Defaults the CLIP and LOCATE boundaries to the hard clip limits.
6. Selects pen one (PEN 1).
7. Selects line type one and repeat length four (LINE TYPE 1, 4).
8. Selects standard character size (CSIZE 15/4.55, 9/15).
9. Selects label orgin one (LORG 1).
10. Sets label direction as left-to-right (LDIR 0).
11. Clears any error conditions.
12. Clears character count from any previous LABEL statement.
13. Executes a GCLEAR.

After initialization, the default conditions can then be altered as necessary by executing one or more of the plotter statements with the proper parameters from the keyboard or from within a program.

PLOTTER...IS ON or IS OFF Statements

The PLOTTER... IS ON or IS OFF statement activates (via ON) or deactivates (via OFF) the plotting device specified by the select code and device address parameters. When activated, a plotting device will respond to all subsequent plotting statements, and when deactivated the plotting device will not respond. When using several plotters, executing a PLOTTER... IS ON for one select code will activate that plotter and deactivate all others. If all plotters are deactivated, the plotting statements are not directed to any plotter.

Syntax:

PLOTTER select code [,HP-IB device address] IS ON

All plotting statements are directed only to the specified device. This statement does NOT set the default conditions described under the PLOTTER IS statement; plotting continues from the state the plotter was last in.

Syntax:

PLOTTER select code [,HP-IB device address] IS OFF

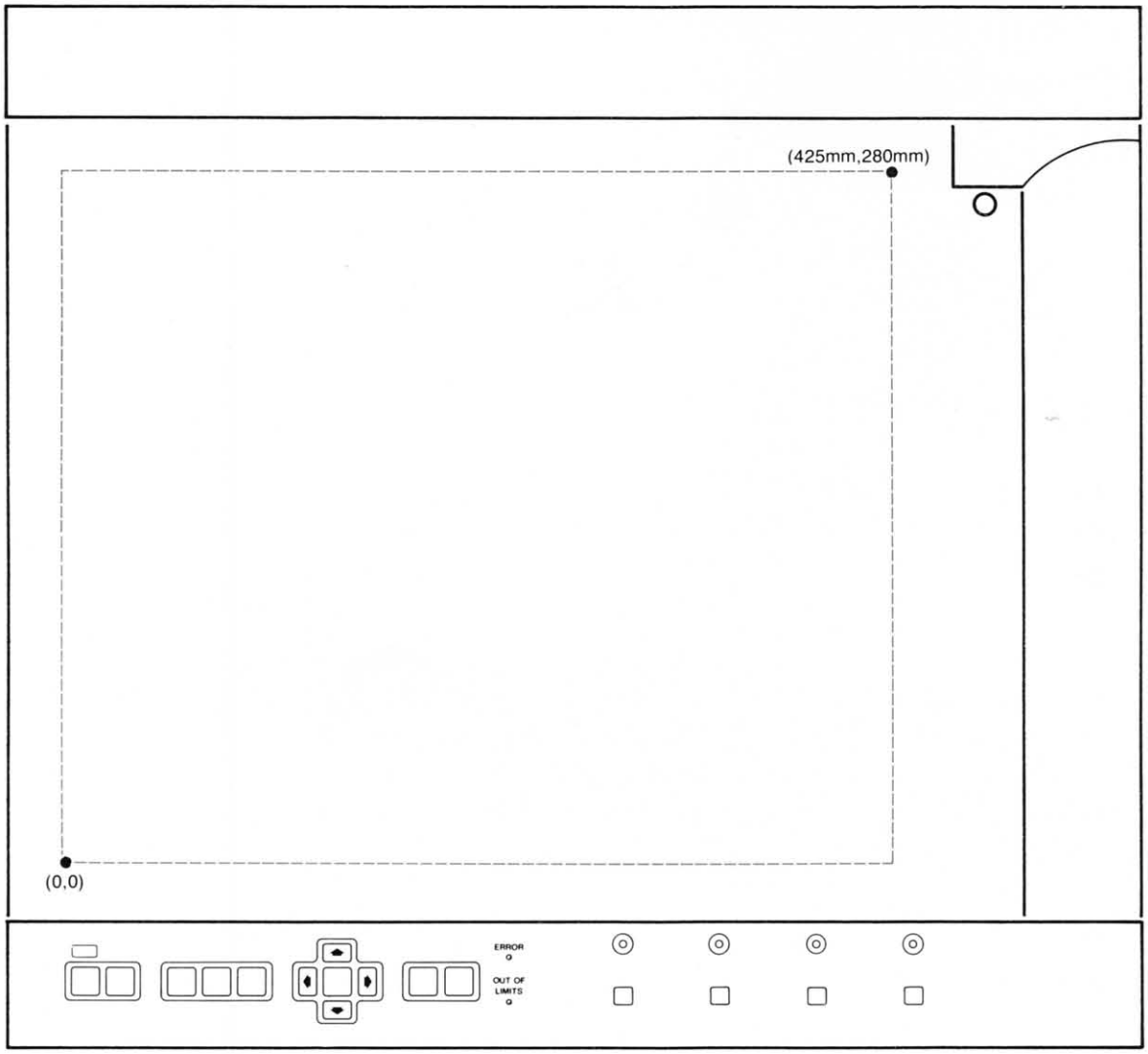
This statement deactivates the plotter set to the specified select code. All plotting statements are executed but the specified plotter does not respond.

Example:

```
10   !
20   !
30   PLOTTER 7,5 IS ON                    ! ACTIVATES HP-IB PLOTTER, DEVICE 5.
40   !
50   PLOTTER 7,5 IS OFF                   ! DEACTIVATES HP-IB PLOTTER, DEVICE 5.
60   !
70   !
80   ! DO NOT RUN THIS PROGRAM, THESE ARE ONLY EXAMPLE PROGRAM LINES.
```

LIMIT Statement

The LIMIT statement allows you to specify the hard clip limits of the plotting area. This statement sets two diagonally spaced calibration points which define an enclosed area in which plotting activity is confined. The computer is NOT allowed to move the pen outside the specified area. This statement is often used to define the size and location of a piece of plotting paper that is smaller than the platen area to prevent any programmed pen movement off the paper.



If a LIMIT statement is not executed, the hard clip limits default to the physical limits of the plotter. A plotter's physical hard clip limits refer to the mechanical limits of pen motion inherent in each plotting device.

Remember, nothing can be drawn or labeled under program control outside of the hard clip limits of the plotting area.

Syntax:

LIMIT [X_{min}, X_{max}, Y_{min}, Y_{max}]

Because you are describing the physical plotting area limits to the computer, the parameter units must be actual units of measure. For this statement the units of measure are always in millimetres and normally the origin (point 0,0) is at the lower-left physical limits of the plotting device. The default upper-right limit values for the 9872A are:

X_{max} = 425mm
Y_{max} = 280mm

Other plotting devices have their own default upper limit values.

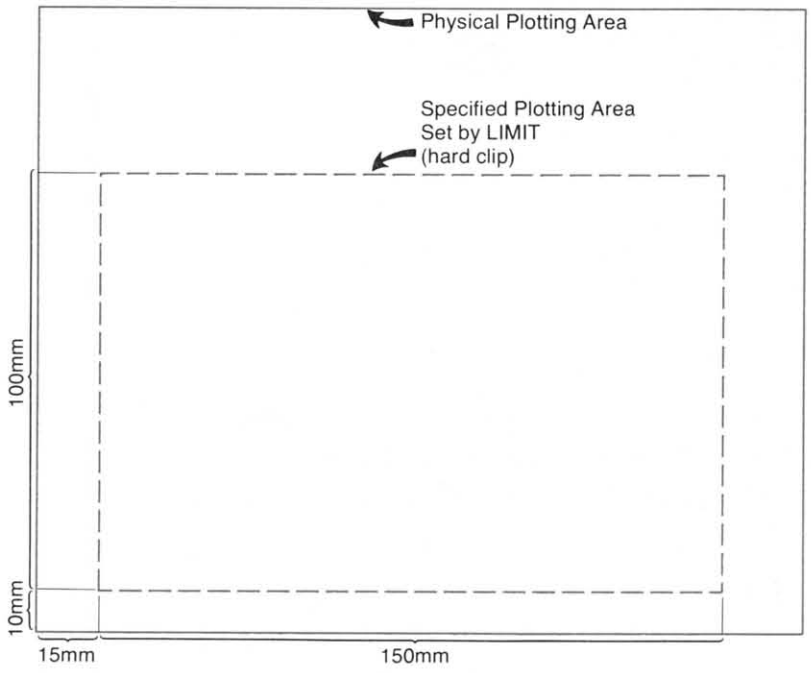
The X min and X max parameters normally specify the left and right limits of the plotting area and the Y min and Y max parameters normally specify the lower and upper limits of the plotting area.

As stated above, the normal sequence of parameters is X min, X max, Y min, Y max. However, the first two parameters can be exchanged to produce a reflected plot across the Y axes. Likewise, the last two parameters can be exchanged to produce a reflected plot across the X axis. Both the first two parameters and second two parameters can be exchanged at the same time to produce a reflected plot across the origin (point 0,0). Refer to the appendix for more information on reflected plots.

Executing the LIMIT statement without parameters allows you to digitize two opposite corners to describe the plotting area. For further details about inputting the parameters by digitizing the corners, refer to the DIGITIZE statement in Chapter 5.

Example:

```
10   ! THIS PROGRAM DEMONSTRATES THE USE OF THE LIMIT STATEMENT.
20   ! NOTE: LINES OR LABELS CAN NOT BE DRAWN OUTSIDE THE HARD CLIP LIMITS
30   ! UNLESS THE LIMITS ARE CHANGED BY EXECUTING ANOTHER LIMIT STATEMENT.
40   !
50   PLOTTER IS 7,5,"9872A"          ! SPECIFY THE 9872A AS PLOTTER.
60   FRAME                           ! FRAME THE MAX PLOTTING AREA FOR YOUR REF.
70   !
80   LIMIT 15,15+150,10,10+100       ! SPECIFY A 150mm X 100mm  PLOTTING AREA
90                                   ! THAT IS OFFSET FROM THE PLOTTERS LOWER
100                                  ! LEFT PHYSICAL BOUNDS.  THE SPECIFIED
110                                  ! OFFSET FOR THIS EXAMPLE IS 10mm UP
120                                  ! AND 15mm TO THE RIGHT. REMEMBER,
130                                  ! UNITS ARE ALWAYS IN MILLIMETRES.
140  !
150  LINE TYPE 3                     ! SPECIFY DASHED LINE FOR FRAME.
160  FRAME                           ! FRAME THE SPECIFIED PLOTTING AREA.
170  END
```



LOCATE Statement

The LOCATE statement specifies the X,Y coordinates (in Graphic Display Units) of two diagonally spaced calibration points. These points are referenced by SCALE and SHOW statements to calibrate the User Defined Units (UDU's) that they specify for the plotting area. In the absence of a LOCATE statement, these points default to those set by the LIMIT statement.

Note: The HP9872A Plotter has two keys, [P1] and [P2], which can be used to manually set the scaling calibration points. Simply move the pen via the pen arm control keys to the desired first calibration point and press [ENTER] and [P1]. Repeat using [ENTER] and [P2] for setting the second point. If this procedure is followed, a subsequent PLOTTER IS statement will NOT reset the hard clip limits to their default size. To do this, turn the plotter off and on and then execute the PLOTTER IS statement (or press [INIT] on the plotter).

The LOCATE statement also sets soft clip limits bounded by the calibration points. These soft clip limits define an area within the hard clip limits in which you want to confine plotting activity. Plotted or drawn lines cannot extend beyond these limits as the pen will automatically raise when it crosses them. Thus, the pen can be positioned between the hard and soft clip limits for purposes such as labeling, but plotted or drawn lines cannot extend beyond the soft clip limits.

Syntax:

LOCATE [X_{min}, X_{max}, Y_{min}, Y_{max}]

The units are always in Graphic Display Units (GDU's) with the origin (GDU point 0,0) normally at the lower-left corner of the plotting area (or as defined by the LIMIT statement).

The length of a GDU is equal to 1/100 (one percent) of the length of the short side of the plotting area. Therefore, the length of the short side is always 100 GDU's. The length of the long side of the plotting area is something greater than 100 depending on the plotting area aspect ratio. Note: the aspect ratio can be found with the RATIO function.

The first two parameters specify the left and right boundary limits and the last two parameters specify the lower and upper boundary limits. Like the LIMIT statement, the parameters can be exchanged to reflect the plot (refer to the LIMIT statement and Reflected Plots in the appendix).

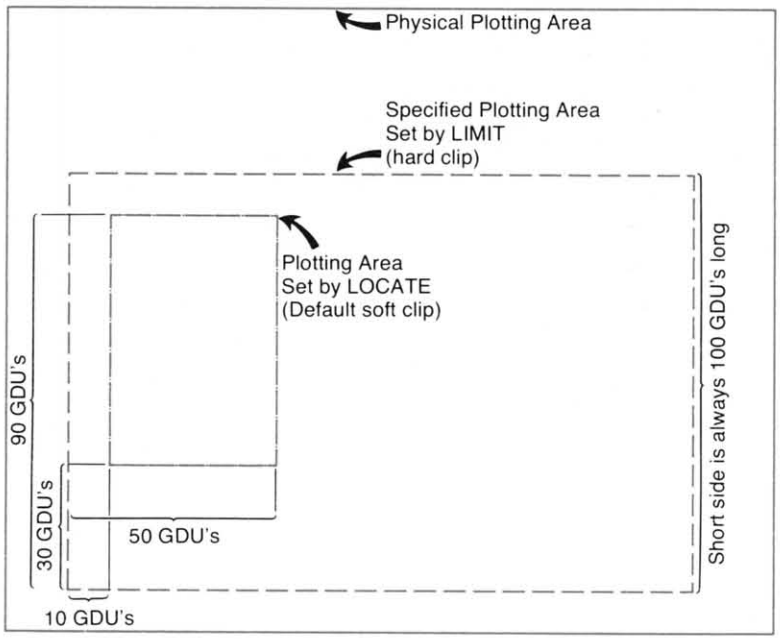
Executing the LOCATE statement without parameters allows you to specify the area by digitizing two opposite corners (normally the lower-left and upper-right corners). Refer to the DIGITIZE Statement in Chapter 5.

The soft clip limits set by the LOCATE statement can be overridden by the CLIP statement.

The default physical length of the short side of all plotting devices is 100 GDU's but the default length of the long side is device dependent. For the 9872A the length of the long side is about 152 GDU's, which is the length/height aspect ratio times the height of 100 GDU's ((425/280 x 100 = 152).

Example:

```
10   ! THIS PROGRAM DEMONSTRATES THE USE OF THE LOCATE STATEMENT.
20   ! NOTE: WHILE IN THE UDU'S MODE, PLOTTED LINES CAN NOT BE DRAWN OUTSIDE THE
30   ! "LOCATE" BOUNDARIES. HOWEVER, LABELS CAN BE POSITIONED  ANYWHERE
40   ! WITHIN THE HARD CLIP LIMITS.
50   !
60   PLOTTER IS 7,5,"9872A"          ! SPECIFY THE 9872A AS PLOTTER.
70   FRAME                           ! FRAME THE MAX PLOTTING AREA FOR YOUR REF.
80   !
90   LIMIT 15,15+150,10,10+100       ! SPECIFY THE PLOTTING AREA.
100  LINE TYPE 3                     ! SPECIFY DASHED LINE TYPE FOR FRAME.
110  FRAME                           ! FRAME THE SPECIFIED PLOTTING AREA.
120  !
130  LOCATE 10,50,30,90              ! "LOCATE" AN AREA WITHIN THE PLOTTING
140                                  ! AREA TO WHICH YOU CAN ASSIGN
150                                  ! UNITS OF MEASURE (SEE SCALE AND SHOW).
160                                  ! REMEMBER, PARAMETERS ARE  IN GDU'S
170                                  ! WHICH ARE A PERCENT OF THE SHORT
180                                  ! SIDE OF THE PLOTTING AREA SET BY THE
190                                  ! "LIMIT" STATEMENT.
200  !
210  LINE TYPE 4                     ! SPECIFY DASH-DOT LINE FOR FRAME.
220  FRAME                           ! FRAME THE LOCATE AREA.
230  END
```



CLIP Statement

The CLIP statement redefines the soft clip limit. This allows the soft clip limits to be moved from the location set by the PLOTTER IS, LIMIT or LOCATE statements. Soft clipping affects lines plotted in User Defined Units, but has no effect on lines plotted in GDU's or as labels.

Syntax:

CLIP [X_{min}, X_{max}, Y_{min}, Y_{max}]

The parameters are interpreted according to current units of measure.

The first two parameters specify the left and right soft clip limits and the last two parameters specify the lower and upper clipping area limits. The order of the parameters can be exchanged to produce reflected plots (refer to Reflected Plots in the appendix).

Lines plotted in the UDU mode from inside this area to points outside the clip boundary are drawn only to the clip boundary. Lines plotted using UDU's outside the CLIP boundaries will not be drawn. Labels and lines plotted in the GDU mode are not affected by the soft clip limits set by the CLIP statement.

Executing the CLIP statement without parameters allows you to specify the soft clip area by digitizing two opposite corners of the area (normally the lower-left and upper-right corners). Refer to the DIGITIZE statement in Chapter 5.

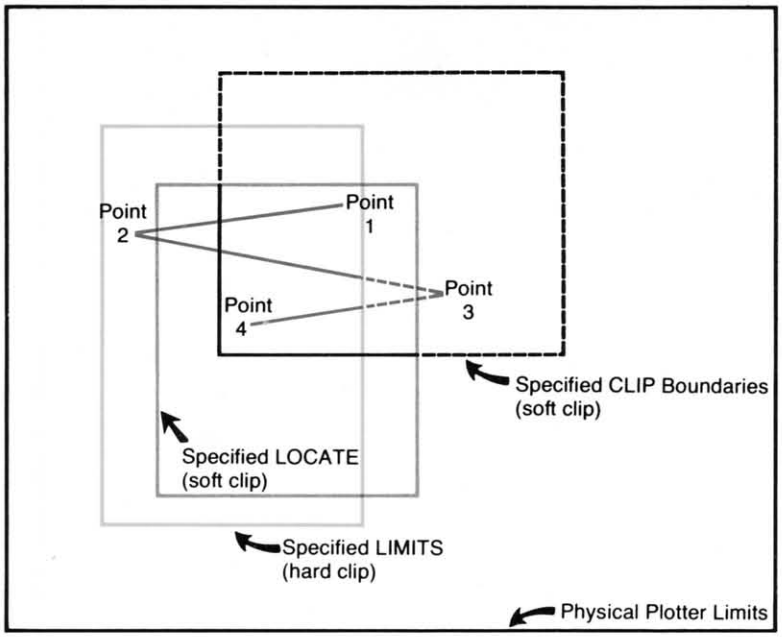
The soft clip limits can be turned off (by UNCLIP) or may be set larger than the hard clip limits. In either case, only the hard clip limits (set by the LIMIT statement or defaulted by the PLOTTER IS statement) are used.

Executing PLOTTER IS, LIMIT, LOCATE or UNCLIP will set various default values for the soft clip limits (refer to PLOTTER IS Statement).

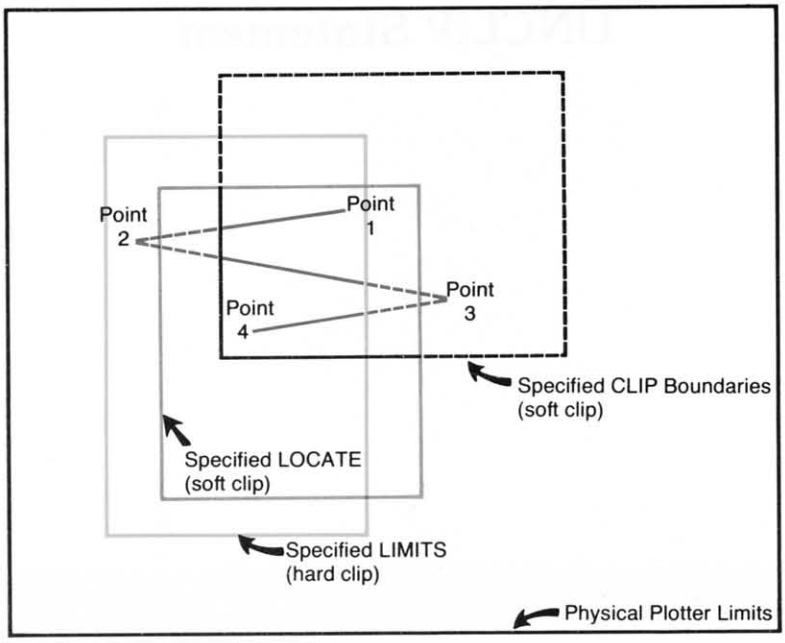
When CLIP is used to set the soft clip limits such that the soft clip rectangle is partially in and partially out of the hard clip limits, UDU plotting is clipped within the intersection of these two limits.

Example:

```
10   !
20   !
30   CLIP 20,80,20,90                    ! CLIP LINES DRAWN IN USER UNITS
40                                       ! AT THE SOFT CLIP BOUNDARIES SPECIFIED
50                                       ! IN CURRENT UNITS.
60   !
70   !
80   !
90   CLIP Xmin,Xmax,Ymin,Ymax            ! SPECIFY SOFT CLIP BOUNDARIES.
100  !
110  !
120  ! DO NOT RUN THIS PROGRAM, THESE ARE ONLY EXAMPLE PROGRAM LINES.
```



Plotting in GDU's



Plotting in UDU's

The above figures show the clipping action when drawing a line from point 1, to point 2, to point 3, and to point 4. The rectangles represent clipping boundaries or limits for the LOCATE, LIMIT, and CLIP statements.

The line drawn in the first figure is clipped only by the hard clip limits, and the line drawn in the second figure is clipped at the intersection of the hard and soft clipping limits.

UNCLIP Statement

The UNCLIP statement resets the soft clip limits equal to the hard clip limits. This allows you to draw lines anywhere in the plotting area defined by the LIMIT statement while still in the user units mode.

Syntax:

```
UNCLIP
```

Clipping is set by executing LOCATE or CLIP statements.

Example:

```
10   !
20   !
30   UNCLIP                              ! RESET THE CLIP LIMITS TO "LIMIT"
40                                       ! BOUNDARIES (THE HARD CLIP LIMITS).
50   !
60   !
70   ! DO NOT RUN THIS PROGRAM, THIS IS ONLY AN EXAMPLE PROGRAM LINE.
```

Summary of Hard and Soft Clip Limit Statements

Statement	Effect on Hard Clip Limits	Effect on Soft Clip Limits	Effect on Scaling Points
PLOTTER IS	Sets to mechanical limits.	Sets to mechanical limits.	Sets to mechanical limits.
LIMIT	Sets to specified or digitized boundaries of the LIMIT statement.	Sets to hard clip limits defined by LIMIT statement.	Sets to hard clip limits defined by LIMIT statement.
LOCATE	No effect	Sets to specified or digitized boundaries of the LOCATE statement.	Sets to the points specified or digitized by the LOCATE statement.
CLIP	No effect	Sets to boundaries specified or digitized by the CLIP statement.	No effect
UNCLIP	No effect	Resets to hard clip limits.	No effect

SCALE Statement

The SCALE statement defines minimum and maximum values of X and Y for the plotting area specified by the LOCATE or LIMIT statements or defined by the use of the [P1] and [P2] keys. This allows you to specify your own units for plotting. These units are referred to as User Defined Units since you define them for your particular plotting application.

Syntax:

SCALE X_{min}, X_{max}, Y_{min}, Y_{max}

The first two parameters specify the values represented by the left and right boundaries of the area specified by the LOCATE statement; the last two parameters specify the values represented by the lower and upper boundaries.

The SCALE statement sets up UDU's such that the point (Xmin, Ymin) falls on the first scaling point (refer to LIMIT and LOCATE statements), and the point (Xmax, Ymax) falls on the second scaling point.

This statement automatically sets the User Defined Units (UDU's) mode. SCALE statement parameters can be exchanged to produce reflected plots (refer to Appendix B).

For example, the first two parameters of the SCALE statement could specify the left edge of plotting area as −20 and the right edge as 30. This has the effect of dividing the horizontal plotting distance into 50 units (30 − (−20) = 50). The last two parameters could specify different values and therefore a different scale or units for the vertical direction. These units can be used to represent distance, volume, time, or whatever units your specific problem requires. The scaling factors for the X and Y directions are completely independent of each other. Thus, plots are stretched or shrunk independently in the X and Y direction to fit the plotting area (anisotropic scaling). Note that this is not the case with the SHOW statement.

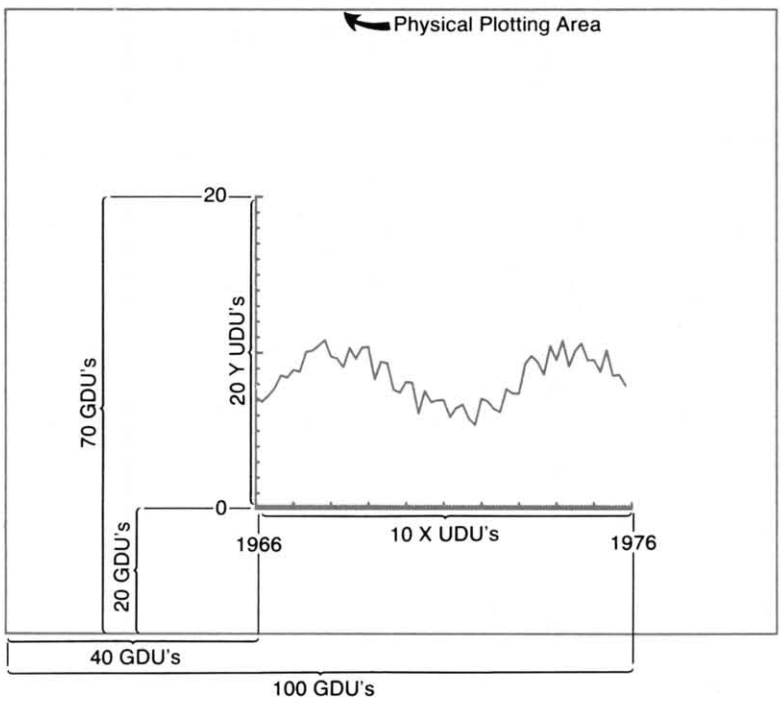
For example, if you wanted to plot the average annual rainfall at a weather station for a 10 year period, the SCALE statement might look like this:

```
SCALE 1966, 1976, 0, 20
```

where the left edge represents year 1966 and the right edge represents 1976. Rainfall would be plotted in the Y direction in volume units (i.e. inches). This allows the data to be plotted in time and volume units directly on the plotter.

Example:

```
10   ! THIS PROGRAM DEMONSTRATES HOW THE SCALE STATEMENT IS USED TO DEFINE
20   ! USER UNITS. IN THIS EXAMPLE; THE X AXIS = YEAR 1966 TO YEAR 1976 AND
30   ! THE Y AXIS = 0 INCHES TO 20 INCHES OF RAIN.
40   !
50   PLOTTER IS 7,5,"9872A"          ! SPECIFY THE 9872A AS PLOTTER.
60   LIMIT 10,210,10,150
70   FRAME                           ! FRAME THE MAX DEFAULT PLOTTING AREA.
80   LOCATE 40,100,25,75             ! DEFINES THE PLOTTING AREA.
90   SCALE 1966,1976,0,20            ! DEFINES VALUES OF LIMITS OF PLOT AREA.
100  AXES 1/12,1,1966,0,12,10        ! DRAWS AXES.
110  !
120  ! ***** DRAW RANDOM DATA FOR THIS EXAMPLE
130  MOVE 1966,0                     ! MOVE TO START OF PLOT (YR 1966, 0 INCH).
140  FOR M=1966 TO 1976 STEP 1/6     ! FOR...NEXT GENERATES RANDOM DATA FOR
150  PLOT M,RND*2+7+2*SIN(M)         ! THIS EXAMPLE.
160  NEXT M                          ! DO IT AGAIN FOR NEXT POINT.
170  END
```



SHOW Statement

The SHOW statement is used to specify scale units such that one horizontal unit is equal in length to one vertical unit (isotropic scaling). The actual size of the units is either stretched or shrunk so that the area specified will fit within either the default or the LOCATE statement plotting area.

The SHOW statement would not normally be used when you want to plot in two different units of measure as in the previous example for the SCALE statement, but it would be used when you want to plot something like a map where one mile along the X axis should equal one mile along the Y axis.

Syntax:

SHOW X_{min}, X_{max}, Y_{min}, Y_{max}

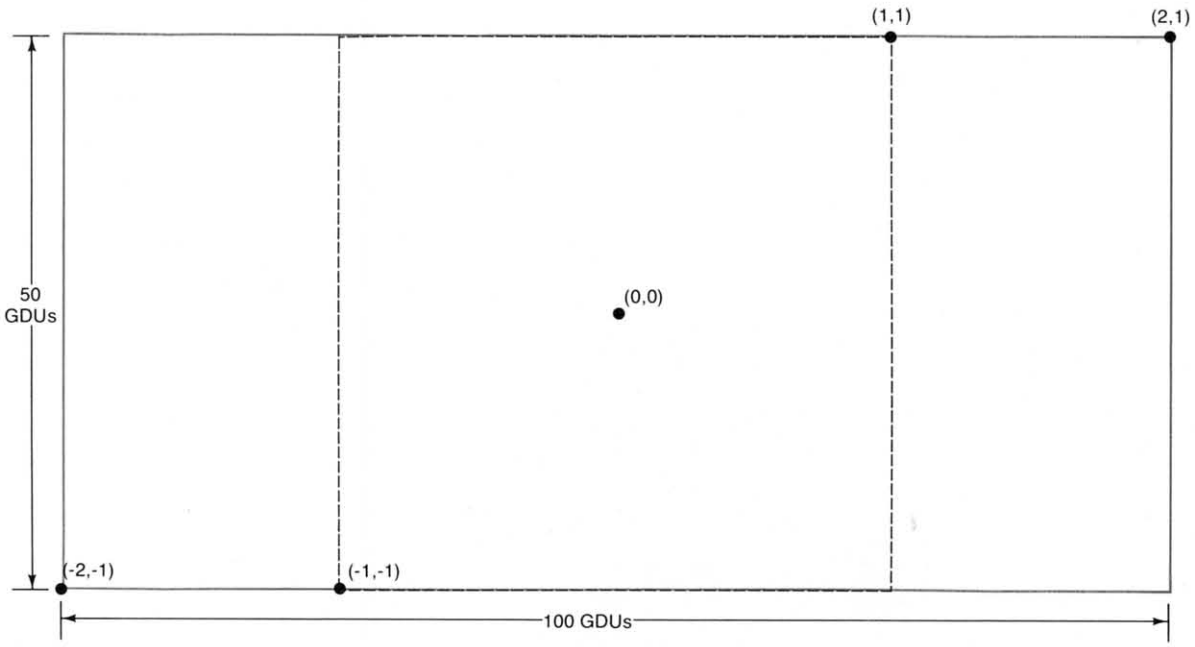
The first two parameters specify the minimum acceptable upper and lower bounds for the X direction and the last two parameters specify the minimum acceptable bounds for the Y direction.

The SHOW statement sets up UDU's such that the specified area is as large as possible and is centered within the LOCATE area. For example, if the LOCATE rectangle is twice as wide as it is high (e.g. LOCATE 0,100,0,50), then

```
SHOW -1,1,-1,1
```

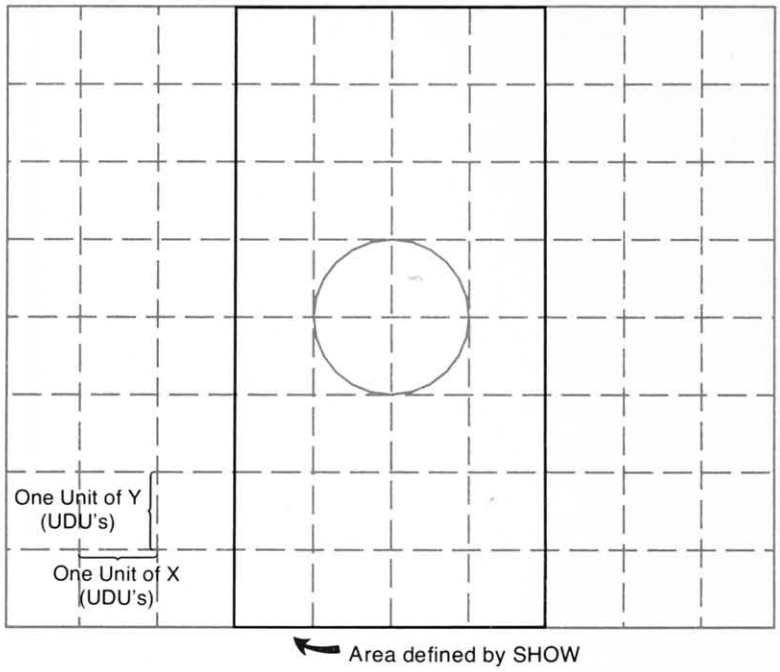
is equivilant to

```
SCALE -2,2,-1,1
```



Example:

```
10   ! THIS PROGRAM DEMONSTRATES THE EFFECTS OF THE SHOW STATEMENT ON THE
20   ! PLOTTING AREA. NOTE THAT THE LENGTH OF A UNIT-OF-MEASURE IN THE X
30   ! AND THE Y DIRECTIONS IS EQUAL.
40   !
50   PLOTTER IS 7,5,"9872A"          ! SPECIFY THE 9872A AS PLOTTER.
60   LIMIT 10,210,10,150             ! DEFINE AN AREA ON THE PLOTTER
70                                   ! PAPER IN WHICH TO PLOT.
80   DEG                             ! SET DEGREES MODE.
90   SHOW -2,2,-4,4                  ! SPECIFY USER UNITS, USING SHOW.
100  LINE TYPE 3                     ! SPECIFY DASHED LINE FOR GRID.
110  GRID 1,1                        ! DRAW GRID.
120  LINE TYPE 1                     ! SPECIFY SOLID LINE FOR FRAME AND CIRCLE.
130  FRAME                           ! FRAME PLOTTING AREA.
140  !
150  !    DRAW A CIRCLE FOR THIS EXAMPLE.
160  MOVE 0,1                        ! MOVE TO START OF CIRCLE.
170  FOR Angle=0 TO 360 STEP 15      ! FOR..NEXT LOOP TO SPECIFY AN ANGLE.
180  DRAW SIN(Angle),COS(Angle)      ! DRAW CIRCLE.
190  NEXT Angle                      ! DO IT AGAIN UNTIL COMPLETE.
200  END
```


One Unit of Y
(UDU's)
One Unit of X
(UDU's)
Area defined by SHOW

MSCALE Statement

The MSCALE statement sets millimetres as user units and defines the origin. This mode is very useful where correspondence with physically measurable objects is desirable, as in drafting and mapping applications. With some plotters, metric units are only approximate.

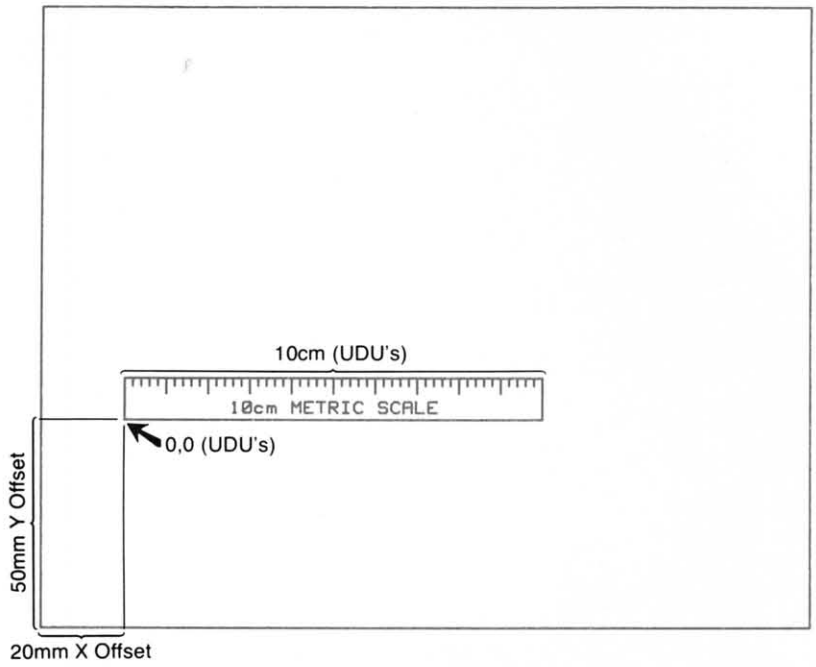
Syntax:

MSCALE X_{offset}, Y_{offset}

MSCALE specifies that current user units are millimetres and that the origin or reference point, that is, the coordinate (0,0) in millimetre-space, is offset from the lower left scaling point by the specified amounts in millimetres. The specified reference point need not be inside the hard clip limits. MSCALE is similar to SCALE except that one user unit is set to be one millimetre in length.

Example:

```
10   ! THIS PROGRAM DRAWS A METRIC RULER (SCALE) AND DEMONSTRATES HOW
20   ! THE MSCALE, CLIP, AND FRAME STATEMENTS CAN BE VERY USEFUL.
30   !
40   PLOTTER IS 7,5,"9872A"                ! SPECIFY THE 9872A AS PLOTTER.
50   FRAME                                 ! FRAME THE DEFAULT PLOTTING AREA.
60   !
70   MSCALE 20,50                          ! OFFSET POINT 0,0 UP 50mm & RIGHT 20mm
80                                         ! AND SET MILLIMETRES AS CURRENT UNITS.
90   !
100  ! ***** DRAW WITH TIC-MARKS A 10cm SCALE.
110  CLIP 0,100,0,10                       ! DEFINE SIZE FOR THE FRAME STATEMENT.
120  FRAME                                 ! FRAME THE METRIC SCALE PLOT.
130  AXES 2,10,0,10,5,10,5                 ! DRAW TIC MARKS (AXES) ON SCALE.
140  !
150  ! ***** LABEL THE SCALE.
160  MOVE 50,3                             ! MOVE TO CENTER OF SCALE.
170  LORG 5                                ! SPECIFY TO CENTER LABEL.
180  LABEL USING "K";"10cm METRIC SCALE"   ! LABEL SCALE.
190  !
200  END
```


10cm (UDU's)
10cm METRIC SCALE
0,0 (UDU's)
50mm Y Offset
20mm X Offset

SETGU and SETUU Statements

The two types of units used by the various Plotter ROM statements are Graphic Display Units (GDU's) and User Defined Units (UDU's). The current units mode refers to the type of units set by the last statement capable of setting one of the unit modes. The SETGU and SETUU statements provide a convenient method of switching to and from the GDU and UDU modes.

Syntax:

SETGU or SETUU

SETGU sets Graphic Display Units (GDU's) as the current units mode.

SETUU sets User Defined Units (UDU's) as the current units mode. UDU's are also set by the SCALE, SHOW and MSCALE statements.

The following statements interpret their parameters according to the current units mode selected:

MOVE	DRAW	PLOT	RPLOT
IPLOT	CLIP	AXES	GRID
WHERE	POINTER	DIGITIZE	CURSOR

Example:

```
10   !
20   !
30   SETGU                              ! SET GDU'S MODE.
40   !
50   SETUU                              ! SET UDU'S MODE.
60   !
70   !
80   ! DO NOT RUN THIS PROGRAM, THESE ARE ONLY EXAMPLE PROGRAM LINES.
```

GCLEAR Statement

The GCLEAR statement clears any previously plotted data. On roll paper plotters this is done by advancing the paper to a clean area.

Syntax:

GCLEAR [paper advance]

The PLOTTER IS statement should normally be used between plots, rather than GCLEAR, since GCLEAR does not restore the default conditions.

On plotting devices with roll paper the optional parameter allows you to advance the paper by a specified amount in millimetres.

On fixed paper plotters (e.g. the HP 9872A) the GCLEAR statement is ignored.

Example:

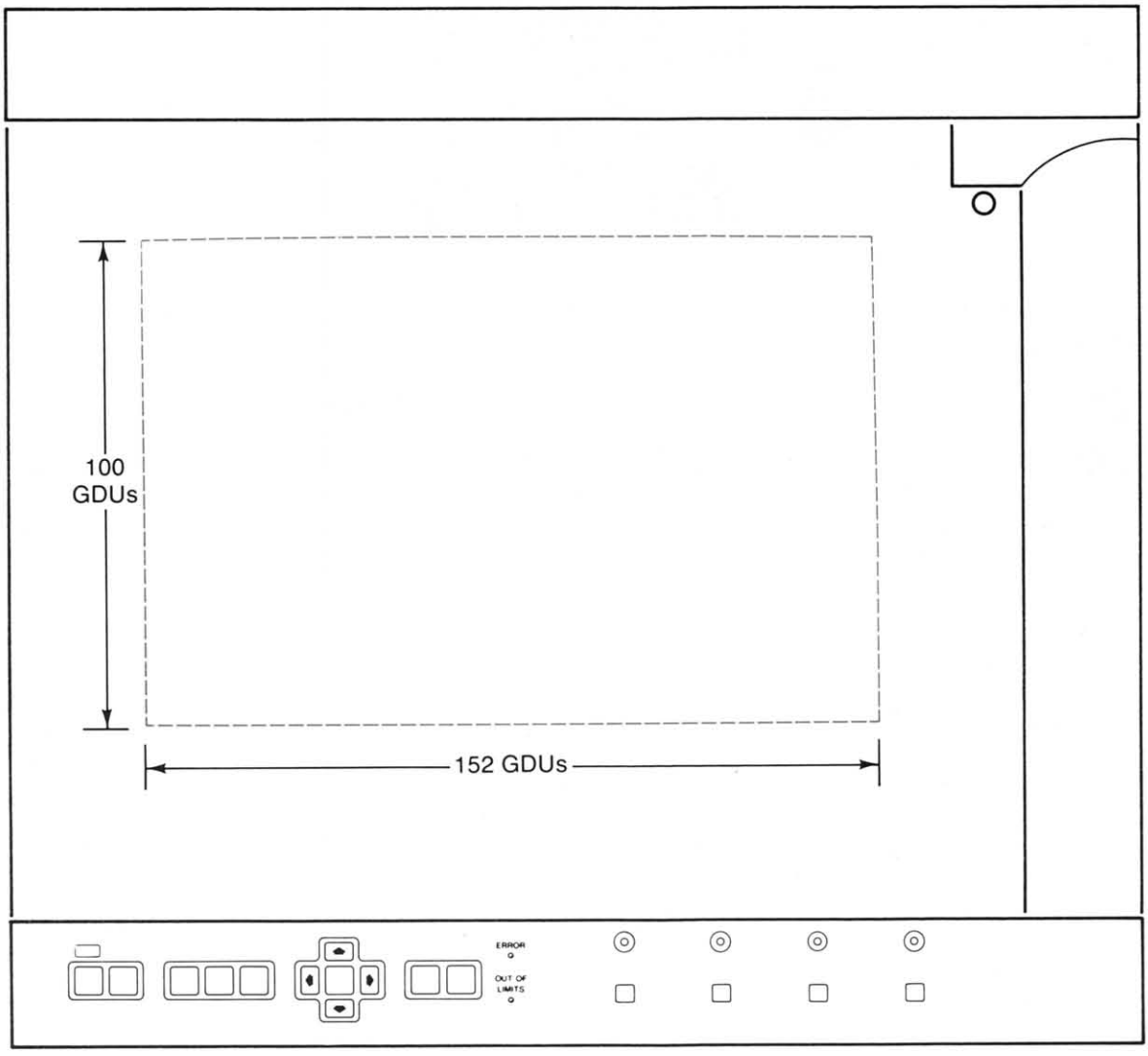
```
10   !
20   !
30   GCLEAR 2540                          ! ADVANCE PAPER 2540mm (10 INCHES).
40   !
50   !
60   !
70   ! DO NOT RUN THIS PROGRAM, THESE ARE ONLY EXAMPLE PROGRAM LINES.
```

RATIO Function

The RATIO function returns a value equal to the ratio of the physical dimensions of the hard clip limit of the plotter. The ratio value is equal to the X dimension (in GDU's) divided by the Y dimension. Thus, if RATIO is greater than 1, then the Y dimension equals 100 GDU's and the X dimension equals RATIO x 100 GDU's. If RATIO is less than 1, then the X dimension equals 100 GDU's and the Y dimension equals 100/RATIO GDU's.

Syntax:

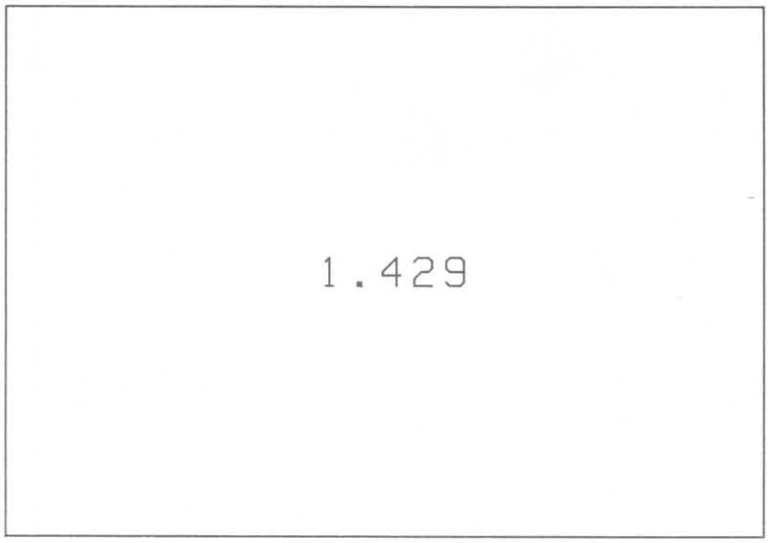
```
RATIO
```



The figure above shows the dimensions, in GDU's, of the default 9872A hard clip limits. A RATIO function would return a value of 152/100 or 1.52.

Example:

```
10   !  *** THIS PROGRAM WILL OUTPUT THE VALUE OF THE RATIO ***
20   !       FUNCTION  OF THE HARD CLIP LIMITS USED IN THE PROGRAM.
30   !
40   PLOTTER IS 7,5,"9872A"          ! SELECT AND ACTIVATE THE PLOTTER.
50   LIMIT 10,210,10,150             ! ESTABLISH THE HARD CLIP LIMITS.
60   FRAME                           ! BOX-IN THE HARD CLIP LIMITS.
70   MOVE 70,50                      ! MOVE TO THE CENTER OF THE BOX.
80   LORG 5                          ! SELECT THE LABEL POSITION.
90   CSIZE 10                        ! SELECT THE SIZE OF THE LETTERS TO
100  !                                 TO BE PRINTED.
110  LABEL USING "DD.DDD";RATIO      ! DRAW THE VALUE OF THE RATIO (HERE,
120                                  ! 1.250) WHICH IS DETERMINED BY THE
130  !                                 SIZE OF THE HARD CLIP LIMITS.
140  END
```



Chapter 3
Plotting Operations

Introduction

The statements described in this chapter allow you to control the following plotter operations:

- Pen movement to plot points and draw lines.
- Pen movement to position the pen.
- Line patterns used when drawing lines.
- Pen selection on multiple pen plotters.

Preview of the Plotting Statements

There are five statements used to move the pen from its current location to a new location. The pen control generally determines whether a point, a line, or nothing is marked between the old and new locations.

The following table shows the five plotting statements, their coordinate references, and their pen control status.

Statement	X,Y Coordinate Reference	Pen Control
PLOT	Absolute	By Parameter
MOVE	Absolute	Always Up
DRAW	Absolute	Always Down
RPLOT	Relative	By Parameter
IPLOT	Incremental	By Parameter

Each statement is explained on the following pages and examples demonstrating typical use are given.

The optional pen control parameter directs the pen's up and down movement and is interpreted as follows:

An odd, positive integer or No parameter specified	The pen remains in its present up or down position, moves to the specified point, and lowers or remains down.
An odd, negative integer	The pen lowers before moving to the specified point and remains down.
An even, positive integer (including zero)	The pen remains in its present up or down position, moves to the specified point, and then lifts up.
An even, negative integer	The pen raises before moving to the specified point and remains up.

PLOT Statement

The PLOT statement provides absolute data plotting with optional pen control. This statement moves the pen to the absolute X,Y coordinate in current units using the current pen number and line type. Pen selection and line types are described near the end of this chapter.

Syntax:

PLOT $X_{parameter}$, $Y_{parameter}$ [, pen control]

The X and Y parameters must be specified and are interpreted according to the current units mode. They can be numbers, variables, or expressions.

The optional pen control parameter specifies the up or down pen movement and defaults to plus one (the pen moves and then drops). The pen control parameter is interpreted as follows:

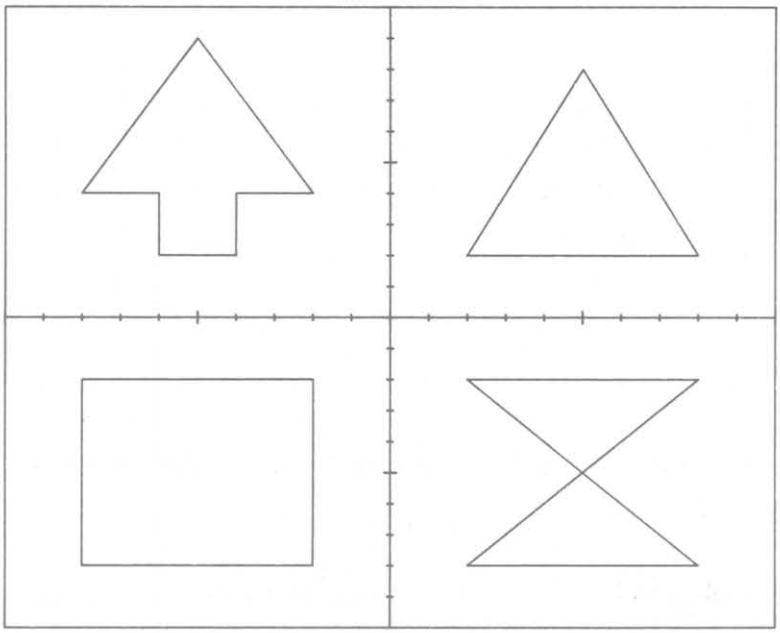
+1 or no parameter	Move or draw, then drop pen
2 or 0	Move or draw, then lift pen
−2	Lift pen, then move
−1	Drop pen, then draw

PLOT is the preferred statement for data-controlled plotting. The pen control parameter allows the data to control the pen's move or draw action rather than a program statement as is necessary with the MOVE and DRAW statements.

All plotted lines are clipped at the soft clip limits if the current units are UDU's, and at the hard clip limits if the current units are GDU's. The pen can be moved by the PLOT statement to points that are outside the soft clip limits but yet inside the hard clip limits for non-plotting purposes such as positioning labels. Refer to the LIMIT, LOCATE, and CLIP statements in Chapter 2 for more information about setting hard and soft clip limits.

Example:

```
10   ! THIS PROGRAM DRAWS FOUR FIGURES FROM DATA FOUND IN THE DATA STATEMENTS.
20   ! THE PLOT STATEMENT ALLOWS DATA TO CONTROL THE PEN POSITION AND THE
30   ! PEN STATUS (UP OR DOWN).
40   !
50   !
60   PLOTTER IS 7,5,"9872A"                ! SPECIFY 9872A AS PLOTTER.
70   LIMIT 10,210,10,150                   ! DEFINE THE PLOTTING AREA.
80   !
90   ! ***** DEFINE MAX & MIN VALUES FOR SCALE STATEMENT.
100  Xmin=-10
110  Xmax=10
120  Ymin=-10
130  Ymax=10
140  SCALE Xmin,Xmax,Ymin,Ymax             ! DEFINE AND SPECIFY USER UNITS.
150  !
160  ! ***** DRAW AXES AND FRAME CLIP AREA.
170  AXES 1,1,0,0,5,5                      ! DRAW AXES.
180  FRAME                                 ! FRAME PLOTTING AREA.
190  !
200  !
210  ON ERROR GOTO Out_of_data             ! SPECIFY BRANCH WHEN OUT OF DATA.
220 Loop: !
230  READ Xvalue,Yvalue,Pen_control        ! READ UNTIL ERROR 36, (OUT OF DATA).
240  PLOT Xvalue,Yvalue,Pen_control        ! PLOT DATA FROM LIST WITH PEN CONTROL.
250  GOTO Loop                             ! DO IT AGAIN, UNTIL OUT OF DATA.
260  !
270  !
280 Out_of_data:!
290  IF ERRN=36 THEN GOTO 320              ! IF ERROR IS 36 (OUT OF DATA) GOTO END
300  BEEP                                  ! BEEP FOR ERROR.
310  DISP ERRM$                            ! DISPLAY THE ERROR MESSAGE.
320  END                                   ! END OF EXAMPLE.
330  !
340  !
350  ! ***** X, Y AND PEN CONTROL DATA FOR PLOT STATEMENT.
360  ! DATA FOR FIRST FIGURE
370  DATA 2,2,1
380  DATA 8,2,-1
390  DATA 5,8,-1
400  DATA 2,2,2
410  ! DATA FOR SECOND FIGURE
420  DATA -4,2,-2
430  DATA -4,4,-1
440  DATA -2,4,-1
450  DATA -5,9,-1
460  DATA -8,4,-1
470  DATA -6,4,-1
480  DATA -6,2,-1
490  DATA -4,2,2
500  ! DATA FOR THIRD FIGURE
510  DATA -2,-2,1
520  DATA -8,-2,-1
530  DATA -8,-8,-1
540  DATA -2,-8,-1
550  DATA -2,-2,2
560  ! DATA FOR FOURTH FIGURE
570  DATA 2,-2,1
580  DATA 8,-2,-1
590  DATA 2,-8,-1
600  DATA 8,-8,-1
610  DATA 2,-2,2
```



MOVE Statement

The MOVE statement lifts the pen and then moves to the absolute X, Y coordinate specified in current units. This statement provides an easy way of moving the pen without drawing a line and without regard to whether the pen is currently up or down. The pen's movement is restricted only by the hard clip limits.

Syntax:

MOVE $X_{parameter}$, $Y_{parameter}$

The X and Y parameters are interpreted according to the current units and are referenced to the current absolute origin point (0,0).

MOVE X, Y is equivalent to PLOT X, Y, -2 (refer to the PLOT statement).

Example:

```
10   !
20   !
30   MOVE 2,5                              ! MOVE WITH PEN UP TO POINT 2,5.
40   !
50   !
60   !
70   MOVE 25,100                           ! MOVE WITH PEN UP TO POINT 25,100.
80   !
90   !
100  ! DO NOT RUN THIS PROGRAM, THESE ARE ONLY EXAMPLE PROGRAM LINES.
```

DRAW Statement

The DRAW statement drops the pen and then moves to the absolute X, Y coordinate specified in current units using the current pen number and line type. This statement provides an easy way of drawing a line from the pen's current location to a new location without regard to whether the pen is currently up or down.

Syntax:

DRAW $X_{parameter}$, $Y_{parameter}$

The X and Y parameters are interpreted according to the current units and are referenced to the current absolute origin point (0,0).

DRAW X, Y is equivalent to PLOT X, Y, -1 (refer to the PLOT statement).

The line that is drawn will be clipped at the soft clip limits as described by the CLIP statement.

When plotting in GDU's, only the hard clip limits are used. That is, lines drawn will extend no farther then the hard clip boundaries in any direction.

When plotting in UDU's, lines will extend no farther then the soft clip boundaries in any direction.

Although plotting will not extend beyond the soft or hard clip boundaries (depending upon the current units), pen motion can continue beyond the specified boundaries. The pen is lifted as it crosses the boundary.

Example:

```
10   !
20   !
30   DRAW 2,5                          ! DRAW A LINE TO POINT 2,5.
40   !
50   !
60   !
70   DRAW 25,100                       ! DRAW A LINE TO POINT 25,100.
80   !
90   !
100  ! DO NOT RUN THIS PROGRAM, THESE ARE ONLY EXAMPLE PROGRAM LINES.
```

RPLOT Statement

The RPLOT statement provides relative plotting capability with pen control. The origin is assumed to be the last pen position determined by a statement other than RPLOT. The line is drawn using the current pen number and line type.
Syntax:

RPLOT $X_{parameter}$, $Y_{parameter}$ [, pen control]

The RPLOT statement interprets the X and Y parameters according to current units relative to a local origin. The local origin is the last absolute plotted point resulting from one of the following statements:

PLOT	DRAW
FRAME	AXES
LABEL	IPLOT
MOVE	GRID

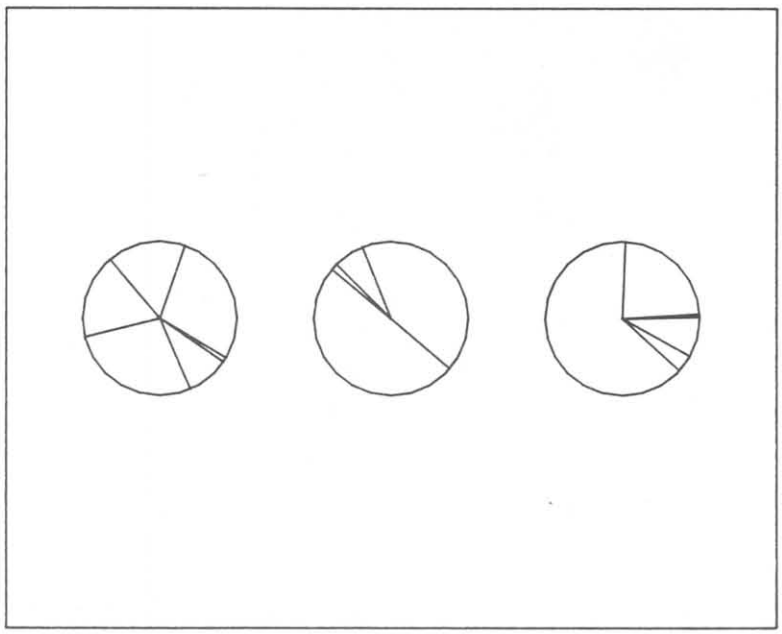
The local coordinate system can be rotated about its origin relative to the master coordinate system by means of the PDIR (plot direction) statement. That is, a figure can be drawn or repeated with the RPLOT statement at another angle by specifying the angle with the PDIR statement. (Refer to the PDIR statement for details.)

The optional pen control parameter directs the up and down movement of the pen and is interpreted the same as for PLOT.

Example:

```
10   ! THIS PROGRAM DEMONSTRATES A WAY TO DRAW PI-CHARTS USING RPLOT AND
20   ! SPECIFYING JUST THE LOCATION OF THE CENTER OF THE CIRCLE.
30   !
40   PLOTTER IS 7,5,"9872A"              ! SPECIFY 9872A AS PLOTTER.
50   DEG                                 ! SET DEGREES MODE.
60   LIMIT 10,210,10,150                 ! DEFINE THE PLOTTING AREA.
70   SHOW 0,10,-1,1                      ! SPECIFY USER UNITS.
80   FRAME                               ! FRAME THE PLOTTING AREA.
90   !
100  ! ***** DRAW THREE PI-CHARTS.
110  FOR Circle=2 TO 8 STEP 3            ! SPECIFY ONE OF THREE CIRCLES
120  MOVE Circle,0                       ! MOVE TO POINT TO DRAW CIRCLE.
130  FOR Arc=0 TO 360 STEP 15            ! SPECIFY POINT ON CIRCLE TO DRAW ARC.
140  PDIR Arc                            ! SPECIY PLOT DIRECTION FOR "RPLOT".
```

```
150  RPLOT 1,0                                  ! DRAW ARC.
160  NEXT Arc                                   ! DO IT AGAIN, UNTIL COMPLETE.
170  !
180  ! ***** DRAW RANDOM SECTION LINES FOR THIS EXAMPLE.
190  FOR Section=1 TO RND*5+2                   ! SPECIFY RANDOM NUMBER OF SECTIONS.
200  MOVE Circle,0                              ! MOVE TO CENTER OF CIRCLE.
210  PDIR RND*360                               ! SPECIFY RANDOM DIRECTION FOR LINE.
220  RPLOT 1,0,-1                               ! DRAW SECTION LINE.
230  NEXT Section                               ! DO IT AGAIN, UNTIL COMPLETE.
240  !
250  NEXT Circle                                ! DO NEXT CIRCLE.
260  END
```



IPLOT Statement

The IPLOT statement provides incremental plotting capability with pen control. The referenced origin is assumed to be the pen's position before this statement is executed. The pen moves the amount specified in the X direction and the amount specified in the Y direction from its current location.

Syntax:

IPLOT $X_{increment}$, $Y_{increment}$ [, pen control]

The IPLOT statement interprets the X and Y parameters according to the current units. The reference origin is that of the pen position before the IPLOT statement is executed (i.e. the current pen position).

The referenced coordinate system can be rotated about the origin relative to the master coordinate system by means of the PDIR (plot direction) statement. That is, a figure or line can be drawn or repeated at another angle by specifying the angle with the PDIR statement. Refer to the PDIR statement for examples.

The optional pen control parameter directs the up and down movement of the pen and is interpreted the same as for PLOT.

Example:

```
10   !
20   !
30   IPLOT 1,3,-1                          ! PLOT ONE UNIT TO THE RIGHT AND
40                                         ! THREE UNITS UP, WITH PEN DOWN.
50   !
60   IPLOT -5,2                            ! PLOT FIVE UNITS TO THE LEFT AND
70                                         ! TWO UNITS UP, WITH CURRENT PEN
80                                         ! STATUS (UP OR DOWN) THEN DROP PEN.
90   !
100  ! DO NOT RUN THIS PROGRAM, THESE ARE ONLY EXAMPLE PROGRAM LINES.
```

PEN Statement

The PEN statement allows you to select any one of the four pens found on the plotter.

Syntax:

PEN pen number

The meaningful range of the pen number parameter is zero (0) through four (4). Non-integer pen number parameters are rounded (up or down) to the nearest integer value.

Pen number zero (0) selects a blank pen. That is, all pens are returned to their stalls.

A pen number of 1,2,3 or 4 selects the pen that is located in the corresponding pen stall on the plotter.

On the 9872A Plotter, if a valid pen number (1 to 4) is specified by the pen statement, the pen in that stall is taken and the pen arm returns to its last location on the platen.

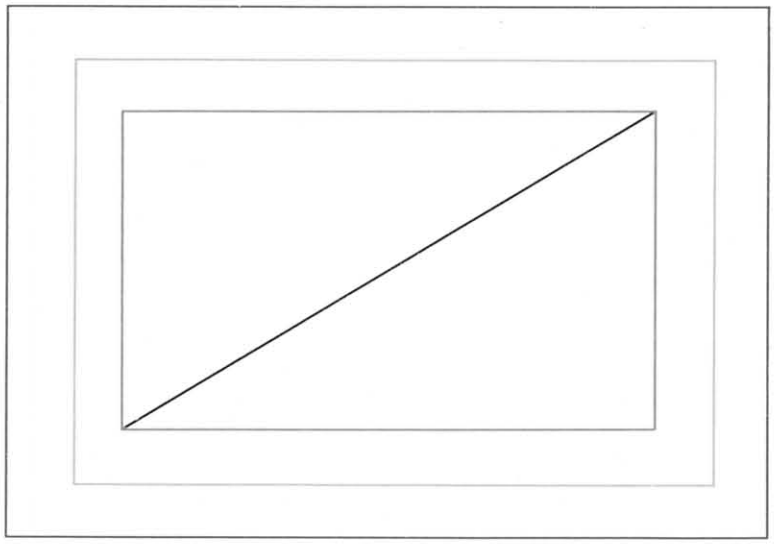
A pen number of zero (0) directs the 9872A Plotter to return the pen it is currently using to an empty storage stall without taking a new pen. On other multiple pen plotters, a pen number of zero simply raises all pens.

It is good practice to end all plotting programs with PEN 0 (zero), as leaving the pens in the open will dry them up.

The following example program draws several figures with different pens.

```
10   ! THIS PROGRAM DEMONSTRATES HOW THE PEN STATEMENT CAN BE USED TO
20   ! SELECT DIFFERENT COLORED PENS OR RETURN A PEN TO ITS HOLDER.
30   ! THREE BOXES AND A DIAGONAL LINE WILL BE DRAWN IN DIFFERENT COLORS.
40   !
50   ! ********* DRAW A SQUARE BOX ON THE PLOTTER PAPER *********
60   !
70   PLOTTER IS 7,5,"9872A"          ! SPECIFY THE 9872A AS PLOTTER.
80   LIMIT 10,210,10,150             ! SET THE HARD CLIP LIMITS.
90   PEN 1                           ! SELECT PEN 1 FOR PLOTTING.
100  FRAME                           ! DRAW A BOX AROUND THE LIMIT AREA.
110  !
120  ! ******** NOW, DRAW A SMALLER BOX IN A DIFFERENT COLOR. **********
130  !
```

```
140  CLIP 10,130,10,90                ! SET THE SOFT CLIP LIMITS
150                                   ! SMALLER THAN THE HARD CLIP LIMITS.
160  PEN 2                            ! SELECT PEN 2 FOR PLOTTING.
170  FRAME                            ! DRAW A BOX AROUND THE SOFT CLIP LIMITS.
180  !
190  ! ****** NOW, DRAW ANOTHER BOX THAT IS SMALLER YET. *********
200  !
210  CLIP 20,120,20,80                ! RE-SET THE SOFT CLIP LIMITS TO BE
220  !                                  SLIGHTLY SMALLER THAN THEY WERE.
230  PEN 3                            ! SELECT PEN 3 FOR PLOTTING.
240  FRAME                            ! DRAW A BOX AROUND THE NEW SOFT  CLIP
250  !                                  LIMITS.
260  !
270  ! ***** TO UTILIZE THE LAST AVAILABLE PEN, DRAW A DIAGONAL LINE
280  !       WITH PEN 4 WITHIN THE SMALLEST BOX.*****
290  !
300  MOVE 20,20                        ! POSITION THE PEN IN THE LOWER LEFT
310  !                                   CORNER OF THE SMALLEST BOX.
320  PEN 4                             ! SELECT PEN 4 FOR PLOTTING.
330  DRAW 120,80                       ! DRAW A LINE TO THE UPPER RIGHT CORNER
340  !                                   OF THE SMALLEST BOX.
350  !
360  PEN 0                             ! PLACE THE LAST PEN USED BACK IN ITS
370  !                                   HOLDER.
380  END
```



PENUP Statement

The PENUP statement lifts the pen.

Syntax:

```
PENUP
```

The pen's up or down status is automatically controlled when using the DRAW or MOVE statements and is controlled by the optional pen control parameter when using the PLOT, RPLOT, and IPLOT statements.

Example:

```
10   !
20   !
30   PENUP                                ! RAISE THE PEN OFF THE PLOTTER PAPER.
40   !
50   !
60   ! DO NOT RUN THIS PROGRAM, THIS IS ONLY AN EXAMPLE PROGRAM LINE.
```

PDIR Statement

The PDIR statement sets the angle of axes rotation for relative (RPLOT) and incremental (IPLOT) plotting. The angular unit of measure can be specified as DEG (degree), RAD (radian), or GRAD (gradient).

Syntax:

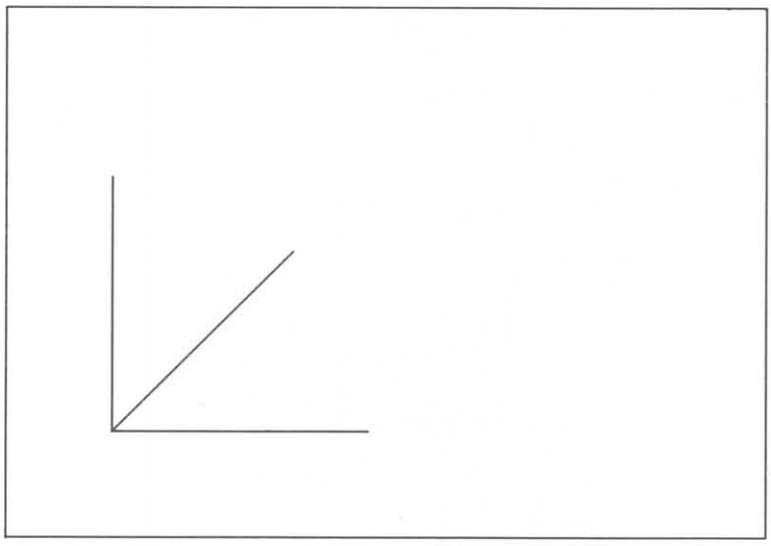
PDIR angle or PDIR run, rise

The angle of axes rotation can be specified in either of two ways:

- As the counter clockwise angle, in current angle units (DEG, RAD, or GRAD), between the new X-axis and the horizontal axis.

  Example:

```
10   !  ***  THIS PROGRAM DEMONSTRATES THE USE OF THE PDIR  ****
20   !       STATEMENT USING THE ANGLE PARAMETER.
30   !
40   !
50   PLOTTER IS 7,5,"9872A"            ! SELECT AND ACTIVATE THE PLOTTER.
60   LIMIT 10,210,10,150               ! SET THE HARD CLIP BOUNDARIES.
70   FRAME                             ! BOX-IN THE HARD CLIP LIMITS.
80   LOCATE 20,80,20,80                ! SET THE SOFT CLIP LIMITS.
90   SCALE 0,10,0,10                   ! SCALE THE SOFT CLIP AREA TO UDU'S.
100  DEG                               ! SET THE DEGREE MODE.
110  !
120  PLOT 0,0                          ! ESTABLISH REFERENCE FOR RPLOT.
130  RPLOT 8,0                         ! DRAW A LINE ON THE X AXIS.
140  PLOT 0,0
150  !
160  PDIR 45                           ! ROTATE THE  AXES 45 DEGREES AND
170                                    ! DRAW A LINE ON THE X AXIS.
180  RPLOT 8,0
190  PLOT 0,0
200  !
210  PDIR 90                           ! ROTATE THE  AXES 90 DEGREES AND
220  RPLOT 8,0                         ! DRAW A LINE ON THE X AXIS.
230  PLOT 0,0
240  PEN 0                             ! RETURN THE PEN TO ITS STALL.
250  END
```

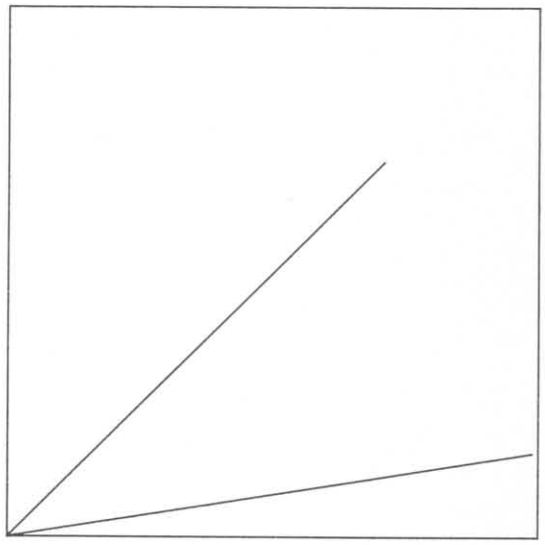


The figure above shows the axes rotation that occurs when a PDIR statement specifying an angle (in degrees) of 45° is executed. When the second PDIR statement specifying an angle of 90° is executed, the axes are rotated from the 45° position to the 90° position as shown. The angles of all successive PDIR statements are referenced to the horizontal axis, not to the previous angle.

- The rotation parameter can alternately be specified as the run and rise units (in current units) of a vector drawn in the desired direction.

Example:

```
10   !  *** THIS PROGRAM DEMONSTRATES THE USE OF THE RUN-RISE ***
20   !      PARAMETERS FOR USE WITH THE PDIR STATEMENT.
30   !
40   PLOTTER IS 7,5,"9872A"          ! SELECT THE 9872A AS PLOTTER.
50   LOCATE 0,100,0,100              ! DEFINE THE SOFT CLIP LIMITS
                                       AND FRAME THEM IN.
60   FRAME
70   SCALE 0,1,0,10                  ! DEFINE 1 X UNIT TO EQUAL 10 Y UNITS
                                       (ESTABLISH UDU'S)
80   PDIR 1,1                        ! ROTATE THE AXES ACCORDING TO THE
                                       RUN-RISE PARAMETERS IN CURRENT UNITS.
90   MOVE 0,0
100  RPLOT 1,0,-1                    ! DRAW A LINE.
110  !
120  SETGU                           ! REDEFINE THE CURRENT UNITS TO BE
                                       GDU'S.
130  PDIR 1,1                        ! ROTATE THE AXES ACCORDING TO THE
                                       PDIR PARAMETERS.
140  MOVE 0,0
150  RPLOT 100,0,-1                  ! DRAW A SECOND LINE.
160  PEN 0                           ! RETURN THE PEN TO ITS STALL.
170  END
```



The figure above shows the axes rotation that results from two PDIR statements using run and rise parameters.

Both PDIR statements rotate the axes such that the lines drawn both pass through a point that is one unit horizontally (run) and one unit vertically (rise) from the origin of the original axes. The lines are not concurrent, however, because the units mode was changed from UDU's to GDU's. This program demonstrates the importance of current units to the PDIR statement.

LINE TYPE Statement

The LINE TYPE statement selects one of several solid or dashed line types for use with plotting operations and defines the length of the repeat pattern for the line type selected.

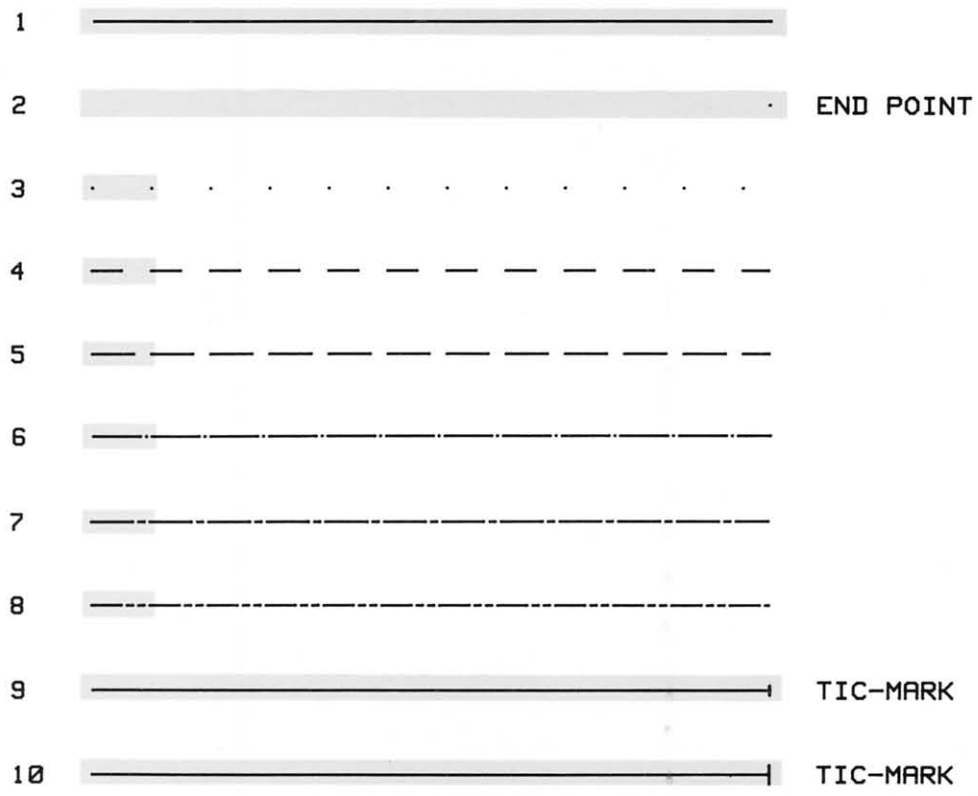
Syntax:

LINE TYPE ID number [, length]

The ID number (integer value 1 through 10) selects one of the ten line types for plotting (see the example below). The default line type is type one (solid line).

The length parameter specifies (in GDU's) the length of the repeat pattern of the line type being selected. The repeat pattern for each line type is the shaded portion of the line shown in the example below. The default length is 4 GDU's if a length parameter is not specified. (Note: Repeat pattern length for end points and tic-marks is determined by the number of times the pen is re-positioned while drawing the particular line).

The line type patterns selected by the ID numbers and generated by the Plotter ROM are shown below:



Chapter 4
Axes and Labeling Statements

Introduction

The statements presented in this chapter will allow you to draw axes and labels on the plotting area. The axes can be in the form of the normal X and Y axes lines, a grid, or a line around the plotting area (frame). Labels can be drawn under program control or typed in from the keyboard. You can specify the size, shape, rotation, and location of the labels.

AXES Statement

The AXES statement draws a pair of axes with optional (linearly-spaced) major and minor tic-marks.

Syntax:

AXES [$X_{tic\text{-}spacing}$, $Y_{tic\text{-}spacing}$ [, $X_{intersection}$, $Y_{intersection}$ [, $X_{major\ count}$, $Y_{major\ count}$ [, major tic size]]]]

The axes drawn intersect at (X intersection, Y intersection); the intersection coordinates are interpreted in current units. The axes are drawn across the entire current clipping area (soft clip if mode is UDU's, hard clip if mode is GDU's). The intersection point may lie outside the clipping area in which case only that portion of the axes within the clipping area is drawn. (This can be used to draw just one axis). The default value for X intersection, Y intersection is 0, 0.

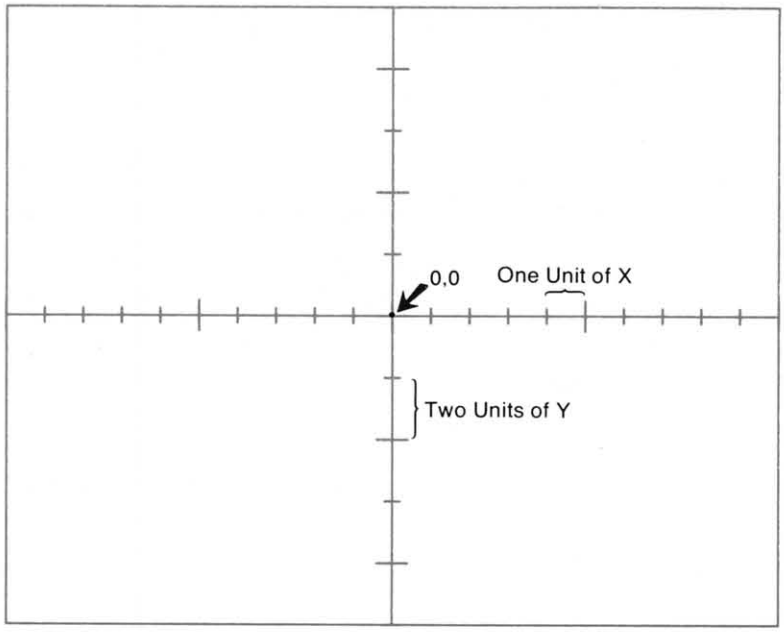
The X and Y tic-spacing parameters specify, in current units, the distance between tic-marks on each axis. They cannot be negative; zero is allowed as a special case signifying "no tics at all". The default value is 0, 0 (no tics on either axis).

The optional X and Y major count parameters are positive integers which specify the number of tic-intervals between major tics. For example, an X major count of 2 means that every other tic on the X axis is a major tic. The tic-marks are drawn so that a major tic falls at the axis intersection point (whether visible or not); tic-marks need not fall on the clipping boundaries. The default value for the count parameter is one (all tics are major tics).

The optional tic size parameter specifies the length of a major tic, end-to-end, in GDU's. Minor tics are always drawn ½ the size of major tics. The default length of a major tic is 2 GDU's.

Example:

```
10   ! THIS PROGRAM DRAWS AN AXES AND FRAMES THE PLOTTING AREA.
20   !
30   PLOTTER IS 7,5,"9872A"              ! SELECTS THE 9872A AS PLOTTER.
40   LIMIT 10,210,10,150                 ! DEFINE THE PLOTTING AREA,
50   SCALE -10,10,-10,10                 ! SPECIFY USER UNITS.
60   !
70   AXES 1,2,0,0,5,2,5                  ! DRAW AXES, SPECIFYING:
80                                       ! ONE MINOR TIC PER UNIT IN X,
90                                       ! ONE MINOR TIC PER TWO UNITS IN Y,
100                                      ! INTERSECT AT 0,0,
110                                      ! ONE MAJOR TIC PER 5 MINOR TICS IN X,
120                                      ! ONE MAJOR TIC PER 2 MINOR TICS IN Y,
130                                      ! MAJOR TIC SIZE IS 5 GDU'S.
140  !
150  FRAME                               ! FRAME PLOTTING AREA.
160  END
```



GRID Statement

The GRID statement can be used as an alternative to the AXES statement when a full grid is desired.

Syntax:

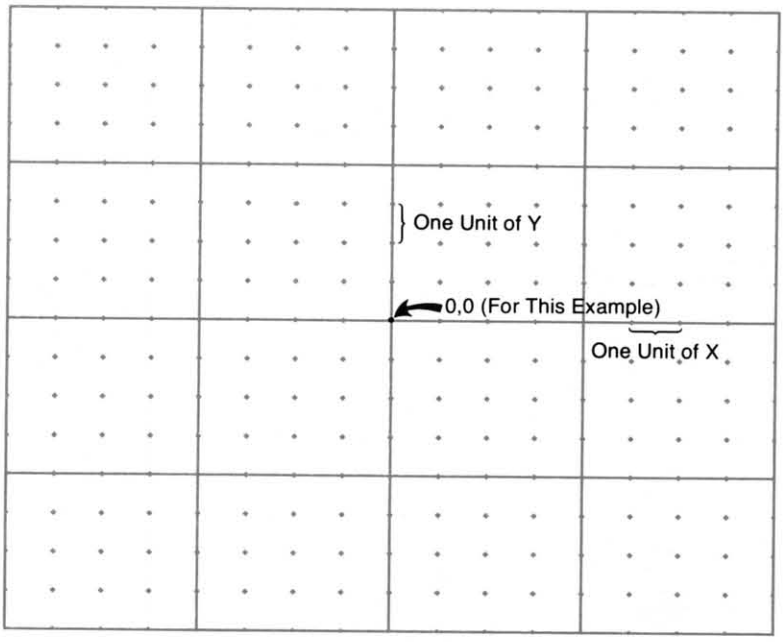
GRID [$X_{tic\text{-}spacing}$, $Y_{tic\text{-}spacing}$ [, $X_{intersection}$, $Y_{intersection}$ [, $X_{major\ count}$, $Y_{major\ count}$ [, minor tic size]]]]

The parameters are the same as for the AXES statement, except that the last parameter specifies the length of the minor tics only. The major tic-marks are drawn completely across the current clipping area and a cross tic is drawn at the intersection of the minor tics. (Note: The actual length of the minor tics (in GDU's) will be ½ of the length which you specify in the minor tic size parameter).

Also, like the AXES statement, the grid line and tic-marks are drawn using the current line type and pen number (refer to Chapter 3).

Example:

```
10   ! THIS PROGRAM DRAWS A GRID AND FRAMES THE PLOTTING AREA.
20   !
30   PLOTTER IS 7,5,"9872A"              ! SPECIFY THE 9872A AS PLOTTER.
40   LIMIT 10,210,10,150                 ! DEFINE THE PLOTTING AREA.
50   SCALE -8,8,-8,8                     ! SPECIFY USER UNITS.
60   !
70   GRID 1,1,0,0,4,4,1                  ! DRAW GRID, SPECIFYING:
80                                       ! ONE MINOR TIC PER UNIT IN X,
90                                       ! ONE MINOR TIC PER UNIT IN Y,
100                                      ! INTERSECT AT 0,0,
110                                      ! ONE MAJOR TIC PER 4 MINOR TICS IN X,
120                                      ! ONE MAJOR TIC PER 4 MINOR TICS IN Y,
130                                      ! MINOR TIC SIZE IS .5 GDU'S.
140  !
150  FRAME                               ! FRAME PLOTTING AREA.
160  END
```


One Unit of Y
0,0 (For This Example)
One Unit of X

FRAME Statement

The FRAME statement draws a box around the current clipping area (soft clip if units are UDU's, hard clip if units are GDU's).

Syntax:

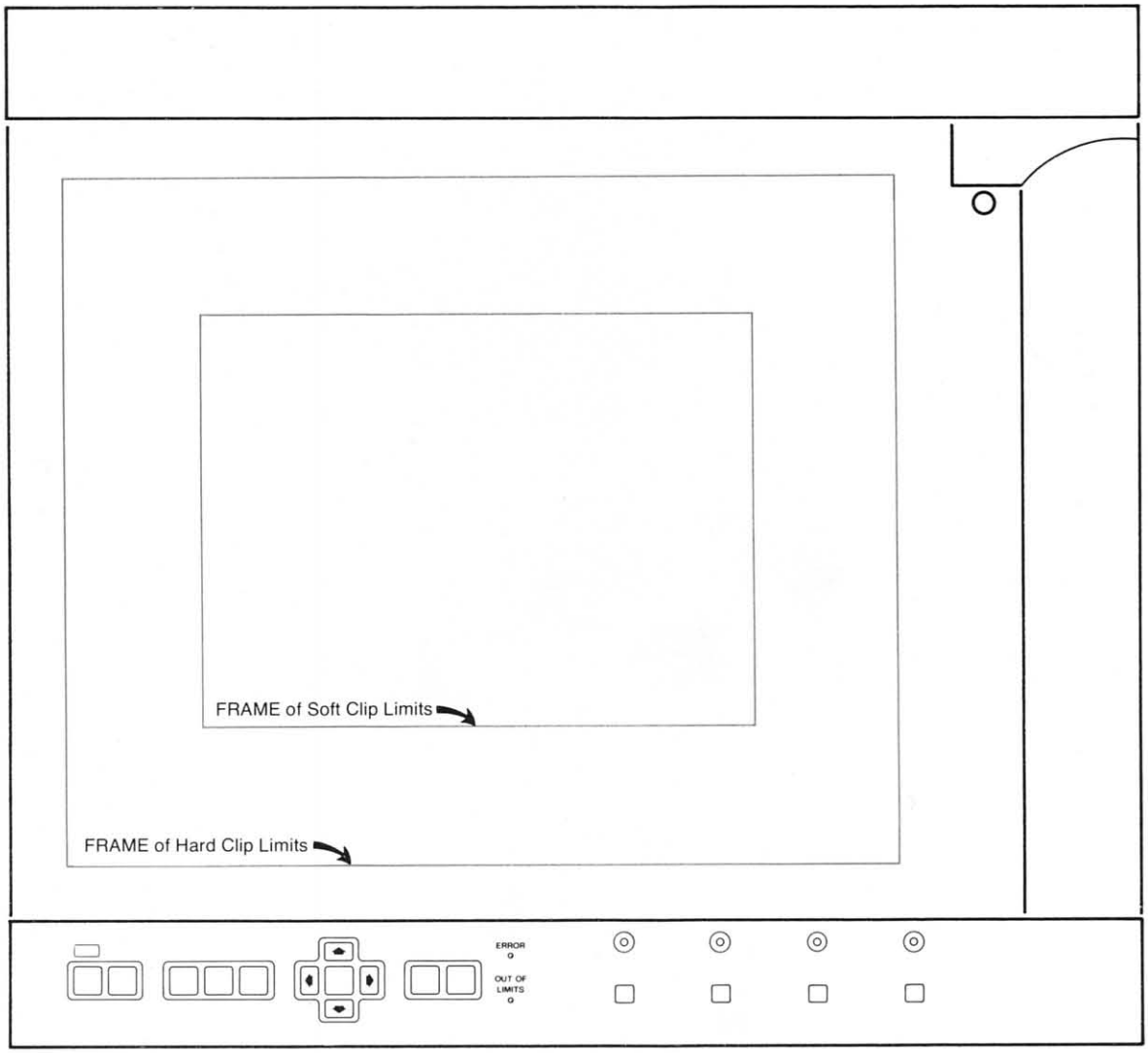
```
FRAME
```

The box is drawn using the current pen and line type around the current clipping area. The pen is positioned at the lower left corner of the frame after the operation is complete.

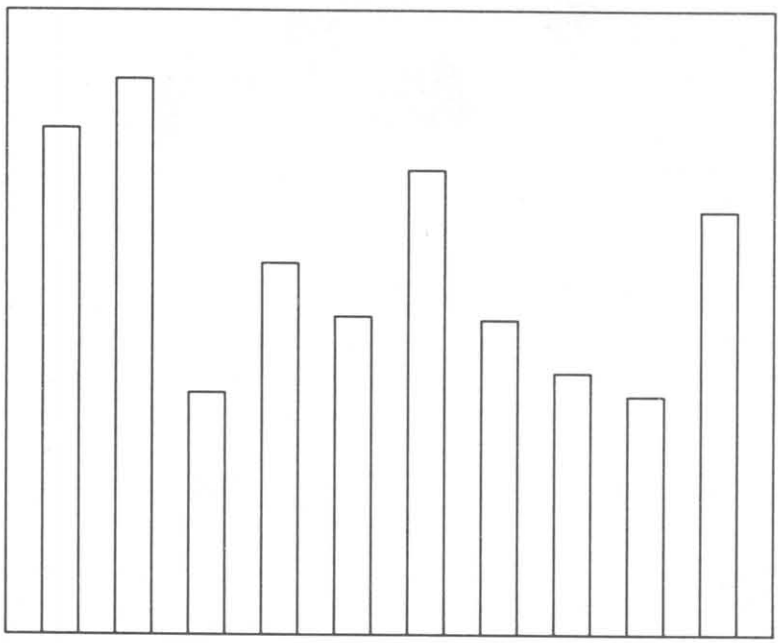
The second example below shows an interesting use of the FRAME and CLIP statements.

Example:

```
10   ! THIS PROGRAM DRAWS A FRAME AROUND THE PLOTTING AREA.
20   !
30   PLOTTER IS 7,5,"9872A"              ! SPECIFY THE 9872A AS PLOTTER.
40   FRAME                               ! FRAME PLOTTING AREA.
50   END
```


FRAME of Soft Clip Limits
FRAME of Hard Clip Limits
ERROR
OUT OF LIMITS

```
10   ! THIS PROGRAM USES THE CLIP AND FRAME STATEMENT TO DRAW A BAR-CHART.
20   !
30   PLOTTER IS 7,5,"9872A"                ! SPECIFY THE 9872A AS PLOTTER.
40   LIMIT 10,210,10,150                   ! DEFINE THE PLOTTING AREA.
50   SCALE 0,21,0,100                      ! SPECIFY USER UNITS.
60   FRAME                                 ! FRAME THE PLOTTING AREA.
70   !
80   ! ***** DRAW 10 BARS AT RANDOM LENGTH.
90   FOR Bar=1 TO 10                       ! SPECIFY ONE OF TEN BARS.
100  Bar_length=RND*100                    ! RANDOM LENGTH FOR THIS EXAMPLE.
110  CLIP Bar*2-1,Bar*2,0,Bar_length       ! CLIP PLOTTING AREA FOR FRAME.
120  FRAME                                 ! FRAME THE BAR.
130  NEXT Bar                              ! DO IT AGAIN FOR THE NEXT BAR.
140  UNCLIP                                ! RESTORE CLIP TO SCALE SIZE.
150  END
```



LABEL and LABEL USING Statements

The LABEL and LABEL USING statements are very similar to the PRINT and PRINT USING statements except that the output list is directed to the current plotter as a label. For detailed information on PRINT and PRINT USING statements see the System 35 Operating and Programming Manual.

Syntax:

LABEL list
or
LABEL USING image specifier ; list

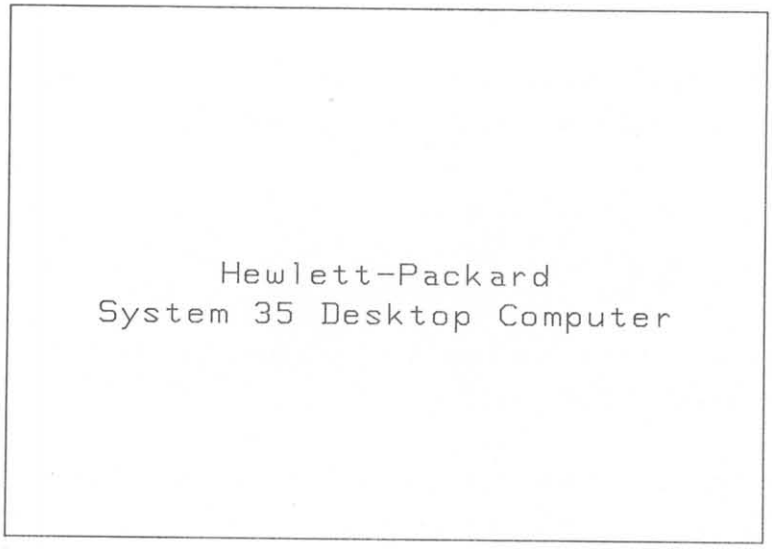
LABEL and LABEL USING follow the same formatting rules as PRINT and PRINT USING

The position and rotation of a label are controlled by the current pen position and the LORG (label origin) and LDIR (label direction) statements. The size and aspect ratio of the characters in the label are controlled by the CSIZE (character size) statement (refer to the next sections of this manual).

The characters are drawn in the GDU mode. They are clipped only at the hard clip limits and they can be reflected only by a LIMIT statement.

Example:

```
10   ! THIS PROGRAM FRAMES AND LABELS THE PLOTTING AREA.
20   !
30   PLOTTER IS 7,5,"9872A"              ! SPECIFY THE 9872A AS PLOTTER.
40   LIMIT 10,210,10,150                 ! DEFINE THE PLOTTING AREA.
50   SCALE -1,1,-1,1                     ! SPECIFY USER UNITS.
60   FRAME                               ! FRAME PLOTTING AREA.
70   CSIZE 7                             ! SPECIFY CHARACTER SIZE.
80   LORG 5                              ! SPECIFY TO CENTER LABELS.
90   MOVE 0,0                            ! MOVE TO CENTER OF PLOTTING AREA.
100  LABEL USING "K";"Hewlett-Packard"   ! DRAW FIRST LABEL.
110  LABEL USING "K";"System 35 Desktop Computer"  ! DRAW SECOND LABEL.
120  END
```


Hewlett-Packard
System 35 Desktop Computer

LORG Statement

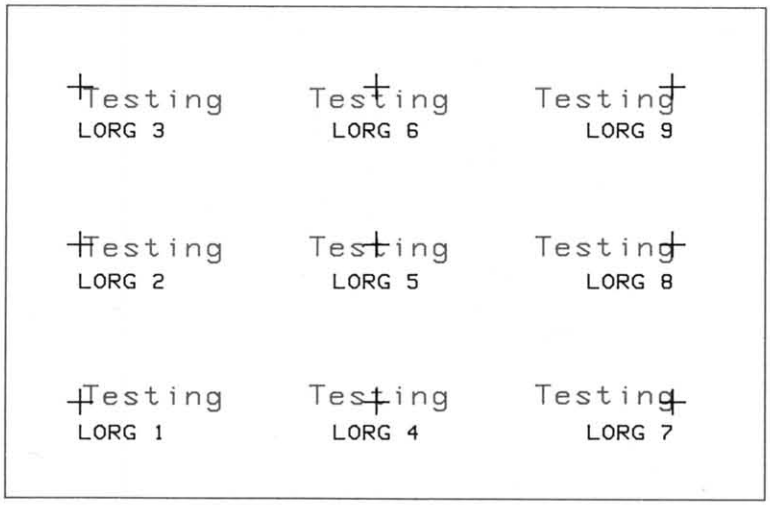
The LORG (label origin) statement sets the label origin position which determines where subsequent labels will be placed relative to the current pen location.

Syntax:

LORG origin position

The origin position parameter can have a value between one and nine. If LORG is not executed, the default origin position is one.

In the following figure, each number shows the initial position of the pen relative to a character space when LORG is executed with that number as its position parameter. LORG positions are all calculated for an upper case letter.



LORG 7, 8, or 9 would give one of three forms of right justification which could be used to label Y axis tic-marks.

LORG 6 labels characters below the pen position which could be used to label X axis tic-marks.

If the label is rotated by the label direction statement (see LDIR), the relationship stays fixed relative to the label, not the plotting area.

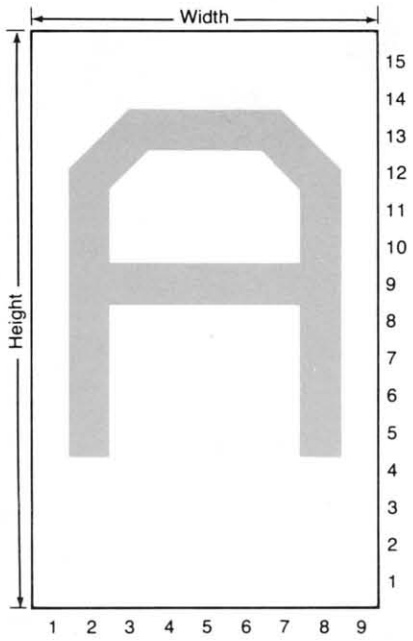
CSIZE Statement

The CSIZE (character size) statement specifies the height and aspect ratio (character space) of the alphanumerics or symbols to be drawn for labels.

Syntax:

CSIZE height [, aspect ratio]

The character space (shown below) is the area occupied by a character plus the additional space around the character that separates it from other characters. Thus, the actual character height will be smaller than the height parameter due to the space around the character.

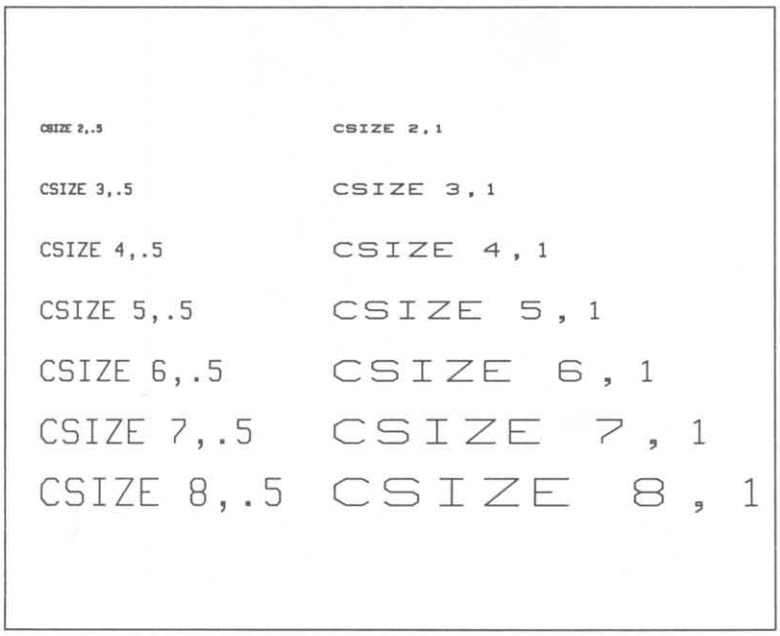


The height parameter specifies the height of the character space in GDU's. The default value is approximately 3.3 GDU's and is set by either the PLOTTER IS or LIMIT statements.

The width of the characters is specified indirectly by the aspect ratio parameter. The aspect ratio is the ratio of the width of the character space to the height. Thus the width of a character space is the height parameter times the aspect ratio.

The default aspect ratio is 9/15 which specifies that the character space is 9 units wide for every 15 units of height.

```
10   ! THIS PROGRAM DEMONSTRATES SOME OF THE DIFFERENT CHARACTER SIZES
20   ! AND ASPECT RATIOS.
30   !
40   PLOTTER IS 7,5,"9872A"                ! SPECIFY 9872A AS PLOTTER.
50   LIMIT 10,210,10,150                   ! DEFINE THE PLOTTING AREA.
60   FRAME                                 ! FRAME PLOTTING AREA.
70   SCALE -.5,10,-10,0                    ! SPECIFY USER UNITS.
80   !
90   ! ***** LABEL PLOTTING AREA WITH TWO COLUMNS OF EXAMPLE CHARACTER SIZES.
100  FOR Column=1 TO 2                     ! SPECIFY ONE OF TWO COLUMNS.
110  FOR Size=2 TO 8                       ! SPECIFY ONE OF EIGHT CHAR SIZE.
120  CSIZE Size,Column/2                   ! SPECIFY CHAR SIZE AND ASPECT RATIO.
130  MOVE (Column-1)*4,-Size               ! MOVE TO LABEL POSITION.
140  LABEL USING "K";"CSIZE ",Size,",",Column/2  ! LABEL PLOTTING AREA.
150  NEXT Size                             ! GET NEXT SIZE.
160  NEXT Column                           ! GET NEXT COLUMN.
170  END                                   ! END OF EXAMPLE.
```



LDIR Statement

The LDIR (label direction) statement specifies the angle at which the LETTER and the LABEL statements will draw characters.

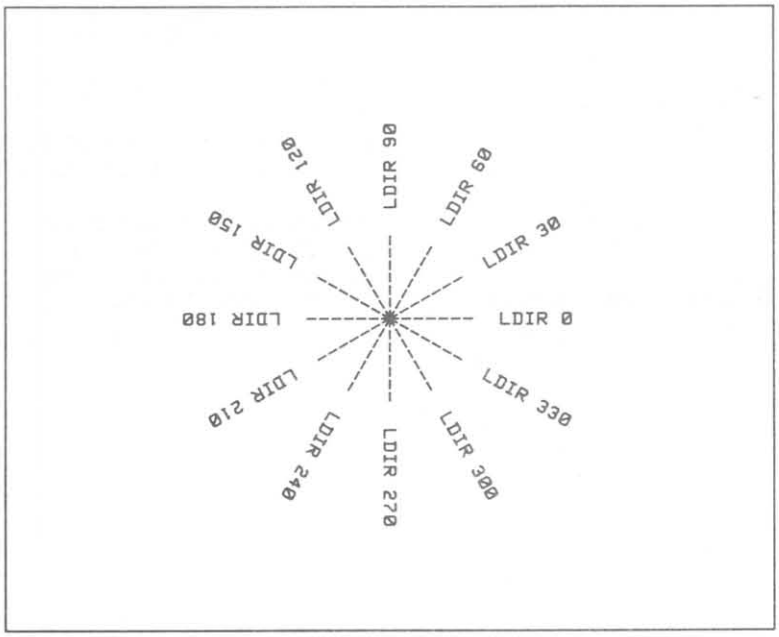
Syntax:

LDIR angle or LDIR run, rise

The angle can be specified in either of the following ways:

- The angle can be specified in current angle units (DEG, RAD or GRAD) of the value of the counter-clockwise angle between the letter direction and the normal (horizontal) X axis as shown below.

```
10   ! THIS PROGRAM DRAWS A LABEL AT EACH 30 DEGREES AROUND A CENTER POINT.
20   !
30   PLOTTER IS 7,5,"9872A"                ! SPECIFY 9872A AS PLOTER.
40   LIMIT 10,210,10,150                   ! DEFINE THE PLOTTING AREA.
50   FRAME                                 ! FRAME THE PLOTTING AREA.
60   DEG                                   ! SET DEGREES MODE FOR LDIR.
70   SCALE -10,10,-10,10                   ! SPECIFY USER UNITS.
80   !
90   ! ***** LABEL EACH 30 DEGREES FROM A CENTER POINT.
100  LORG 2                                ! SPECIFY LORG, CENTER ON LEFT END.
110  FOR Degree=0 TO 330 STEP 30           ! LOOP FOR DEGREES.
120  LDIR Degree                           ! SPECIFY A DIRECTION.
130  MOVE 0,0                              ! MOVE TO CENTER POINT.
140  LABEL USING "K";"-------  LDIR ",Degree ! LABEL PLOTTING AREA.
150  NEXT Degree                           ! DO IT AGAIN, UNTIL COMPLETE.
160  END
```

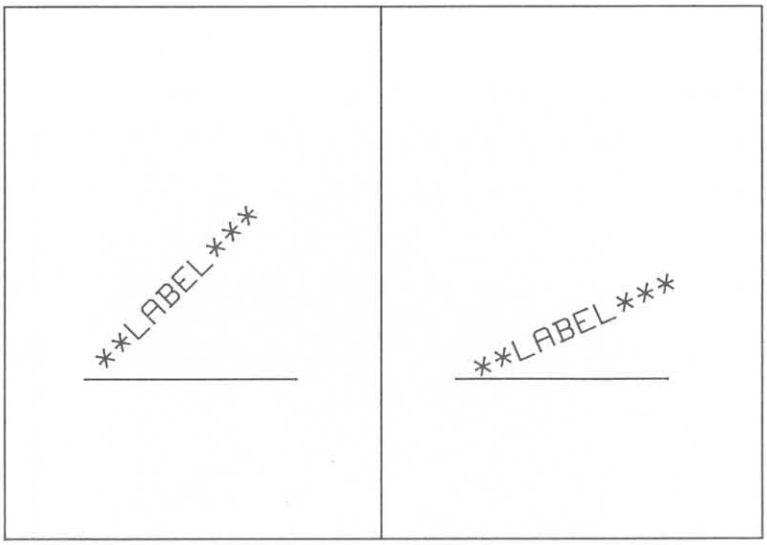


Note: These examples assume that DEG units are set. RAD units are the default units set in the computer.

- The angle can be specified as the number of current units of run (horizontal distance) along the normal X axis and the number of current units of rise (vertical distance) above the X axis for a point that the direction of lettering passes through.

Example:

```
10   ! *** THIS PROGRAM DEMONSTRATES THE USE OF THE LDIR  ***
20   !     STATEMENT USING THE RUN-RISE PARAMETER.
30   !
40   PLOTTER IS 7,5,"9872A"            ! DEFINE & ACTIVATE THE PLOTTER.
50   LIMIT 10,210,10,150               ! ESTABLISH THE HARD CLIP LIMITS
60   FRAME                             ! AND BOX THEM IN.
70   MOVE 71,100
80   DRAW 71,0                         ! DIVIDE THE "BOX" IN HALF.
90   !
100  LOCATE 15,65,30,80                ! DEFINE THE SOFT CLIP AREA.
110  SCALE 0,10,0,10                   ! ESTABLISH USER UNITS.
120  MOVE 0,0                          ! MOVE TO THE ORIGIN.
130  RPLOT 8,0                         ! DRAW A LINE ON THE X AXIS.
140  PLOT 0,0
150  !
160  LDIR 5,2                          ! ROTATE THE AXES ACCORDING TO THE
170                                    ! PARAMETERS (5 RUN, AND 2 RISE).
180  GOSUB Loop                        ! GO TO THE LABELING ROUTINE.
190  !
200  LOCATE 90,140,30,80               ! REDEFINE THE SOFT CLIP AREA.
210  SCALE 0,10,0,10                   ! REDEFINE THE USER UNITS.
220  PDIR 0                            ! RESET THE X AXIS TO THE HORIZONTAL.
230  MOVE 0,0                          ! MOVE TO THE NEW ORIGIN.
240  RPLOT 8,0                         ! DRAW A LINE ON THE X AXIS.
250  PLOT 0,0
260  !
270  LDIR 7,4                          ! ROTATE THE AXES ACCORDING TO
280                                    ! THE SECOND LDIR STATEMENT (7 RUN,
                                         AND 4 RISE).
290  GOSUB Loop                        ! GO TO THE LABELING SUBROUTINE.
300  !
310  PEN 0                             ! RETURN THE CURRENT PEN TO ITS
320  END                               ! HOLDER AND END THE PROGRAM.
330  !
340 Loop:                              ! THE LABELING SUBROUTINE:
350  CSIZE 7                           ! SELECTS CHARACTER SIZE.
360  LORG 2                            ! SELECTS LABEL ORIGIN POSITION.
370  LABEL USING "K";"**LABEL***"      ! DRAWS "**LABEL***".
380  RETURN
```



LDIR 5,2 LDIR 7,4

LETTER Statement

The LETTER statement allows you to draw all keyboard alphanumerics and symbols by typing them in on the keyboard. The size and direction of the characters are controlled the same as with the LABEL statement (refer to CSIZE and LDIR).

Syntax:

```
LETTER
```

The normal lower left corner of the character is placed at the current cursor position (refer to Chapter 5 for cursor information). The cursor position can be set by a POINTER statement (refer to POINTER statement) or by the display control keys. The control keys are used in the following manner:

↑ moves up one line spacing.
↓ moves down one line spacing.
← moves left one character space.
→ moves right one character space.
SHIFT ↑, ↓, ←, → moves one plotter resolution unit (.025mm on 9872A) in the indicated direction.

The display control keys always move the cursor horizontally or vertically. Should you want to move the cursor along rotated axes (e.g. after an LDIR statement), use the following key:

space moves right one character space.
CONT G (backspace) moves left one character space.
CONT J (linefeed) moves down one line space.
CONT H (vertical tab) moves up one line space.

In addition, CONT M (carriage return) returns the pen to the position it had before the LETTER statement, or to the point last moved to by a display control key.

LETTERing is performed in LORG 1 and with current CSIZE, LDIR, and PEN parameters. To exit the letter mode press the CONT, STOP, STEP, or any special function key.

```
10   ! *** THIS PROGRAM ALLOWS YOU TO PRINT LETTERS ON THE PLOTTER ***
20   !     BY TYPING THEM IN ON THE KEYBOARD.
30   !
40   PLOTTER IS 7,5,"9872A"          ! SELECT THE 9872A AS PLOTTER.
50   LIMIT 10,210,10,150             ! DEFINE AND FRAME THE HARD CLIP
60   FRAME                           ! LIMITS.
70   CSIZE 7,.5                      ! SELECT THE CHARACTER SIZE AND
80   !                                 ASPECT RATIO.
90   LETTER                          ! DEFINE THE LETTER MODE. MOVE
100  !                                 THE PEN (VIA THE SYSTEM 35 DISPLAY
110  !                                 CONTROL KEYS) TO ANY POSITION
120  !                                 WITHIN THE PLOTTING AREA AND DRAW A
121  !                                 CHARACTER BY TYPING IT IN ON THE
122  !                                 KEYBOARD.
130  END
```

Chapter 5
Digitizing and Cursor Control Statements

Introduction

The statements explained in this chapter allow you to obtain X,Y coordinate data from previously plotted data points. This process is called digitizing and is essentially the inverse operation of plotting. Plotting sends X,Y coordinate values to the plotter which moves the pen to the specified location on the plotting area. Digitizing lets you move the plotter's pen to a point on the plotting area and return the X,Y coordinate values of that point to the computer.

It is important to note that the "pen" and the "cursor" are two separate entities; one does not affect the location of the other. The location of each is controlled and maintained by the computer.

The pen location is the location at which plotting operations are being performed; the cursor position is the point where digitizing is being performed. For digitizing, the pen is raised and moved to the current cursor position. It shows the cursor position until digitizing is complete. The pen is then returned to the logical pen position for further plotting operations.

The examples in this chapter utilize an HP 9872A Plotter as the plotting device. Position the pen (used as the cursor) by pressing the pen arm control buttons located on the plotter's front panel. To enter a point during a digitizing operation, press the (ENTER) key on the plotter and the value is returned to the computer.

On a 9872A equipped with a digitizing sight, the sight must be placed into a pen stall and selected by a PEN statement for proper operation. The digitizing procedure is the same as that for a plotter without a digitizing sight.

DIGITIZE Statement

The DIGITIZE statement stops the program and allows you to reposition the pen (or optional digitizing sight on the 9872A). It waits for you to press (ENTER) at which time the coordinate values of the location (in current units) are assigned to the first two variables specified in the DIGITIZE statement. The third variable, if specified, is assigned pen status information.

Syntax:

DIGITIZE $X_{variable}$, $Y_{variable}$ [, pen status string variable]

The first two variables shown above are required. The X coordinate value is returned to the first variable specified and the Y coordinate value is returned to the second variable, both in current units.

The optional third variable must be a string variable or substring and, if present, is assigned the character 0 or 1 depending on the pen's status. If the pen is up, 0 is assigned to the string variable, and if the pen is down, 1 is assigned to the string variable.

On most plotting devices the pen is used for digitizing. On the 9872A, a special digitizing sight is optional for digitizing operations. This sight can be loaded into one of the pen stalls and is selected with a PEN statement for use with DIGITIZE statements.

To digitize on an incremental plotter, position the pen via the display control keys (refer to LETTER statement), then press (CONT) .

Digitizing On the 9872A

When a DIGITIZE statement is executed and a 9872A Plotter is the current plotter, the following activities typically occur:

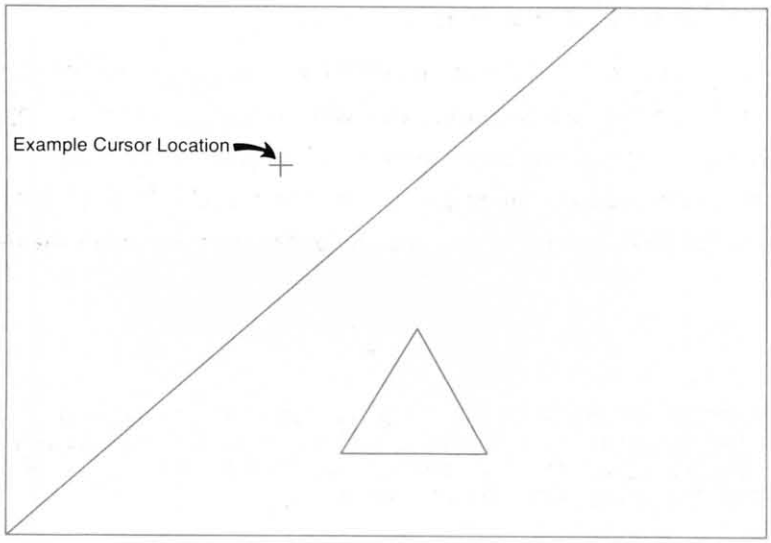
- If the DIGITIZE statement is being executed for the first time after a PLOTTER IS statement, the plotter's pen arm moves to the lower left corner of the hard clip limits. The (ENTER) key indicator lights and the program halts execution. Position the pen (or digitizing sight) over the point to be digitized by using the pen arm control buttons on the plotter's front panel. Press the (ENTER) key to send the coordinate values of the point to the computer. The program automatically continues execution.

Digitize For Other Statements

If the LIMIT, LOCATE, or CLIP statements are executed without parameters, the computer will automatically enter a digitize mode and wait for you to enter two opposite corners in place of the parameters of the executed statement. The pen on the plotter can be moved and the points entered as described in the previous paragraphs. (Use ENTER, P1, and ENTER, P2). On plotters other than the 9872A, refer to the plotters' operating manual for the digitize procedure.

Example:

```
10   ! THIS PROGRAM DEMONSTRATES THE USE OF THE DIGITIZE STATEMENT. SEVERAL
20   ! LINES ARE DRAWN ON THE PLOTTER; YOU CAN FIND THE COORDINATES OF ANY
30   ! POINT ON THE LINES BY POSITIONING THE CURSOR (PEN) OVER THE POINT AND
40   ! PRESSING THE ENTER KEY ON THE 9872A.
50   !
60   PRINTER IS 0                          ! SPECIFY PRINTOUT DEVICE.
70   FIXED 2                               ! SPECIFY FIXED 2 FOR PRINTOUT.
80   PLOTTER IS 7,5,"9872A"                ! SPECIFY 9872A AS PLOTTER.
90   LIMIT 10,210,10,150                   ! DEFINE THE PLOTTING AREA.
100  FRAME                                 ! FRAME PLOTTING AREA.
110  !
120  !
130  ! ***** DRAW A LINE TO GDU 100,100 FOR THIS EXAMPLE.
140  MOVE 0,0                              ! MOVE THE PEN TO 0,0.
150  DRAW 100,100                          ! DRAW THE LINE TO 100,100.
160  !
170  ! ***** DRAW A TRIANGLE FOR THIS EXAMPLE.
180  MOVE 60,50
190  DRAW 80,10
200  DRAW 40,10
210  DRAW 60,50
220  !
230  ! ***** INITIALIZE CURSOR POSITION AND TYPE.
240  POINTER 50,50                         ! POSITION CURSOR IN CENTER OF PLOTTING
250  !                                       AREA.
260  !
270  !
280  ! ***** LOOP TO DIGITIZE POINTS
290 Loop: !
300  DIGITIZE X,Y,A$                       ! INPUT CURSOR COORDINATE & PEN STATUS.
310  PRINT X,Y,A$                          ! PRINT COORDINATE.
320  GOTO Loop                             ! DO IT AGAIN, FOREVER.
```


Example Cursor Location

POINTER Statement

The POINTER statement moves the cursor to a specified absolute cursor location.

Syntax:

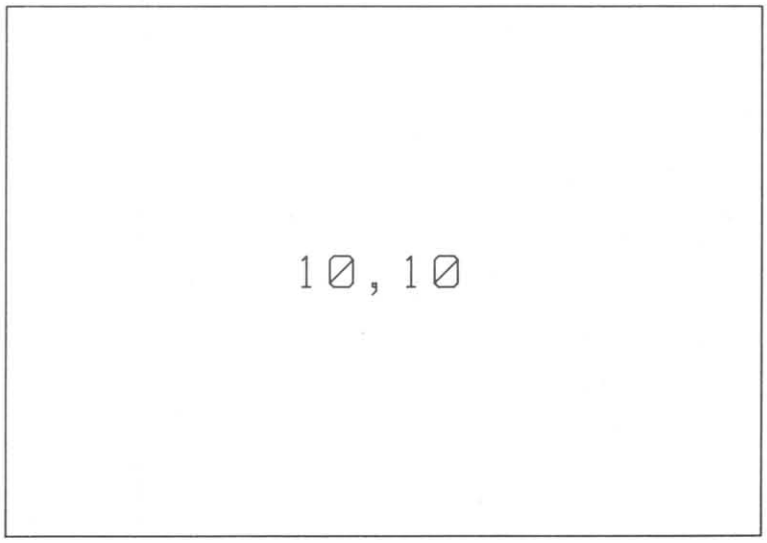
POINTER $X_{parameter}$, $Y_{parameter}$

The X and Y parameters are specified in current units. If the cursor location is outside the hard clip limit, the pen moves only to the limit and stops.

This statement can be used to position the pen when an initial digitizing point is known.

Example:

```
1    ! *** THIS PROGRAM DEMONSTRATES THE USE OF THE POINTER ***
          STATEMENT TO MOVE THE CURSOR TO A DESIRED LOCATION.
2    !
10   PLOTTER IS 7,5,"9872A"            ! SELECT THE 9872A AS PLOTTER.
30   LIMIT 10,210,10,150               ! DEFINE THE PLOTTING AREA.
                                         AND FRAME IT IN.
40   FRAME
50   POINTER 10,10                     ! MOVE THE CURSOR TO POINT (10,10).
60   CURSOR X,Y                        ! RETURN THE COORDINATES VIA A
                                         CURSOR STATEMENT AND PRINT
70   MOVE 70,50                        ! THEM IN THE CENTER OF THE HARD
                                         CLIP "BOX".
80   LORG 5
90   CSIZE 7
100  LABEL USING "K";X,",",Y
110  PEN 0
120  END
```



CURSOR Statement

The CURSOR statement returns the cursor coordinate location and pen status information to the specified variables.

Syntax:

CURSOR $X_{variable}$, $Y_{variable}$[, pen status string variable]

The returned X and Y values are the coordinate values of the cursor location in current units.

The optional third variable must be a string variable or substring and is assigned the character 0 or 1 depending on the pen's up or down status. If the pen is up, 0 is assigned to the string variable and if the pen is down, 1 is assigned to the string variable.

Remember, the plotting location and the cursor location are NOT the same thing. Although they may physically be the same, the plotting location of the pen and the cursor location are kept track of separately by the computer (refer to Chapter 5, Introduction).

On the 9872A, the actual pen location at the current time is returned to the variables. On incremental plotters, the position most recently set for the cursor (by POINTER or DIGITIZE) is returned.

Example:

```
10   ! THE FOLLOWING PROGRAM LINES DEMONSTRATE HOW TO FIND AND PRINT
20   ! THE CURSOR'S LOCATION AND PEN STATUS.
30   !
40   PLOTTER IS 7,5,"9872A"              ! SPECIFY 9872A AS PLOTTER.
50   PRINTER IS 0                        ! ACTIVATE THE SYSTEM 35 PRINTER.
60   LIMIT 10,210,10,150                 ! DEFINE THE PLOTTING AREA.
70   FRAME                               ! FRAME THE PLOTTING AREA.
80   !
90   POINTER 50,50                       ! SET THE CURSOR POINT FOR THIS EXAMPLE
100  !
110  !
120  CURSOR X,Y,A$                       ! INPUT CURSOR POSITION AND PEN STATUS.
130  PRINT X,Y,A$                        ! PRINT CURSOR POSITION AND PEN STATUS.
140  !
150  !
160  END
```

WHERE Statement

The WHERE statement returns the coordinate values in current units of the current logical pen position. If the pen is displaying the cursor location, WHERE will not return the physical pen position.

Syntax:

WHERE $X_{variable}$, $Y_{variable}$ [, pen status string variable]

The returned X and Y values are the coordinates of the pen position in current units. The WHERE statement is capable of returning coordinates that lie outside of the clipping area.

The optional third variable must be a string variable or substring and is assigned the character 0 or 1 depending on the pen's up or down status. If the pen is up, 0 is assigned to the string variable and if the pen is down, 1 is assigned to the string variable.

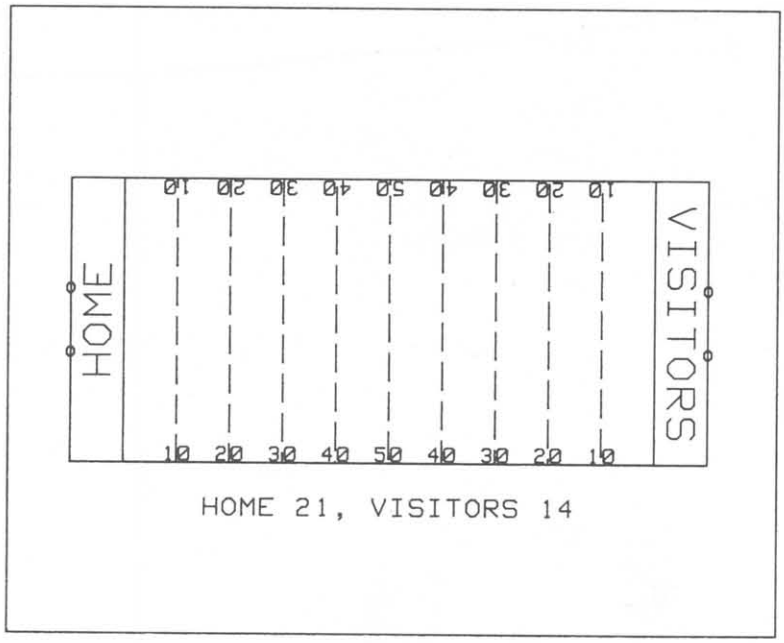
Example:

```
10   !
20   !
30   WHERE X,Y,A$                          ! RETURN THE COORDINATE OF THE
40                                         ! LAST LOGICAL PEN POSITION AND
                                             PEN STATUS.
50   !
60   PRINT X,Y,A$                          ! PRINT X,Y AND PEN STATUS.
70   !
80   !
90   ! DO NOT RUN THIS PROGRAM, THESE ARE ONLY EXAMPLE PROGRAM LINES.
```

Appendix A
Example Programs

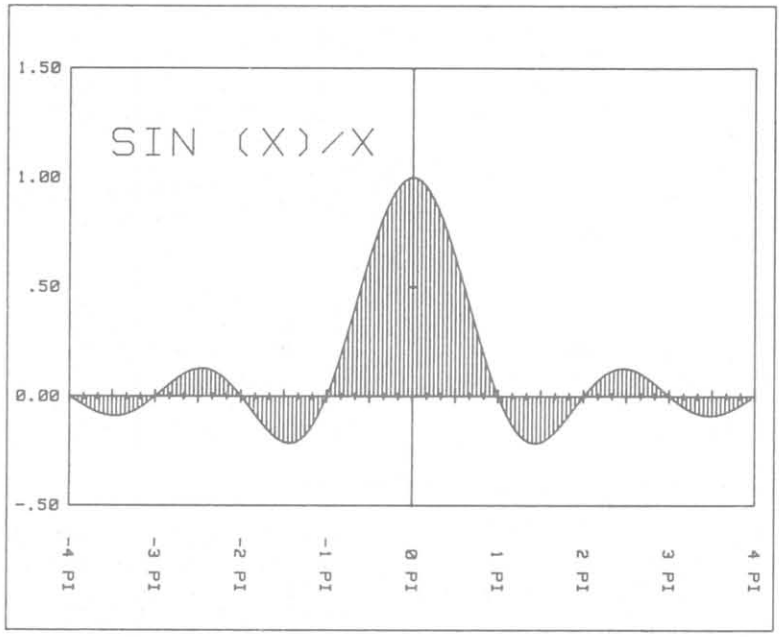
The example programs contained in this appendix demonstrate some applications of the System 35's plotting capability. You can experiment with them to become more familiar with the plotting procedures presented in this manual, or revise them to fit your own applications.

```
10   ! THIS PROGRAM DRAWS A FOOTBALL FIELD TO DEMONSTRATE SOME INTERESTING
20   ! CAPABILITIES AND PROGRAMMING TECHNIQUES.
30   !
40   PLOTTER IS 7,5,"9872A"              ! SPECIFY 9872A AS PLOTTER.
50   FRAME                               ! FRAME PLOTTING AREA.
60   LOCATE 10,112,10,90                 ! SPECIFY NEW PLOTTING AREA.
70   SHOW -60,60,-80/3,80/3              ! SPECIFY OVERALL SIZE.
80   DEG                                 ! SET DEGREES MODE.
90   !
100  ! ***** DRAW YARD LINES.
110  CLIP -40,40,-80/3,80/3              ! CLIP LENGHT OF YARD LINES.
120  LINE TYPE 3                         ! SPECIFY DASH LINE.
130  GRID 10,70,-40,-30                  ! DRAW YARD LINES.
140  !
150  ! ***** DRAW FIELD PERIMETER.
160  CLIP -50,50,-80/3,80/3              ! CLIP AT FIELD PERIMETER.
170  LINE TYPE 1                         ! SPECIFY SOLID LINE.
180  FRAME                               ! DRAW PERIMETER.
190  !
200  ! ***** DRAW END ZONES.
210  CLIP -60,60,-80/3,80/3              ! CLIP AT END ZONES.
220  FRAME                               ! DRAW PERIMETER AROUND END ZONES.
230  !
240  ! ***** DRAW GOALPOSTS.
250  CSIZE 3                             ! SPECIFY CHARACTER SIZE.
260  LORG 5                              ! CENTER LABELS.
270  LDIR 0                              ! LABEL LEFT TO RIGHT.
280  FOR Goal=-1 TO 1 STEP 2             ! SPECIFY ONE OF TWO GOALS.
290  FOR Post=-1 TO 1 STEP 2             ! SPECIFY ONE OF TWO POSTS.
300  MOVE Goal*60,Post*6                 ! MOVE TO GOALPOST POSITION.
310  LABEL USING "K";"O"                 ! DRAW GOALPOST.
320  NEXT Post                           ! DO IT AGAIN FOR OTHER POST.
330  NEXT Goal                           ! DO IT AGAIN FOR OTHER GOAL.
340  !
350  ! ***** LABEL YARD LINES.
360  CSIZE 4                             ! SPECIFY CHARACTER SIZE.
370  LORG 5                              ! CENTER LABELS.
380  FOR Side=-1 TO 1 STEP 2             ! SPECIFY ONE OF TWO FIELD SIDES.
390  FOR Yard=-40 TO 40 STEP 10          ! SPECIFY YARD LINE.
400  LDIR 90+90*SGN(Side)                ! INVERT LABEL DEPENDING ON SIDE.
410  MOVE Yard,Side*25                   ! MOVE TO YARD AND SIDE.
420  LABEL USING "DD";50-ABS(Yard)       ! LABEL YARD LINE.
430  NEXT Yard                           ! DO IT AGAIN FOR NEXT YARD LINE.
440  NEXT Side                           ! DO IT AGAIN FOR OTHER SIDE.
450  !
460  ! ***** LABEL END ZONES.
470  CSIZE 8                             ! SET CHARACTER SIZE.
480  LORG 5                              ! CENTER LABELS.
490  LDIR 90                             ! LABEL BOTTOM TO TOP.
500  MOVE -55,0                          ! MOVE TO LEFT END ZONE.
510  LABEL USING "K";"HOME"              ! LABEL END ZONE.
520  LDIR -90                            ! LABEL TOP TO BOTTOM.
530  MOVE 55,0                           ! MOVE TO RIGHT END ZONE.
540  LABEL USING "K";"VISITORS"          ! LABEL RIGHT END ZONE.
550  !
560  ! ***** LABEL SCORE
570  CSIZE 5                             ! SET CHARACTER SIZE.
580  LORG 5                              ! CENTER LABELS.
590  LDIR 0                              ! LABEL LEFT TO RIGHT.
600  MOVE 0,-35                          ! MOVE TO BOTTOM OF PLOTTING AREA.
610  LABEL USING "K";"HOME 21, VISITORS 14"    ! LABEL SCORE.
620  END
```

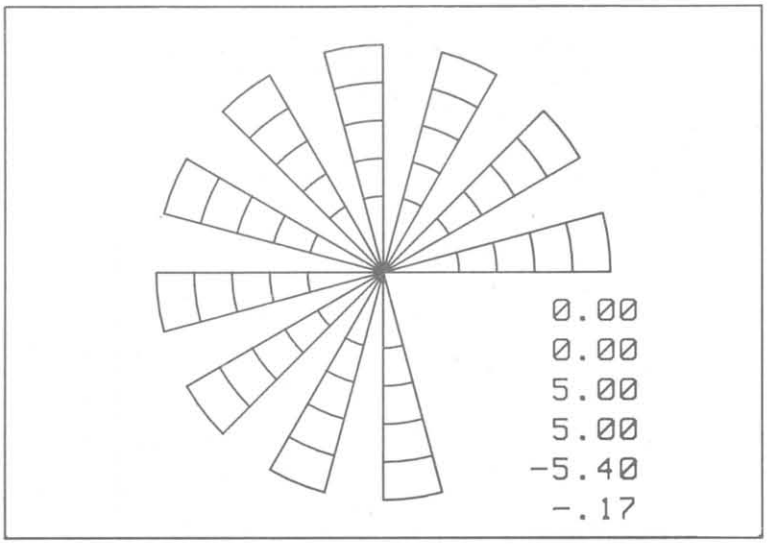

HOME
VISITORS
10 20 30 40 50 40 30 20 10
10 20 30 40 50 40 30 20 10
HOME 21, VISITORS 14

```
10   ! THIS PROGRAM PLOTS THE SINE(X)/X FROM -4PI TO +4PI TO DEMONSTRATE
20   ! CAPABILITIES AND PROGRAMMING TECHNIQUES.
30   ! THE PROGRAM WILL STOP AND WAIT FOR YOU TO MOVE THE CURSOR TO DIGITIZE
40   ! A POINT, AND THEN PRINT THE "X" AND "Y" VALUES.
50   !
60   PLOTTER IS 7,5,"9872A"                ! SPECIFY 9872A AS PLOTTER.
70   LIMIT 10,210,10,150                   ! DEFINE THE PLOTTING AREA.
80   FRAME                                 ! FRAME PLOTTING AREA.
90   PRINTER IS 0                          ! SPECIFY INTERNAL PRINTER.
100  RAD                                   ! SET RADIANS MODE.
110  LOCATE 15,125,15,85                   ! SPECIFY GRAPH BOUNDARIES.
120  !
130  ! ***** SPECIFY MAXIMUM AND MINIMUM VALUES FOR USER UNITS.
140  Xmin=-4*PI
150  Xmax=4*PI
160  Ymin=-.5
170  Ymax=1.5
180  !
190  ! ***** SPECIFY USER UNITS, DRAW AXES AND FRAME GRAPH.
200  SCALE Xmin,Xmax,Ymin,Ymax             ! SPECIFY USER UNITS.
210  AXES PI/6,.5,0,0,3,10                 ! DRAW AXES.
220  FRAME                                 ! FRAME PLOTTING AREA.
230  !
240  ! ***** LABEL AXES, USING SUBROUTINES.
250  GOSUB Lxaxis                          ! LABEL X AXIS.
260  GOSUB Lyaxis                          ! LABEL Y AXIS.
270  !
280  ! ***** PLOT FUNCTION WITH FILL TO BASE LINE.
290  FOR X=Xmin TO Xmax STEP PI/20
300  IF X=Xmin THEN MOVE X,SIN(X)/X        ! MOVE TO START IF X=Xmin.
310  IF X=0 THEN 350                       ! AVOID DIVIDING BY ZERO.
320  DRAW X,SIN(X)/X                       ! DRAW TO NEXT POINT ON CURVE.
330  MOVE X,0                              ! MOVE TO BASE LINE.
340  DRAW X,SIN(X)/X                       ! DRAW BACK TO CURVE FOR FILL.
350  NEXT X                                ! NEXT POINT ON CURVE.
360  !
370  ! ***** MOVE AND LABEL PLOT
380  MOVE -3.5*PI,1.1                      ! MOVE TO START OF LABEL.
390  LORG 1                                ! SPECIFY LABEL ORIGIN.
400  CSIZE 8                               ! SPECIFY CHARACTER SIZE.
410  LABEL USING "K";"SIN (X)/X"           ! LABEL PLOT.
420  CSIZE 3                               ! RESET CHAR SIZE FOR DIGITIZE.
430  POINTER -2*PI,.5,0                    ! PUT POINTER AT 0,0 AS SMALL CROSS.
440  !
450  ! ***** THIS ALLOWS YOU TO DIGITIZE AND PRINT POINTS
460 Loop: !
470  DIGITIZE X,Y                          ! WAIT FOR CONTINUE THEN INPUT X AND Y
480                                        ! & PRINT X AND Y ON SPECIFIED PRINTER.
490  PRINT USING "2(K,XMD.2D),2/";"X=",X/PI," PI,     Y=",Y
500  GOTO Loop                             ! DO IT AGAIN, FOREVER.
510  END
520  !
530  !
540  ! ***** LABEL AXES ROUTINES.
550 Lxaxis: !
```

```
560  CSIZE 3                                  ! SPECIFY CHARACTER SIZE.
570  LDIR -(PI/2)                             ! SPECIFY LABEL DIRECTION, DOWN.
580  LORG 2                                   ! SPECIFY LABEL ORIGIN.
590  FOR X1=Xmin TO Xmax STEP PI
600  MOVE X1,Ymin                             ! MOVE TO LABEL POSITION.
610  LABEL USING "M4DX,K";X1/PI,"PI"          ! DRAW LABEL.
620  NEXT X1                                  ! DO IT AGAIN, UNTIL COMPLETE.
630  RETURN
640  !
650 Lyaxis: !
660  CSIZE 3                                  ! SPECIFY CHARACTER SIZE.
670  LDIR 0                                   ! SPECIFY LABEL DIRECTION, L TO R.
680  LORG 8                                   ! SPECIFY LABEL ORIGIN.
690  FOR Y1=Ymin TO Ymax STEP .5
700  MOVE Xmin,Y1                             ! MOVE TO LABEL POSITION.
710  LABEL USING "MD.DDX";Y1                  ! DRAW LABEL.
720  NEXT Y1                                  ! DO IT AGAIN, UNTIL COMPLETE.
730  RETURN
```



```
10   ! *** THIS PROGRAM DEMONSTRATES THE USE OF DIGITIZE  ***
20   !     AND CURSOR STATEMENTS TO RETURN AND PRINT
30   !     COORDINATE DATA. ALSO, ADDITIONAL TRIG FUNCTIONS
40   !     ARE DEMONSTRATED.
50   !
60   PLOTTER IS 7,5,"9872A"          !SELECT AND ACTIVATE PLOTTER.
70   LIMIT 10,210,10,150             ! DEFINE THE HARD CLIP LIMITS.
80   FRAME                           ! BOX-IN THE HARD CLIP LIMITS.
90   SCALE -10,10,-7,7               ! ESTABLISH USER DEFINED UNITS.
100  !
110                                  ! DRAW A WINDMILL:
120  PLOT 0,0                        ! PLOT TO THE CENTER OF THE BOX, SET
130  Radius=6                        ! THE DEGREE MODE, AND ESTABLISH AN
140  DEG                             ! INITIAL RADIUS.
150  FOR Section=0 TO 270 STEP 30    ! DRAW THE BLADES: DEFINE 3/4 OF
                                       THE CIRCUMFERENCE FOR THE BLADES.
160  FOR Degree=Section TO Section+15 STEP 5    ! DEFINE BLADE WIDTH (15 Deg's).
170  PLOT Radius*COS(Degree),Radius*SIN(Degree) ! DRAW THE BLADES BY PLOTTING
                                                   FROM ORIGIN TO CIRCUMFERENCE.
180  NEXT Degree                     ! GO ON TO THE NEXT Degree.
190  PLOT 0,0
200  NEXT Section                    ! GO ON TO THE NEXT Section.
210  !
220  !
230                                  ! DRAW ADDITIONAL RADII:
240  FOR Radius=5 TO 2 STEP -1       ! DEFINE THE NUMBER OF RADII TO BE
250  FOR Section=0 TO 270 STEP 30    ! DRAWN THROUGH 3/4 OF THE CIRCLE.
260  MOVE Radius*COS(Degree),Radius*SIN(Degree)  ! MOVE TO THE PROPER
                                                   LOCATION ON THE BLADES.
270  FOR Degree=Section TO Section+15 STEP 5     ! CONFINE PLOTTING WITHIN
                                                   THE BLADE WIDTH.
280  PLOT Radius*COS(Degree),Radius*SIN(Degree)  ! DRAW THE RADII.
290  !
300  NEXT Degree                     ! GO ON TO THE NEXT Degree.
310  NEXT Section                    ! GO ON TO THE NEXT Section.
320  NEXT Radius                     ! GO ON TO THE NEXT Radius.
330  !
340  !
350  MOVE 0,0                        ! USING THE ORIGIN OF THE CIRCLE
360  WHERE A(1),A(2)                 ! AS THE PEN POSITION, RETURN
370  !                               ! ITS COORDINATES VIA WHERE STATEMENT
                                       TO A(1) AND A(2).
380  POINTER 5,5                     ! MOVE CURSOR TO NEW LOCATION (HERE,5,5)
                                       AND RETURN ITS COORDINATES VIA A
390  CURSOR A(3),A(4)                ! CURSOR STATEMENT TO A(3) AND A(4).
400  !
410  DIGITIZE A(5),A(6)              ! MOVE THE PEN ARM TO ANY POINT (HERE,
                                       -5.4,-.17), AND PRESS "ENTER".
420  !                               THE COORDINATES ARE RETURNED TO
                                       A(5) AND A(6).
430  !
440                                  ! DRAW THE RETURNED VALUES:
450  MOVE 5,-1                       ! POSITION THE PEN IN THE
460  LORG 5                          ! UNMARKED QUADRANT OF THE CIRCLE AND
470  CSIZE 7                         ! ESTABLISH CHARACTER SIZE AND ORIGIN.
480  FOR Element=1 TO 6              ! DEFINE THE VALUES TO BE DRAWN.
490  LABEL USING "3D.DD";A(Element)  ! DRAW THE VALUES ON THE PLOTTING AREA.
500  NEXT Element                    ! GO ON TO THE NEXT VALUE.
510  PEN 0                           ! RETURN THE PEN TO ITS STALL.
520  END
```


0.00
0.00
5.00
5.00
-5.40
-.17

Appendix B
Reflected Plots

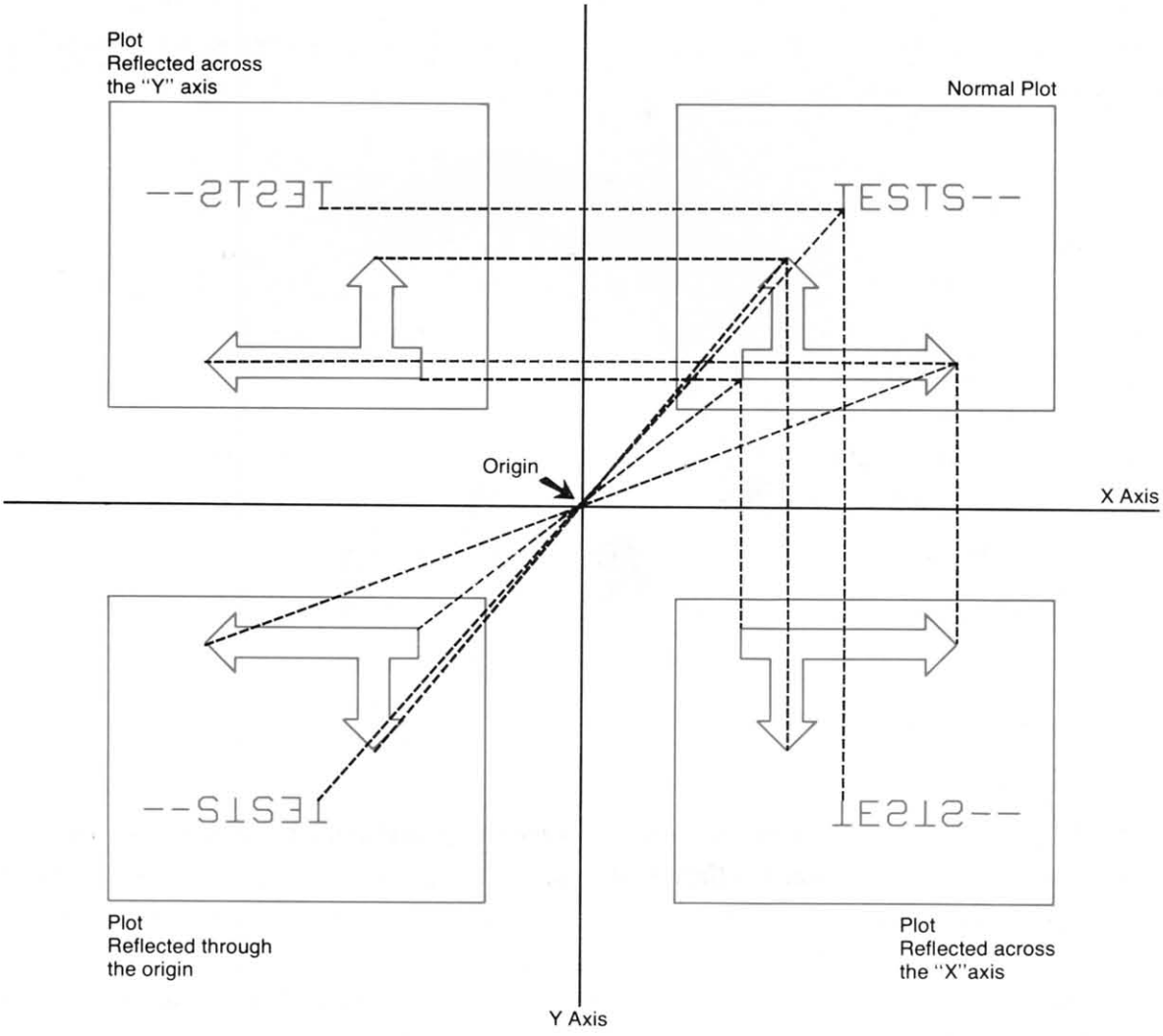
Reflected plots are those that appear to be upside down, backwards, or mirror images of what would be considered a normal plot. Sometimes it is desirable to produce a reflected plot, such as when you want to draw on the back side of clear plastic to produce a correct reading image when read from the front.

To produce reflected plots, exchange one or more sets of parameters in one or more of the following plotter statements.

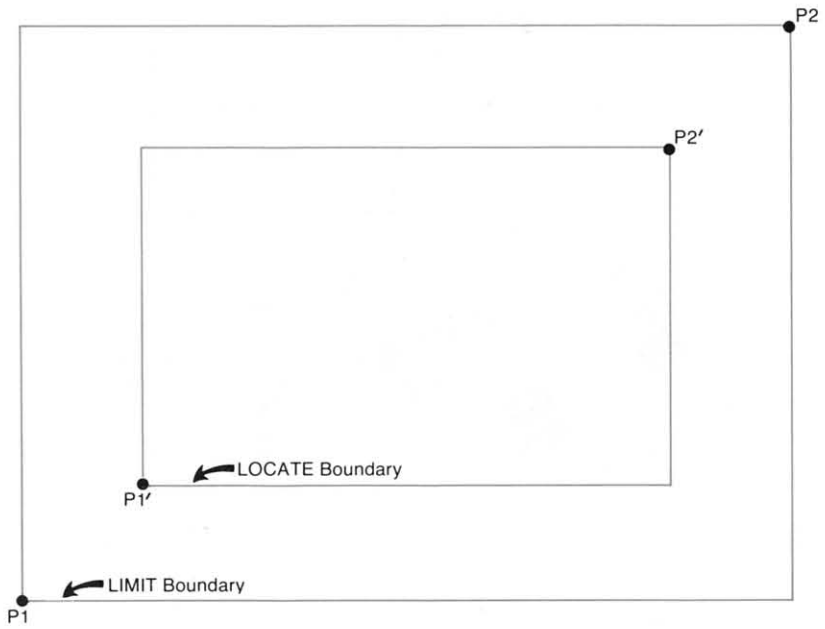
- LIMIT
- LOCATE
- SCALE
- SHOW

When two or more of the above statements are used in a program the net reflected result is the combination of each statement's effect on the plot.

The following illustrations show the three types of reflected plots:



Exchanging various parameters of the clipping and scaling statements will produce a number of reflected plot results. As the diagram below indicates, P1 and P2 are the scaling calibration points set by the LIMIT statement and P1′ and P2′ are the scaling points set by the LOCATE statement (these default to P1 and P2 in the absence of a LOCATE statement). Exchanging parameters alters the location of these points, and therefore, the plotted results.



Whether a plot, or label, or both are reflected depends upon which parameters are exchanged. In general, exchanging the hard clip parameters will alter plots and labels within the hard clip limits and altering the soft clip parameters will alter only those plots within the soft clip limits.

It should be noted that the LIMIT statement can be used to reflect BOTH plots and labels, but altering LOCATE parameters will reflect only plots.

Appendix C
External Plotter Installation

Introduction

Hewlett-Packard and several other manufacturers have external plotters that can be connected to the System 35. The following information will aid in connecting the HP 9872A Plotter and some of the other manufacturers' incremental plotters to the computer.

9872A Plotter Installation

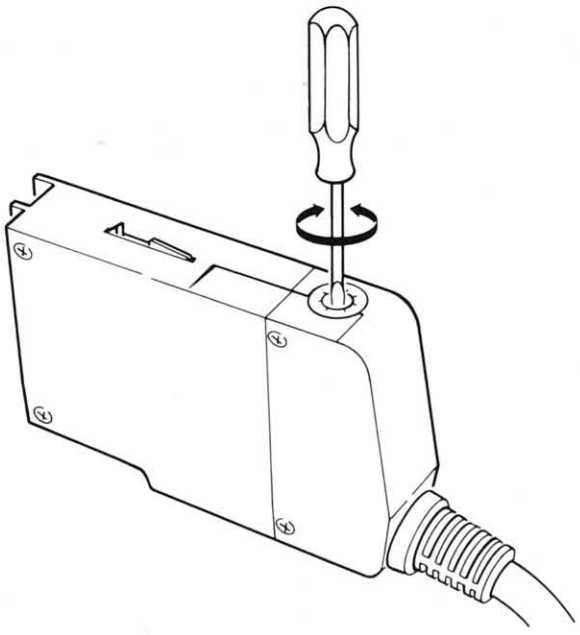
The 9872A Plotter can be used as an external plotter with the System 35. Refer to the PLOTTER IS statement for information on how to select the 9872A as the active plotter.

Insure that the interface select code switch and plotter address code switches are set to the proper positions as indicated below.

Interface Select Code

The 9872A Plotter is connected to the System 35 via an HP 98034A HP-IB Interface. Refer to the HP 98034A HP-IB Interface Installation and Service Manual for complete information about the interface and cables(P/N 98034-90000).

The interface is preset to a select code of 7 at the factory. To change the setting, rotate the switch (shown below) using a small screwdriver.



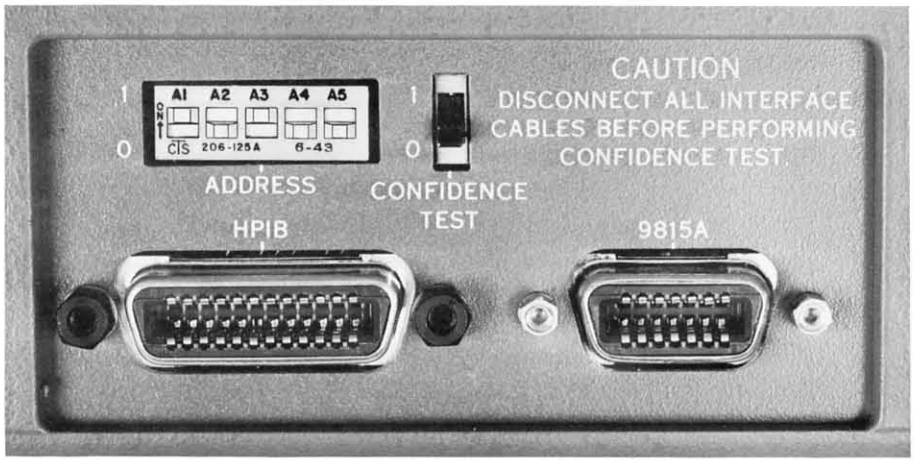
Select Code Switch

Plotter Address Code

Since each HP-IB interface can have as many as 14 devices connected to it, each device must be set to a specific address code.

The plotter can be set to any one of 31 HP-IB addresses ranging from 0 thru 30. Each address can be selected by setting the switches on the plotter back panel (shown below) to the appropriate binary bit positions for the particular address value desired.

The plotter is set to an address code of 5 at the factory. Check your plotter for the proper switch positions.



Plotter Address Switches

The following table lists the switch positions for each address value:

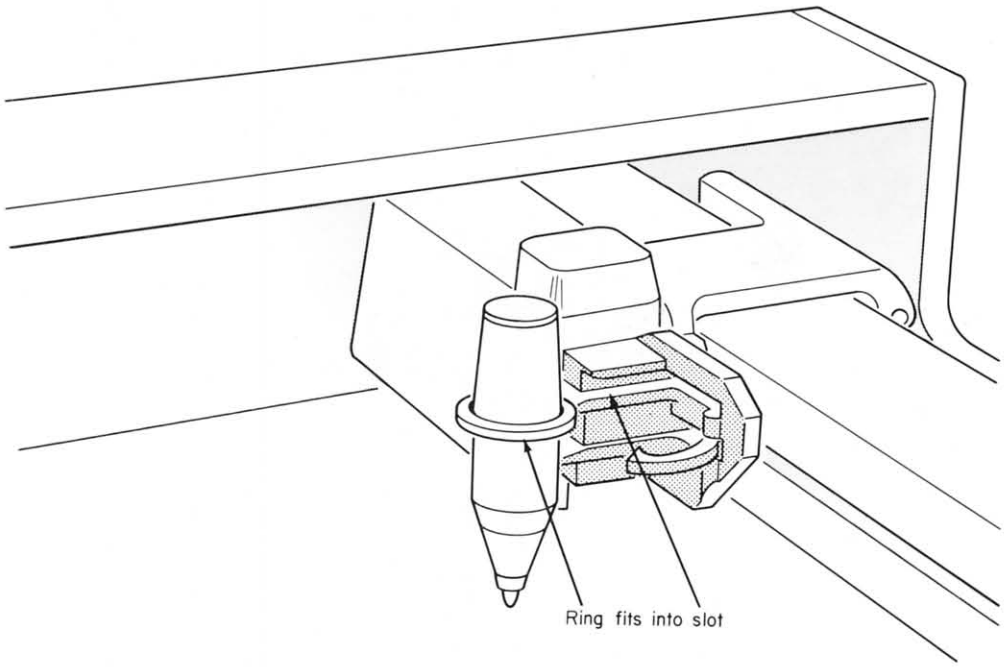
Address Switch Positions

Address Characters		Address Switch Settings					Address Codes	
Listen	Talk	(5)	(4)	(3)	(2)	(1)	decimal	octal
SP	@	0	0	0	0	0	0	0
!	A	0	0	0	0	1	1	1
"	B	0	0	0	1	0	2	2
#	C	0	0	0	1	1	3	3
$	D	0	0	1	0	0	4	4
%	E	0	0	1	0	1	5	5← preset
&	F	0	0	1	1	0	6	6
'	G	0	0	1	1	1	7	7
(	H	0	1	0	0	0	8	10
)	I	0	1	0	0	1	9	11
*	J	0	1	0	1	0	10	12
+	K	0	1	0	1	1	11	13
,	L	0	1	1	0	0	12	14
-	M	0	1	1	0	1	13	15
.	N	0	1	1	1	0	14	16
/	O	0	1	1	1	1	15	17
0	P	1	0	0	0	0	16	20
1	Q	1	0	0	0	1	17	21
2	R	1	0	0	1	0	18	22
3	S	1	0	0	1	1	19	23
4	T	1	0	1	0	0	20	24
5	U	1	0	1	0	1	21	25
6	V	1	0	1	1	0	22	26
7	W	1	0	1	1	1	23	27
8	X	1	1	0	0	0	24	30
9	Y	1	1	0	0	1	25	31
:	Z	1	1	0	1	0	26	32
;	[	1	1	0	1	1	27	33
<	\	1	1	1	0	0	28	34
=	]	1	1	1	0	1	29	35
>	^	1	1	1	1	0	30	36

9872A Loading Instructions

Loading Pens

Switch the plotter power switch on. After the plotter's initialization process is complete and the plotter arm has stopped moving, you can install the pens.



Installing The Pens

Select the color of pen that you want in pen storage location 1. Remove the cap and place it in the pen stall as shown in the picture above. Note that the thick ring around the middle of the pen fits into the slot in the pen stall. Now press [ENTER] and pen location button [1]. The plotter arm will put the pen in the first storage location. Repeat this procedure with three more pens, substituting the appropriate pen location button for each one.

Loading Paper

To load paper, first press [CHART LOAD]. This releases the paper hold-down mechanism and moves the plotter arm to the upper right corner of the platen. Lay a sheet of paper on the platen surface and smooth it out. Make sure that the paper is positioned squarely against the ridge at the bottom of the platen. Press [CHART HOLD].

Incremental Plotter Installation

An incremental plotter can be used as an external plotter with the System 35 using the 98040A Interface. Refer to the PLOTTER IS statement for information on how to select the incremental plotter as the plotting device.

Insure that the interface select code switch is set to the proper position.

Refer to the 98040A Interface Installation and Service Manual (P/N 98040-90000) for information concerning the select code switch and a list of incremental plotters that can be used with this interface.

Appendix D
Syntax Summary

AXES [$X_{tic\ spacing}$, $Y_{tic\ spacing}$ [, $X_{intersection}$, $Y_{intersection}$ [, $X_{major\ count}$, $Y_{major\ count}$ [, major-tic size]]]]

The AXES statement draws a pair of axes with optional (linearly spaced) tic-marks.

CLIP [X_{min} , X_{max} , Y_{min} , Y_{max}]

The CLIP statement defines the soft clip limits. Omitting the parameters allows any two diagonal corners to be digitized.

CSIZE height [, aspect ratio]

The CSIZE (character size) statement is used to specify the size and aspect ratio of characters used in labels. The height defaults to approximately 3.3 GDU's (15/4.54). The aspect ratio (width/height) defaults to 9/15.

CURSOR $X_{variable}$, $Y_{variable}$ [, pen status string variable]

The CURSOR statement returns the values of the cursor coordinate to the specified variables. Pen status is assigned to the string variable; 0 for up, 1 for down.

DIGITIZE $X_{variable}$, $Y_{variable}$ [, pen status string variable]

The DIGITIZE statement pauses program execution and allows you to reposition the cursor; after two points are digitized, execution is resumed automatically. The coordinate of the cursor is assigned to the specified variables. Pen status is assigned to the string variable; 0 for up, 1 for down.

DRAW $X_{parameter}$, $Y_{parameter}$

The DRAW statement drops the pen and moves it to the absolute X,Y coordinate.

FRAME

The FRAME statement draws a box around the current clipping area.

GCLEAR [paper advance]

The GCLEAR statement clears any previously plotted data. On the HP 9872A Plotter, this statement is ignored. On plotters with roll-paper, this statement would advance the paper.

GRID [$X_{tic\ spacing}$, $Y_{tic\ spacing}$ [, $X_{intersection}$, $Y_{intersection}$ [, $X_{major\ count}$, $Y_{major\ count}$ [, minor tic size]]]]

The GRID statement can be used as an alternative to the AXES statement and is used to draw a full screen grid.

IPLOT $X_{increment}$, $Y_{increment}$ [, pen control]

The IPLOT statement allows incremental plotting from the last plotted point. The pen control is the same as for the PLOT statement.

LABEL list

The LABEL statement is used like the PRINT statement to draw labels on the plotter.

LABEL USING image specifier; list

The LABEL USING statement is used like the PRINT USING statement to draw formatted labels on the plotter.

LETTER

The LETTER statement allows you to draw all keyboard alphanumerics and symbols by typing them in on the keyboard.

LDIR angle

The LDIR statement specifies the angle at which subsequent labels will be drawn. The angle specifies counter-clockwise rotation of the label from the positive X-axis in current angular units.

LIMIT [X_{min}, X_{max}, Y_{min}, Y_{max}]

The LIMIT statement defines the hard clip limits (or plotting area). The units are expressed in millimetres with the origin at the lower left physical limit. When the parameters aren't included, any two diagonal corner points can be digitized.

LINE TYPE ID number [, length]

The LINE TYPE statement selects one of several solid or dashed line types. The range of the ID number is 1 through 10; 1 is the default length.

LOCATE [X_{min}, X_{max}, Y_{min}, Y_{max}]

The LOCATE statement sets the area that SHOW will fill or SCALE will map. The units are expressed in **GDU's**. Any two diagonal corner points can be digitized if the parameters are not included. LOCATE also invokes soft clipping at its boundaries.

LORG origin position

The LORG (label origin) statement sets the label origin position which determines where any subsequent labels are drawn relative to the current pen location. The range of the origin position is 1 through 9.

MOVE $X_{parameter}$, $Y_{parameter}$

The MOVE statement lifts the pen and moves it to the absolute X,Y coordinate.

MSCALE X_{offset}, Y_{offset}

The MSCALE statement sets millimetres as current user units and defines the origin. The origin is offset from the minimum hard clip corner by the specified amount in millimetres.

PDIR angle

The PDIR statement sets the angle of rotation for relative and incremental plotting. The angle parameter specifies a counter-clockwise rotation from the positive X-axis in current angular units.

PEN pen number

The PEN statement specifies the pen to be used. PEN 0 (zero) specifies return all pens to their holders on the 9872A.

PENUP

The PENUP statement lifts the pen off the plotter paper.

PLOT $X_{parameter}$, $Y_{parameter}$ [, pen control]

The PLOT statement provides absolute data plotting and pen control. The pen control defaults to plus one. The pen control parameter is interpreted as follows:

Odd = drop pen
Even = lift pen
Positive = pen change after motion
Negative = pen change before motion

PLOTTER IS [select code [, HP-IB device address],] "plotter ID string" [, step size [, # of pens, pen offset, incremental plotter ID]]

The PLOTTER IS statement defines where all plotter operations will be directed. The two plotter ID strings and their default select codes are:

"9872A" 7,5
"INCREMENTAL" 5

The default values for the INCREMENTAL parameters are:

Parameter	Default value
step size	.254 mm (.01 inch)
# of pens	1
pen offset	0 mm
incremental plotter ID	1

PLOTTER select code [, HP-IB device address] IS OFF

The PLOTTER... IS OFF statement deactivates the plotter set to the specified select code. All plotting statements are executed but the specified plotter does not respond.

PLOTTER select code [, HP-IB device address] IS ON

The PLOTTER...IS ON statement activates the specified plotting device and deactivates all others. That is, all plotting statements are directed only to the specified device. This statement **does not** set the default conditions described under the PLOTTER IS statement.

POINTER $X_{parameter}$, $Y_{parameter}$

The POINTER statement moves the cursor to the specified absolute position.

RATIO

The RATIO function returns a value equal to the ratio of the physical dimension of the hard clip limits, that is, the X dimension divided by the Y dimension.

RPLOT $X_{parameter}$, $Y_{parameter}$ [, pen control]

The RPLOT statement allows relative plotting from the last absolute plotted point which is used as the origin. The pen control is the same as for the PLOT statement.

SCALE X_{min}, X_{max}, Y_{min}, Y_{max}

The SCALE statement sets User Defined Units which are mapped onto the LOCATE plotting area.

SETGU

The SETGU statement sets Graphic Display Units (GDU's) as the current units.

SETUU

The SETUU statement sets User Defined Units (UDU's) as the current units.

SHOW X_{min}, X_{max}, Y_{min}, Y_{max}

The SHOW statement defines an area that is stretched or shrunk equally in X,Y directions to fit within the boundaries defined by the LOCATE statement.

UNCLIP

The UNCLIP statement sets the soft clip limits equal to the hard clip limits.

WHERE $X_{variable}$, $Y_{variable}$ [, pen status string variable]

The WHERE statement returns the coordinate values of the current logical pen position. Pen status information is assigned to the string variable; 0 for up, 1 for down.

Appendix E
Plotter ROM Error Messages

ERROR	Description
110	Plotter type specification not recognized.
111	PLOTTER IS statement missing.
113	LIMIT specifications out of range.

Appendix F
Parallel and Serial Polling

Parallel and serial polling refer to the retrieving of status information from HP-IB peripheral devices that are connected to the System 35 Desktop Computer. Parallel polling will indicate whether status information is available from a pheripheral and serial polling will determine what that status is. Polling commands may be entered on the keyboard or included within a program.

This appendix contains general information on polling. Refer to the System 35 I/O ROM Programming Manual (Part No. 09835-90060) for detailed information.

NOTE

The I/O ROM must be installed in the computer in order to perform polling operations.

Masking Syntax

The mask command is used to define the status which is output by parallel and serial polling. The following syntax is used:

```
OUTPUT select code; "IM [E-mask[, S-mask[, P-mask]]]"
```

The three mask parameters allow you to specify the conditions under which an error message, require service message, and parallel poll response will occur.

E-Mask

specifies the decimal equivalent of the bit values of the plotter error numbers that will set the error bit (bit 5) of the plotter status byte and turn on the error light on the plotter front panel.

E-Mask Bit Value	Error Number	Meaning
1	1	Instruction not recognized
2	2	Wrong number of parameters
4	3	Bad parameters received
8	4	Illegal character
16	5	Unknown character set
32	6	Position overflow
64	7	Not used
128	8	Not used

For example an E-mask value 252 (4 + 8 + 16 + 32 + 64 + 128) will specify that error numbers 3 through 8 can set the error bit in the status byte and turn on the error light whenever they occur. Errors 1 and 2, however, will not set the error bit or turn on the error light if they occur since they are not included in the E-mask value.

S-Mask

The S-mask value specifies the status-byte conditions that can send the require service message by setting interface line SRQ to a logical 1.

The S-mask is the decimal equivalent of the bit values of the selected status-byte bits.

S-Mask Bit Values	Status Bit	Meaning
1	0	Pen down
2	1	P1 or P2 changed from default; cleared on "OP"
4	2	Digitized point available; cleared on "OD" or DIGITIZE
8	3	Initialized; cleared on "OS"
16	4	Ready for data
32	5	Error; cleared on "OS"
	6	Require service sent (SRQ)
	7	Not used

Only combinations of the first 6 bits can be specified to send the require service message. Bit 6 is used to specify whether or not the plotter has sent the require service message or not and bit 7 is not used (always set to logical 0).

For example, an S-mask value of 16 specifies that the ready for data bit (bit 4) of the status byte will send the require service message. The other 5 bits (bits 0 through 3 and bit 5) will not send the require message.

P-Mask

The P-mask value specifies which of the status-byte conditions will result in a logical 1 response to a parallel poll.

P-Mask Bit Value	Status Bit Number	Meaning
1	0	Pendown
2	1	P1 or P2 changed
4	2	Digitized point available
8	3	Initialized
16	4	Ready for data
32	5	Error
	6	Require service sent (SRQ)
	7	Not used

For example, a P-mask value of 48 specifies that only bits 4 and 5 (16 + 32) of the status byte can cause the plotter to respond to a parallel poll with a logical 1 on the appropriate data line.

Parallel Polling

Parallel polling will indicate which peripheral device(s) has status information available. To retrieve parallel poll information, execute the following:

```
PPOLL (select code)
```

All devices set to the specified select code will respond to the parallel poll if they have status information available. The 9872A Plotter will respond by sending a logical 1 on one of 8 data lines. The line used is determined by the plotter's address value as shown in the following table:

Plotter Address	Parallel Poll Bit Position	HP-IB Data Line Number	Value Returned
0	7	8	128
1	6	7	64
2	5	6	32
3	4	5	16
4	3	4	8
5	2	3	4
6	1	2	2
7	0	1	1

The address settings from 8 through 30 will not respond to a parallel poll.

For example, assume that a 9872A Plotter is set to device address 5 and select code 7. To perform a parallel poll, execute the following:

```
PPOLL (7)
```

The result would be a displayed value of 4. This would indicate that bit position 2, or plotter address 5 (the 9872A Plotter) is responding. If the value displayed were 6, this would indicate that another peripheral device set to address 6 is also responding.

Serial Polling

If a peripheral device responds to a parallel poll, its complete status can be obtained by a serial poll. The serial poll command syntax is:

STATUS select code-device address; variable

where the status byte is returned to the variable specified

The 9872A responds to a serial poll by sending the following status byte:

Bit Value	Bit Position	Bit Meaning
1	0	Pen down
2	1	P1 or P2 changed
4	2	Digitized point available
8	3	Initialized
16	4	Ready for data
32	5	Error
64	6	Require service message sent
0	7	Not used (always set to 0)

For example, assume that a 9872A Plotter (select code 7, address 5) responded to a parallel poll. To determine its complete status, the following command might be executed:

```
STATUS 705; A
```

where 7 is the select code, (0)5 is the device address, and A is the variable to which the status byte is returned. If A were found to contain the bit value 32, this would indicate that an error condition exists. The nature of the error would have been determined by the value to which the E-mask had been set. If the variable A contained the value 18, this would indicate that the plotter is ready to accept data (bit value 16) and that P1 or P2 had changed (bit value 2).

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