Graphics ROM Programming

HP System 45B Desktop Computer

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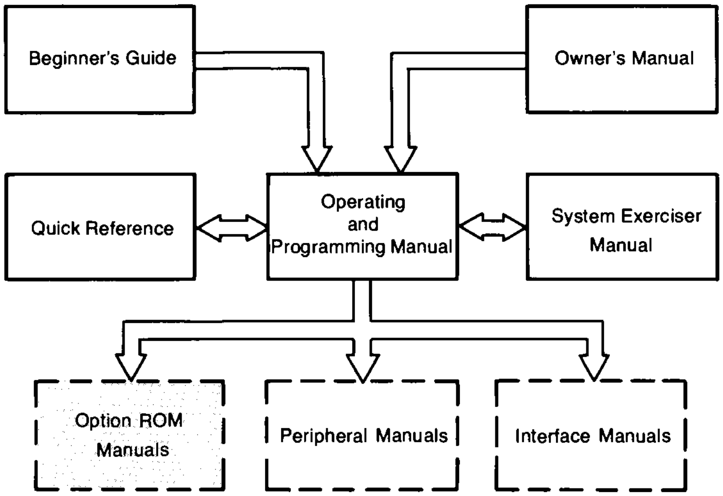
Manual Map


Beginner's Guide
Owner's Manual
Quick Reference
Operating and Programming Manual
System Exerciser Manual
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General Information

Overview

Your HP System 45B Graphics ROM provides CRT graphic solutions and/or hard copy illustrations of problems solved by the computer. In addition, graphics provides other valuable capabilities such as labeling plots, axes, tick marks on the axes, and digitizing from a plot or graphic display.

Before attempting to use your System 45B and this manual, you should be familiar with the basic operation of your System 45B. Refer to your System 45B Operating and Programming manual if you need this information.

Information contained in this manual is specifically directed to the CRT as the graphics display device. Most information contained in this manual is applicable to other external display or plotting units, such as the HP 9872A Plotter. Some of the more common differences between a graphics statement's effect on the CRT versus the 9872A plotter are mentioned in the discussion concerning the statement.

The simulated CRT graphic drawings used to produce this manual were actually drawn on the HP 9872A Plotter. Therefore, the simulations in this manual may appear slightly different from the results you obtain on the CRT.

Chapter 1

For the Beginning Graphics Programmer

Graphics is the solution to a problem which is provided by means of graphs or diagrams rather than by a printed list of numbers.

Example programs are provided throughout this manual to give you some hands-on experience and to enhance the explanation of various statements. Each of the forty-one graphics statements for your System 45B is explained at its appropriate place in this manual.

By the end of this manual, you should be able to plot, label and digitize the various solutions to the problems and equations in your programs.

For the Advanced Graphics Programmer

If you have programming experience using graphics, you can either use the summary pages at the beginning of each chapter or you may go directly to the tear-out reference card in the back of this manual.

Plotting Space

Plotting devices have physically-imposed **hard clip** limits which restrict pen movement (e.g., CRT screen size and plotter platen size). Default hard clip limits and the resulting plotting area size depend upon which plotting device is being used. As seen later, hard clip limits can be made smaller under program control (e.g., to fit a piece of paper), or on some plotters, manually. Whether this area is the default or has been set to a specified size, it is still referred to as the area within the hard clip limits.

Another set of limits that further restrict pen movement is the soft clip limits. Soft clip limits are defaulted to hard clip limits, but can be altered under program control. **Soft clip** limits restrict pen movement when the User Defined Units (**UDU**) mode is set and not when the Graphic Display Units (**GDU**) mode is set. As seen later, this capability is very useful, since you may wish to label outside of the plotting area.

Unit-of-Measure Modes

Your System 45B allows you to define or declare dimensions for its X,Y coordinate system. This allows you to access an X,Y coordinate by using your coordinate system, even though your System 45B is converting and computing your coordinate system onto its coordinate system.

There are three unit-of-measure modes that can be selected under program control: **Graphic Display Units** (GDU), **User Defined Units** (UDU), and **Metric Units**.

One **GDU** is defined as being one percent of the length of the shortest side of the space bounded by the current hard-clip limits. Thus, the short side is 100 GDU's long and the length of the long side is 100 times the ratio of the long to short dimensions. This unit mode allows plotter space access on a percent of full scale basis.

UDUs are the units defined by your application. Statements which operate in the UDU mode can have values for the parameters directly in user units. Several statements are provided to allow you to define the units of measure for a particular application.

The unit of measure in the **Metric Unit** mode is the millimetre. This mode is implemented as a special case of UDUs, such that plotting statements executed in this mode 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 such as the CRT and the thermal printer, metric units are only approximate.

The term **current units** refers to the last unit of measure mode that was set.

Most of the statements explained in this manual interpret their parameters according to the last unit-of-measure mode set (or current units); other statements interpret their parameters in one of the three modes (GDU, UDU or Metric).

Line Generation

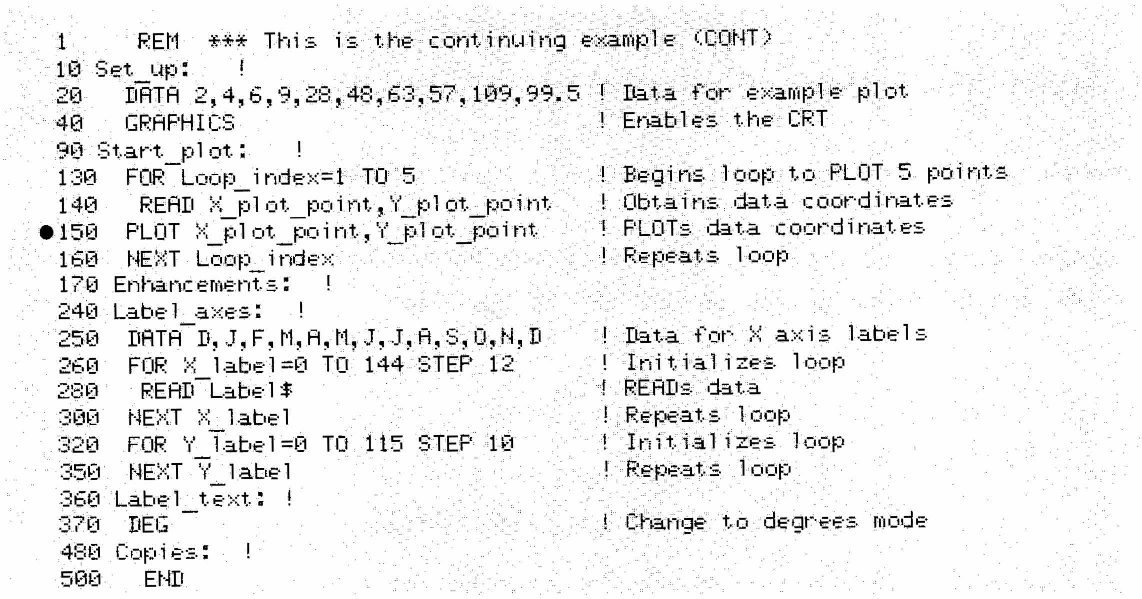
Line Generation refers to the process of producing a line on the CRT, which is similar to drawing a line with a pen on an external plotter. Unlike the external plotter, the CRT has no actual pen. The CRT does have a point referred to as "the pen", which when moved, produces a line if line generation is turned on (pen down). If line generation is turned off (pen up) no line is produced, but the point moves.

About the Examples

While all of the graphics statements in this manual are keyboard executable, perhaps the best way to familiarize yourself with the statements is to use the example programs. For your convenience, there are two types of examples which appear throughout the manual.

The first type of example is a "continuing example". This example "grows" as each programming syntax is explained. The continuing example is used with most programming statements. It allows you to develop a complex graphics program by first typing in the initial program lines, and then adding each statement as it is explained. This provides you with a unified approach to each statement, as the effects of each statement can be seen as it is executed.

This "continuing example" is shown next. You should notice that there are gaps in the sequence of the line numbers. These gaps are intentional. Their function is to allow you to use the continuing example with a minimal amount of inconvenience in typing the program.



```
 1     REM  *** This is the continuing example (CONT)
 10 Set_up:   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 40   GRAPHICS                          ! Enables the CRT
 90 Start_plot:   !
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
●150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 480 Copies:  !
 500   END
```

Any syntax statements which consistently occur in the example, end with a zero as the last digit (such as 10, 20, 30). If a syntax statement appears which is not consistently used in the continuing example, its last digit is a five (as in 25, 35, 45). This way, line numbers which end in a five can be deleted as soon as possible after you have run the program. The line numbers ending in zero should be retained. This way you never have to type more than one or two additional program lines to the continuing example.

Not all of the statements immediately affect the plot in the continuing example. Therefore, a second type of example is used to demonstrate the explained syntax in a specific application. These applications are chosen to highlight the statement, rather than a specific graphics application. These examples can be found in Chapter 7, Additional Graphics Techniques. If you choose to alternate between the examples, you may wish to store the continuing example on tape, to eliminate the re-typing of it.

With all of the examples which appear in your System 45B Graphics manual, a ● appears to the left of the line number which uses the statement being explained.

The Appendices

Appendix A contains a glossary of terms which are used in this manual.

Appendix B contains the summary of the graphics programming statements.

Appendix C contains various items, such as the equipment supplied, graphics specifications for the CRT, and installation information for the HP 9872A Plotter.

Syntax Guidelines

The following general conventions apply to the statements which appear in this manual.

Dot Matrix	All items appearing in Dot Matrix must be entered as shown.
[ ]	All items in brackets are optional and explained in the accompanying text.

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Hewlett-Packard Company
Desktop Computer Division
3404 East Harmony Road
Fort Collins, Colorado 80525 U.S.A.
Attn. Customer Documentation

Summary

Your System 45B can be used to draw plots of data and digitize data from plots. The plot is displayed on a graphics display device, such as the CRT. When the plot is displayed on the CRT, it is plotted on a 560 x 455 dot matrix with the plotted information being stored in a 32k byte R/W memory.

There are three units of measure for your System 45B Graphics system –

- Graphic Display Units (GDU s) where the shorter side of the plotting area is always equal to 100; the longer side of the plotting area is always equal to the shorter side times its ratio.
- User Defined Units (UDU s) where you can set limits on the plotting area for both the short and the long side.
- Metric units where the plotting area is physically scaled to millimetres. The CRT on the System 45B approximates the metric units rather than being exact. (20cm is actually 18.4 cm).

Simple Plotting Operations

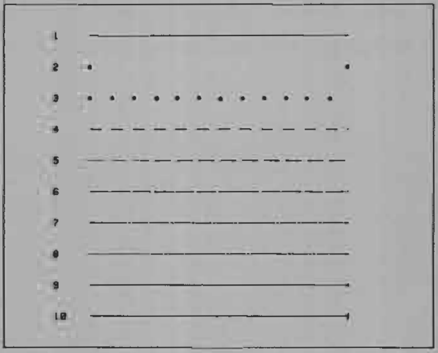
Terms

- Hard Clip Area —The physical limits of the plotting device, beyond which no line can be drawn.
- Soft Clip Area — The limits of the plotting device which restricts pen movement for lines drawn in UDUs.
- Clipping Area — The area which restricts the pen movement whenever lines are drawn in UDUs.
- Plotting Coordinates — The X,Y coordinate pair which specifies a plotting point.
- UDUs — User Defined Units. Defined by the program to whatever X and Y units of measure which are convenient.
- GDUs — Graphic Display Units. An X,Y reference system which at default defines the CRT to extend from X minimum = 0 to X maximum = 123.127753304, Y minimum = 0 to Y maximum = 100.

Default Conditions Set by PLOTTER IS

Graphics R/W memory is cleared
Soft clip area = hard clip limits
UDUs = GDUs
UDUs are current units
Pen #1
Line type 1
Characters
  Size = 3.3 GDU's
  Aspect ratio = 9/15
  Slant = 0°
Label origin 1
Label direction horizontal
  (left to right)

Line Types



Chapter 2

Plotting Boundaries

All plotting takes place within some type of boundary on the plotting device, whether the plotting device is the CRT or an external plotter. There are two boundaries which you are concerned with on your System 45B Graphics system –

Hard Clip Area

The **hard clip area** can be set to any size, up to and including the physical limits of the CRT's graphics raster. This is an area equal to 20 cm horizontally and 16.25 cm vertically on the CRT. On most plotters, the hard clip area is approximately equal to the platen size.

Soft Clip Area

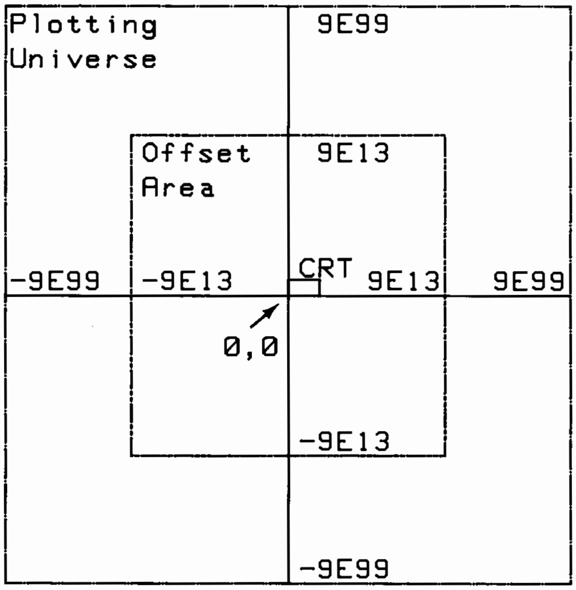
The **soft clip area** (also called the **clipping area**) is the boundary which actually limits the plotting (i.e. lines cannot be drawn outside of the soft clip area). The soft clip area can be set to any size, up to and including the hard clip limits of the plotting device.

Both of the soft and hard clip areas can be altered by various graphics statements which are explained in this manual. However, for simple plotting operations they are not needed. The statements which alter the soft and hard clip areas are explained in Chapter 3.

Plotting Coordinates

All points within the soft clip and hard clip areas can be referenced by means of a coordinate system. This coordinate system can be specified by various graphics statements which are explained in this manual. However, for simple plotting operations which are described in this chapter the following information should be sufficient.

Your System 45B uses a coordinate system scaled as shown –



The acceptable values for processing coordinates are from −9E99 to +9E99 along both the X and Y axes.

As you can see, the CRT is positioned at the intersection of the X and Y axes (0,0). However, you can offset the CRT to anywhere from −9E13 to +9E13 along both axes.

The coordinate system which is in effect at power-on is referred to as the "default" system. The coordinate system is a simple X(horizontal), Y(vertical) coordinate system with the following values –

	min X unit	**min Y unit**	**max X units**	**max Y units**
•CRT	0	0	123.127753304	100
•9872A	0	0	152	100
•Incremental	0	0	152	100

In effect, this means that unless you change the plotting coordinate system by means of a scaling statement (Chapter 3), the only points which can be plotted on the CRT are those which occur between 0 and 123.127753304 on the X axis, and 0 and 100 along the Y axis. Keep in mind that while only the coordinates which lie between these limits are plotted, data which exceeds these coordinates can still be calculated and processed by your System 45B.

GRAPHICS and EXIT GRAPHICS Statements

The GRAPHICS and EXIT GRAPHICS statements turn the CRT graphics raster on and off respectively. If you are plotting on the CRT and want to see what you are plotting, GRAPHICS must be executed. You can plot on the CRT while the alphanumeric raster is on and then switch on the graphics raster to see what you have plotted.

Syntax:

```
GRAPHICS
```

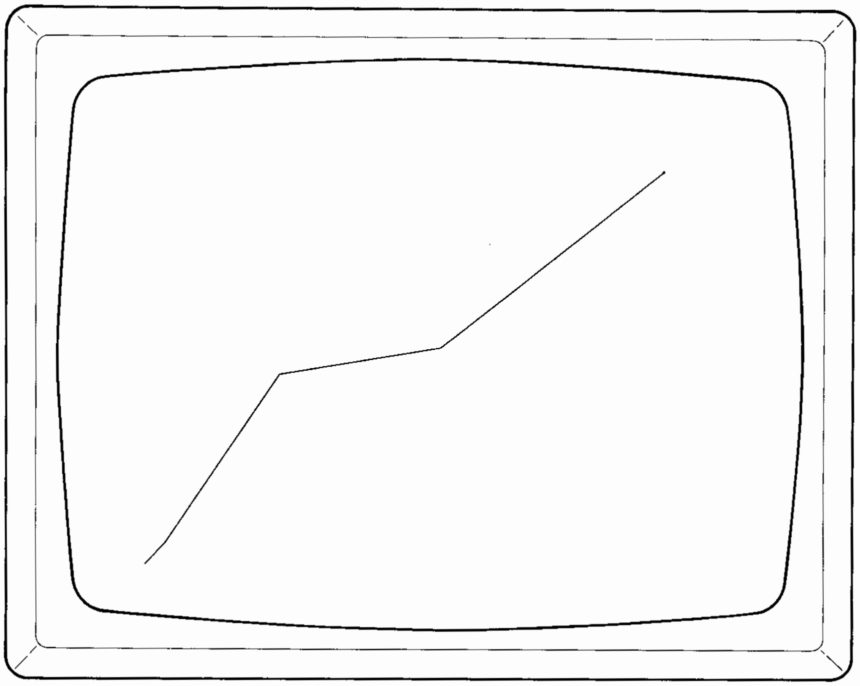
or

```
EXIT GRAPHICS
```

The graphics raster remains on the CRT until EXIT GRAPHICS is executed, an error occurs, or either a typing key or the recall key is pressed on the keyboard. If you accidentally get out of graphics, type G R A P H I C S EXEC, to get back into it.

External plotters do not use the Graphics R/W memory. Executing a GRAPHICS statement when a device other than the CRT is the plotter results in a random pattern being displayed as the CRT memory contents.

Example



```
 1     REM  *** This is the continuing example (CONT1)
 10 Set_up:    !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
●40   GRAPHICS                          ! Enables the CRT
 90 Start_plot:    !
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:   !
 240 Label_axes:   !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 480 Copies:   !
●485   EXIT GRAPHICS                    ! Returns to alphanumeric raster
 500   END
```

PEN Statement

The PEN statement allows you to select a specific pen. On the HP 9872A Plotter, this could be any of four different pens.

Syntax:

PEN pen number

The range of the pen number parameter is minus one (−1) through plus 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. On the 9872A Plotter all pens are returned to their holders. When using a 9872A Plotter, it is a good idea to end all programs with a PEN 0. This helps keep the pens from drying out.

On external plotters that have more than one pen, the absolute value of the pen parameter is used to select one of four pens (possibly of different colors).

On the CRT, any positive pen number draws a line. A negative pen number selects an "eraser". A line redrawn with a negative pen number is erased along with the intersecting points of any intersecting lines.

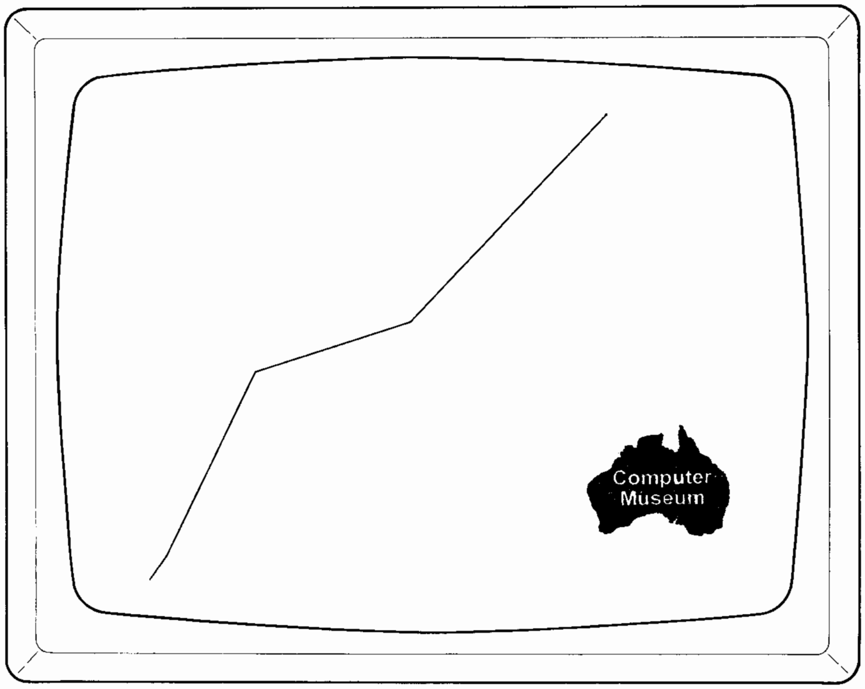
Jaggies

You may notice an occurrence called "Jaggies". Jaggies are caused by the turning on of adjacent phosphor dots which do not lie in the same direction as the line being plotted. This becomes evident when you attempt to erase a line which has jaggies.

The proper way to erase a line using PEN -1 is to re-draw or re-plot it from end point to end point in the same direction which it was drawn. This ensures that all of the jaggies are erased.

Executing a PEN statement with a negative pen number (the eraser) resets the LINE TYPE to type one, (refer to the next section of this manual).

Example



```
 1      REM  *** This is the continuing example (CONT2)
 10 Set_up:   !
●15   PEN 1                                  ! Selects PEN #1
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 40   GRAPHICS                               ! Enables the CRT
 90 Start_plot:   !
 130  FOR Loop_index=1 TO 5                  ! Begins loop to PLOT 5 points
 140    READ X_plot_point,Y_plot_point       ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point         ! PLOTs data coordinates
 160  NEXT Loop_index                        ! Repeats loop
 170 Enhancements:  !
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D        ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12           ! Initializes loop
 280    READ Label$                          ! READs data
 300  NEXT X_label                           ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10           ! Initializes loop
 350  NEXT Y_label                           ! Repeats loop
 360 Label_text: !
 370  DEG                                    ! Change to degrees mode
 480 Copies:  !
 500    END
```

LINE TYPE Statement

The LINE TYPE statement selects one of several solid or dashed line types and defines the length of the repeat pattern for the dashed or dotted lines.

Syntax:

LINE TYPE identifier number [, length]

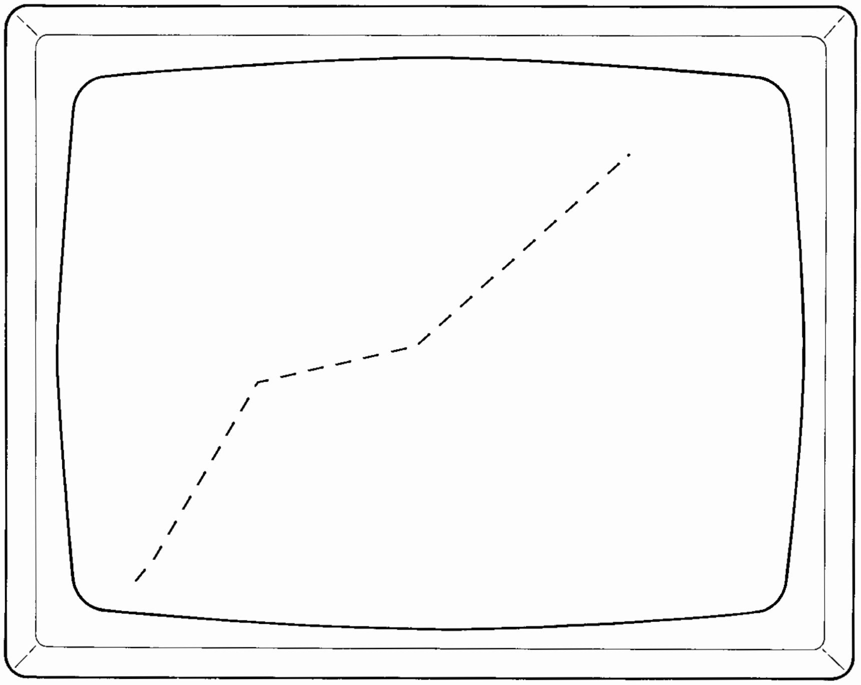
The identifier number parameter (integer value 1 through 10) selects one of the ten line types for plotting (see the next example). The default line type is type one.

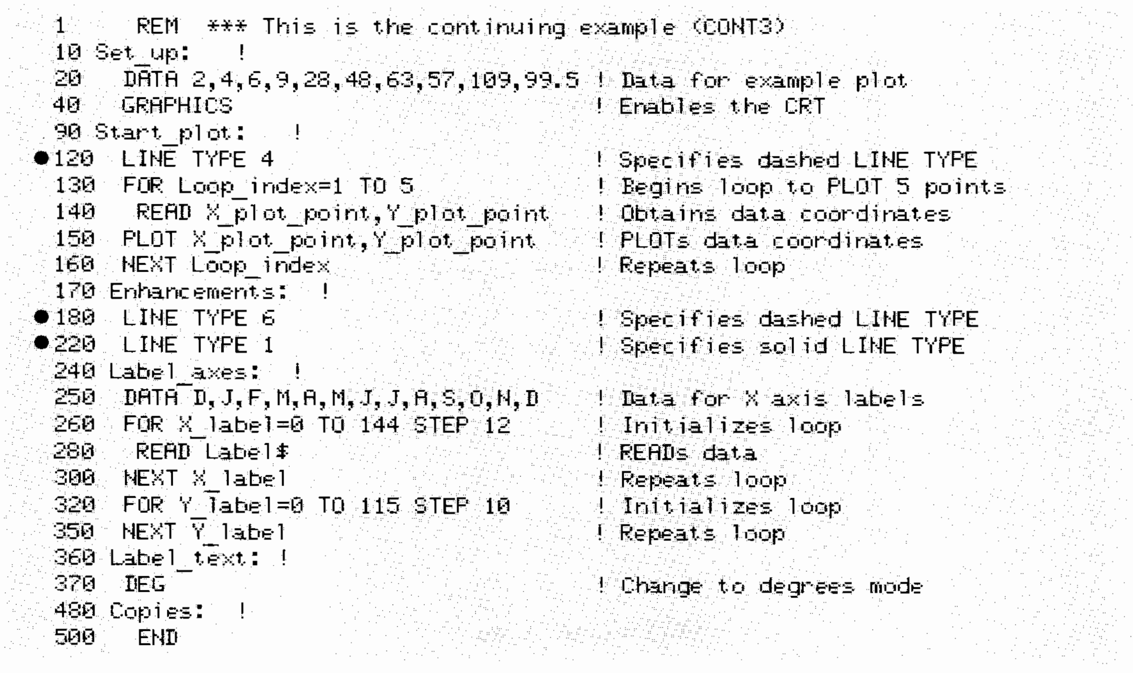
The length parameter specifies the approximate length of the dashed line repeat pattern, in GDU's. The default length is 4 GDUs.

NOTE

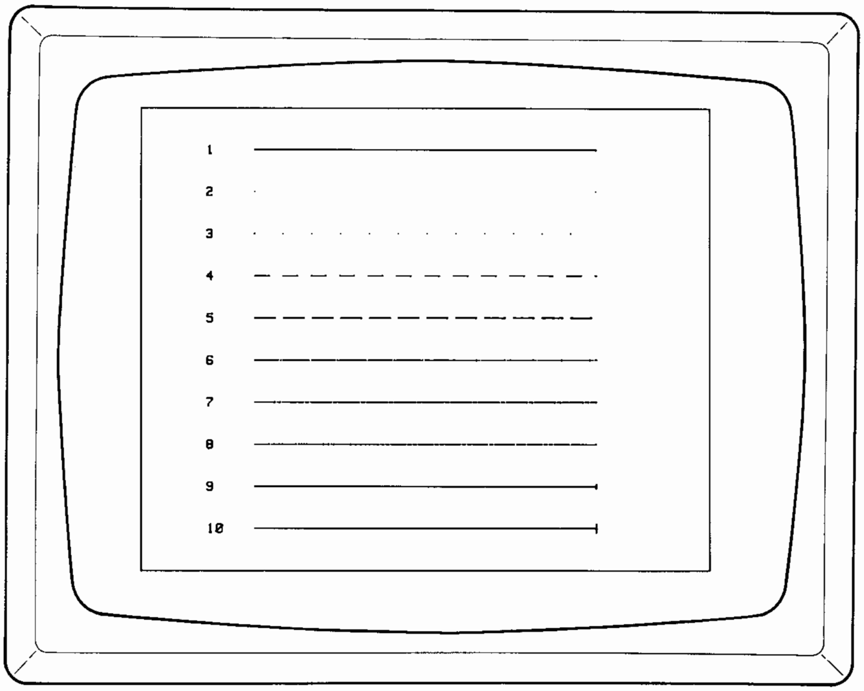
The line type patterns generated by external plotters are slightly different from the line types drawn on the CRT.

Examples

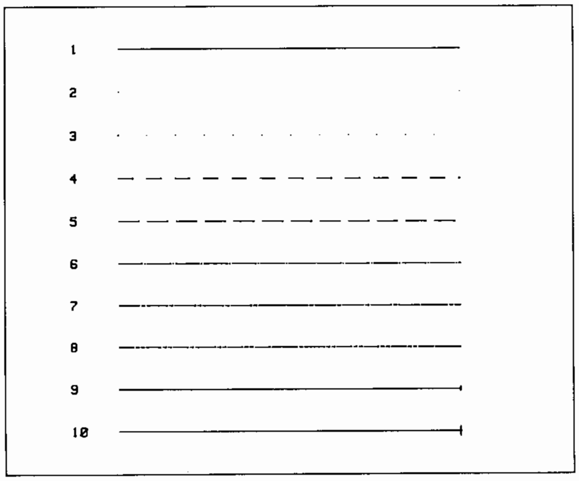




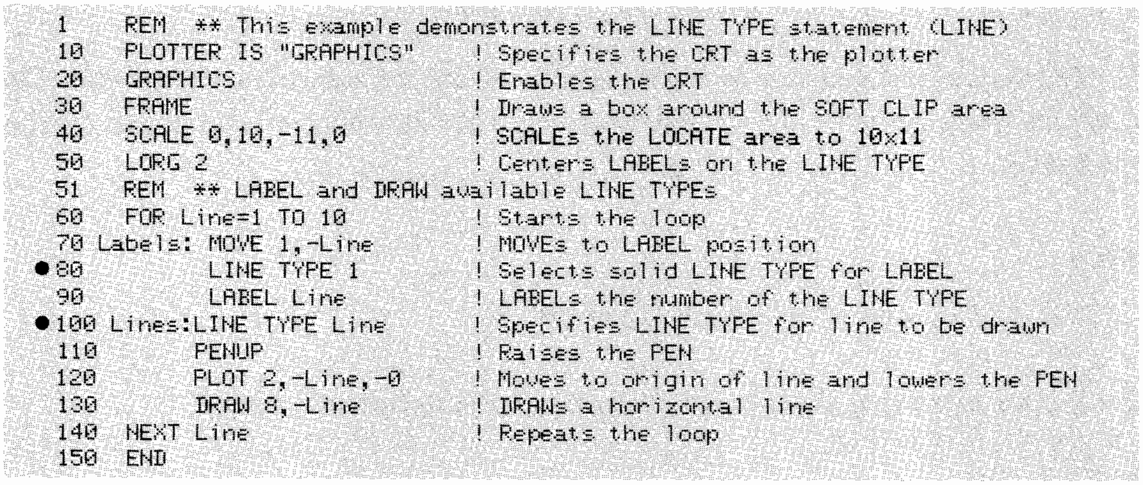
```
   1     REM  *** This is the continuing example (CONT3)
  10 Set_up:   !
  20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
  40   GRAPHICS                          ! Enables the CRT
  90 Start_plot:   !
●120   LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130   FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140    READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150   PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160   NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
●180   LINE TYPE 6                       ! Specifies dashed LINE TYPE
●220   LINE TYPE 1                       ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250   DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260   FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280    READ Label$                      ! READs data
 300   NEXT X_label                      ! Repeats loop
 320   FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350   NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370   DEG                               ! Change to degrees mode
 480 Copies:  !
 500    END
```



CRT Line Types



9872A Line Types



```
 1     REM  ** This example demonstrates the LINE TYPE statement (LINE)
 10    PLOTTER IS "GRAPHICS"      ! Specifies the CRT as the plotter
 20    GRAPHICS                   ! Enables the CRT
 30    FRAME                      ! Draws a box around the SOFT CLIP area
 40    SCALE 0,10,-11,0           ! SCALEs the LOCATE area to 10x11
 50    LORG 2                     ! Centers LABELs on the LINE TYPE
 51    REM  ** LABEL and DRAW available LINE TYPEs
 60    FOR Line=1 TO 10           ! Starts the loop
 70 Labels: MOVE 1,-Line          ! MOVEs to LABEL position
●80          LINE TYPE 1          ! Selects solid LINE TYPE for LABEL
 90          LABEL Line           ! LABELs the number of the LINE TYPE
●100 Lines:LINE TYPE Line         ! Specifies LINE TYPE for line to be drawn
 110        PENUP                 ! Raises the PEN
 120        PLOT 2,-Line,-0       ! Moves to origin of line and lowers the PEN
 130        DRAW 8,-Line          ! DRAWs a horizontal line
 140   NEXT Line                  ! Repeats the loop
 150   END
```

PLOT Statement

The PLOT statement provides data plotting with an optional pen control parameter. This statement moves the pen to the X,Y coordinate in current units using the current pen number and line type.

Syntax:

PLOT X parameter, Y parameter [, pen control]

The X and Y parameters are interpreted according to the current units mode.

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.

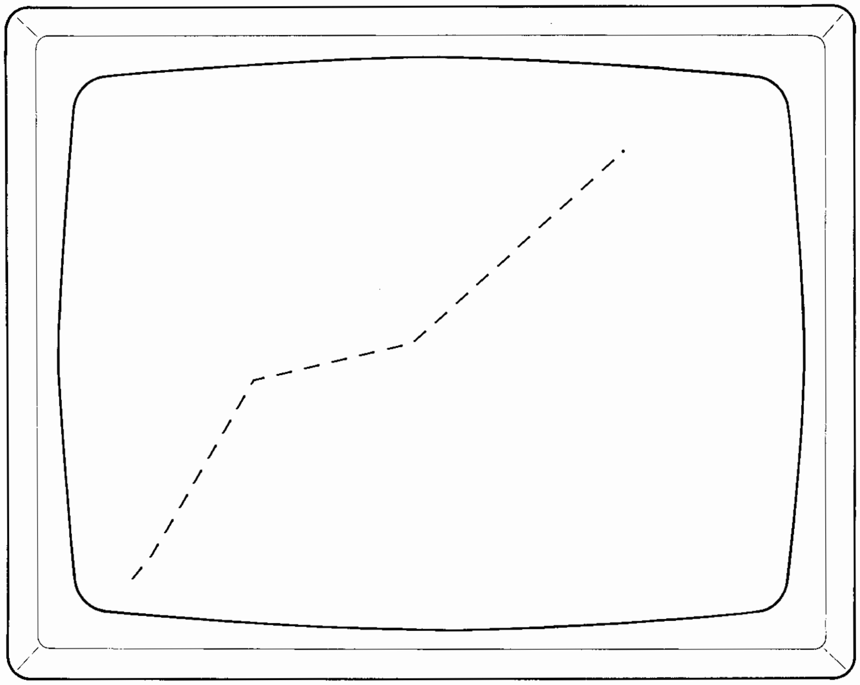
Odd =	Drop pen (pen down or start line generation)
Even =	Lift pen (pen up or stop line generation)
Positive =	Pen change after motion
Negative =	Pen change before motion

For example,

+1 or no parameter	Change pen location, then drop pen
2 or 0	Change pen location, then lift pen
−2	Lift pen, then change pen location
−1	Drop pen, then change pen location

This pen control parameter is specified in the PLOT, IPLOT and RPLOT statements. Once you have set the pen control parameter, it remains in effect until it is changed by a default condition, or by another pen control parameter, a PENUP or a MOVE.

Example



```
 1     REM  *** This is the continuing example (CONT4)
 10 Set_up:   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 40   GRAPHICS                          ! Enables the CRT
 90 Start_plot:   !
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
●150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 480 Copies:  !
 500   END
```

PLOTTER IS Statement

A PLOTTER IS statement is used to specify the select code and the type of plotting device to which successive plotter operations are directed.

Syntax:

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

Statement Parameters

The select code of the CRT (when used as a plotter) is 13 and is used for most examples in this manual.

The plotter identifier 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. External plotting devices (e.g. HP 9872A Plotter) set to a select code other than 13 can be connected to the computer. The plotter identifier string should specify the type of plotting device. The three plotter identifier strings and default select codes are:

Identifier String	Select Code
"GRAPHICS"	13
"9872A"	7,5
"INCREMENTAL"	5

CRT

The plotter identifier string, "GRAPHICS", specifies the CRT as the display device.

9872A

The plotter identifier string "9872A", can specify either the HP 9872A, 7245A or 7225A as the plotter which must be connected to the computer via the HP 98034A HP-IB Interface. Refer to Appendix C and the 98034A Installation and Service Manual for hookup information.

Incremental

The last four optional parameters of the PLOTTER IS statement provide a means for you to describe the features of the 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	.254mm
number of pens	1
pen offset	0mm
incremental plotter identifier	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 to be specified, 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 identifier parameter is used to specify one of several known incremental plotters that 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 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.

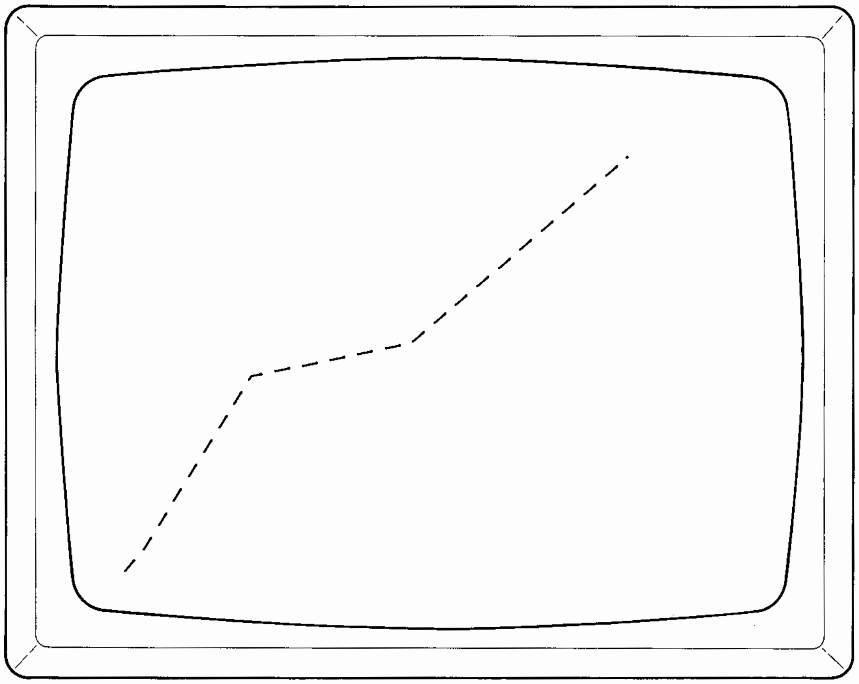
1. Activates the plotting device specified.
2. Sets UDU's (User Defined Units) as current units.
3. Sets UDU's (User Defined Units) equal to GDU's.
4. Reads hardware-set hard clip limits from the plotting device.
5. Defaults the soft clip area to the hard clip limits.
6. Clears the graphics display.
7. Selects pen one.
8. Selects line type one.
9. Selects the standard character size.
10. Selects label origin one.
11. Sets label direction as left to right.
12. Clears any error conditions.
13. Clears character count from any previous LABEL statement.

The default conditions can 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.

Note

Executing the LIMIT statement sets all of the previous default conditions except default condition number 6.

Example



```
  1     REM  *** This is the continuing example (CONT5)
  10 Set_up:    !
  20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
● 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
  40   GRAPHICS                          ! Enables the CRT
  90 Start_plot:    !
  120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
  130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
  140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
  150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
  160  NEXT Loop_index                   ! Repeats loop
  170 Enhancements:  !
  180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
  220  LINE TYPE 1                       ! Specifies solid LINE TYPE
  240 Label_axes:  !
  250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
  260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
  280   READ Label$                      ! READs data
  300  NEXT X_label                      ! Repeats loop
  320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
  350  NEXT Y_label                      ! Repeats loop
  360 Label_text: !
  370  DEG                               ! Change to degrees mode
  480 Copies:  !
  500   END
```

PLOTTER. . .IS ON or IS OFF Statements

The PLOTTER. . .IS ON or IS OFF statement activates (ON) or deactivates (OFF) the plotting device specified by the select code. When activated, a plotting device responds to all of the plotting statements and when deactivated the plotting device does not respond. Executing a PLOTTER. . .IS ON for one select code automatically deactivates all other plotters. If all plotters are deactivated, the plotting statements are executed but are not directed to any plotter.

Syntax:

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

This 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 any of the default conditions described under the PLOTTER IS statement.

Syntax:

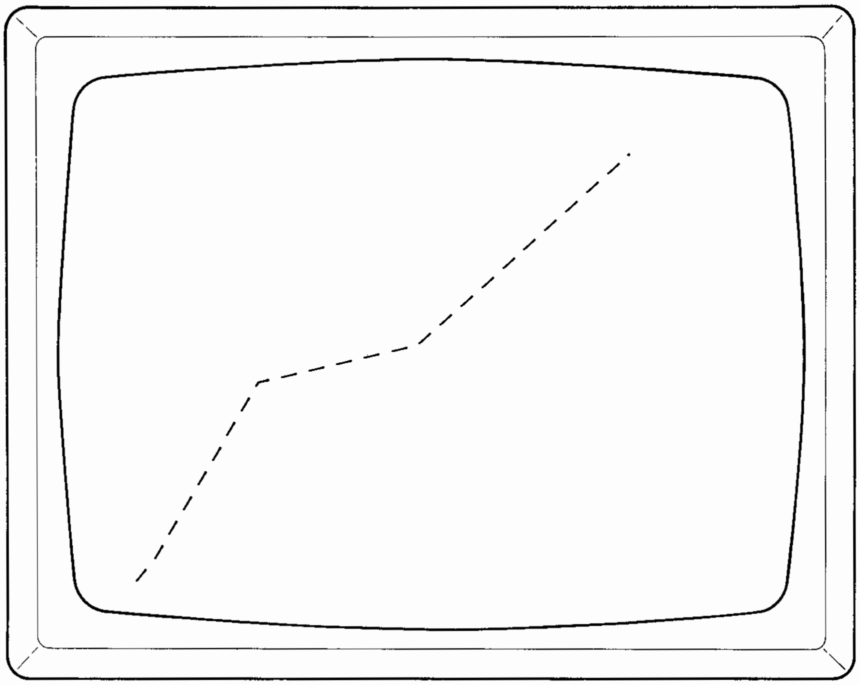
PLOTTER select code [, HP-IB device address] IS OFF

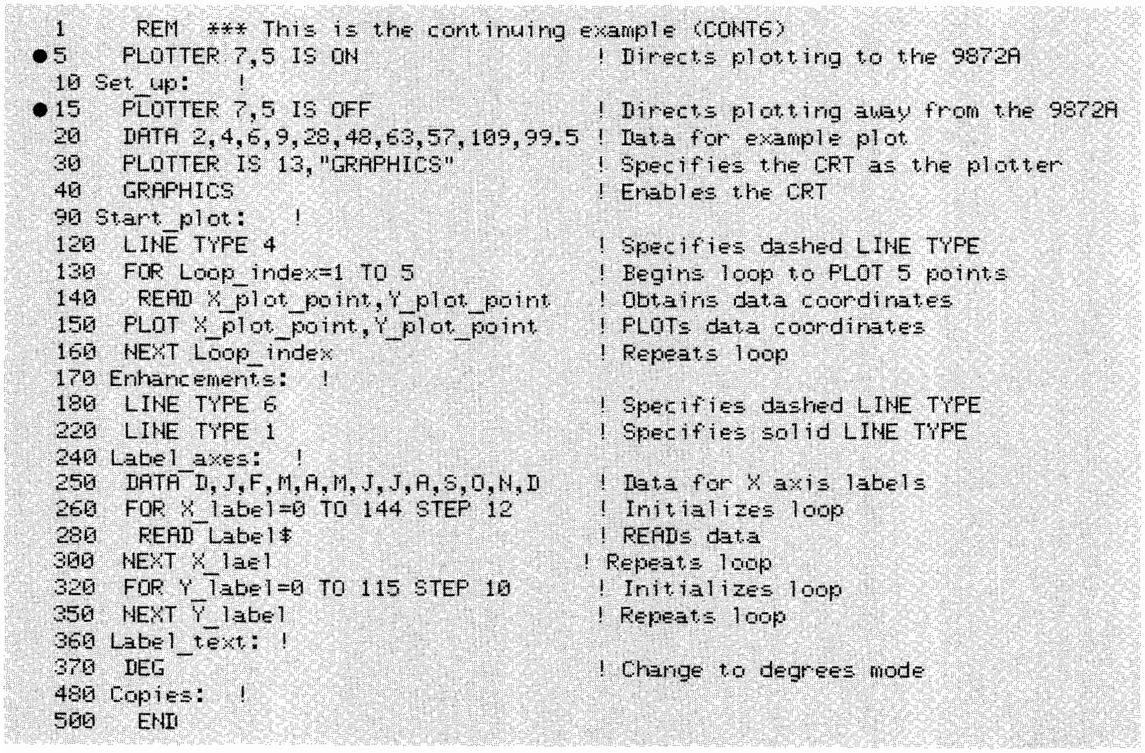
This statement deactivates the plotter set to the specified select code. All plotting statements are executed but the specified plotter does not respond.

NOTE

If you do not have an HP-IB interface connected to the computer, an ERROR 111 is generated by lines 5 and 15.

Example





```
  1     REM  *** This is the continuing example (CONT6)
●5    PLOTTER 7,5 IS ON                     ! Directs plotting to the 9872A
 10 Set_up:   !
●15   PLOTTER 7,5 IS OFF                    ! Directs plotting away from the 9872A
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"              ! Specifies the CRT as the plotter
 40   GRAPHICS                              ! Enables the CRT
 90 Start_plot:   !
 120  LINE TYPE 4                           ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5                 ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point       ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point        ! PLOTs data coordinates
 160  NEXT Loop_index                       ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                           ! Specifies dashed LINE TYPE
 220  LINE TYPE 1                           ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D        ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12          ! Initializes loop
 280   READ Label$                          ! READs data
 300  NEXT X_lael                         ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10          ! Initializes loop
 350  NEXT Y_label                          ! Repeats loop
 360 Label_text: !
 370  DEG                                   ! Change to degrees mode
 480 Copies:  !
 500   END
```

GCLEAR Statement

The GCLEAR statement clears the graphics memory and the CRT screen of any previously plotted data. The GCLEAR statement does not reset or set the default parameters for any other statement.

Syntax:

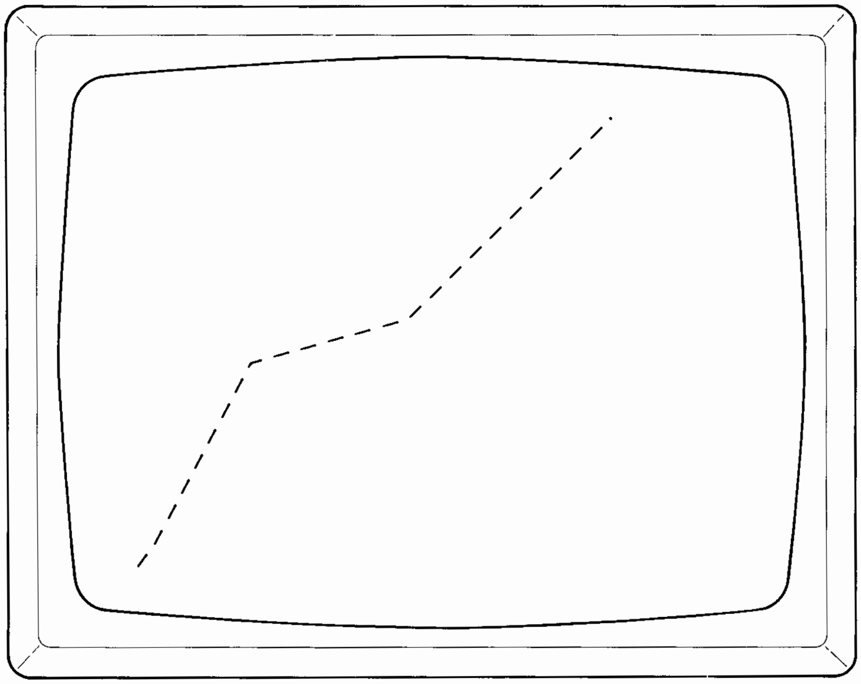
GCLEAR [paper advance]

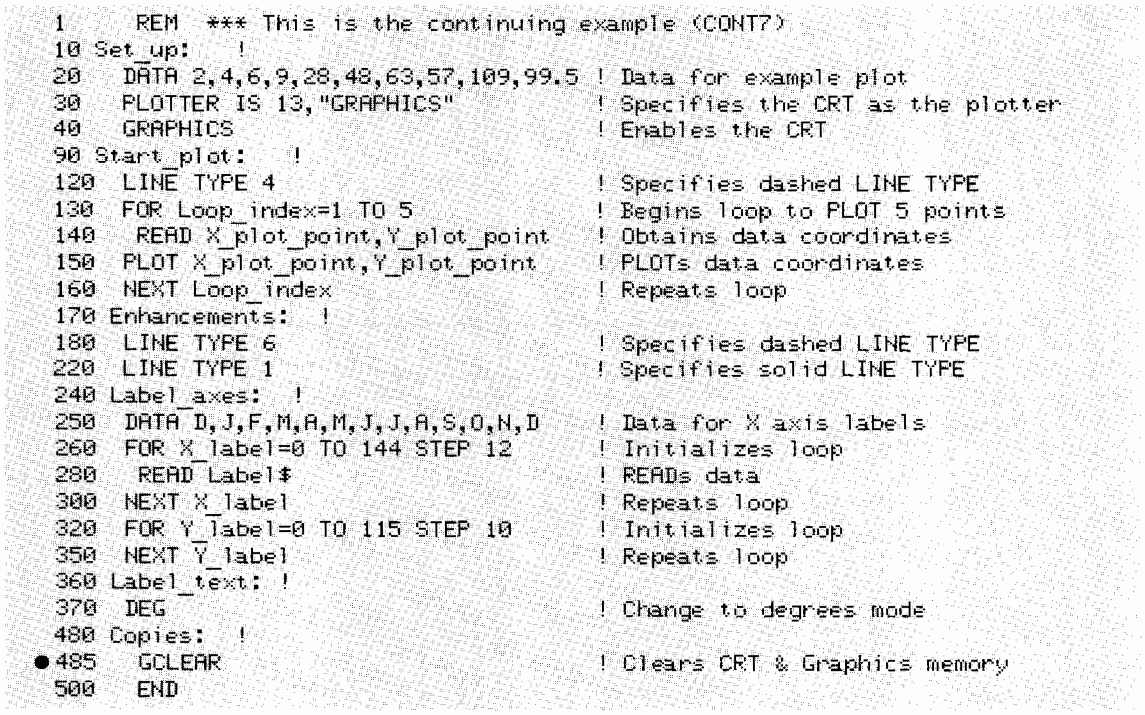
The PLOTTER IS statement should normally be used between plots, rather than GCLEAR, since GCLEAR does not restore the default conditions.

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

On fixed paper plotters (e.g., HP 9872A) and on the CRT, the paper advance parameter is ignored.

Example





```
 1     REM  *** This is the continuing example (CONT7)
 10 Set_up:   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 40   GRAPHICS                          ! Enables the CRT
 90 Start_plot:   !
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 480 Copies:  !
●485   GCLEAR                           ! Clears CRT & Graphics memory
 500   END
```

FRAME Statement

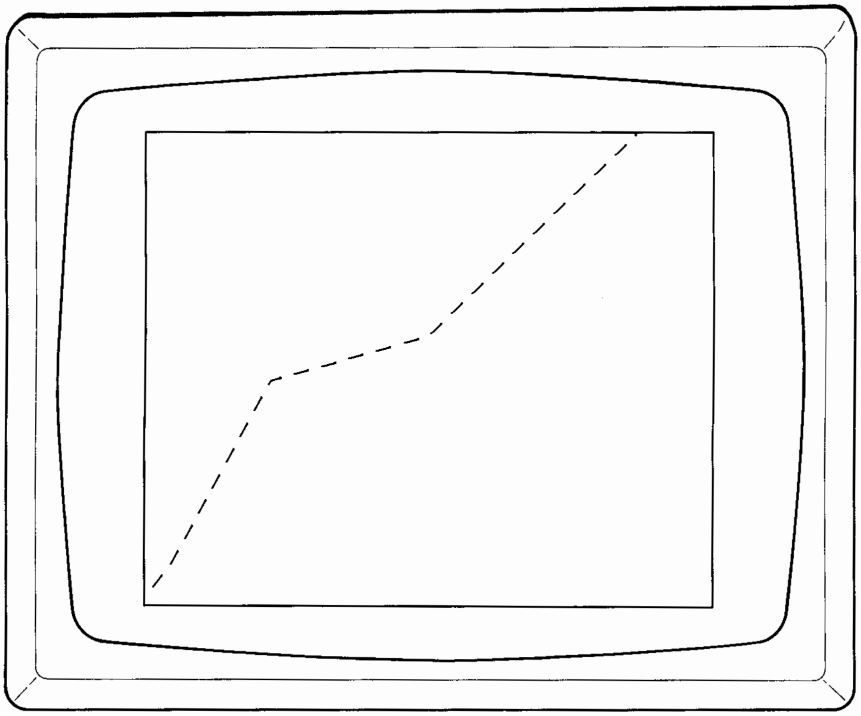
The `FRAME` statement draws a box around the current clipping area (the soft clip limits).

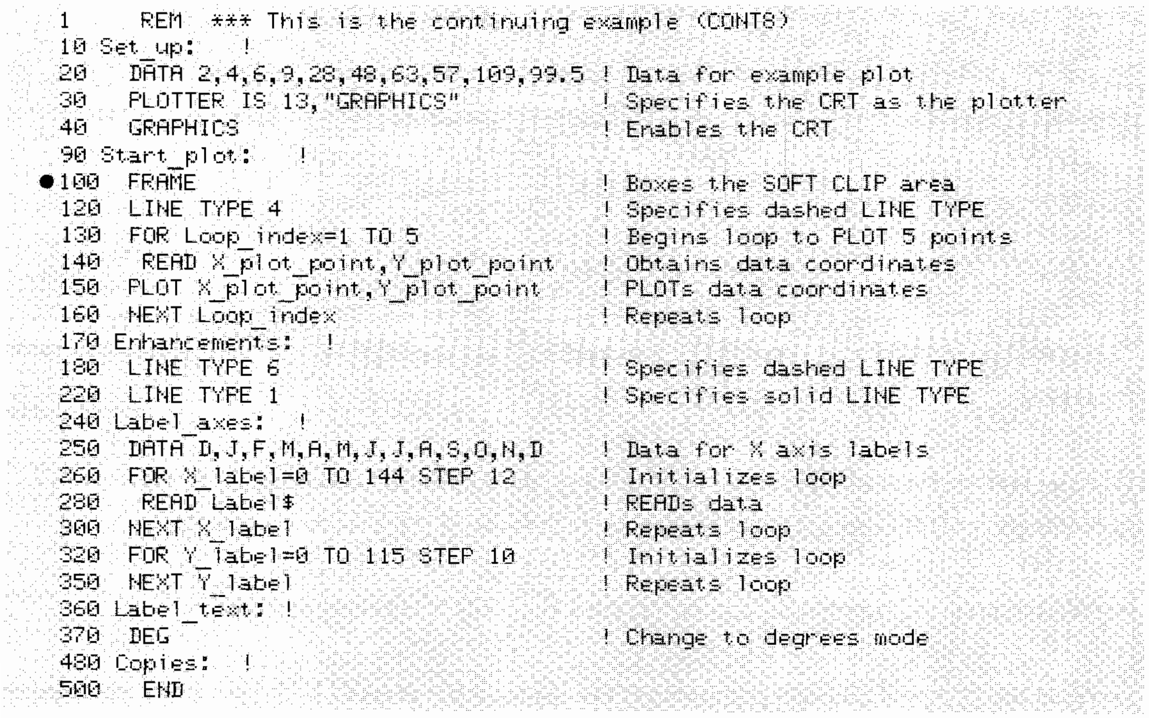
Syntax:

```
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.

Example





```
 1     REM  *** This is the continuing example (CONT8)
 10 Set_up:   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 40   GRAPHICS                          ! Enables the CRT
 90 Start_plot:   !
●100  FRAME                             ! Boxes the SOFT CLIP area
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 480 Copies:  !
 500   END
```

DUMP GRAPHICS Statement

The DUMP GRAPHICS statement allows a graphic display on the CRT to be copied onto the internal printer. You must have the optional thermal printer installed to execute this statement.

Syntax:

```
DUMP GRAPHICS [lower-bound, [upper-bound] ]
```

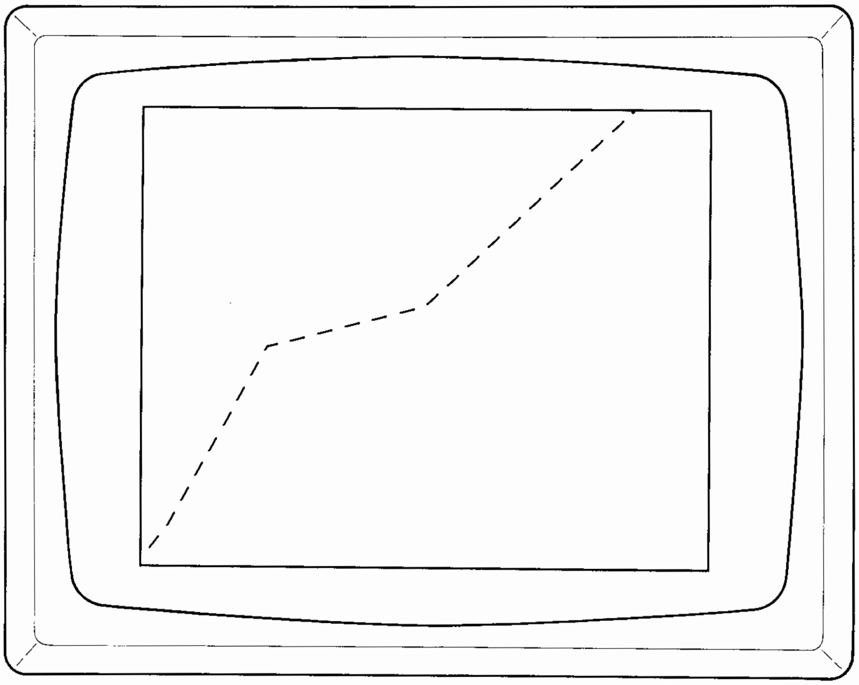
This statement can be executed by the program or from the keyboard while the graphics raster is off or on.

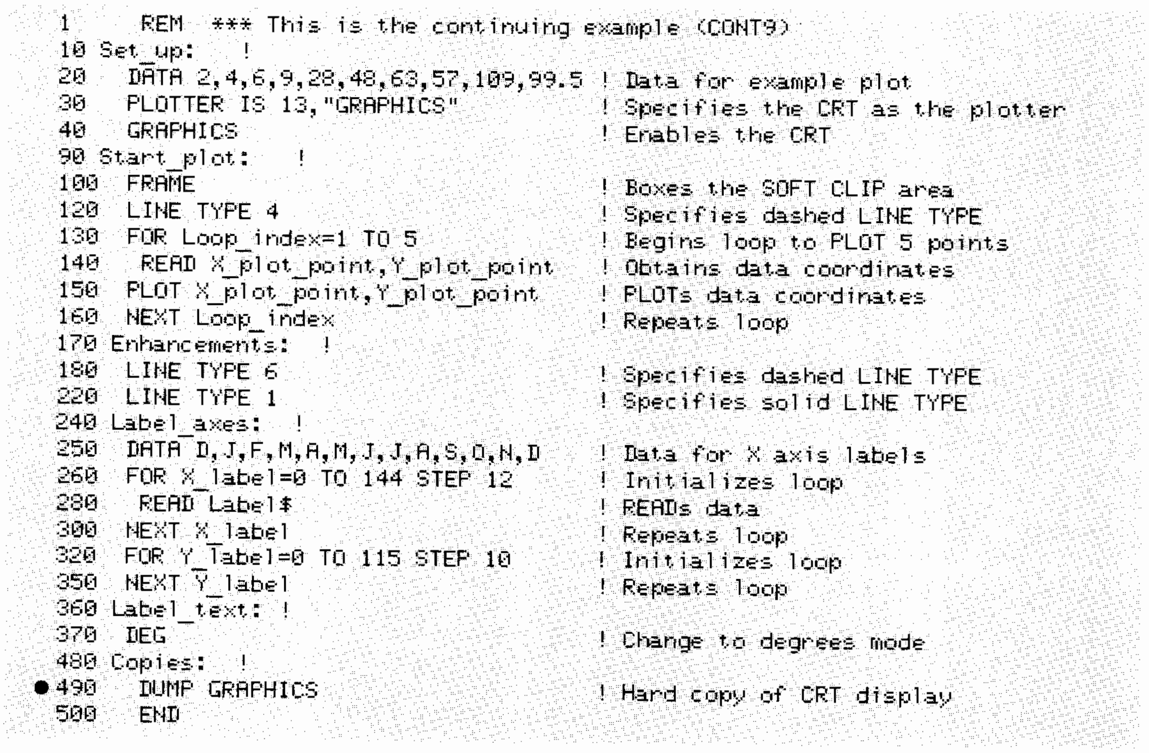
The two optional parameters allow you to copy any horizontal area displayed on the CRT by specifying in current units the upper and lower bounds of the area to be copied.

Without the second parameter, the top of the CRT is used as the upper bound.

Without the first and second parameters, the entire CRT display is copied onto the internal printer.

Example





```
 1      REM  *** This is the continuing example (CONT9)
 10 Set_up:   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 40   GRAPHICS                          ! Enables the CRT
 90 Start_plot:   !
 100  FRAME                             ! Boxes the SOFT CLIP area
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 480 Copies:  !
●490   DUMP GRAPHICS                    ! Hard copy of CRT display
 500   END
```

PENUP Statement

The PENUP statement lifts the pen.

Syntax:

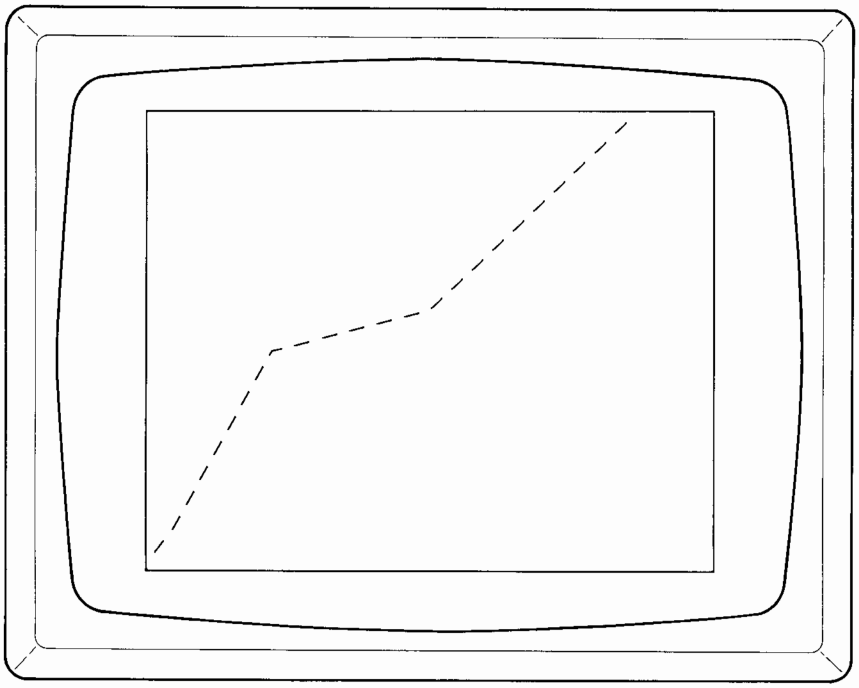
```
    PENUP
```

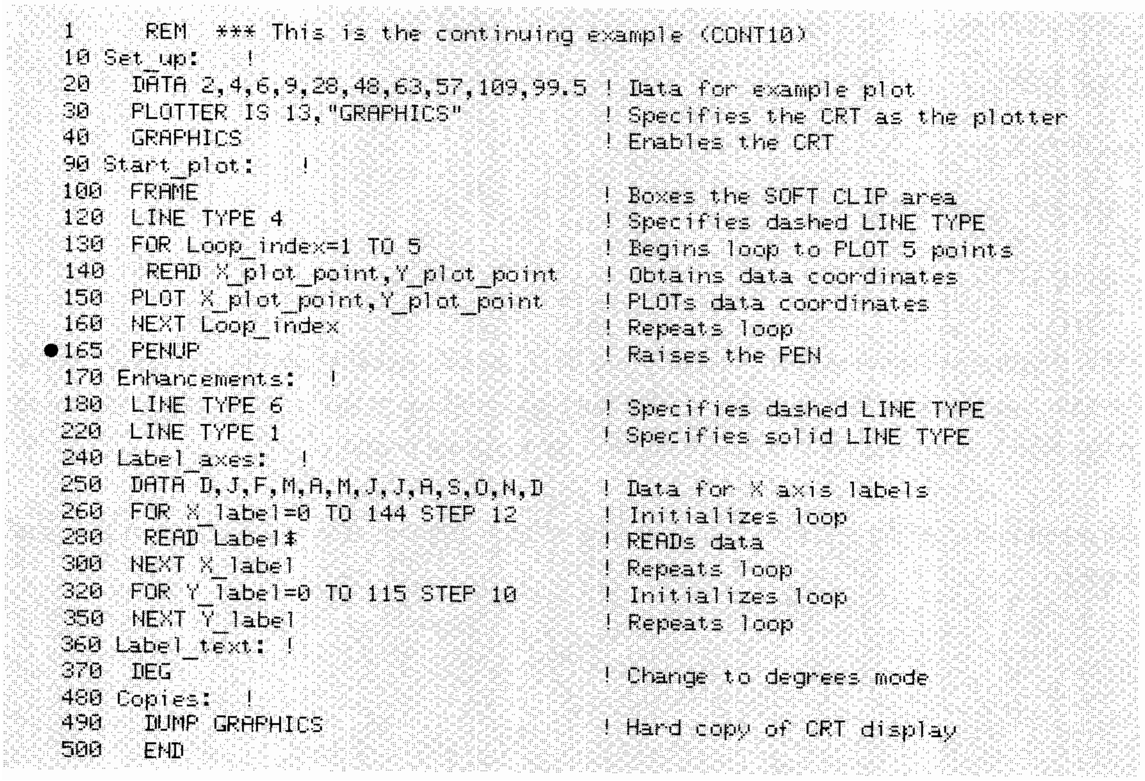
On plotting devices with actual pens (e.g. 9872A Plotter) this statement lifts the pen. The pen can then be moved without drawing a line. This allows you to avoid generating an ink blot on the paper after a plot has been finished or during a lengthy calculation.

On the CRT this statement turns off line generation. If the pen is moved (with the pen up) its new location is not apparent on the CRT, but the pen's coordinate values can be found by executing the WHERE statement (refer to Chapter 6).

The pen up or down status can be automatically controlled by using the DRAW and MOVE statements or the PLOT, RPLOT and IPLOT statements with the optional pen control parameter.

Example





```
 1      REM  *** This is the continuing example (CONT10)
 10 Set_up:   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 40   GRAPHICS                          ! Enables the CRT
 90 Start_plot:   !
 100  FRAME                             ! Boxes the SOFT CLIP area
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
●165  PENUP                             ! Raises the PEN
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 480 Copies:  !
 490   DUMP GRAPHICS                    ! Hard copy of CRT display
 500   END
```

Summary

The second chapter covered –

- simple plotting operations
- plotting boundaries
- hard and soft clip areas
- plotting coordinate system
- `GRAPHICS`
- `EXIT GRAPHICS`
- `PEN`
- `LINE TYPE`
- `PLOT`
- `PLOTTER IS`
- `PLOTTER. . . IS ON`
- `PLOTTER. . . IS OFF`
- `GCLEAR`
- `FRAME`
- `DUMP GRAPHICS`
- `PENUP`

In this chapter you learned how to enable the CRT, as well as other plotting devices, how to plot data based on an X-Y coordinate reference system, how to get a hard copy printout on System 45B's thermal printer and how to clear the graphic's memory.

Information concerning positioning and scaling of your plotting area is contained in the next chapter.

Positioning and Scaling Plots

Terms

- Hard clip limits – The physical limits of the plotting device, beyond which no line can be drawn.
- Soft clip limits – The limits of the plotting device which restricts pen movement for lines drawn in UDU's.
- Current units – The mode of X,Y reference which is in effect; may be either GDUs, UDUs or Metric (mm).

Statement	Effect on Hard Clip Limits	Effect on Soft Clip Limits	Effect on Scaling Points
PLOTTER IS	Reads the hardware P1 and P2.	Sets to hardware P1 and P2.	Sets to hardware P1 and P2.
LIMIT	Sets boundaries to area specified or digitized by LIMIT statement.	Sets to hard clip limits or digitized boundaries of the 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

Summary of Scaling Statements

Scaling statements affect the area defined by the LOCATE rectangle.
Scaling statements set UDUs as the current units.
SCALE defines the UDUs.
SHOW causes specified area to have 1 unit of X = 1 unit of Y.
MSCALE specifies millimetres as UDUs.

Chapter 3

Overview

Basically, there are two things which you may wish to do with a plot –

- position the plot on the graphics device
- scale the plotting area to some dimensions

Positioning the plot is actually done with three statements –

- LIMIT (which defines the hard clip area)
- CLIP (which defines the soft clip area)
- UNCLIP (which changes the soft clip area to equal the hard clip area)

Scaling the plot is done with four statements –

- LOCATE (which defines the area that is being scaled)
- SCALE (which defines the X-Y coordinates along dimensions that you specify)
- MSCALE (which defines the X-Y coordinates to metric units (millimetres))
- SHOW (which defines one unit of X to equal one unit of Y)

Current Units

Before you can start positioning the plot, you have to know something about how your plotting device's X-Y coordinate system is referenced, or what its **current units** are. The term current units refers to whether the X-Y coordinate system in effect is in Graphic Display Units (GDU) or User Defined Units (UDU).

GDUs sets the shorter of the two axes (X or Y) equal to 100 units. The number of units in the longer axis then becomes equal to the ratio of the longer axis divided by the shorter axis times 100. The end result of this is that the shorter axis is equal to 100 units, while the longer axis is a value = > 100.

UDUs are defined by you when you use the SCALE statement or when you use the MSCALE statement. The SCALE statement allows you to select any numeric units for the axes, while the MSCALE statement defines the X and Y axes to be equal to millimetres.

Positioning

Positioning allows you to designate an area on the plotting device where the plot appears. This can be very useful for a number of considerations, among them are –

- leaving space for labeling operations
- placing several related plots on the same display or piece of paper
- aesthetic reasons

As previously mentioned, all plotting takes place within the **soft clip limits**. The default on the CRT sets the soft clip limits equal to the **hard clip limits**.

On some plotting devices, such as the HP9872A Plotter, you can manually change the hard clip limits by using the P1 and P2 keys. The hard clip limits can also be changed under program control by using the LIMIT statement. Remember, the hard clip limits can never exceed the physical limits of the plotting device.

However, the soft clip limits can be set less than, equal to or greater than the hard clip limits. This can be done by the CLIP statement. If your plotted coordinates exceed the physical limits of the plotting device and are within the soft clip limits, the System 45B can still compute your data. Once the plotted data returns to a point within the soft and hard clip limits, it can be plotted.

If you wish to change the soft clip limits back equal to the hard clip limits, you can use the UNCLIP statement.

Scaling

Scaling is the process of changing the X-Y coordinate reference system values. This is done when the X-Y reference system which is currently in effect is no longer applicable to your application (why plot on a 123x100 area when you need an area of 5x12?).

Scaling is accomplished by first defining which area of the plotting device is to be scaled. The defining can be done either by using the default condition of the hard clip area, or by using the LOCATE statement to specify an area.

The scaling is done with two statements –

- SCALE
- MSCALE

SCALE allows you to specify values which define the number of units into which X and Y axes are to be divided.

MSCALE divides the plotting area into metric units. On the CRT, this division is not exact due to the dot matrix of the CRT. This results in a 20cm value actually being equal to 18.4cm. However on the 9872A plotter, the metric values are exact.

The SHOW statement is similar to a scaling statement where X min = Y min and X max = Y max. A figure is then plotted into the LOCATE rectangle, showing only as much as fits into the rectangle.

Offsets

The LIMIT and MSCALE statements also allow an offset distance in millimetres to be specified. The offset allows you to locate the plotting area away from the lower left hand corner of your CRT or 9872A plotter.

Other Statements

Some of the other statements which may prove useful in these applications are –

- SETGU (which makes GDUs the current units.)
- SETUU (which makes UDUs the current units.)
- RATIO (which computes the GDU ratio of the length of the X axis divided by the length of the Y axis.)

LIMIT Statement

The LIMIT statement allows you to define the "plotting area" as a subset of the physical plotting area by setting the hard clip limits. In effect you are describing the size and location of a piece of paper or a specified area of the CRT to the computer. The computer is NOT allowed to move the pen outside the specified area without executing a new LIMIT statement for the area.

This statement overrides any previously set or defaulted hard or soft clip values. If the parameters are specified outside the physical limits of the plotting device, ERROR 113 is generated.

If the LIMIT statement is not executed in a program, the hard clip limits are automatically read from the specified plotting device. On the HP 9872A Plotter, the default hard clip area is somewhat smaller than the physical plotting area. The plotting area is scaled in GDUs when the LIMIT statement is executed. Nothing can be labeled or drawn outside the currently specified hard clip limits.

Syntax:

```
LIMIT [X min, X max, Y min, Y max]
```

The first two parameters normally specify the left and right limits and the second two parameters normally specify the lower and upper limits of the plotting area.

Because you are describing a physical piece of paper or plotting area to the computer, the units must be actual units of measure. For this syntax the units of measure are always 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 CRT and thermal printer are X max = 184.47, Y max = 149.8. Other plotting devices have their own default upper limit values.

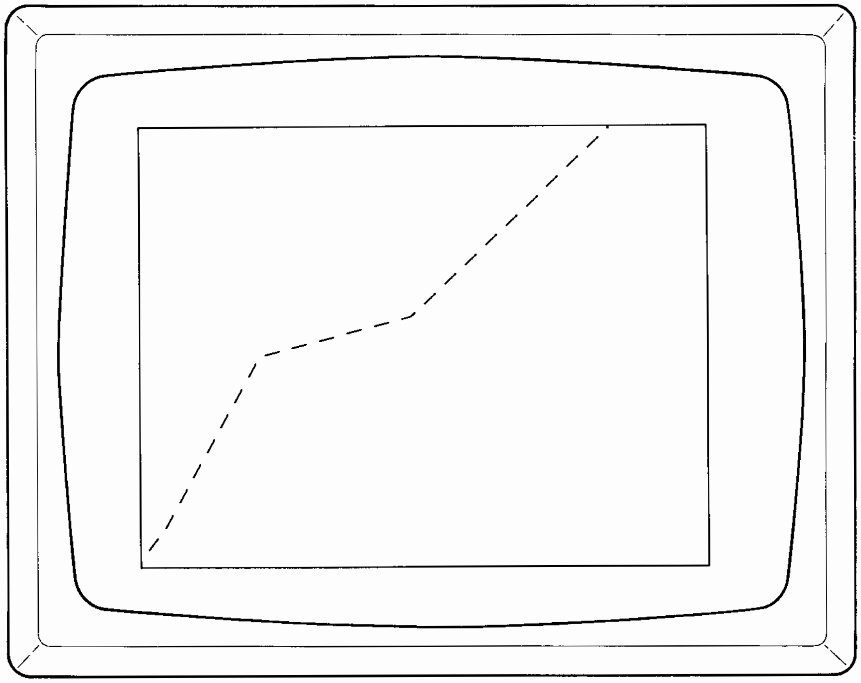
In the normal sequence of parameters, the first two parameters can be exchanged to produce a reflected plot across the Y axes (i.e. LIMIT X max, X min, Y min, Y max). Likewise the last two parameters can be exchanged to produce a reflected plot across the X axes (i.e. LIMIT X min, X max, Y max, Y min). Both the first two parameters and second two parameters can be exchanged, at the same time, to produce a reflected plot across the origin (i.e. LIMIT X max, X min, Y max, Y min). Chapter 7 contains more information on reflected plots.

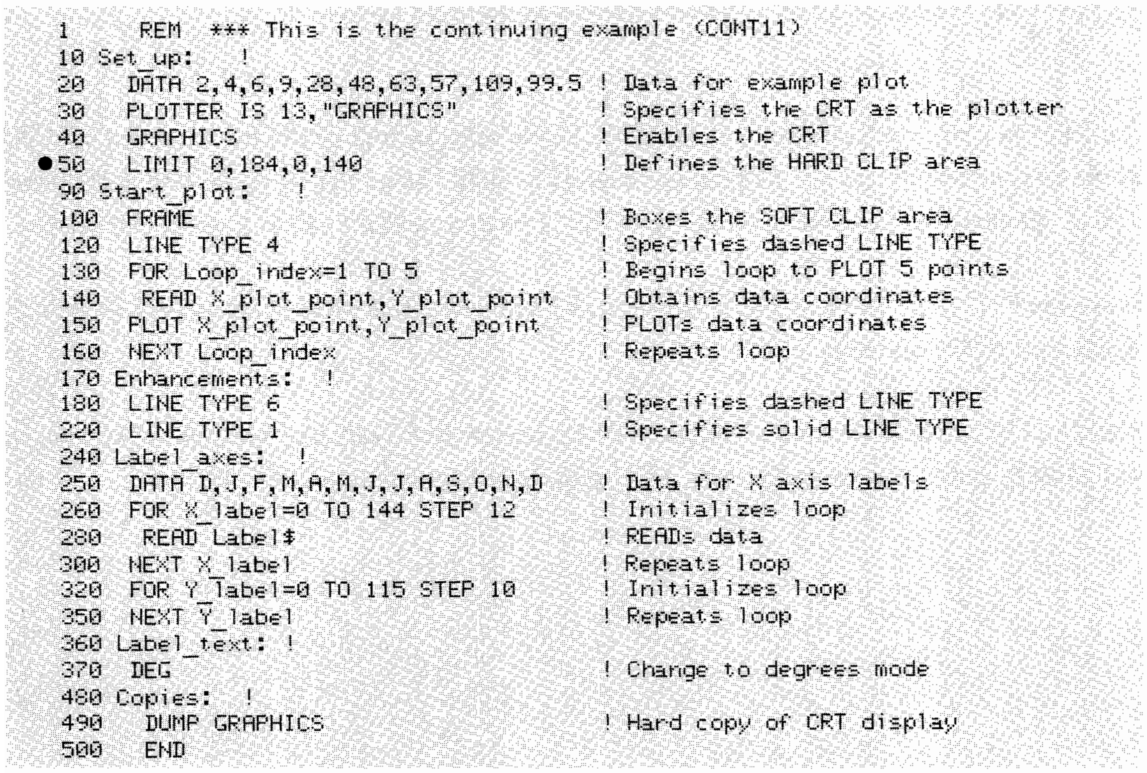
Executing the LIMIT statement without parameters allows you to digitize two opposite corners to describe the plotting area. For further details about inputting parameters by digitizing, refer to the DIGITIZE Statement in Chapter 6.

The LIMIT statement is the software equivalent of manually setting the graph limits (keys P1 and P2) on a 9872A Plotter.

When the HP 9872A is specified in the PLOTTER IS statement and the LIMIT statement is executed without parameters, the pen moves to the current P1 and P2 coordinates. This is so you can position the pen at your desired P1 and P2 coordinates which are input as the LIMIT X min, Y min, and X max, Y max points when the ENTER key on the plotter is pressed. These coordinates become the default hard clip limits for all subsequent programs until a new LIMIT statement is executed.

Example





```
1     REM  *** This is the continuing example (CONT11)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
40   GRAPHICS                          ! Enables the CRT
●50   LIMIT 0,184,0,140                ! Defines the HARD CLIP area
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:   !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
240 Label_axes:   !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
280   READ Label$                      ! READs data
300  NEXT X_label                      ! Repeats loop
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
480 Copies:   !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
500   END
```

CLIP Statement

The CLIP statement defines the soft clip boundaries. This allows the soft clip boundaries to be moved from their default location set by the PLOTTER IS, LIMIT or LOCATE statements. Soft clipping affects lines plotted in UDU's, 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 boundaries and the last two parameters specify the lower and upper boundaries of the clipping area.

Lines plotted from inside this area to points outside the clip boundary extend no farther than the boundary. Lines plotted outside the CLIP boundaries are not drawn (unless drawn in GDUs).

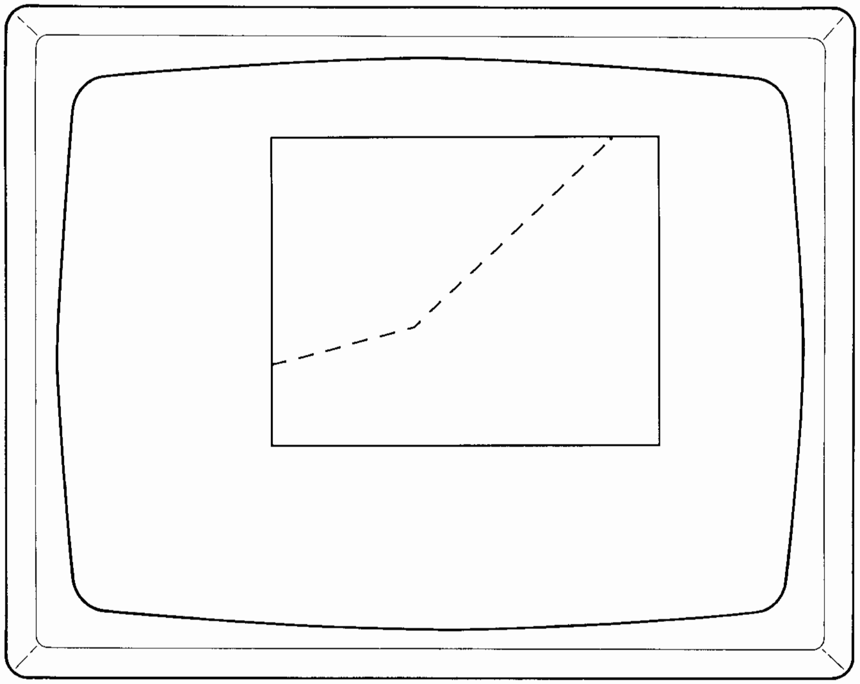
Executing the CLIP statement without parameters allows you to specify the area by digitizing two opposite corners (normally the lower-left and upper-right corners).

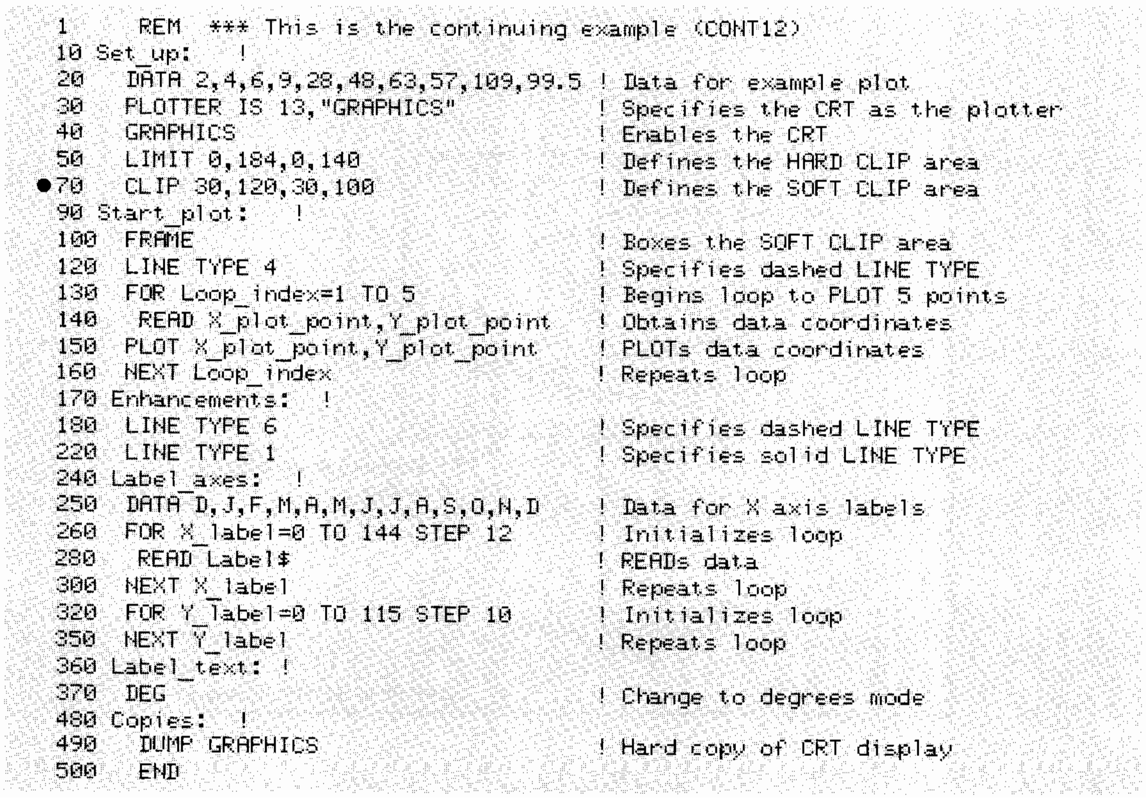
The soft clip limits can be turned off (by UNCLIP) or may be set beyond the hard clip limit. In either case and in the case of plotting commands in GDUs only, the hard clip limit (set by the LIMIT statement or defaulted by the PLOTTER IS statement) is used as the soft clip area.

Executing PLOTTER IS, LIMIT, LOCATE or UNCLIP reinstates various default values including the soft clip boundaries.

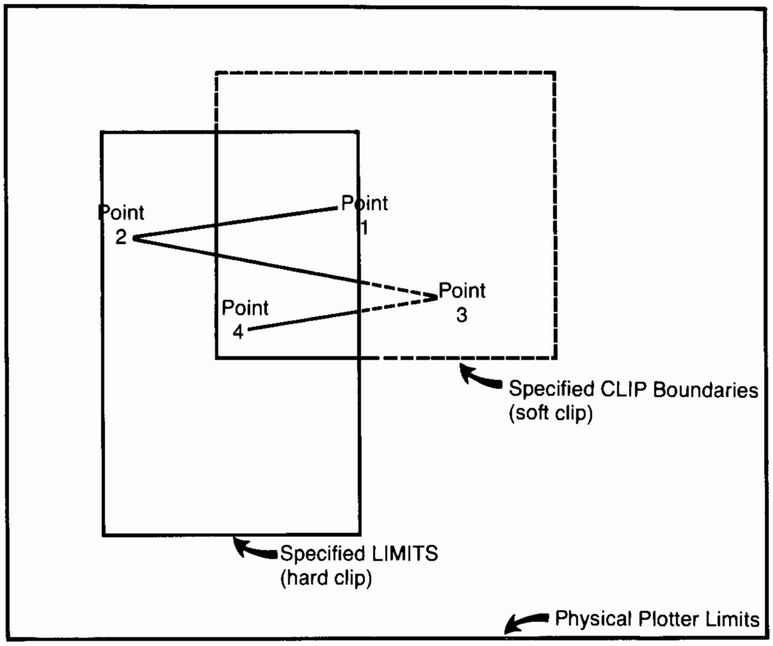
When CLIP is used to set the soft clip boundaries such that the soft clip rectangle is partially in and partially out of the hard clip limits, UDU plotting is clipped at the hard clip limits.

Example

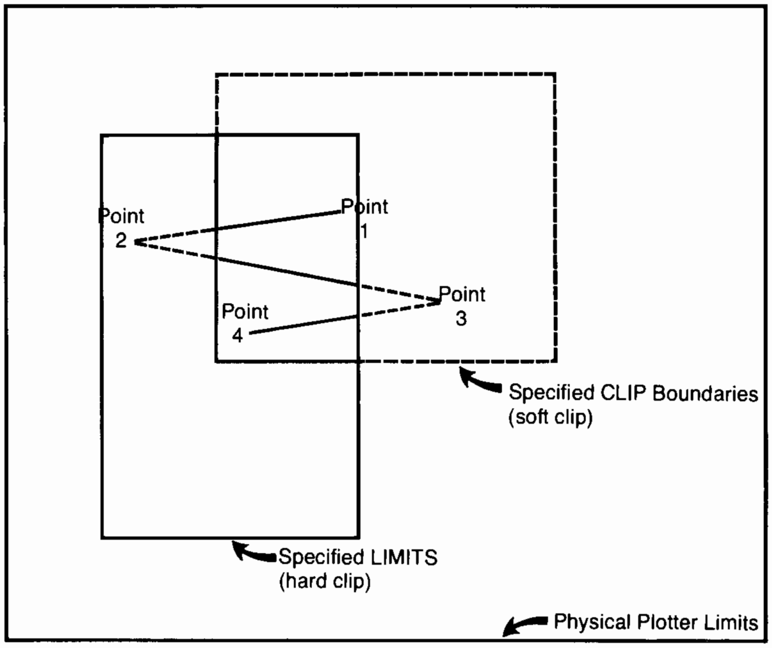




```
1      REM  *** This is the continuing example (CONT12)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
40   GRAPHICS                          ! Enables the CRT
50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
●70  CLIP 30,120,30,100                ! Defines the SOFT CLIP area
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
280   READ Label$                      ! READs data
300  NEXT X_label                      ! Repeats loop
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
480 Copies:  !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
500   END
```



Plotting in GDUs



Plotting in UDUs

These two figures show the clipping action to expect when drawing a line from point 1, to point 2, to point 3 and then to point 4. The rectangles represent clipping boundaries or limits for the associated statements (LIMIT and CLIP).

Notice that the line drawn in the first figure (plotted in GDU's) is clipped only by the hard clip limits, and the line drawn in the second figure (plotted in UDU's) is clipped at the soft (CLIP) boundaries.

Another feature of CLIP is that you can specify a soft clip area greater than the hard clip area. The System 45B calculates the plots outside the hard clip area, and the plotted lines re-enter the soft clip area at the appropriate points.

In effect, the hard clip area then becomes a ''window'', while the soft clip area is the known plotting area. If you wished, you could set the hard clip limits to be the acceptable parameters of a test, while the soft clip limits could be the results of the test. Any line types which were plotted could then represent satisfactory test results.

UNCLIP Statement

The UNCLIP statement sets the soft clip boundaries equal to the hard clip limits. This allows you to draw lines anywhere in the plotting area defined by the LIMIT statement while in UDUs. It is primarily used whenever a LOCATE or CLIP statement has changed the soft clip area from the default hard clip area.

Syntax:

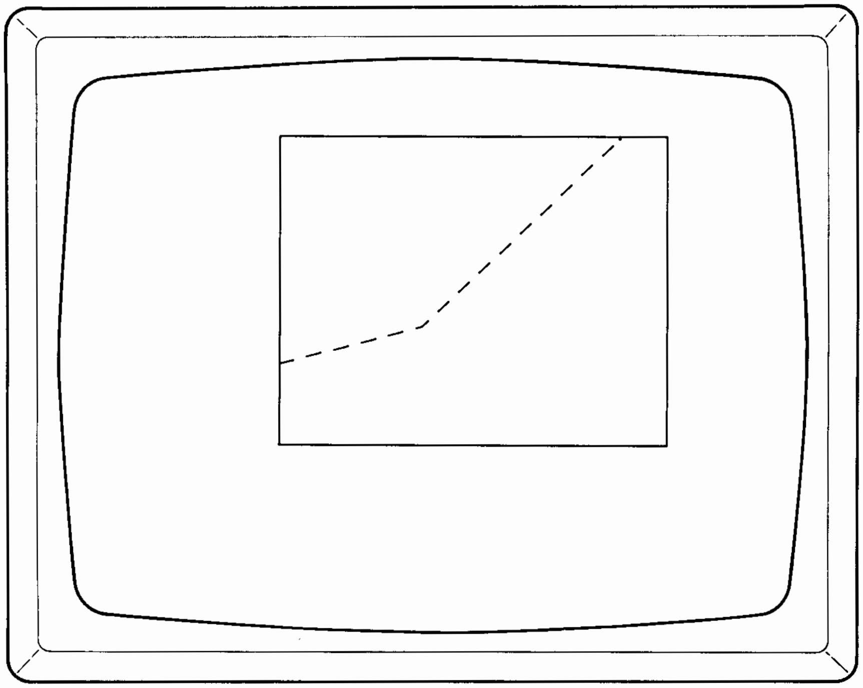
```
    UNCLIP
```

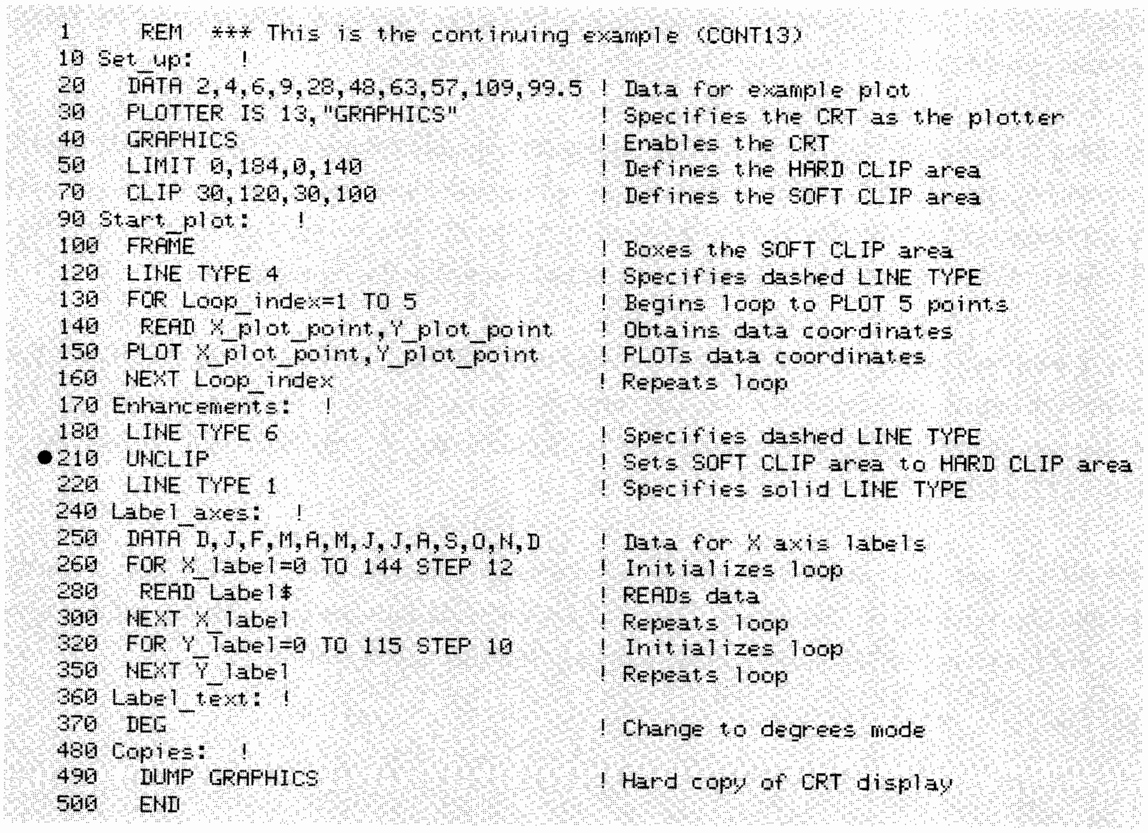
Clipping is set by executing PLOTTER IS, LIMIT, LOCATE, or CLIP statements. SCALE and SHOW do not affect the clipping limits.

NOTE

Executing an UNCLIP statement **does not** override the scaled area defined by a LOCATE statement.

Example





```
1      REM  *** This is the continuing example (CONT13)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
40   GRAPHICS                          ! Enables the CRT
50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
●210  UNCLIP                           ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
280   READ Label$                      ! READs data
300  NEXT X_label                      ! Repeats loop
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
480 Copies:  !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
500   END
```

LOCATE Statement

The LOCATE statement allows you to define an area which the SCALE statement dimensions or the SHOW statement fills. The LOCATE statement also defines and resets the default soft clip boundaries.

Syntax:

```
LOCATE [X min, X max, Y min, Y max]
```

The first two parameters specify the left and right boundary limits and the last two parameters specify the lower and upper boundary limits.

The units are **always** in Graphic Display Units (GDU) 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 shorter side of the plotting area. Therefore, the length of the shorter side is always 100 GDU's. The length of the longer side of the plotting area is something greater than 100 depending on the plotting area aspect ratio. The aspect ratio can be found using the RATIO function as shown later.

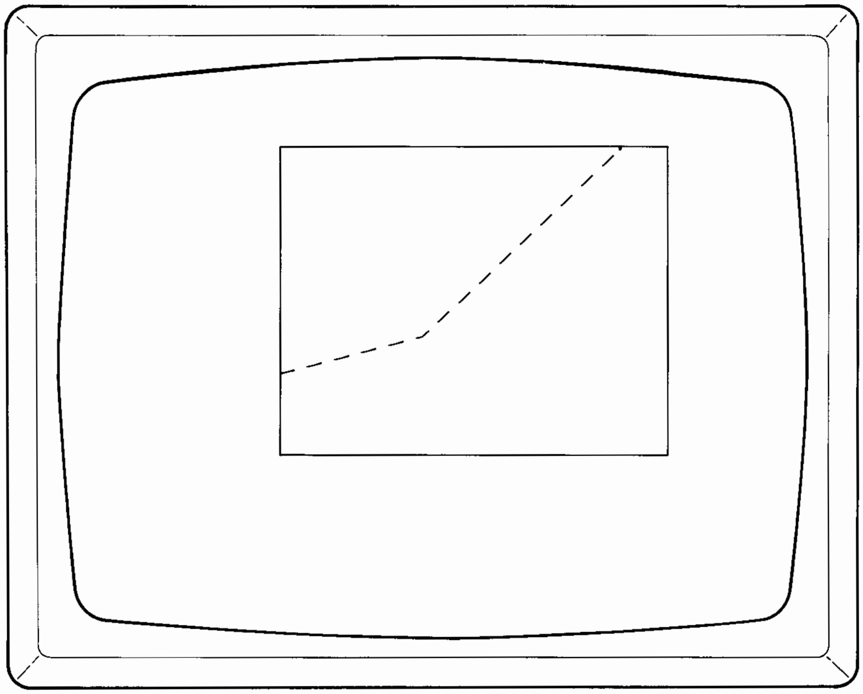
Executing the LOCATE statement without parameters allows you to specify the area by digitizing two opposite corners (the lower-left and upper-right corners).

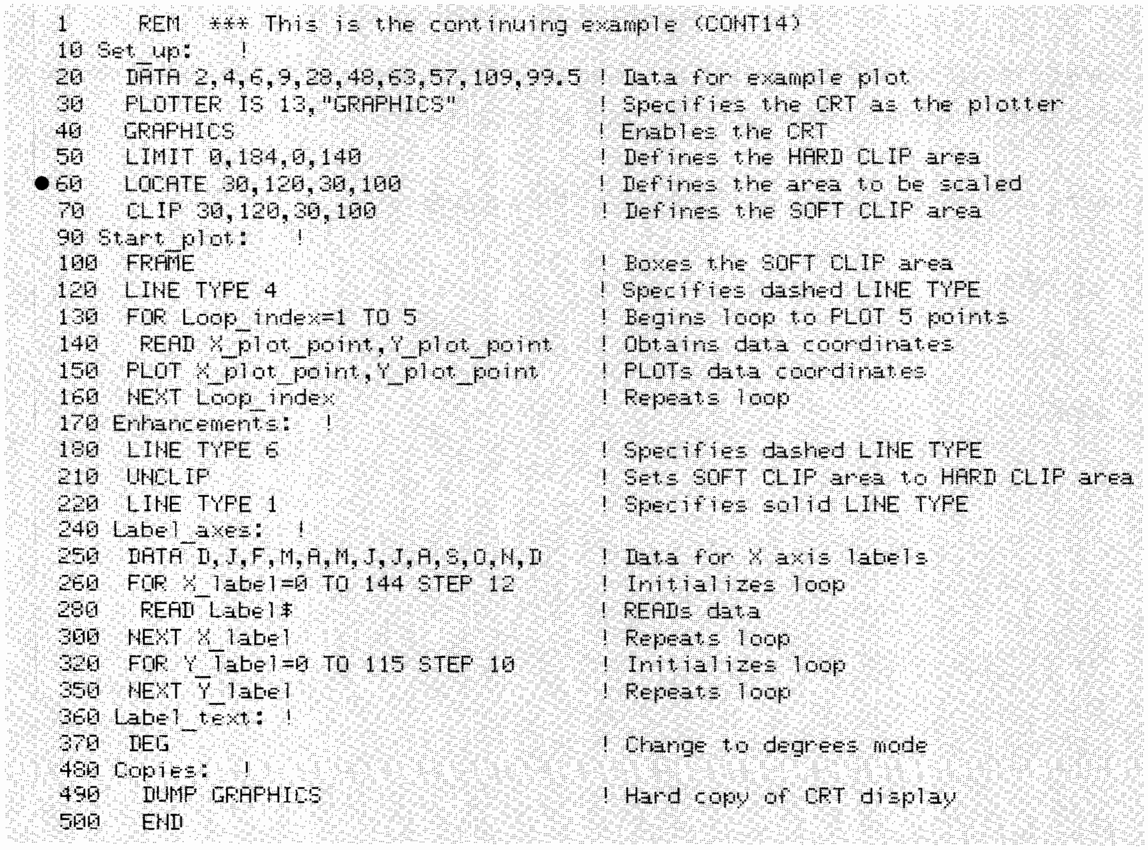
All lines drawn while in the UDUs mode and after executing the LOCATE statement do not extend beyond the soft clip boundaries. The pen can be positioned between the soft clip boundaries and the hard clip limits to draw labels, but plotted lines do not extend into this area. Plotting in GDUs, you can always draw lines anywhere within the hard clip area.

The default physical length of the shorter side of all plotting devices is 100 GDUs but the default length of the longer side is device dependent. For the CRT, the default length of the longer side is the length/height aspect ratio times the height of 100 GDUs (559÷ 454x100 = 123.127753304).

The SCALE and SHOW statements assign user definable units of measure (UDU's) to the area specified by the LOCATE statement. The SCALE and SHOW statements act on this area in two very different ways as can be seen in the next two sections of this manual.

Example





```
 1      REM  *** This is the continuing example (CONT14)
 10 Set_up:   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 40   GRAPHICS                          ! Enables the CRT
 50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
●60   LOCATE 30,120,30,100              ! Defines the area to be scaled
 70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
 90 Start_plot:   !
 100  FRAME                             ! Boxes the SOFT CLIP area
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
 210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 480 Copies:  !
 490   DUMP GRAPHICS                    ! Hard copy of CRT display
 500   END
```

Statement	Effect on Hard Clip Limits	Effect on Soft Clip Limits	Effect on Scaling Points
PLOTTER IS	Reads the hardware P1 and P2.	Sets to hardware P1 and P2.	Sets to hardware P1 and P2.
LIMIT	Sets boundaries to area specified or digitized by LIMIT statement.	Sets to hard clip limits or digitized boundaries of the 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

Scaling the Plotting Area

Once you have specified the plotting area to be scaled, you may wish to dimension, define, or scale it in units which are suitable to your particular application.

The following statements can be used to define the located area –

- SCALE
- SHOW
- MSCALE

SCALE Statement

The SCALE statement defines minimum and maximum values of X and Y for the plotting area as specified by the LOCATE statement. This allows you to specify your own units for plotting.

Syntax:

```
SCALE X min, X max, Y min, Y max
```

This statement automatically sets the current units to the User Defined Units (UDU's) mode.

The first two parameters specify the values represented by the left and right boundary of the area specified by the LOCATE statement. The last two parameters specify the values represented by the lower and upper boundary in a similar manner.

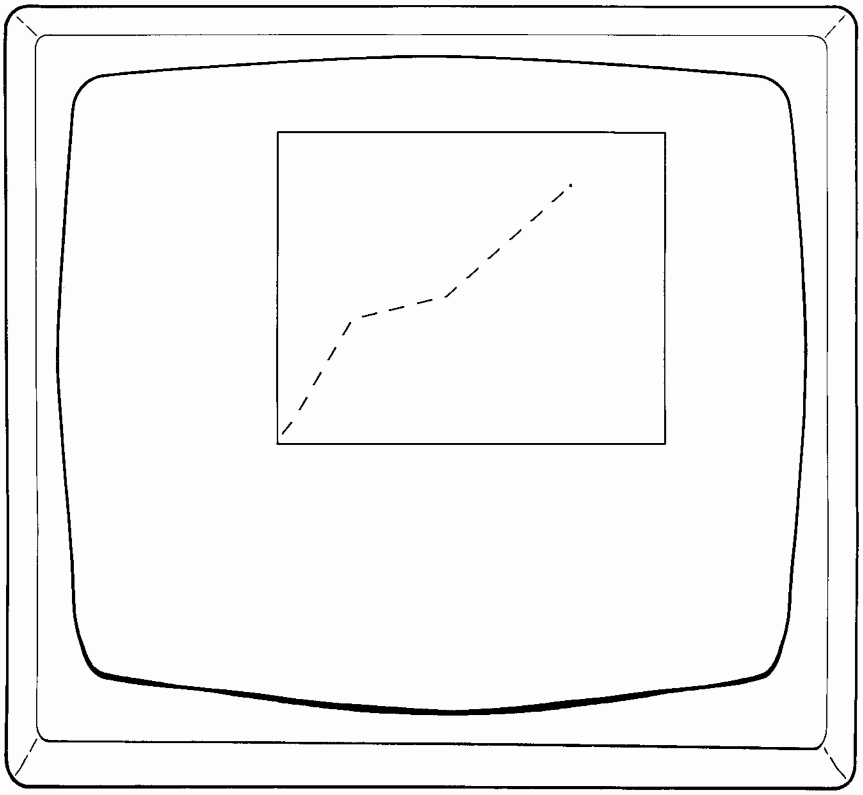
For example, the first two parameters of the SCALE statement could specify the left edge of the plotting area as −20 and the right edge as 30. This has the effect of dividing the horizontal plotting distance into 50 units (30 − (−20) =50). The last two parameters could specify different values and therefore a different scale 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.

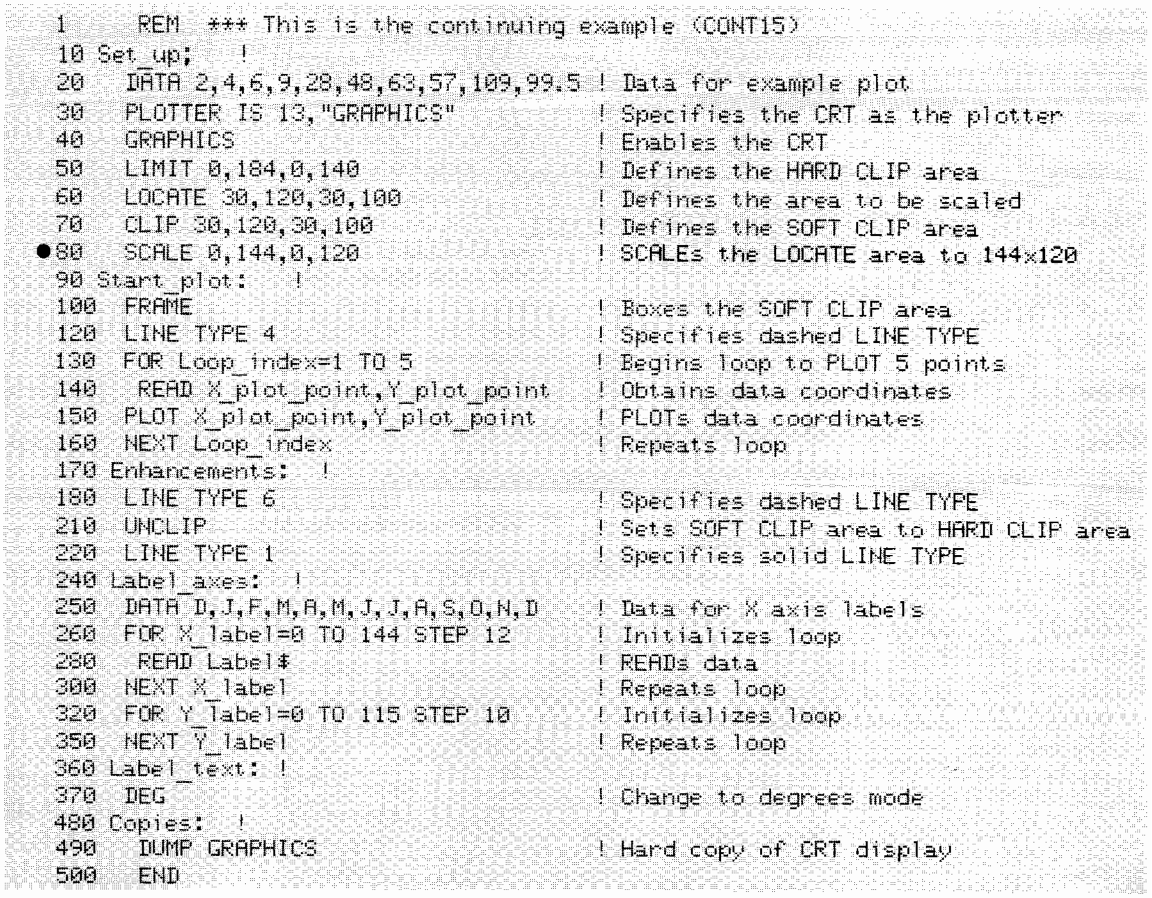
For example, if you wanted to plot the average annual rainfall at a weather station for a 10 year period, the SCALE statement might look like this:

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

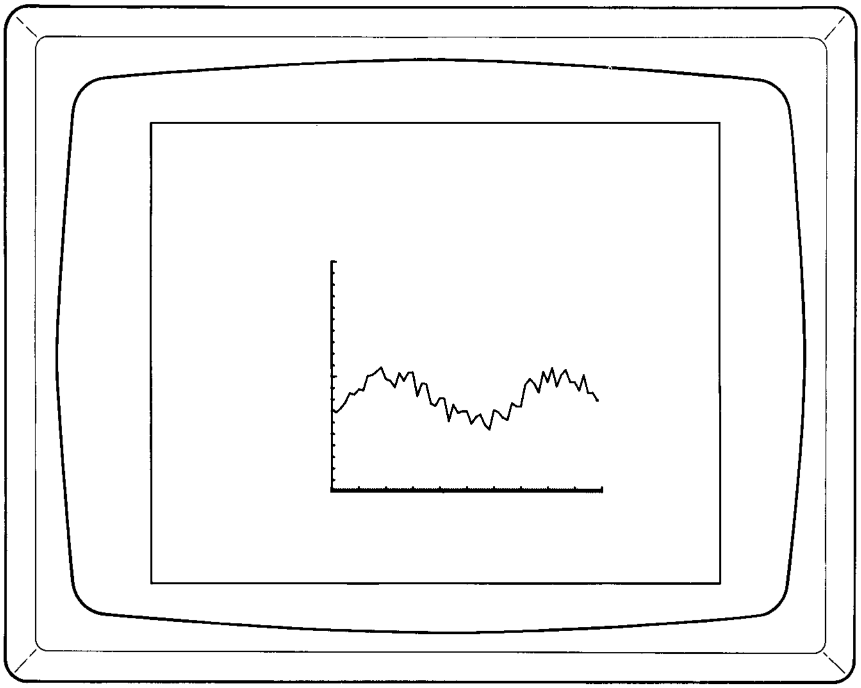
where the left edge represents the year 1966 and the right edge represents 1976. Rainfall would be plotted in the Y direction in units of depth (e.g. inches). This allows the data to be plotted in years and inches (e.g. 1976, 7) directly on the plotter.

Examples





```
 1      REM  *** This is the continuing example (CONT15)
 10 Set_up;   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 40   GRAPHICS                          ! Enables the CRT
 50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
 60   LOCATE 30,120,30,100              ! Defines the area to be scaled
 70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
●80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
 90 Start_plot:   !
 100  FRAME                             ! Boxes the SOFT CLIP area
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
 210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 480 Copies:  !
 490   DUMP GRAPHICS                    ! Hard copy of CRT display
 500   END
```



```
 1      REM  ** This is the SCALE example (SCALE)
 2      REM  ** In this example, the X axis is SCALEd to represent the
 3      REM  ** years from 1966 to 1976. The Y axis is SCALEd to represent
 4      REM  ** from 0 to 20 inches of rainfall.
 5      REM  *******************************************************************
 10     PLOTTER IS 13,"GRAPHICS"  ! Specifies the CRT as the plotter
 20     GRAPHICS                  ! Enables the CRT
 30     FRAME                     ! Draws a FRAME around the SOFT CLIP area
 40     LOCATE 40,100,20,70       ! LOCATE an area within the SOFT CLIP area
● 50    SCALE 1966,1976,0,20      ! SCALEs the LOCATE area to 10x20
 60     AXES 1/12,1,1966,0,12,10  ! Draws AXES for the plot
 61     REM  ** The next section PLOTs using random data
 62     REM  ** lines 80,90,100 generate and PLOT the random data
 63     REM  *******************************************************************
 70     MOVE 1966,0               ! MOVE to lower left corner of plot
 80     FOR Random_data=1966 TO 1976 STEP 1/6
 90         PLOT Random_data,RND*2+7+2*SIN(Random_data)
 100    NEXT Random_data
 110    END
```

SHOW Statement

The SHOW statement displays an area within the LOCATE rectangle where one unit of X equals one unit of Y.

Syntax:

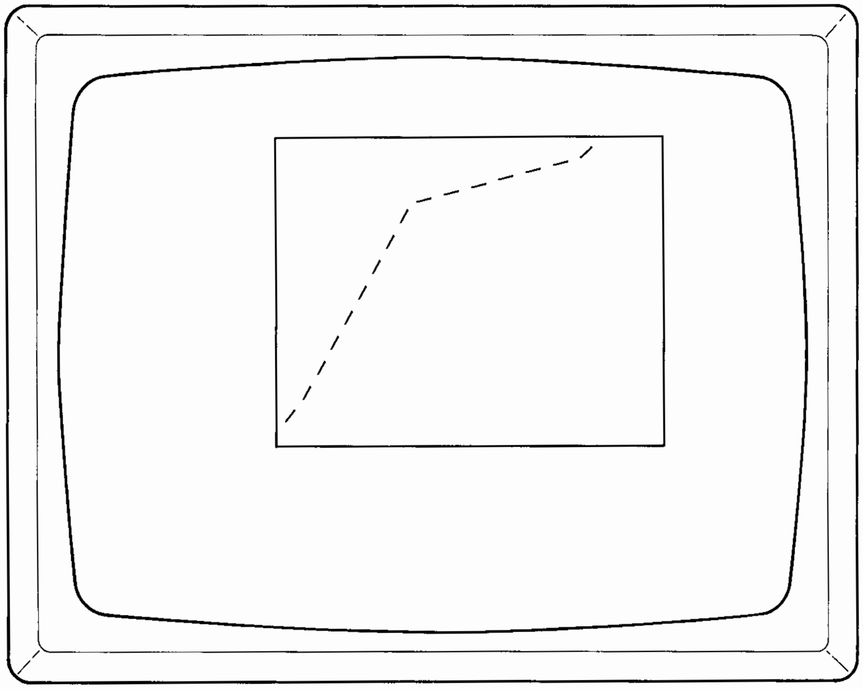
SHOW X min, X max, Y min, Y max

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

The SHOW statement defines an area that is stretched or shrunk proportionately in the X and Y directions so that the specified area fits into the plotting area defined by default or by the LOCATE statement. The aspect ratio of the units is forced to be equal to one (1) by the SHOW statement. That is, one unit of measure in the X direction is equal to one unit of measure in the Y direction (isotropic scaling).

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 where inches of rainfall and years were used as units of measure. But SHOW should 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.

Example



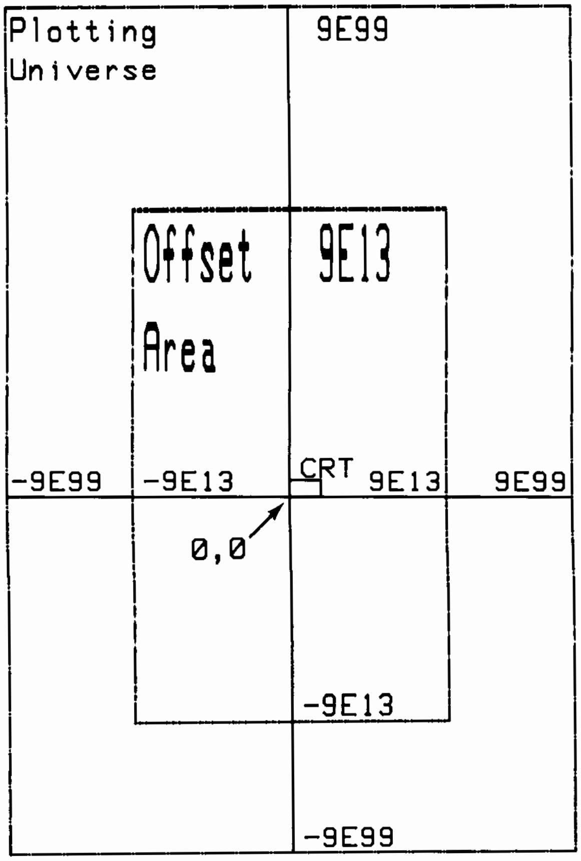
```
 1     REM  *** This is the continuing example (CONT16)
 10 Set_up:   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 40   GRAPHICS                          ! Enables the CRT
 50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
 60   LOCATE 30,120,30,100              ! Defines the area to be scaled
 70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
 80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
●85   SHOW 0,80,0,60                    ! SHOW's area as 1 unit of X= 1 unit of Y
 90 Start_plot:   !
 100  FRAME                             ! Boxes the SOFT CLIP area
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
 210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 480 Copies:  !
 490   DUMP GRAPHICS                    ! Hard copy of CRT display
 500   END
```

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. On the CRT and the thermal printer, metric units are only approximate (i.e. .033 cm per dot).

Syntax:

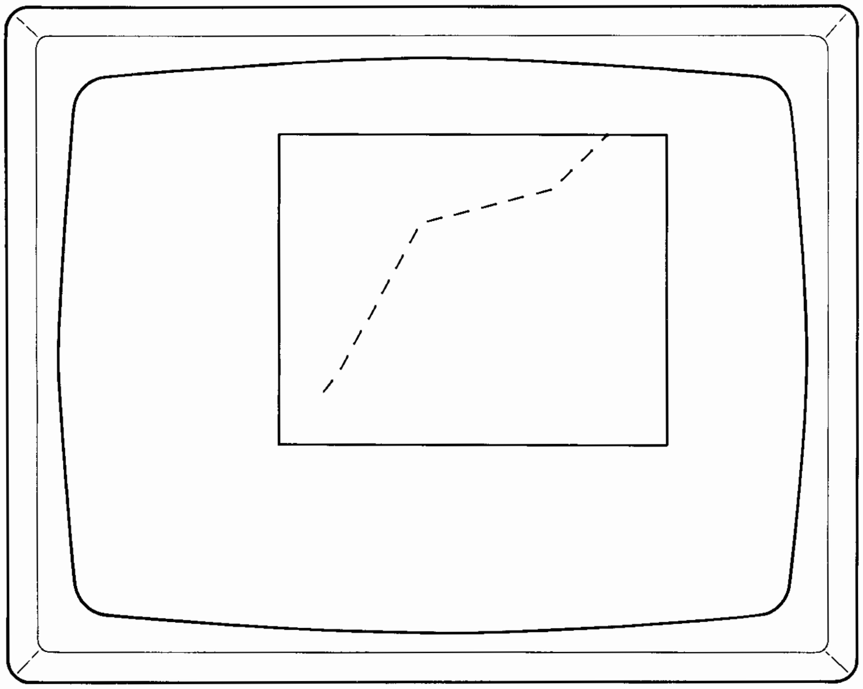
MSCALE X offset, Y offset

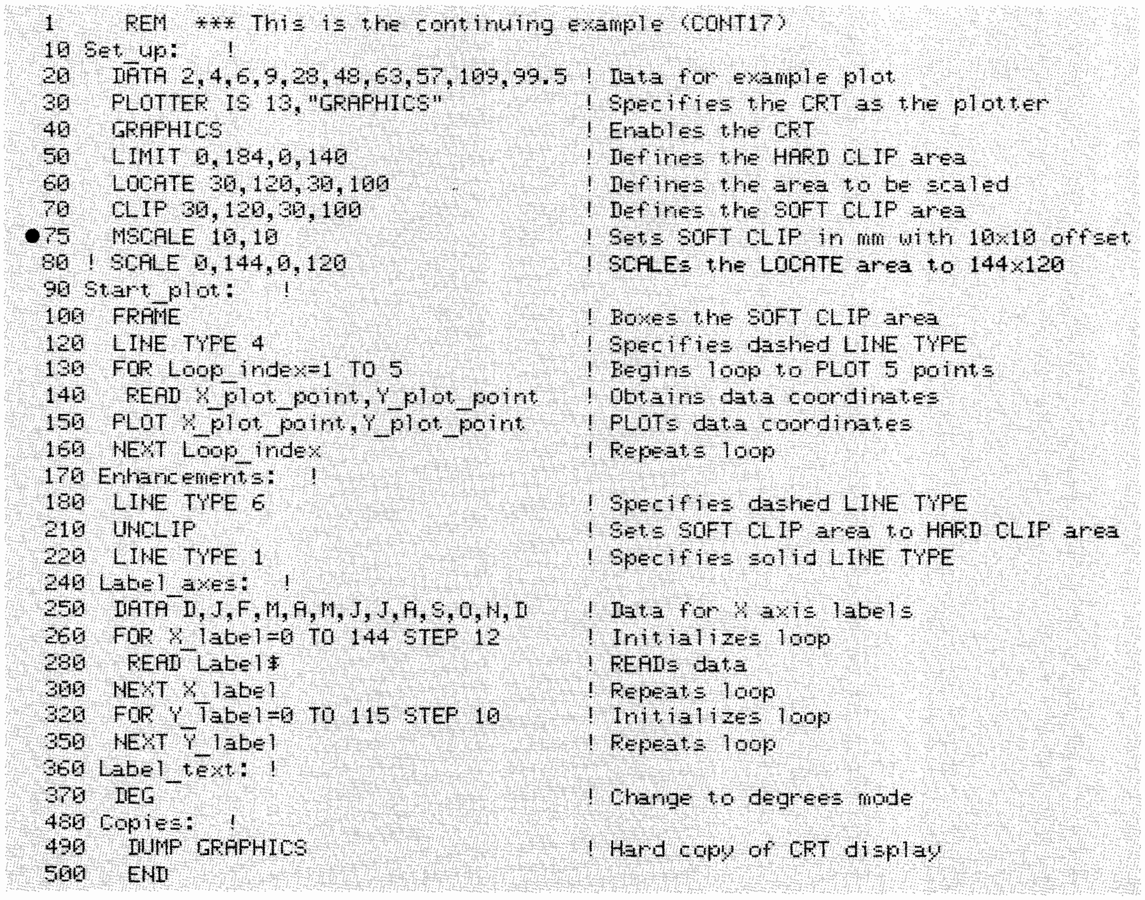
MSCALE specifies the current user units as millimetres. Once the MSCALE statement has been executed, the soft clip area is defined as follows:



with the CRT displaying only the area shown. The offset position allows you to position the "window" of the CRT anywhere within the range of from −9 E 13 to 9 E 13.

Example





```
1     REM  *** This is the continuing example (CONT17)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
40   GRAPHICS                          ! Enables the CRT
50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
60   LOCATE 30,120,30,100              ! Defines the area to be scaled
70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
●75   MSCALE 10,10                      ! Sets SOFT CLIP in mm with 10x10 offset
80 ! SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
280   READ Label$                      ! READs data
300  NEXT X_label                      ! Repeats loop
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
480 Copies:  !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
500   END
```

More About Plotting Units

The System 45B gives you the choice of using either the graphic display units (GDUs) or the user defined units (UDUs).

The GDUs are always dimensioned with the shorter side of the hard clip area (either horizontal or vertical) equal to 100. The longer side then becomes equal to 100 times the ratio of the longer side divided by the shorter side.

GDUs allow plotter space access on a percent of full scale basis. Some people prefer to do their plotting in UDUs and then switch back to GDUs to position the pen for labeling their plots.

User defined units are defined by the most recently executed SCALE, SHOW, or MSCALE statement.

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

SETGU and SETUU Statements

Several graphic statements (as indicated) interpret their parameters using the units currently selected. These two statements provide the means to change the units mode.

Syntax:

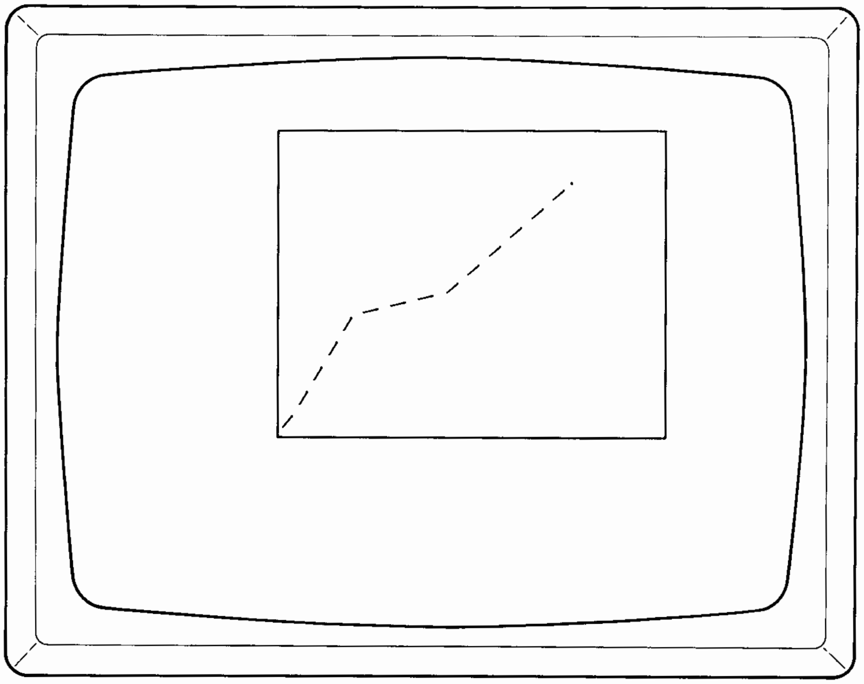
```
SETGU or SETUU
```

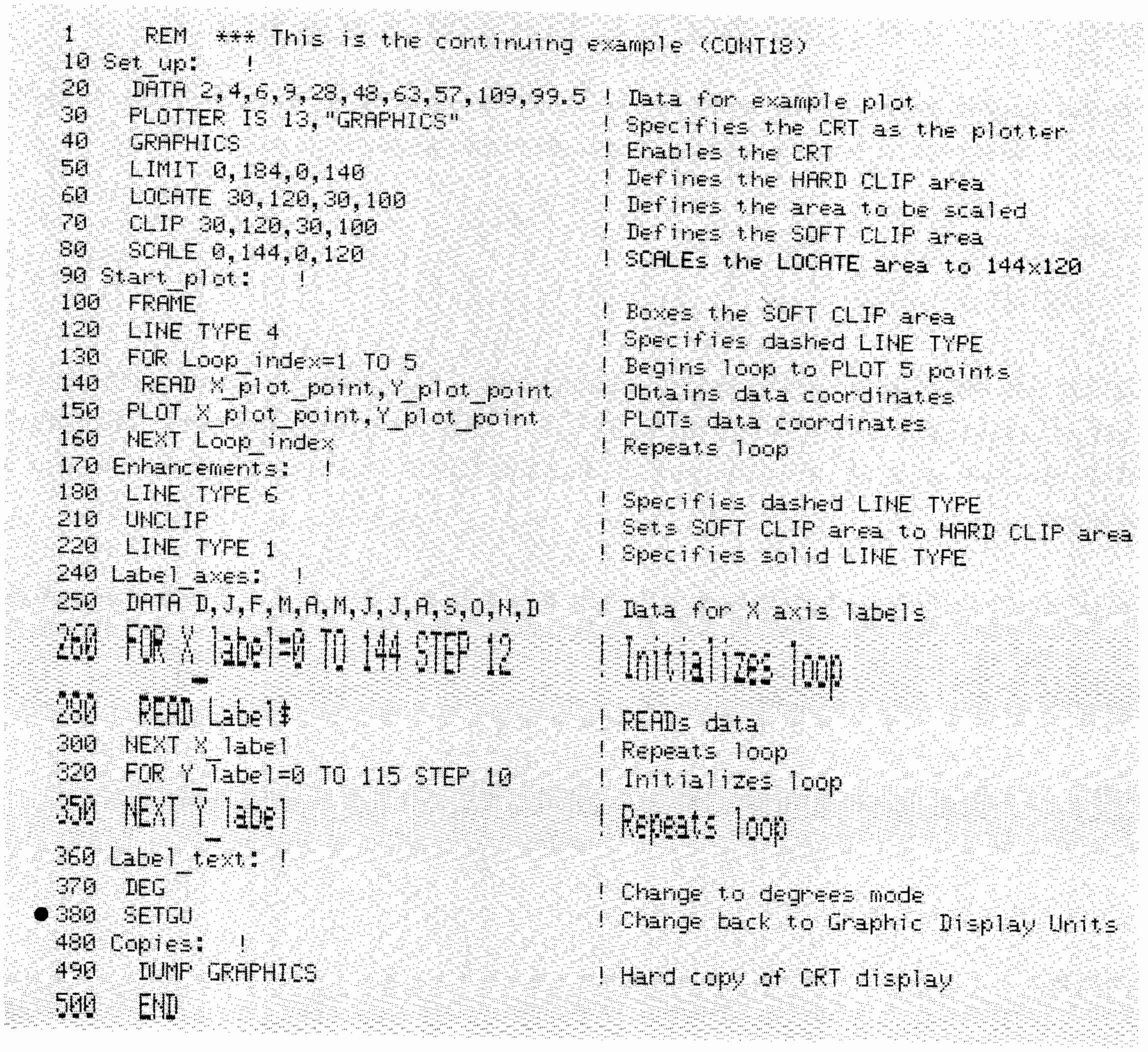
SETGU sets the current units to graphic display units. SETUU sets the current units to user defined units. UDUs are also set by the PLOTTER IS and the LIMIT statements. The default UDUs are defined to be equivalent to GDUs until a SCALE, SHOW or MSCALE statement is executed.

GDUs are primarily intended to position the pen on the plotting device (i.e., the plotting area as specified by the LIMIT statement).

UDUs are defined by the most recently executed SCALE, SHOW or MSCALE statement.

Example





```
1     REM  *** This is the continuing example (CONT18)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
40   GRAPHICS                          ! Enables the CRT
50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
60   LOCATE 30,120,30,100              ! Defines the area to be scaled
70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
280   READ Label$                      ! READs data
300  NEXT X_label                      ! Repeats loop
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
●380  SETGU                            ! Change back to Graphic Display Units
480 Copies:  !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
500   END
```

RATIO Function

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.

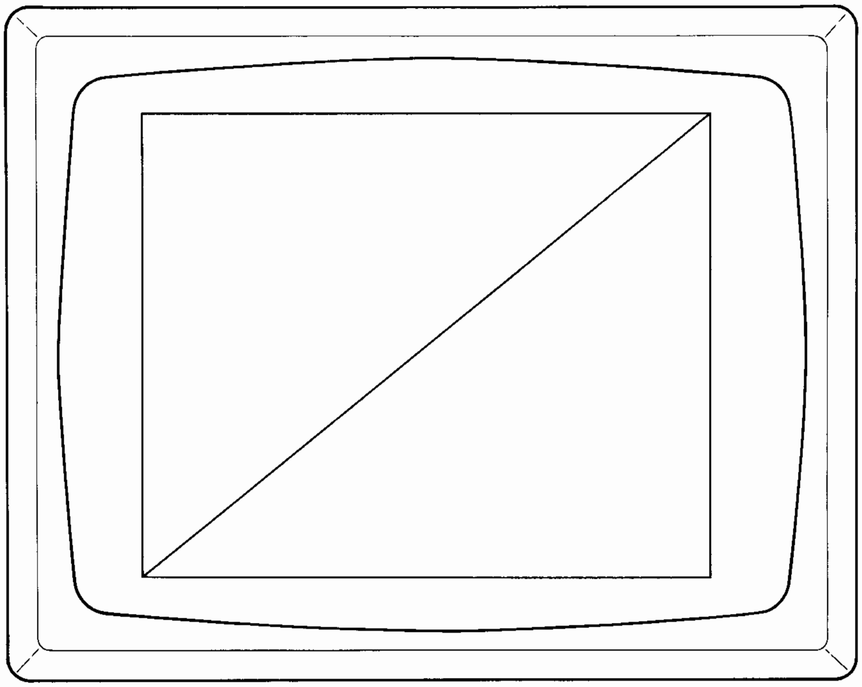
Syntax:

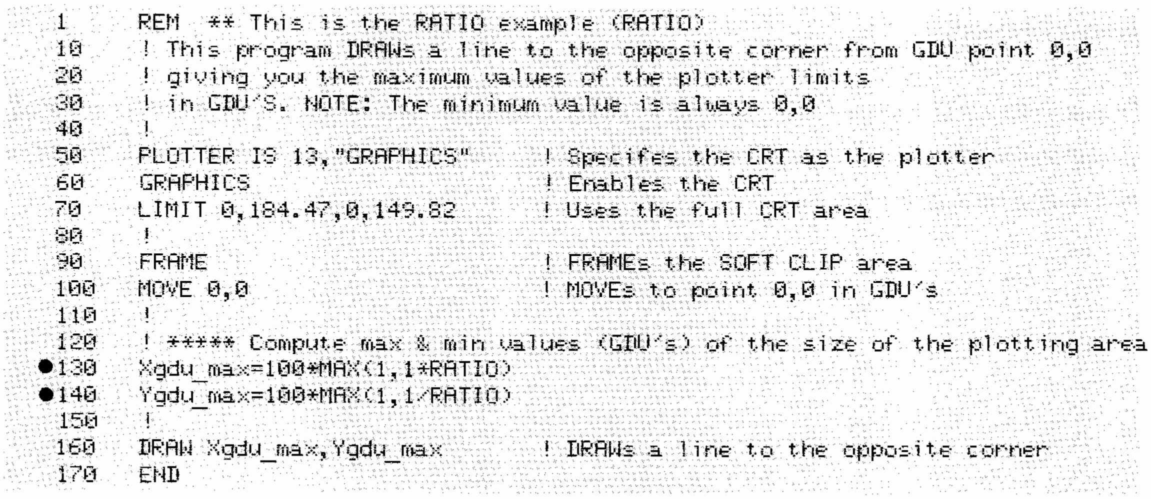
```
RATIO
```

The function can be used to find the maximum length of the longer side of the hard clip area. If the X axis is the longer axis, the ratio is >1; if the X axis is the shorter axis, the ratio is <1.

The following program always moves the pen to the opposite corner of point 0, 0 (in GDU's) regardless of the size or shape of the plotting area.

Example





```
 1     REM  ** This is the RATIO example (RATIO)
 10    ! This program DRAWs a line to the opposite corner from GDU point 0,0
 20    ! giving you the maximum values of the plotter limits
 30    ! in GDU'S. NOTE: The minimum value is always 0,0
 40    !
 50    PLOTTER IS 13,"GRAPHICS"      ! Specifes the CRT as the plotter
 60    GRAPHICS                      ! Enables the CRT
 70    LIMIT 0,184.47,0,149.82       ! Uses the full CRT area
 80    !
 90    FRAME                         ! FRAMEs the SOFT CLIP area
 100   MOVE 0,0                      ! MOVEs to point 0,0 in GDU's
 110   !
 120   ! ***** Compute max & min values (GDU's) of the size of the plotting area
●130   Xgdu_max=100*MAX(1,1*RATIO)
●140   Ygdu_max=100*MAX(1,1/RATIO)
 150   !
 160   DRAW Xgdu_max,Ygdu_max        ! DRAWs a line to the opposite corner
 170   END
```

Summary

The following graphics programming statements were covered in this chapter –

- LIMIT
- CLIP
- UNCLIP
- LOCATE
- SCALE
- SHOW
- MSCALE
- SETGU
- SETUU
- RATIO

In this chapter you learned what current units are, how to position your plots on your graphics device, and how to scale those plots on your graphics device so the data which is plotted can be easily interpolated.

The next chapter covers some plotting enhancements, such as relative and absolute plotting, changing the direction of your plots, and laying out your plots by marking your X and Y axes or by plotting on a grid.

Plotting Enhancements

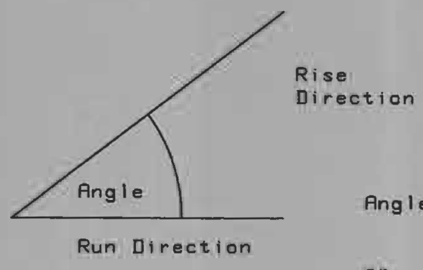
Terms

- Absolute Plotting – Plotting to a coordinate which has its X and Y values specified in the current user units.
- Relative Plotting – Plotting which specifies plotting from an origin rather than to a specific X,Y coordinate.
- Origin – The coordinate point at which a plotting operation begins.
- Plotted Point – The point which has been plotted or drawn to.

Pen Control Parameters

Odd	= Drop pen (pen down or start line generation)
Even	= Lift pen (pen up or stop line generation)
Positive	= Pen change after motion
Negative	= Pen change before motion

Implementing an Angular Tangent



```
Angle equals
        36.8698976457 Degrees
or
        Run = 4  Rise = 3
```

Chapter 4

Overview

There are other statements which enable the plotting of data. You can use the MOVE statement to move the pen; you can draw a line with the DRAW statement.

Your plotting can be done in either of two ways, absolute or relative.

Absolute plotting uses a specific X-Y coordinate that is being plotted to. The PLOT statement does this, as does the DRAW statement.

Relative plotting bases its plot on an **origin** point. The origin can be the same place for successive RPLOT statements, or it can be the point which was plotted to last as in the IPLOT statement. In effect, the RPLOT statement references all of its lines to a local origin. The IPLOT statement's origin changes from plotted point to plotted point.

Interpolation of plots can be made easier by the use of the AXES and GRID statements. The AXES statement allows you to draw an axis, with tick marks, along either or both the X-Y axes. The GRID statement can be used to section the plotting area into a grid coordinate system.

Enhancing the Plotting Area

There are many ways to enhance your graphics plot. One of the most common enhancements is the use of axes to help your interpolation of the plot.

AXES Statement

The AXES statement draws a pair of axes, with optional, equally spaced, tick marks.

Syntax:

AXES [X tick spacing, Y tick spacing[, X intersection, Y intersection[, X major count, Y major count [, major-tick size]]]]

The X and Y tick-spacing parameter values are interpreted in current units. The sign of each parameter is ignored.

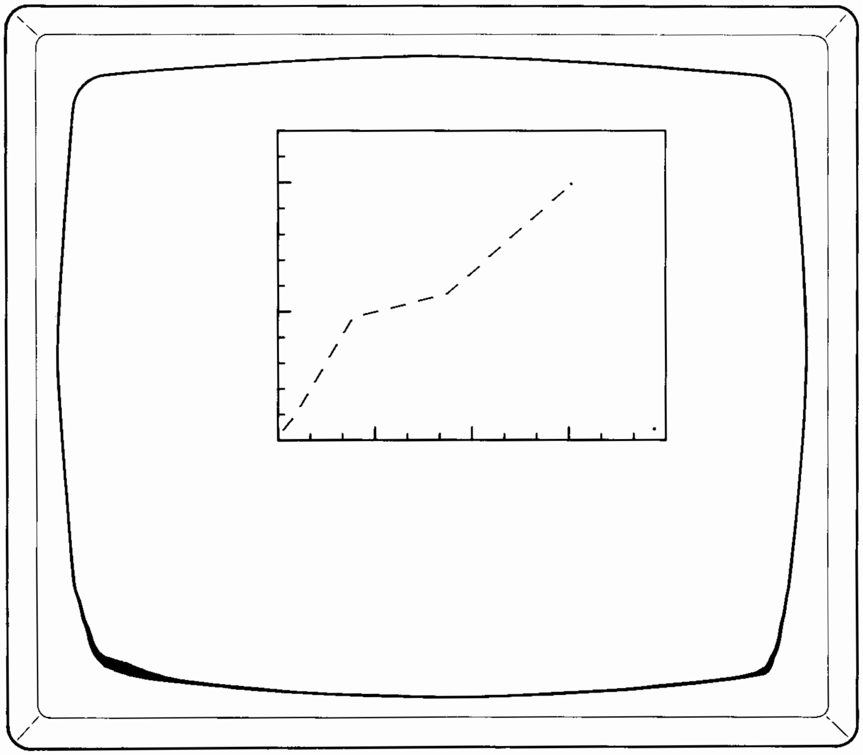
The AXES statement generates an X axis at the Y intersection and a Y axis at the X intersection, assuming that these values are within the current user units clipping limits. The axes extend across the soft clipping area. The default value for X and Y intersection is 0,0.

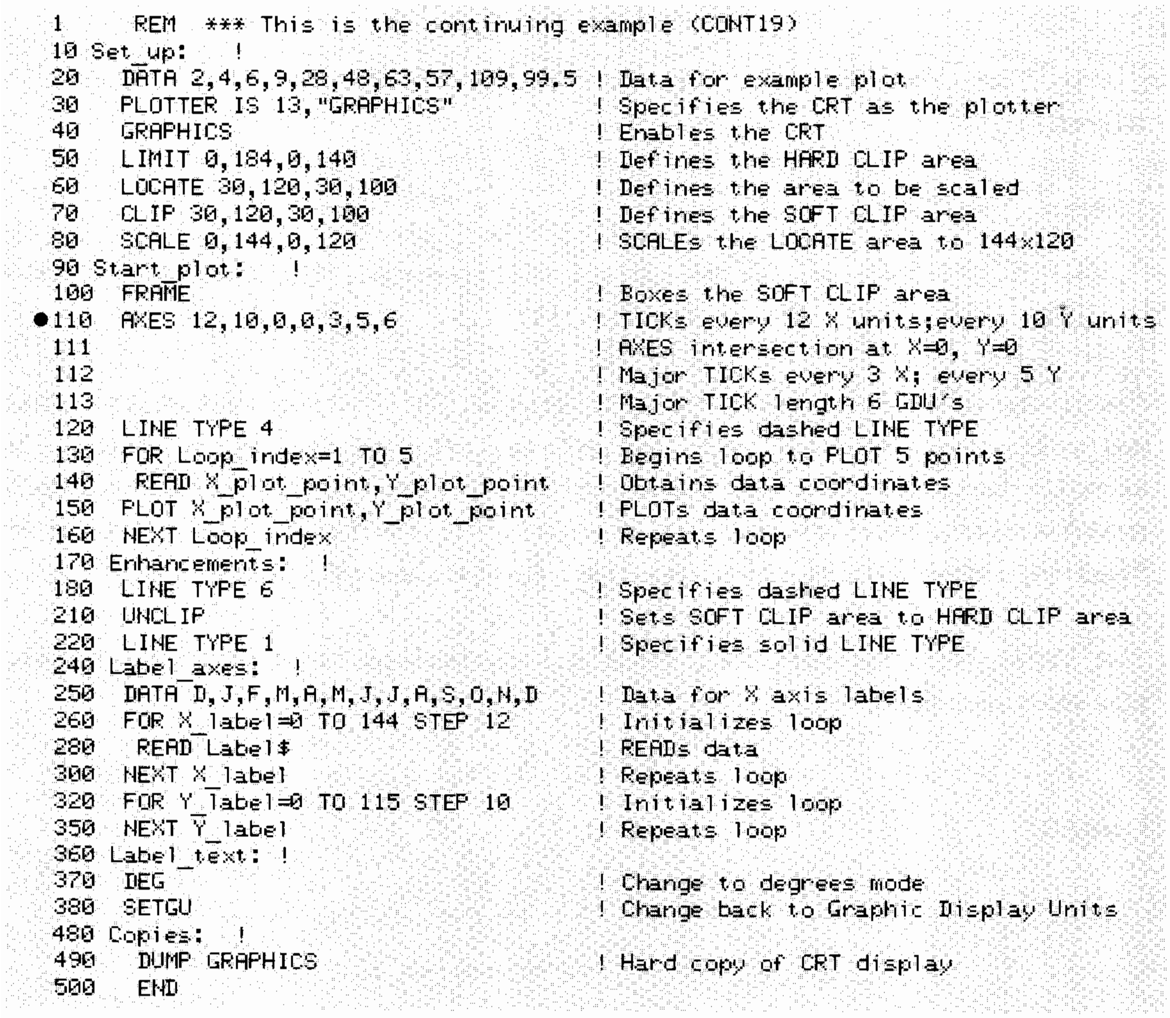
The X and Y major counts are unitless integer values which specify the number of minor tick intervals between major tick marks. The tick marks are positioned along each axis such that a major tick mark falls on the origin (whether visible or not). Tick marks may or may not coincide with the edge of the clipping boundary. The sign of each major count parameter is ignored and the default value for each is one (i.e. all major ticks).

The major-tick size specifies the length of the major tick marks (end to end) and like the minor tick marks, they are symmetric about the axes. The minor ticks are one half the length of the major ticks. The default size of the major tick marks is 2 GDU's. Both the major and minor tick marks are clipped at the soft clip limits.

Axes and tick marks are drawn using the current line type and pen number.

Example





```
 1      REM  *** This is the continuing example (CONT19)
 10 Set_up:   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 40   GRAPHICS                          ! Enables the CRT
 50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
 60   LOCATE 30,120,30,100              ! Defines the area to be scaled
 70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
 80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
 90 Start_plot:   !
 100  FRAME                             ! Boxes the SOFT CLIP area
●110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
 111                                    ! AXES intersection at X=0, Y=0
 112                                    ! Major TICKs every 3 X; every 5 Y
 113                                    ! Major TICK length 6 GDU's
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
 210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 380  SETGU                             ! Change back to Graphic Display Units
 480 Copies:  !
 490   DUMP GRAPHICS                    ! Hard copy of CRT display
 500   END
```

GRID Statement

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

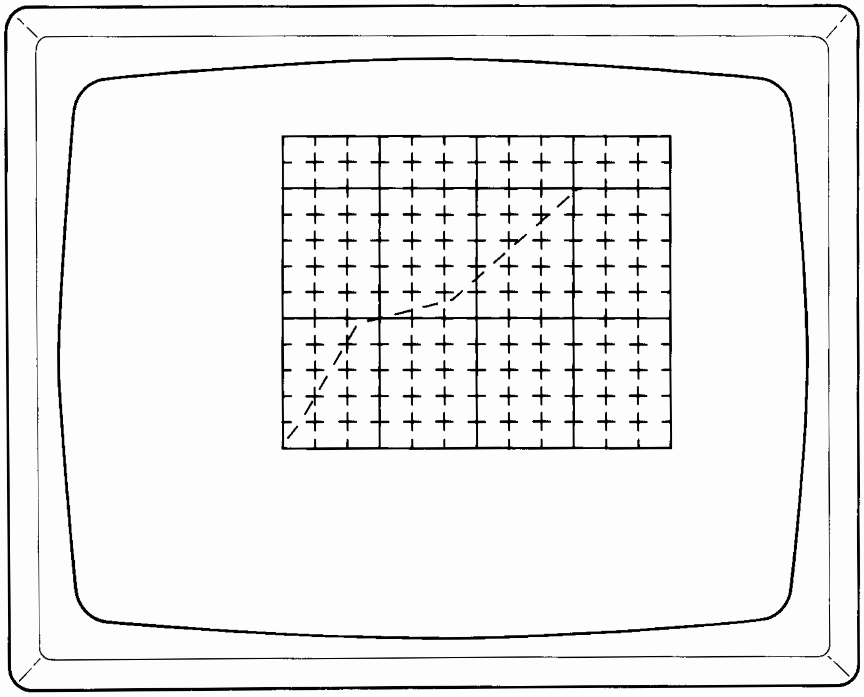
Syntax:

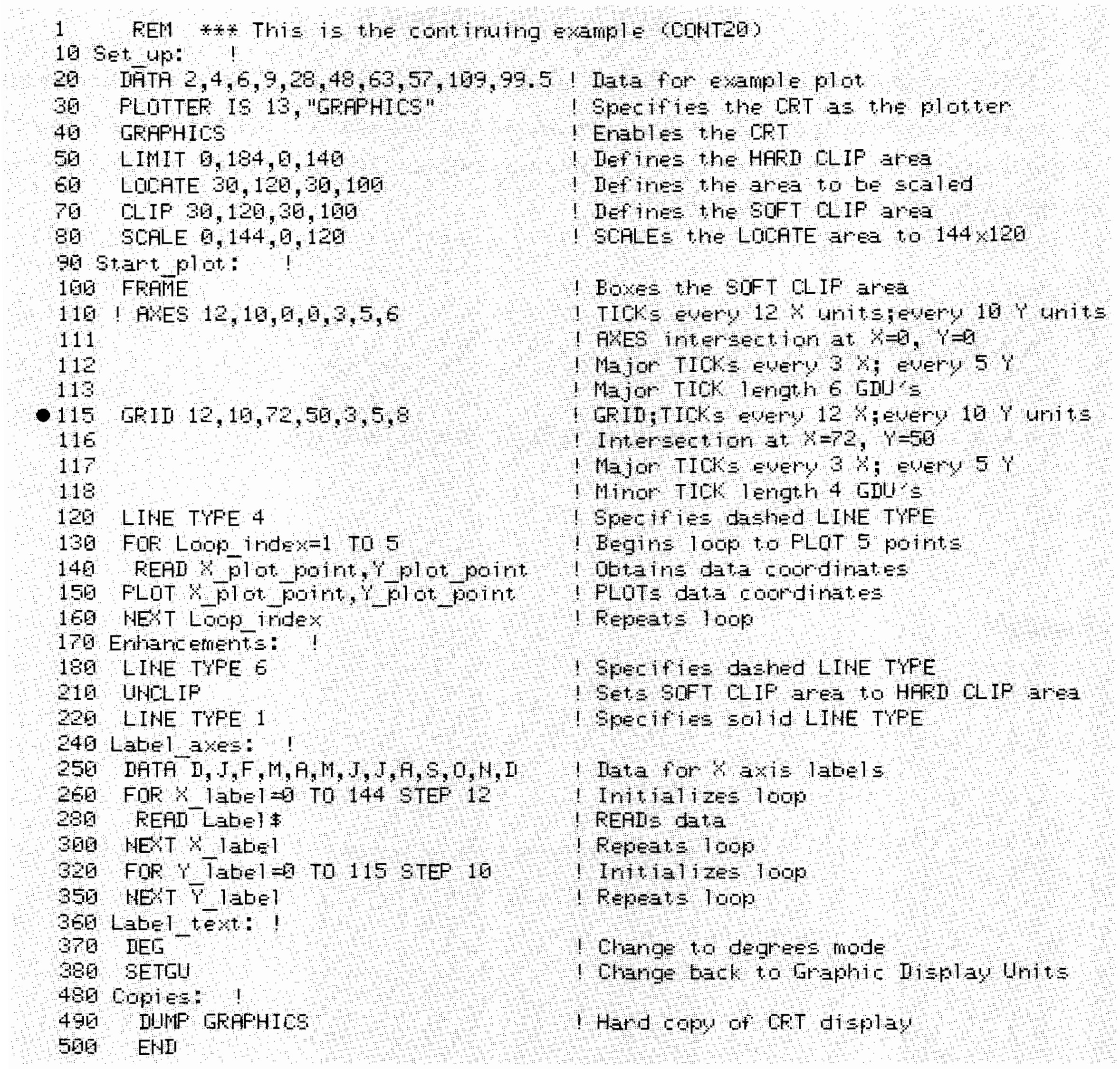
GRID [X tick spacing, Y tick spacing[, X intersection, Y intersection [, X major count, Y major count [, major-tick size]]]]

The parameters are the same as for the AXES statement. The GRID statement draws the major tick marks as lines extending across the soft clip area, located at the major count intervals. The minor tick mark intersections are drawn as cross ticks. The way to specify the minor tick size is to set the major tick mark size equal to twice whatever you want the minor tick mark size to be. Specifying a major tick mark size of 0 results in a dot at the minor tick mark intersection.

Also, like the AXES statement, the grid lines and tick marks are drawn using the current line type and pen number.

Example





```
1     REM  *** This is the continuing example (CONT20)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"         ! Specifies the CRT as the plotter
40   GRAPHICS                         ! Enables the CRT
50   LIMIT 0,184,0,140                ! Defines the HARD CLIP area
60   LOCATE 30,120,30,100             ! Defines the area to be scaled
70   CLIP 30,120,30,100               ! Defines the SOFT CLIP area
80   SCALE 0,144,0,120                ! SCALEs the LOCATE area to 144x120
90 Start_plot:   !
100  FRAME                            ! Boxes the SOFT CLIP area
110 ! AXES 12,10,0,0,3,5,6            ! TICKs every 12 X units;every 10 Y units
111                                   ! AXES intersection at X=0, Y=0
112                                   ! Major TICKs every 3 X; every 5 Y
113                                   ! Major TICK length 6 GDU's
●115  GRID 12,10,72,50,3,5,8          ! GRID;TICKs every 12 X;every 10 Y units
116                                   ! Intersection at X=72, Y=50
117                                   ! Major TICKs every 3 X; every 5 Y
118                                   ! Minor TICK length 4 GDU's
120  LINE TYPE 4                      ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5            ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point  ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point   ! PLOTs data coordinates
160  NEXT Loop_index                  ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                      ! Specifies dashed LINE TYPE
210  UNCLIP                           ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                      ! Specifies solid LINE TYPE
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D   ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12     ! Initializes loop
280   READ Label$                     ! READs data
300  NEXT X_label                     ! Repeats loop
320  FOR Y_label=0 TO 115 STEP 10     ! Initializes loop
350  NEXT Y_label                     ! Repeats loop
360 Label_text: !
370  DEG                              ! Change to degrees mode
380  SETGU                            ! Change back to Graphic Display Units
480 Copies:  !
490   DUMP GRAPHICS                   ! Hard copy of CRT display
500   END
```

MOVE Statement

The MOVE statement lifts the pen and then moves to the absolute X, Y coordinate 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 physical movement is restricted only by the hard clip limits.

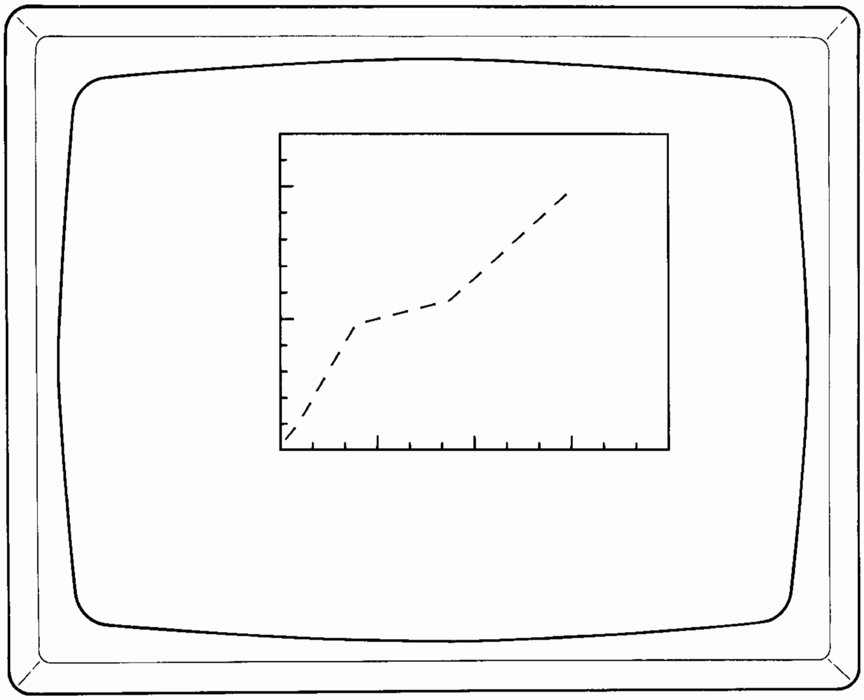
Syntax:

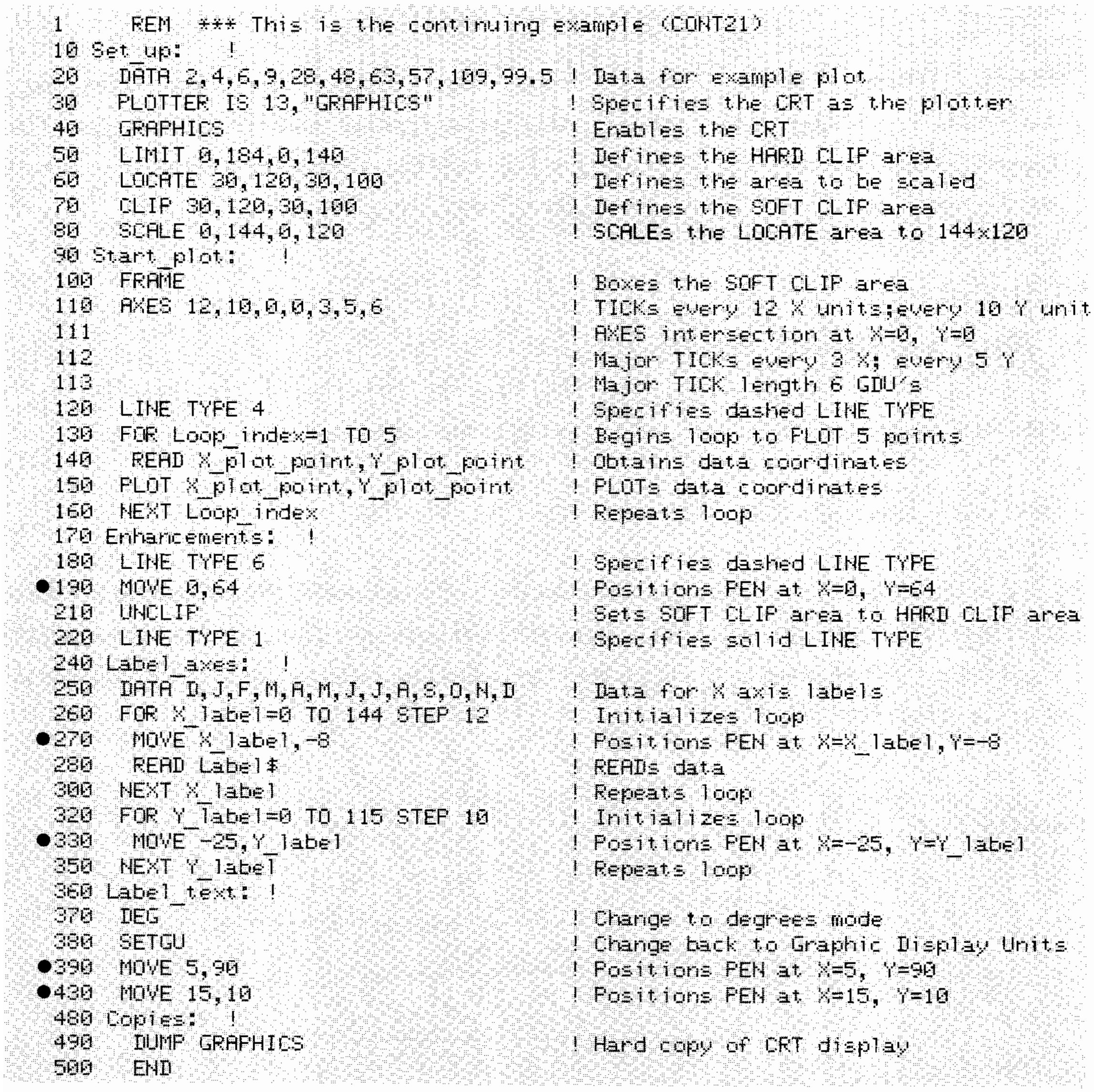
MOVE X parameter, Y parameter

The X and Y parameters are interpreted according to the current units.

MOVE X, Y is equivalent to PLOT X, Y,-2 .

Example





```
 1     REM  *** This is the continuing example (CONT21)
 10 Set_up:   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 40   GRAPHICS                          ! Enables the CRT
 50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
 60   LOCATE 30,120,30,100              ! Defines the area to be scaled
 70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
 80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
 90 Start_plot:   !
 100  FRAME                             ! Boxes the SOFT CLIP area
 110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
 111                                    ! AXES intersection at X=0, Y=0
 112                                    ! Major TICKs every 3 X; every 5 Y
 113                                    ! Major TICK length 6 GDU's
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
●190  MOVE 0,64                         ! Positions PEN at X=0, Y=64
 210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
●270   MOVE X_label,-8                  ! Positions PEN at X=X_label,Y=-8
 280   READ Label$                      ! READs data
 300  NEXT X_label                      ! Repeats loop
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
●330   MOVE -25,Y_label                 ! Positions PEN at X=-25, Y=Y_label
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 380  SETGU                             ! Change back to Graphic Display Units
●390  MOVE 5,90                         ! Positions PEN at X=5, Y=90
●430  MOVE 15,10                        ! Positions PEN at X=15, Y=10
 480 Copies:  !
 490   DUMP GRAPHICS                    ! Hard copy of CRT display
 500   END
```

DRAW Statement

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

Syntax:

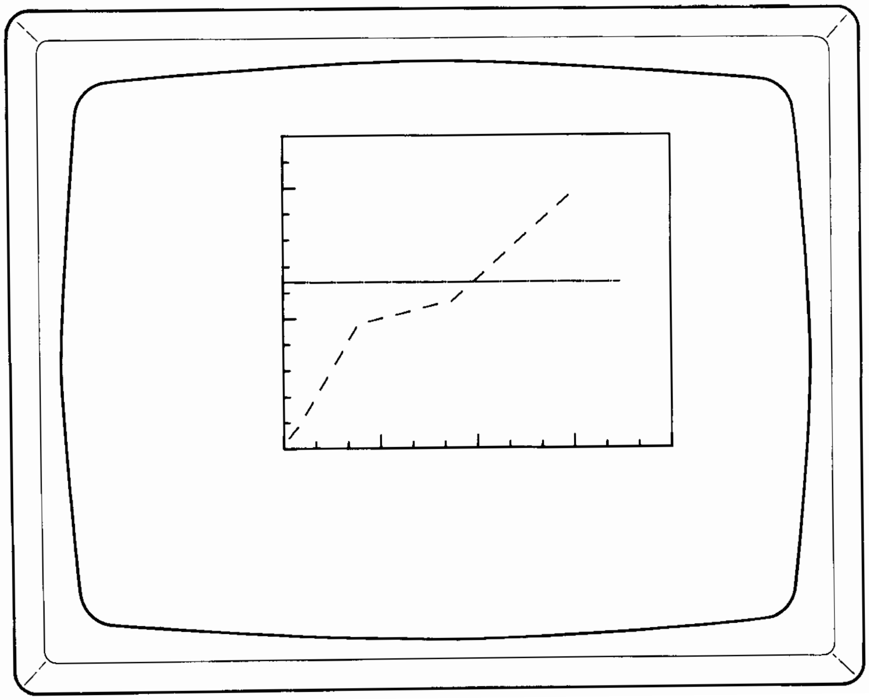
```
DRAW  X parameter,  Y parameter
```

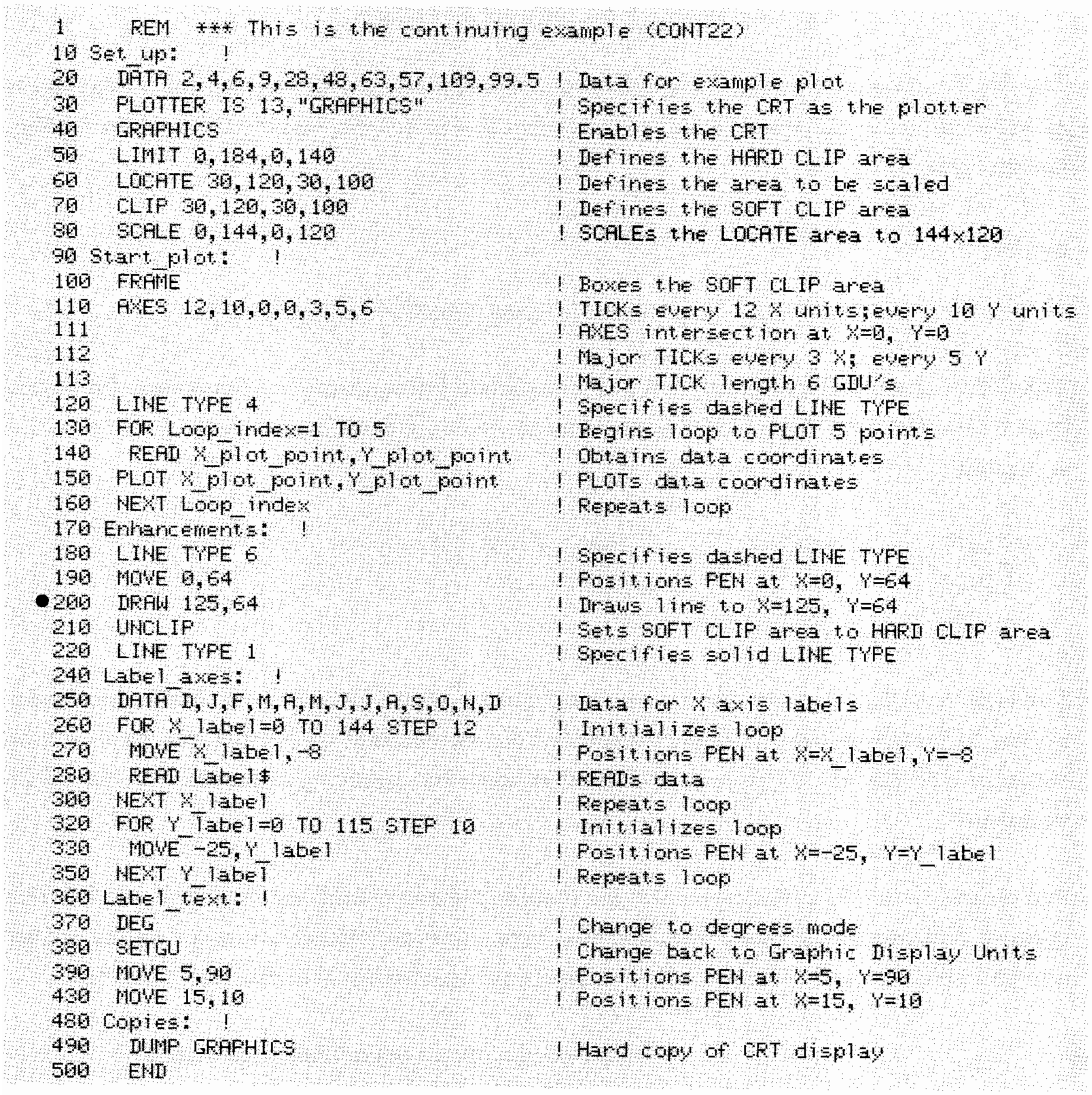
The X and Y parameters are interpreted according to the current units.

DRAW X, Y is equivalent to PLOT X, Y, -1.

The line that is drawn is clipped as described for the CLIP statement. When drawing in GDUs only the hard clip limits are used. That is, drawn lines extend no further than the hard clip limit in any direction. When drawing in UDUs the lines extend no further than the soft clip boundaries in any direction.

Example





```
1      REM  *** This is the continuing example (CONT22)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
40   GRAPHICS                          ! Enables the CRT
50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
60   LOCATE 30,120,30,100              ! Defines the area to be scaled
70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
111                                    ! AXES intersection at X=0, Y=0
112                                    ! Major TICKs every 3 X; every 5 Y
113                                    ! Major TICK length 6 GDU's
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
190  MOVE 0,64                         ! Positions PEN at X=0, Y=64
●200  DRAW 125,64                      ! Draws line to X=125, Y=64
210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
270   MOVE X_label,-8                  ! Positions PEN at X=X_label,Y=-8
280   READ Label$                      ! READs data
300  NEXT X_label                      ! Repeats loop
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
330   MOVE -25,Y_label                 ! Positions PEN at X=-25, Y=Y_label
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
380  SETGU                             ! Change back to Graphic Display Units
390  MOVE 5,90                         ! Positions PEN at X=5, Y=90
430  MOVE 15,10                        ! Positions PEN at X=15, Y=10
480 Copies:  !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
500   END
```

RPLOT Statement

The RPLOT statement provides capability for relative plotting with pen control. The origin is assumed to be the last absolute plotted point. 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        MOVE
FRAME       AXES        GRID
LABEL       IPLOT
```

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.

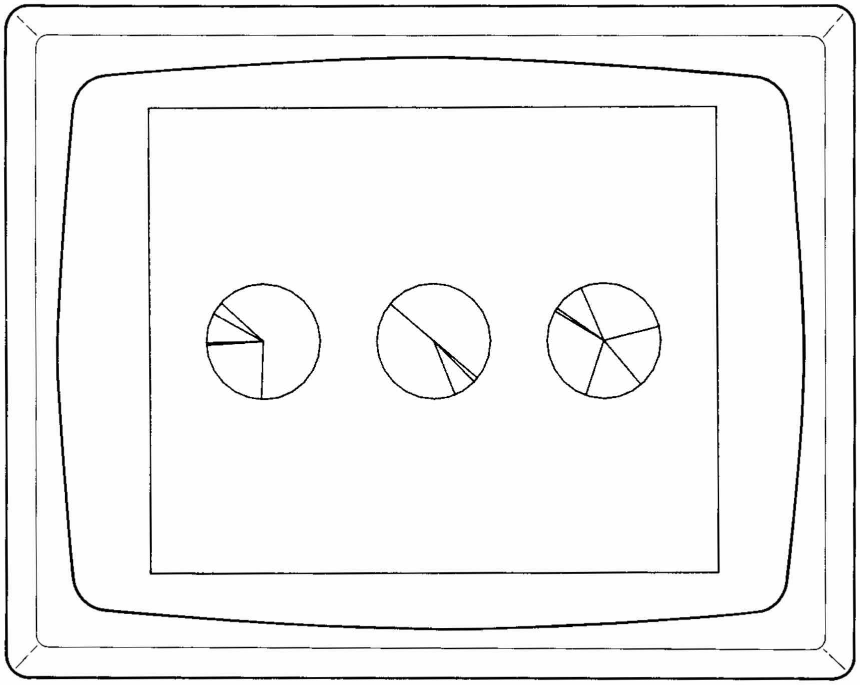
Pen control for the RPLOT statement is the same as the pen control for PLOT and IPLOT. The optional pen control parameter specifies the up or down pen movement and defaults to plus one (the pen moves and then drops). The pen control parameter is interpreted as follows.

Odd	= Drop pen (pen down or start line generation)
Even	= Lift pen (pen up or stop line generation)
Positive	= Pen change after motion
Negative	= Pen change before motion

The pen control parameter remains in effect until it is changed by a default condition, or by another pen control parameter, PENUP or MOVE.

When plotting in GDUs, only the hard clip limits are used. Drawn lines extend no further than the hard clip limit in any direction. When plotting in UDUs, the line extends no further than the soft clip boundaries in any direction.

Example



```
  1     REM  ** This is the RPLOT example (RPLOT)
  10    PLOTTER IS 13,"GRAPHICS"        ! Specifies the CRT as the plotter
  20    GRAPHICS                        ! Enables the CRT
  30    DEG                             ! Sets the degrees mode
  40    SHOW 0,10,-1,1                  ! Sets the SHOW area
  50    FRAME                           ! Draws a FRAME around the SOFT CLIP area
  60 Pie_charts:!
  70    FOR Circle=2 TO 8 STEP 3        ! Selects one of three circles
  80    MOVE Circle,0                   ! MOVE to point to draw the circle
  90      FOR Arc=1 TO 360              ! Specify point on circle to draw arc
  100     PDIR Arc                      ! Specify Plot DIRection for "RPLOT"
●110      RPLOT 1,0                     ! Draws arc
  120     NEXT Arc                      ! Repeats the loop
  130 Random_lines:!
  140     FOR Section=1 TO RND*5+2      ! Specify a random number of sections
  150     MOVE Circle,0                 ! MOVE to the center of the circle
  160     PDIR RND*360                  ! Specify a random line direction
●170      RPLOT 1,0,-1                  ! Draws a line section
  180     NEXT Section                  ! Repeats the loop
  190   NEXT Circle                     ! Repeats the loop for the next circle
  200   END
```

IPLOT Statement

The IPLOT statement provides capability for incremental plotting with pen control. The origin is assumed to be the last plotted point. That is, the origin is always the pen's position before this statement is executed.

Syntax:

```
IPLOT  X increment,  Y increment [ , pen control]
```

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

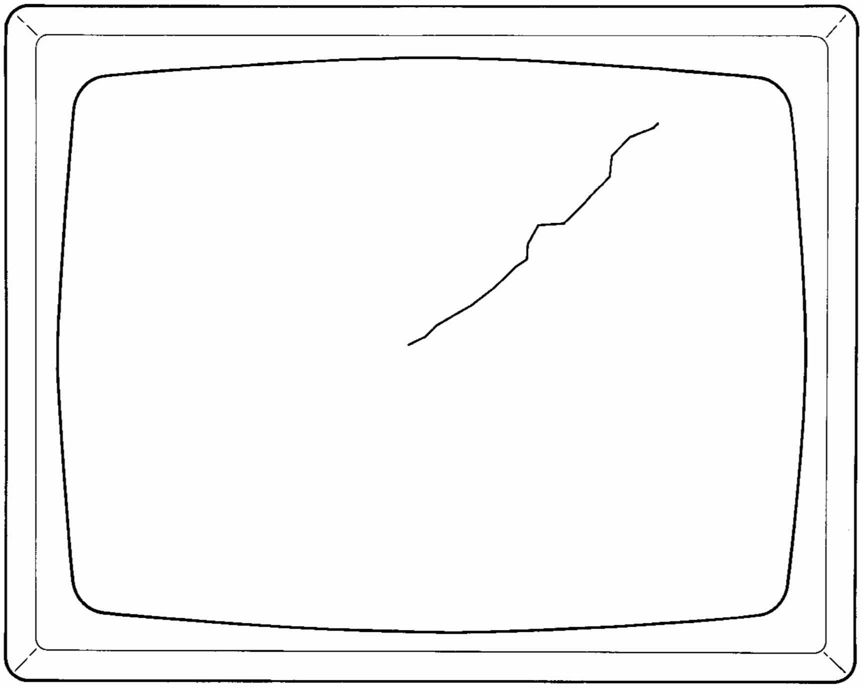
The local coordinate system can be rotated about its origin relative to the master coordinate system by means of the PDIR (plot direction) statement. That is, a figure can be drawn or repeated at another angle by specifying the angle with the PDIR statement.

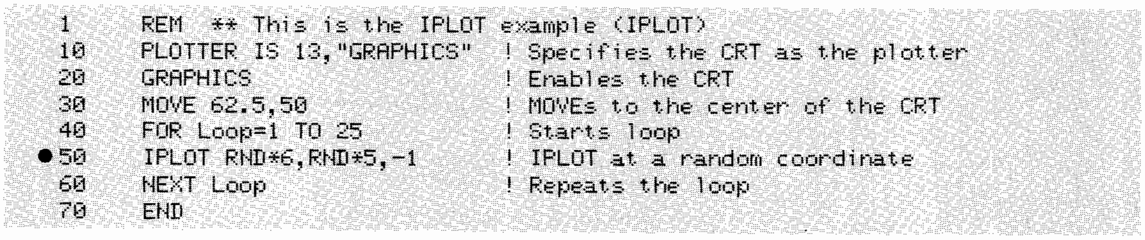
The pen control for IPLOT is the same as the pen control for PLOT and RPLOT. The optional pen control parameter specifies up or down pen movement, and defaults to plus one (the pen moves and then drops). The pen control parameter is interpreted as follows.

Odd	= Drop pen (pen down or start line generation)
Even	= Lift pen (pen up or stop line generation)
Positive	= Pen change after motion
Negative	= Pen change before motion

The pen control parameter remains in effect until it is changed by a default condition, or another pen control parameter, PENUP or MOVE. When plotting in GDUs only the hard clip limits are used. That is, drawn lines extend no further than the hard clip limit in any direction. When plotting in UDUs the line extends no further than the soft clip boundaries in any direction.

Example

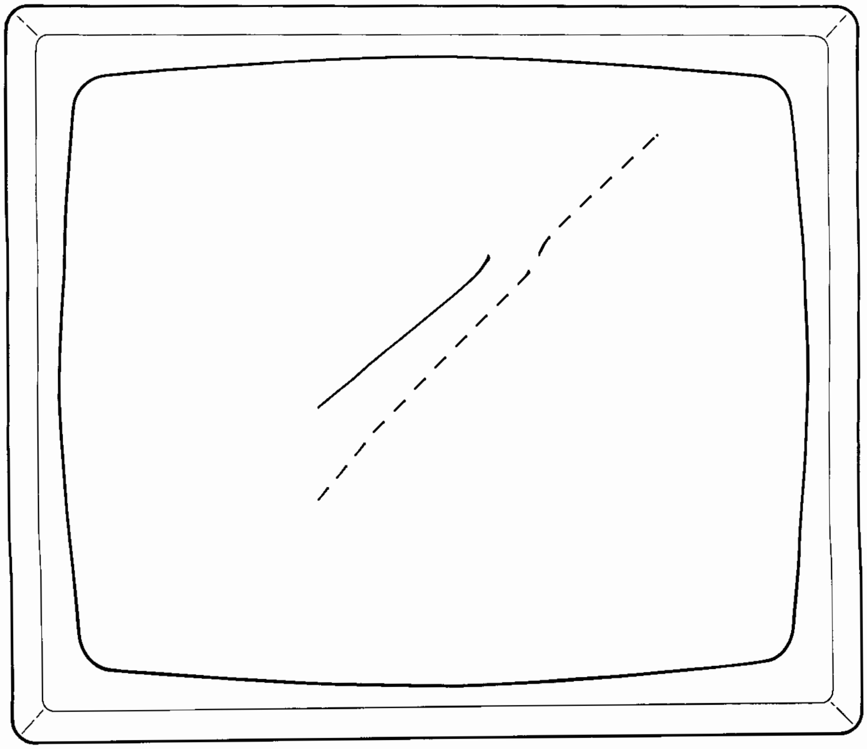


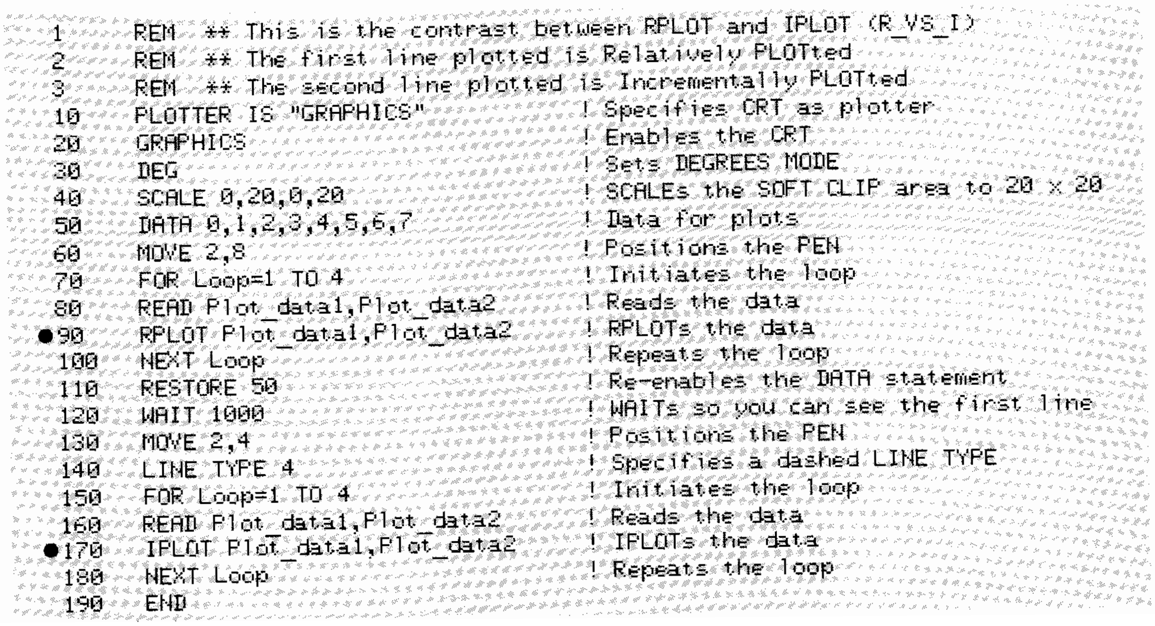


```
 1     REM  ** This is the IPLOT example (IPLOT)
 10    PLOTTER IS 13,"GRAPHICS"  ! Specifies the CRT as the plotter
 20    GRAPHICS                  ! Enables the CRT
 30    MOVE 62.5,50              ! MOVEs to the center of the CRT
 40    FOR Loop=1 TO 25          ! Starts loop
●50    IPLOT RND*6,RND*5,-1      ! IPLOT at a random coordinate
 60    NEXT Loop                 ! Repeats the loop
 70    END
```

RPLOT vs IPLOT

RPLOT (relative plotting) is different from IPLOT (incremental plotting). In relative plotting, the lines are plotted with respect to a fixed point of origin. With incremental plotting, the lines are plotted with respect to the last plotted point. Running this example program should clarify the difference between the RPLOT and IPLOT.





```
  1     REM  ** This is the contrast between RPLOT and IPLOT (R_VS_I)
  2     REM  ** The first line plotted is Relatively PLOTted
  3     REM  ** The second line plotted is Incrementally PLOTted
  10    PLOTTER IS "GRAPHICS"             ! Specifies CRT as plotter
  20    GRAPHICS                          ! Enables the CRT
  30    DEG                               ! Sets DEGREES MODE
  40    SCALE 0,20,0,20                   ! SCALEs the SOFT CLIP area to 20 x 20
  50    DATA 0,1,2,3,4,5,6,7              ! Data for plots
  60    MOVE 2,8                          ! Positions the PEN
  70    FOR Loop=1 TO 4                   ! Initiates the loop
  80    READ Plot_data1,Plot_data2        ! Reads the data
 ●90    RPLOT Plot_data1,Plot_data2       ! RPLOTs the data
  100   NEXT Loop                         ! Repeats the loop
  110   RESTORE 50                        ! Re-enables the DATA statement
  120   WAIT 1000                         ! WAITs so you can see the first line
  130   MOVE 2,4                          ! Positions the PEN
  140   LINE TYPE 4                       ! Specifies a dashed LINE TYPE
  150   FOR Loop=1 TO 4                   ! Initiates the loop
  160   READ Plot_data1,Plot_data2        ! Reads the data
 ●170   IPLOT Plot_data1,Plot_data2       ! IPLOTs the data
  180   NEXT Loop                         ! Repeats the loop
  190   END
```

Rotating the Plot

A plot of a figure that has been drawn by the RPLOT or IPLOT statements can be turned or rotated. This feature can be used to give apparent motion to a figure, or to provide a different point of view to a plot.

PDIR is the statement that provides the angle of rotation for rotating the plot. PDIR is also helpful in positioning incrementally defined figures.

PDIR Statement

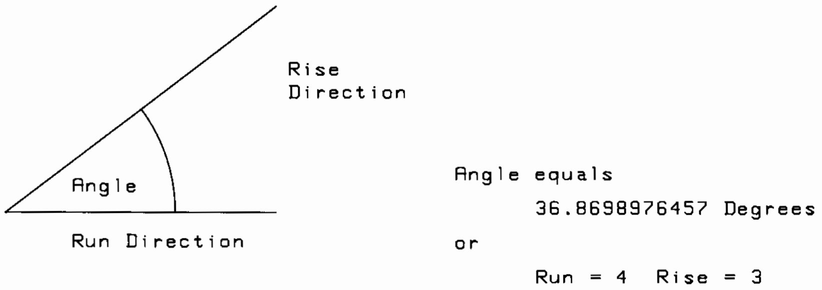
The PDIR statement sets the angle of rotation for relative (RPLOT) and incremental (IPLOT) plotting.

Syntax:

PDIR angle or PDIR run, rise

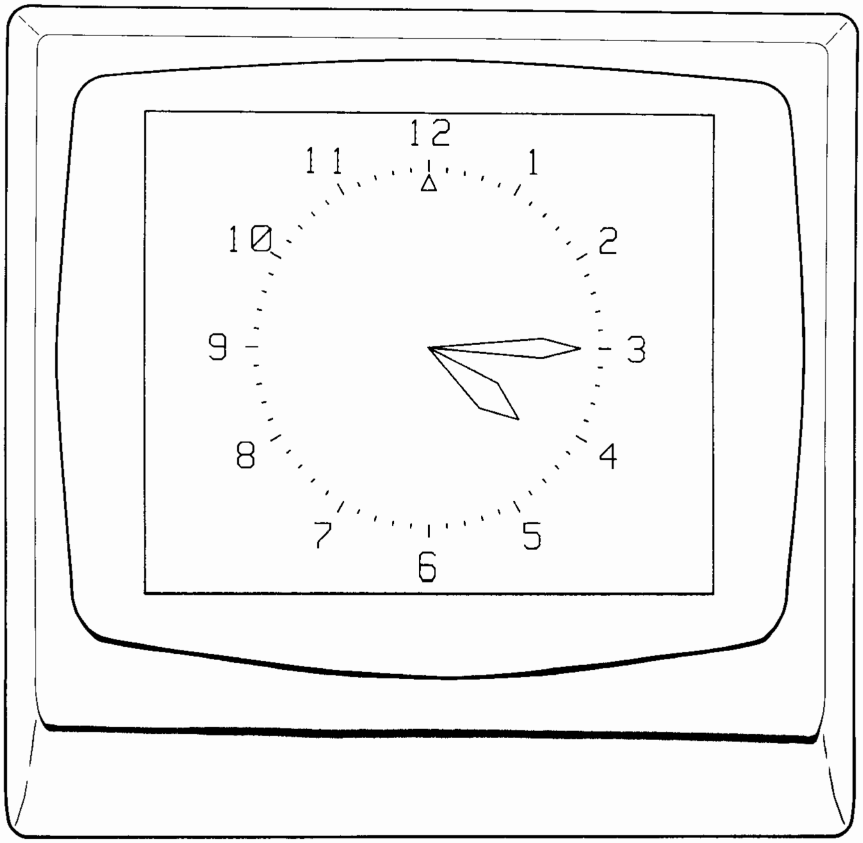
The angle of axes rotation can be specified in either of two ways:

- As the counter-clockwise angle, in the current angular units set by the DEG, RAD, and the GRAD statements, between the new X-axis and the horizontal axis.
- The rotation parameter can also be specified as the run and rise units (in current units) of a vector drawn in the desired direction. The run parameter is the distance out along the X axis, while the rise parameter is the final height which the line must rise along the Y axis.

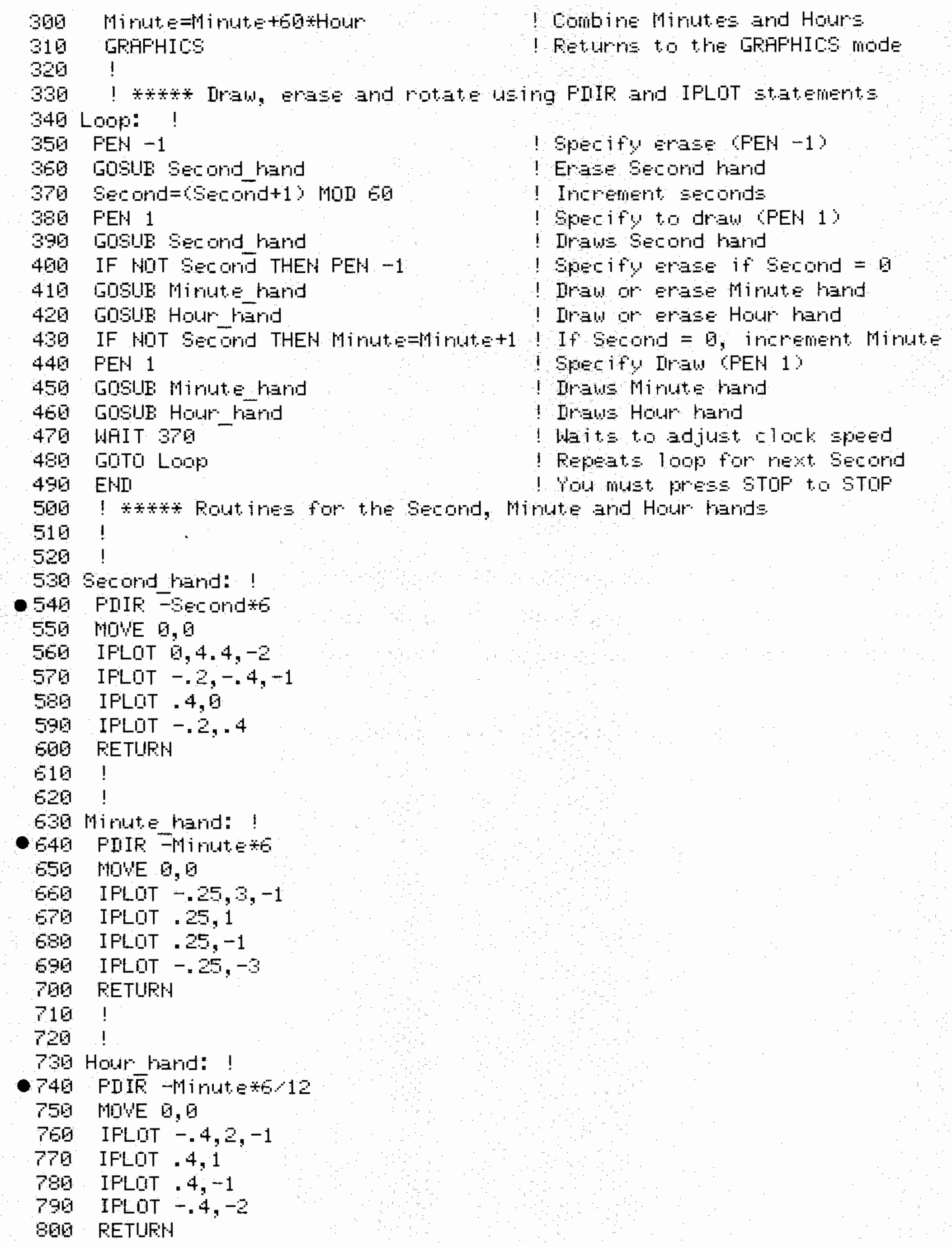


On the CRT you can make a figure appear to move or rotate by erasing the old figure and redrawing it after executing a PDIR statement with a new angle. To erase the old figure on the CRT, either execute a GCLEAR statement or redraw the old figure using a negative pen number.

Example



```
1       REM  ** This is the PDIR example (PDIR)
10      ! This program shows how the PDIR statement can be used to rotate
20      ! a set of fixed points, in this case, the hands of a clock.
30      !
40      PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
50      GRAPHICS                          ! Enables the CRT
60      SHOW -6,6,-6,6                    ! Sets X = Y
70      FRAME                             ! FRAMEs the SOFT CLIP area
80      DEG                               ! Sets degrees mode
90      !
100     ! Draw the face of a clock
110     CSIZE 10                          ! Sets Character SIZE to 10 GDU's
120     LORG 5                            ! Specify centered numbers
130     FOR Minute=1 TO 60                ! FOR..NEXT to specify Minute mark
140     MOVE 0,0                          ! MOVEs to the center of the clock
●150    PDIR 360*(1-Minute/60)            ! Plot DIRection for Minute
160     IPLOT 0,4.5,-2                    ! IPLOT to rim of the clock
170     IPLOT 0,.1,-1                     ! IPLOT the Minute mark
180     IF Minute MOD 5 THEN GOTO 220     ! If not on 5 Minute mark, skip to NEXT
190     IPLOT 0,.2                        ! IPLOT 5 Minute mark with longer length
200     IPLOT 0,.7,-2                     ! Moves to center of number
210     LABEL USING "K";Minute/5          ! LABEL with a number
220     NEXT Minute                       ! Repeat the loop for the NEXT Minute
230     !
240     ! ***** Enter the current time
250     EXIT GRAPHICS                     ! EXIT GRAPHICS for data input
260     INPUT "Enter the hour",Hour       ! Enter the Hour
270     Hour=INT(Hour) MOD 12             ! Adjust Hour to 12 Hour clock
280     INPUT "Enter the minutes",Minute  ! Enter the Minute
290     Minute=INT(Minute) MOD 60         ! Adjust the Minute to a 60 Minute Hour
```



```
 300   Minute=Minute+60*Hour              ! Combine Minutes and Hours
 310   GRAPHICS                           ! Returns to the GRAPHICS mode
 320   !
 330   ! ***** Draw, erase and rotate using PDIR and IPLOT statements
 340 Loop:  !
 350  PEN -1                              ! Specify erase (PEN -1)
 360  GOSUB Second_hand                   ! Erase Second hand
 370  Second=(Second+1) MOD 60            ! Increment seconds
 380  PEN 1                               ! Specify to draw (PEN 1)
 390  GOSUB Second_hand                   ! Draws Second hand
 400  IF NOT Second THEN PEN -1           ! Specify erase if Second = 0
 410  GOSUB Minute_hand                   ! Draw or erase Minute hand
 420  GOSUB Hour_hand                     ! Draw or erase Hour hand
 430  IF NOT Second THEN Minute=Minute+1  ! If Second = 0, increment Minute
 440  PEN 1                               ! Specify Draw (PEN 1)
 450  GOSUB Minute_hand                   ! Draws Minute hand
 460  GOSUB Hour_hand                     ! Draws Hour hand
 470  WAIT 370                            ! Waits to adjust clock speed
 480  GOTO Loop                           ! Repeats loop for next Second
 490  END                                 ! You must press STOP to STOP
 500  ! ***** Routines for the Second, Minute and Hour hands
 510  !
 520  !
 530 Second_hand: !
●540  PDIR -Second*6
 550  MOVE 0,0
 560  IPLOT 0,4.4,-2
 570  IPLOT -.2,-.4,-1
 580  IPLOT .4,0
 590  IPLOT -.2,.4
 600  RETURN
 610  !
 620  !
 630 Minute_hand: !
●640  PDIR -Minute*6
 650  MOVE 0,0
 660  IPLOT -.25,3,-1
 670  IPLOT .25,1
 680  IPLOT .25,-1
 690  IPLOT -.25,-3
 700  RETURN
 710  !
 720  !
 730 Hour_hand: !
●740  PDIR -Minute*6/12
 750  MOVE 0,0
 760  IPLOT -.4,2,-1
 770  IPLOT .4,1
 780  IPLOT .4,-1
 790  IPLOT -.4,-2
 800  RETURN
```

Summary

The statements covered in this chapter include –

- MOVE
- DRAW
- RPLOT
- IPLOT
- PDIR
- AXES
- GRID

In this chapter you learned how to move the pen, draw a line to a specific coordinate, how to plot respective to an origin, how to plot an incremental figure, how to plot at an angular tangent, and how to mark axes and grids onto your plotting area.

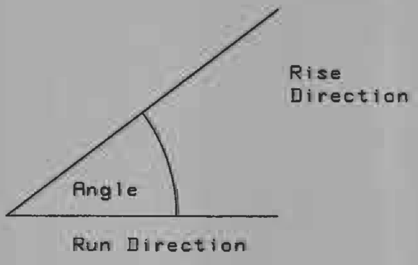
The next chapter covers labeling and lettering of your graphic's plot.

Labeling Statements

Terms

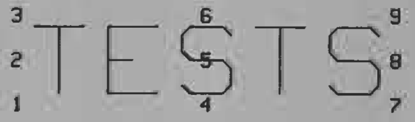
- •Hard Clip -The physical limits of the plotting device,beyond which no line can be drawn.
- •Angle – The direction at which a line or label is drawn, represented in degrees counter-clockwise from the horizontal.
- •Slant – The angle at which a character is drawn, represented in clockwise degrees from the vertical.
- •Origin -The coordinate point at which a plotting operation begins.

Implementing the LDIR Angle



```
Angle equals
      36.8698976457 Degrees
or
      Run = 4  Rise = 3
```

Label Origins



Chapter 5

Overview

System 45B graphics allows you to label or letter your plots or graphics outputs. Labeling can be done with the LABEL statement, while labeling using a format can be done with the LABEL USING statement. You can also "type" directly onto the plot with the LETTER statement.

If you wish to change the size, aspect ratio or **slant** of the characters which are being labeled, you can use the CSIZE statement.

Positioning of the labeling string can be changed by the LDIR statement, so you can label at any **angle**.

Justification (alignment) of text can be accomplished by using the LORG statement. In case you are not familiar with justification of text, the following example is provided for you.

This text is
left-justified.

And this text is
centered.

While this text is
right-justified.

The default labeling conditions are characters with a size of .3 cm, and an aspect ratio of 9/15.

The characters are slanted at 0 from the vertical and the text is labeled from left to right on a straight line (this is similar to the text in this book). All of the labels are left justified (a label origin value of one).

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 is directed to the current plotter as a label. The available labeling area is defined by the current **hard clip** area.

Syntax:

LABEL list
or
LABEL USING image specifier ; list

LABEL and LABEL USING follow the same rules as PRINT and PRINT USING with one exception. The exception is that an ASCII Ex (CHR$(3)) terminates the labeled output at that point in the list.

For example, the program

```
 1    REM  ** This is the little example (LITTLE)
 10   PLOTTER IS "GRAPHICS"              ! Specifies the CRT as the plotter
 20   GRAPHICS                           ! Enables the CRT
 30   MOVE 0,50                          ! Positions the PEN
 40   LABEL "THIS IS A"&CHR$(3)&"TEST"   ! LABELs text
 50   END
```

results in just

```
THIS IS A
```

being labeled.

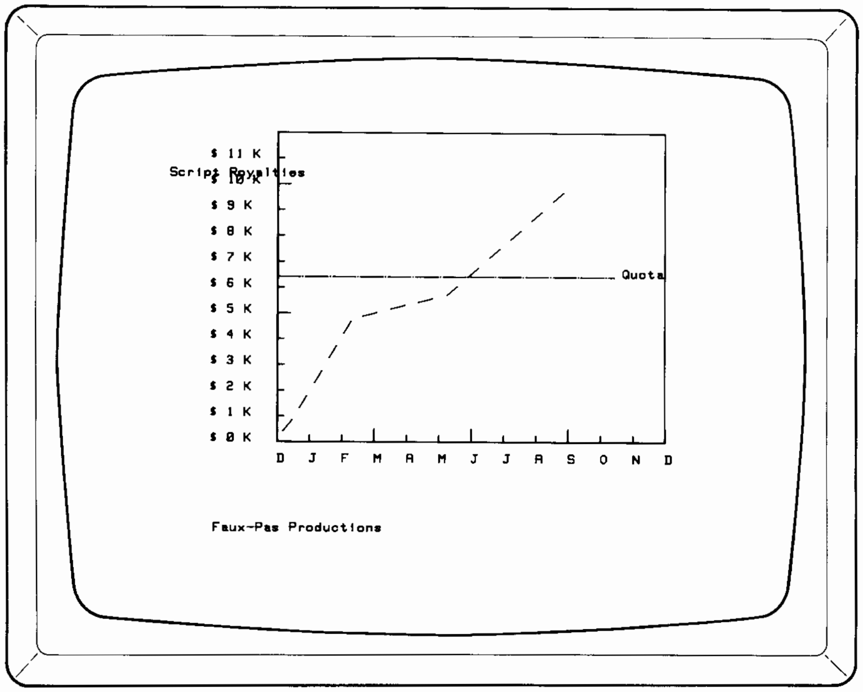
The position and rotation of a label is controlled by the pen positions and the LORG (label **origin**) and LDIR (label direction) statements. The size and aspect ratio as well as the slant of the characters are controlled by the CSIZE (character size) statement.

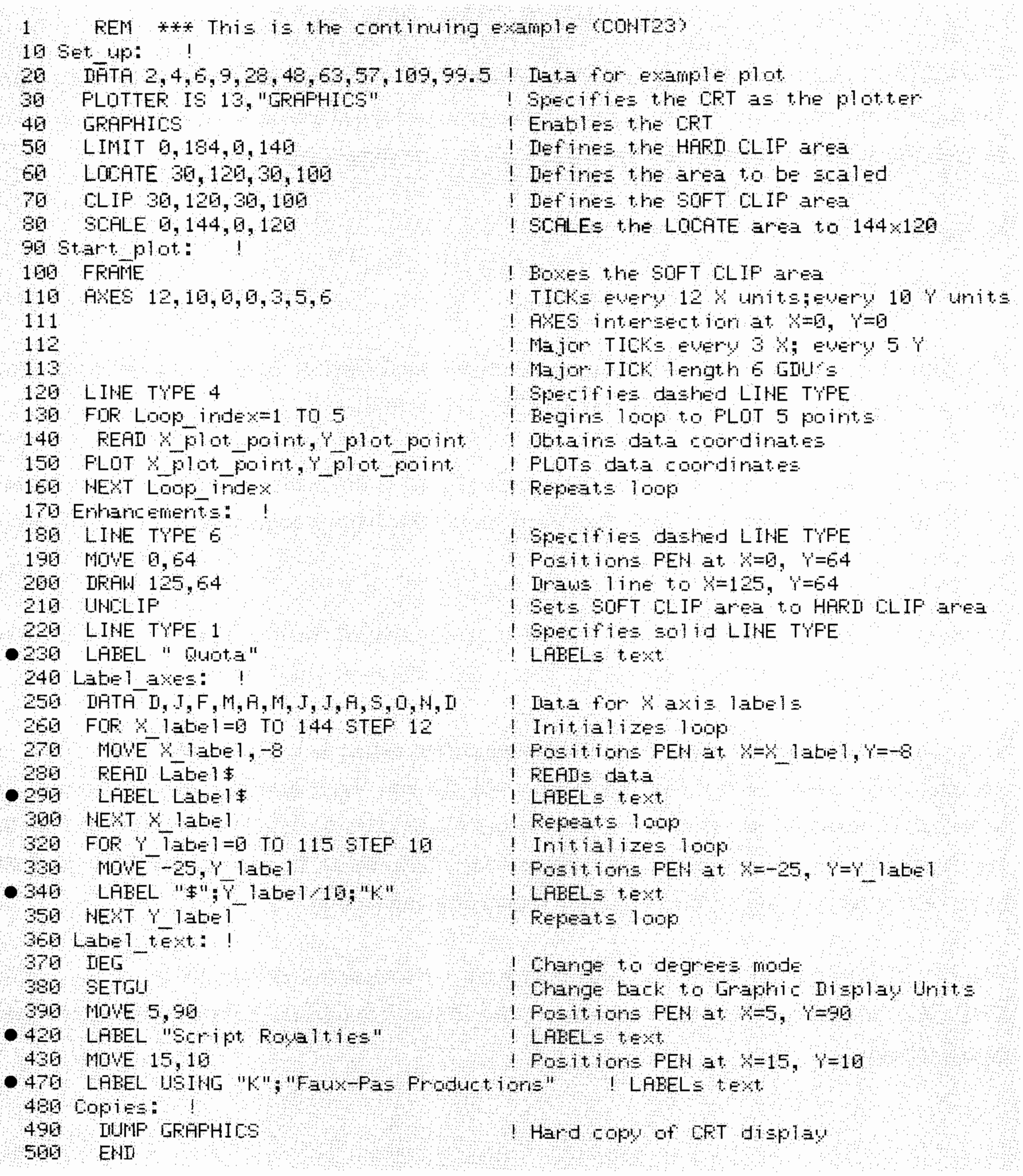
Remember, labeling can be done anywhere within the hard clip limits. The soft clip limits do not affect the labels.

Note

The LABEL USING statement requires the use of image specifiers with variables and text. Failure to use either numeric image specifiers with numeric variables or string image specifiers with string variables results in errors 100 and 101 being generated under program execution.

Example


Script Royalties
$ 11 K
$ 10 K
$ 9 K
$ 8 K
$ 7 K
$ 6 K
$ 5 K
$ 4 K
$ 3 K
$ 2 K
$ 1 K
$ 0 K
Quota
D J F M A M J J A S O N D
Faux-Pas Productions



```
  1     REM  *** This is the continuing example (CONT23)
  10 Set_up:   !
  20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
  30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
  40   GRAPHICS                          ! Enables the CRT
  50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
  60   LOCATE 30,120,30,100              ! Defines the area to be scaled
  70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
  80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
  90 Start_plot:   !
  100  FRAME                             ! Boxes the SOFT CLIP area
  110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
  111                                    ! AXES intersection at X=0, Y=0
  112                                    ! Major TICKs every 3 X; every 5 Y
  113                                    ! Major TICK length 6 GDU's
  120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
  130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
  140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
  150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
  160  NEXT Loop_index                   ! Repeats loop
  170 Enhancements:  !
  180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
  190  MOVE 0,64                         ! Positions PEN at X=0, Y=64
  200  DRAW 125,64                       ! Draws line to X=125, Y=64
  210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
  220  LINE TYPE 1                       ! Specifies solid LINE TYPE
● 230  LABEL " Quota"                    ! LABELs text
  240 Label_axes:  !
  250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
  260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
  270   MOVE X_label,-8                  ! Positions PEN at X=X_label,Y=-8
  280   READ Label$                      ! READs data
● 290   LABEL Label$                     ! LABELs text
  300  NEXT X_label                      ! Repeats loop
  320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
  330   MOVE -25,Y_label                 ! Positions PEN at X=-25, Y=Y_label
● 340   LABEL "$";Y_label/10;"K"         ! LABELs text
  350  NEXT Y_label                      ! Repeats loop
  360 Label_text: !
  370  DEG                               ! Change to degrees mode
  380  SETGU                             ! Change back to Graphic Display Units
  390  MOVE 5,90                         ! Positions PEN at X=5, Y=90
● 420  LABEL "Script Royalties"          ! LABELs text
  430  MOVE 15,10                        ! Positions PEN at X=15, Y=10
● 470  LABEL USING "K";"Faux-Pas Productions"    ! LABELs text
  480 Copies:  !
  490   DUMP GRAPHICS                    ! Hard copy of CRT display
  500   END
```

LETTER Statement

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

Syntax:

```
LETTER
```

Executing the LETTER statement directly from the keyboard or under program control automatically places the System 45B into the GRAPHICS mode.

The normal lower-left corner of the character is placed at the cursor position. You can preset the position of the cursor with the POINTER statement before executing the LETTER statement.

On the CRT, the cursor for the LETTER statement is a small flashing line. The actual cursor position is the center of the flashing line. This is where the pen draws the character.

To move the CRT cursor, press the shifted or unshifted arrow keys ← → ↑ ↓ as needed. The shifted keys move the cursor one dot row each time the key is pressed; the unshifted keys move the cursor one character cell (refer to the CSIZE statement) each time the key is pressed. Pressing HOME moves the cursor to the lower-left corner of the CRT hard clip limits. Remember, pressing the key firmly repeats the key action.

The LETTER statement is much slower than typing, because the characters are drawn on the CRT. You should wait for the character to be drawn completely before pressing the next character key.

Erasing Characters

GCLEAR erases **everything** which you have on the CRT in the graphics mode. Erasing a single letter consists of exiting the graphics mode, changing the pen to a negative number, re-executing the LETTER statement, positioning the cursor under the character which you want to erase, typing the same character, exiting the graphics mode, changing the pen to a positive number, re-executing the LETTER statement, positioning the cursor and pressing the proper key for the character.

To exit the LETTER mode, press either STEP CONT any special function key (such as k0) or STOP.

The LETTER statement leaves both the pen position and the cursor position at the same point whenever you exit graphics.

The Graphicswriter

The LETTER statement allows the System 45B to use its graphics labeling similar to a typewriter. This use can be enhanced by using the following available keys.

↑ moves the cursor up one line each time it is pressed.

↓ moves the cursor down one line each time it is pressed.

← moves the cursor left one character space each time it is pressed.

→ moves the cursor right one character space each time it is pressed.

Pressing the SHIFT with any of the "arrow" keys moves the cursor one resolution unit in that direction. (On the CRT, this is approximately .033 mm. On the 9872A, this is equal to .025mm.)

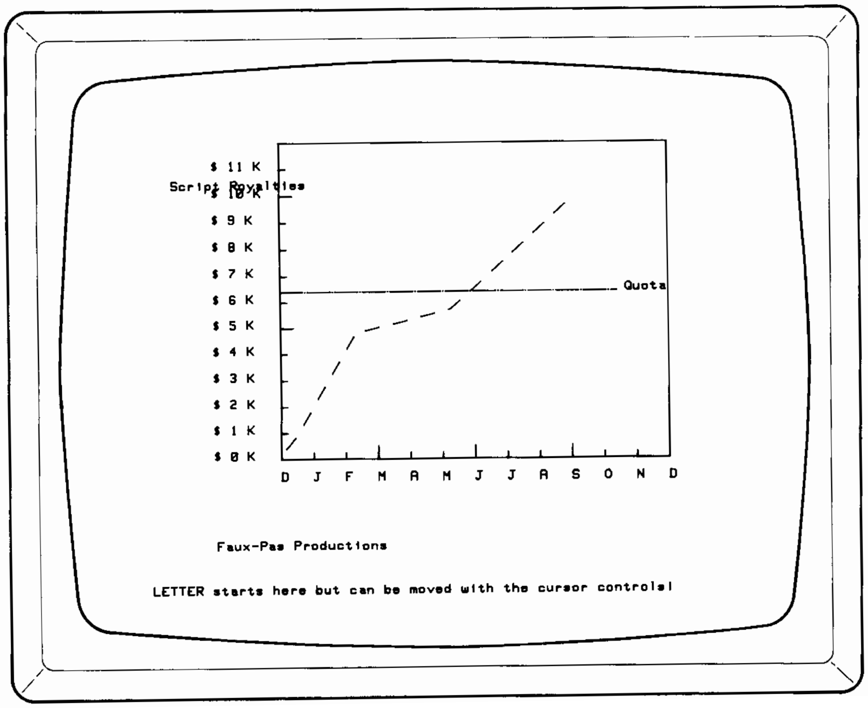
These directional movements are valid even when the label line is at an angle due to a LDIR statement.

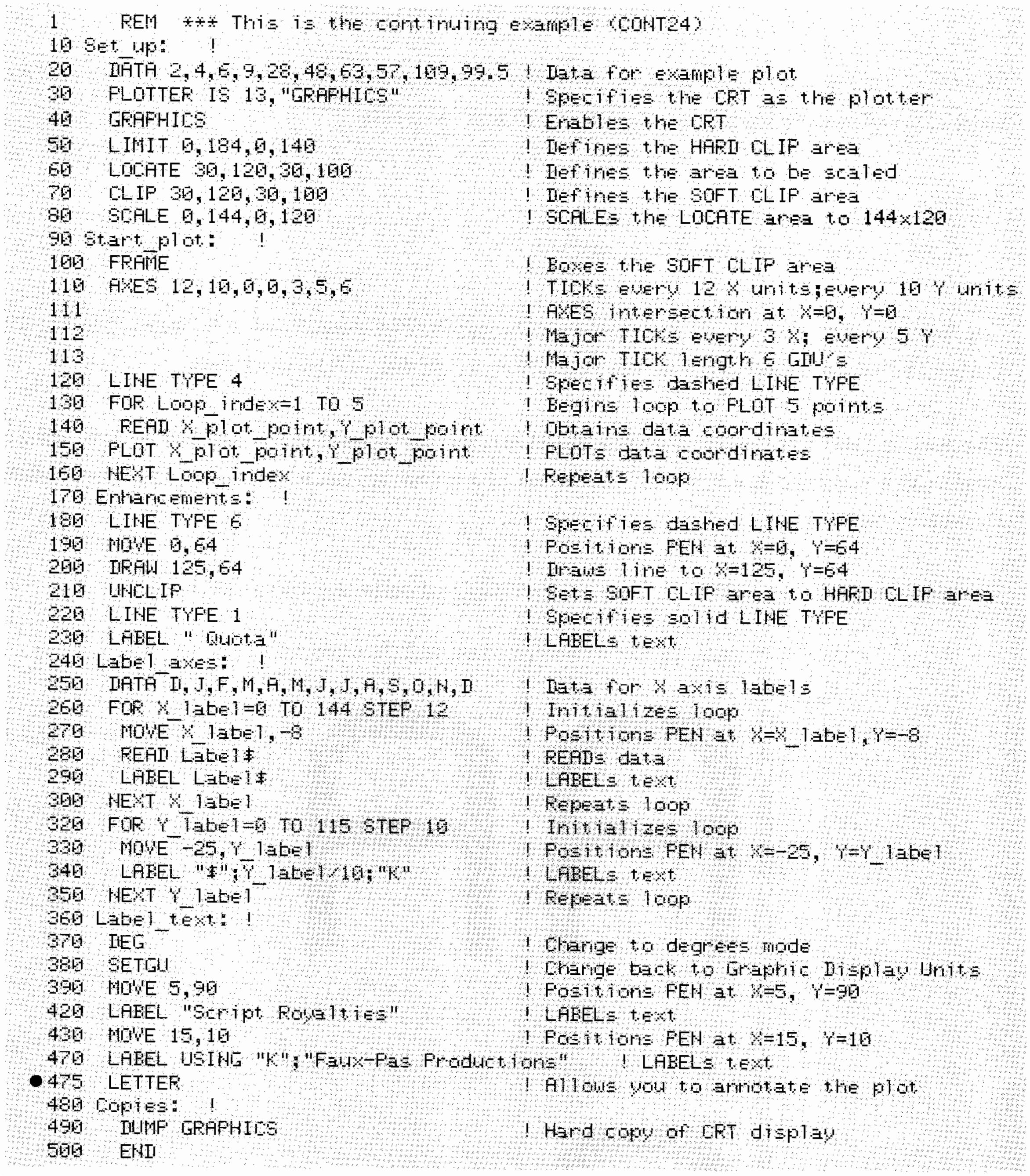
Pressing CONTROL and one of the typing keys generates an ASCII control character. The following control key combinations may be useful to you as typing aids.

CONTROL M	Carriage Return. The cursor moves to the beginning of the line or to the point last moved to with an arrow key.
CONTROL J	Linefeed. The cursor moves down one line.
CONTROL K	Vertical Tab. The cursor moves up one line.
CONTROL H	Backspace. The cursor moves backwards one character space.

The LETTER statement always uses LORG 1. The cursor is always positioned at the lower-left corner of the character cell.

Example





```
1     REM  *** This is the continuing example (CONT24)
10 Set_up:    !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
40   GRAPHICS                          ! Enables the CRT
50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
60   LOCATE 30,120,30,100              ! Defines the area to be scaled
70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
111                                    ! AXES intersection at X=0, Y=0
112                                    ! Major TICKs every 3 X; every 5 Y
113                                    ! Major TICK length 6 GDU's
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
190  MOVE 0,64                         ! Positions PEN at X=0, Y=64
200  DRAW 125,64                       ! Draws line to X=125, Y=64
210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
230  LABEL " Quota"                    ! LABELs text
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
270   MOVE X_label,-8                  ! Positions PEN at X=X_label,Y=-8
280   READ Label$                      ! READs data
290   LABEL Label$                     ! LABELs text
300  NEXT X_label                      ! Repeats loop
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
330   MOVE -25,Y_label                 ! Positions PEN at X=-25, Y=Y_label
340   LABEL "$";Y_label/10;"K"         ! LABELs text
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
380  SETGU                             ! Change back to Graphic Display Units
390  MOVE 5,90                         ! Positions PEN at X=5, Y=90
420  LABEL "Script Royalties"          ! LABELs text
430  MOVE 15,10                        ! Positions PEN at X=15, Y=10
470  LABEL USING "K";"Faux-Pas Productions"     ! LABELs text
●475  LETTER                           ! Allows you to annotate the plot
480 Copies:  !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
500   END
```

CSIZE Statement

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

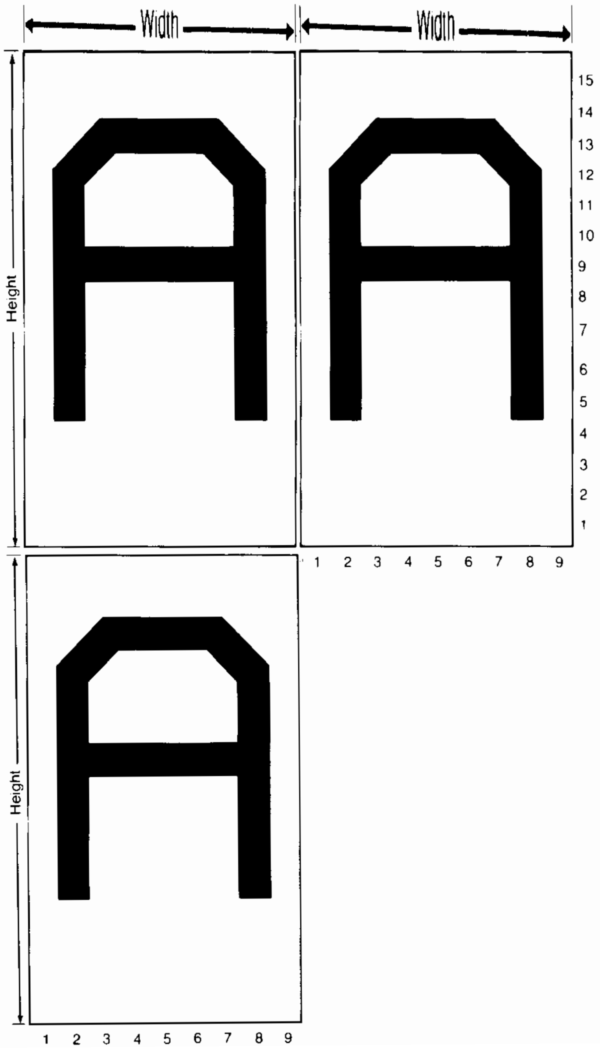
Syntax:

CSIZE height[, aspect ratio [, slant]]

The height parameter is in GDUs and must be given. The default value is approximately 3.3 GDUs (15/4.54) which is set by the PLOTTER IS or the LIMIT statement.

The aspect ratio parameter specifies the character cell aspect ratio, defined as the width/height. The default value is 9/15. The width of a character cell is defined as the height times the aspect ratio.

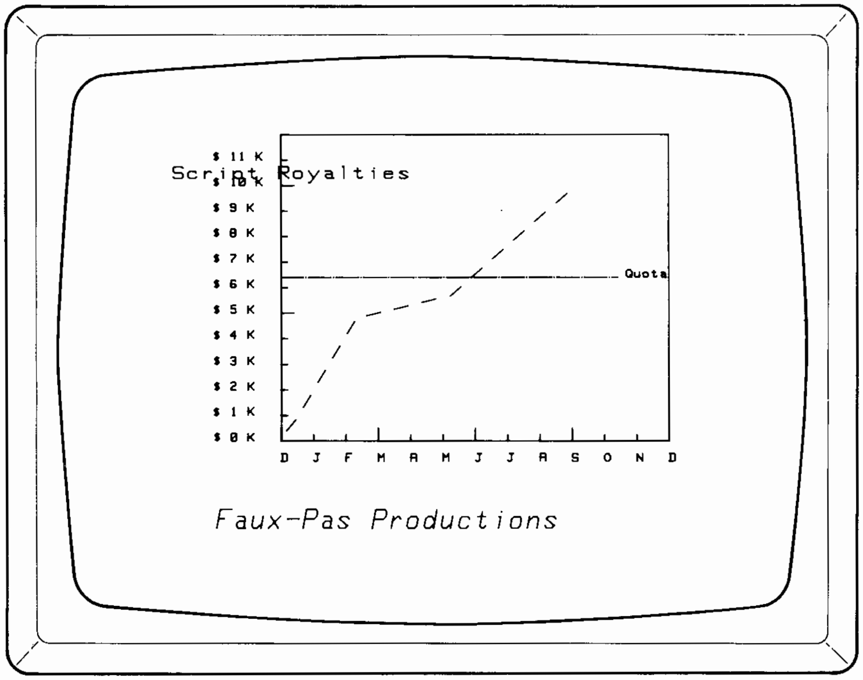
The character cells are adjacent, both horizontally and vertically, as shown here

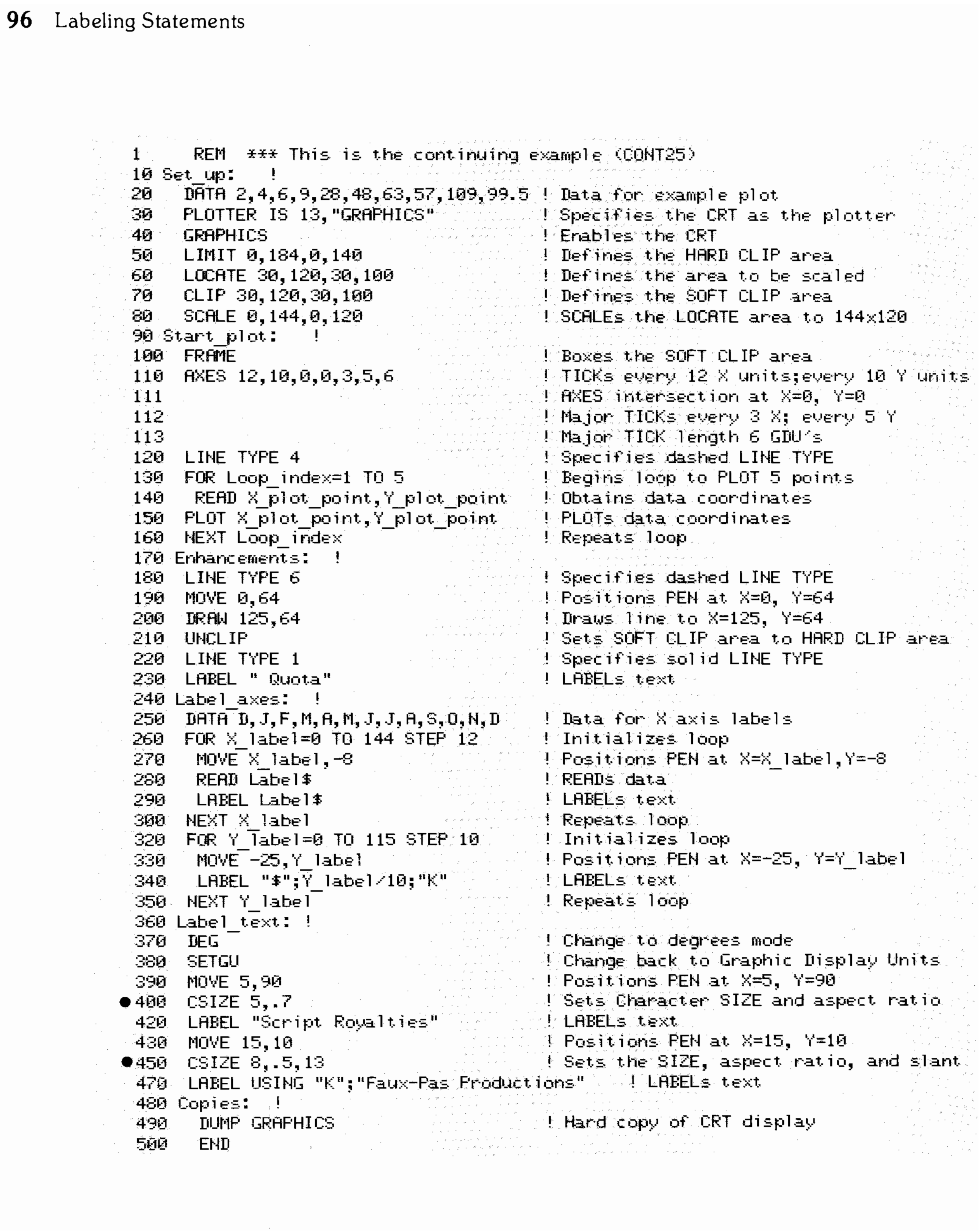


This results in the spacing between adjacent characters being dependent upon each character's positioning in its cell and the CSIZE statement which is currently in effect.

Of course, a line is equal to the height of a character cell, while a space between characters is equal to the width of a character cell.

Examples

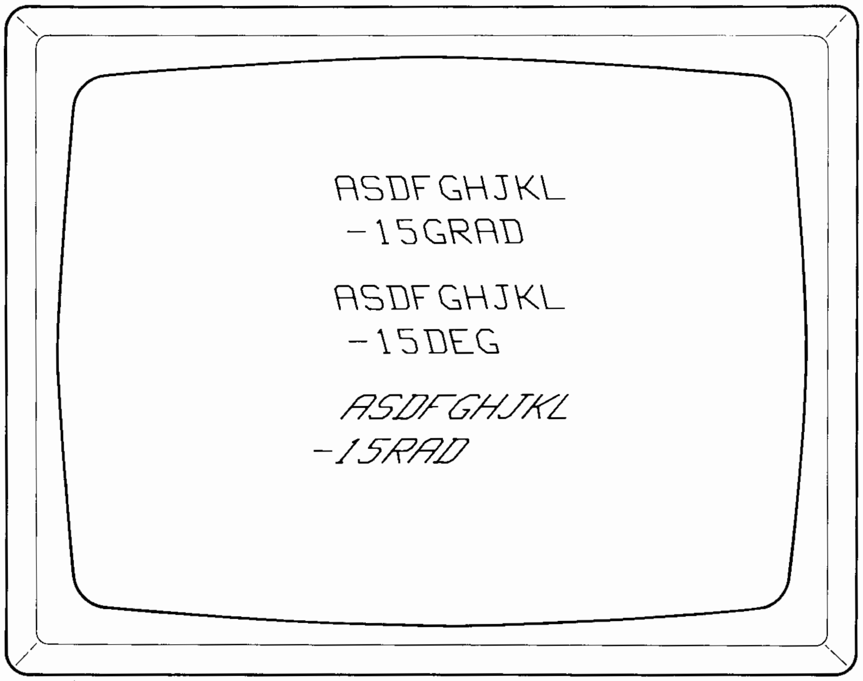




```
1     REM  *** This is the continuing example (CONT25)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5  ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"           ! Specifies the CRT as the plotter
40   GRAPHICS                           ! Enables the CRT
50   LIMIT 0,184,0,140                  ! Defines the HARD CLIP area
60   LOCATE 30,120,30,100               ! Defines the area to be scaled
70   CLIP 30,120,30,100                 ! Defines the SOFT CLIP area
80   SCALE 0,144,0,120                  ! SCALEs the LOCATE area to 144x120
90 Start_plot:   !
100  FRAME                              ! Boxes the SOFT CLIP area
110  AXES 12,10,0,0,3,5,6               ! TICKs every 12 X units;every 10 Y units
111                                     ! AXES intersection at X=0, Y=0
112                                     ! Major TICKs every 3 X; every 5 Y
113                                     ! Major TICK length 6 GDU's
120  LINE TYPE 4                        ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5              ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point    ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point     ! PLOTs data coordinates
160  NEXT Loop_index                    ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                        ! Specifies dashed LINE TYPE
190  MOVE 0,64                          ! Positions PEN at X=0, Y=64
200  DRAW 125,64                        ! Draws line to X=125, Y=64
210  UNCLIP                             ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                        ! Specifies solid LINE TYPE
230  LABEL " Quota"                     ! LABELs text
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D     ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12       ! Initializes loop
270   MOVE X_label,-8                   ! Positions PEN at X=X_label,Y=-8
280   READ Label$                       ! READs data
290   LABEL Label$                      ! LABELs text
300  NEXT X_label                       ! Repeats loop
320  FOR Y_label=0 TO 115 STEP 10       ! Initializes loop
330   MOVE -25,Y_label                  ! Positions PEN at X=-25, Y=Y_label
340   LABEL "$";Y_label/10;"K"          ! LABELs text
350  NEXT Y_label                       ! Repeats loop
360 Label_text: !
370  DEG                                ! Change to degrees mode
380  SETGU                              ! Change back to Graphic Display Units
390  MOVE 5,90                          ! Positions PEN at X=5, Y=90
●400  CSIZE 5,.7                        ! Sets Character SIZE and aspect ratio
420  LABEL "Script Royalties"           ! LABELs text
430  MOVE 15,10                         ! Positions PEN at X=15, Y=10
●450  CSIZE 8,.5,13                     ! Sets the SIZE, aspect ratio, and slant
470  LABEL USING "K";"Faux-Pas Productions"    ! LABELs text
480 Copies:  !
490   DUMP GRAPHICS                     ! Hard copy of CRT display
500   END
```

The character slant is an angular measurement, expressed in the current machine mode (DEG,RAD or GRAD) in effect at the time the CSIZE statement is executed, which causes the characters to be labeled at the specified angle.

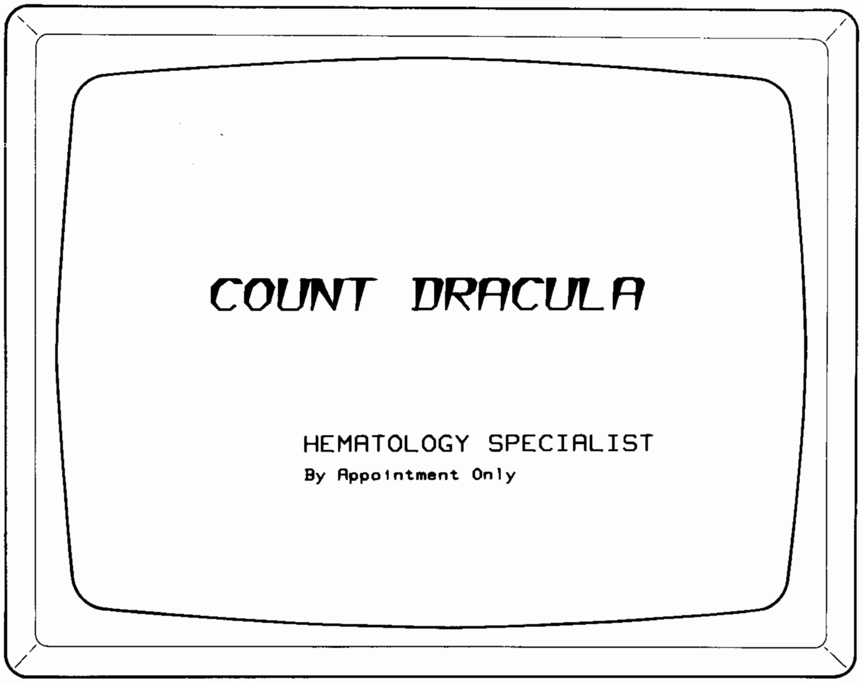
This program demonstrates the effects that the various modes have on the same angular setting.



```
ASDFGHJKL
 -15GRAD

ASDFGHJKL
 -15DEG

ASDFGHJKL
-15RAD
```

```
 10    REM  ** This is the Angle example (ANGLE)
 20    PLOTTER IS "GRAPHICS"              ! Specifies the CRT as the plotter
 30    GRAPHICS                           ! Enables the CRT
 40    Yposition=15                       ! Sets Yposition
 50    DATA RAD,DEG,GRAD                  ! DATA for Mode$
 60    RAD                                ! Sets RADians mode
 70    GOSUB Sample                       ! Performs LABELing
 80    DEG                                ! Sets DEGrees mode
 90    GOSUB Sample                       ! Performs LABELing
 100   GRAD                               ! Sets GRADs mode
 110   GOSUB Sample                       ! Performs LABELing
 120   END
 130 Sample:!
●140   CSIZE 10,.6,-15                    ! Sets Angle to -15
 150   MOVE 40,Yposition                  ! Positions the PEN
 160   READ Mode$                         ! Keeps track of current mode
 170   LABEL "ASDFGHJKL"                  ! Characters to be LABELed
 180   LABEL "-15";Mode$                  ! Angular setting and current mode
 190   Yposition=Yposition+25             ! Increments Yposition
 200   RETURN
```

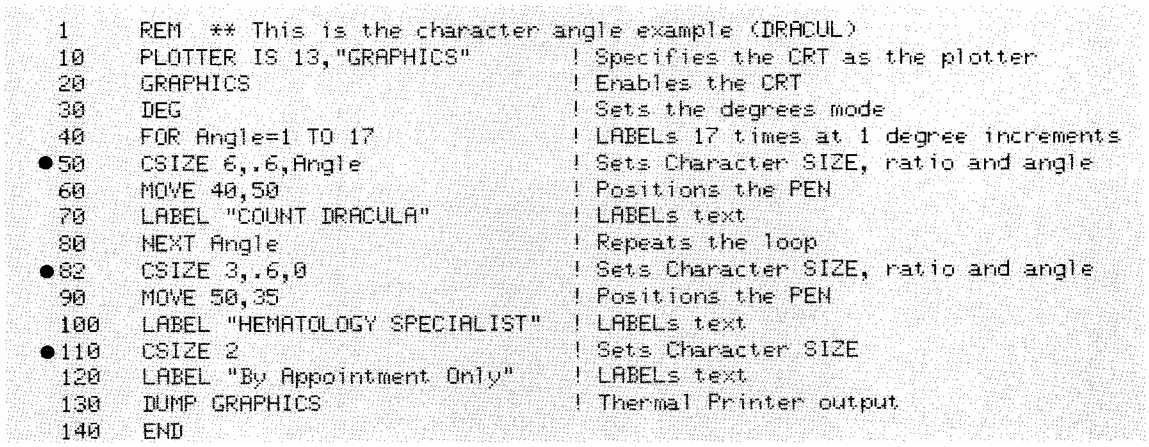
Another interesting effect which can be obtained with the angle parameter is the re-drawing of characters while incrementing their angle by a degree at a time. This is shown in the following program.



COUNT DRACULA

HEMATOLOGY SPECIALIST

By Appointment Only



```
  1     REM  ** This is the character angle example (DRACUL)
  10    PLOTTER IS 13,"GRAPHICS"        ! Specifies the CRT as the plotter
  20    GRAPHICS                        ! Enables the CRT
  30    DEG                             ! Sets the degrees mode
  40    FOR Angle=1 TO 17               ! LABELs 17 times at 1 degree increments
 ●50    CSIZE 6,.6,Angle                ! Sets Character SIZE, ratio and angle
  60    MOVE 40,50                      ! Positions the PEN
  70    LABEL "COUNT DRACULA"           ! LABELs text
  80    NEXT Angle                      ! Repeats the loop
 ●82    CSIZE 3,.6,0                    ! Sets Character SIZE, ratio and angle
  90    MOVE 50,35                      ! Positions the PEN
  100   LABEL "HEMATOLOGY SPECIALIST"   ! LABELs text
 ●110   CSIZE 2                         ! Sets Character SIZE
  120   LABEL "By Appointment Only"     ! LABELs text
  130   DUMP GRAPHICS                   ! Thermal Printer output
  140   END
```

LDIR Statement

The LDIR (label direction) statement specifies the angle at which the LETTER and the LABEL statements draw characters. The label direction is distinct from the character slant.

Syntax:

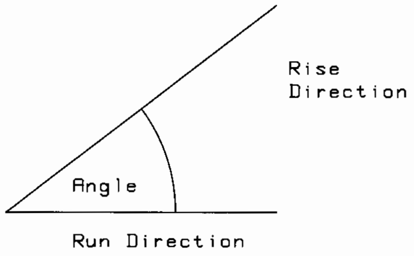
LDIR angle
or
LDIR run, rise

The LDIR statement allows you to rotate a label about its origin (refer to LORG) by specifying the required angle.

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

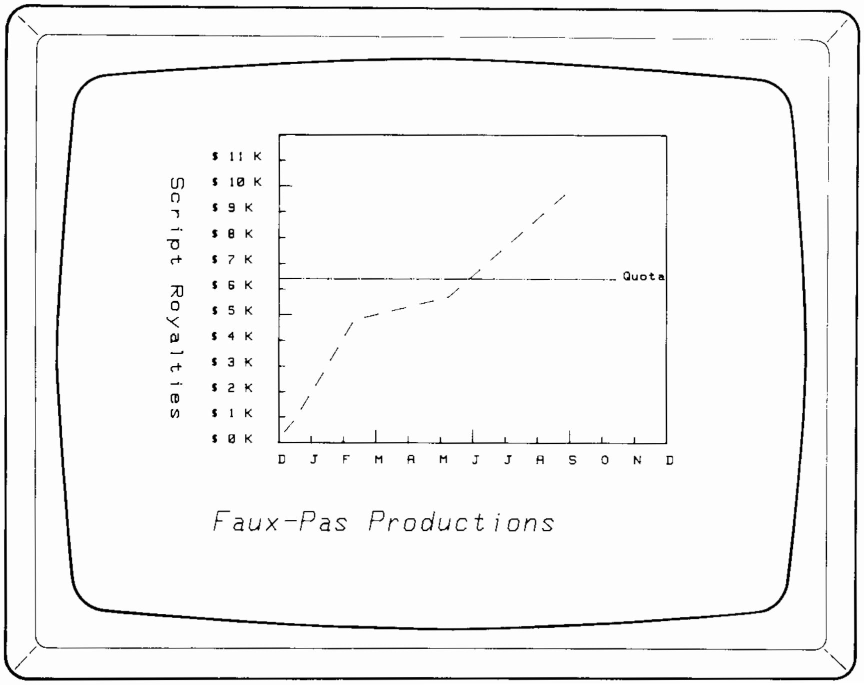
- As the counter-clockwise angle, in the current angular units set by the DEG, RAD, and the GRAD statements, between the new X axis and the horizontal axis.

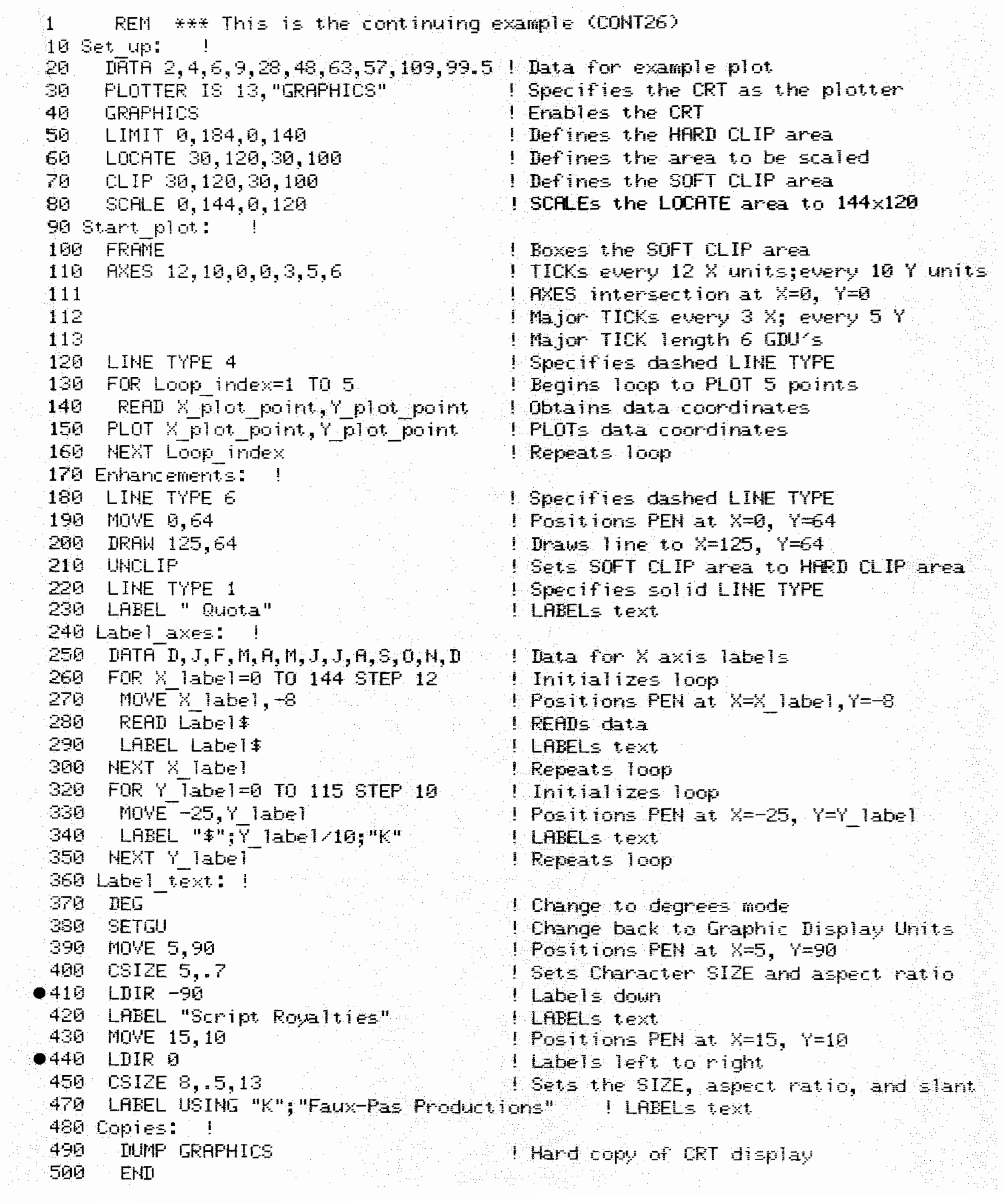
- The rotation parameter can also be specified as the run and rise units (in current units) of a vector drawn in the desired direction. The run parameter is the distance cut along the x axis, while the rise parameter is the final height which the line must rise along the Y axis.



```
Angle equals
      36.8698976457 Degrees
or
      Run = 4  Rise = 3
```

Example


Script Royalties
$ 11 K
$ 10 K
$ 9 K
$ 8 K
$ 7 K
$ 6 K
$ 5 K
$ 4 K
$ 3 K
$ 2 K
$ 1 K
$ 0 K
Quota
D J F M A M J J A S O N D
Faux-Pas Productions



```
1     REM  *** This is the continuing example (CONT26)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
40   GRAPHICS                          ! Enables the CRT
50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
60   LOCATE 30,120,30,100              ! Defines the area to be scaled
70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
111                                    ! AXES intersection at X=0, Y=0
112                                    ! Major TICKs every 3 X; every 5 Y
113                                    ! Major TICK length 6 GDU's
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
190  MOVE 0,64                         ! Positions PEN at X=0, Y=64
200  DRAW 125,64                       ! Draws line to X=125, Y=64
210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
230  LABEL " Quota"                    ! LABELs text
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
270   MOVE X_label,-8                  ! Positions PEN at X=X_label,Y=-8
280   READ Label$                      ! READs data
290   LABEL Label$                     ! LABELs text
300  NEXT X_label                      ! Repeats loop
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
330   MOVE -25,Y_label                 ! Positions PEN at X=-25, Y=Y_label
340   LABEL "$";Y_label/10;"K"         ! LABELs text
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
380  SETGU                             ! Change back to Graphic Display Units
390  MOVE 5,90                         ! Positions PEN at X=5, Y=90
400  CSIZE 5,.7                        ! Sets Character SIZE and aspect ratio
●410  LDIR -90                         ! Labels down
420  LABEL "Script Royalties"          ! LABELs text
430  MOVE 15,10                        ! Positions PEN at X=15, Y=10
●440  LDIR 0                           ! Labels left to right
450  CSIZE 8,.5,13                     ! Sets the SIZE, aspect ratio, and slant
470  LABEL USING "K";"Faux-Pas Productions"     ! LABELs text
480 Copies:   !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
500   END
```

LORG Statement

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

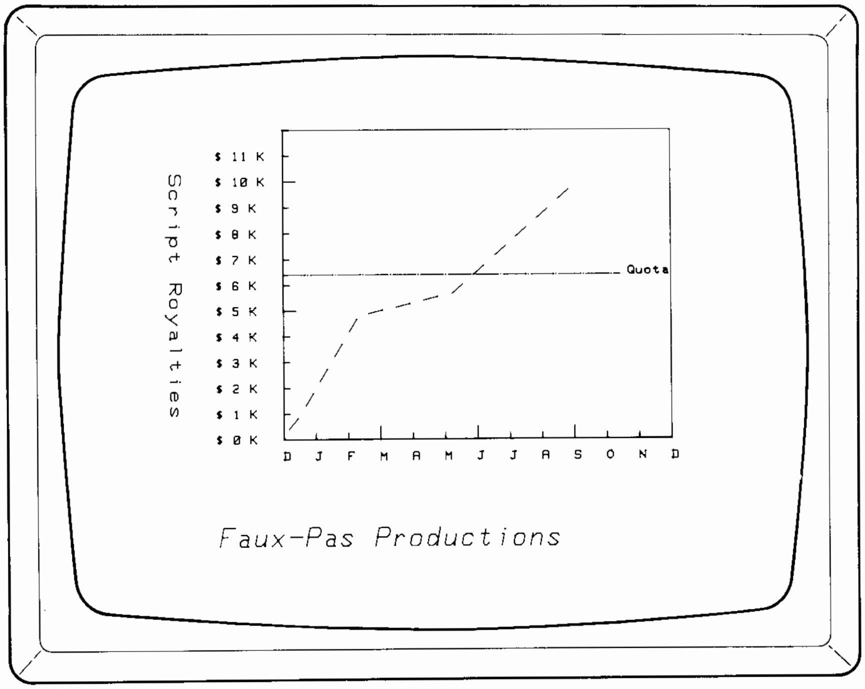
Syntax:

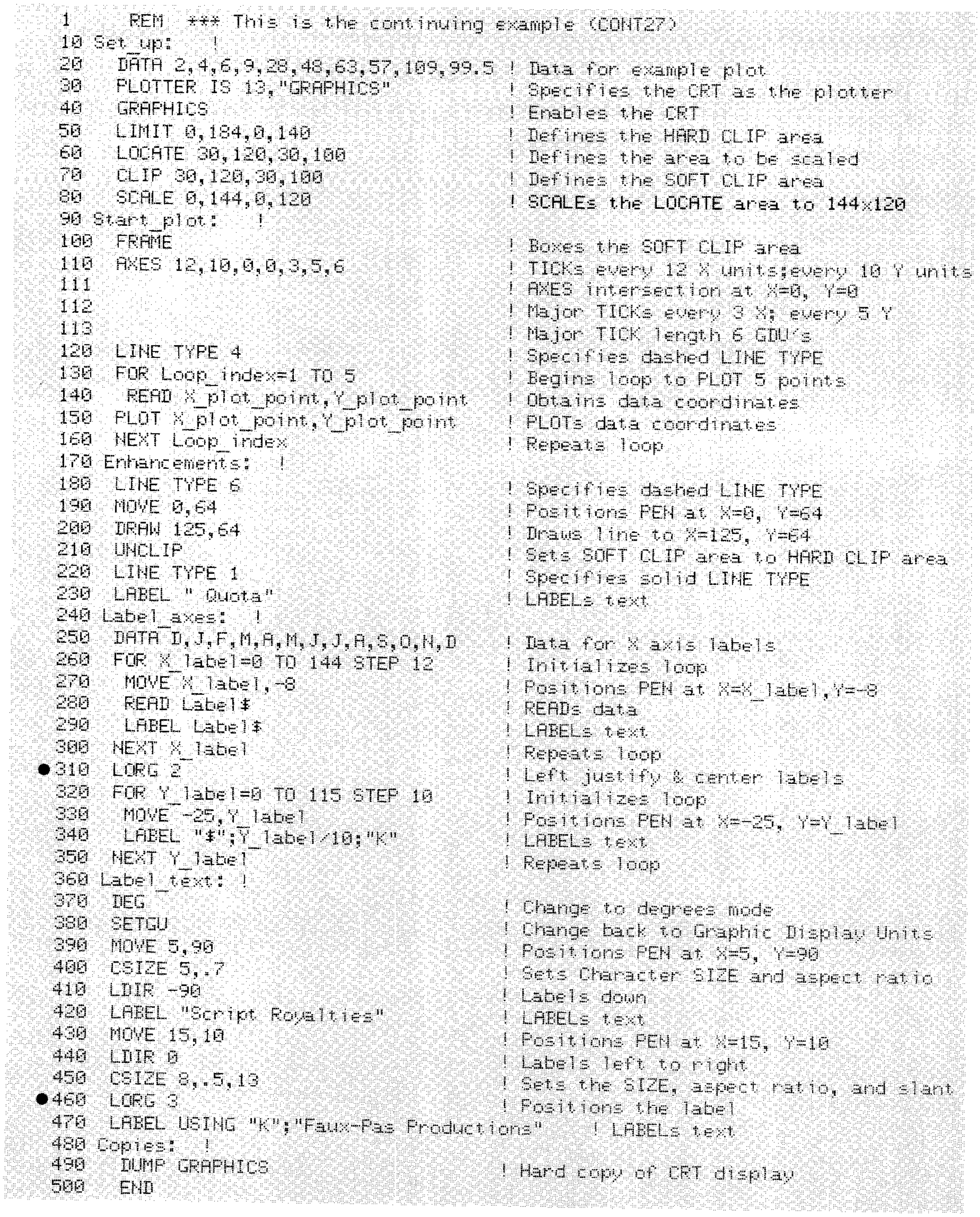
LORG origin position

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

LORG 1, 2 and 3 causes left justified labels. LORG 4,5 and 6 causes centered labels. LORG 7,8 and 9 causes right justified labels.

Example

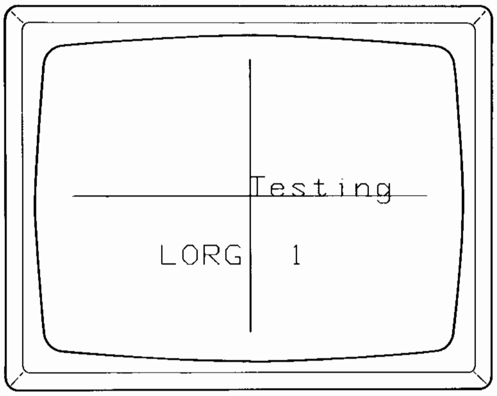


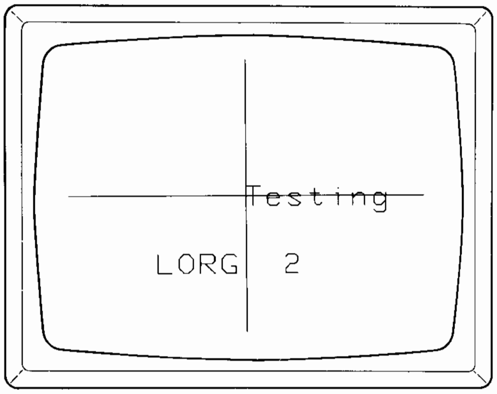


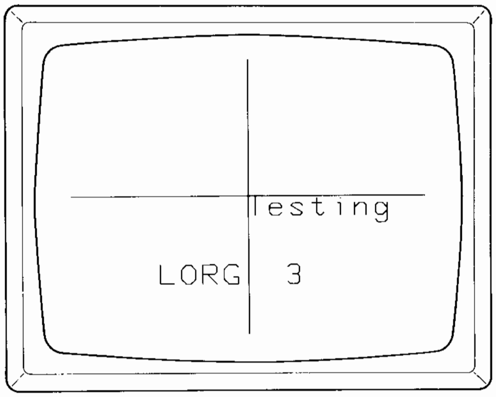
```
1      REM  *** This is the continuing example (CONT27)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5  ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"           ! Specifies the CRT as the plotter
40   GRAPHICS                           ! Enables the CRT
50   LIMIT 0,184,0,140                  ! Defines the HARD CLIP area
60   LOCATE 30,120,30,100               ! Defines the area to be scaled
70   CLIP 30,120,30,100                 ! Defines the SOFT CLIP area
80   SCALE 0,144,0,120                  ! SCALEs the LOCATE area to 144x120
90 Start_plot:   !
100  FRAME                              ! Boxes the SOFT CLIP area
110  AXES 12,10,0,0,3,5,6               ! TICKs every 12 X units;every 10 Y units
111                                     ! AXES intersection at X=0, Y=0
112                                     ! Major TICKs every 3 X; every 5 Y
113                                     ! Major TICK length 6 GDU's
120  LINE TYPE 4                        ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5              ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point    ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point     ! PLOTs data coordinates
160  NEXT Loop_index                    ! Repeats loop
170 Enhancements:   !
180  LINE TYPE 6                        ! Specifies dashed LINE TYPE
190  MOVE 0,64                          ! Positions PEN at X=0, Y=64
200  DRAW 125,64                        ! Draws line to X=125, Y=64
210  UNCLIP                             ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                        ! Specifies solid LINE TYPE
230  LABEL " Quota"                     ! LABELs text
240 Label_axes:   !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D     ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12       ! Initializes loop
270   MOVE X_label,-8                   ! Positions PEN at X=X_label,Y=-8
280   READ Label$                       ! READs data
290   LABEL Label$                      ! LABELs text
300  NEXT X_label                       ! Repeats loop
●310  LORG 2                            ! Left justify & center labels
320  FOR Y_label=0 TO 115 STEP 10       ! Initializes loop
330   MOVE -25,Y_label                  ! Positions PEN at X=-25, Y=Y_label
340   LABEL "$";Y_label/10;"K"          ! LABELs text
350  NEXT Y_label                       ! Repeats loop
360 Label_text: !
370  DEG                                ! Change to degrees mode
380  SETGU                              ! Change back to Graphic Display Units
390  MOVE 5,90                          ! Positions PEN at X=5, Y=90
400  CSIZE 5,.7                         ! Sets Character SIZE and aspect ratio
410  LDIR -90                           ! Labels down
420  LABEL "Script Royalties"           ! LABELs text
430  MOVE 15,10                         ! Positions PEN at X=15, Y=10
440  LDIR 0                             ! Labels left to right
450  CSIZE 8,.5,13                      ! Sets the SIZE, aspect ratio, and slant
●460  LORG 3                            ! Positions the label
470  LABEL USING "K";"Faux-Pas Productions"     ! LABELs text
480 Copies:   !
490   DUMP GRAPHICS                     ! Hard copy of CRT display
500   END
```

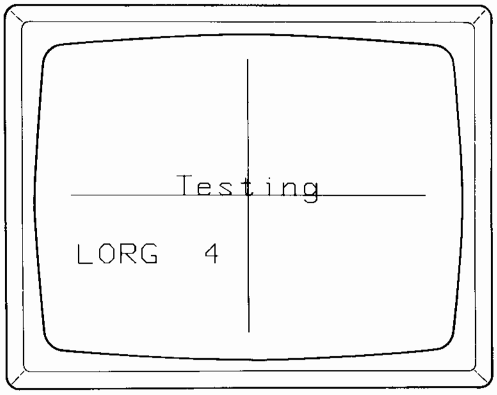
The following example demonstrates the various ways that you can position a label by using the LORG statement. All LORG positions are calculated based upon an upper-case character.

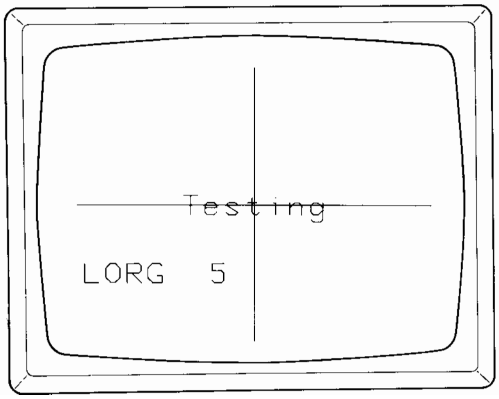
If you would like a hard copy printout and your System 45B has the built-in thermal printer option, change line 110 to DUMP GRAPHICS.

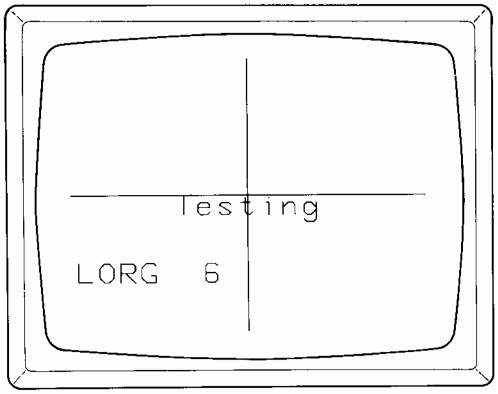


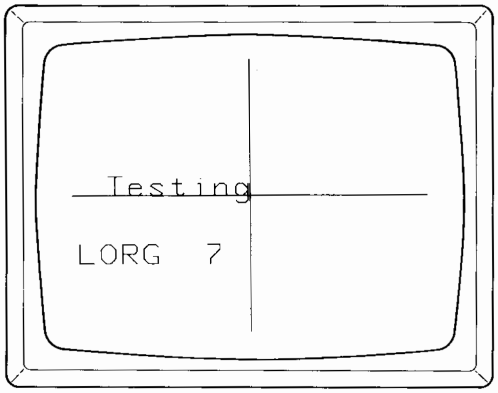


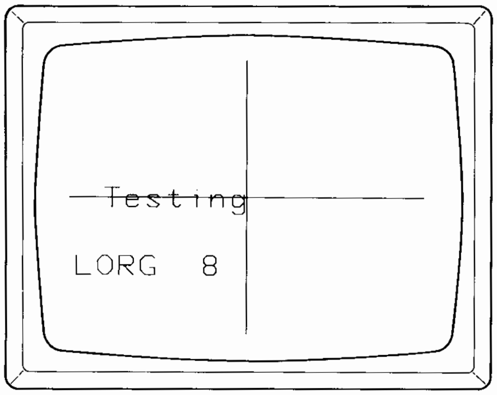


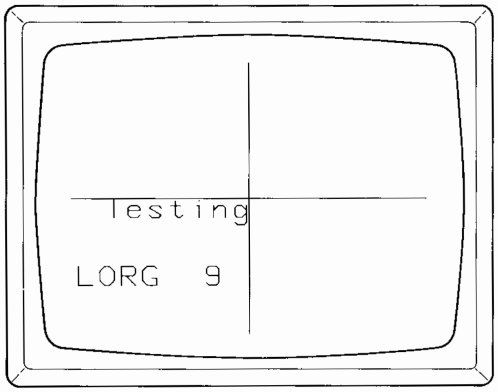


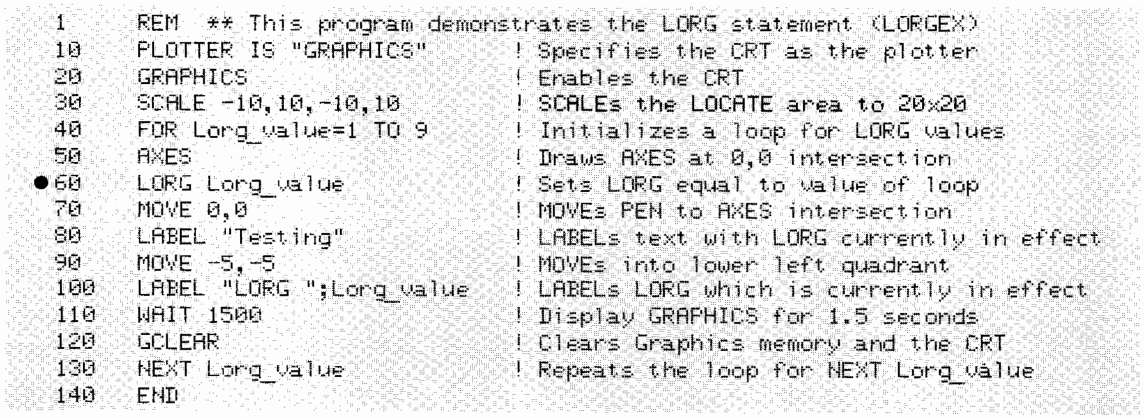








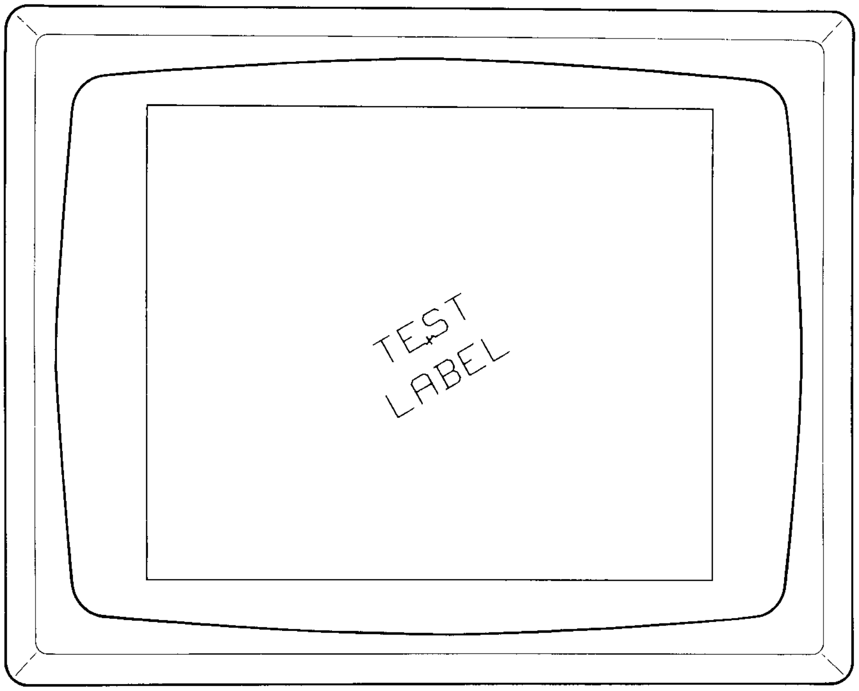


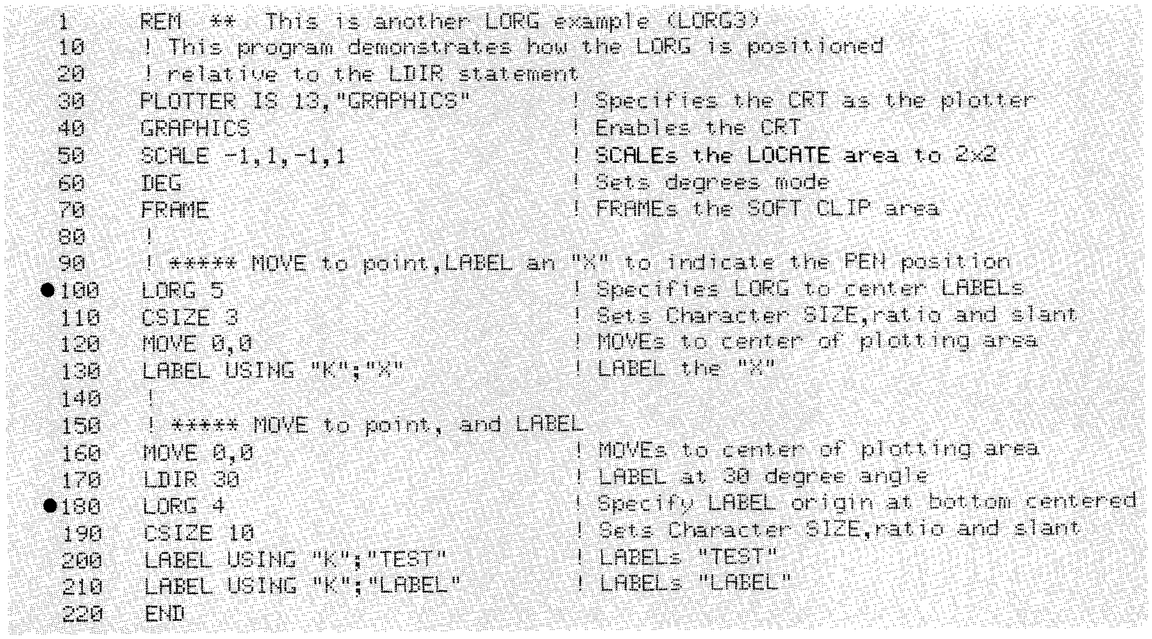


```
 1     REM  ** This program demonstrates the LORG statement (LORGEX)
 10    PLOTTER IS "GRAPHICS"      ! Specifies the CRT as the plotter
 20    GRAPHICS                   ! Enables the CRT
 30    SCALE -10,10,-10,10        ! SCALEs the LOCATE area to 20x20
 40    FOR Lorg_value=1 TO 9      ! Initializes a loop for LORG values
 50    AXES                       ! Draws AXES at 0,0 intersection
●60    LORG Lorg_value            ! Sets LORG equal to value of loop
 70    MOVE 0,0                   ! MOVEs PEN to AXES intersection
 80    LABEL "Testing"            ! LABELs text with LORG currently in effect
 90    MOVE -5,-5                 ! MOVEs into lower left quadrant
 100   LABEL "LORG ";Lorg_value   ! LABELs LORG which is currently in effect
 110   WAIT 1500                  ! Display GRAPHICS for 1.5 seconds
 120   GCLEAR                     ! Clears Graphics memory and the CRT
 130   NEXT Lorg_value            ! Repeats the loop for NEXT Lorg_value
 140   END
```

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

Example





```
 1     REM  **  This is another LORG example (LORG3)
 10    ! This program demonstrates how the LORG is positioned
 20    ! relative to the LDIR statement
 30    PLOTTER IS 13,"GRAPHICS"         ! Specifies the CRT as the plotter
 40    GRAPHICS                         ! Enables the CRT
 50    SCALE -1,1,-1,1                  ! SCALEs the LOCATE area to 2x2
 60    DEG                              ! Sets degrees mode
 70    FRAME                            ! FRAMEs the SOFT CLIP area
 80    !
 90    ! ***** MOVE to point,LABEL an "X" to indicate the PEN position
●100   LORG 5                           ! Specifies LORG to center LABELs
 110   CSIZE 3                          ! Sets Character SIZE,ratio and slant
 120   MOVE 0,0                         ! MOVEs to center of plotting area
 130   LABEL USING "K";"X"              ! LABEL the "X"
 140   !
 150   ! ***** MOVE to point, and LABEL
 160   MOVE 0,0                         ! MOVEs to center of plotting area
 170   LDIR 30                          ! LABEL at 30 degree angle
●180   LORG 4                           ! Specify LABEL origin at bottom centered
 190   CSIZE 10                         ! Sets Character SIZE,ratio and slant
 200   LABEL USING "K";"TEST"           ! LABELs "TEST"
 210   LABEL USING "K";"LABEL"          ! LABELs "LABEL"
 220   END
```

Summary

The following statements were explained in this chapter

- LABEL
- LABEL USING
- LETTER
- CSIZE
- LDIR
- LORG

In this chapter you learned how to label a plot, change the size, aspect ratio, and slant of each character, change the angle at which a line is labeled, and how to center and align (justify) labels.

The following chapter covers the statements associated with digitizing and cursor control.

Digitizing and Cursor Control

page 111 •**POINTER** (positions the cursor and specifies the type of cursor

page 114 •**CURSOR** (returns current cursor coordinates and pen up/down information)

page 116 •**DIGITIZE** (allows positioning of cursor before returning current cursor coordinates and pen up/down information)

page 120 •**WHERE** (returns current pen coordinates and pen up/down information)

Terms

•Pen – The device which is used to draw or plot lines, and to label characters.

•Cursor – The device which is used to obtain digitizing information.

•Digitizing – The process of obtaining an X,Y coordinate pair based on the location of the cursor.

Digitizing Information

Device	Cursor Moved by	Coordinates Entered by
CRT	← → ↑ ↓ and SHIFT and HOME	CONT STEP or any k0
HP 9872A	↑ ← FAST → ↓	ENTER ○
Incremental Plotter	← → ↑ ↓ and SHIFT and HOME	CONT STEP or any k0

Chapter 6

Pen vs Cursor Concept

All plotting operations are done with a **pen**. Conversely, all digitizing operations are done with a **cursor**. On a lot of plotting/digitizing devices (such as the 9872A Plotter), the pen and the cursor can be the same physical component on the device. However, the System 45B considers the pen and the cursor as two logically separate devices. Consequently your System 45B is able to keep track of one set of coordinates for the location of the pen, and another set of coordinates for the cursor's location. Moving the pen does not affect the position that the cursor occupies.

The POINTER statement is used to position a cursor on your graphic display at a specific X,Y coordinate. The POINTER statement is also used to select which type of two available cursors (large cross-hair, or small blinking cross-hair) is currently being used.

The CURSOR statement allows your System 45B to obtain the present X,Y coordinate of the cursor from the specified plotting device, as well as whether the pen is raised or lowered on the plotting surface.

The DIGITIZE statement pauses the program execution until you have positioned the cursor over a specific point on the plot and pressed CONT to enter the X,Y coordinate data. The pen up/down information is also obtained by the DIGITIZE statement.

The WHERE statement is similar to the CURSOR statement, except that the X,Y coordinate data and the up/down information refers to the pen which is currently in use.

Remember, the pen position is the location at which plotting and labeling operations are done; the cursor position is the location at which digitizing operations are done.

Only six statements allow the cursor to be used. The six statements are –

- LIMIT (without parameters)
- LOCATE (without parameters)
- CLIP (without parameters)
- POINTER
- CURSOR
- DIGITIZE

Of the four statements explained in this chapter, three of them (POINTER, CURSOR and DIGITIZE) refer to the cursor position. Only the WHERE statement refers to the pen position.

POINTER Statement

The POINTER statement moves the cursor to a specified absolute position. This is similar to a MOVE statement for the plotter's pen.

Syntax:

POINTER X parameter, Y parameter[, cursor type]

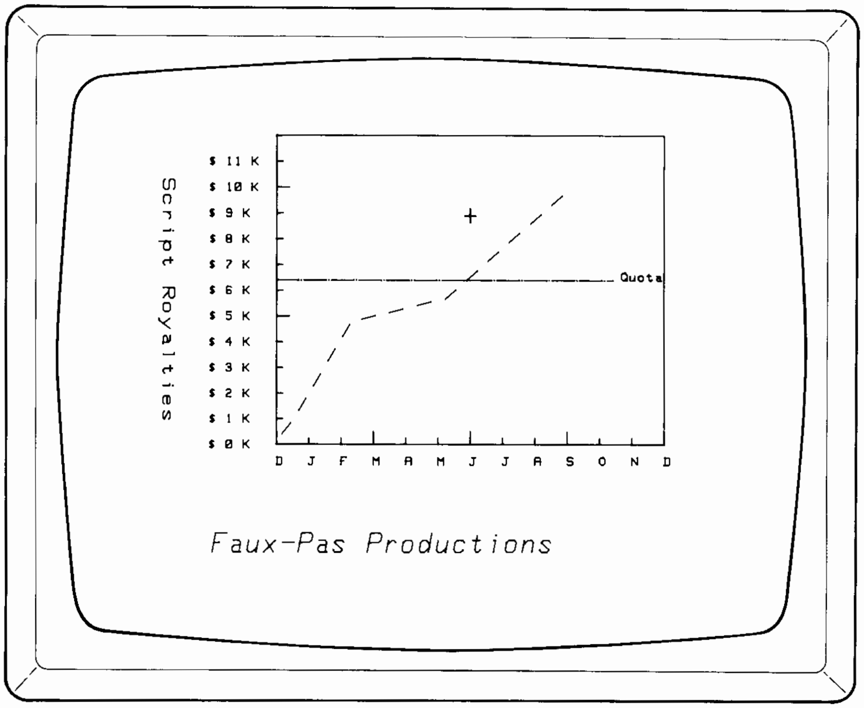
The X and Y parameters are specified in current units. If the POINTER is positioned outside the hard clip limit, the cursor is turned off.

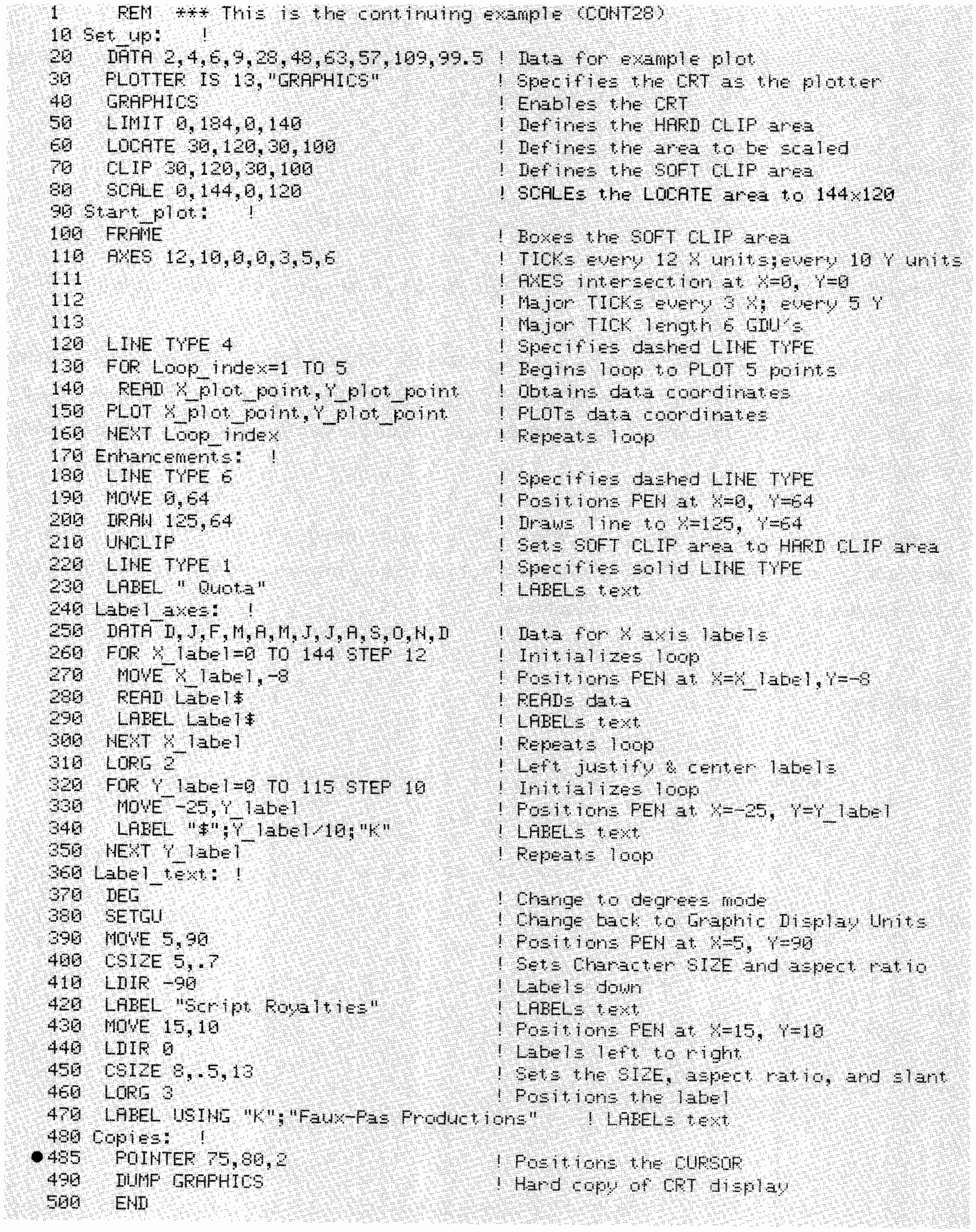
The cursor type parameter specifies one of two types of cursors available on the CRT.

- An odd number produces a full screen crossed-line cursor.
- An even number produces a small blinking cross cursor.

Once a cursor type is selected, it is the type used by all other statements that use the cursor (e.g. DIGITIZE and LIMIT without parameters) until changed again. The default cursor type for the CRT is the full screen crossed-lines. For external plotting devices, the cursor type parameter is ignored.

Example


Script Royalties
$ 11 K
$ 10 K
$ 9 K
$ 8 K
$ 7 K
$ 6 K
$ 5 K
$ 4 K
$ 3 K
$ 2 K
$ 1 K
$ 0 K
Quota
D
J
F
M
A
M
J
J
A
S
O
N
D
Faux-Pas Productions



```
 1      REM  *** This is the continuing example (CONT28)
 10 Set_up:    !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 40   GRAPHICS                          ! Enables the CRT
 50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
 60   LOCATE 30,120,30,100              ! Defines the area to be scaled
 70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
 80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
 90 Start_plot:    !
 100  FRAME                             ! Boxes the SOFT CLIP area
 110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
 111                                    ! AXES intersection at X=0, Y=0
 112                                    ! Major TICKs every 3 X; every 5 Y
 113                                    ! Major TICK length 6 GDU's
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
 190  MOVE 0,64                         ! Positions PEN at X=0, Y=64
 200  DRAW 125,64                       ! Draws line to X=125, Y=64
 210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 230  LABEL " Quota"                    ! LABELs text
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 270   MOVE X_label,-8                  ! Positions PEN at X=X_label,Y=-8
 280   READ Label$                      ! READs data
 290   LABEL Label$                     ! LABELs text
 300  NEXT X_label                      ! Repeats loop
 310  LORG 2                            ! Left justify & center labels
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 330   MOVE -25,Y_label                 ! Positions PEN at X=-25, Y=Y_label
 340   LABEL "$";Y_label/10;"K"         ! LABELs text
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 380  SETGU                             ! Change back to Graphic Display Units
 390  MOVE 5,90                         ! Positions PEN at X=5, Y=90
 400  CSIZE 5,.7                        ! Sets Character SIZE and aspect ratio
 410  LDIR -90                          ! Labels down
 420  LABEL "Script Royalties"          ! LABELs text
 430  MOVE 15,10                        ! Positions PEN at X=15, Y=10
 440  LDIR 0                            ! Labels left to right
 450  CSIZE 8,.5,13                     ! Sets the SIZE, aspect ratio, and slant
 460  LORG 3                            ! Positions the label
 470  LABEL USING "K";"Faux-Pas Productions"     ! LABELs text
 480 Copies:  !
●485   POINTER 75,80,2                  ! Positions the CURSOR
 490   DUMP GRAPHICS                    ! Hard copy of CRT display
 500   END
```

CURSOR Statement

The CURSOR statement returns the cursor's coordinates and the pen status information to the specified variables, without pausing program execution.

Syntax:

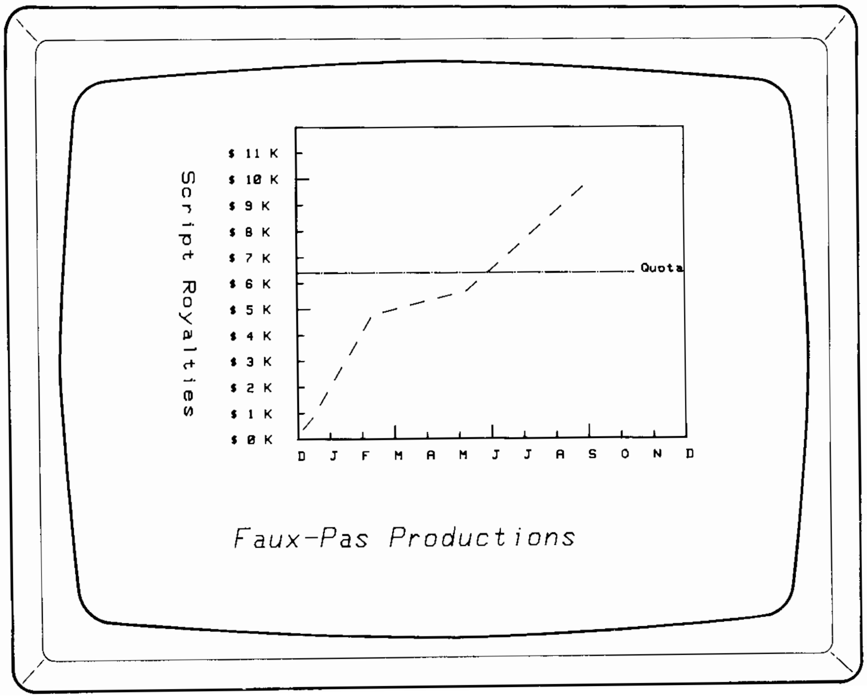
CURSOR X variable, Y variable [, pen status string variable]

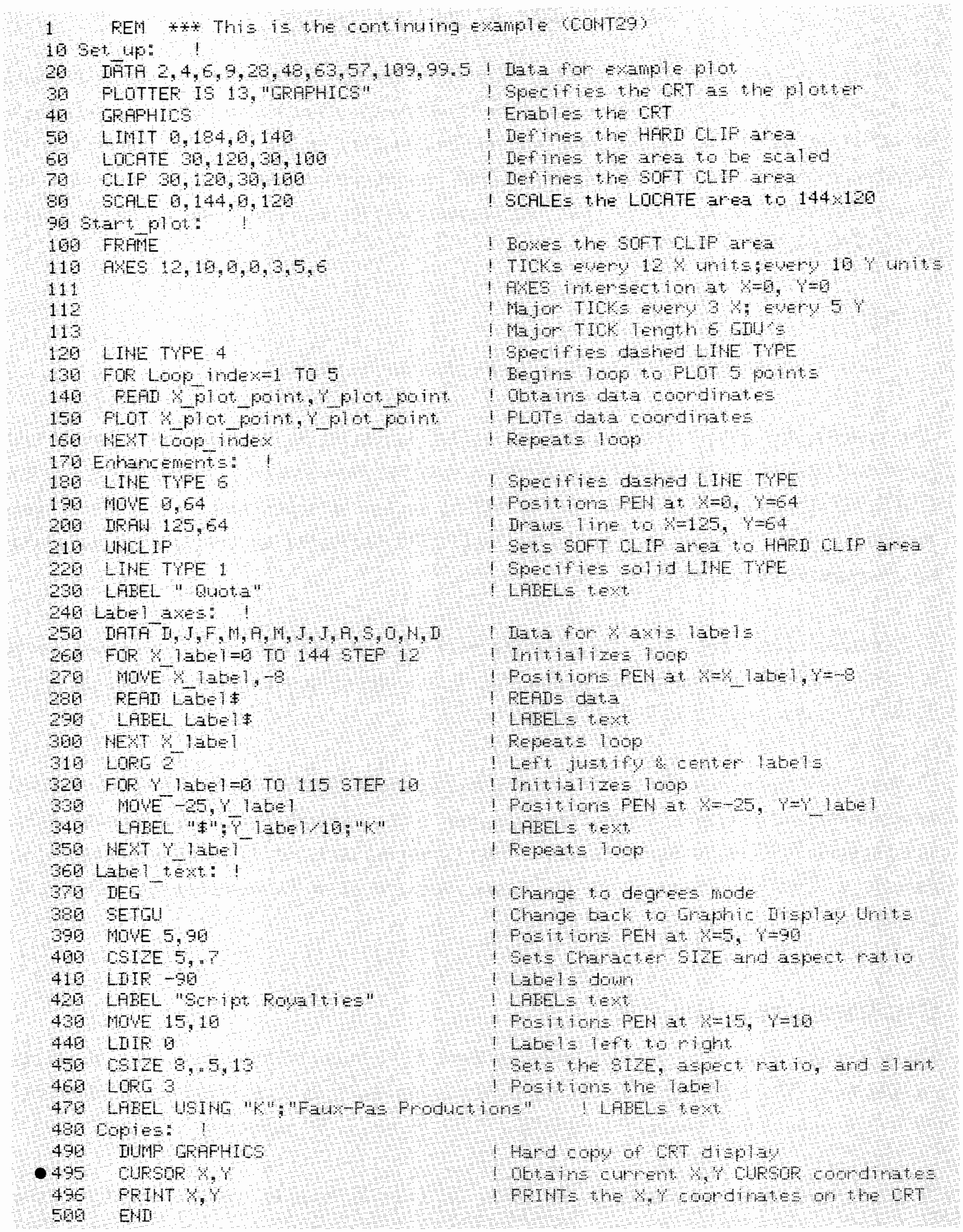
The returned X and Y values are the coordinate values of the cursor in current units.

The optional third variable must be a string variable or substring. If the pen status string variable is present, it 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 pen and the cursor are NOT the same thing. On some plotters, they are physically the same (e.g. HP 9872A Plotter), but the logical location of the pen and the cursor are kept track of separately by the computer.

Example





```
1     REM  *** This is the continuing example (CONT29)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
40   GRAPHICS                          ! Enables the CRT
50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
60   LOCATE 30,120,30,100              ! Defines the area to be scaled
70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
111                                    ! AXES intersection at X=0, Y=0
112                                    ! Major TICKs every 3 X; every 5 Y
113                                    ! Major TICK length 6 GDU's
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
190  MOVE 0,64                         ! Positions PEN at X=0, Y=64
200  DRAW 125,64                       ! Draws line to X=125, Y=64
210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
230  LABEL " Quota"                    ! LABELs text
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
270   MOVE X_label,-8                  ! Positions PEN at X=X_label,Y=-8
280   READ Label$                      ! READs data
290   LABEL Label$                     ! LABELs text
300  NEXT X_label                      ! Repeats loop
310  LORG 2                            ! Left justify & center labels
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
330   MOVE -25,Y_label                 ! Positions PEN at X=-25, Y=Y_label
340   LABEL "$";Y_label/10;"K"         ! LABELs text
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
380  SETGU                             ! Change back to Graphic Display Units
390  MOVE 5,90                         ! Positions PEN at X=5, Y=90
400  CSIZE 5,.7                        ! Sets Character SIZE and aspect ratio
410  LDIR -90                          ! Labels down
420  LABEL "Script Royalties"          ! LABELs text
430  MOVE 15,10                        ! Positions PEN at X=15, Y=10
440  LDIR 0                            ! Labels left to right
450  CSIZE 8,.5,13                     ! Sets the SIZE, aspect ratio, and slant
460  LORG 3                            ! Positions the label
470  LABEL USING "K";"Faux-Pas Productions"    ! LABELs text
480 Copies:  !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
●495   CURSOR X,Y                      ! Obtains current X,Y CURSOR coordinates
496   PRINT X,Y                        ! PRINTs the X,Y coordinates on the CRT
500   END
```

DIGITIZE Statement

The DIGITIZE statement pauses the program and allows you to reposition the cursor and then waits for you to press CONT STEP or a special function key. Once this is done, the coordinate values of the cursor (in current units) are assigned to the first two variables specified in the digitize statement. The third variable, if specified, is assigned the pen's status information. The cursor type which is used in the DIGITIZE statement is the one which was specified last in a POINTER statement.

Syntax:

DIGITIZE X variable, Y variable[, pen status string variable]

This statement is similar to the computer's INPUT statement except that a minimum of two numeric variables are assigned values from the active plotter. The other difference is that if a DIGITIZE statement (or a LIMIT or LOCATE) is waiting for coordinates to be entered, you cannot EDIT the program until either the DIGITIZE statement has been completed or the program halted by pressing STOP.

The optional third variable must be a string variable or a substring. If the pen status string variable is present, it is assigned the character 0 or 1, depending on the pen being up (0) or down (1), just as in the CURSOR statement.

On most plotting devices, the pen becomes the cursor for digitizing. On the CRT, the cursor is separate from what would be considered the pen. The cursor on the CRT has the lower-left corner of the CRT as its default position. If you wish the cursor to be positioned elsewhere, execute a POINTER statement for the desired location prior to executing the DIGITIZE statement.

Digitizing from the CRT

There are two types of cursors available on the CRT: a small blinking cross and full-screen crossed lines. The cursor type is selected from the last specified cursor selection in either the POINTER or its default value set by the PLOTTER IS or LIMIT statement.

To move the CRT cursor press the →, ←, ↓, or ↑ keys as needed. The shift of the keys moves the cursor one dot row each time the key is pressed, the unshift of these keys moves the cursor one character cell. Press HOME to move the cursor to the lower-left corner.

To enter a digitized point from the CRT press CONT or STEP or one of the special function keys. If CONT is pressed the computer takes the coordinate of the digitized point and then continues program execution. If a special function key is pressed instead of the continue key, the computer takes the digitized point and performs the operation as defined by the special function key. Refer to the System 45B Operating and Programming Manual for more information on the operations and definitions of special function keys.

If the LIMIT, LOCATE, or CLIP statements are executed without parameters, the computer waits for the two opposite corners to be entered while in a digitize mode. The cursor on the CRT can be moved and the point entered as described in the previous two paragraphs.

Digitizing with the 9872A

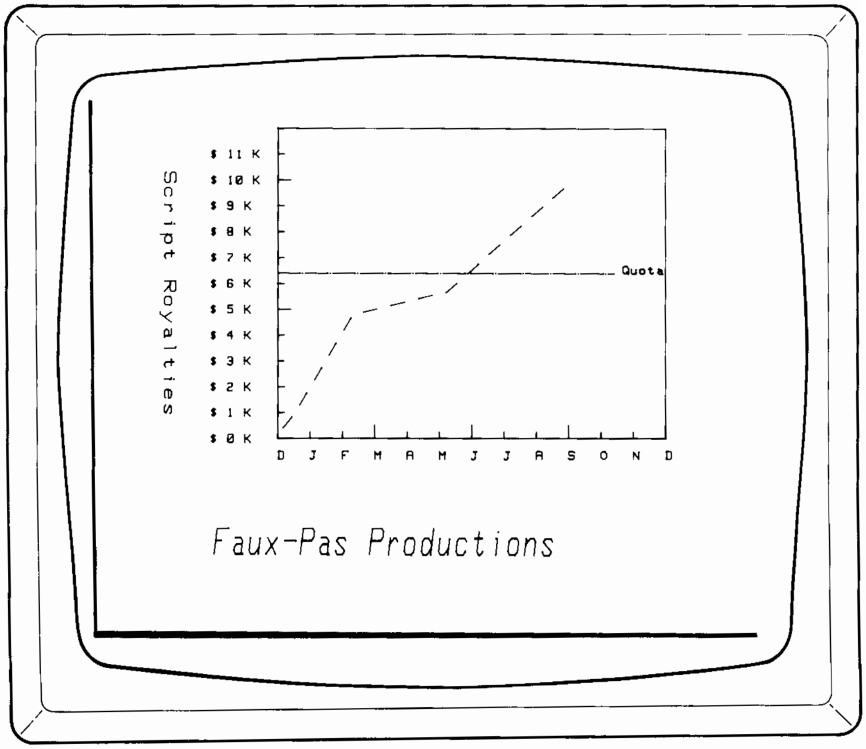
On most plotting devices, the pen is used for digitizing. On the 9872A, a special digitizing sight is optional for digitizing operations. This sight can be loaded into one of the pen stalls and is selected with a PEN statement for use with the DIGITIZE statement.

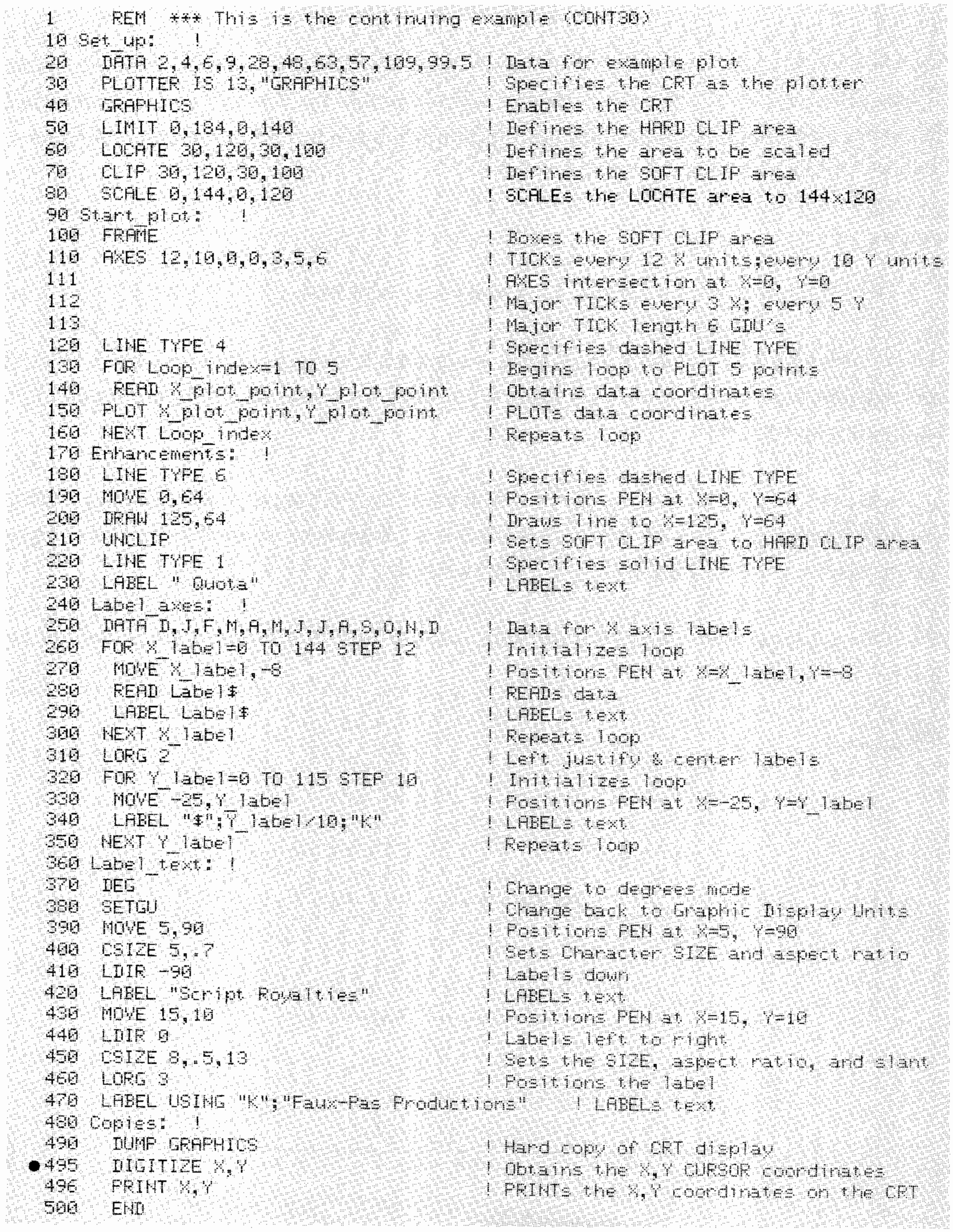
When a DIGITIZE statement is executed, the plotter's pen arm moves to the last specified cursor position. The ENTER o key indicator lights and the program execution pauses. The pen should then be positioned over the point to be digitized by using the pen arm control keys on the plotter's front panel. Press the ENTER o key to send the coordinate values of the point to the computer. The program execution automatically resumes after entering the coordinates.

Digitizing with an Incremental Plotter

Points are digitized on the Incremental Plotter in a similar manner to digitizing points on the CRT. The incremental plotter's cursor is moved by the four arrow keys (← → ↓ ↑) on the System 45B, just as you move the cursor on the CRT. When the cursor is in the proper position, press CONT to enter the point's X,Y coordinate.

Example


Script Royalties
$ 11 K
$ 10 K
$ 9 K
$ 8 K
$ 7 K
$ 6 K
$ 5 K
$ 4 K
$ 3 K
$ 2 K
$ 1 K
$ 0 K
Quota
D J F M A M J J A S O N D
Faux-Pas Productions



```
1     REM  *** This is the continuing example (CONT30)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
40   GRAPHICS                          ! Enables the CRT
50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
60   LOCATE 30,120,30,100              ! Defines the area to be scaled
70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
111                                    ! AXES intersection at X=0, Y=0
112                                    ! Major TICKs every 3 X; every 5 Y
113                                    ! Major TICK length 6 GDU's
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
190  MOVE 0,64                         ! Positions PEN at X=0, Y=64
200  DRAW 125,64                       ! Draws line to X=125, Y=64
210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
230  LABEL " Quota"                    ! LABELs text
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
270   MOVE X_label,-8                  ! Positions PEN at X=X_label,Y=-8
280   READ Label$                      ! READs data
290   LABEL Label$                     ! LABELs text
300  NEXT X_label                      ! Repeats loop
310  LORG 2                            ! Left justify & center labels
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
330   MOVE -25,Y_label                 ! Positions PEN at X=-25, Y=Y_label
340   LABEL "$";Y_label/10;"K"         ! LABELs text
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
380  SETGU                             ! Change back to Graphic Display Units
390  MOVE 5,90                         ! Positions PEN at X=5, Y=90
400  CSIZE 5,.7                        ! Sets Character SIZE and aspect ratio
410  LDIR -90                          ! Labels down
420  LABEL "Script Royalties"          ! LABELs text
430  MOVE 15,10                        ! Positions PEN at X=15, Y=10
440  LDIR 0                            ! Labels left to right
450  CSIZE 8,.5,13                     ! Sets the SIZE, aspect ratio, and slant
460  LORG 3                            ! Positions the label
470  LABEL USING "K";"Faux-Pas Productions"     ! LABELs text
480 Copies:  !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
●495   DIGITIZE X,Y                    ! Obtains the X,Y CURSOR coordinates
496   PRINT X,Y                        ! PRINTs the X,Y coordinates on the CRT
500   END
```

WHERE Statement

The WHERE statement returns the pen's coordinate values of the last plotted or moved-to point. These values are in current units. If the last point is outside the clip boundaries the returned value does not reflect the current physical position of the pen but rather the logical position of the pen (its last plotted or moved-to point).

Syntax:

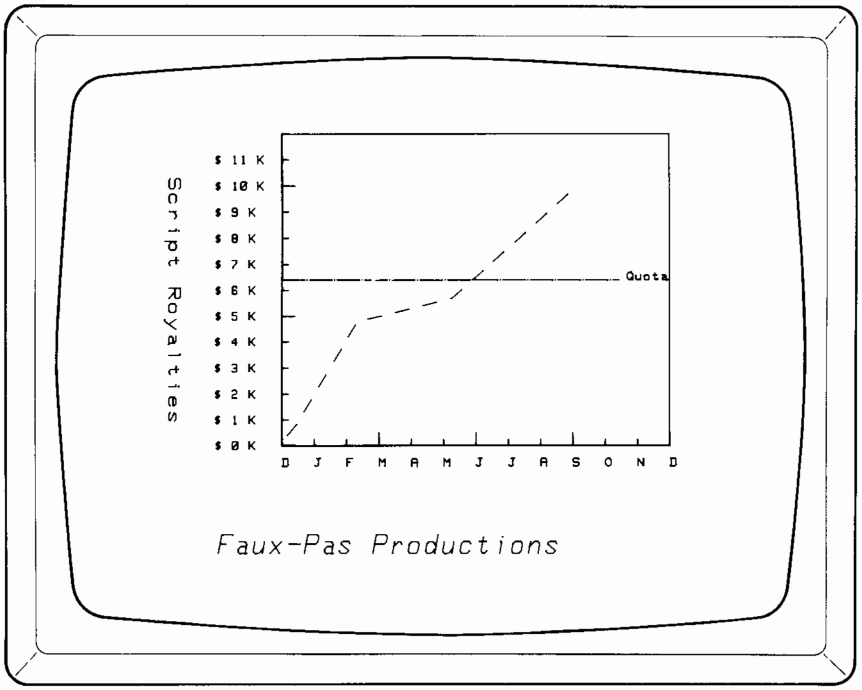
WHERE X variable, Y variable[, pen status string variable]

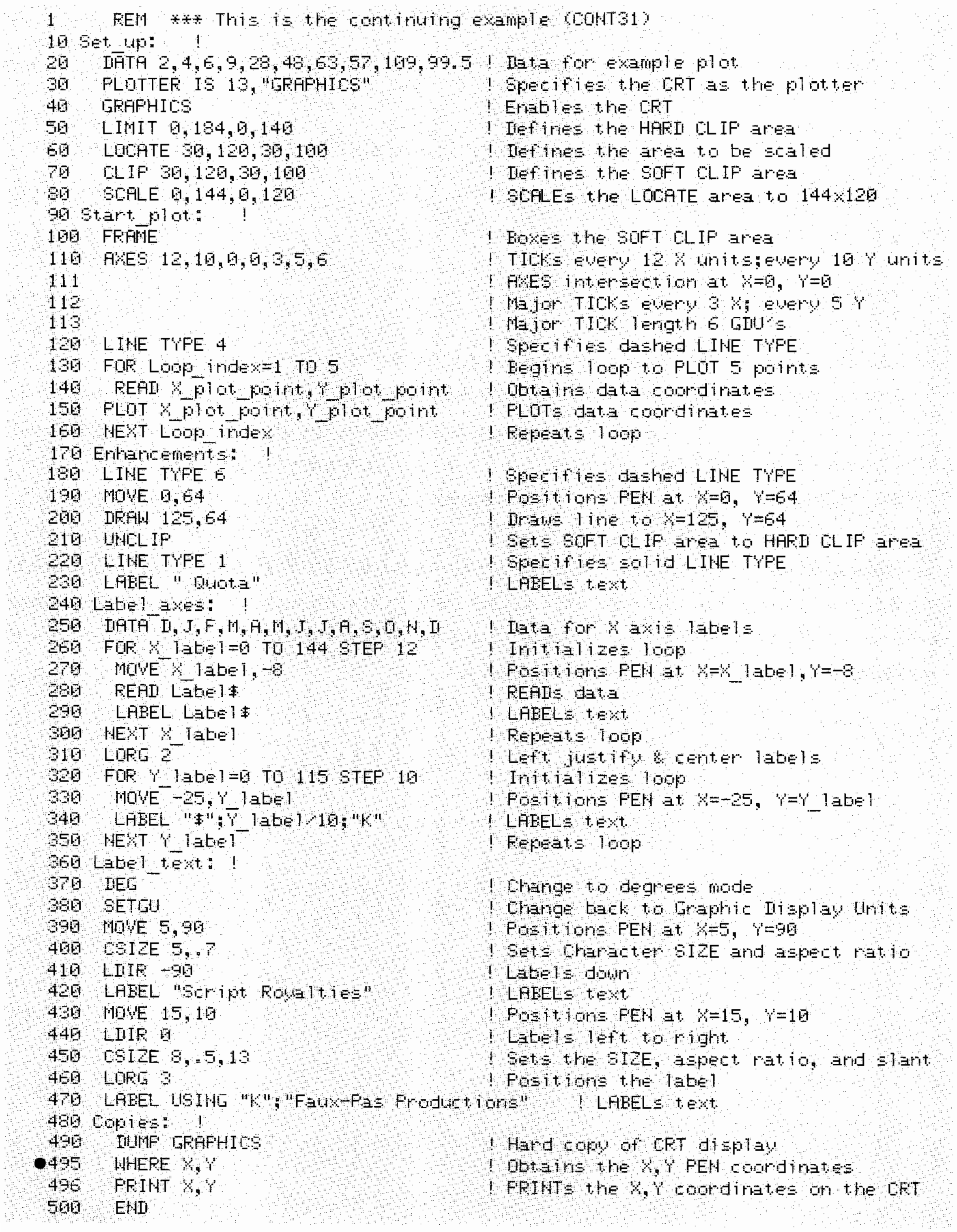
The returned X and Y values are the logical coordinates of the pen position in current units. If the pen was sent outside of the soft clip area, its coordinates are returned even though it is outside the soft clip area.

The optional third variable must be a string variable or a substring. If the pen status string variable is present, it is assigned the character 0 or 1, depending on whether the pen is up or down, similar to the CURSOR and DIGITIZE statements.

Press the space bar after running this example, because the X,Y coordinates are printed on the CRT.

Example





```
1     REM  *** This is the continuing example (CONT31)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
40   GRAPHICS                          ! Enables the CRT
50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP area
60   LOCATE 30,120,30,100              ! Defines the area to be scaled
70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
111                                    ! AXES intersection at X=0, Y=0
112                                    ! Major TICKs every 3 X; every 5 Y
113                                    ! Major TICK length 6 GDU's
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
190  MOVE 0,64                         ! Positions PEN at X=0, Y=64
200  DRAW 125,64                       ! Draws line to X=125, Y=64
210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
230  LABEL " Quota"                    ! LABELs text
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
270   MOVE X_label,-8                  ! Positions PEN at X=X_label,Y=-8
280   READ Label$                      ! READs data
290   LABEL Label$                     ! LABELs text
300  NEXT X_label                      ! Repeats loop
310  LORG 2                            ! Left justify & center labels
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
330   MOVE -25,Y_label                 ! Positions PEN at X=-25, Y=Y_label
340   LABEL "$";Y_label/10;"K"         ! LABELs text
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
380  SETGU                             ! Change back to Graphic Display Units
390  MOVE 5,90                         ! Positions PEN at X=5, Y=90
400  CSIZE 5,.7                        ! Sets Character SIZE and aspect ratio
410  LDIR -90                          ! Labels down
420  LABEL "Script Royalties"          ! LABELs text
430  MOVE 15,10                        ! Positions PEN at X=15, Y=10
440  LDIR 0                            ! Labels left to right
450  CSIZE 8,.5,13                     ! Sets the SIZE, aspect ratio, and slant
460  LORG 3                            ! Positions the label
470  LABEL USING "K";"Faux-Pas Productions"    ! LABELs text
480 Copies:  !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
●495   WHERE X,Y                       ! Obtains the X,Y PEN coordinates
496   PRINT X,Y                        ! PRINTs the X,Y coordinates on the CRT
500   END
```

Summary

This chapter covered the following statements

- POINTER
- CURSOR
- DIGITIZE
- WHERE

Other information in this chapter covered the difference between the pen and the cursor, the difference between plotting and digitizing, how to position and change the cursor type using the POINTER statement, how to obtain the current cursor location by using the CURSOR statement, how to enter an X,Y coordinate by using the DIGITIZE statement, and how to find the current position of the pen by using the WHERE statement.

The final chapter in this manual is concerned with some advanced graphic techniques such as loading and storing the entire graphics display, and curve smoothing. There are also some other example programs which you may find interesting in an approach to problem solving as well as in the way certain statements are used.

Advanced Graphic Techniques

page 124 •**GLOAD** (loads integer array from R/W memory to CRT/graphics memory)
page 124 •**GSTORE** (stores CRT/graphics memory array into integer array in R/W memory

Terms

•Reflected Plot – A plot produced by interchanging either the X min, X max coordinates, the Y min, Y max coordinates or both X and Y coordinate pairs to change the plot.
•HPGL – The instruction set resident within the HP 9872A Graphics Plotter.

Reflected Plots

Parameter Sequence	Resulting Plot
X min, X max, Y min, Y max	Normal
X max, X min, Y min, Y max	Reflects Across Y Axis
X min, X max, Y max, Y min	Reflects Across X Axis
X max, X min, Y max, Y min	Reflects Through the Origin

Array Specifications for GLOAD and GSTORE

Array Type – Integer
Maximum Number of Elements – 16 381
Pointer – First Array Element

Chapter 7

GLOAD and GSTORE Statements

The GLOAD and GSTORE statements allow you to copy the CRT graphics memory to or from an integer array within the computer's R/W memory. The CRT graphics memory contains the data that produces dots, which make up the CRT graphics display. When copied into the computer's R/W memory the data can be stored (GSTORE), manipulated, MAT PRINT onto a mass storage device, MAT READ from a mass storage device, and then later copied back (GLOAD) into the CRT memory for display.

A complex graphics display may take several minutes to generate using the plotting statements, but by using GSTORE and then later GLOAD, the same display can be re-displayed in a fraction of a second.

Syntax:

GLOAD integer array name (*)
or
GSTORE integer array name (*)

The integer array used with these statements must have 36 elements for each horizontal dot row, plus one extra element for a pointer. The pointer is the first element of the array.

If you want to store the entire graphics display, you need to dimension an integer array with 16 381 elements. One element is for the pointer, plus 36 elements for each row, and there are 455 rows (1+36x455=16 381). If you are using OPTION BASE 0 the subscript of the first element of the array is zero (e.g., Array(0)) and the dimension size could be as shown.

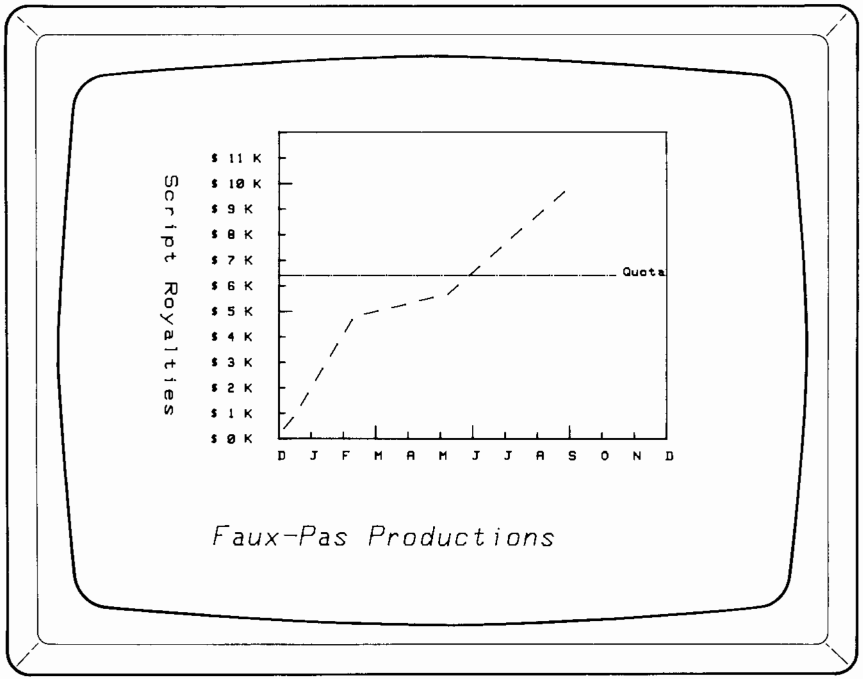
```
10 OPTION BASE 0
20 INTEGER A(16380)
```

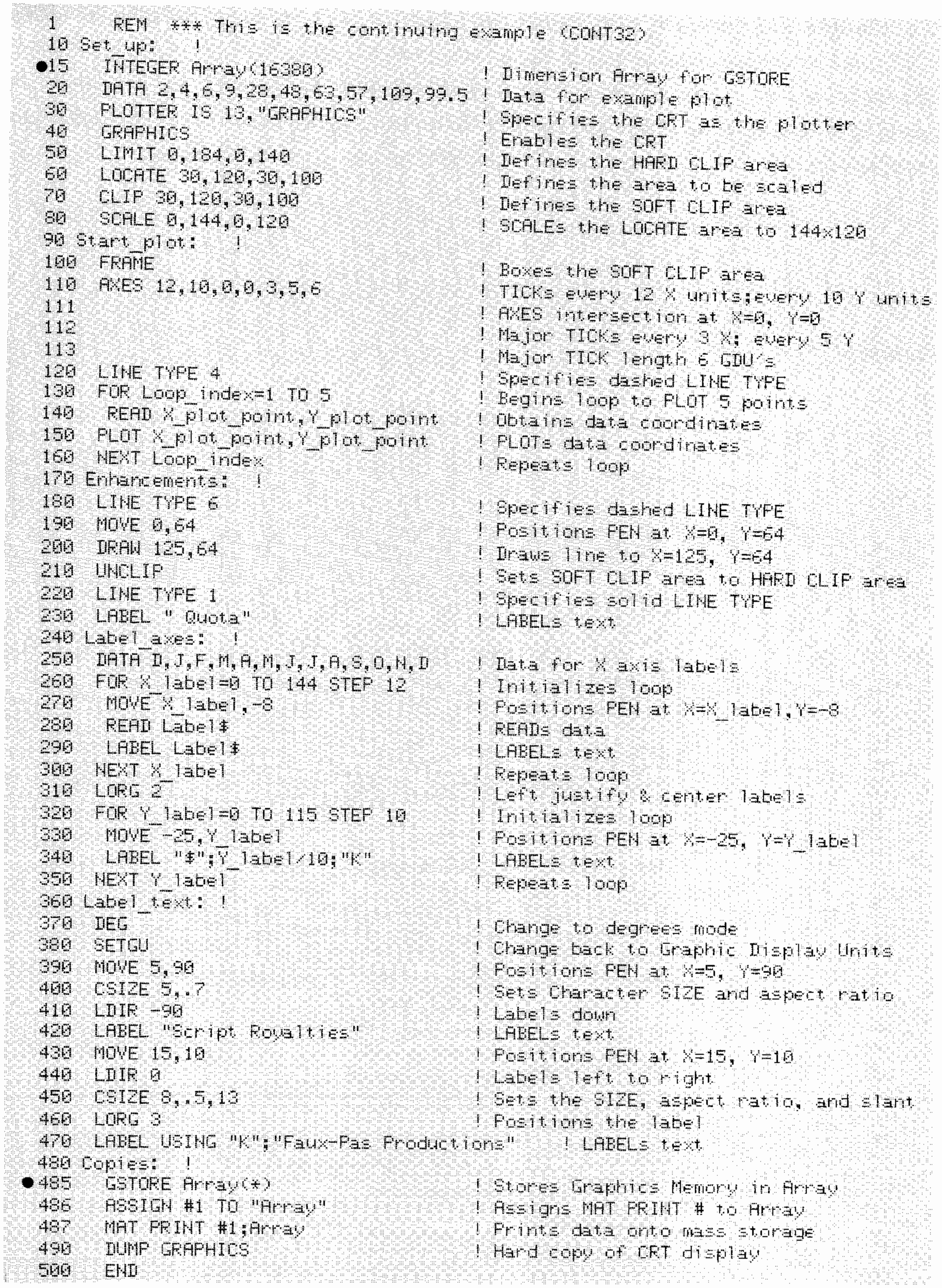
Zero through 16 380 equals 16 381 elements.

If it is not necessary to copy the entire graphics display you can dimension the integer array smaller. An integer array with 8 173 elements (1+227x36=8 173) holds about one half of the graphics display (227 dot rows).

For example, by adding the following program lines to your continuing example, the entire CRT graphics display could be stored into an array which is called "Array". As you can see in the program, the contents of "Array" are then stored away onto the mass storage device. At some later time, you could then read the data file containing the contents of "Array" back into your System 45B, and by using a GLOAD statement, re-display your CRT picture.

Example





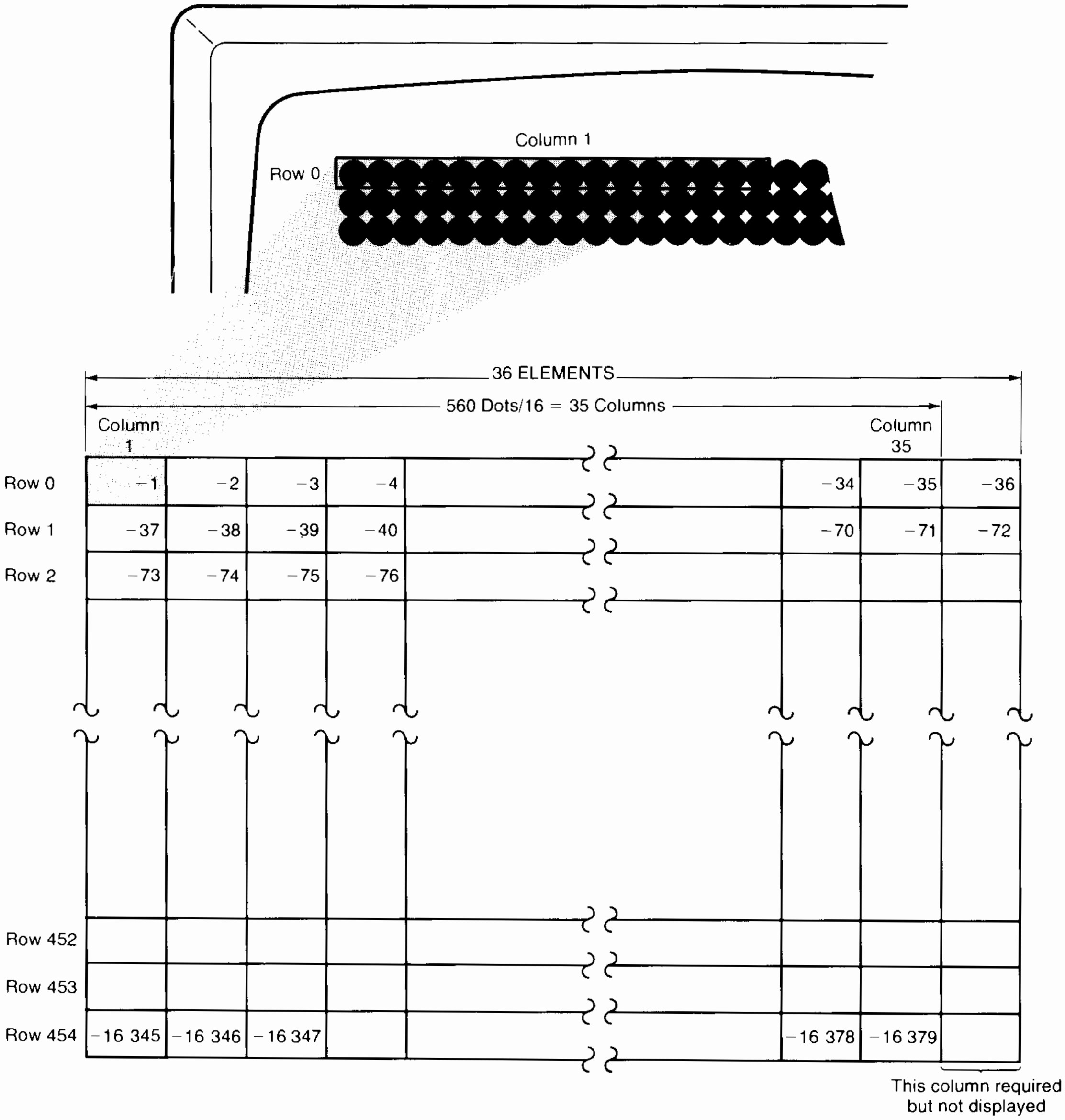
```
 1     REM  *** This is the continuing example (CONT32)
 10 Set_up:   !
●15   INTEGER Array(16380)                            ! Dimension Array for GSTORE
 20   DATA 2,4,6,9,28,48,63,57,109,99.5  ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"                    ! Specifies the CRT as the plotter
 40   GRAPHICS                                        ! Enables the CRT
 50   LIMIT 0,184,0,140                               ! Defines the HARD CLIP area
 60   LOCATE 30,120,30,100                            ! Defines the area to be scaled
 70   CLIP 30,120,30,100                              ! Defines the SOFT CLIP area
 80   SCALE 0,144,0,120                               ! SCALEs the LOCATE area to 144x120
 90 Start_plot:   !
 100  FRAME                                           ! Boxes the SOFT CLIP area
 110  AXES 12,10,0,0,3,5,6                            ! TICKs every 12 X units;every 10 Y units
 111                                                  ! AXES intersection at X=0, Y=0
 112                                                  ! Major TICKs every 3 X; every 5 Y
 113                                                  ! Major TICK length 6 GDU's
 120  LINE TYPE 4                                     ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5                           ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point                 ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point                  ! PLOTs data coordinates
 160  NEXT Loop_index                                 ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                                     ! Specifies dashed LINE TYPE
 190  MOVE 0,64                                       ! Positions PEN at X=0, Y=64
 200  DRAW 125,64                                     ! Draws line to X=125, Y=64
 210  UNCLIP                                          ! Sets SOFT CLIP area to HARD CLIP area
 220  LINE TYPE 1                                     ! Specifies solid LINE TYPE
 230  LABEL " Quota"                                  ! LABELs text
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D                  ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12                    ! Initializes loop
 270   MOVE X_label,-8                                ! Positions PEN at X=X_label,Y=-8
 280   READ Label$                                    ! READs data
 290   LABEL Label$                                   ! LABELs text
 300  NEXT X_label                                    ! Repeats loop
 310  LORG 2                                          ! Left justify & center labels
 320  FOR Y_label=0 TO 115 STEP 10                    ! Initializes loop
 330   MOVE -25,Y_label                               ! Positions PEN at X=-25, Y=Y_label
 340   LABEL "$";Y_label/10;"K"                       ! LABELs text
 350  NEXT Y_label                                    ! Repeats loop
 360 Label_text: !
 370  DEG                                             ! Change to degrees mode
 380  SETGU                                           ! Change back to Graphic Display Units
 390  MOVE 5,90                                       ! Positions PEN at X=5, Y=90
 400  CSIZE 5,.7                                      ! Sets Character SIZE and aspect ratio
 410  LDIR -90                                        ! Labels down
 420  LABEL "Script Royalties"                        ! LABELs text
 430  MOVE 15,10                                      ! Positions PEN at X=15, Y=10
 440  LDIR 0                                          ! Labels left to right
 450  CSIZE 8,.5,13                                   ! Sets the SIZE, aspect ratio, and slant
 460  LORG 3                                          ! Positions the label
 470  LABEL USING "K";"Faux-Pas Productions"     ! LABELs text
 480 Copies:  !
●485   GSTORE Array(*)                                ! Stores Graphics Memory in Array
 486   ASSIGN #1 TO "Array"                           ! Assigns MAT PRINT # to Array
 487   MAT PRINT #1;Array                             ! Prints data onto mass storage
 490   DUMP GRAPHICS                                  ! Hard copy of CRT display
 500   END
```

More About CRT Arrays

The first element (i.e.,A(0)in option base 0) is always used as the load or store pointer and must be a negative number. The value that you assign to the pointer determines where the load or store operation begins.

You cannot REDIM the integer array which is used in either a GLOAD or a GSTORE statement.

The range of value for the pointer is −1 to −16 379 as shown next.



The number represents the starting address that must be assigned to the pointer to start a load or store operation at the location represented by the square, as shown above.

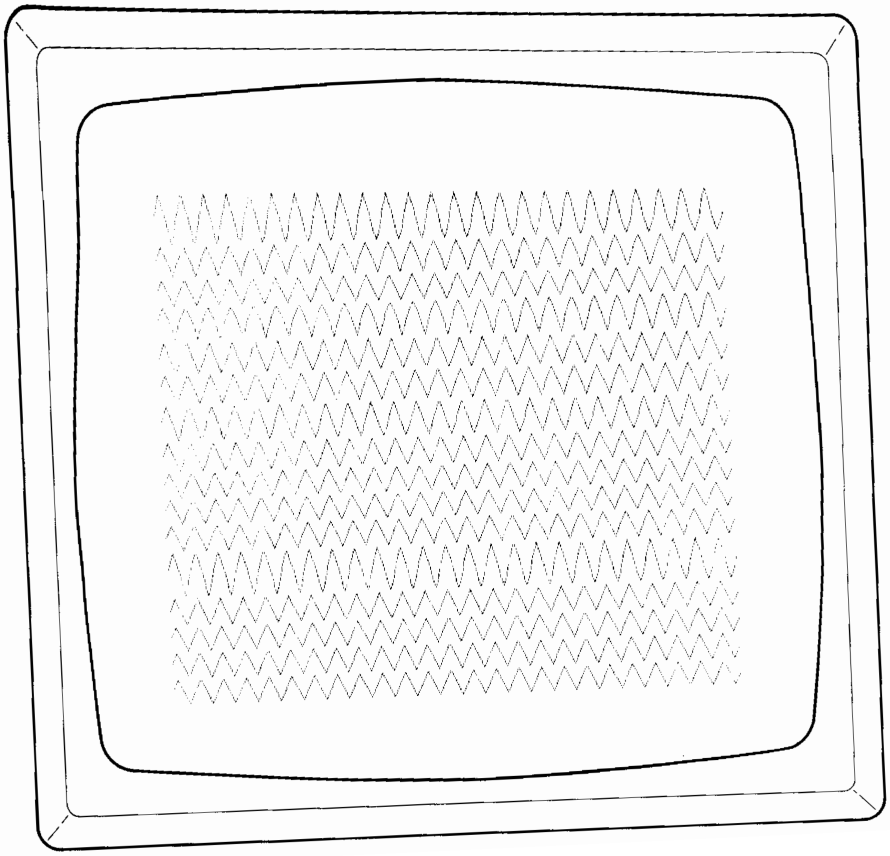
The following expression can be used to compute the starting address for a given dot row. Note: the assigned value must be negative.

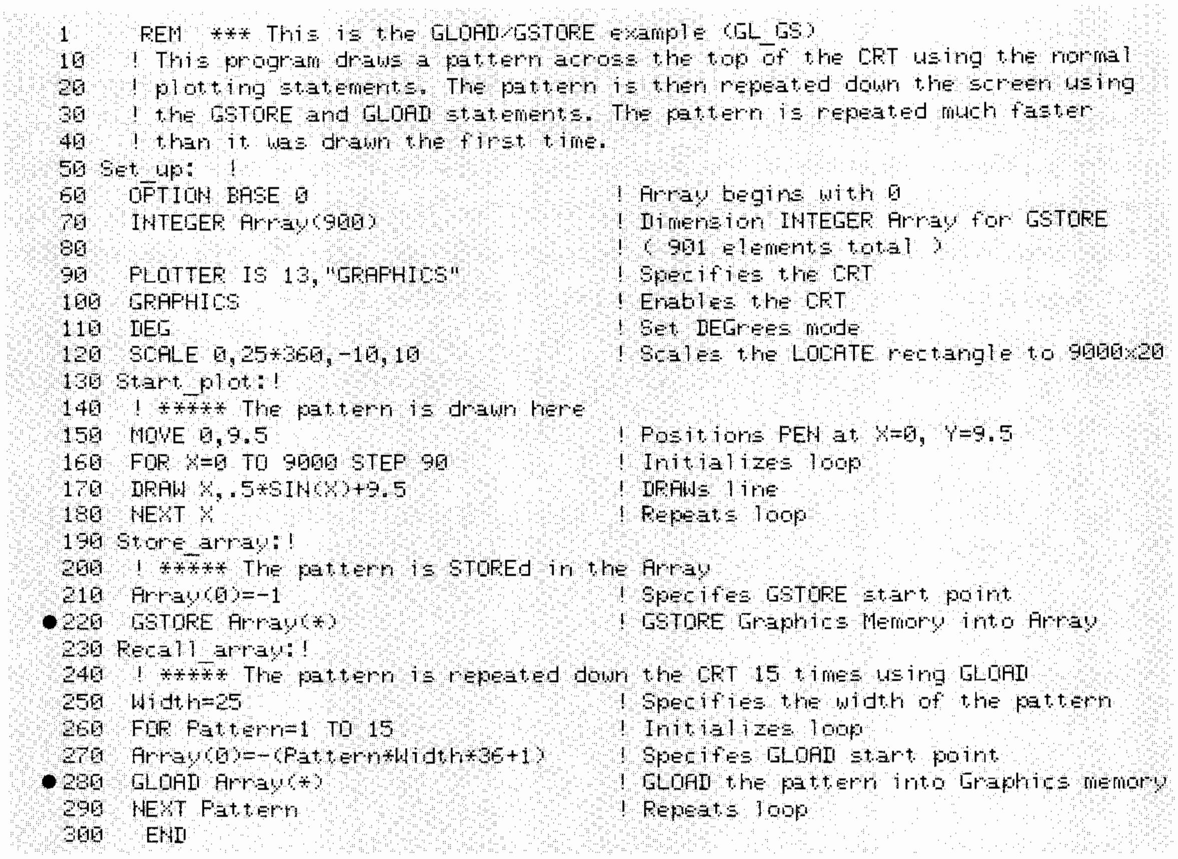
$$A(0) = -(\text{Row}\times 36+1)$$

where the variable Row is the number (0 to 454) that you want to start the load or store operation. The top row number is zero (0) and the bottom row number is 454.

The program produces a pattern across the top of the CRT at the normal line generating speed. Then by using GSTORE and GLOAD, the pattern is repeated 15 times down the screen (25 dot rows at a time). As you can see, the pattern is repeated faster than it can be generated the first time.

Example





```
 1     REM  *** This is the GLOAD/GSTORE example (GL_GS)
 10   ! This program draws a pattern across the top of the CRT using the normal
 20   ! plotting statements. The pattern is then repeated down the screen using
 30   ! the GSTORE and GLOAD statements. The pattern is repeated much faster
 40   ! than it was drawn the first time.
 50 Set_up:  !
 60   OPTION BASE 0                       ! Array begins with 0
 70   INTEGER Array(900)                  ! Dimension INTEGER Array for GSTORE
 80                                       ! ( 901 elements total )
 90   PLOTTER IS 13,"GRAPHICS"            ! Specifies the CRT
 100  GRAPHICS                            ! Enables the CRT
 110  DEG                                 ! Set DEGrees mode
 120  SCALE 0,25*360,-10,10               ! Scales the LOCATE rectangle to 9000x20
 130 Start_plot:!
 140  ! ***** The pattern is drawn here
 150  MOVE 0,9.5                          ! Positions PEN at X=0, Y=9.5
 160  FOR X=0 TO 9000 STEP 90             ! Initializes loop
 170  DRAW X,.5*SIN(X)+9.5                ! DRAWs line
 180  NEXT X                              ! Repeats loop
 190 Store_array:!
 200  ! ***** The pattern is STOREd in the Array
 210  Array(0)=-1                         ! Specifes GSTORE start point
●220  GSTORE Array(*)                     ! GSTORE Graphics Memory into Array
 230 Recall_array:!
 240  ! ***** The pattern is repeated down the CRT 15 times using GLOAD
 250  Width=25                            ! Specifies the width of the pattern
 260  FOR Pattern=1 TO 15                 ! Initializes loop
 270  Array(0)=-(Pattern*Width*36+1)      ! Specifes GLOAD start point
●280  GLOAD Array(*)                      ! GLOAD the pattern into Graphics memory
 290  NEXT Pattern                        ! Repeats loop
 300   END
```

Reflective Plotting

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 different types of reflected plots, such as, when you want to draw on the back side of clear plastic or film to produce a right reading image when read from the front side. This technique is very useful in slide generation because the resulting slides are more resistant to handling or wear in addition to allowing you to mark and erase marks along the top side of the slide.

Reflected plots are produced by exchanging one or more sets of parameters in the following Graphics statements.

```
LIMIT
SHOW
SCALE
```

With each of these three statements, the parameters are in the order of

X1,X2,Y1,Y2

If you enter the parameters as X2,X1,Y1,Y2 the resulting plot is reflected across the Y-axis.

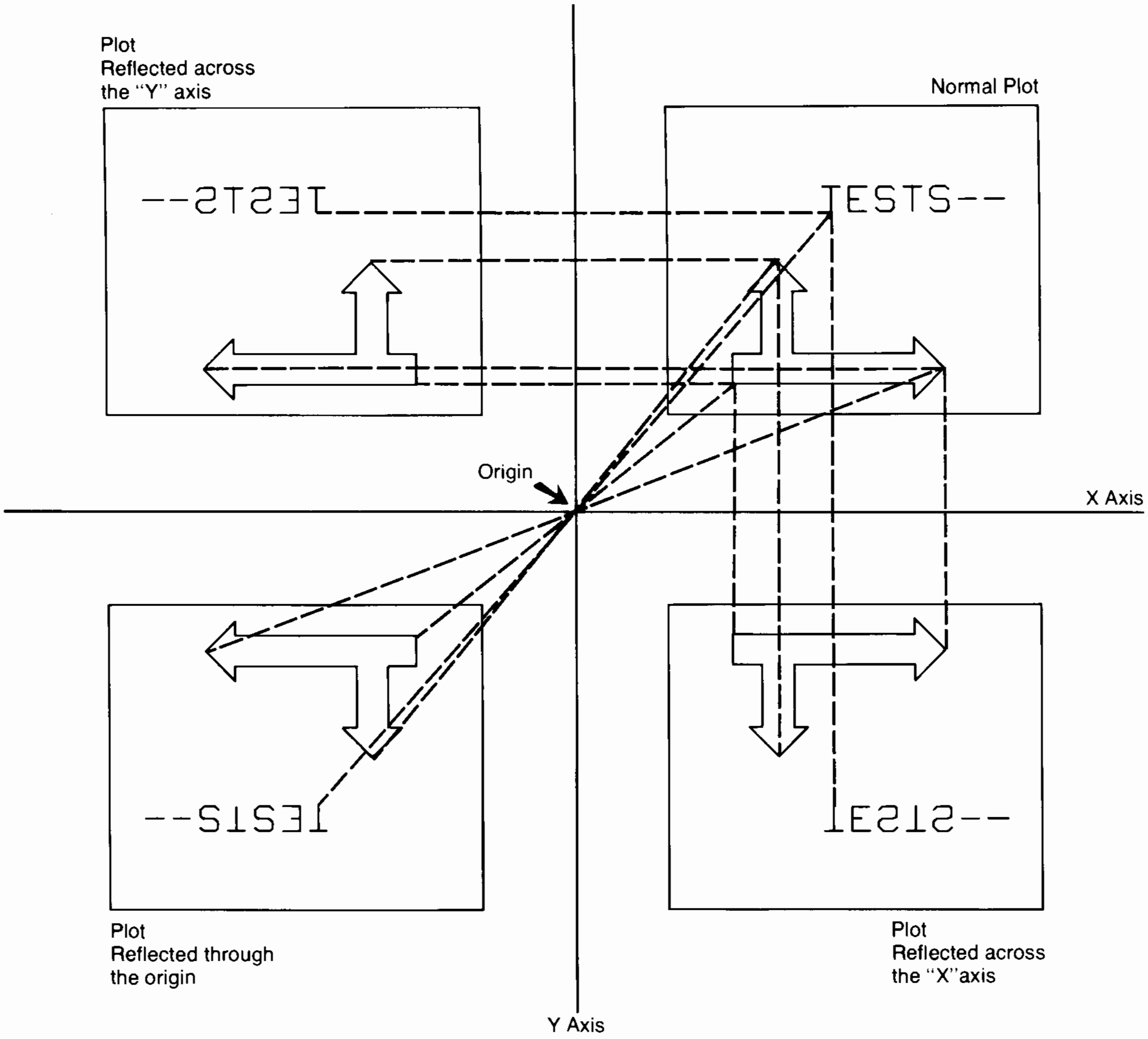
If you enter the parameters as X1, X2, Y2, Y1 the resulting plot is reflected across the X-axis.

If you enter the parameters as X2,X1,Y2,Y1 the resulting plot is reflected through its origin.

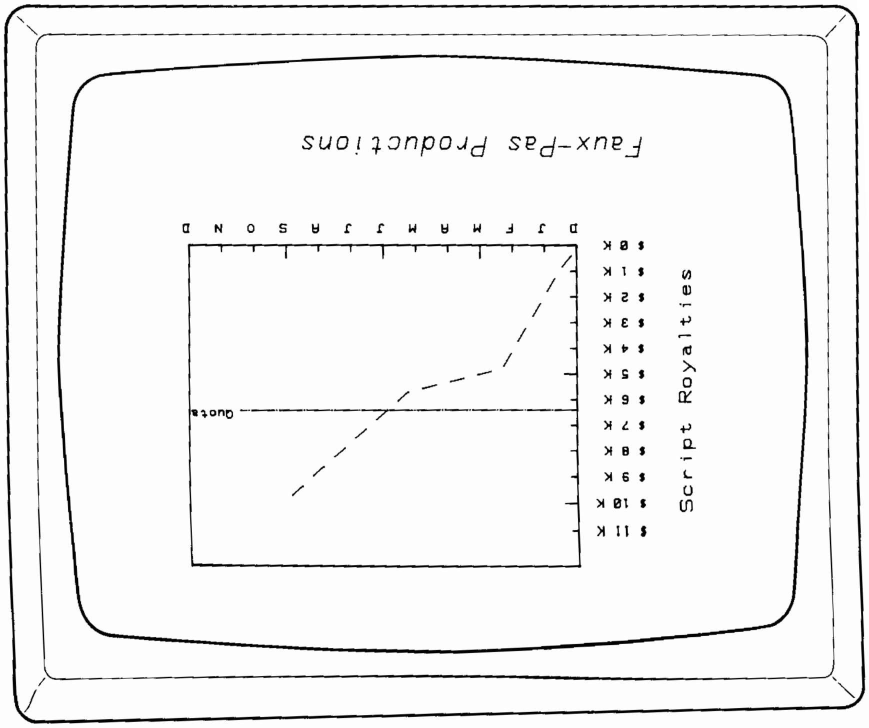
Labeling is done in the GDU's mode. Therefore, the LIMIT statement is the only statement which reflects labels as well as plots.

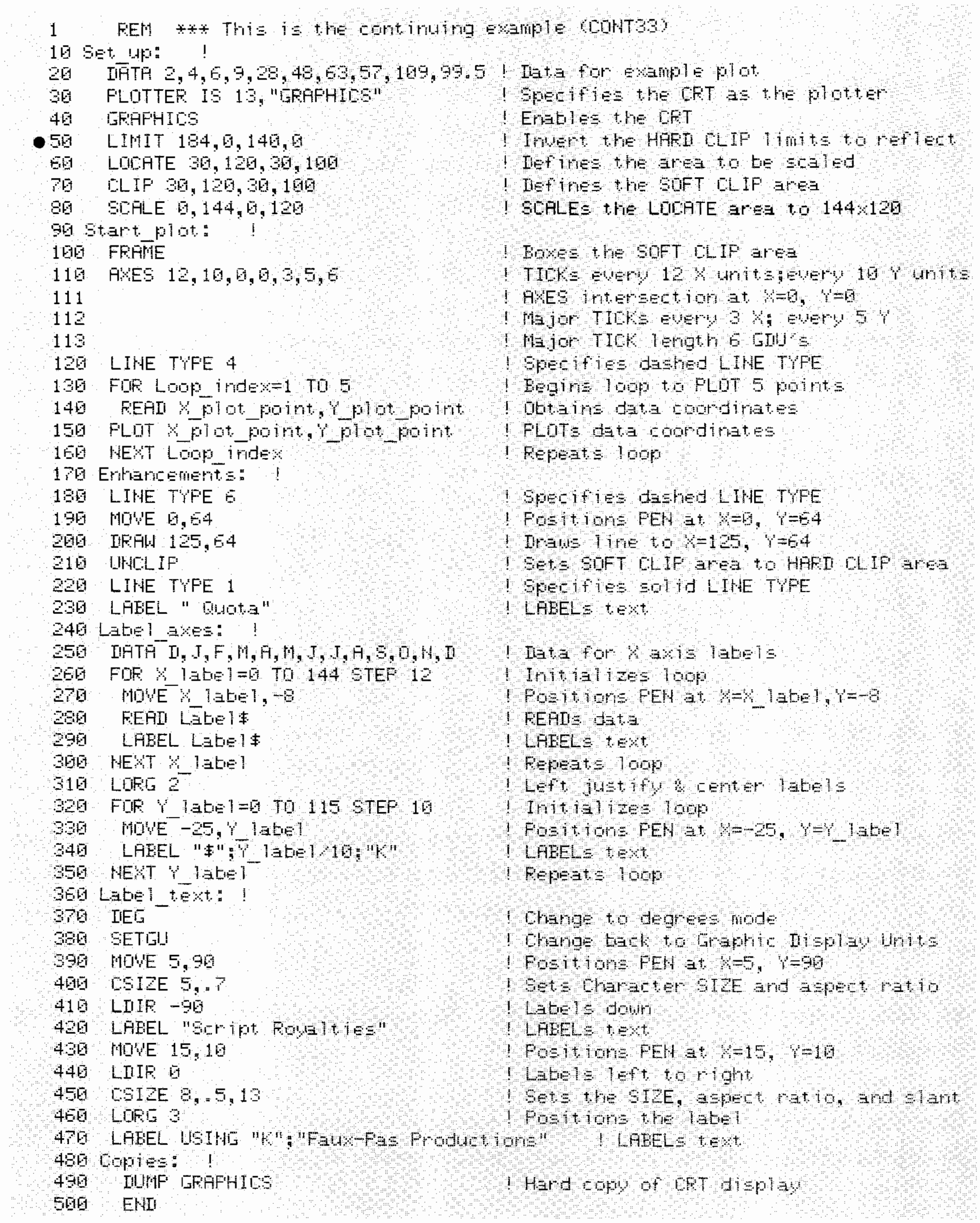
The SHOW and SCALE statements position the labels relative to the X,Y position called for by a MOVE statement, regardless of how that looks due to the reflection.

The following illustrations show the three types of reflected plots:


Plot
Reflected across
the "Y" axis
Normal Plot
TESTS--
Origin
X Axis
Plot
Reflected through
the origin
Plot
Reflected across
the "X"axis
Y Axis

Example


Faux-Pas Productions
D J F M A M J J A S O N D
$ 0 K
$ 1 K
$ 2 K
$ 3 K
$ 4 K
$ 5 K
$ 6 K
$ 7 K
$ 8 K
$ 9 K
$ 10 K
$ 11 K
Quota
Script Royalties



```
 1     REM  *** This is the continuing example (CONT33)
 10 Set_up:   !
 20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
 30   PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 40   GRAPHICS                          ! Enables the CRT
●50   LIMIT 184,0,140,0                 ! Invert the HARD CLIP limits to reflect
 60   LOCATE 30,120,30,100              ! Defines the area to be scaled
 70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
 80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
 90 Start_plot:   !
 100  FRAME                             ! Boxes the SOFT CLIP area
 110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
 111                                    ! AXES intersection at X=0, Y=0
 112                                    ! Major TICKs every 3 X; every 5 Y
 113                                    ! Major TICK length 6 GDU's
 120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
 130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
 140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
 150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
 160  NEXT Loop_index                   ! Repeats loop
 170 Enhancements:  !
 180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
 190  MOVE 0,64                         ! Positions PEN at X=0, Y=64
 200  DRAW 125,64                       ! Draws line to X=125, Y=64
 210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
 220  LINE TYPE 1                       ! Specifies solid LINE TYPE
 230  LABEL " Quota"                    ! LABELs text
 240 Label_axes:  !
 250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
 260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
 270   MOVE X_label,-8                  ! Positions PEN at X=X_label,Y=-8
 280   READ Label$                      ! READs data
 290   LABEL Label$                     ! LABELs text
 300  NEXT X_label                      ! Repeats loop
 310  LORG 2                            ! Left justify & center labels
 320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
 330   MOVE -25,Y_label                 ! Positions PEN at X=-25, Y=Y_label
 340   LABEL "$";Y_label/10;"K"         ! LABELs text
 350  NEXT Y_label                      ! Repeats loop
 360 Label_text: !
 370  DEG                               ! Change to degrees mode
 380  SETGU                             ! Change back to Graphic Display Units
 390  MOVE 5,90                         ! Positions PEN at X=5, Y=90
 400  CSIZE 5,.7                        ! Sets Character SIZE and aspect ratio
 410  LDIR -90                          ! Labels down
 420  LABEL "Script Royalties"          ! LABELs text
 430  MOVE 15,10                        ! Positions PEN at X=15, Y=10
 440  LDIR 0                            ! Labels left to right
 450  CSIZE 8,.5,13                     ! Sets the SIZE, aspect ratio, and slant
 460  LORG 3                            ! Positions the label
 470  LABEL USING "K";"Faux-Pas Productions"    ! LABELs text
 480 Copies:  !
 490   DUMP GRAPHICS                    ! Hard copy of CRT display
 500   END
```

More About the HP 9872A Plotter

The HP 9872A Plotter responds to a graphics language called HPGL. The advantage of this language set is that the 9872A can be driven by any controller or computer which can output these HPGL instructions using proper I/O formats. The advantage of the unified graphics statements which are presented in this manual is that the unified graphics language allows you to go from one plotting device to another plotting device by changing only one statement, as opposed to changing every HPGL statement in a program.

Some people may wish to incorporate some of the HPGL instructions which are found in Section IV of the HP 9872A Graphics Plotter Operating and Service Manual.

While all HPGL instructions are accessible to you, you may probably need only the following three HPGL instructions.

- VA
- VN
- VS

VA (velocity adaptive) allows the pen to plot incoming data at rates approaching the incoming data rate. Remember that the physical limit of the pen is 36 cm/sec.

VS (velocity selection) sets the pen speed for each pen at integer intervals of between 1 cm/sec to 36 cm/sec. You have the option of sending this instruction to apply for just one pen, or all pens. The VS instruction is very useful for slowing down the pen speed to improve the quality of your plotted lines on the HP9872A.

VN (velocity normal) returns the plotting speed to 36 cm/sec. It is used to clear the VA and VS instructions from the 9872A.

Once you change the pen speed, consider the fact that a complex plot which takes 1 minute to plot on the 9872A at 36 cm/sec, is going to take 36 minutes to plot at 1 cm/sec.

The method to use to send an HPGL instruction is simple –

- PRINTER IS 7,5
- PRINT "HPGL instruction"

inserted after you go into the GRAPHICS mode of your program, with a PRINT for each individual HPGL instruction you wish to use.

The only problem which may arise as a result of this is that executing the PLOTTER IS or the LIMIT statement in the program clears out all HPGL instructions to their default conditions (i.e. pen speed to 36 cm/sec.). Therefore, you would either have to

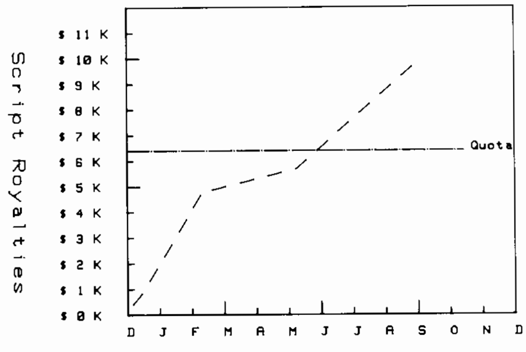
1. Not execute the PLOTTER IS or LIMIT statements.

   or

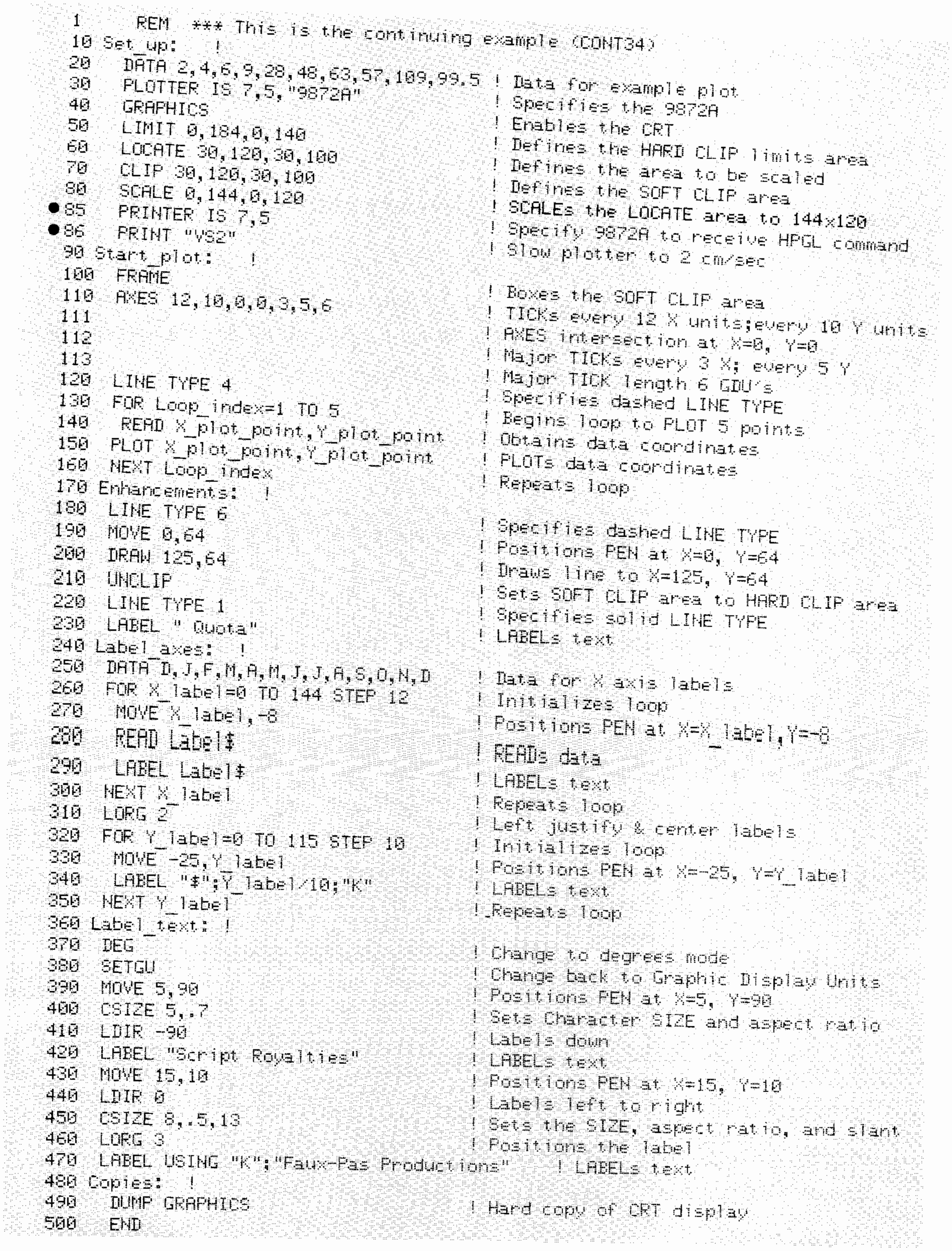
2. Put the PRINTER IS and PRINT statements **after** the PLOTTER IS and LIMIT statements.

The following example has been provided to assist you. Remember, if you want to clear out any of the HPGL instructions, just execute either a PLOTTER IS or a LIMIT statement.

Example



Faux-Pas Productions



```
1      REM  *** This is the continuing example (CONT34)
10 Set_up:   !
20   DATA 2,4,6,9,28,48,63,57,109,99.5 ! Data for example plot
30   PLOTTER IS 7,5,"9872A"            ! Specifies the 9872A
40   GRAPHICS                          ! Enables the CRT
50   LIMIT 0,184,0,140                 ! Defines the HARD CLIP limits area
60   LOCATE 30,120,30,100              ! Defines the area to be scaled
70   CLIP 30,120,30,100                ! Defines the SOFT CLIP area
80   SCALE 0,144,0,120                 ! SCALEs the LOCATE area to 144x120
●85  PRINTER IS 7,5                    ! Specify 9872A to receive HPGL command
●86  PRINT "VS2"                       ! Slow plotter to 2 cm/sec
90 Start_plot:   !
100  FRAME                             ! Boxes the SOFT CLIP area
110  AXES 12,10,0,0,3,5,6              ! TICKs every 12 X units;every 10 Y units
111                                    ! AXES intersection at X=0, Y=0
112                                    ! Major TICKs every 3 X; every 5 Y
113                                    ! Major TICK length 6 GDU's
120  LINE TYPE 4                       ! Specifies dashed LINE TYPE
130  FOR Loop_index=1 TO 5             ! Begins loop to PLOT 5 points
140   READ X_plot_point,Y_plot_point   ! Obtains data coordinates
150  PLOT X_plot_point,Y_plot_point    ! PLOTs data coordinates
160  NEXT Loop_index                   ! Repeats loop
170 Enhancements:  !
180  LINE TYPE 6                       ! Specifies dashed LINE TYPE
190  MOVE 0,64                         ! Positions PEN at X=0, Y=64
200  DRAW 125,64                       ! Draws line to X=125, Y=64
210  UNCLIP                            ! Sets SOFT CLIP area to HARD CLIP area
220  LINE TYPE 1                       ! Specifies solid LINE TYPE
230  LABEL " Quota"                    ! LABELs text
240 Label_axes:  !
250  DATA D,J,F,M,A,M,J,J,A,S,O,N,D    ! Data for X axis labels
260  FOR X_label=0 TO 144 STEP 12      ! Initializes loop
270   MOVE X_label,-8                  ! Positions PEN at X=X_label,Y=-8
280   READ Label$                      ! READs data
290   LABEL Label$                     ! LABELs text
300  NEXT X_label                      ! Repeats loop
310  LORG 2                            ! Left justify & center labels
320  FOR Y_label=0 TO 115 STEP 10      ! Initializes loop
330   MOVE -25,Y_label                 ! Positions PEN at X=-25, Y=Y_label
340   LABEL "$";Y_label/10;"K"         ! LABELs text
350  NEXT Y_label                      ! Repeats loop
360 Label_text: !
370  DEG                               ! Change to degrees mode
380  SETGU                             ! Change back to Graphic Display Units
390  MOVE 5,90                         ! Positions PEN at X=5, Y=90
400  CSIZE 5,.7                        ! Sets Character SIZE and aspect ratio
410  LDIR -90                          ! Labels down
420  LABEL "Script Royalties"          ! LABELs text
430  MOVE 15,10                        ! Positions PEN at X=15, Y=10
440  LDIR 0                            ! Labels left to right
450  CSIZE 8,.5,13                     ! Sets the SIZE, aspect ratio, and slant
460  LORG 3                            ! Positions the label
470  LABEL USING "K";"Faux-Pas Productions"    ! LABELs text
480 Copies:  !
490   DUMP GRAPHICS                    ! Hard copy of CRT display
500   END
```

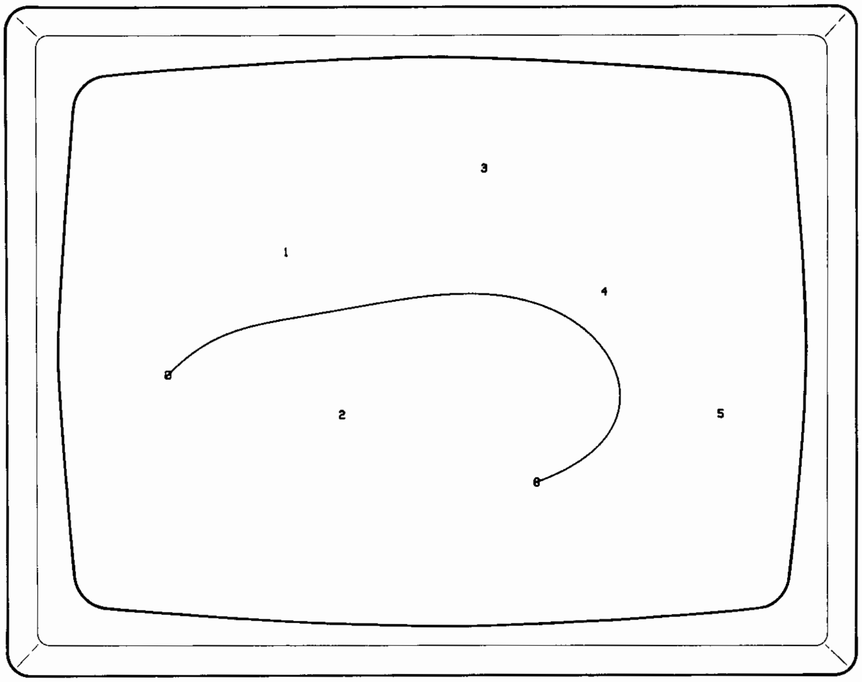
Curve Fitting

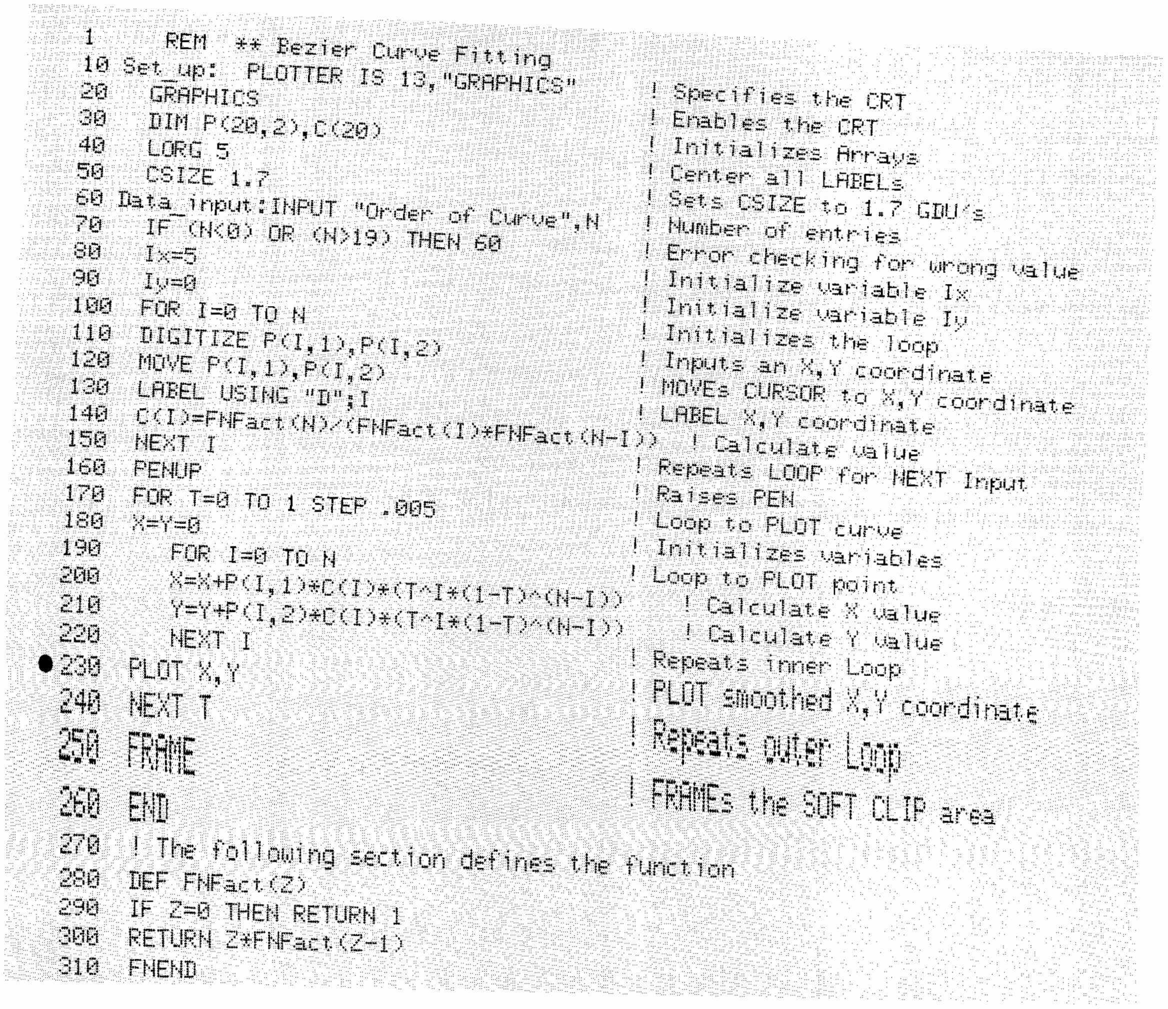
Curve fitting is a technique by which the general tendencies of data points can be plotted, as well as the individual points which make up the data for the curve.

There are many curve-fitting applications available. Once you have decided which algorithm best suits your application, the graphic display can be used to show the results of the plot.

For this example, the Bezier curve smoothing algorithm is used. The program allows you to specify which data points are to be entered as the basis for the smoothing algorithm. When using the Bezier technique, only the first and last points actually lie on the curve. The derivatives, order and shape of the curve are determined by the other vertices.

Example





```
1      REM  ** Bezier Curve Fitting
10 Set_up:  PLOTTER IS 13,"GRAPHICS"
20    GRAPHICS                                ! Specifies the CRT
30    DIM P(20,2),C(20)                       ! Enables the CRT
40    LORG 5                                  ! Initializes Arrays
50    CSIZE 1.7                               ! Center all LABELs
60 Data_input:INPUT "Order of Curve",N        ! Sets CSIZE to 1.7 GDU's
70    IF (N<0) OR (N>19) THEN 60              ! Number of entries
80    Ix=5                                    ! Error checking for wrong value
90    Iy=0                                    ! Initialize variable Ix
100   FOR I=0 TO N                            ! Initialize variable Iy
110   DIGITIZE P(I,1),P(I,2)                  ! Initializes the loop
120   MOVE P(I,1),P(I,2)                      ! Inputs an X,Y coordinate
130   LABEL USING "D";I                       ! MOVEs CURSOR to X,Y coordinate
140   C(I)=FNFact(N)/(FNFact(I)*FNFact(N-I))  ! LABEL X,Y coordinate
150   NEXT I                                    ! Calculate value
160   PENUP                                   ! Repeats LOOP for NEXT Input
170   FOR T=0 TO 1 STEP .005                  ! Raises PEN
180   X=Y=0                                   ! Loop to PLOT curve
190      FOR I=0 TO N                         ! Initializes variables
200      X=X+P(I,1)*C(I)*(T^I*(1-T)^(N-I))   ! Loop to PLOT point
210      Y=Y+P(I,2)*C(I)*(T^I*(1-T)^(N-I))      ! Calculate X value
220      NEXT I                                 ! Calculate Y value
●230  PLOT X,Y                                ! Repeats inner Loop
240   NEXT T                                  ! PLOT smoothed X,Y coordinate
250   FRAME                                   ! Repeats outer Loop
260   END                                     ! FRAMEs the SOFT CLIP area
270   ! The following section defines the function
280   DEF FNFact(Z)
290   IF Z=0 THEN RETURN 1
300   RETURN Z*FNFact(Z-1)
310   FNEND
```

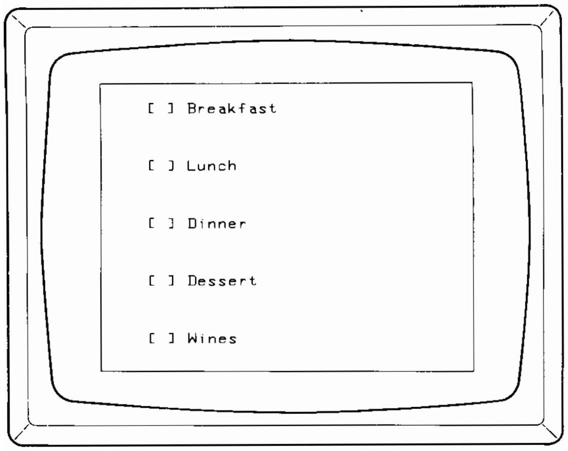
Menu Selection

Menu selection is a graphics technique which can prove useful in some applications. Its primary value is as an interactive tool which enables the operator of the computer to perform things which require a minimum of programming knowledge, similar to an ON KEY statement.

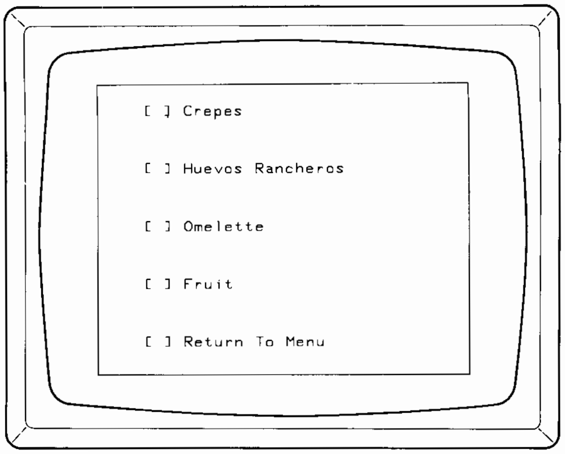
The menu selection technique is quite simple in implementation: present a choice of items, allow the operator to position the cursor at a selected item and press CONT to digitize the X,Y coordinate, then determine which menu item the X,Y coordinate represents and implement the appropriate program steps.

In this first example, the menu is used to provide the operator with a menu (literally). Since this is a simple application, the Y coordinate value is the only coordinate being checked. You should note that the SCALE statement is set up and the label is placed to provide minimum complications caused by positioning the cursor on the boundary between two adjacent items.

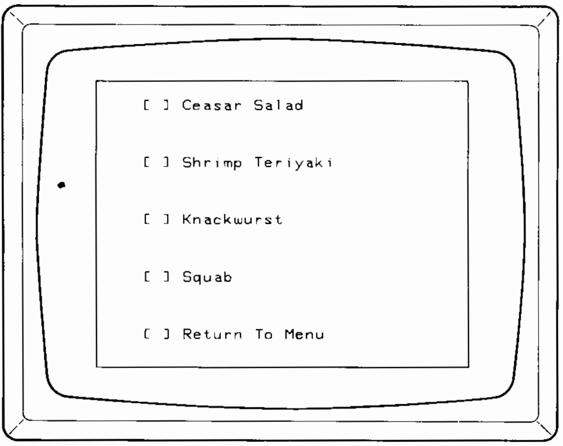
Examples



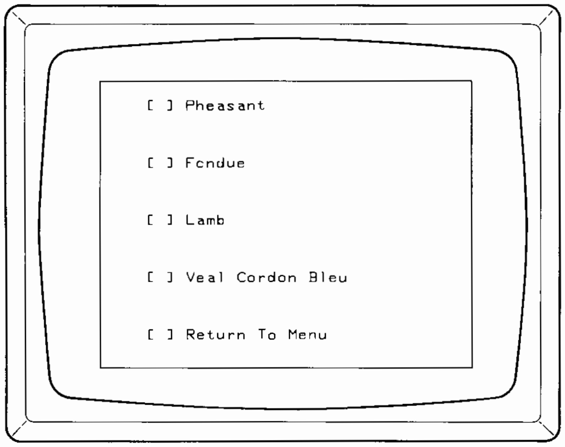
```
[ ] Breakfast

[ ] Lunch

[ ] Dinner

[ ] Dessert

[ ] Wines
```



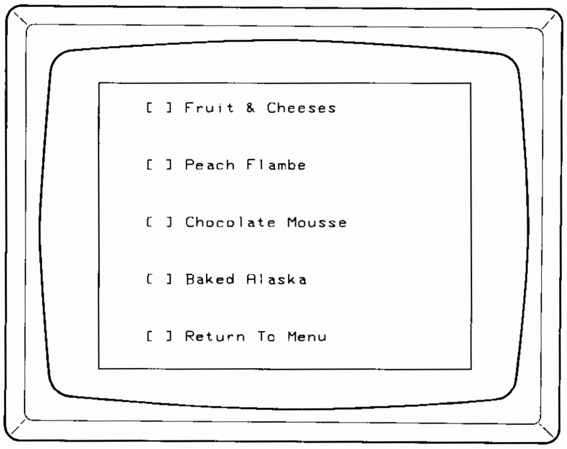
```
[ ] Crepes

[ ] Huevos Rancheros

[ ] Omelette

[ ] Fruit

[ ] Return To Menu
```



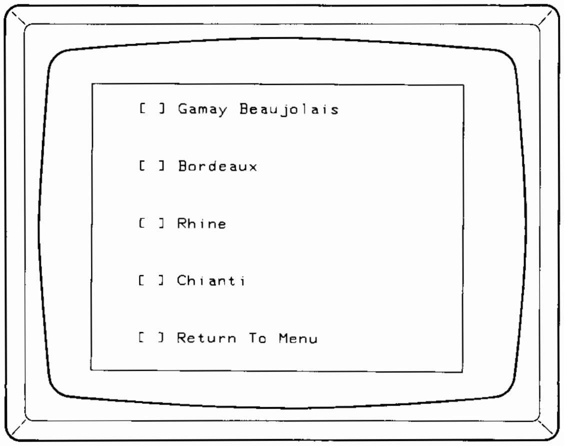
```
[ ] Ceasar Salad

[ ] Shrimp Teriyaki

[ ] Knackwurst

[ ] Squab

[ ] Return To Menu
```



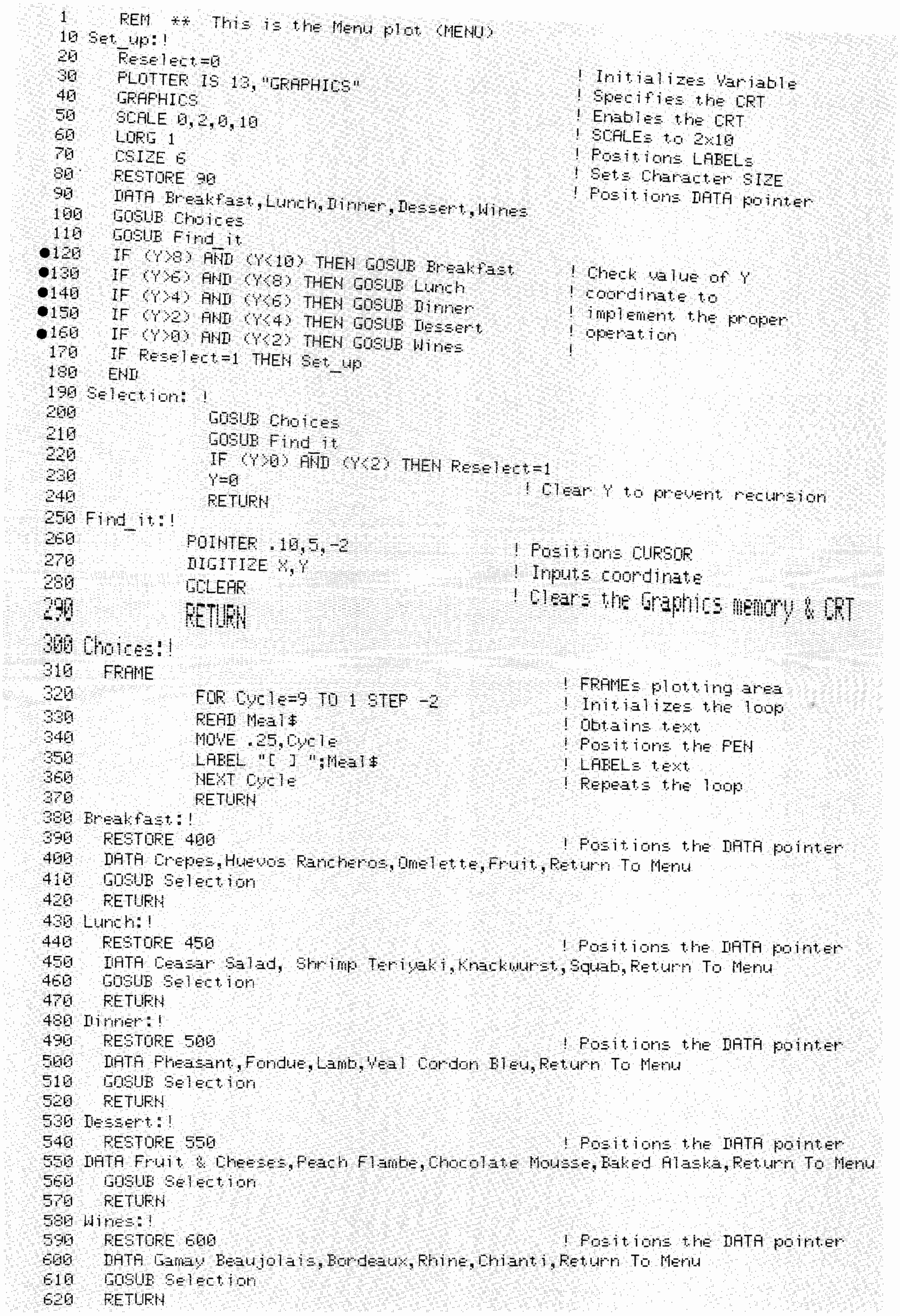
```
[ ] Pheasant

[ ] Fondue

[ ] Lamb

[ ] Veal Cordon Bleu

[ ] Return To Menu
```



```
[ ] Fruit & Cheeses

[ ] Peach Flambe

[ ] Chocolate Mousse

[ ] Baked Alaska

[ ] Return To Menu
```

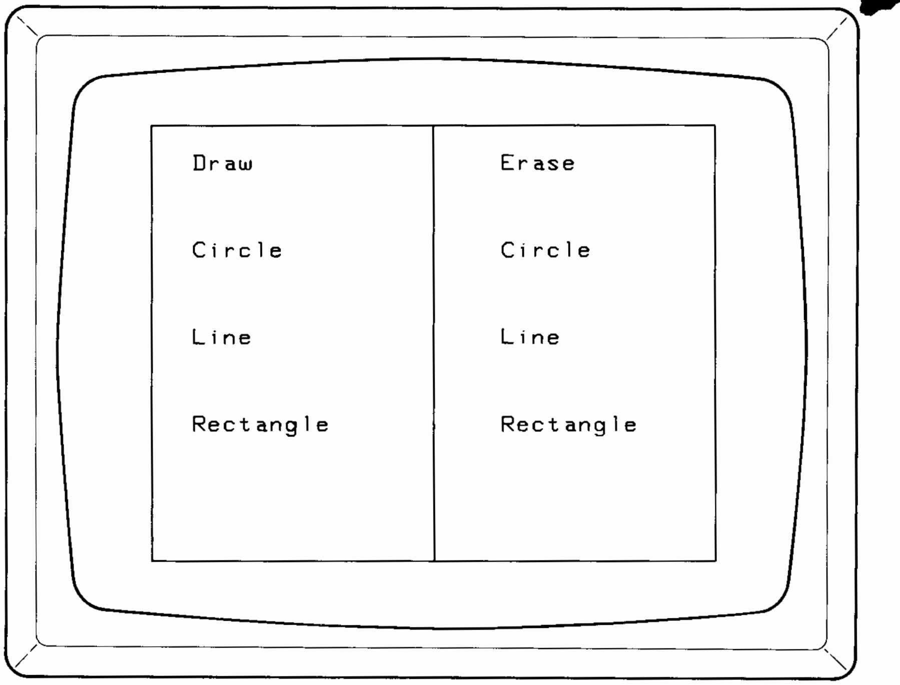


```
[ ] Gamay Beaujolais

[ ] Bordeaux

[ ] Rhine

[ ] Chianti

[ ] Return To Menu
```



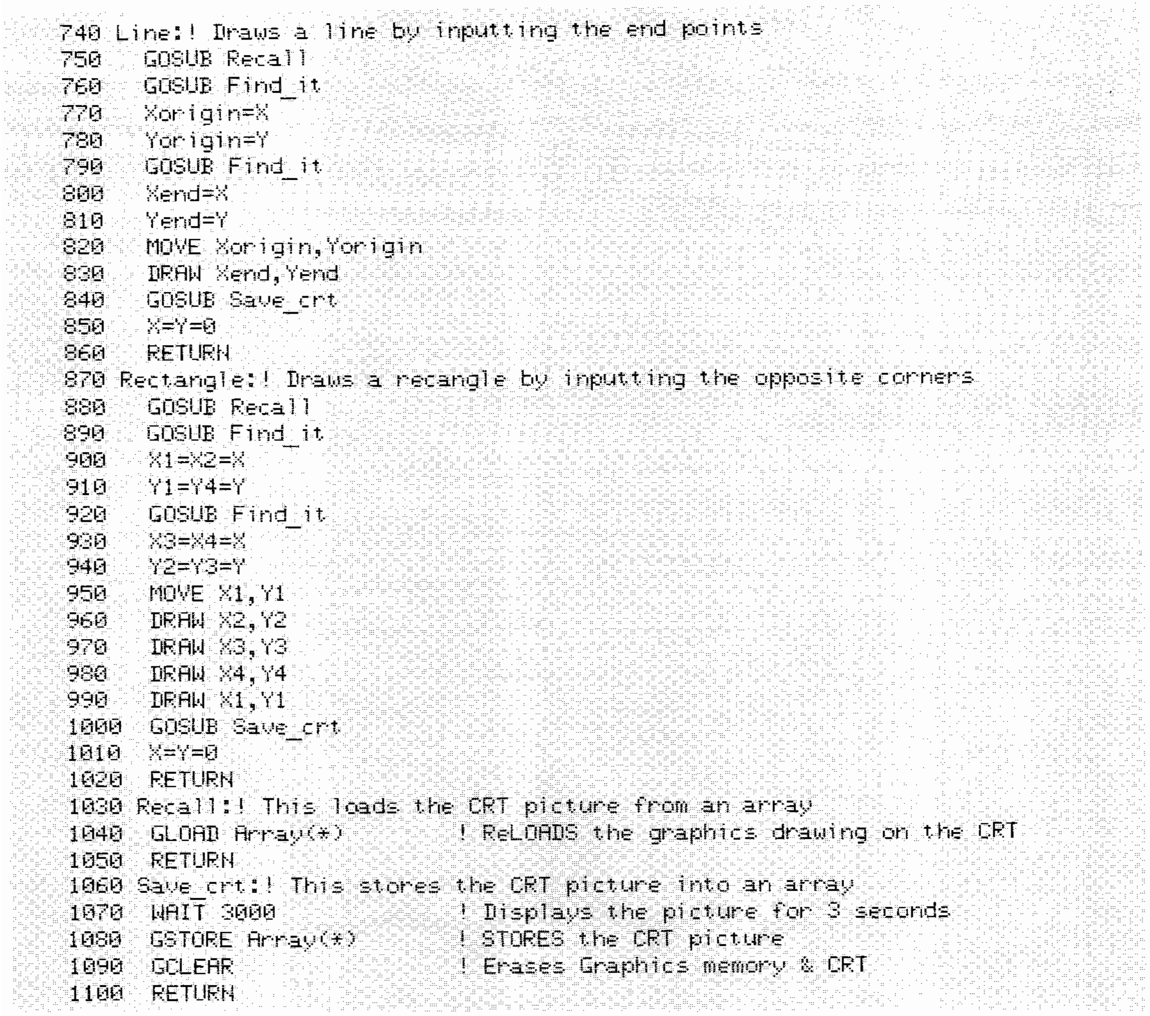
```
 1      REM  **  This is the Menu plot (MENU)
 10 Set_up:!
 20     Reselect=0
 30     PLOTTER IS 13,"GRAPHICS"                        ! Initializes Variable
 40     GRAPHICS                                        ! Specifies the CRT
 50     SCALE 0,2,0,10                                  ! Enables the CRT
 60     LORG 1                                          ! SCALEs to 2x10
 70     CSIZE 6                                         ! Positions LABELs
 80     RESTORE 90                                      ! Sets Character SIZE
 90     DATA Breakfast,Lunch,Dinner,Dessert,Wines       ! Positions DATA pointer
 100    GOSUB Choices
 110    GOSUB Find_it
●120    IF (Y>8) AND (Y<10) THEN GOSUB Breakfast
●130    IF (Y>6) AND (Y<8) THEN GOSUB Lunch             ! Check value of Y
●140    IF (Y>4) AND (Y<6) THEN GOSUB Dinner            ! coordinate to
●150    IF (Y>2) AND (Y<4) THEN GOSUB Dessert           ! implement the proper
●160    IF (Y>0) AND (Y<2) THEN GOSUB Wines             ! operation
 170    IF Reselect=1 THEN Set_up                       !
 180    END
 190 Selection: !
 200             GOSUB Choices
 210             GOSUB Find_it
 220             IF (Y>0) AND (Y<2) THEN Reselect=1
 230             Y=0
 240             RETURN                             ! Clear Y to prevent recursion
 250 Find_it:!
 260           POINTER .10,5,-2                     ! Positions CURSOR
 270           DIGITIZE X,Y                         ! Inputs coordinate
 280           GCLEAR                               ! Clears the Graphics memory & CRT
 290           RETURN
 300 Choices:!
 310    FRAME
 320            FOR Cycle=9 TO 1 STEP -2                ! FRAMEs plotting area
 330            READ Meal$                              ! Initializes the loop
 340            MOVE .25,Cycle                          ! Obtains text
 350            LABEL "[ ] ";Meal$                      ! Positions the PEN
 360            NEXT Cycle                              ! LABELs text
 370            RETURN                                  ! Repeats the loop
 380 Breakfast:!
 390    RESTORE 400                                     ! Positions the DATA pointer
 400    DATA Crepes,Huevos Rancheros,Omelette,Fruit,Return To Menu
 410    GOSUB Selection
 420    RETURN
 430 Lunch:!
 440    RESTORE 450                                     ! Positions the DATA pointer
 450    DATA Ceasar Salad, Shrimp Teriyaki,Knackwurst,Squab,Return To Menu
 460    GOSUB Selection
 470    RETURN
 480 Dinner:!
 490    RESTORE 500                                     ! Positions the DATA pointer
 500    DATA Pheasant,Fondue,Lamb,Veal Cordon Bleu,Return To Menu
 510    GOSUB Selection
 520    RETURN
 530 Dessert:!
 540    RESTORE 550                                     ! Positions the DATA pointer
 550 DATA Fruit & Cheeses,Peach Flambe,Chocolate Mousse,Baked Alaska,Return To Menu
 560    GOSUB Selection
 570    RETURN
 580 Wines:!
 590    RESTORE 600                                     ! Positions the DATA pointer
 600    DATA Gamay Beaujolais,Bordeaux,Rhine,Chianti,Return To Menu
 610    GOSUB Selection
 620    RETURN
```

In the second example, the menu selection allows the operator to select a graphics driver routine. This routine is used in conjunction with further interaction in the form of specifying the origin and end points of the figure which is to be plotted or erased.



```
1      REM  ** This is the DRIVER (DRIVER) example.
10 Overhead:!
20     DEG                                         ! Sets DEGrees mode
30     Reselect=0                                  ! Initializes variable
40     DATA Draw,Erase,Circle,Circle,Line,Line,Rectangle,Rectangle
50     INTEGER Array(16380),Menu(16380)            ! Sets up arrays
60     PLOTTER IS 13,"GRAPHICS"                    ! Specifies the CRT as the plotter
70     GRAPHICS                                    ! Enables the CRT
80     SHOW 0,560,0,455                            ! Sets SOFT CLIP area to 10X10
90     LORG 5                                      ! Sets LABEL origin
100    CSIZE 6                                     ! Sets Character SIZE
110 Choices:!
120             FRAME                              ! FRAMEs plotting area
130             MOVE 280,0                         ! MOVEs the PEN
140             DRAW 280,455                       ! DRAWs a vertical line
150             FOR Cycle=9 TO 3 STEP -2           ! Begins the loop
160             READ Choice$,Duplicate$            ! Reads LABELs for line
170             MOVE 250,Cycle*40                  ! Positions LABEL
180             LABEL Choice$,Duplicate$           ! LABELs line
190             NEXT Cycle                         ! Repeats the loop
200             GSTORE Menu(*)                     ! STOREs Graphics memory
```

```
 210 Set_up:!
 220   PEN 1
 230   GLOAD Menu(*)                              ! Selects the PEN
 240   GOSUB Find_it                              ! ReLOADS Graphics memory
 250   GCLEAR                                     ! Selects an item
 260   IF X>280 THEN PEN -1                       ! Erases Graphics memory & CRT
●270   IF (Y>240) AND (Y<320) THEN GOSUB Circle    ! Check X location for erase
●280   IF (Y>160) AND (Y<240) THEN GOSUB Line       ! Determines operation
●290   IF (Y>2) AND (Y<160) THEN GOSUB Rectangle   ! Determines operation
 300   GOTO Set_up                                 ! Determines operation
 310   END                                        ! Repeats for figure
 320   REM  **  The subroutines are in the following lines
 330 Find_it:!
 340          POINTER 5,5,-2
 350          DIGITIZE X,Y                       ! Positions CURSOR
 360          RETURN                             ! Inputs X,Y coordinate
 370 Circle:! Draws a circle by digitizing 3 points on the circumference
 380        ! When erasing the circle, choose three points which are
 390        ! equidistant for best results. Jaggies may require several erasures.
 400   GOSUB Recall
 410   GOSUB Find_it
 420   Xa=X
 430   Ya=Y
 440   GOSUB Find_it
 450   Xb=X
 460   Yb=Y
 470   GOSUB Find_it
 480   Xc=X
 490   Yc=Y
 500   Side_a=SQR(ABS(Xb-Xc)^2+ABS(Yb-Yc)^2) ! Calculates side BC
 510   Side_b=SQR(ABS(Xc-Xa)^2+ABS(Yc-Ya)^2) ! Calculates side CA
 520   Side_c=SQR(ABS(Xa-Xb)^2+ABS(Ya-Yb)^2) ! Calculates side AB
 530   Angle_cab=ACS((Side_a^2-Side_b^2-Side_c^2)/(-2*Side_b*Side_c))
 540   Avg_side=.5*(Side_a+Side_b+Side_c)
 550  Radius=Side_a*Side_b*Side_c/(4*Avg_side*(Avg_side-Side_a)*TAN(Angle_cab/2))
 560   M1=-1/((Ya-Yb)/(Xa-Xb))
 570   M2=-1/((Yb-Yc)/(Xb-Xc))
 580   Xa_prime=(Xa+Xb)/2
 590   Ya_prime=(Ya+Yb)/2
 600   Xb_prime=(Xb+Xc)/2
 610   Yb_prime=(Yb+Yc)/2
 620   B1=Ya_prime-M1*Xa_prime
 630   B2=Yb_prime-M2*Xb_prime
 640   Xintersect=(B1-B2)/(M2-M1)
 650   Yintersect=(M2*B1-M1*B2)/(M2-M1)
 660   MOVE SIN(0)*Radius+Xintersect,COS(0)*Radius+Yintersect
 670   FOR I=0 TO 360 STEP 15
 680   DRAW SIN(I)*Radius+Xintersect,COS(I)*Radius+Yintersect
 690   NEXT I
 700 Done_circle:  ! Exit for circle routine
 710   GOSUB Save_crt
 720   X=Y=0
 730   RETURN
```

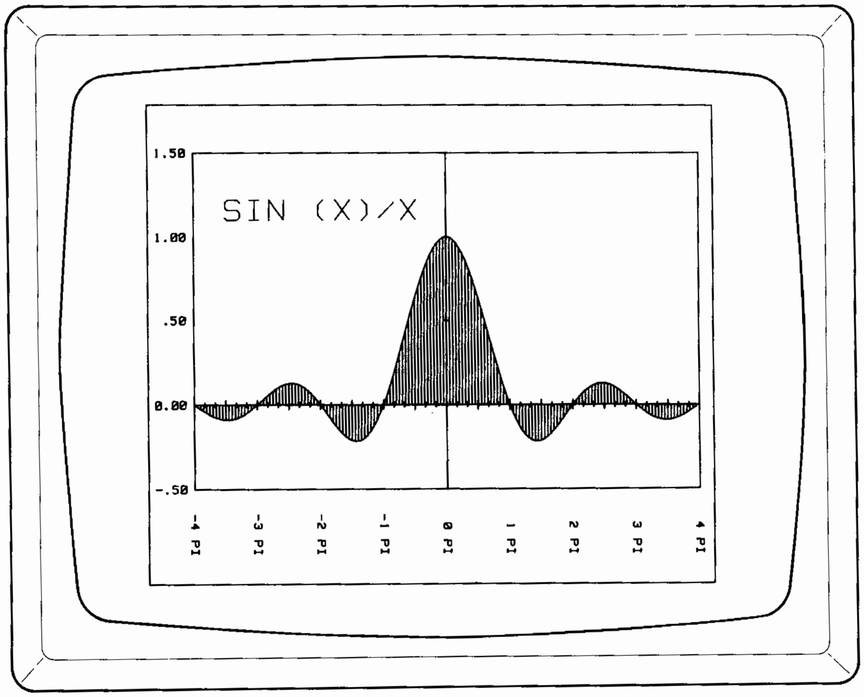


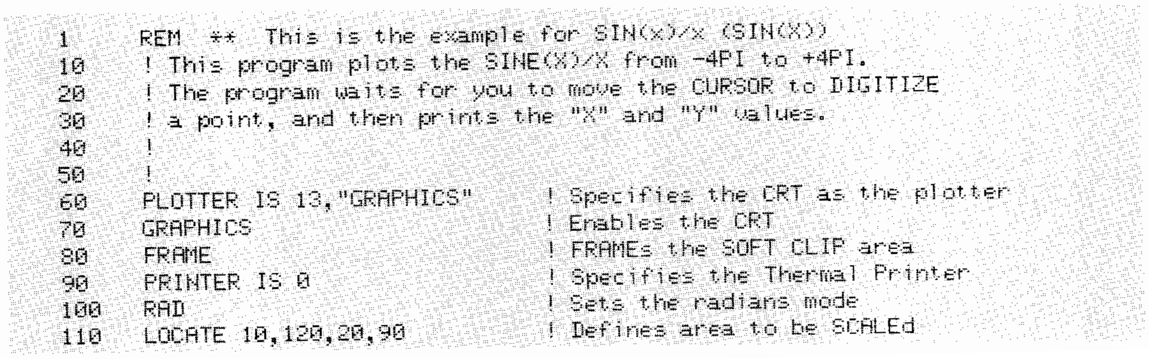
```
740 Line:! Draws a line by inputting the end points
750   GOSUB Recall
760   GOSUB Find_it
770   Xorigin=X
780   Yorigin=Y
790   GOSUB Find_it
800   Xend=X
810   Yend=Y
820   MOVE Xorigin,Yorigin
830   DRAW Xend,Yend
840   GOSUB Save_crt
850   X=Y=0
860   RETURN
870 Rectangle:! Draws a recangle by inputting the opposite corners
880   GOSUB Recall
890   GOSUB Find_it
900   X1=X2=X
910   Y1=Y4=Y
920   GOSUB Find_it
930   X3=X4=X
940   Y2=Y3=Y
950   MOVE X1,Y1
960   DRAW X2,Y2
970   DRAW X3,Y3
980   DRAW X4,Y4
990   DRAW X1,Y1
1000  GOSUB Save_crt
1010  X=Y=0
1020  RETURN
1030 Recall:! This loads the CRT picture from an array
1040  GLOAD Array(*)         ! ReLOADS the graphics drawing on the CRT
1050  RETURN
1060 Save_crt:! This stores the CRT picture into an array
1070  WAIT 3000              ! Displays the picture for 3 seconds
1080  GSTORE Array(*)        ! STORES the CRT picture
1090  GCLEAR                 ! Erases Graphics memory & CRT
1100  RETURN
```

Some Interesting Examples

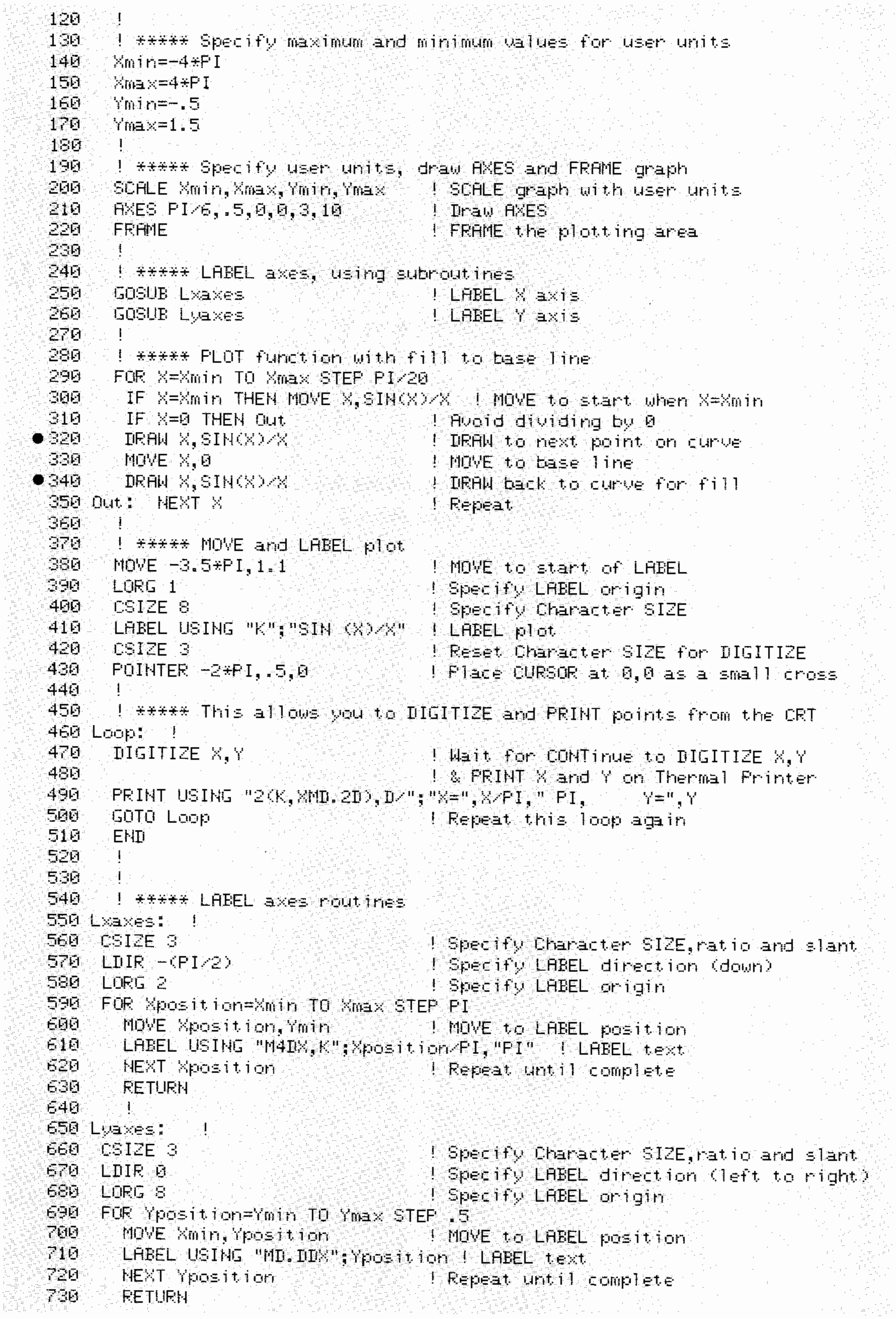
The programs in this section are given to show some interesting capabilities and programming techniques. In most cases, each program line has a comment that describes what the line does. After running the program and understanding how it works, change a few lines to make the program do something different to fit one of your applications.

SIN(X)/X Example



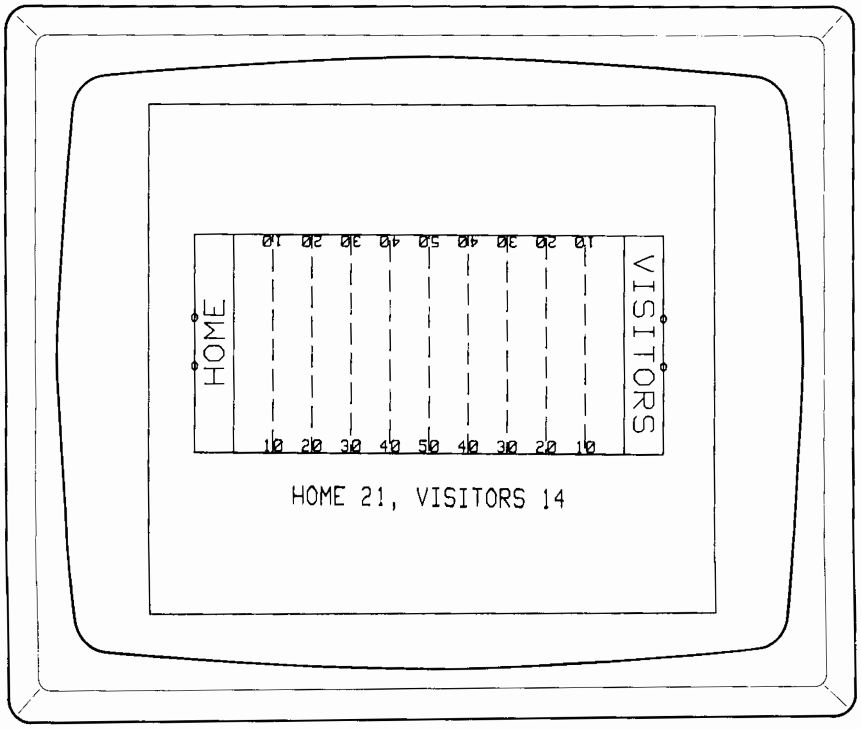


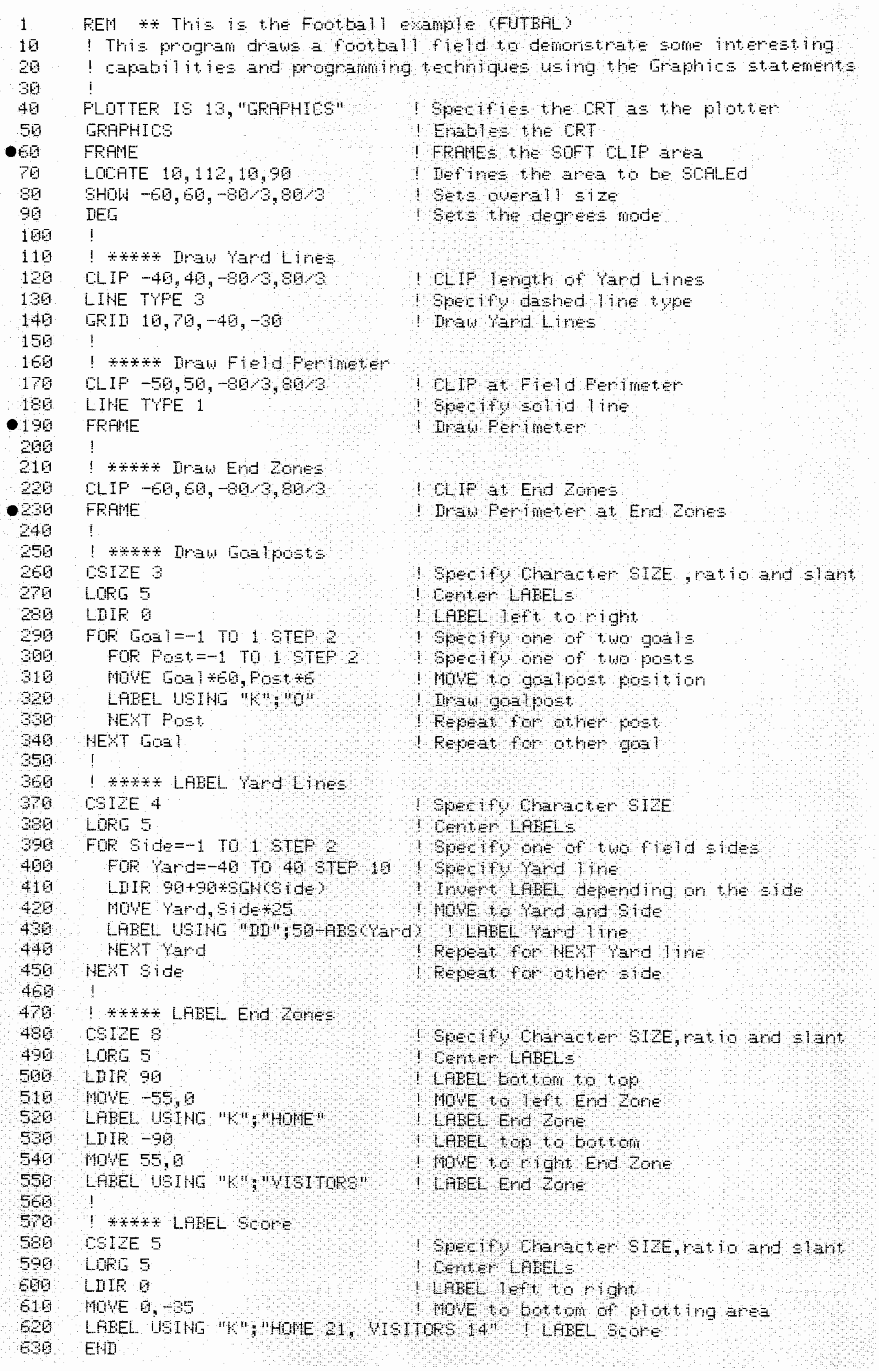
```
1       REM  **  This is the example for SIN(x)/x (SIN(X))
10      ! This program plots the SINE(X)/X from -4PI to +4PI.
20      ! The program waits for you to move the CURSOR to DIGITIZE
30      ! a point, and then prints the "X" and "Y" values.
40      !
50      !
60      PLOTTER IS 13,"GRAPHICS"       ! Specifies the CRT as the plotter
70      GRAPHICS                       ! Enables the CRT
80      FRAME                          ! FRAMEs the SOFT CLIP area
90      PRINTER IS 0                   ! Specifies the Thermal Printer
100     RAD                            ! Sets the radians mode
110     LOCATE 10,120,20,90            ! Defines area to be SCALEd
```



```
 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      ! SCALE graph with user units
 210    AXES PI/6,.5,0,0,3,10          ! Draw AXES
 220    FRAME                          ! FRAME the plotting area
 230    !
 240    ! ***** LABEL axes, using subroutines
 250    GOSUB Lxaxes                   ! LABEL X axis
 260    GOSUB Lyaxes                   ! 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 when X=Xmin
 310     IF X=0 THEN Out               ! Avoid dividing by 0
●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 Out:  NEXT X                      ! Repeat
 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 Character SIZE for DIGITIZE
 430    POINTER -2*PI,.5,0             ! Place CURSOR at 0,0 as a small cross
 440    !
 450    ! ***** This allows you to DIGITIZE and PRINT points from the CRT
 460 Loop:  !
 470    DIGITIZE X,Y                   ! Wait for CONTinue to DIGITIZE X,Y
 480                                   ! & PRINT X and Y on Thermal Printer
 490    PRINT USING "2(K,XMD.2D),D/";"X=",X/PI," PI,      Y=",Y
 500    GOTO Loop                      ! Repeat this loop again
 510    END
 520    !
 530    !
 540    ! ***** LABEL axes routines
 550 Lxaxes:  !
 560   CSIZE 3                         ! Specify Character SIZE,ratio and slant
 570   LDIR -(PI/2)                    ! Specify LABEL direction (down)
 580   LORG 2                          ! Specify LABEL origin
 590   FOR Xposition=Xmin TO Xmax STEP PI
 600     MOVE Xposition,Ymin           ! MOVE to LABEL position
 610     LABEL USING "M4DX,K";Xposition/PI,"PI"  ! LABEL text
 620     NEXT Xposition                ! Repeat until complete
 630     RETURN
 640     !
 650 Lyaxes:   !
 660   CSIZE 3                         ! Specify Character SIZE,ratio and slant
 670   LDIR 0                          ! Specify LABEL direction (left to right)
 680   LORG 8                          ! Specify LABEL origin
 690   FOR Yposition=Ymin TO Ymax STEP .5
 700     MOVE Xmin,Yposition           ! MOVE to LABEL position
 710     LABEL USING "MD.DDX";Yposition ! LABEL text
 720     NEXT Yposition                ! Repeat until complete
 730     RETURN
```

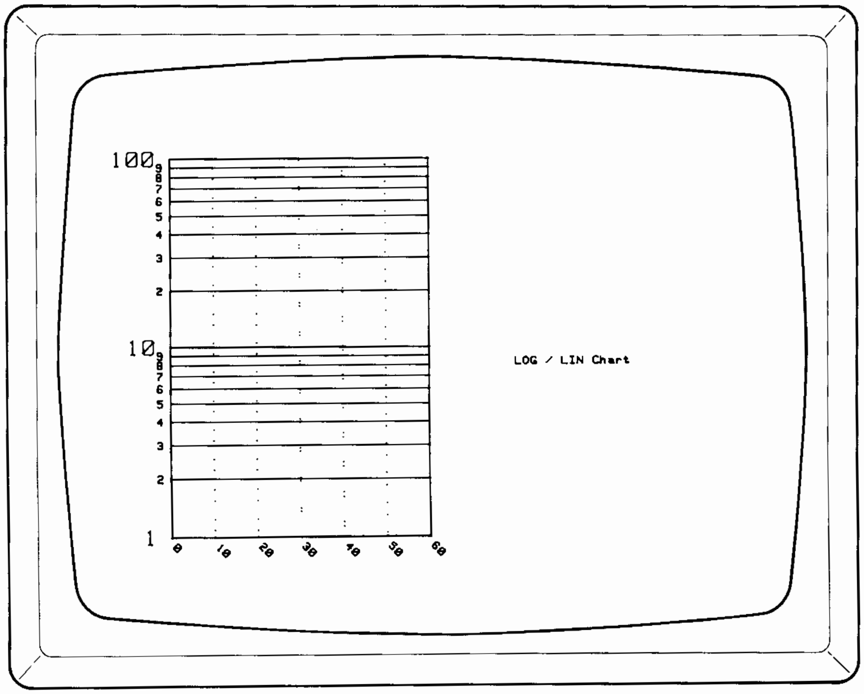
Football Field Example

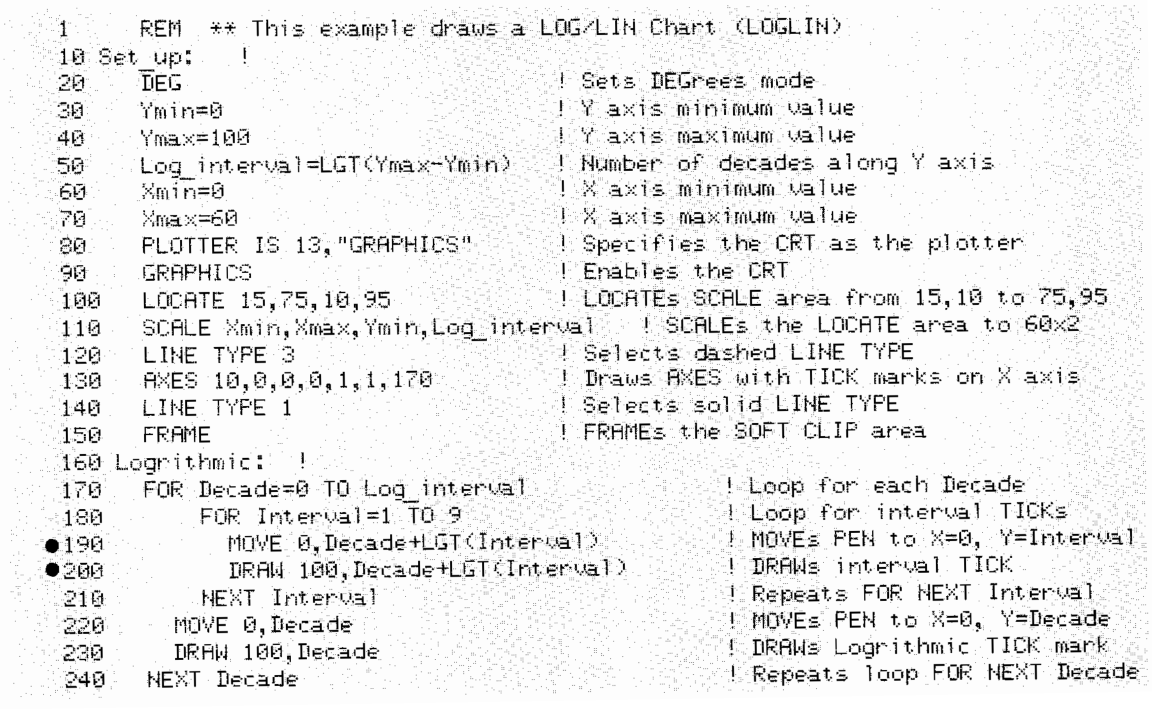




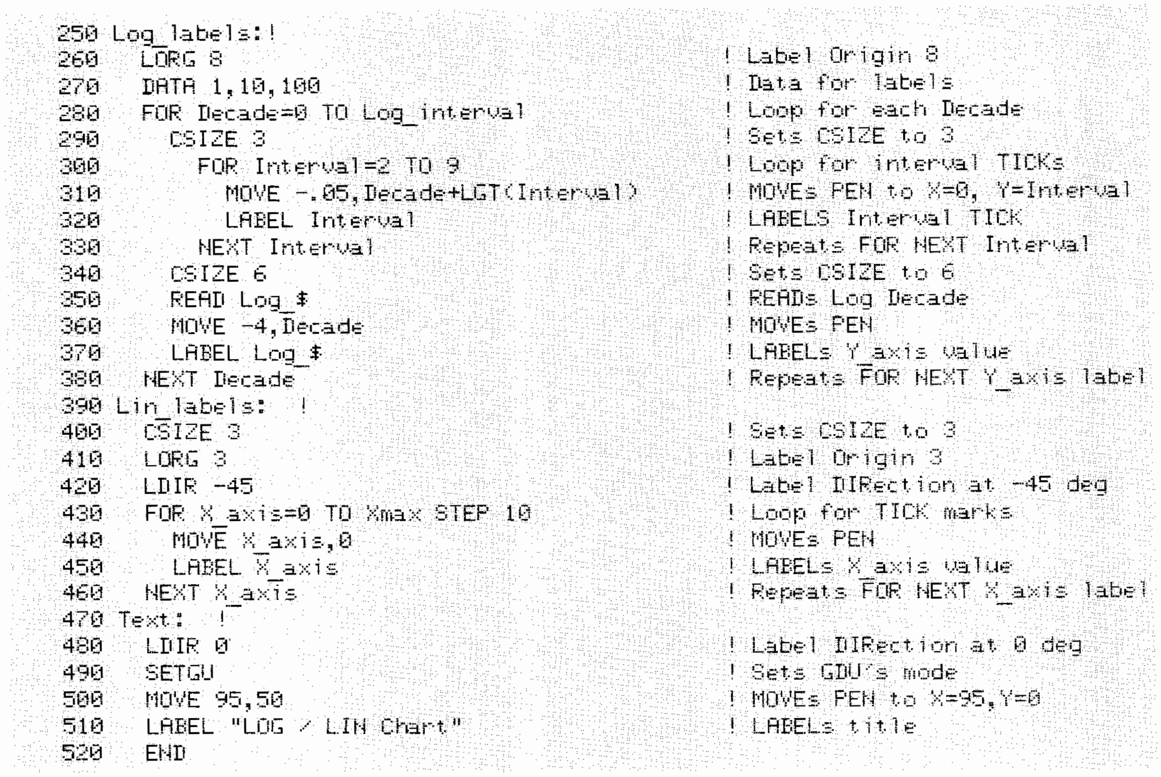
```
  1   REM  ** This is the Football example (FUTBAL)
 10   ! This program draws a football field to demonstrate some interesting
 20   ! capabilities and programming techniques using the Graphics statements
 30   !
 40   PLOTTER IS 13,"GRAPHICS"      ! Specifies the CRT as the plotter
 50   GRAPHICS                      ! Enables the CRT
●60   FRAME                         ! FRAMEs the SOFT CLIP area
 70   LOCATE 10,112,10,90           ! Defines the area to be SCALEd
 80   SHOW -60,60,-80/3,80/3        ! Sets overall size
 90   DEG                           ! Sets the degrees mode
100   !
110   ! ***** Draw Yard Lines
120   CLIP -40,40,-80/3,80/3        ! CLIP length of Yard Lines
130   LINE TYPE 3                   ! Specify dashed line type
140   GRID 10,70,-40,-30            ! Draw Yard Lines
150   !
160   ! ***** Draw Field Perimeter
170   CLIP -50,50,-80/3,80/3        ! CLIP at Field Perimeter
180   LINE TYPE 1                   ! Specify solid line
●190  FRAME                         ! Draw Perimeter
200   !
210   ! ***** Draw End Zones
220   CLIP -60,60,-80/3,80/3        ! CLIP at End Zones
●230  FRAME                         ! Draw Perimeter at End Zones
240   !
250   ! ***** Draw Goalposts
260   CSIZE 3                       ! Specify Character SIZE ,ratio and slant
270   LORG 5                        ! Center LABELs
280   LDIR 0                        ! LABEL left to right
290   FOR Goal=-1 TO 1 STEP 2       ! Specify one of two goals
300     FOR Post=-1 TO 1 STEP 2     ! Specify one of two posts
310     MOVE Goal*60,Post*6         ! MOVE to goalpost position
320     LABEL USING "K";"O"         ! Draw goalpost
330     NEXT Post                   ! Repeat for other post
340   NEXT Goal                     ! Repeat for other goal
350   !
360   ! ***** LABEL Yard Lines
370   CSIZE 4                       ! Specify Character SIZE
380   LORG 5                        ! Center LABELs
390   FOR Side=-1 TO 1 STEP 2       ! Specify one of two field sides
400     FOR Yard=-40 TO 40 STEP 10  ! Specify Yard line
410     LDIR 90+90*SGN(Side)        ! Invert LABEL depending on the side
420     MOVE Yard,Side*25           ! MOVE to Yard and Side
430     LABEL USING "DD";50-ABS(Yard)  ! LABEL Yard line
440     NEXT Yard                   ! Repeat for NEXT Yard line
450   NEXT Side                     ! Repeat for other side
460   !
470   ! ***** LABEL End Zones
480   CSIZE 8                       ! Specify Character SIZE,ratio and slant
490   LORG 5                        ! Center LABELs
500   LDIR 90                       ! LABEL bottom to top
510   MOVE -55,0                    ! MOVE to left End Zone
520   LABEL USING "K";"HOME"        ! LABEL End Zone
530   LDIR -90                      ! LABEL top to bottom
540   MOVE 55,0                     ! MOVE to right End Zone
550   LABEL USING "K";"VISITORS"    ! LABEL End Zone
560   !
570   ! ***** LABEL Score
580   CSIZE 5                       ! Specify Character SIZE,ratio and slant
590   LORG 5                        ! Center LABELs
600   LDIR 0                        ! LABEL left to right
610   MOVE 0,-35                    ! MOVE to bottom of plotting area
620   LABEL USING "K";"HOME 21, VISITORS 14"  ! LABEL Score
630   END
```

LOG / LIN Chart Example



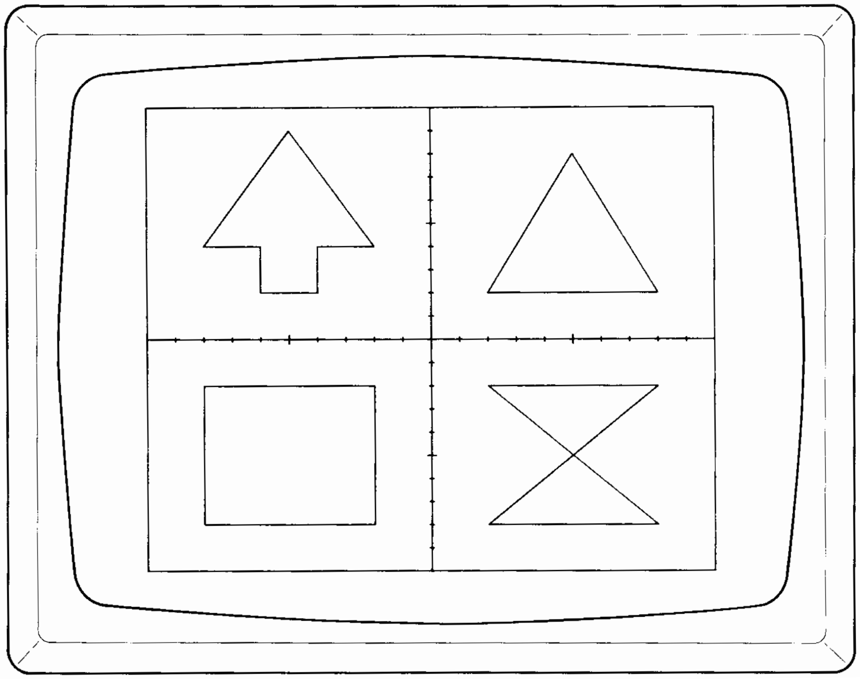


```
1     REM  ** This example draws a LOG/LIN Chart (LOGLIN)
10 Set_up:   !
20    DEG                              ! Sets DEGrees mode
30    Ymin=0                           ! Y axis minimum value
40    Ymax=100                         ! Y axis maximum value
50    Log_interval=LGT(Ymax-Ymin)      ! Number of decades along Y axis
60    Xmin=0                           ! X axis minimum value
70    Xmax=60                          ! X axis maximum value
80    PLOTTER IS 13,"GRAPHICS"         ! Specifies the CRT as the plotter
90    GRAPHICS                         ! Enables the CRT
100   LOCATE 15,75,10,95               ! LOCATEs SCALE area from 15,10 to 75,95
110   SCALE Xmin,Xmax,Ymin,Log_interval    ! SCALEs the LOCATE area to 60x2
120   LINE TYPE 3                      ! Selects dashed LINE TYPE
130   AXES 10,0,0,0,1,1,170            ! Draws AXES with TICK marks on X axis
140   LINE TYPE 1                      ! Selects solid LINE TYPE
150   FRAME                            ! FRAMEs the SOFT CLIP area
160 Logrithmic:  !
170   FOR Decade=0 TO Log_interval                 ! Loop for each Decade
180       FOR Interval=1 TO 9                      ! Loop for interval TICKs
●190        MOVE 0,Decade+LGT(Interval)            ! MOVEs PEN to X=0, Y=Interval
●200        DRAW 100,Decade+LGT(Interval)          ! DRAWs interval TICK
210       NEXT Interval                            ! Repeats FOR NEXT Interval
220     MOVE 0,Decade                              ! MOVEs PEN to X=0, Y=Decade
230     DRAW 100,Decade                            ! DRAWs Logrithmic TICK mark
240   NEXT Decade                                  ! Repeats loop FOR NEXT Decade
```

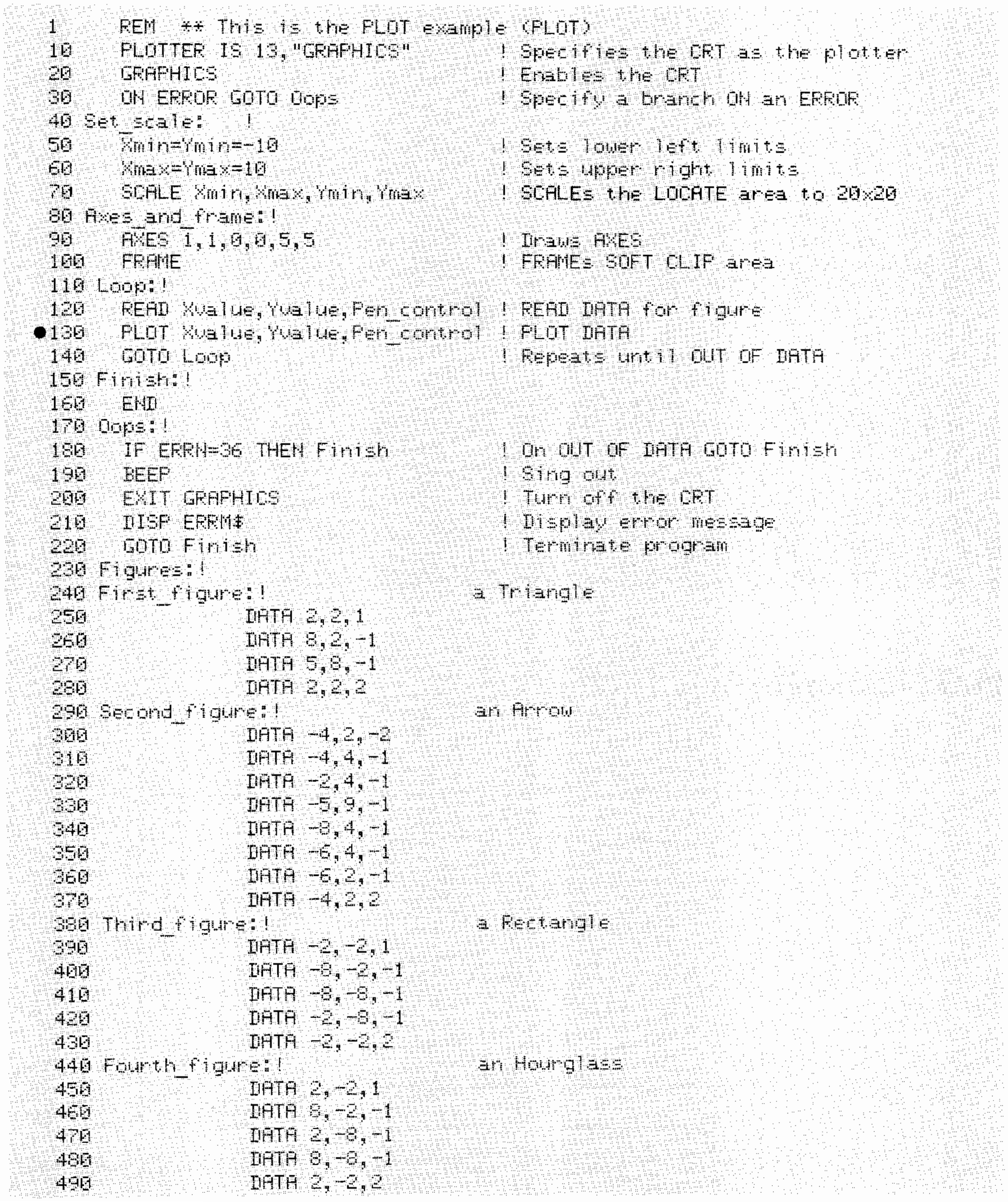


```
250 Log_labels:!
260   LORG 8                                  ! Label Origin 8
270   DATA 1,10,100                           ! Data for labels
280   FOR Decade=0 TO Log_interval            ! Loop for each Decade
290     CSIZE 3                               ! Sets CSIZE to 3
300     FOR Interval=2 TO 9                   ! Loop for interval TICKs
310       MOVE -.05,Decade+LGT(Interval)      ! MOVEs PEN to X=0, Y=Interval
320       LABEL Interval                      ! LABELS Interval TICK
330     NEXT Interval                         ! Repeats FOR NEXT Interval
340     CSIZE 6                               ! Sets CSIZE to 6
350     READ Log_$                            ! READs Log Decade
360     MOVE -4,Decade                        ! MOVEs PEN
370     LABEL Log_$                           ! LABELs Y_axis value
380   NEXT Decade                             ! Repeats FOR NEXT Y_axis label
390 Lin_labels:  !
400   CSIZE 3                                 ! Sets CSIZE to 3
410   LORG 3                                  ! Label Origin 3
420   LDIR -45                                ! Label DIRection at -45 deg
430   FOR X_axis=0 TO Xmax STEP 10            ! Loop for TICK marks
440     MOVE X_axis,0                         ! MOVEs PEN
450     LABEL X_axis                          ! LABELs X_axis value
460   NEXT X_axis                             ! Repeats FOR NEXT X_axis label
470 Text:  !
480   LDIR 0                                  ! Label DIRection at 0 deg
490   SETGU                                   ! Sets GDU's mode
500   MOVE 95,50                              ! MOVEs PEN to X=95,Y=0
510   LABEL "LOG / LIN Chart"                 ! LABELs title
520   END
```

PLOT Example

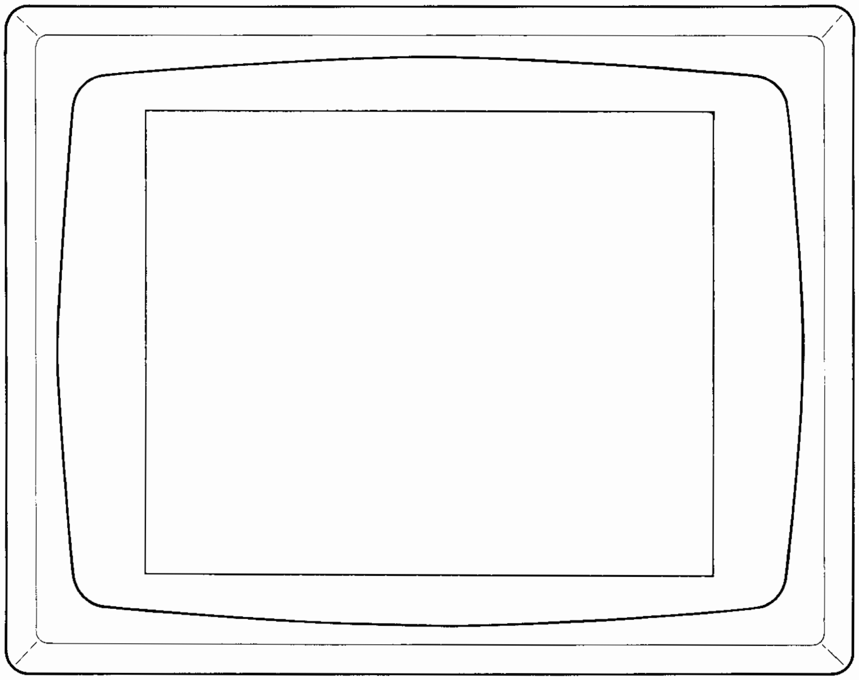


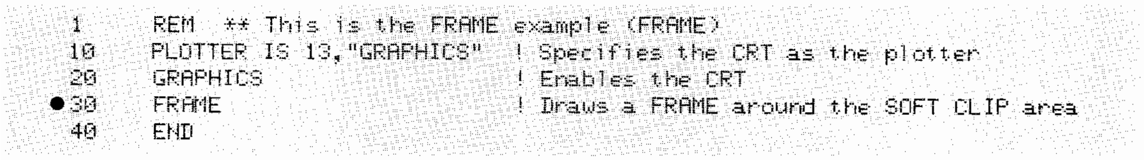
PLOT Example continued



```
 1      REM  ** This is the PLOT example (PLOT)
 10     PLOTTER IS 13,"GRAPHICS"        ! Specifies the CRT as the plotter
 20     GRAPHICS                        ! Enables the CRT
 30     ON ERROR GOTO Oops              ! Specify a branch ON an ERROR
 40 Set_scale:   !
 50     Xmin=Ymin=-10                   ! Sets lower left limits
 60     Xmax=Ymax=10                    ! Sets upper right limits
 70     SCALE Xmin,Xmax,Ymin,Ymax       ! SCALEs the LOCATE area to 20x20
 80 Axes_and_frame:!
 90     AXES 1,1,0,0,5,5                ! Draws AXES
 100    FRAME                           ! FRAMEs SOFT CLIP area
 110 Loop:!
 120    READ Xvalue,Yvalue,Pen_control  ! READ DATA for figure
●130    PLOT Xvalue,Yvalue,Pen_control  ! PLOT DATA
 140    GOTO Loop                       ! Repeats until OUT OF DATA
 150 Finish:!
 160    END
 170 Oops:!
 180    IF ERRN=36 THEN Finish          ! On OUT OF DATA GOTO Finish
 190    BEEP                            ! Sing out
 200    EXIT GRAPHICS                   ! Turn off the CRT
 210    DISP ERRM$                      ! Display error message
 220    GOTO Finish                     ! Terminate program
 230 Figures:!
 240 First_figure:!                   a Triangle
 250            DATA 2,2,1
 260            DATA 8,2,-1
 270            DATA 5,8,-1
 280            DATA 2,2,2
 290 Second_figure:!                  an Arrow
 300            DATA -4,2,-2
 310            DATA -4,4,-1
 320            DATA -2,4,-1
 330            DATA -5,9,-1
 340            DATA -8,4,-1
 350            DATA -6,4,-1
 360            DATA -6,2,-1
 370            DATA -4,2,2
 380 Third_figure:!                   a Rectangle
 390            DATA -2,-2,1
 400            DATA -8,-2,-1
 410            DATA -8,-8,-1
 420            DATA -2,-8,-1
 430            DATA -2,-2,2
 440 Fourth_figure:!                  an Hourglass
 450            DATA 2,-2,1
 460            DATA 8,-2,-1
 470            DATA 2,-8,-1
 480            DATA 8,-8,-1
 490            DATA 2,-2,2
```

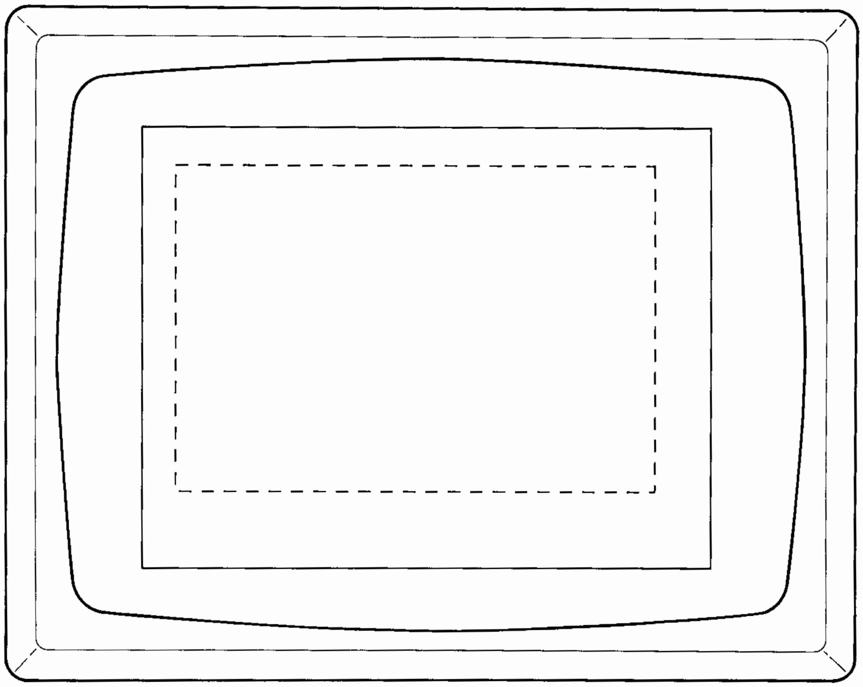
FRAME Example

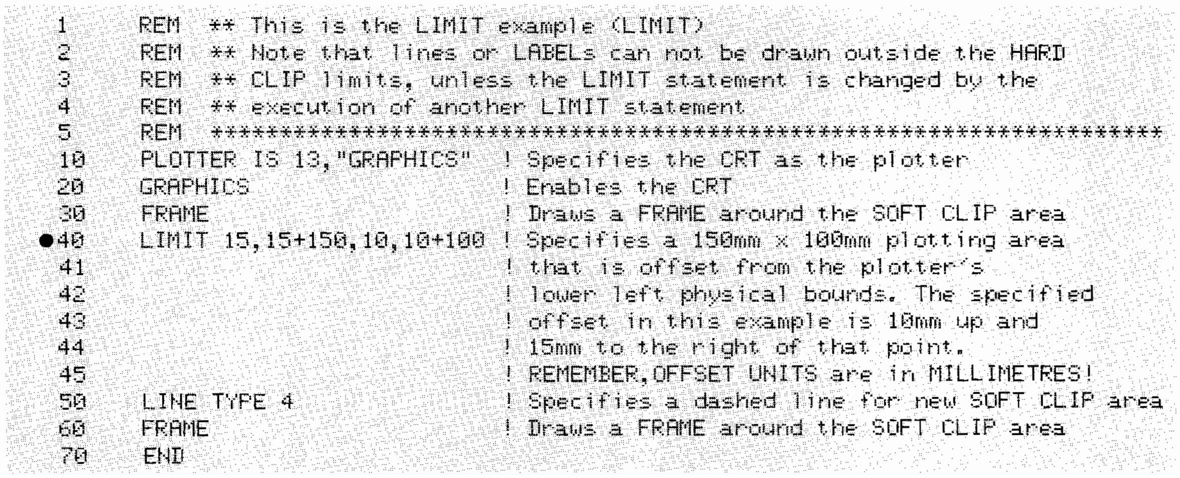




```
  1     REM  ** This is the FRAME example (FRAME)
 10     PLOTTER IS 13,"GRAPHICS"  ! Specifies the CRT as the plotter
 20     GRAPHICS                  ! Enables the CRT
●30     FRAME                     ! Draws a FRAME around the SOFT CLIP area
 40     END
```

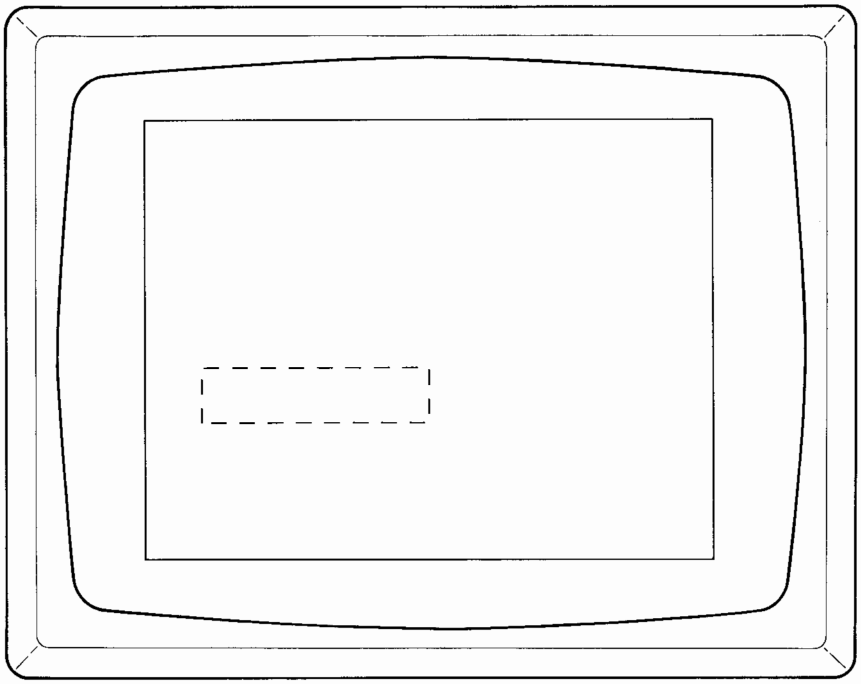
LIMIT Example

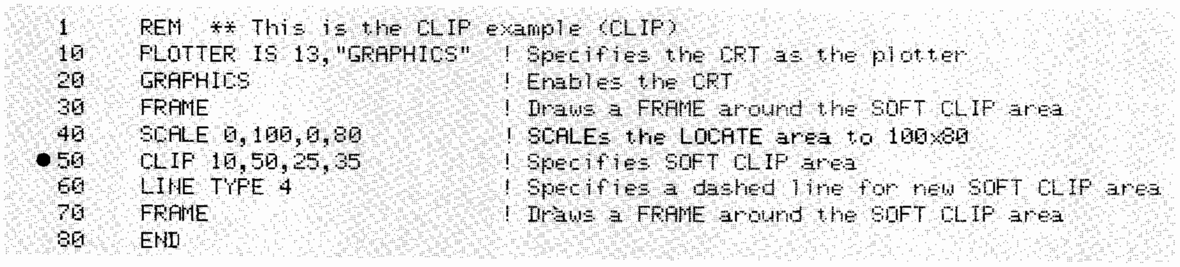




```
 1     REM  ** This is the LIMIT example (LIMIT)
 2     REM  ** Note that lines or LABELs can not be drawn outside the HARD
 3     REM  ** CLIP limits, unless the LIMIT statement is changed by the
 4     REM  ** execution of another LIMIT statement
 5     REM  ****************************************************************
 10    PLOTTER IS 13,"GRAPHICS"  ! Specifies the CRT as the plotter
 20    GRAPHICS                  ! Enables the CRT
 30    FRAME                     ! Draws a FRAME around the SOFT CLIP area
●40    LIMIT 15,15+150,10,10+100 ! Specifies a 150mm x 100mm plotting area
 41                              ! that is offset from the plotter's
 42                              ! lower left physical bounds. The specified
 43                              ! offset in this example is 10mm up and
 44                              ! 15mm to the right of that point.
 45                              ! REMEMBER,OFFSET UNITS are in MILLIMETRES!
 50    LINE TYPE 4               ! Specifies a dashed line for new SOFT CLIP area
 60    FRAME                     ! Draws a FRAME around the SOFT CLIP area
 70    END
```

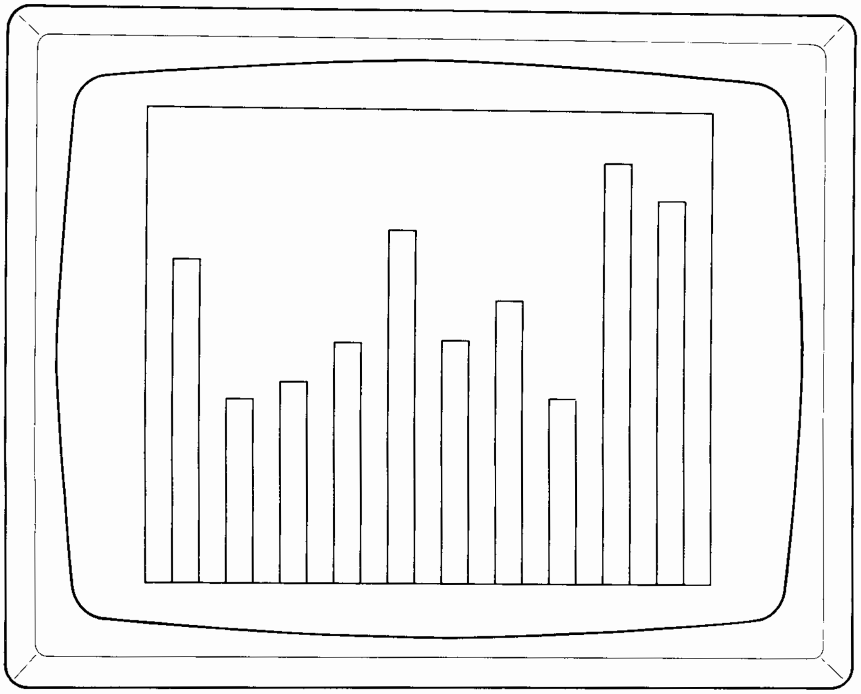
CLIP Example

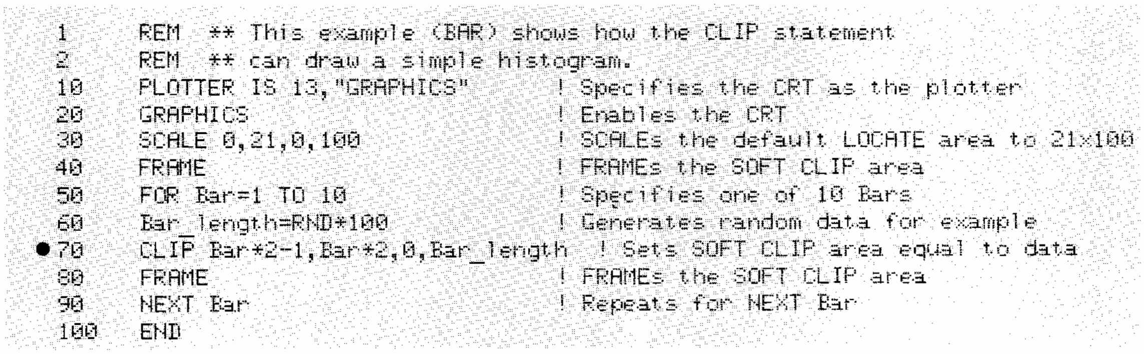




```
  1      REM  ** This is the CLIP example (CLIP)
 10      PLOTTER IS 13,"GRAPHICS"  ! Specifies the CRT as the plotter
 20      GRAPHICS                  ! Enables the CRT
 30      FRAME                     ! Draws a FRAME around the SOFT CLIP area
 40      SCALE 0,100,0,80          ! SCALEs the LOCATE area to 100x80
●50      CLIP 10,50,25,35          ! Specifies SOFT CLIP area
 60      LINE TYPE 4               ! Specifies a dashed line for new SOFT CLIP area
 70      FRAME                     ! Dràws a FRAME around the SOFT CLIP area
 80      END
```

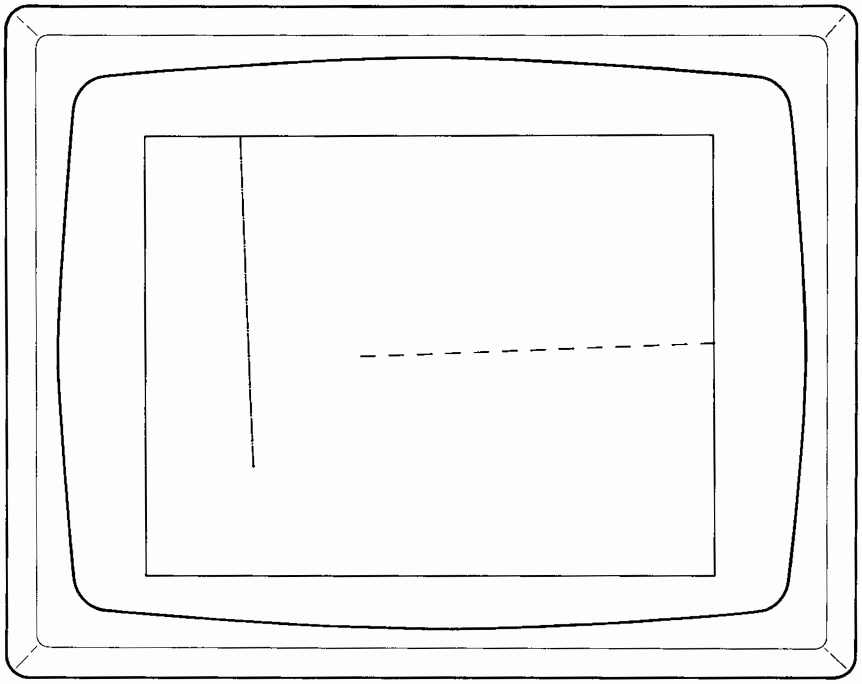
Histogram Using CLIP Statement





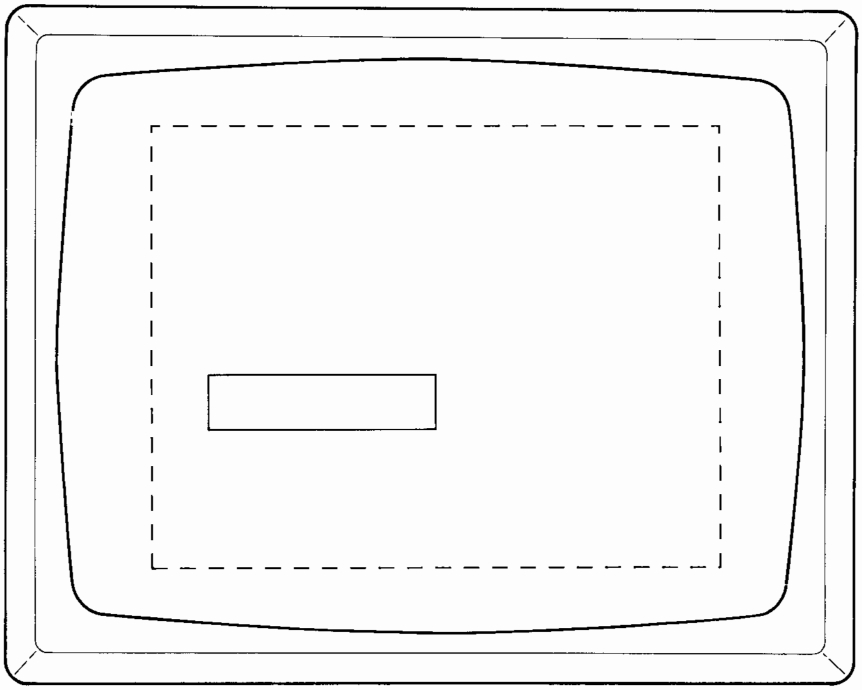
```
  1     REM  ** This example (BAR) shows how the CLIP statement
  2     REM  ** can draw a simple histogram.
  10    PLOTTER IS 13,"GRAPHICS"        ! Specifies the CRT as the plotter
  20    GRAPHICS                        ! Enables the CRT
  30    SCALE 0,21,0,100                ! SCALEs the default LOCATE area to 21x100
  40    FRAME                           ! FRAMEs the SOFT CLIP area
  50    FOR Bar=1 TO 10                 ! Specifies one of 10 Bars
  60    Bar_length=RND*100              ! Generates random data for example
● 70    CLIP Bar*2-1,Bar*2,0,Bar_length  ! Sets SOFT CLIP area equal to data
  80    FRAME                           ! FRAMEs the SOFT CLIP area
  90    NEXT Bar                        ! Repeats for NEXT Bar
  100   END
```

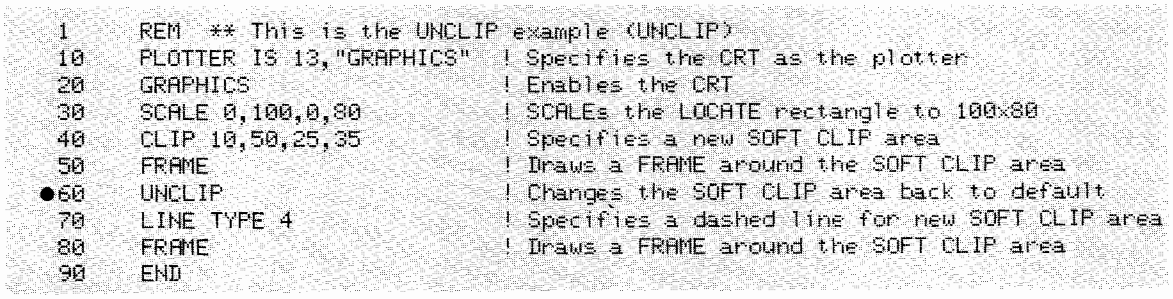
Plotting Outside the Hard Clip Area



```
  1     REM ** This example demonstrates plotting
  2     REM ** outside of the physical plotting
  3     REM ** limits of the device. (LOST)
 10     PLOTTER IS "GRAPHICS"      ! Specifies the CRT as the plotter
 20     GRAPHICS                   ! Enables the CRT
 30     LIMIT 0,184,0,149          ! Sets LIMITs at physical maximum for the CRT
 40     FRAME                      ! Draws border around the SOFT CLIP area
 50     CLIP 0,1000,0,1000         ! Sets SOFT CLIP area greater than
 51                                ! HARD CLIP area
 60     LINE TYPE 4                ! Changes the LINE TYPE
 70     MOVE 50,50                 ! MOVEs near the center of the CRT
● 80    DRAW 750,75                ! DRAWs line beginning inside and ending
 81                                ! outside the HARD CLIP area
 90     LINE TYPE 5                ! Changes LINE TYPE
●100    DRAW 0,700                 ! DRAWs a line beginning and ending
 101                               ! outside the HARD CLIP area
 110    LINE TYPE 6                ! Changes LINE TYPE
●120    DRAW 25,25                 ! DRAWs a line beginning outside and
 121                               ! ending inside the HARD CLIP area
 130    END
```

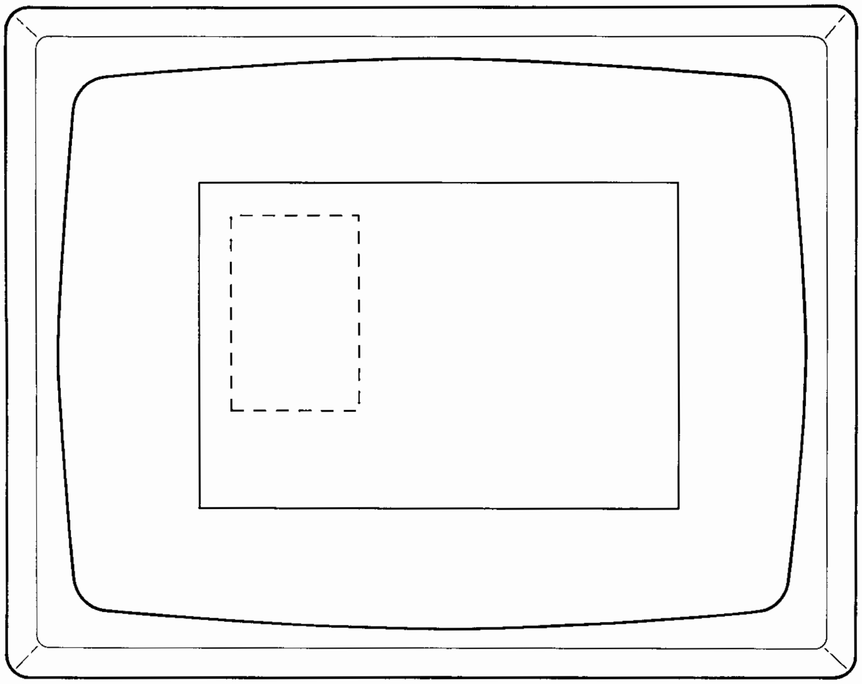
UNCLIP Example

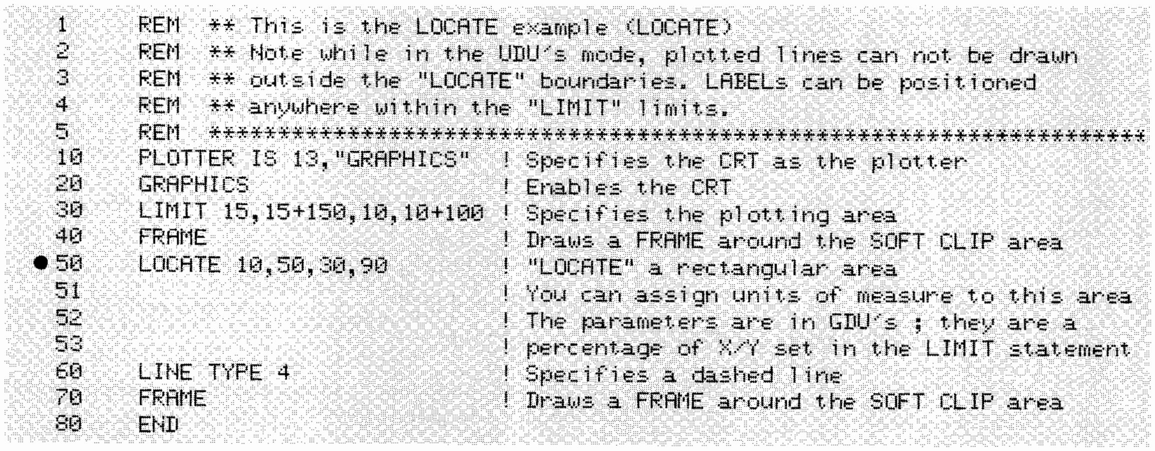




```
  1    REM  ** This is the UNCLIP example (UNCLIP)
 10    PLOTTER IS 13,"GRAPHICS"   ! Specifies the CRT as the plotter
 20    GRAPHICS                   ! Enables the CRT
 30    SCALE 0,100,0,80           ! SCALEs the LOCATE rectangle to 100x80
 40    CLIP 10,50,25,35           ! Specifies a new SOFT CLIP area
 50    FRAME                      ! Draws a FRAME around the SOFT CLIP area
●60    UNCLIP                     ! Changes the SOFT CLIP area back to default
 70    LINE TYPE 4                ! Specifies a dashed line for new SOFT CLIP area
 80    FRAME                      ! Draws a FRAME around the SOFT CLIP area
 90    END
```

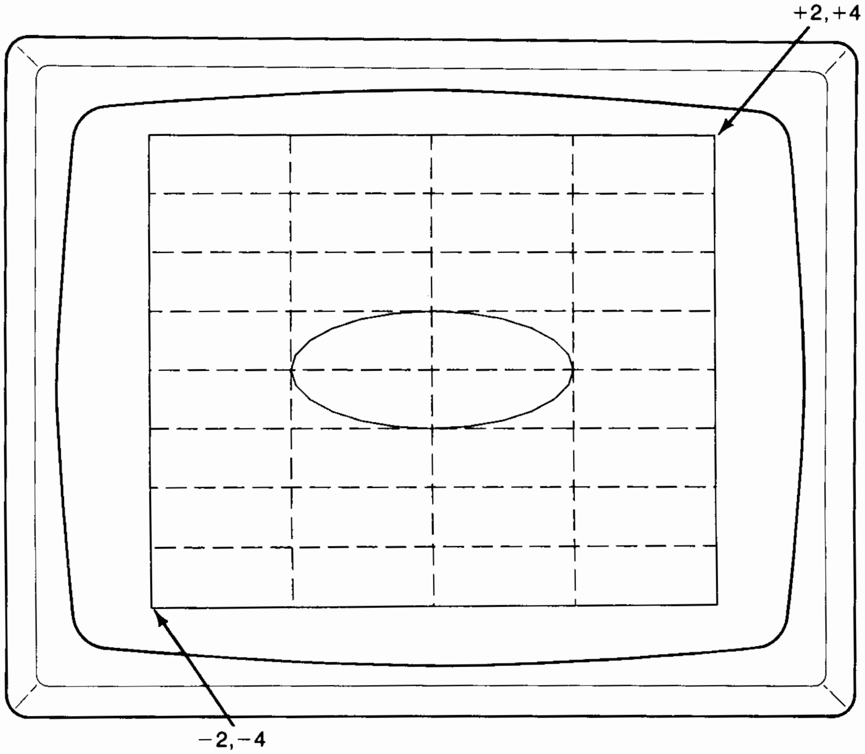
LOCATE Example

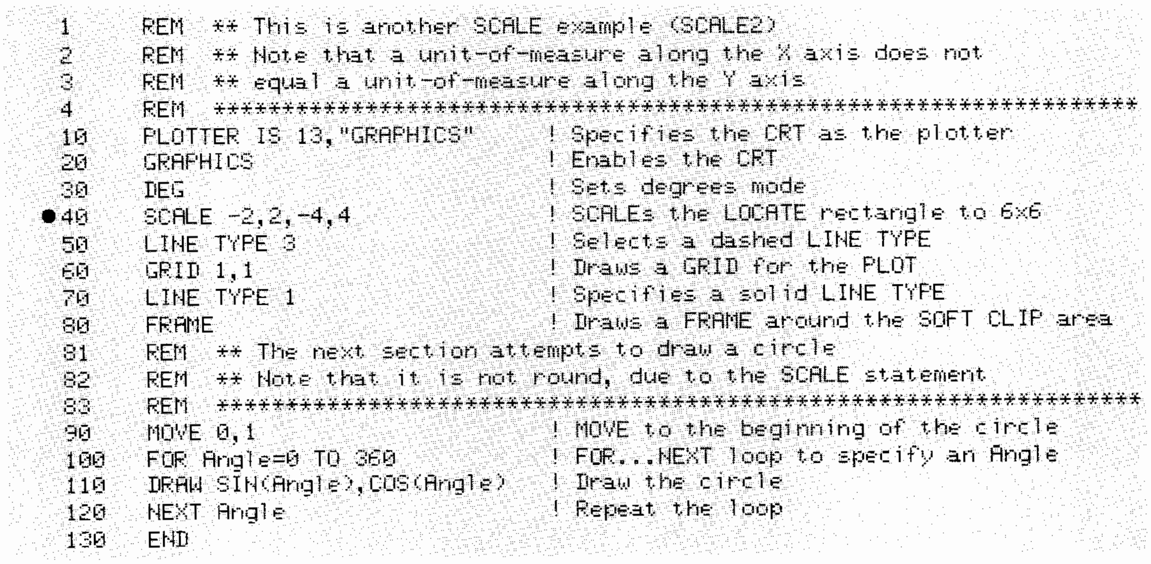




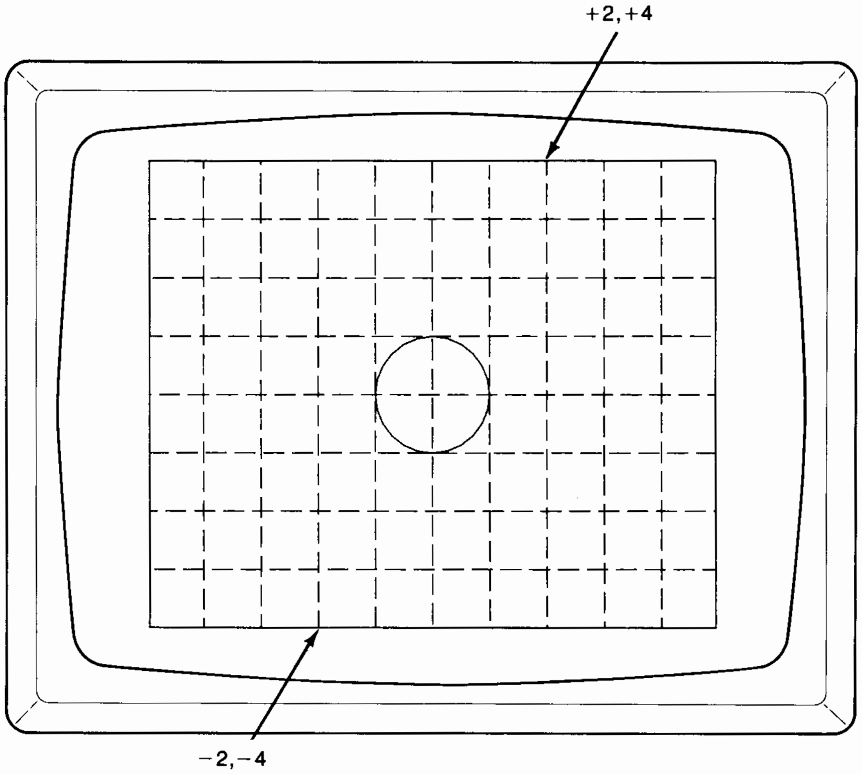
```
   1  REM  ** This is the LOCATE example (LOCATE)
   2  REM  ** Note while in the UDU's mode, plotted lines can not be drawn
   3  REM  ** outside the "LOCATE" boundaries. LABELs can be positioned
   4  REM  ** anywhere within the "LIMIT" limits.
   5  REM  ********************************************************************
  10  PLOTTER IS 13,"GRAPHICS"  ! Specifies the CRT as the plotter
  20  GRAPHICS                  ! Enables the CRT
  30  LIMIT 15,15+150,10,10+100 ! Specifies the plotting area
  40  FRAME                     ! Draws a FRAME around the SOFT CLIP area
● 50  LOCATE 10,50,30,90        ! "LOCATE" a rectangular area
  51                            ! You can assign units of measure to this area
  52                            ! The parameters are in GDU's ; they are a
  53                            ! percentage of X/Y set in the LIMIT statement
  60  LINE TYPE 4               ! Specifies a dashed line
  70  FRAME                     ! Draws a FRAME around the SOFT CLIP area
  80  END
```

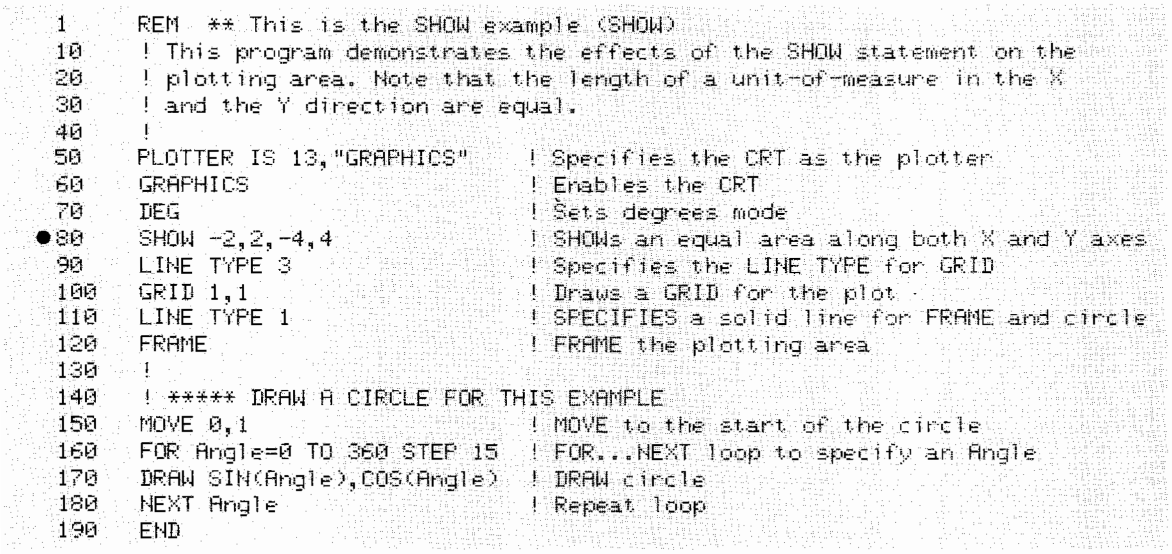
SHOW and SCALE Examples



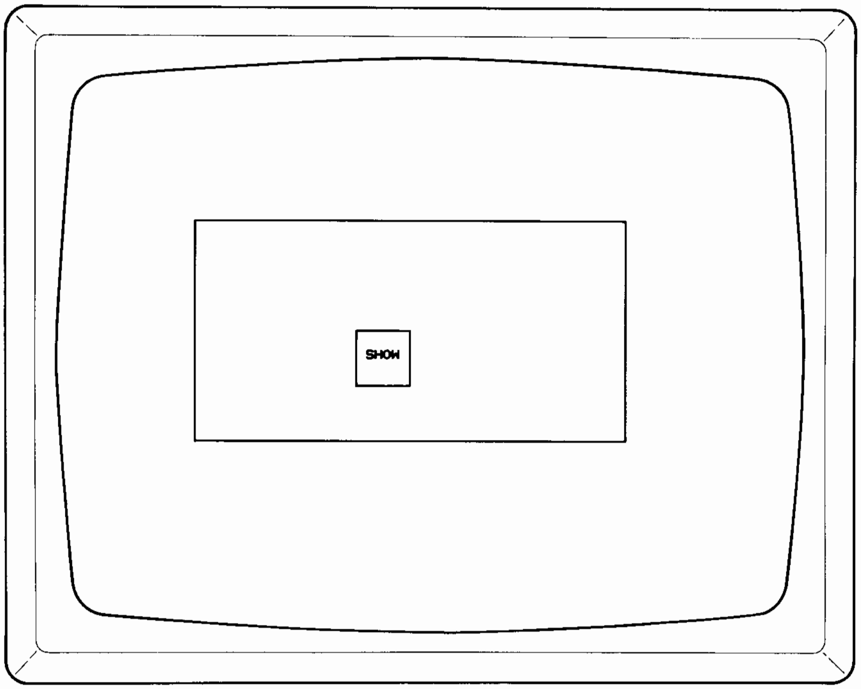


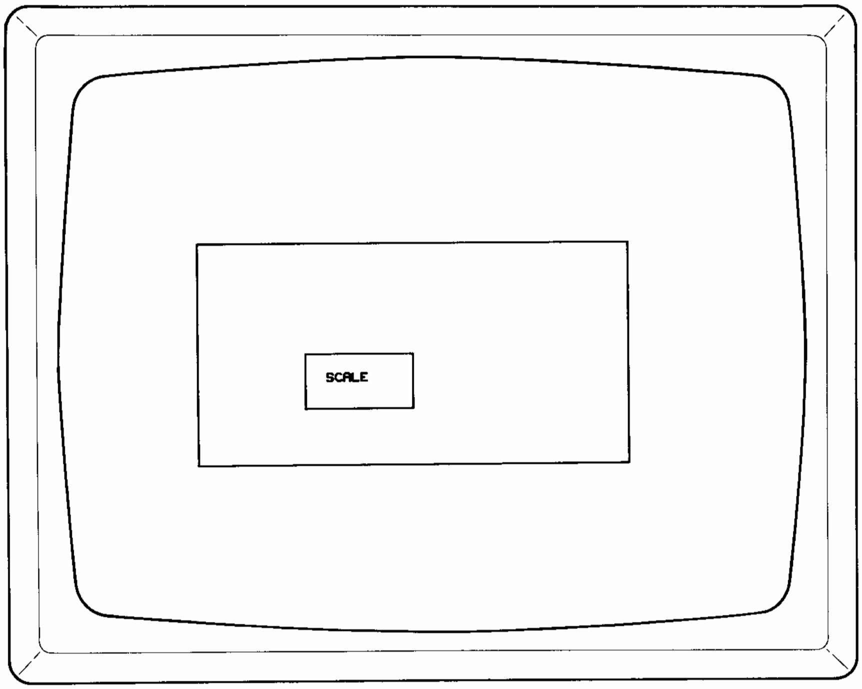
```
1     REM  ** This is another SCALE example (SCALE2)
2     REM  ** Note that a unit-of-measure along the X axis does not
3     REM  ** equal a unit-of-measure along the Y axis
4     REM  ******************************************************************
10    PLOTTER IS 13,"GRAPHICS"      ! Specifies the CRT as the plotter
20    GRAPHICS                      ! Enables the CRT
30    DEG                           ! Sets degrees mode
●40   SCALE -2,2,-4,4               ! SCALEs the LOCATE rectangle to 6x6
50    LINE TYPE 3                   ! Selects a dashed LINE TYPE
60    GRID 1,1                      ! Draws a GRID for the PLOT
70    LINE TYPE 1                   ! Specifies a solid LINE TYPE
80    FRAME                         ! Draws a FRAME around the SOFT CLIP area
81    REM  ** The next section attempts to draw a circle
82    REM  ** Note that it is not round, due to the SCALE statement
83    REM  ******************************************************************
90    MOVE 0,1                      ! MOVE to the beginning of the circle
100   FOR Angle=0 TO 360            ! FOR...NEXT loop to specify an Angle
110   DRAW SIN(Angle),COS(Angle)    ! Draw the circle
120   NEXT Angle                    ! Repeat the loop
130   END
```

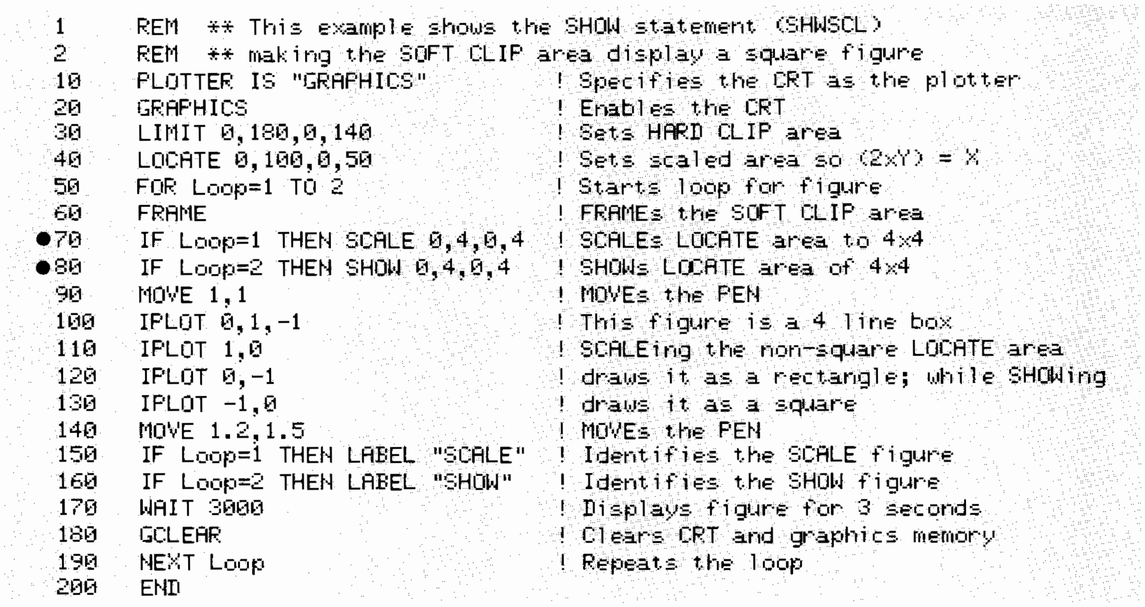




```
 1     REM  ** This is the SHOW example (SHOW)
 10    ! This program demonstrates the effects of the SHOW statement on the
 20    ! plotting area. Note that the length of a unit-of-measure in the X
 30    ! and the Y direction are equal.
 40    !
 50    PLOTTER IS 13,"GRAPHICS"      ! Specifies the CRT as the plotter
 60    GRAPHICS                      ! Enables the CRT
 70    DEG                           ! Sets degrees mode
●80    SHOW -2,2,-4,4                ! SHOWs an equal area along both X and Y axes
 90    LINE TYPE 3                   ! Specifies the LINE TYPE for GRID
 100   GRID 1,1                      ! Draws a GRID for the plot
 110   LINE TYPE 1                   ! SPECIFIES a solid line for FRAME and circle
 120   FRAME                         ! FRAME the plotting area
 130   !
 140   ! ***** DRAW A CIRCLE FOR THIS EXAMPLE
 150   MOVE 0,1                      ! MOVE to the start of the circle
 160   FOR Angle=0 TO 360 STEP 15    ! FOR...NEXT loop to specify an Angle
 170   DRAW SIN(Angle),COS(Angle)    ! DRAW circle
 180   NEXT Angle                    ! Repeat loop
 190   END
```

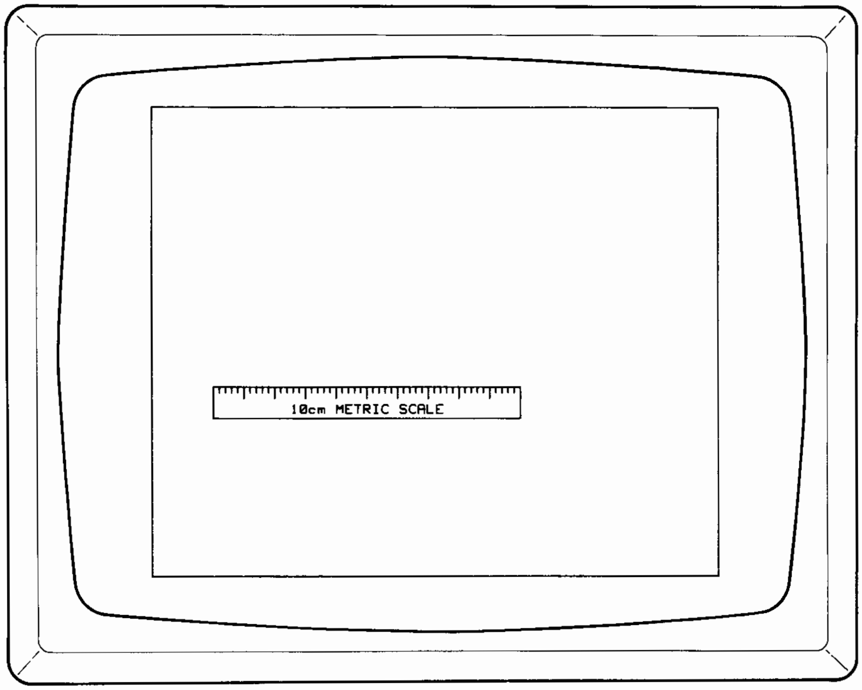

SHOW

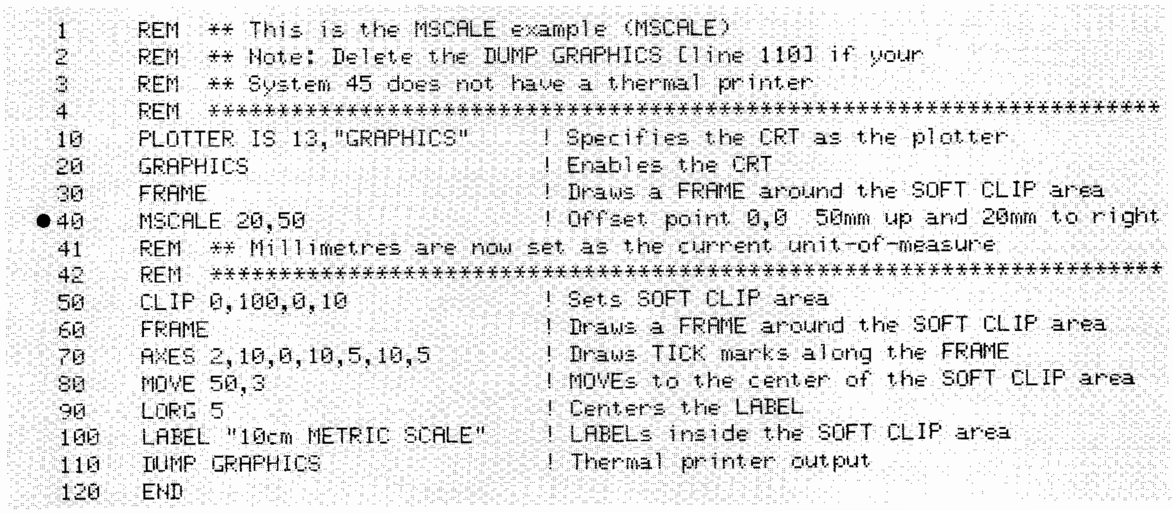

SCALE



```
 1      REM  ** This example shows the SHOW statement (SHWSCL)
 2      REM  ** making the SOFT CLIP area display a square figure
 10     PLOTTER IS "GRAPHICS"          ! Specifies the CRT as the plotter
 20     GRAPHICS                       ! Enables the CRT
 30     LIMIT 0,180,0,140              ! Sets HARD CLIP area
 40     LOCATE 0,100,0,50              ! Sets scaled area so (2xY) = X
 50     FOR Loop=1 TO 2                ! Starts loop for figure
 60     FRAME                          ! FRAMEs the SOFT CLIP area
●70     IF Loop=1 THEN SCALE 0,4,0,4   ! SCALEs LOCATE area to 4x4
●80     IF Loop=2 THEN SHOW 0,4,0,4    ! SHOWs LOCATE area of 4x4
 90     MOVE 1,1                       ! MOVEs the PEN
 100    IPLOT 0,1,-1                   ! This figure is a 4 line box
 110    IPLOT 1,0                      ! SCALEing the non-square LOCATE area
 120    IPLOT 0,-1                     ! draws it as a rectangle; while SHOWing
 130    IPLOT -1,0                     ! draws it as a square
 140    MOVE 1.2,1.5                   ! MOVEs the PEN
 150    IF Loop=1 THEN LABEL "SCALE"   ! Identifies the SCALE figure
 160    IF Loop=2 THEN LABEL "SHOW"    ! Identifies the SHOW figure
 170    WAIT 3000                      ! Displays figure for 3 seconds
 180    GCLEAR                         ! Clears CRT and graphics memory
 190    NEXT Loop                      ! Repeats the loop
 200    END
```

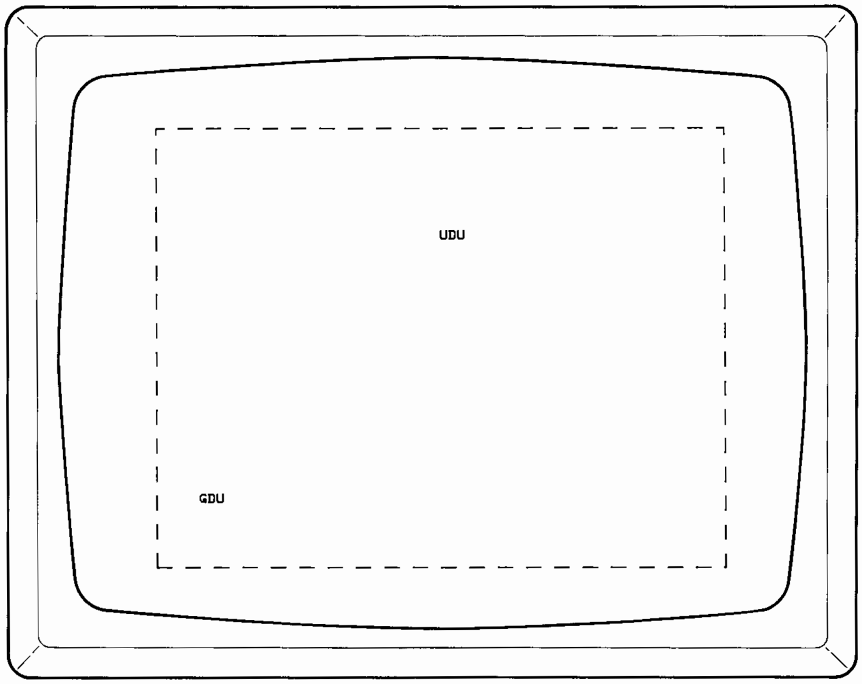
Metric Scale Example





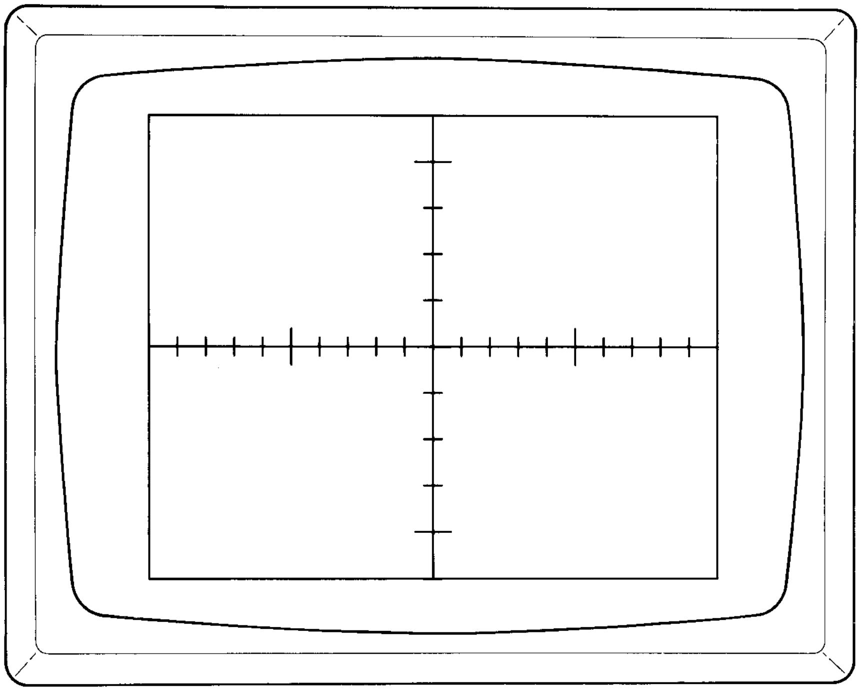
```
  1    REM  ** This is the MSCALE example (MSCALE)
  2    REM  ** Note: Delete the DUMP GRAPHICS [line 110] if your
  3    REM  ** System 45 does not have a thermal printer
  4    REM  ***********************************************************************
 10    PLOTTER IS 13,"GRAPHICS"     ! Specifies the CRT as the plotter
 20    GRAPHICS                     ! Enables the CRT
 30    FRAME                        ! Draws a FRAME around the SOFT CLIP area
●40    MSCALE 20,50                 ! Offset point 0,0  50mm up and 20mm to right
 41    REM  ** Millimetres are now set as the current unit-of-measure
 42    REM  ***********************************************************************
 50    CLIP 0,100,0,10              ! Sets SOFT CLIP area
 60    FRAME                        ! Draws a FRAME around the SOFT CLIP area
 70    AXES 2,10,0,10,5,10,5        ! Draws TICK marks along the FRAME
 80    MOVE 50,3                    ! MOVEs to the center of the SOFT CLIP area
 90    LORG 5                       ! Centers the LABEL
100    LABEL "10cm METRIC SCALE"    ! LABELs inside the SOFT CLIP area
110    DUMP GRAPHICS                ! Thermal printer output
120    END
```

GDU and UDU Example

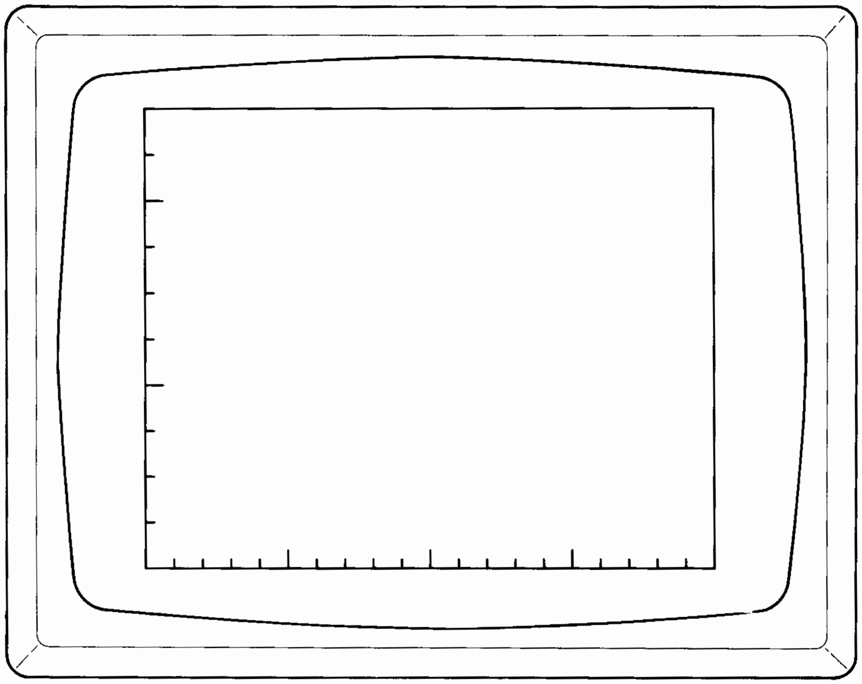


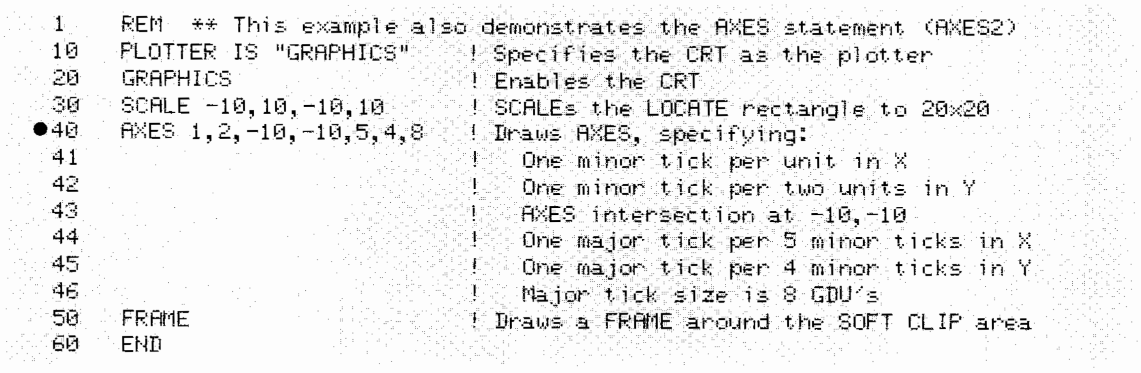
```
 10   REM  ** This example contrasts GDU's and UDU's (GDUUDU)
 20   DATA GDU,UDU              ! Names of modes
 30   PLOTTER IS "GRAPHICS"     ! Specifies the CRT as the plotter
 40   GRAPHICS                  ! Enables the CRT
 50   LIMIT 0,184,0,149         ! Defines the HARD CLIP area
 60   SCALE 0,20,0,20           ! SCALEs LOCATE rectangle to 20x20
 70   LINE TYPE 4               ! Selects a dashed LINE TYPE
 80   FRAME                     ! Draws a FRAME around the SOFT CLIP area
●90   SETGU                     ! Sets Graphics Display Units (GDU's) mode
 100  GOSUB Text                ! LABELing operation
●110  SETUU                     ! Sets User Defined Units (UDU's) mode
 120  GOSUB Text                ! LABELing operation
 130  END
 140 Text:  !
 150    LINE TYPE 1             ! Selects a solid LINE TYPE
 160    MOVE 10,15              ! MOVEs the PEN to 10,15 in current units
 170    READ Text$              ! READs the data for the current mode
 180    LABEL Text$             ! LABELs text
 190    RETURN
```

AXES Examples



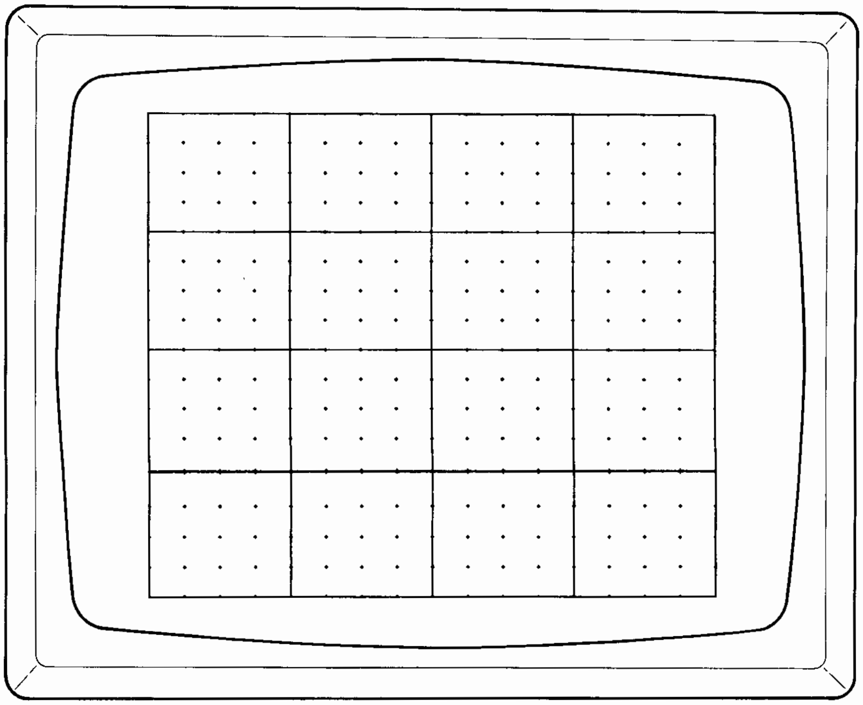
```
   1   REM  ** This example demonstrates the AXES statement (AXES)
  10   PLOTTER IS "GRAPHICS"     ! Specifies the CRT as the plotter
  20   GRAPHICS                  ! Enables the CRT
  30   SCALE -10,10,-10,10       ! SCALEs LOCATE rectangle to 20x20
● 40   AXES 1,2,0,0,5,4,8        ! Draws AXES, specifying:
  41                             !   One minor tick per unit in X
  42                             !   One minor tick per two units in Y
  43                             !   AXES intersection at 0,0
  44                             !   One major tick per 5 minor ticks in X
  45                             !   One major tick per 4 minor ticks in Y
  46                             !   Major tick size is 8 GDU´s
  50   FRAME                     ! Draws a FRAME around the SOFT CLIP area
  60   END
```

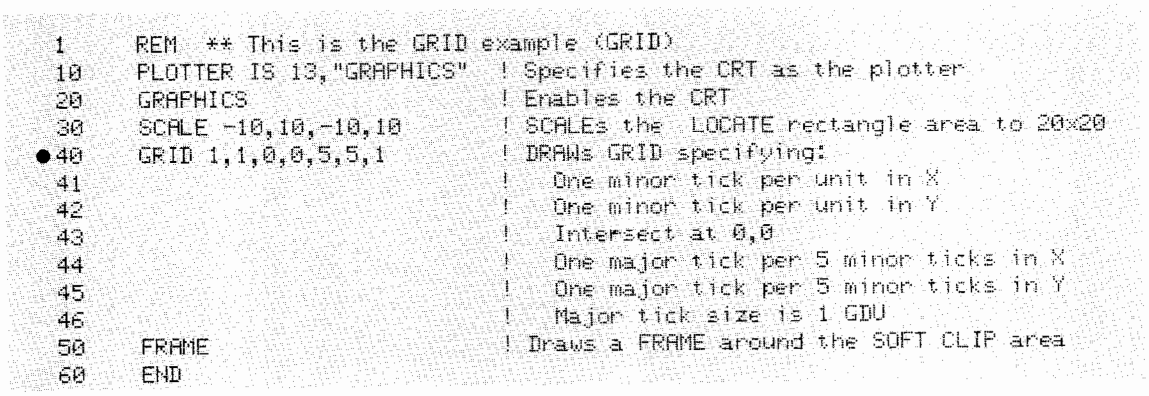




```
 1    REM  ** This example also demonstrates the AXES statement (AXES2)
 10   PLOTTER IS "GRAPHICS"      ! Specifies the CRT as the plotter
 20   GRAPHICS                   ! Enables the CRT
 30   SCALE -10,10,-10,10        ! SCALEs the LOCATE rectangle to 20x20
●40   AXES 1,2,-10,-10,5,4,8     ! Draws AXES, specifying:
 41                              !   One minor tick per unit in X
 42                              !   One minor tick per two units in Y
 43                              !   AXES intersection at -10,-10
 44                              !   One major tick per 5 minor ticks in X
 45                              !   One major tick per 4 minor ticks in Y
 46                              !   Major tick size is 8 GDU's
 50   FRAME                      ! Draws a FRAME around the SOFT CLIP area
 60   END
```

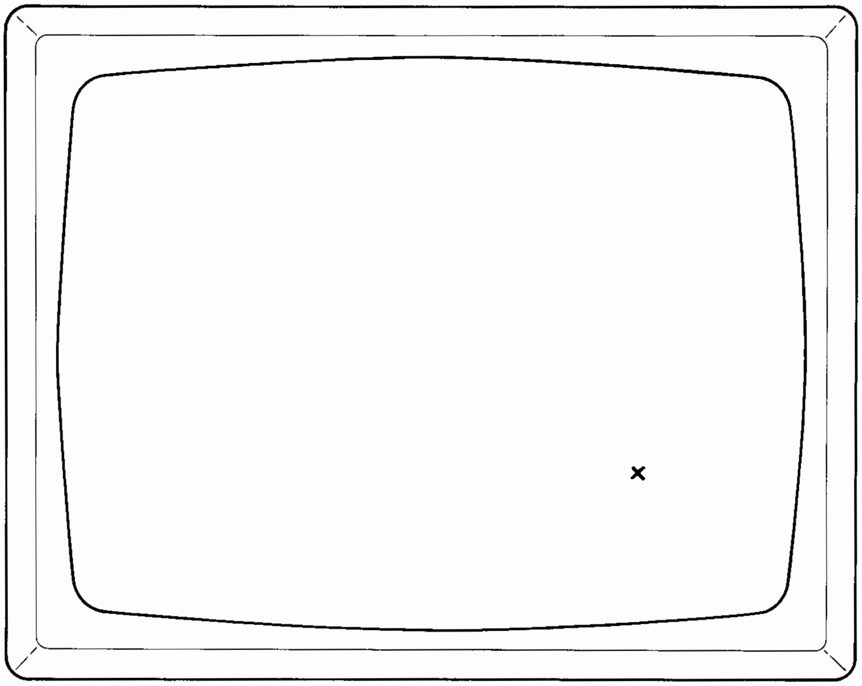
GRID Example

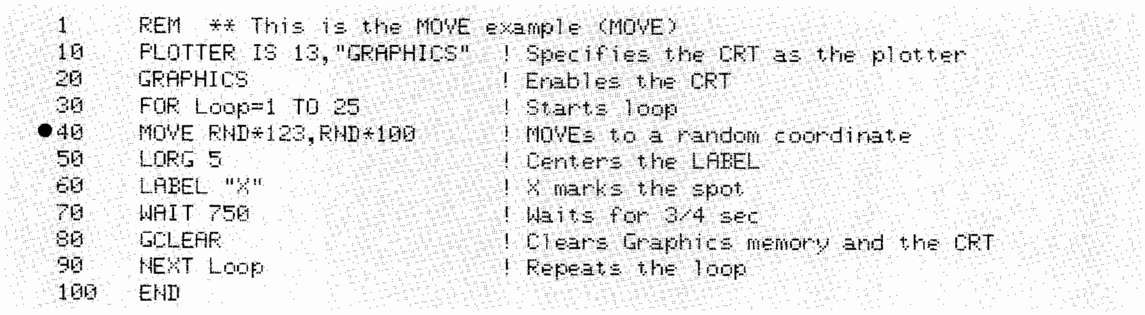




```
  1     REM  ** This is the GRID example (GRID)
 10     PLOTTER IS 13,"GRAPHICS"  ! Specifies the CRT as the plotter
 20     GRAPHICS                  ! Enables the CRT
 30     SCALE -10,10,-10,10       ! SCALEs the  LOCATE rectangle area to 20x20
●40     GRID 1,1,0,0,5,5,1        ! DRAWs GRID specifying:
 41                               !   One minor tick per unit in X
 42                               !   One minor tick per unit in Y
 43                               !   Intersect at 0,0
 44                               !   One major tick per 5 minor ticks in X
 45                               !   One major tick per 5 minor ticks in Y
 46                               !   Major tick size is 1 GDU
 50     FRAME                     ! Draws a FRAME around the SOFT CLIP area
 60     END
```

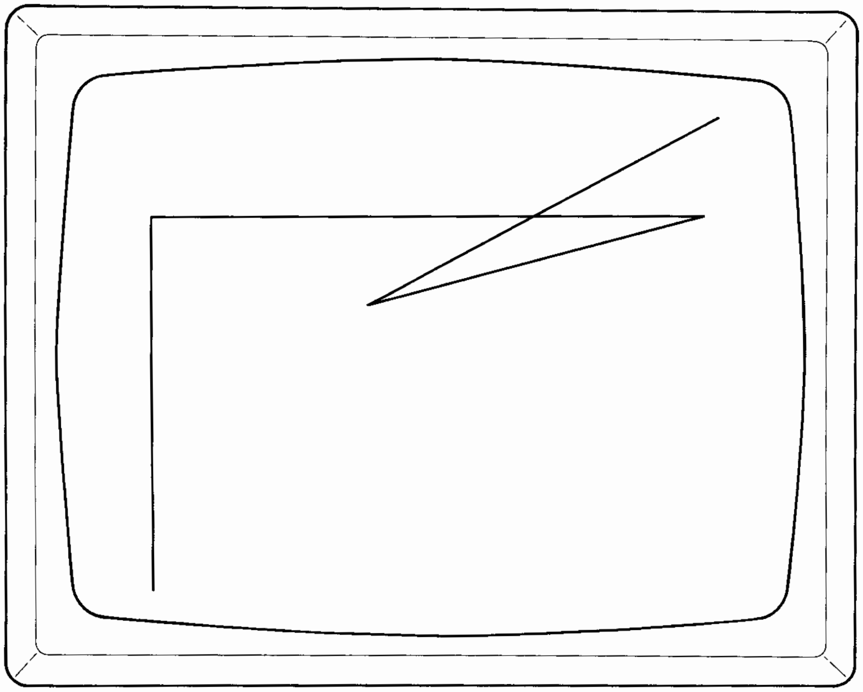
MOVE Example

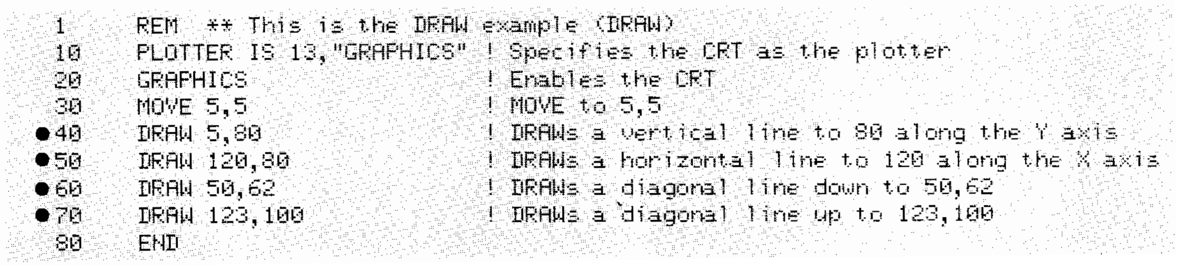




```
   1     REM  ** This is the MOVE example (MOVE)
  10     PLOTTER IS 13,"GRAPHICS"   ! Specifies the CRT as the plotter
  20     GRAPHICS                   ! Enables the CRT
  30     FOR Loop=1 TO 25           ! Starts loop
 ●40     MOVE RND*123,RND*100       ! MOVEs to a random coordinate
  50     LORG 5                     ! Centers the LABEL
  60     LABEL "X"                  ! X marks the spot
  70     WAIT 750                   ! Waits for 3/4 sec
  80     GCLEAR                     ! Clears Graphics memory and the CRT
  90     NEXT Loop                  ! Repeats the loop
 100     END
```

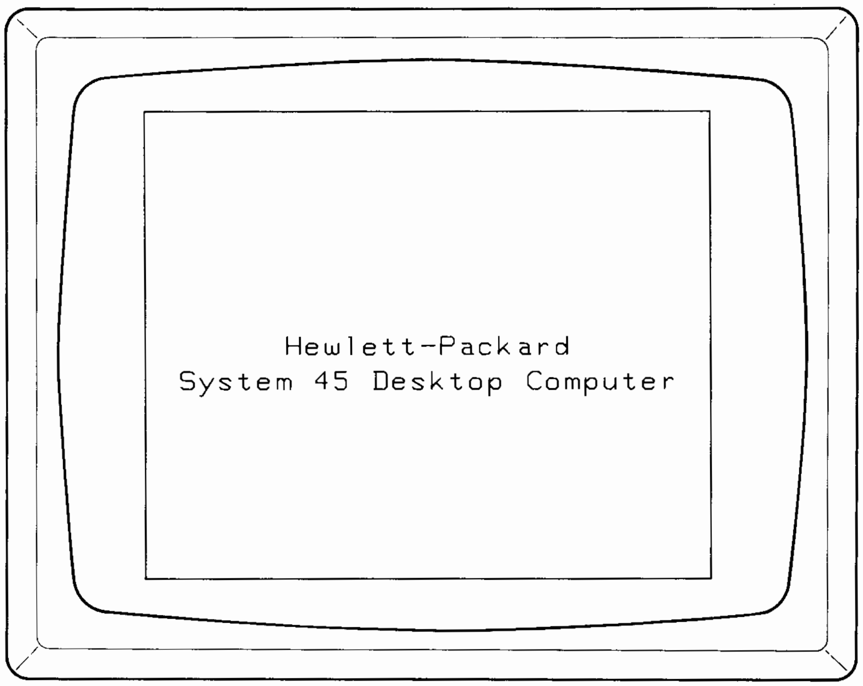
DRAW Example

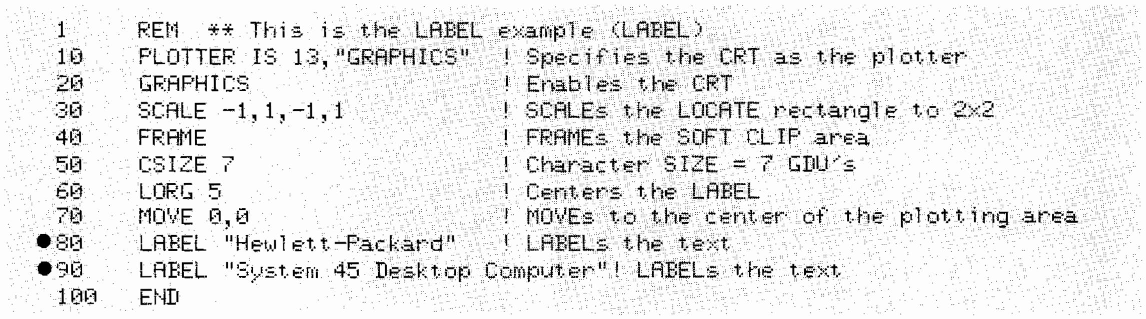




```
  1    REM  ** This is the DRAW example (DRAW)
  10   PLOTTER IS 13,"GRAPHICS" ! Specifies the CRT as the plotter
  20   GRAPHICS                 ! Enables the CRT
  30   MOVE 5,5                 ! MOVE to 5,5
 ●40   DRAW 5,80                ! DRAWs a vertical line to 80 along the Y axis
 ●50   DRAW 120,80              ! DRAWs a horizontal line to 120 along the X axis
 ●60   DRAW 50,62               ! DRAWs a diagonal line down to 50,62
 ●70   DRAW 123,100             ! DRAWs a `diagonal line up to 123,100
  80   END
```

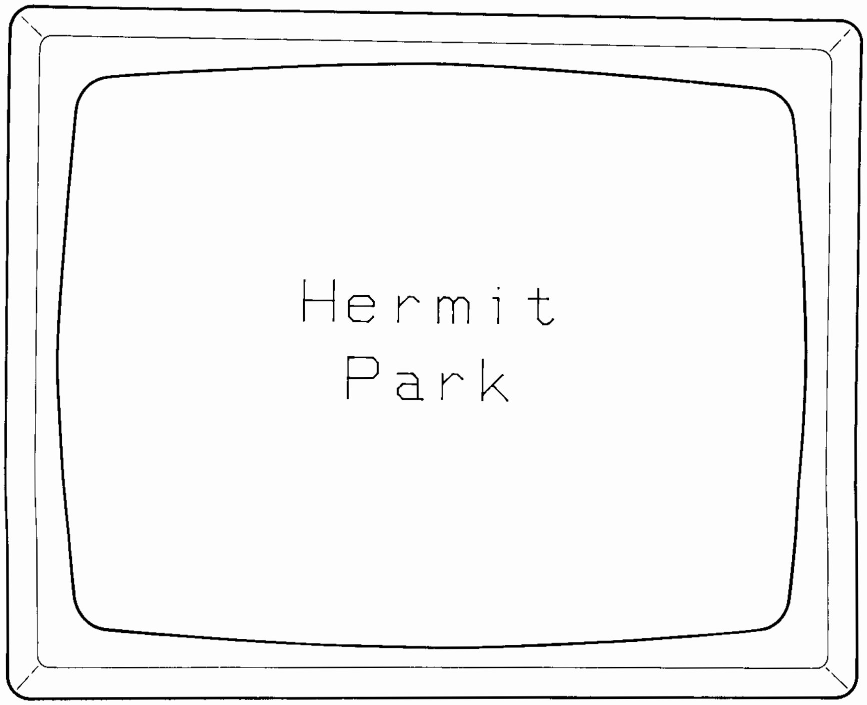
LABEL Example





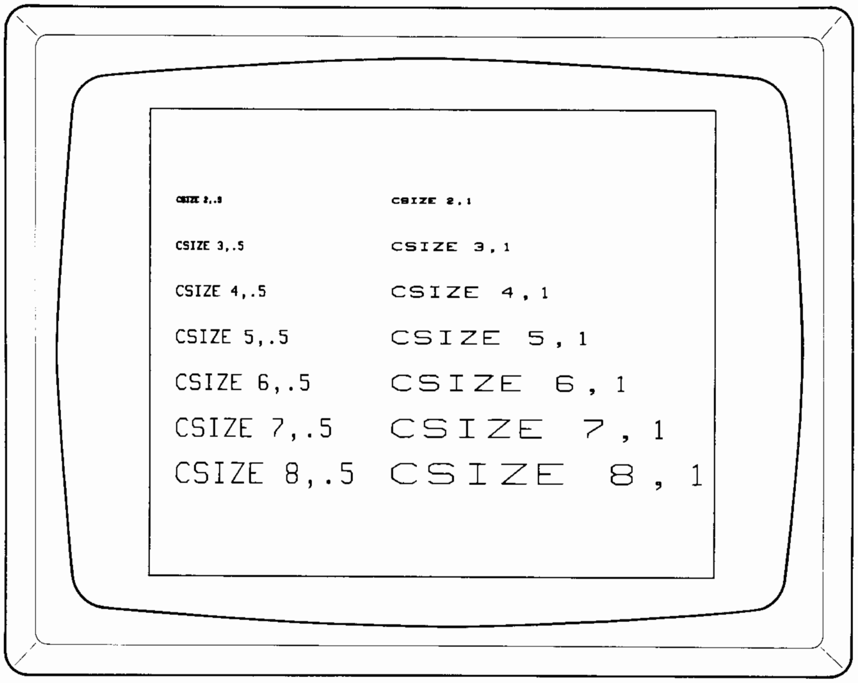
```
  1    REM  ** This is the LABEL example (LABEL)
 10    PLOTTER IS 13,"GRAPHICS"  ! Specifies the CRT as the plotter
 20    GRAPHICS                  ! Enables the CRT
 30    SCALE -1,1,-1,1           ! SCALEs the LOCATE rectangle to 2x2
 40    FRAME                     ! FRAMEs the SOFT CLIP area
 50    CSIZE 7                   ! Character SIZE = 7 GDU's
 60    LORG 5                    ! Centers the LABEL
 70    MOVE 0,0                  ! MOVEs to the center of the plotting area
●80    LABEL "Hewlett-Packard"   ! LABELs the text
●90    LABEL "System 45 Desktop Computer"! LABELs the text
 100   END
```

LETTER Example



```
 1     REM  ** This is the LETTER example (LETTER)
 10    PLOTTER IS 13,"GRAPHICS" ! Specifies the CRT as the plotter
 20    GRAPHICS                 ! Enables the CRT
 30    CSIZE 5,.4               ! Character SIZE = 5 GDU's
 31                             ! Aspect ratio = .4
 32                             ! Character slant = 0 degrees
●40    LETTER                   ! Sets the LETTER mode
 50    END
```

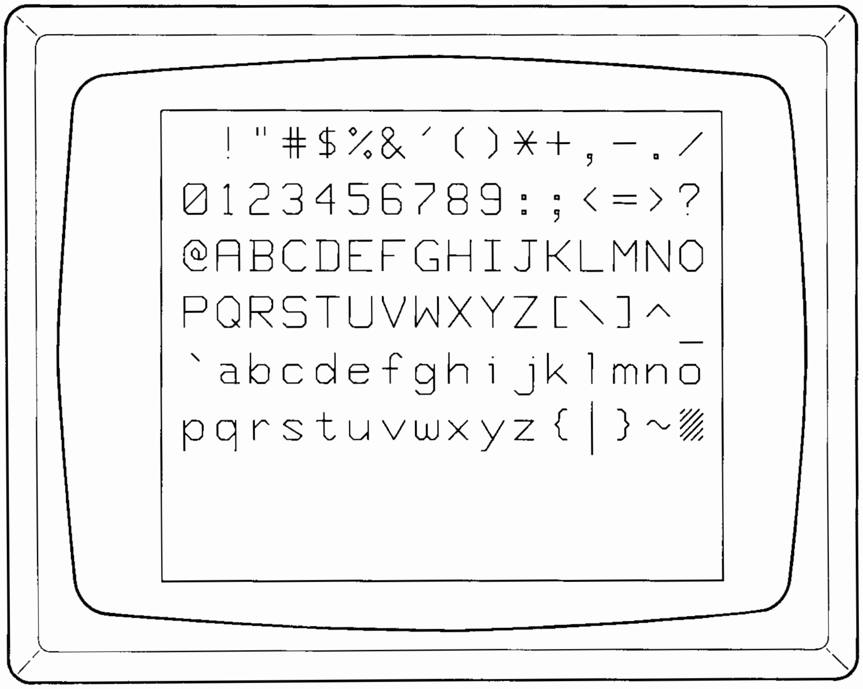
CSIZE Example



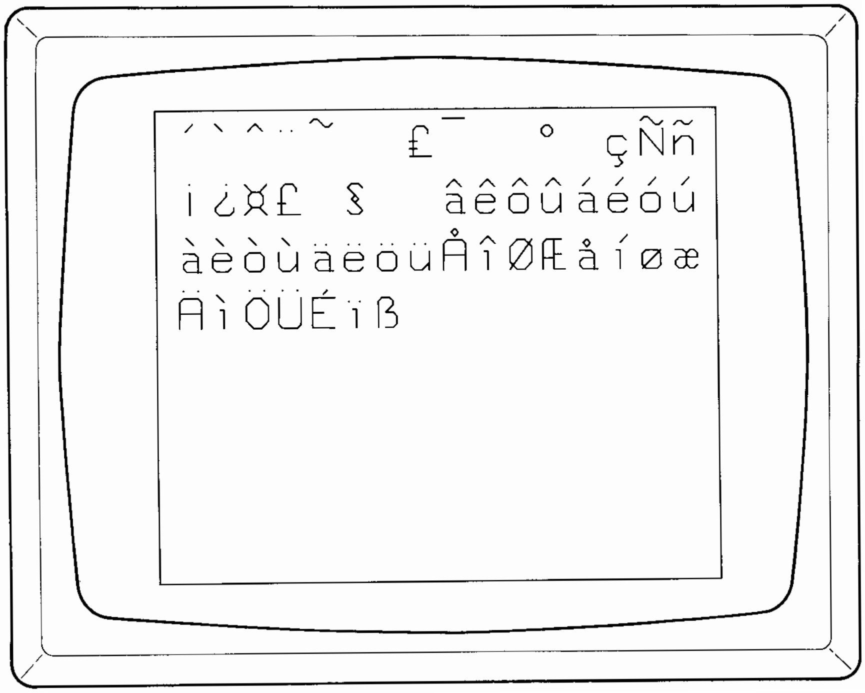
```
CSIZE 2,.5          CSIZE 2,1
CSIZE 3,.5          CSIZE 3,1
CSIZE 4,.5          CSIZE 4,1
CSIZE 5,.5          CSIZE 5,1
CSIZE 6,.5          CSIZE 6,1
CSIZE 7,.5          CSIZE 7,1
CSIZE 8,.5          CSIZE 8,1
```

```
 1     REM  **  This is the CSIZE example (CSIZE)
 10     ! This program demonstrates some of the different
 20     ! Character SIZEs and aspect ratios
 30     !
 40    PLOTTER IS 13,"GRAPHICS"          ! Specifies the CRT as the plotter
 50    GRAPHICS                          ! Enables the CRT
 60    FRAME                             ! FRAMEs the SOFT CLIP area
 70    SCALE -.5,10,-10,0                ! SCALEs the plotting area to 10.5x10
 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=1 TO 8                   ! Specify one of eight Character SIZEs
●120   CSIZE Size,Column/2               ! Sets Character SIZE and aspect ratio
 130   MOVE (Column-1)*4,-Size           ! MOVEs PEN to LABEL position
 140   LABEL USING "K";"CSIZE ",Size,",",Column/2   !LABELs plotting area
 150   NEXT Size                         ! Increments to NEXT Size
 160   NEXT Column                       ! Repeats for NEXT Column
 170   END
```

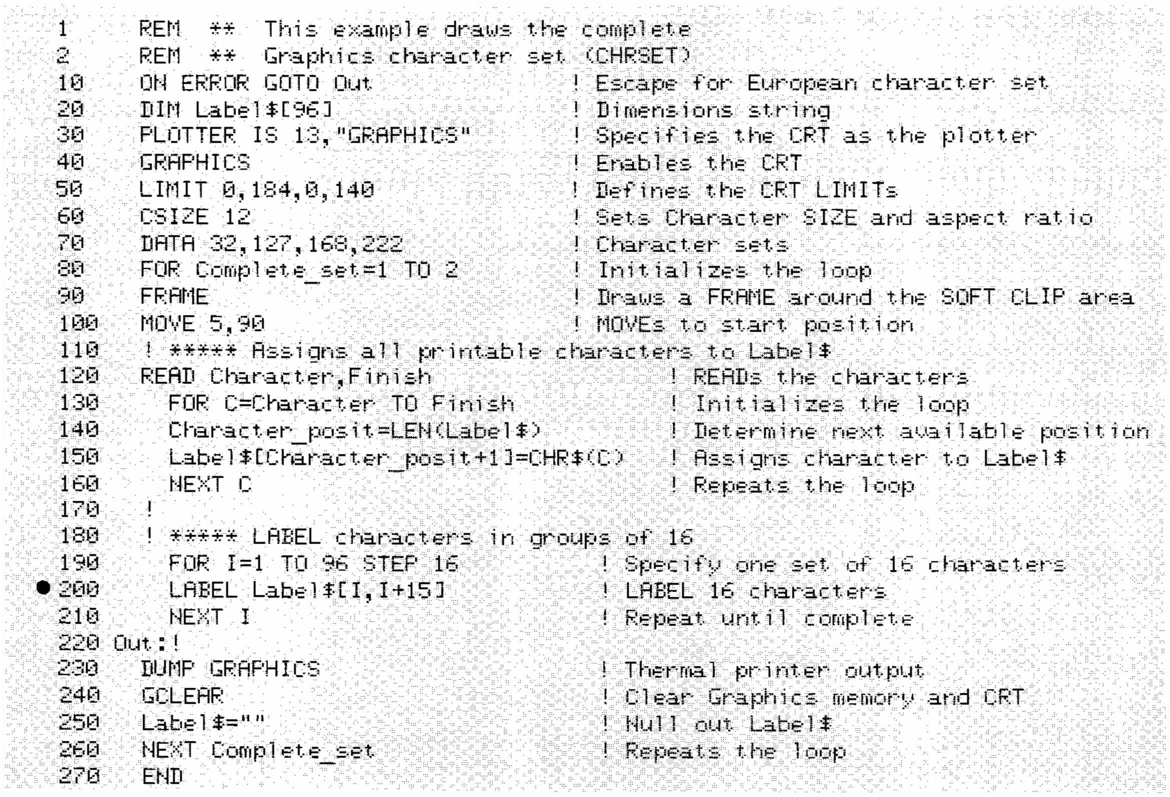
Character Set Example



```
 !"#$%&´()*+,-./
0123456789:;<=>?
@ABCDEFGHIJKLMNO
PQRSTUVWXYZ[\]^_
`abcdefghijklmno
pqrstuvwxyz{|}~▒
```

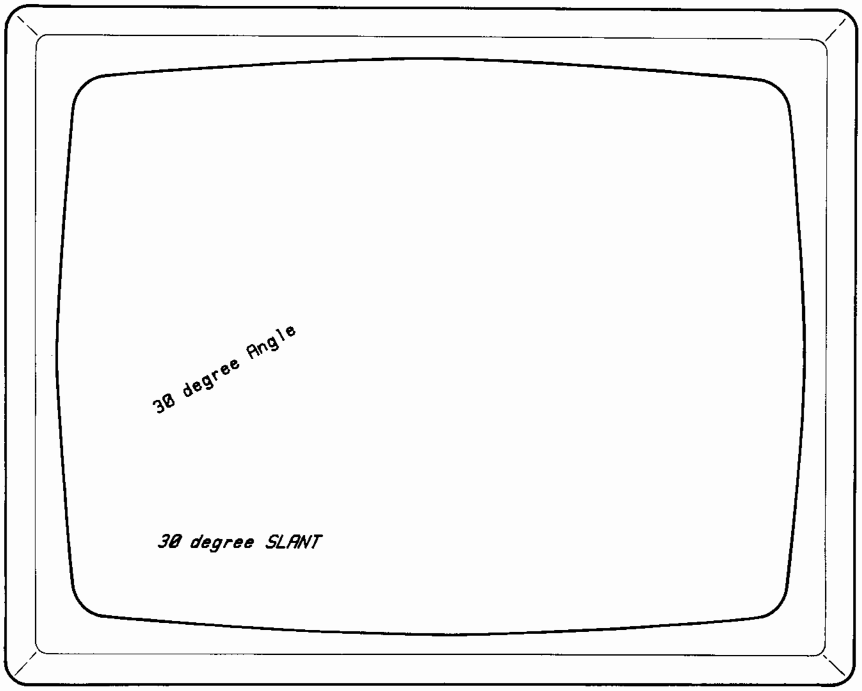


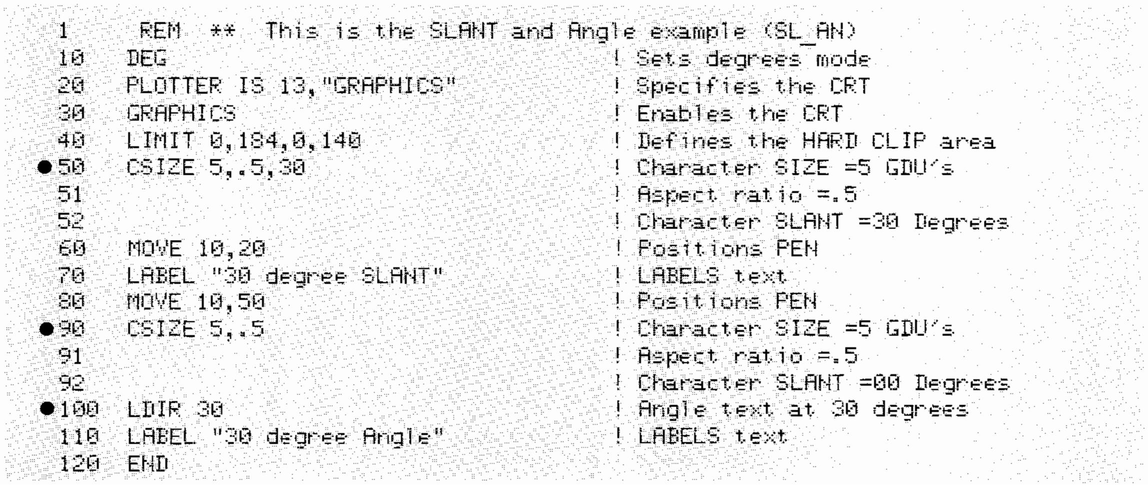
```
´`^¨~  £¯  °  çÑñ
¡¿¤£ §  âêôûáéóú
àèòùäëöüÅîØÆåíøæ
ÄìÖÜÉïß
```



```
 1    REM  **  This example draws the complete
 2    REM  **  Graphics character set (CHRSET)
 10   ON ERROR GOTO Out                  ! Escape for European character set
 20   DIM Label$[96]                     ! Dimensions string
 30   PLOTTER IS 13,"GRAPHICS"           ! Specifies the CRT as the plotter
 40   GRAPHICS                           ! Enables the CRT
 50   LIMIT 0,184,0,140                  ! Defines the CRT LIMITs
 60   CSIZE 12                           ! Sets Character SIZE and aspect ratio
 70   DATA 32,127,160,222                ! Character sets
 80   FOR Complete_set=1 TO 2            ! Initializes the loop
 90   FRAME                              ! Draws a FRAME around the SOFT CLIP area
 100  MOVE 5,90                          ! MOVEs to start position
 110  ! ***** Assigns all printable characters to Label$
 120  READ Character,Finish                       ! READs the characters
 130    FOR C=Character TO Finish                 ! Initializes the loop
 140    Character_posit=LEN(Label$)               ! Determine next available position
 150    Label$[Character_posit+1]=CHR$(C)         ! Assigns character to Label$
 160    NEXT C                                    ! Repeats the loop
 170  !
 180  ! ***** LABEL characters in groups of 16
 190    FOR I=1 TO 96 STEP 16              ! Specify one set of 16 characters
● 200    LABEL Label$[I,I+15]              ! LABEL 16 characters
 210    NEXT I                             ! Repeat until complete
 220 Out:!
 230   DUMP GRAPHICS                       ! Thermal printer output
 240   GCLEAR                              ! Clear Graphics memory and CRT
 250   Label$=""                           ! Null out Label$
 260   NEXT Complete_set                   ! Repeats the loop
 270   END
```

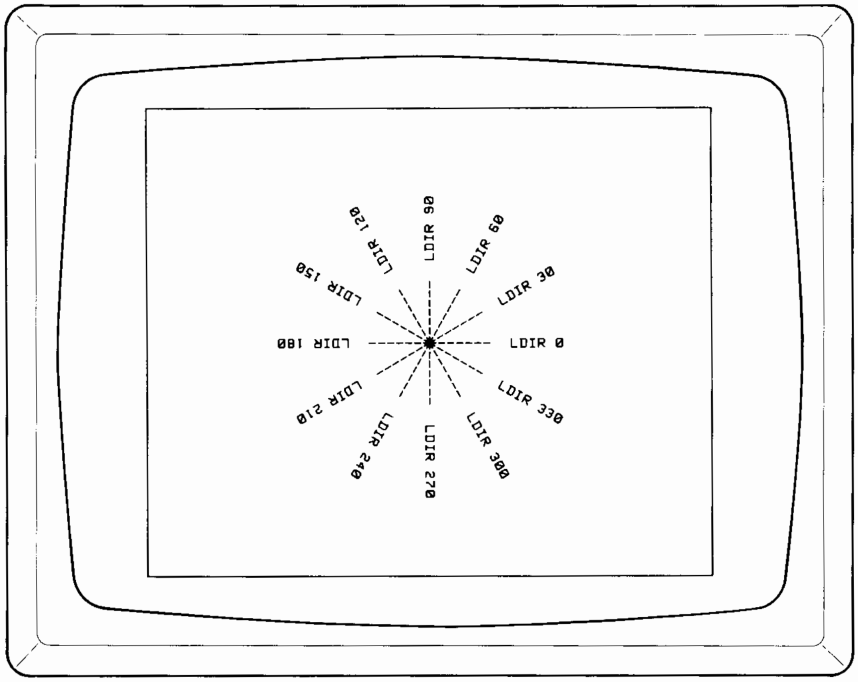
Slant and Angle Example

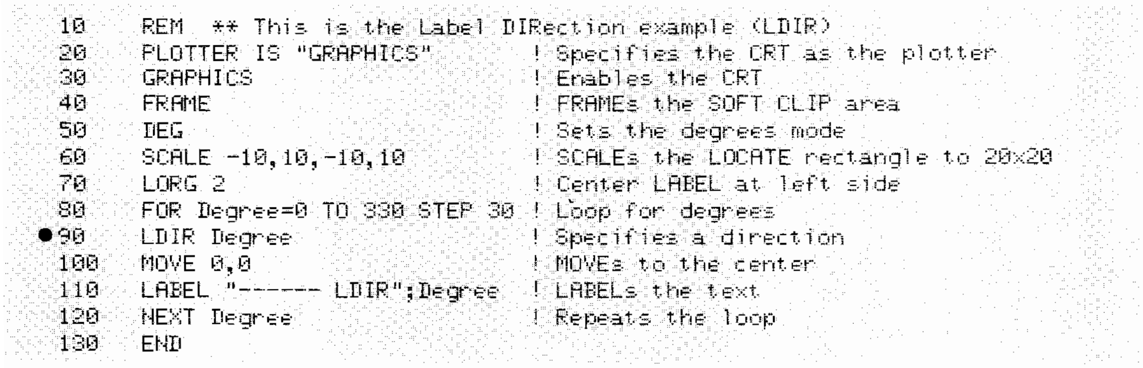




```
 1     REM  **  This is the SLANT and Angle example (SL_AN)
 10   DEG                                ! Sets degrees mode
 20   PLOTTER IS 13,"GRAPHICS"           ! Specifies the CRT
 30   GRAPHICS                           ! Enables the CRT
 40   LIMIT 0,184,0,140                  ! Defines the HARD CLIP area
●50   CSIZE 5,.5,30                      ! Character SIZE =5 GDU's
 51                                      ! Aspect ratio =.5
 52                                      ! Character SLANT =30 Degrees
 60   MOVE 10,20                         ! Positions PEN
 70   LABEL "30 degree SLANT"            ! LABELS text
 80   MOVE 10,50                         ! Positions PEN
●90   CSIZE 5,.5                         ! Character SIZE =5 GDU's
 91                                      ! Aspect ratio =.5
 92                                      ! Character SLANT =00 Degrees
●100  LDIR 30                            ! Angle text at 30 degrees
 110  LABEL "30 degree Angle"            ! LABELS text
 120  END
```

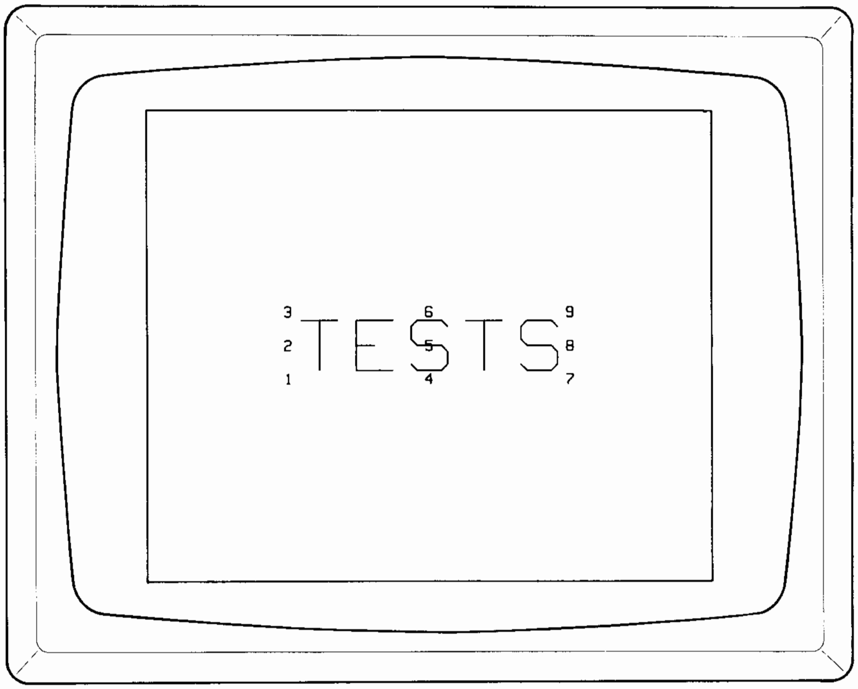
LDIR Example

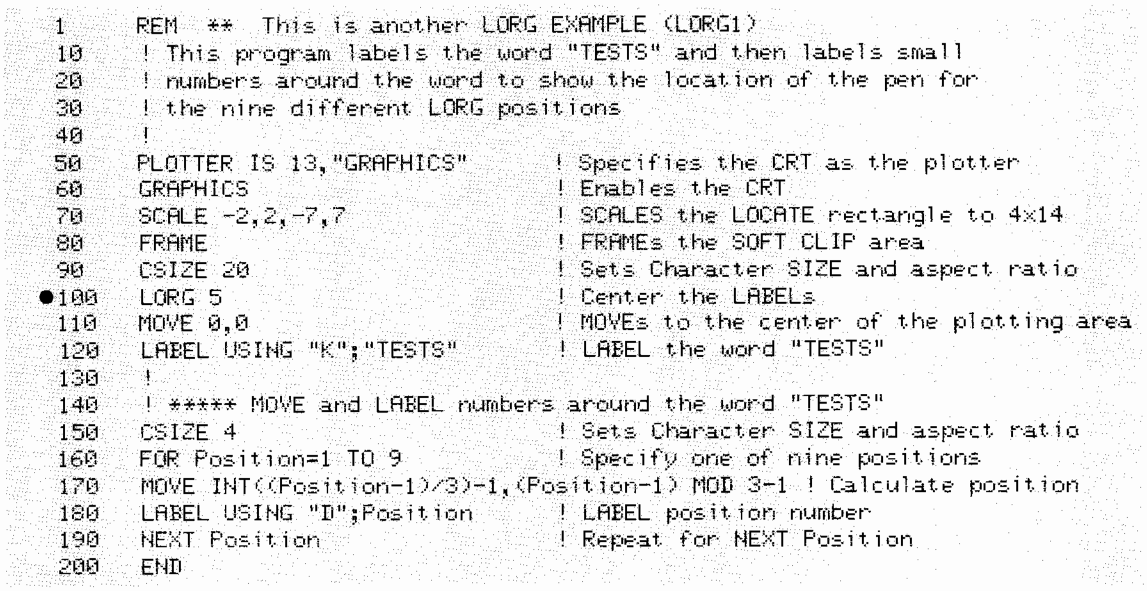




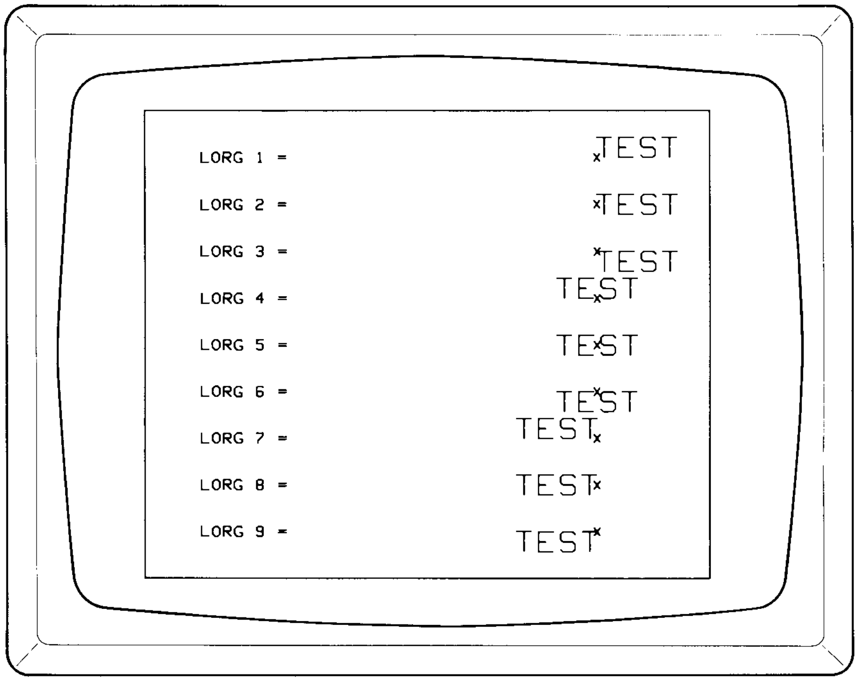
```
 10    REM  ** This is the Label DIRection example (LDIR)
 20    PLOTTER IS "GRAPHICS"        ! Specifies the CRT as the plotter
 30    GRAPHICS                     ! Enables the CRT
 40    FRAME                        ! FRAMEs the SOFT CLIP area
 50    DEG                          ! Sets the degrees mode
 60    SCALE -10,10,-10,10          ! SCALEs the LOCATE rectangle to 20x20
 70    LORG 2                       ! Center LABEL at left side
 80    FOR Degree=0 TO 330 STEP 30  ! Loop for degrees
●90    LDIR Degree                  ! Specifies a direction
 100   MOVE 0,0                     ! MOVEs to the center
 110   LABEL "------ LDIR";Degree   ! LABELs the text
 120   NEXT Degree                  ! Repeats the loop
 130   END
```

LORG Examples



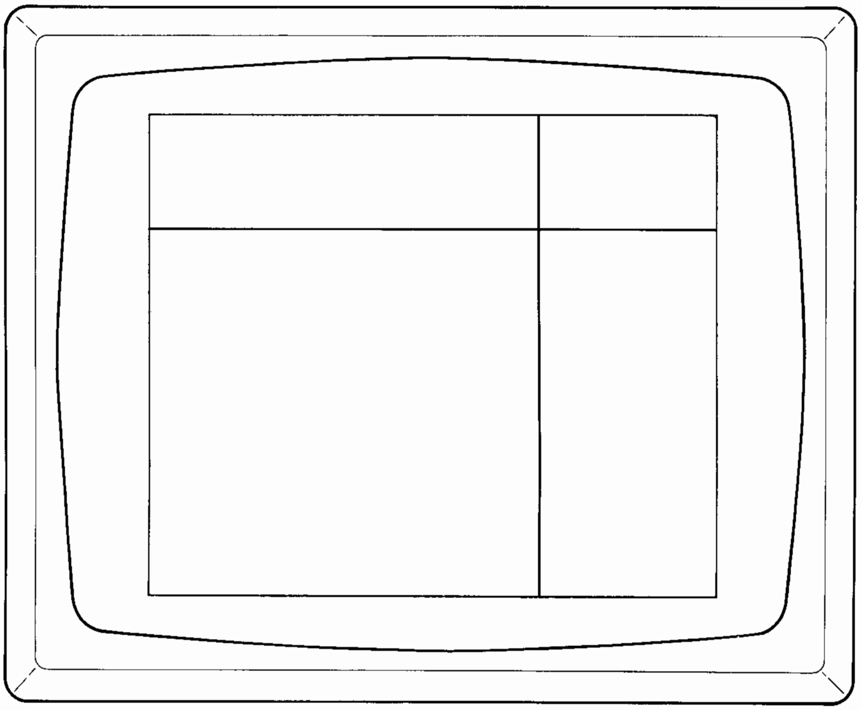


```
   1    REM  **  This is another LORG EXAMPLE (LORG1)
  10    ! This program labels the word "TESTS" and then labels small
  20    ! numbers around the word to show the location of the pen for
  30    ! the nine different LORG positions
  40    !
  50    PLOTTER IS 13,"GRAPHICS"       ! Specifies the CRT as the plotter
  60    GRAPHICS                       ! Enables the CRT
  70    SCALE -2,2,-7,7                ! SCALES the LOCATE rectangle to 4x14
  80    FRAME                          ! FRAMEs the SOFT CLIP area
  90    CSIZE 20                       ! Sets Character SIZE and aspect ratio
 ●100   LORG 5                         ! Center the LABELs
 110    MOVE 0,0                       ! MOVEs to the center of the plotting area
 120    LABEL USING "K";"TESTS"        ! LABEL the word "TESTS"
 130    !
 140    ! ***** MOVE and LABEL numbers around the word "TESTS"
 150    CSIZE 4                        ! Sets Character SIZE and aspect ratio
 160    FOR Position=1 TO 9            ! Specify one of nine positions
 170    MOVE INT((Position-1)/3)-1,(Position-1) MOD 3-1 ! Calculate position
 180    LABEL USING "D";Position       ! LABEL position number
 190    NEXT Position                  ! Repeat for NEXT Position
 200    END
```

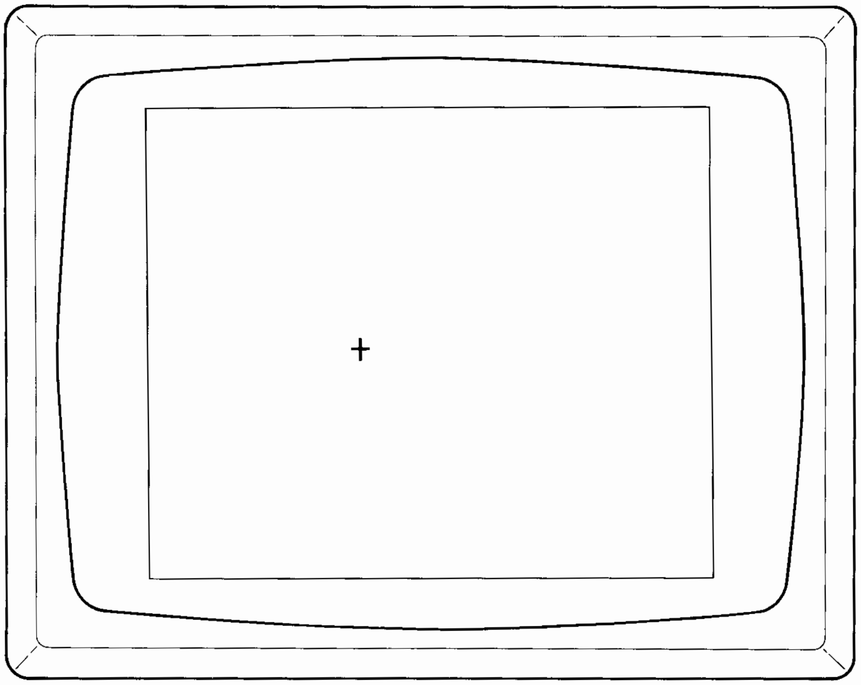


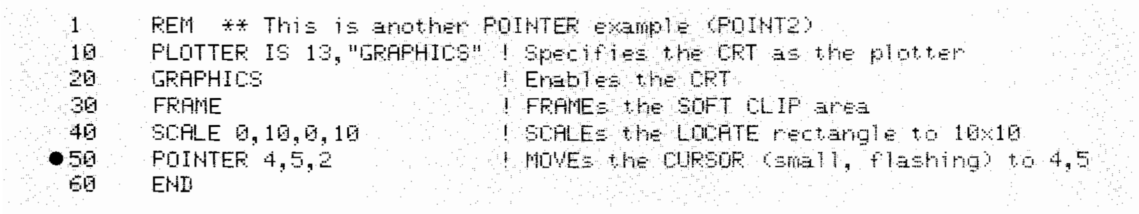
```
 1     REM  **  This is another LORG example (LORG2)
 10    ! This program labels the word "TESTS"
 20    ! using each of the LORG parameters; an "X" is drawn
 30    ! to indicate the position of the PEN for each LORG
 40    PLOTTER IS 13,"GRAPHICS"       ! Specifies the CRT as the plotter
 50    GRAPHICS                       ! Enables the CRT
 60    SCALE 0,10,-10,0               ! SCALEs the LOCATE rectangle to 10x10
 70    FRAME                          ! FRAMEs the SOFT CLIP area
 80    ! ***** LABEL the word "TEST" using each LORG
 90    ! ***** the "X" indicates the reference position for the LORG
 100   FOR Position=1 TO 9            ! Specify one of nine positions
●110   LORG 2                         ! Specifies LORG for LABELs
 120   CSIZE 4                        ! Sets Character SIZE and aspect ratio
 130   MOVE 1,-Position               ! MOVE to left LABEL Position
 140   LABEL USING "5A,D,2A";"LORG ",Position," ="   ! LABEL line
 150   !
 160   ! ***** MOVE to point, LABEL an "X" to indicate initial PEN Position
●170   LORG 5                         ! Specifies LORG for the "X"
 180   CSIZE 3                        ! Sets Character SIZE for the "X"
 190   MOVE 8,-Position               ! MOVE to Position for the "X"
 200   LABEL "X"                      ! LABEL the "X" to indicate PEN Position
 210   !
 220   ! ***** MOVE to point, LABEL with the word "Test"
●230   LORG Position                  ! Specifies LORG for the word "Test"
 240   CSIZE 8                        ! Sets Character SIZE for the word "Test"
 250   MOVE 8,-Position               ! MOVE to Position for "X"
 260   LABEL "Test"                   ! LABEL "Test"
 270   NEXT Position                  ! Repeat for the NEXT LORG
 280   END
```

POINTER Examples



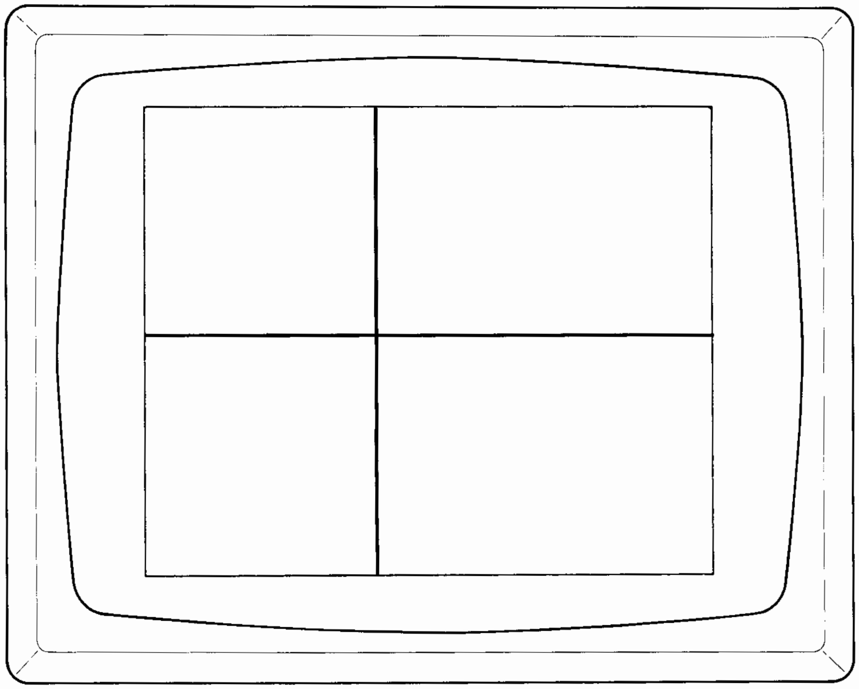
```
 1     REM  ** This is the POINTER example (POINT)
 10    PLOTTER IS 13,"GRAPHICS"  ! Specifies the CRT as the plotter
 20    GRAPHICS                  ! Enables the CRT
 30    FRAME                     ! FRAMES the SOFT CLIP area
 40    SCALE 0,10,0,10           ! SCALEs the LOCATE rectangle to 10x10
●50    POINTER 7,6,1             ! MOVEs the CURSOR (large type) TO 7,6
 60    END
```

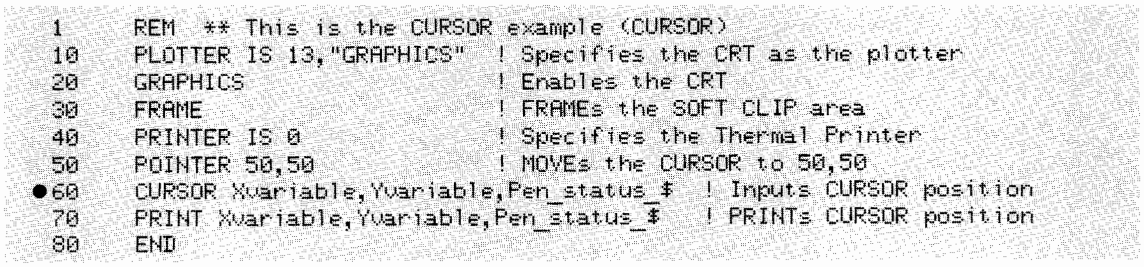




```
  1    REM  ** This is another POINTER example (POINT2)
 10    PLOTTER IS 13,"GRAPHICS" ! Specifies the CRT as the plotter
 20    GRAPHICS                 ! Enables the CRT
 30    FRAME                    ! FRAMEs the SOFT CLIP area
 40    SCALE 0,10,0,10          ! SCALEs the LOCATE rectangle to 10x10
●50    POINTER 4,5,2            ! MOVEs the CURSOR (small, flashing) to 4,5
 60    END
```

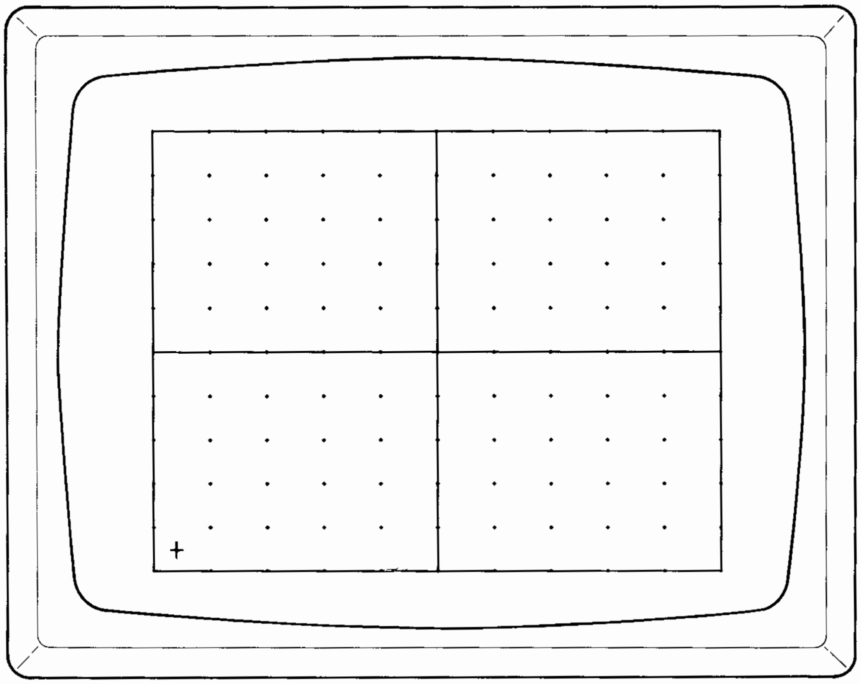
CURSOR Example

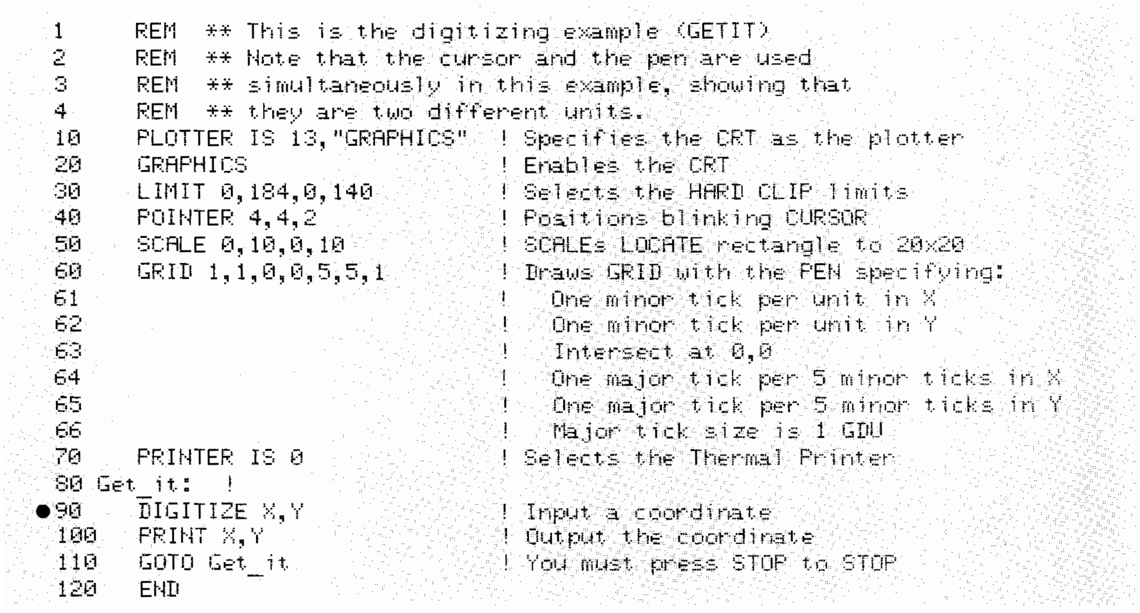




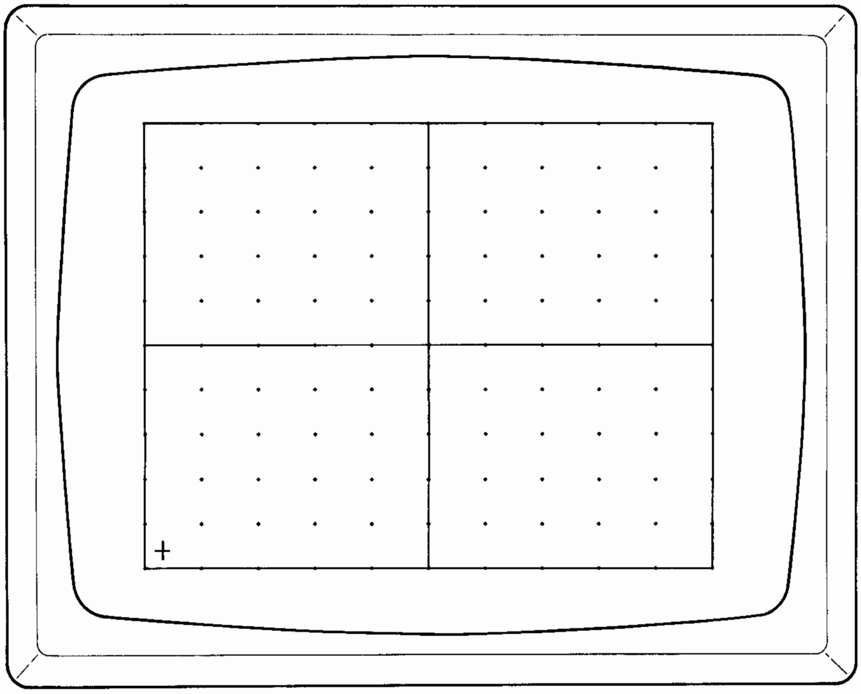
```
 1     REM  ** This is the CURSOR example (CURSOR)
 10    PLOTTER IS 13,"GRAPHICS"  ! Specifies the CRT as the plotter
 20    GRAPHICS                  ! Enables the CRT
 30    FRAME                     ! FRAMEs the SOFT CLIP area
 40    PRINTER IS 0              ! Specifies the Thermal Printer
 50    POINTER 50,50             ! MOVEs the CURSOR to 50,50
●60    CURSOR Xvariable,Yvariable,Pen_status_$  ! Inputs CURSOR position
 70    PRINT Xvariable,Yvariable,Pen_status_$   ! PRINTs CURSOR position
 80    END
```

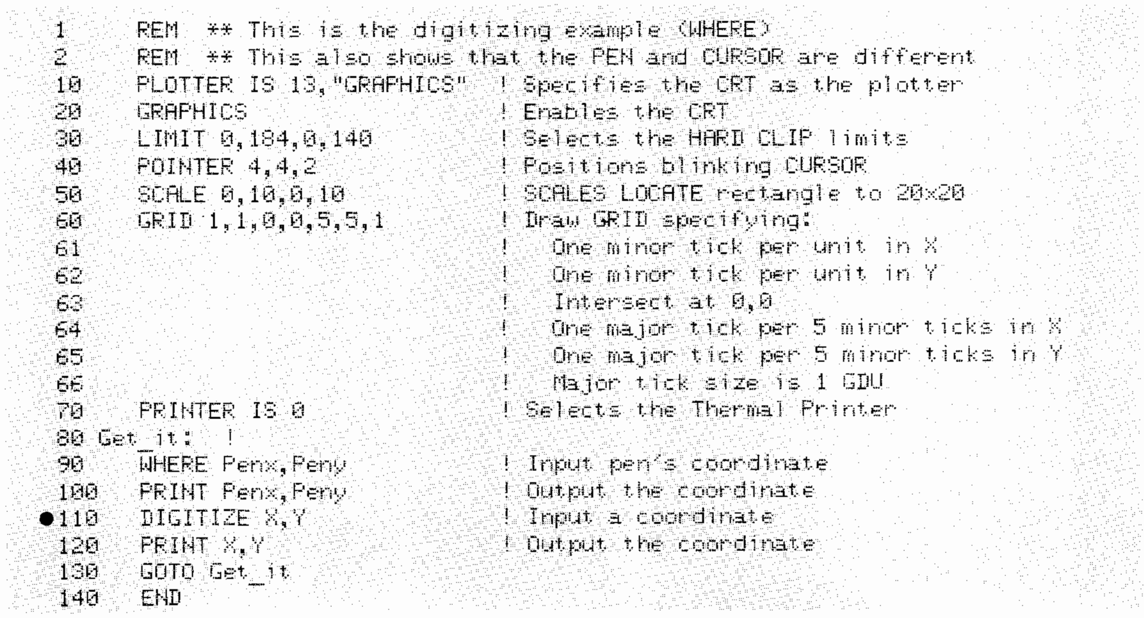
DIGITIZE Examples





```
 1      REM  ** This is the digitizing example (GETIT)
 2      REM  ** Note that the cursor and the pen are used
 3      REM  ** simultaneously in this example, showing that
 4      REM  ** they are two different units.
 10     PLOTTER IS 13,"GRAPHICS"   ! Specifies the CRT as the plotter
 20     GRAPHICS                   ! Enables the CRT
 30     LIMIT 0,184,0,140          ! Selects the HARD CLIP limits
 40     POINTER 4,4,2              ! Positions blinking CURSOR
 50     SCALE 0,10,0,10            ! SCALEs LOCATE rectangle to 20x20
 60     GRID 1,1,0,0,5,5,1         ! Draws GRID with the PEN specifying:
 61                                !   One minor tick per unit in X
 62                                !   One minor tick per unit in Y
 63                                !   Intersect at 0,0
 64                                !   One major tick per 5 minor ticks in X
 65                                !   One major tick per 5 minor ticks in Y
 66                                !   Major tick size is 1 GDU
 70     PRINTER IS 0               ! Selects the Thermal Printer
 80 Get_it:  !
●90     DIGITIZE X,Y               ! Input a coordinate
 100    PRINT X,Y                  ! Output the coordinate
 110    GOTO Get_it                ! You must press STOP to STOP
 120    END
```





```
  1      REM  ** This is the digitizing example (WHERE)
  2      REM  ** This also shows that the PEN and CURSOR are different
 10      PLOTTER IS 13,"GRAPHICS"  ! Specifies the CRT as the plotter
 20      GRAPHICS                  ! Enables the CRT
 30      LIMIT 0,184,0,140         ! Selects the HARD CLIP limits
 40      POINTER 4,4,2             ! Positions blinking CURSOR
 50      SCALE 0,10,0,10           ! SCALES LOCATE rectangle to 20x20
 60      GRID 1,1,0,0,5,5,1        ! Draw GRID specifying:
 61                                !   One minor tick per unit in X
 62                                !   One minor tick per unit in Y
 63                                !   Intersect at 0,0
 64                                !   One major tick per 5 minor ticks in X
 65                                !   One major tick per 5 minor ticks in Y
 66                                !   Major tick size is 1 GDU
 70      PRINTER IS 0              ! Selects the Thermal Printer
 80 Get_it:  !
 90      WHERE Penx,Peny           ! Input pen´s coordinate
 100     PRINT Penx,Peny           ! Output the coordinate
●110     DIGITIZE X,Y              ! Input a coordinate
 120     PRINT X,Y                 ! Output the coordinate
 130     GOTO Get_it
 140     END
```

Glossary

Absolute Plotting – Plotting to a coordinate which has its X and Y values specified in the current user units.

Angle – The vector at which a line or label is drawn, represented in degrees counter-clockwise from the horizontal.

Anisotropic – The X and Y axes units are not displayed as equal to each other.

Axes – Plural of axis.

Axis – A line drawn within the Cartesian coordinate system along either the horizontal (X) direction or the vertical (Y) direction.

Clipping Area – The area which restricts the pen movement whenever lines are drawn in UDUs.

Current Units – The mode of X,Y reference which is in effect; may be either GDUs, UDUs or Metric (mm).

Cursor – The device which is used to obtain digitizing information.

Digitizing – The process of obtaining an X,Y coordinate pair based on the location of the cursor.

GDUs – Graphic Display Units. An X,Y reference system which at default defines the CRT to extend from X minimum = 0 to X maximum = 123.127753304, Y minimum = 0 to Y maximum = 100.

Hard Clip – The physical limits of the plotting device, beyond which no line can be drawn.

Appendix A

HPGL – The instruction set resident within the HP 9872A Graphics Plotter.

Isotropic – The X and Y axes units are displayed as equal to each other.

Metric Units – A unit of measure mode where everything is referenced in millimetres.

Origin – The coordinate point at which a plotting operation begins.

Pen – The device which is used to draw or plot lines, and to label characters.

Pointer – The method used to position the cursor, or to select a type of cursor.

Plotted Point – The point which has been plotted or drawn to.

Plotting Coordinates – The X,Y coordinate pair which specifies a plotting point.

Plotting Space – The area within which plotting can occur.

Reflected Plot – A plot produced by interchanging either the X min, X max coordinates, the Y min, Y max coordinates or both X and Y coordinate pairs to change the plot.

Relative Plotting – Plotting which specifies plotting from an origin rather than to a specific X,Y coordinate.

Soft Clip – The limits of the plotting device which restricts pen movement for lines drawn in UDU's.

Slant – The angle at which a character is drawn, represented in clockwise degrees from the vertical.

UDUs – User Defined Units. Defined by the program to whatever X and Y units of measure which are convenient.

Syntax Summary

AXES [X tick spacing, Y tick spacing [, X intersection, Y intersection [, X major count, Y major count [, major-tick size]]]]

The AXES statement draws a pair of axes with optional tick marks.

CLIP [X min, X max, Y min, Y max]

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

CSIZE height[, aspect ratio [, slant]]

The CSIZE (character size) statement is used to specify the size, aspect ratio and slant of characters used in labels. The height defaults to approximately 3.3 GDUs (15/4.54). The aspect ratio (width/height) defaults to 9/15). The slant defaults to 0 degrees.

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; execution is resumed by pressing the CONT key, any SFK or the STEP key. 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.

Appendix B

DUMP GRAPHICS [lower bound [, upper bound]

The DUMP GRAPHICS statement copies the CRT graphic display onto the internal thermal printer. Any horizontal area can be copied by specifying its upper and/or lower bound in current units.

EXIT GRAPHICS

The EXIT GRAPHICS statement returns the CRT to the alphanumerics raster from the graphics raster.

FRAME

The FRAME statement draws a box around the current soft clip area.

GCLEAR [paper advance]

The GCLEAR statement clears the CRT and the graphics R/W memory of previously plotted data. The paper advance value specifies how many millimetres of paper to advance on certain plotters; it has no effect on CRT graphics.

GLOAD integer array name (*)

GLOAD transfers data from an integer array to the CRT graphics memory. The first element in the integer array is the load pointer.

GRAPHICS

The GRAPHICS statement sets the CRT to the graphics mode.

GRID [X tick spacing, Y tick spacing[, X intersection, Y intersection[, X major count, Y major count[, major-tick size]]]]

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

GSTORE integer array name (*)

GSTORE transfers data from the CRT graphics memory to an integer array. The first element in the integer array is the store pointer.

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 label.

LABEL USING image specifier; list

The LABEL USING statement is used like the PRINT USING statement to format labels.

LDIR angle
or LDIR run, rise

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.

LETTER

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

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 identifier number [, length]

The LINE TYPE statement selects one of several solid or dashed line types. The range of the identifier number is 1 through 10; 4 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 define. 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 coordinates.

MSCALE X offset, Y offset

The MSCALE statement sets **millimetres** as current user units and defines the origin. The origin is offset from the first LOCATE point (X min, Y min) the specified amounts in millimetres.

PDIR angle
or PDIR run, rise

The PDIR statement sets the angle of rotation for relative and incremental plotting. The angle supplied 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. Negative pen numbers specify "erase" on the CRT.

PENUP

The PENUP statement lifts the pen.

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 identifier string" [, step size[, # of pens, pen offset, [incremental plotter identifier]]]

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

"GRAPHICS"	13
"9872A"	7,5
"INCREMENTAL"	5

The default values for the INCREMENTAL parameters are:

step size	-	.254 mm
# of pens	-	1
pen offset	-	0 mm
incremental plotter i.d.	-	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[, cursor type]

The POINTER statement moves the cursor to the specified absolute position and can select one of two types of cursor. An even number specifies a small blinking cross; an odd number specifies full-screen crossed lines. Cursor type defaults to the full-screen crossed lines (cursor type 1).

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 dimension the LOCATE rectangle.

SETGU

The SETGU statement sets graphic display units (GDUs) as the current units.

SETUU

The SETUU statement sets user defined units (UDUs) 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 boundaries equal to the hard clip limits.

WHERE X variable, Y variable[, pen status string variable]

The WHERE statement returns the coordinate values of the last plotted or moved-to point. Pen status information is assigned to the string variable; 0 for up, 1 for down.

Graphics Device Information

CRT Graphics Hardware Installation

The Graphics package for the System 45B consists of:

- 98437B Graphics ROM
- 98470B CRT Graphics Memory
- 09845-91050 Graphics ROM Programming Manual

Factory Installed Graphics

If your System 45B was ordered from the factory with the Graphic Option (Opt. 311 and Opt. 700), the hardware (ROM, CRT memory and error message sticker) is already installed for you.

Field Installed Graphics

If you are updating your System 45B with graphics, the hardware has to be installed. The CRT Graphics Memory should be installed by trained HP Service personnel, because installation procedures involve high voltage and a potentially dangerous situation associated with handling CRT's.

You install the Graphics ROM in one of the open slots in the ROM drawer on the right side of the computer. If you are unfamiliar with procedures for installing a ROM, refer to the System 45B Owner's Manual for proper procedures. You can also install the Graphics error message sticker on your option error pull-out card. If you want, the service person will install the Graphics ROM and the error message sticker when the Graphics Memory is installed.

Appendix C

CRT Graphics Specifications

System 45B has two CRT display modes: alphanumeric and graphics. Each mode has its own display area and raster. Normally the CRT is in the alphanumeric mode and without the Graphics ROM and hardware, this is the only mode available to you. When the Graphics ROM and hardware is installed, the graphics mode can be selected.

Display Area

The following figure shows the approximate size and location of the alphanumeric and graphics display areas.

Graphics Resolution

The horizontal and vertical resolution is approximately .04cm. This results in a dot matrix pattern for the display area of 560 usable dots in the horizontal direction and 455 usable dots in the vertical direction.

Line Generation Speed

Straight lines are generated on the CRT at about 200 cm/sec. (The 9872A plotter generates straight lines at about 36 cm/sec.) Curved lines are generated at somewhat slower speeds because your System 45B first computes the points and then plots the curved line.

Graphics Select Code

The select code of the CRT graphics option is internally set at the factory to 13 and cannot be changed. If you are going to use an external plotting device (e.g., HP 9872A) refer to the appropriate Interface Installation and Service Manual and this appendix for information about how to set the select code.

Graphics Memory

The Graphics ROM automatically decreases the available user memory by 90 bytes. This is generally not a concern unless you have a large program or large data base.

The 32K bytes of Read/Write Memory (CRT Graphics Memory) installed in the CRT does not increase your available R/W memory, it only provides a storage location for data which produces the graphics display on the CRT. When using an external display or plotting device, this memory space is not used.

HP 9872A Plotter Installation

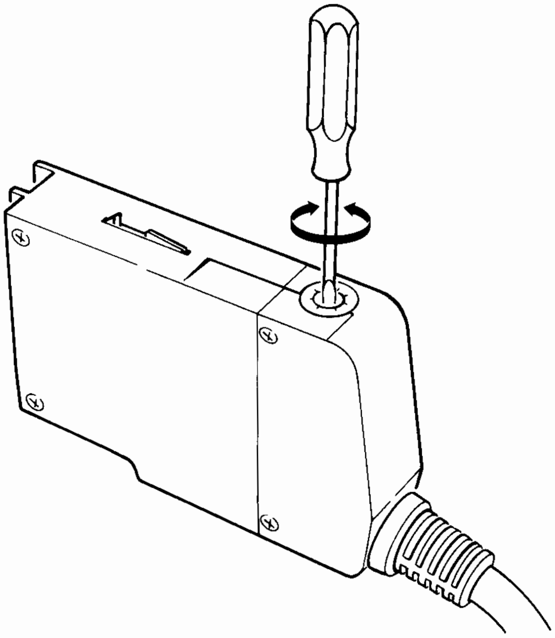
The 9872A Plotter can be used as an external plotter with the System 45B. Refer to the PLOTTER IS statement for information on how to select the 9872A as the active plotter.

Ensure 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 45B 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.

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.



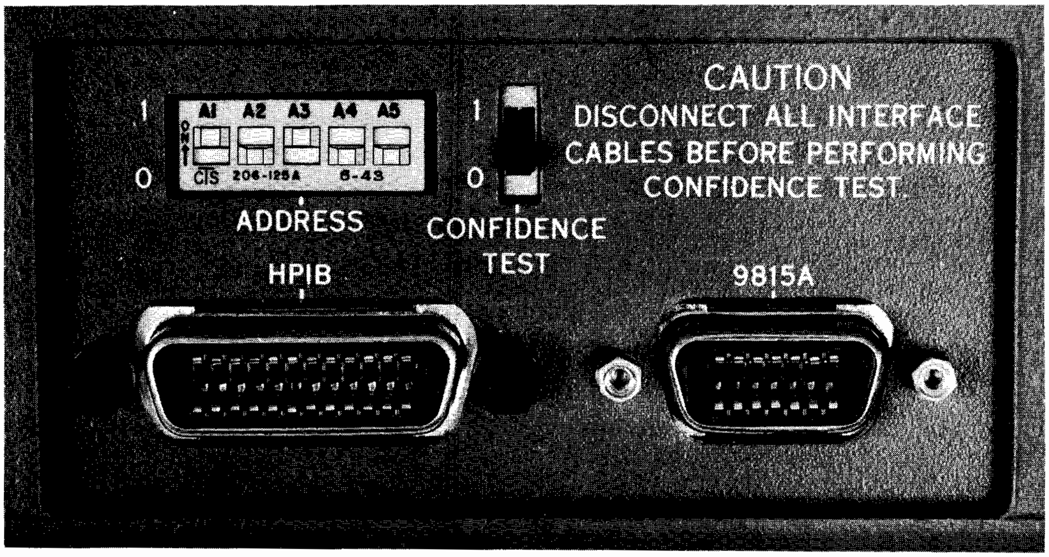
Select Code Switch

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 next) to the appropriate binary bit positions for the particular address value desired.

The plotter is set to an address code of 05 at the factory. Check your plotter for the proper switch positions shown below.



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	O	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

Incremental Plotter Installation

An incremental plotter can be used as an external plotter with the System 45B, using the HP 98040A Interface. Refer to the PLOTTER IS statement for information on how to select the incremental plotter as the plotter.

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

Refer to the HP 98040A Interface Installation and Service Manual for information concerning the select code switch and a list of incremental plotters that can be used with this interface.

Note

Hewlett-Packard products which use cathode ray tubes are designed to limit X-radiation levels to values of 0.5 mR/hour or below. This level has been established by the United States Bureau of Radiological Health, and conforms to similar international requirements. All measurements are made using a Victoreen 440 RF/C instrument, and are conducted with the equipment operating under normal as well as worse case control midadjustment.

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