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CINEMATIC - FORTRAN SUBPROGRAMS FOR AUTOMATIC COMPUTER MICROFILM PLOTTING

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Cleveland, Ohio

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16. Abstract

CINEMATIC is a collection of computer subprograms that gives the computer user easy access to graphic output of his results on microfilm. CINEMATIC subprograms are written in and used in FORTRAN IV. The computer user programs for film output in terms of what he wants to see on film rather than in terms of how the film recorder works. As a result, the structure of CINEMATIC does not depend on the particular film recorder used.

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SUMMARY

CINEMATIC is a collection of computer subprograms that gives the computer user easy access to graphic output of his results on microfilm. CINEMATIC subprograms are written in and used in FORTRAN IV. The computer user programs for film output in terms of what he wants to see on film rather than in terms of how the film recorder works. As a result, the structure of CINEMATIC does not depend on the particular film recorder used.

INTRODUCTION

CINEMATIC is the result of a need at the Lewis Research Center for a language to program for graphic computer output on cathode ray tube (CRT) data display devices. The language needed to be

(1) Device-independent so that future CRT devices could be added to the computing system without significant change in users' programs

(2) A compiler-level language so that it could be used on more than one computer at Lewis

(3) General enough to produce a wide variety of graphic output formats and to exploit the special features of the plotting devices used

CINEMATIC has been in use for 18 months to make plots on the Control Data Corporation DD280 film recorder.

The CINEMATIC-FORTRAN plotting subprograms make film plotting available to users of Lewis' three large computing systems. CINEMATIC on the IBM 360/67 computer offers the user film plots in a time-shared computer environment. Several batch and conversational users can be making plots at the same time. Their plots are kept in auxiliary storage until they are sent to the film recorder as a background task. The

DD280 is online with the IBM 360/67.

Users of the Lewis IBM 7090-7040 series Direct Couple Systems make plots with the same subprogram calls as on the IBM 360/67. Plots are stored on magnetic tape. The computer operators transfer the plot tapes to the IBM 360/67 with no further intervention by the user.

CINEMATIC PROGRAM DESCRIPTION

CINEMATIC is a collection of FORTRAN IV plotting subprograms for the Control Data Corporation DD280 microfilm recorder. (A guide to these subprograms is given in the appendix.) The computer user calls CINEMATIC subprograms from his FORTRAN program to make plots on frames of film. CINEMATIC enables the computer user to make plots without having to learn and program for the details of how the DD280 works. CINEMATIC is available for use on both the IBM 7090-7040 series Direct Couple Systems and the IBM 360/67 at the Lewis Research Center.

CINEMATIC PLOTS

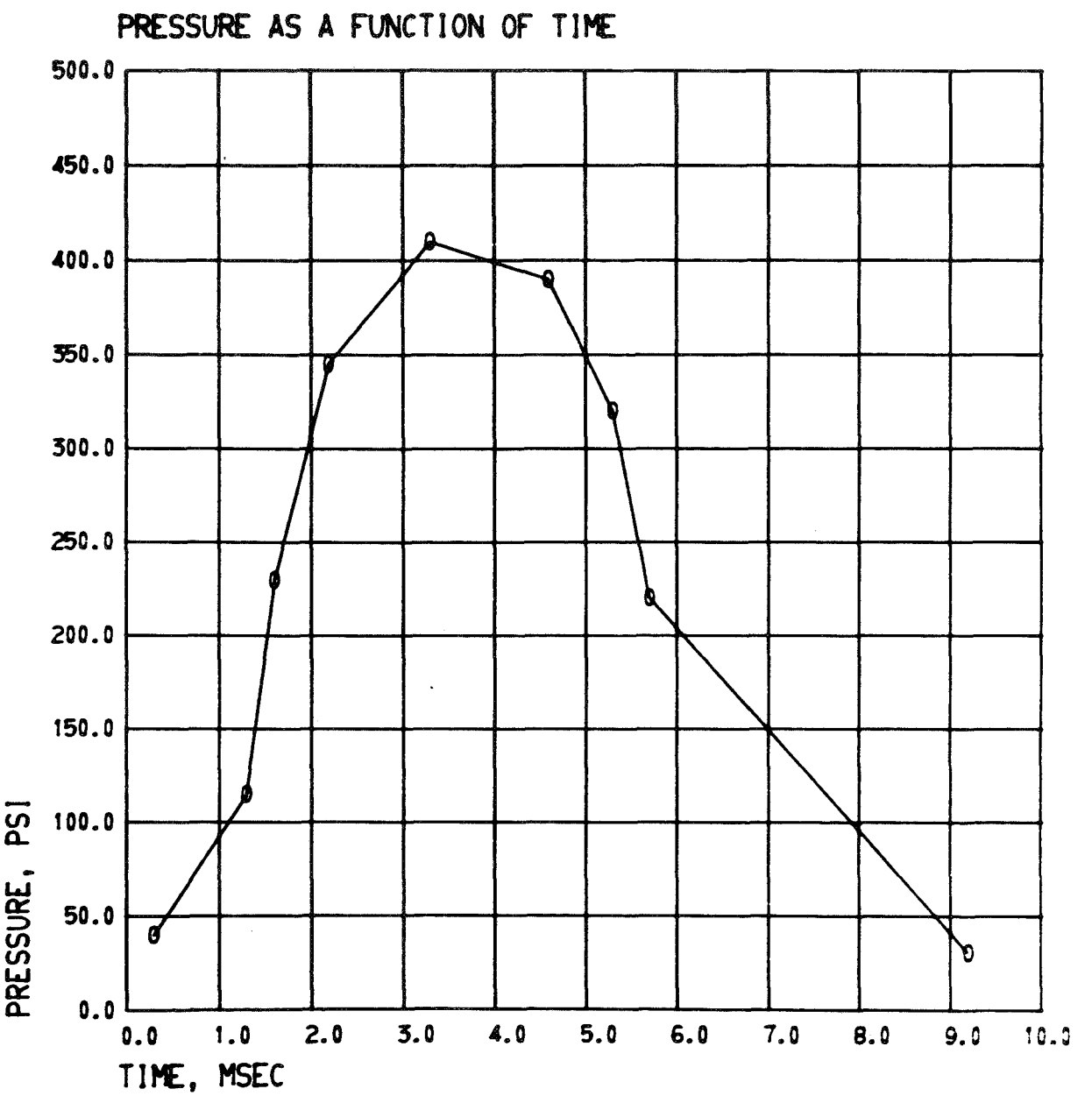
The computer user supplies the (X, Y) coordinates of and the number of points for a microfilm plot. He gives the coordinates and number of points as arguments of a CINEMATIC subroutine. CINEMATIC scales the user's data points to fit one frame of film. CINEMATIC puts grid lines on the plot and labels them with their values. It also leaves enough margin around the grid system for plot legends. The CINEMATIC user may supply a line of print characters for legends, above, below, and to the left of the grid system. Figure 1 shows a CINEMATIC plot and the data needed to make the plot.

The CINEMATIC user may specify the number of grid lines on the plot (see fig. 2). He may specify either how many grid lines he needs or the interval between them in the same units as his data appear. He may also specify the use of tick marks instead of grid lines (see fig. 3).

The user can expand the plot horizontally to cover several frames of film (see fig. 4). This type of plot is called a butted-frame or a butted plot. Once he has specified how many frames of film he needs, the user specifies butted plots the same as single-frame plots.

The user can expand the margins around the grid. By expanding the margins, he can put several plots on one frame of film (see fig. 5), or he can leave room for more lines of legend information (see fig. 6).

The user can print legends anywhere on the plot. He specifies the starting point of



Data for plot, 9 points:

X-coordinates	Y-coordinates
0.3	40.0
1.3	115.0
1.6	230.0
2.2	345.0
3.3	410.0
4.6	390.0
5.3	320.0
5.7	220.0
9.2	30.0

Upper legend characters, 30:
"PRESSURE AS A FUNCTION OF TIME"

Lower legend characters, 10:
"TIME, MSEC"

Left legend characters, 13:
"PRESSURE, PSI"

Figure 1. - A CINEMATIC plot.

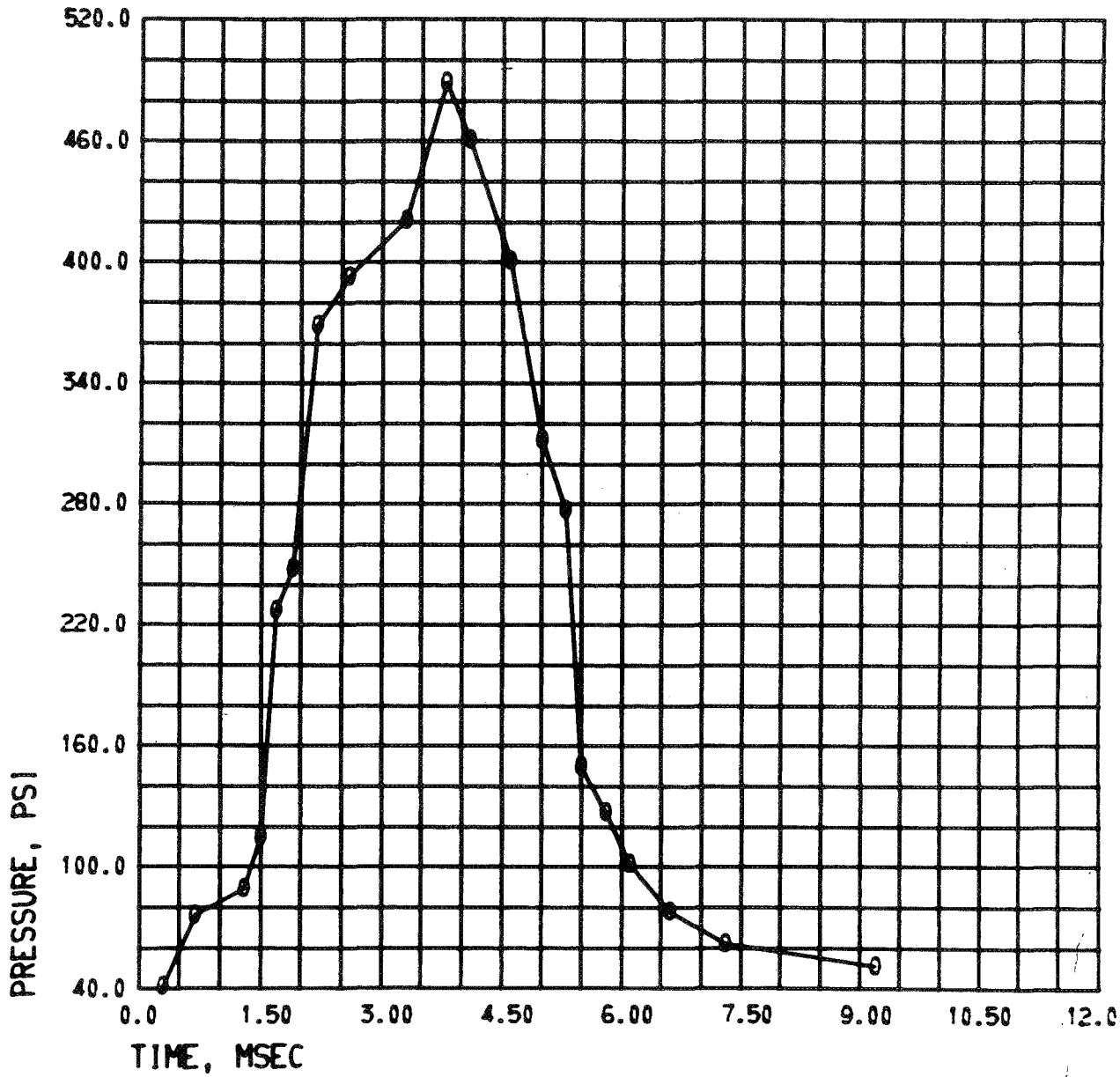


Figure 2. - Twenty-five grid lines in each direction.

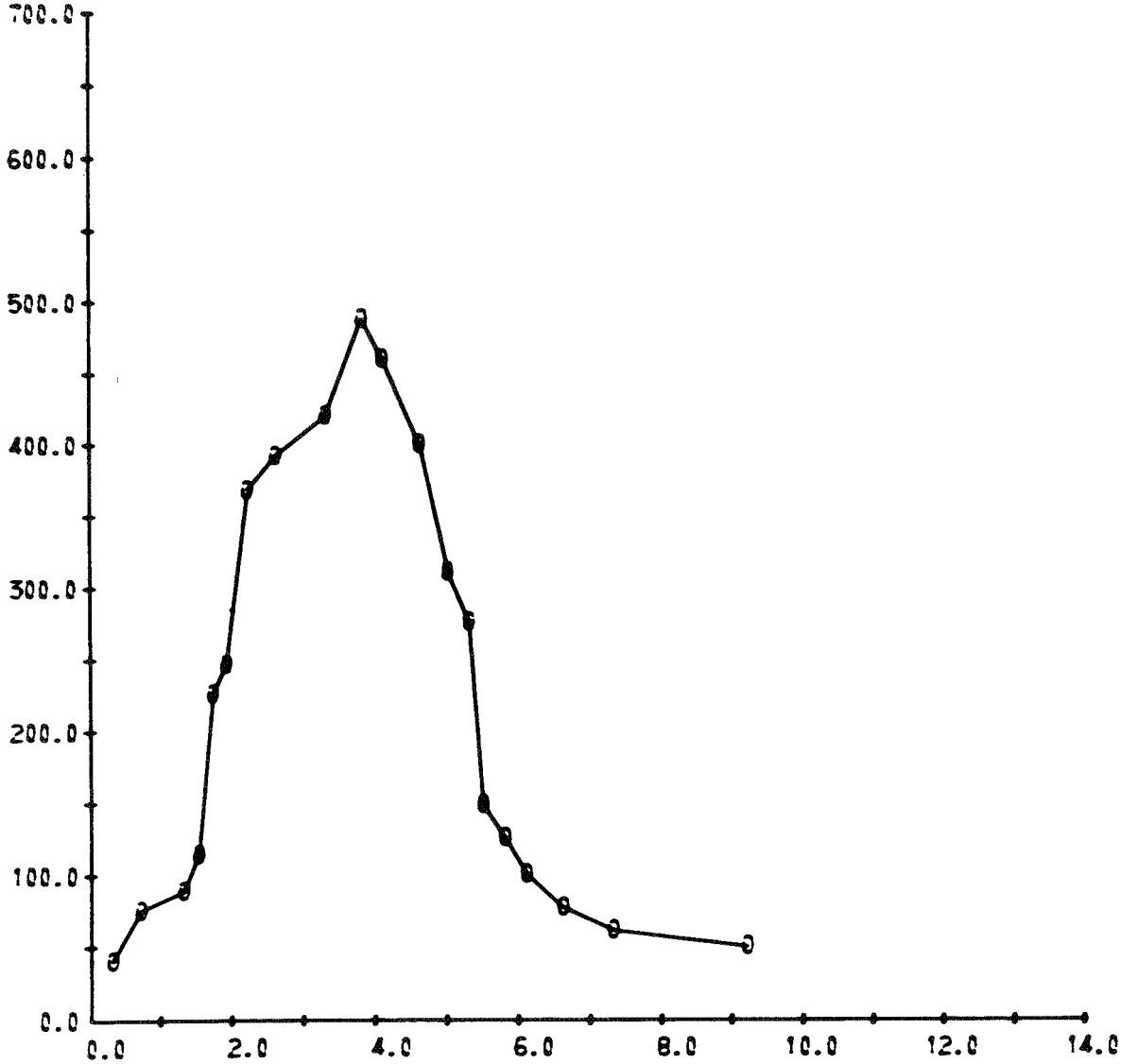


Figure 3. - Fifteen tick marks in each direction.

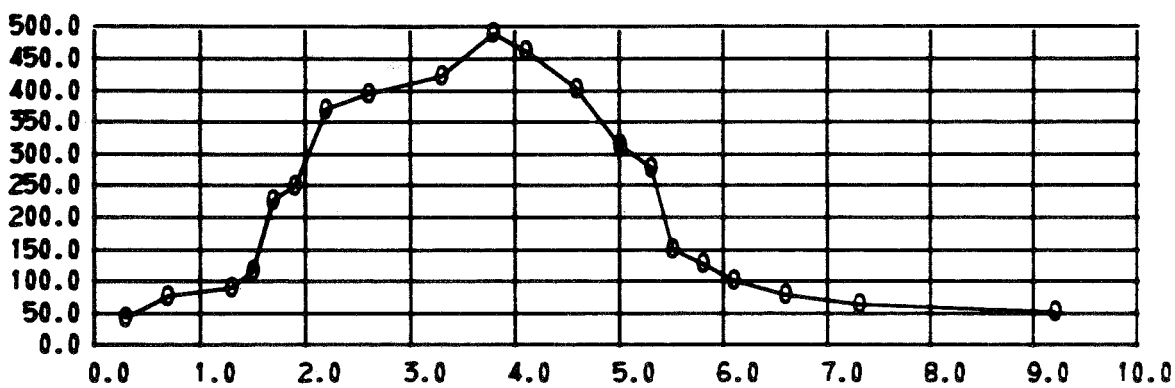


Figure 4. - Butted plot on three frames of film.

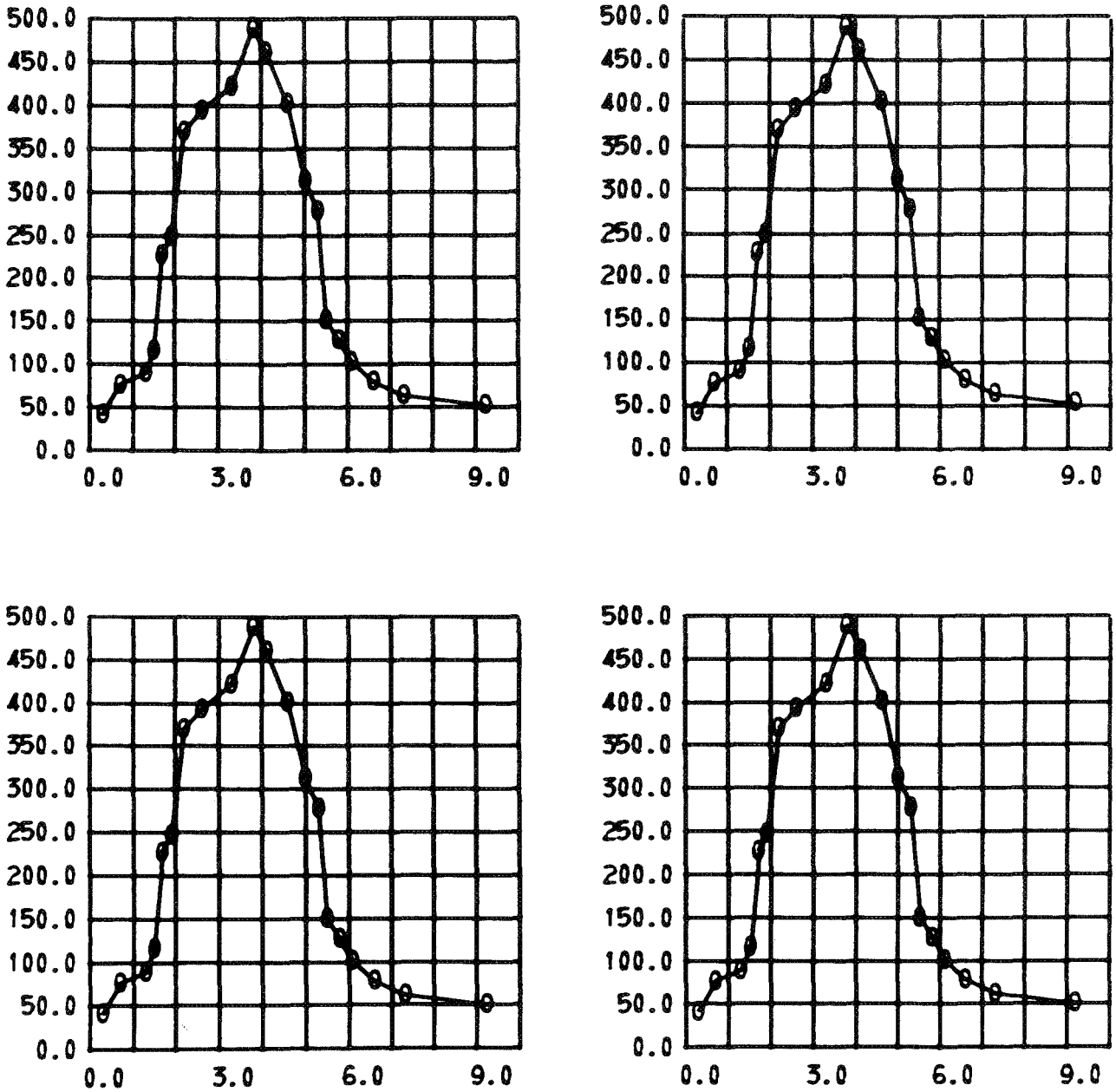


Figure 5. - Four plots on one frame of film.

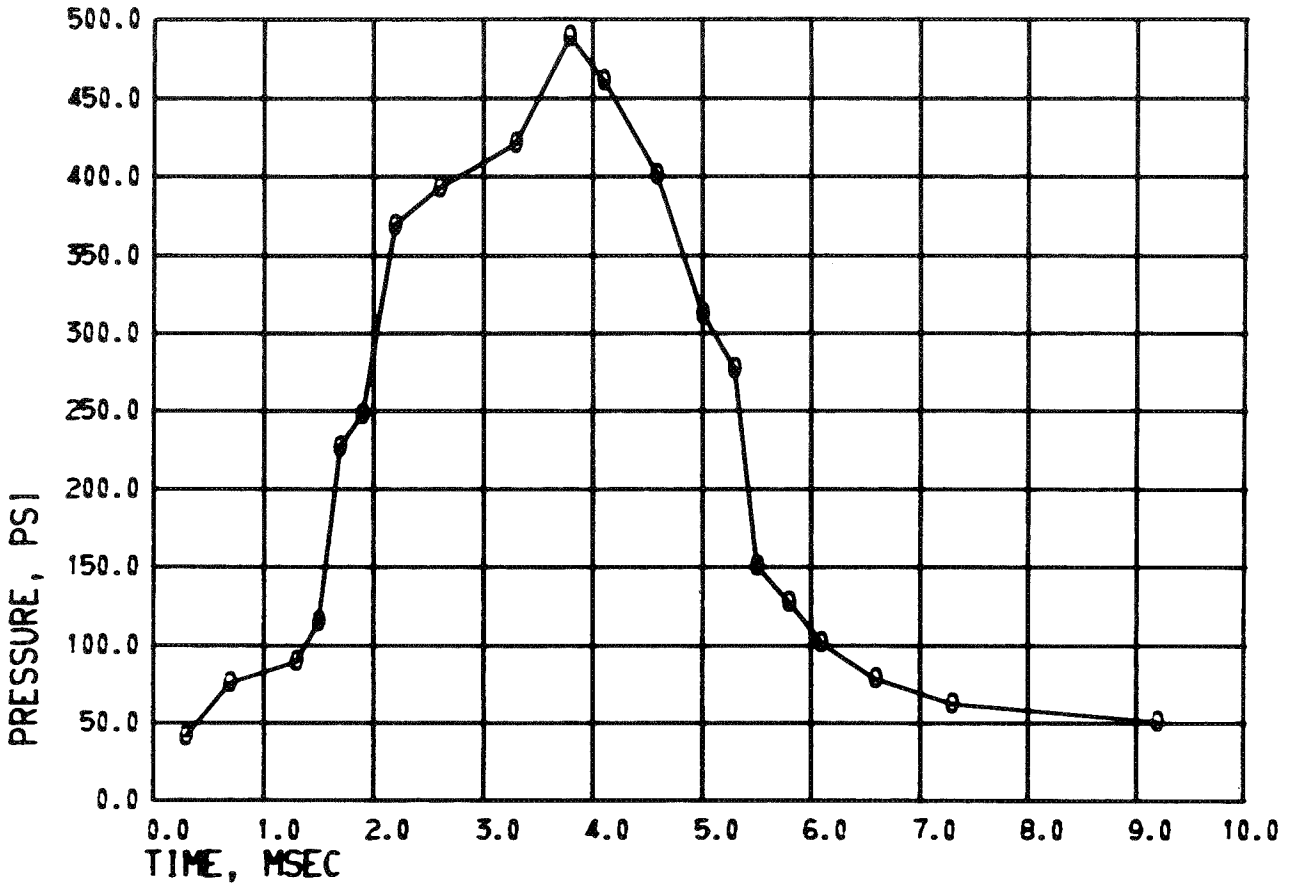


Figure 6. - Larger bottom margin.

the legend and gives the line of print characters for the legend. He can express the starting point as a fixed point on the frame of film (see fig. 6), or he can express the starting point of a legend in the same units as the curve points appear. This type of legend is called a data point label or simply a label (see fig. 7).

The user can put several curves on the same plot (see fig. 8). He can supply the (X, Y) coordinates of the curves with one call to a CINEMATIC subroutine. If he does not have all the coordinates in the computer memory at the same time, he can supply them with several subroutine calls for the same plot.

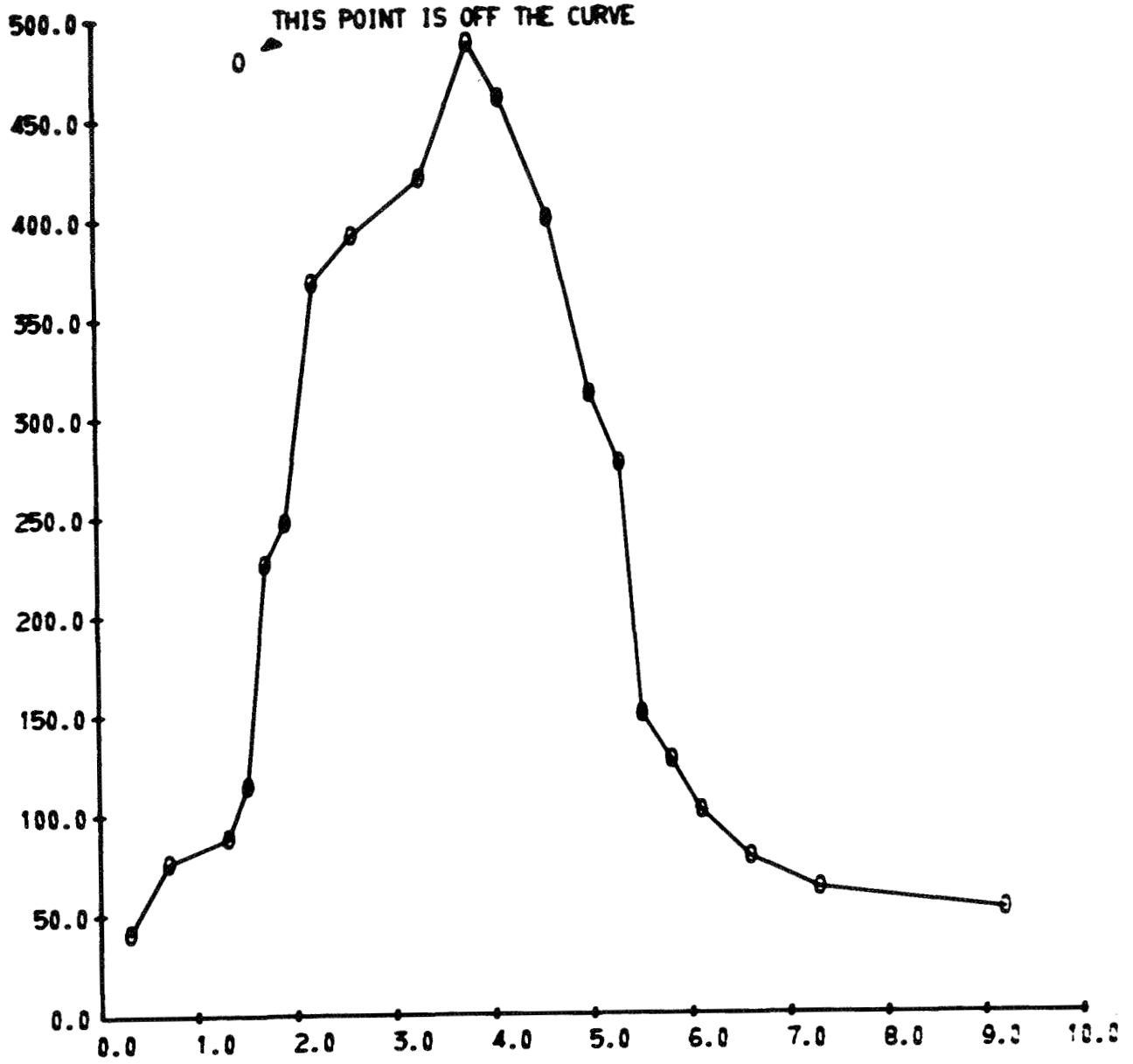


Figure 7. - Labeled data points.

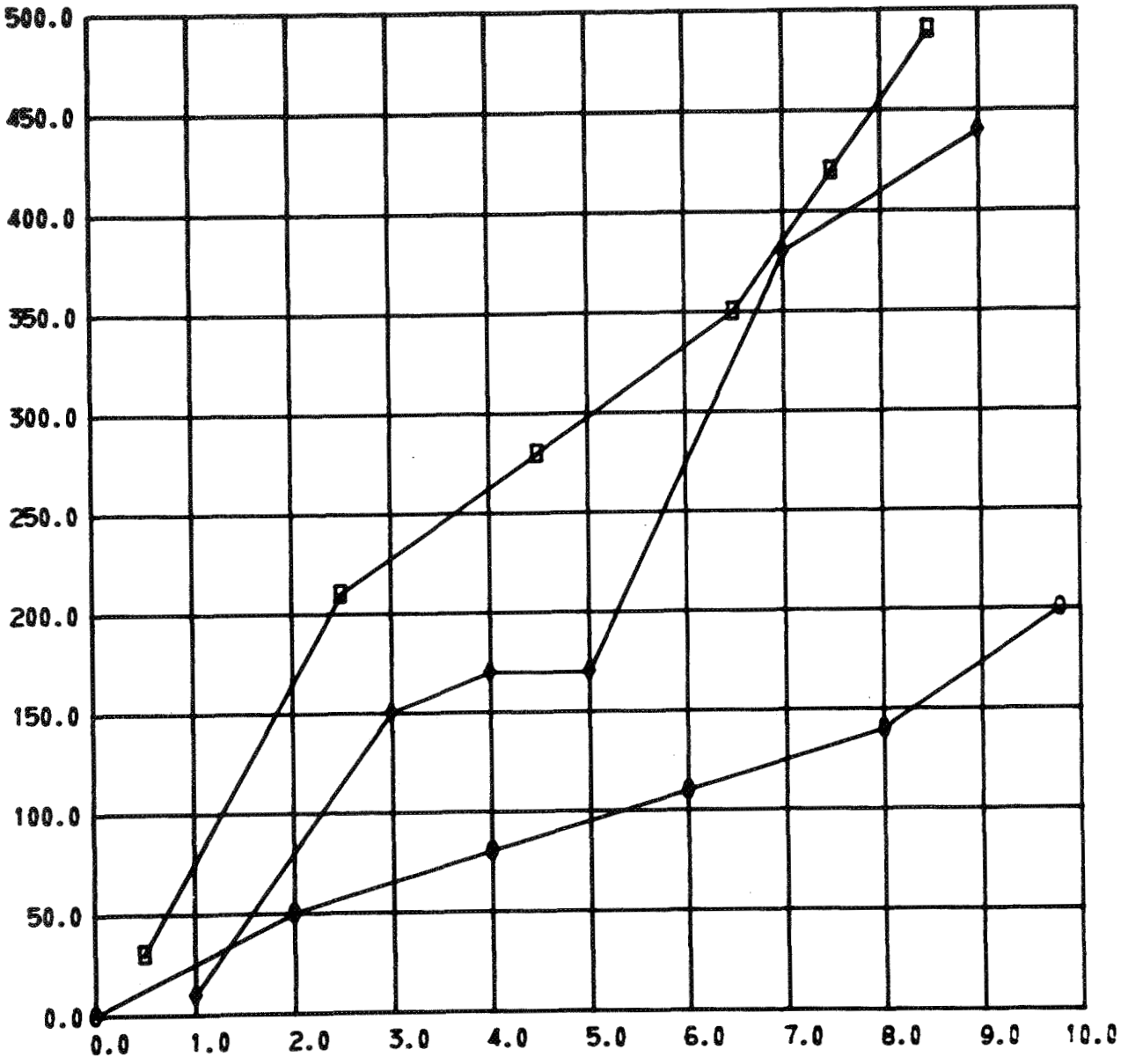


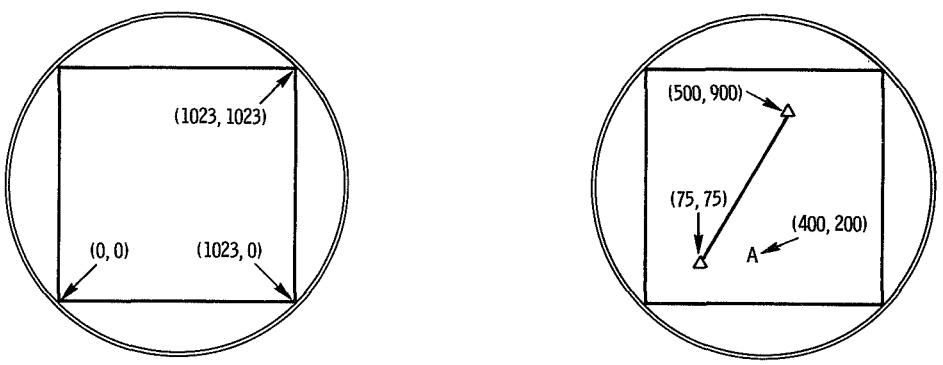
Figure 8. - A multiple-curve plot.

DD280 MICROFILM RECORDER

Description

The Control Data Corporation DD280 microfilm recorder contains a high precision $5\frac{1}{4}$ inch cathode ray display tube (CRT) and a 35-millimeter camera. The camera photographs symbols, lines, and dots displayed on the CRT. The IBM 360/67 computer sends display data directly to the DD280 through a hardware interface. The IBM 7090-7040 series Direct Couple Computer Systems write display data on a magnetic tape which is later read into the 360/67 and sent out to the DD280.

The CRT on the DD280 has a square display area of 1024 by 1024 addressable points. The display is referred to as the raster area. The addressable points are called raster points (fig. 9(a)). Lines, symbols, and dots are positioned on the CRT in terms of



(a) Raster area, 1024 by 1024 addressable points.

(b) Raster area showing coordinates of line and symbol.

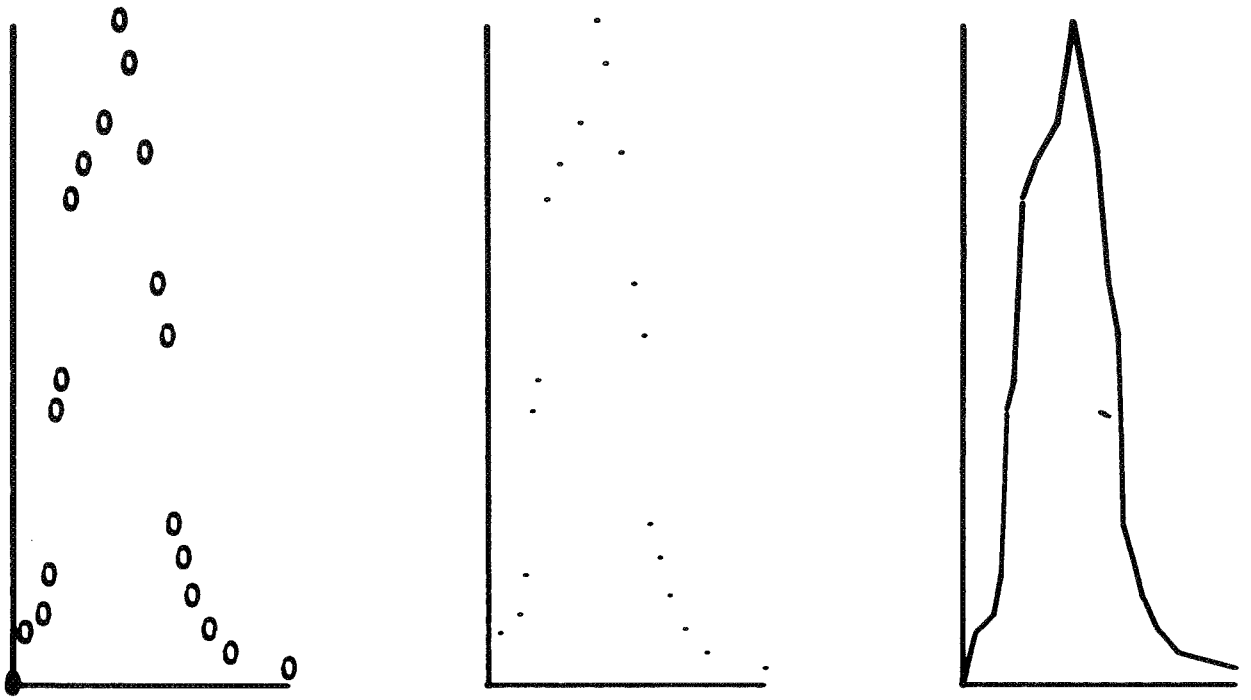
Figure 9. - DD280 cathode ray tube (CRT) display area.

raster points (fig. 9(b)). The line extends from raster point (75, 75) to raster point (500, 900). The center of the symbol A lies at raster point (400, 200). A raster unit is the horizontal or vertical distance from one raster point to the next.

The 360/67 computer program controls the time when and the location where lines, symbols, or dots are displayed on the CRT. The program also controls the time when the camera advances a frame of film.

Features

CINEMATIC makes all the features of the DD280 available to the FORTRAN user.



(a) Symbol plot. (b) Dot plot. (c) Line plot.

Figure 10. - Three types of DD280 plots.

Plot types. - The DD280 can represent the points on a curve with dots or with symbols, and it can also join two points with a straight line (a vector plot) as shown in figure 10. The CINEMATIC user can plot curves with symbols, lines, dots, or any combination of these types. The symbols available include the letters A to Z, the digits 0 to 9, and the plotting symbols ○, □, △, ◇, ▱, ⌂, ⌂, ◊, and ▽.

Butted plots. - A butted plot extends over several frames of film without any gaps between the frames (fig. 11). Special hardware features on the DD280 and computer programming on the 360/67 make butted plots possible. On command from the 360/67, the DD280 can electronically expand and exchange the display image on the CRT. The

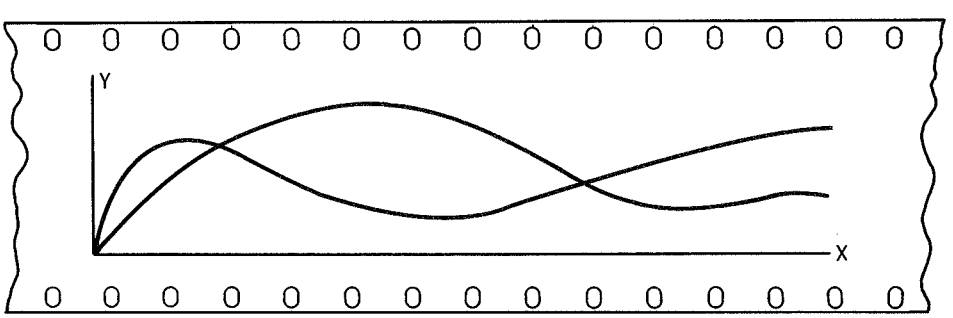


Figure 11. - A butted plot on microfilm.

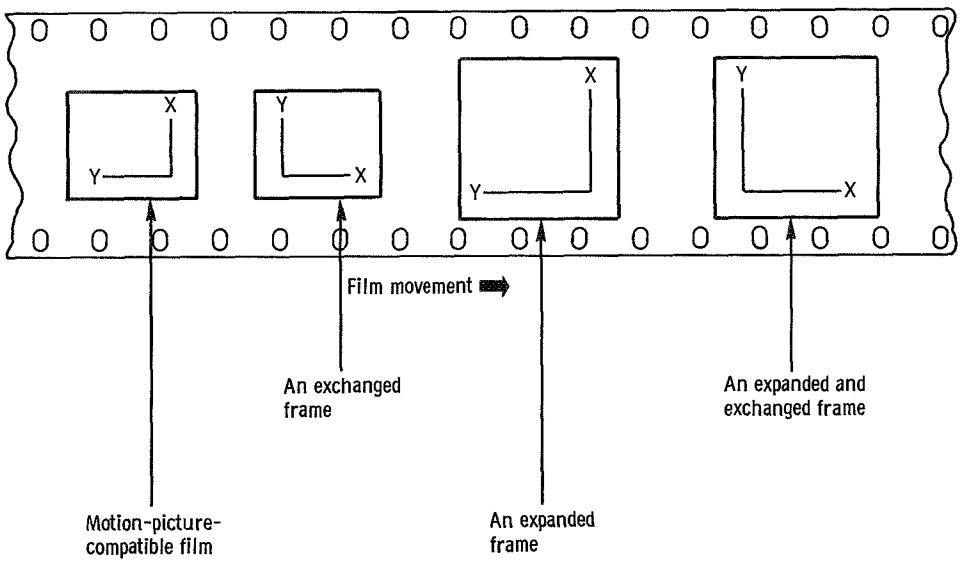


Figure 12. - Frame sizes and orientations.

exchange has the effect of a 90^{o} rotation of the entire display area of the CRT (fig. 12). Expanding the size of each frame makes the frames butt together to remove the gaps between frames.

CINEMATIC programming on the 360/67 sorts out the lines, symbols, and dots that belong to each frame of a butted plot. CINEMATIC then outputs the lines, symbols, and dots one frame at a time to make the butted plot. CINEMATIC can make butted plots up to 50 frames long.

Motion-picture-compatible film. - The CINEMATIC user may specify motion-picture compatible orientation of frames of film (fig. 12). The frames may be expanded or non-expanded.

Character set. - The DD280 character set has 128 printable characters (fig. 13). It includes lower case Greek, mathematical, and plotting symbols. There are also four pointers ▷, ◁, ◿, ▽ which are useful for pointing to labeled data points.

Character size. - The DD280 has four character sizes (fig. 14). The CINEMATIC user may select any of the four sizes for printing a plot legend or data point label. If he does not select a character size, CINEMATIC selects a suitable one for him.

Horizontal and vertical printing. - The DD280 can print characters horizontally (left to right) and vertically (bottom to top), as shown in figure 15.

Italics. - The DD280 can italicize the entire character set (fig. 16), but for horizontal printing only. The CINEMATIC user can turn on and turn off italics printing mode.

Tabbing and carriage return. - The DD280 has the typewriter-type functions of tabbing and carriage return. CINEMATIC allows the FORTRAN user to tab printed

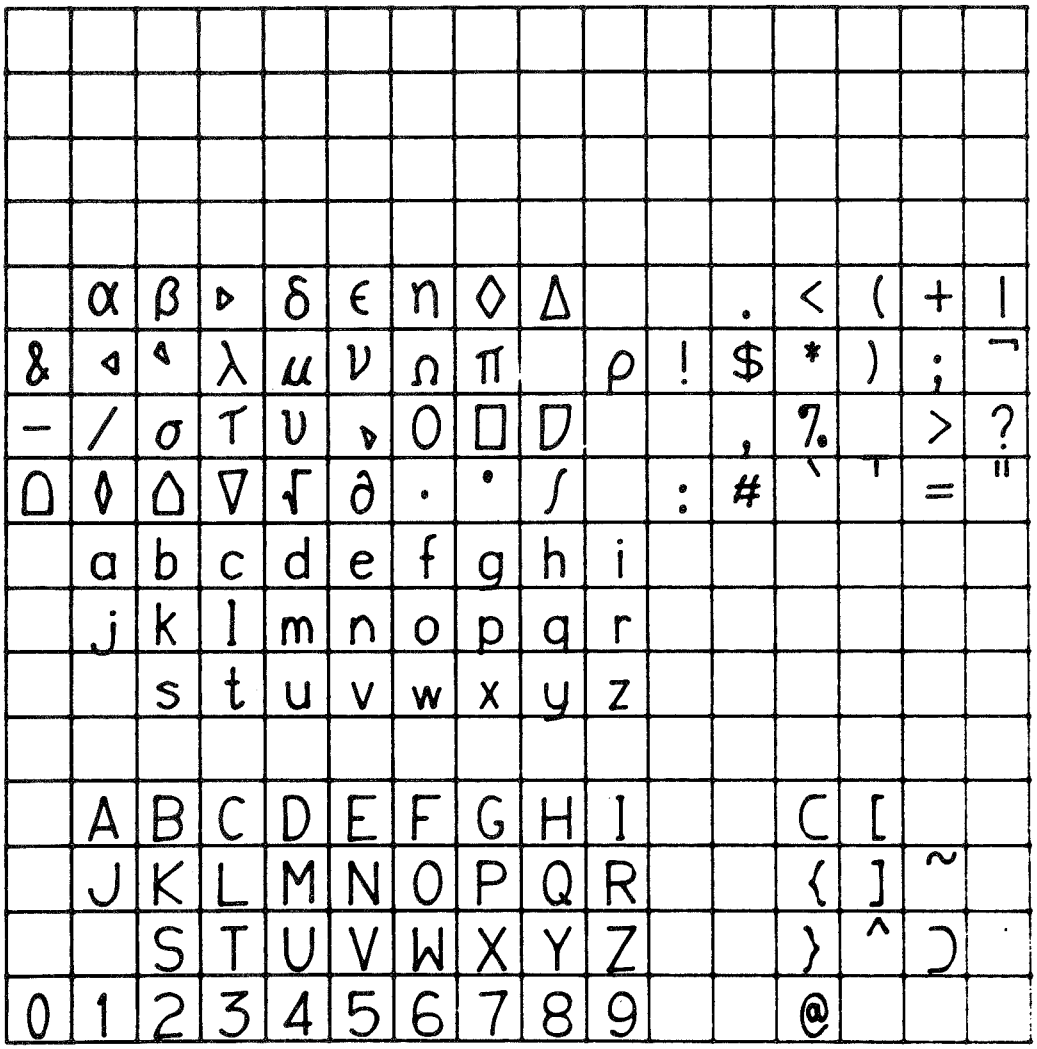


Figure 13. - DD280 character set.

ABCDEF

ABCDEF

ABCDEF

ABCDEF

Size	Characters per line	Lines per frame
Miniature	128	64
Small	86	43
Medium	64	32
Large	43	22

Figure 14. - DD280 character sizes.

Vertical printing

ABCDEF

Horizontal printing

ABCDEF

Figure 15. - Print orientations.

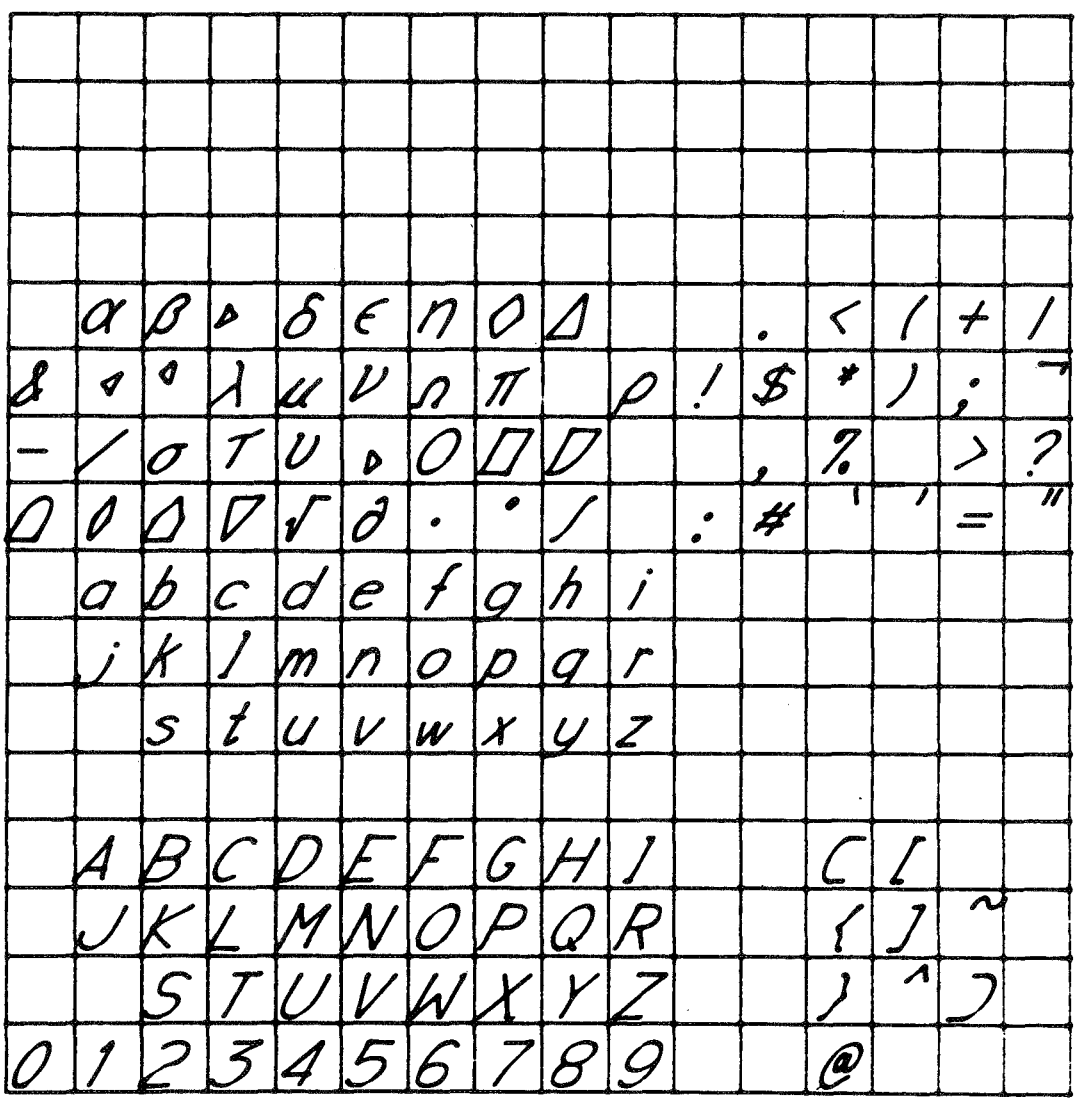


Figure 16. - DD280 character set in italics.

ABCDEFGH

ABCDEFGH

Figure 17. - Two image intensities.

characters or to carriage return for another line of printing.

Image intensities. - The DD280 can put images (dots, lines, or symbols) on film with either basic or high intensity (fig. 17). A high-intensity image is extra heavy and bright. Basic intensity gives a clearly recognizable image. High intensity is meant for highlighting or emphasizing part of a plot.

CONCLUDING REMARKS

Computer users at the Lewis Research Center have found CINEMATIC useful for producing film output of computed results. Programmers with limited experience in the use of FORTRAN have been able to use CINEMATIC. After reading the User's Guide, they have been able to make satisfactory plots with a minimum of personal assistance.

The flexibility of CINEMATIC has been useful for a variety of plotting applications:

1. Motion pictures of charged particle interactions and of flow patterns
2. Graphs and tables of numbers for technical publication
3. Contour plots
4. Multiple frame plots of experimental data before it is reduced on the computer

Since the structure of CINEMATIC does not depend on the film recorder hardware, it can be adapted to other plotting devices.

Lewis Research Center,
National Aeronautics and Space Administration,
Cleveland, Ohio, August 1, 1969,
129-04.

APPENDIX - USER'S GUIDE

1. How To Use CINEMATIC

The FORTRAN user calls the CINEMATIC subroutines needed for the type of plot he wants. Section 1.1 gives a short method to make a single-curve plot. Section 1.2 shows how to make a multiple-curve plot. Section 1.3 outlines the use of all the CINEMATIC subroutines.

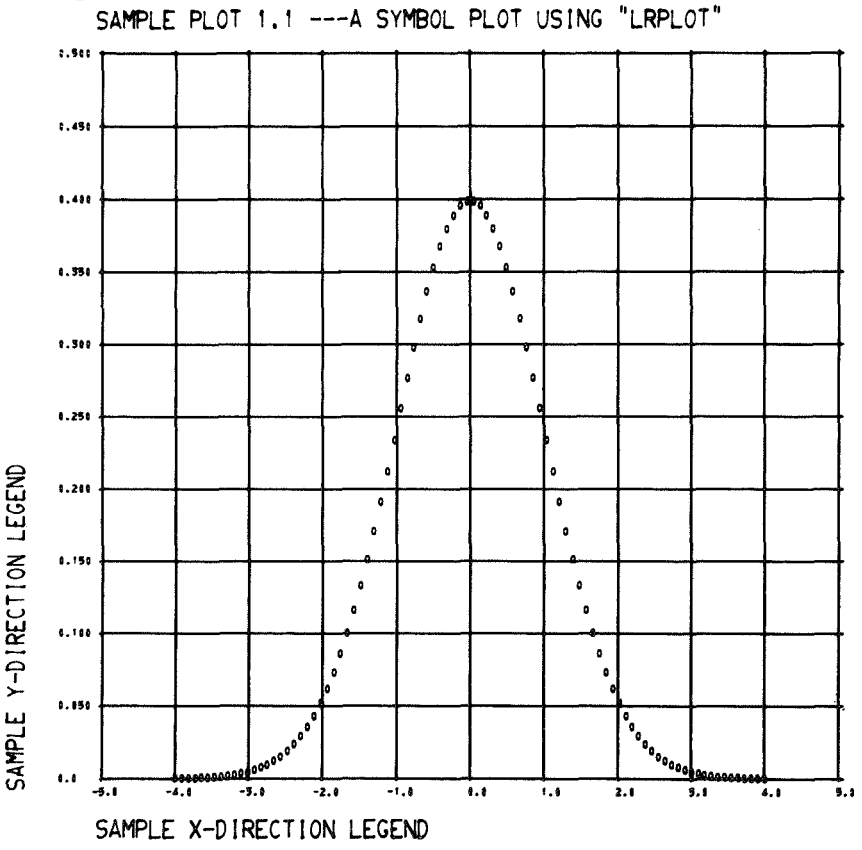
Section 1.4 describes the JOB CONTROL CARD changes needed for microfilm plotting. Section 1.5 shows how CINEMATIC identifies a computer job's film output. Section 8 discusses error messages and debug aids.

Section 9 shows how to put program listings and printed output on film instead of on a line printer.

1.1 A Short Method For Single-Curve Plots

A)	To print a horizontal legend below the plot. (If this type of legend is not wanted, do not call LRXLEG.)	CALL LRXLEG (CHARS, N) (Sec. 3.1)
B)	To print a vertical legend to the left of the plot, if desired.	CALL LRYLEG (CHARS, N) (Sec. 3.2)
C)	To print a title above the plot, if desired.	CALL LRTLEG (CHARS, N) (Sec. 3.3)
D)	To put a curve and grid system on the plot.	CALL LRPLOT (X, Y, N) (Sec. 2.1)

Examples: Sample plots 1.1 and 1.2.



```
C   SAMPLE PLOT 1.1 --- A SYMBOL PLOT MADE BY =LRPLOT=
C
    DIMENSION X(100), Y(100)
    REAL TCHAR(15)/'SAMPLE PLOT 1.1 ---A SYMBOL PLOT USING 'LRPLOT' '/
    REAL XCHAR(7)/'SAMPLE X-DIRECTION LEGEND '/
    REAL YCHAR(7)/'SAMPLE Y-DIRECTION LEGEND '/
C
C   PRINT LEGENDS AND TITLE
C
    CALL LRTLEG(TCHAR, 49)
    CALL LRXLEG(XCHAR, 28)
    CALL LRYLEG(YCHAR, 28)
C
C   GENERATE X AND Y POINTS FOR A HAYSTACK CURVE
C
    XDIFF = 8.0/89.0
    CON = 1.0/SQRT (2*3.14)
    X(1) = -4.0
    Y(1) = CON*EXP(-0.5*X(1)*X(1))
    DO 10 I=2.90
    X(I) = X(I-1)+DIFF
 10 Y(I) = CON*EXP(-0.5*X(I)*X(I))
C
C   DRAW CURVE AND GRID LINES
C
    CALL LRPLOT(X, Y, 90)
    STOP
    END
```

Note: The DATA statements used in the sample programs are available on the 360/67 only.

1.2 How To Make A Multiple-Curve Plot

A)	To print a horizontal legend below the the plot, if desired.	CALL LRXLEG (CHARS, N) (Sec. 3.1)
B)	To print a vertical legend to the left of the plot, if desired.	CALL LRYLEG (CHARS, N) (Sec. 3.2)
C)	To print a title above the plot, if desired.	CALL LRTLEG (CHARS, N) (Sec. 3.3)
D)	To put one or more curves and a grid system on the plot.	CALL LRCPLT (X, Y, KKK) (Sec. 2.2)

Example: Sample plot 1.3.

Note: All of the points for the plot must be in the computer memory when LRCPLT is called. LRCURV (Sec. 2.3) is used when all the points are not in memory at the same time.

1.3 Use Of All CINEMATIC Subroutines

A) Printing on a plot.

1. to print a horizontal legend below the plot	CALL LRXLEG (Sec. 3.1)
2. to print a vertical legend to the left of the plot	CALL LRYLEG (Sec. 3.2)
3. to print a title above the plot	CALL LRTLEG (Sec. 3.3)

4. to print anywhere on a plot	CALL LRLEGN (Sec. 3.4)
5. to change the size of printed characters	CALL LRCHSZ (Sec. 6.1)
6. to "carriage return" or "tab" a printed line	see TABBING CHARACTERS (Sec. 6.2)
7. to print the non-FORTRAN character in the DD80 character set	see LOWER CASE and SPECIAL CHARACTERS (Sec. 6.3)
8. to italicize characters	CALL LRION (Sec. 6.4)
9. to rotate characters	CALL LRTON (Sec. 6.5)

B) Curve-drawing on a plot.

1. to make a single-curve plot (symbol or dot plot)	CALL LRPLOT (Sec. 2.1)
2. to make a multiple-curve plot (symbol, dot, or vector plot)	CALL LRCPLT (Sec. 2.2)
3. for more flexibility in drawing curves (symbol, dot, or vector plot)	CALL LRCURV (Sec. 2.3)

C) Modifying the format of a plot.

1. to specify the frequency of grid lines	CALL LRGRID (Sec. 4.2)
2. to specify intervals between grid lines	CALL LRGRID (Sec. 4.2)
3. to use "tick marks" instead of grid lines	CALL LRGRID (Sec. 4.2)
4. to specify the range of data values	CALL LRANGE (Sec. 4.1)
5. to specify a butted plot (i.e. expand the size of a plot to more than one frame of film)	CALL LRSIZE (Sec. 4.3)
6. to change margin sizes	CALL LRMRGN (Sec. 4.4)

D) Labeling a plotted data point

1. to print a label at a data point	CALL LRLABL (Sec. 5.1)
2. to position a label slightly away from a data point	see TABBING CHARACTERS (Sec. 6.2)
3. to convert a binary number (real or integer) into printable characters	CALL LRCNVT (Sec. 5.2)
4. all the character options of Section A, (above) also apply to LRLABL	

E) Miscellaneous

1. to highlight part of a plot	CALL LRNON (Sec. 7.1)
2. to make movie-compatible film	CALL LRMON (Sec. 7.2)

1.4 Job Control Card Changes For Microfilm Plotting

A) 7090-7040 Direct-couple computer system.
Microfilm plotting on the direct-couple system requires two job control cards:

```
CC1                16

      $DECK        FILMID          (immediately after the $ID card.)
      $DECK        FPLOT           (immediately after the $IBJOB card.)
```

For example:

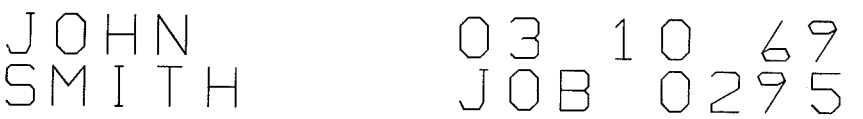
```
CC1                8          16

      $ID          XZQ7777    JOHN SMITH
      $DECK                   FILMID
      $DISPATCH               DEBANN
      $TCP                    TIME=1, PAGES=15
      $ATEND                  0, 77777
      $IBJOB
      $DECK                   FPLOT
      $IBFTC
```

could be used for a microfilm plotting computer job on the direct-couple computer system

1.5 Identification Of Microfilm Output

Block lettering identifies the start of each computer job's film output.
See Figure 1.4

Figure 1.4: Sample Identification of Film Output



For the direct-couple system, film identification includes:

programmer's name (columns 16-39 of ID card)
date
run number

2.1

IDENTIFICATION: LRPLOT

PURPOSE: To specify a single curve plot.

USAGE: CALL LRPLOT (X, Y, N) where

X - (floating point) is an array of X-coordinates of the curve.
Y - (floating point) is an array of Y-coordinates of the curve.
N - (fixed point) the number of (X, Y) points to be plotted.

Examples: Sample plots 1.1 and 1.2

METHOD: Type of Plot: For $N \leq 300$, the symbol "0" represents each point.
For $N > 300$, a dot represents each point.

Scaling: The X and Y arrays are in the user's units. LRPLOT scales his units to the size of the plot. LRPLOT finds the range of user's data by searching the X-Y arrays. A call to LRANGE (Sec. 4.1) will set the user's data range and no search of the X-Y arrays will occur.

Grid: Ten grid intervals in each direction. Grid intervals are equal to $Z \times 10^n$ where "Z" = 1.0, 2.0, 2.5 or 5.0 and "n" depends on the user's units. LRPLOT adjusts the user's data range to get ten equal intervals of $Z \times 10^n$. Use LRGRID (Sec. 4.2) to change the grid.

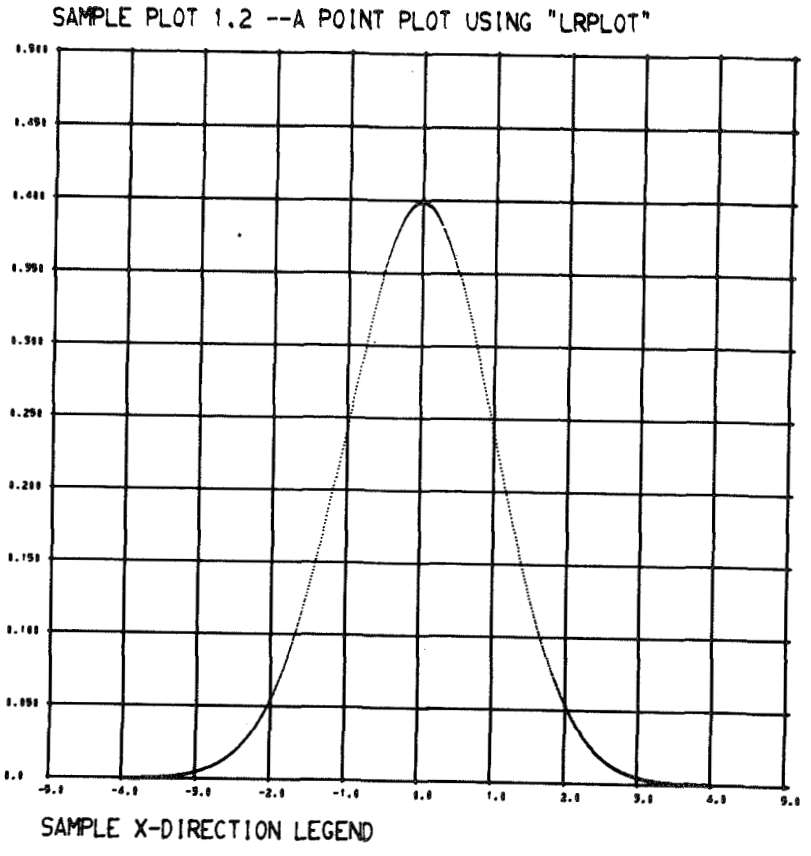
Margins: 0.10 frame at the left and bottom 0.04 frame at the right and top. These margins allow enough space for a title and legends printed by LRTLEG, LRXLEG and LRYLEG.

Plot Size: The size of the entire plot is one frame of film. With the above margins, the user's data range is scaled to a coordinate system of 981x981 points. Choice of a good plot size depends on how the points are distributed. As a rule of thumb, one frame of film is needed for every 1000 points on the plotted curve. Use LRSIZE (Sec. 4.3) to expand the plot size to more than one frame.

Sorting: The X-Y arrays need not be sorted for LRPLOT.

LRPLOT does not alter the content of X, Y, or N during plotting.

ERROR MESSAGES: See Sec. 8 for complete list of error messages.



```
C       SAMPLE PLOT 1.2 -- A POINT PLOT MADE BY =LRPLOT=
C
        DIMENSION X(800), Y(800)
        REAL TCHAR(15/'SAMPLE PLOT 1.2 -- A POINT PLOT USING 'LRPLOT' '/
        REAL XCHAR(7)/'SAMPLE X-DIRECTION LEGEND '/
C
C       PRINT LEGENDS AND TITLE
C
        CALL LRTLEG(TCHAR, 49)
        CALL LRXLEG(XCHAR, 28)
C
C       A Y-DIRECTION LEGEND IS NOT DESIRED
C
C
C       GENERATE X AND Y CURVE POINTS
C
        XDIFF = 8.0/699.0
        CON = 1.0/SQRT (2*3.14)
        X(1) = -4.0
        Y(1) = CON*EXP(0.5*X(1)*X(1))
        DO 10 I=2,700
        X(I) = X(I-1)+XDIFF
   10   Y(I) = CON*EXP(-0.5*X(I)*(I))
C
C       DRAW CURVE AND GRID LINES
C
        CALL LRPLOT (X, Y, 700)
        STOP
        END
```

NOTE: The DATA statements apply to the 360/67 only.

2.2

IDENTIFICATION: LRCPLT

PURPOSE: to specify a multiple-curve plot

USAGE: CALL LRCPLT (X, Y, KKK) where

X (floating point) is an array of X-coordinates for all the curves. (See Figure 2.1)

Y (floating point) is an array of Y-coordinates for all the curves. (See Figure 2.1)

KKK (fixed point) is an array at least six words long. It is used as follows.

KKK (1) is a switch that indicates whether CINEMATIC should duplicate any of the coordinates in the X or Y arrays.

- = 1 means duplicate X-coordinates
- = 2 means duplicate Y-coordinates
- = 3 means no duplication (See Figure 2.1)

KKK (2) indicates type of plot desired.

- = 0 means that all successive points on a curve be connected by straight lines (a vector plot)
- = N specifies a vector plot with a plotting symbol placed at every Nth point. KKK(5) indicates the symbol.
- = -N means that every Nth point is represented by a plotting symbol. KKK(5) indicates the symbol.
- = 999 means that several curves with different KKK(2) numbers are being plotted. Let KN be the number of such curves. Then the KKK(2) number for each curve is supplied in KKK(KN+6) through KKK(2KN+5).

KKK (3) is the number of curves to be plotted.
KKK (4) is a switch that indicates whether a call to LRLABL will follow this call to LRCPLT. LRLABL labels a curve point.

= 0 means no call to LRLABL will follow.
= 1 means a call to LRLABL will follow.

KKK (5) whenever symbols are plotted, KKK(5) equals the number of the symbol used to plot the first curve. Symbols for successive curves are chosen in order. KKK(5) > 31 is interpreted as KKK(5) modulo 32. See Figure 2.2 for list of symbols.

KKK (6) gives the number of points in each curve when KKK(1) equals 1 or 2.

KKK (6) gives the number of points in the first curve when KKK(1) equals 3. The number of points for successive curves appears in KKK(7) through KKK(KN+5), where KN is the number of curves being plotted.

Example: Sample plot 1.3.

METHOD:

Duplication of coordinates: When the set of X-coordinates for all the curves is the same, it may appear only once in the X array. KKK(1)=1 indicates this arrangement of the user's data. LRCPLT will use the one set of X's for all the curves to be plotted. The Y-coordinates for all the curves must appear in the Y array. Similarly, a common set of Y-coordinates may be duplicated for several sets of X-coordinates. (See Figure 2.1).

Scaling: The X and Y arrays are in whatever units the user is working with. LRCPLT scales his units to the size of the plot. LRCPLT finds the range of the user's data by searching the X and Y arrays. A call to LRANGE (Sec. 4.1) before LRCPLT will set the user's range and no search of the arrays will occur.

Grid: Ten grid intervals in each direction. Grid intervals are equal to $Z \times 10^n$ where Z=1, 2, 2.5, or 5 and n depends on the range of the user's data. LRCPLT will adjust the range of the user's data to get ten equal intervals of $Z \times 10^n$. Use LRGRID (Sec. 4.2) to change the grid.

Margins: 0.10 frame at the left and bottom, 0.04 frame at the right and top. These margins allow enough space for a title and legends printed by LRTLEG, LRXLEG and LRYLEG. Use LRMRGN (Sec. 4.4) to change margins.

Plot size: The size of the entire plot is one frame of film. If needed, the size may be expanded to several continuous frames of film by a call to LRSIZE (Sec. 4.3). With the above margins, the user's data range is scaled to a coordinate system of 981x981 distinct points. Choice of a good plot size depends on the plotting resolution needed. As a rule of thumb, one frame is needed for every 1000 points. (300 points for a symbol plot).

Sorting: The X and Y arrays need not be sorted for LRCPLT. However, for a vector plot, straight lines will connect the points in the order that they appear in the X and Y arrays.

LRCPLT does not destroy the contents of X, Y, and KKK during plotting.

ERROR MESSAGES: See Section 8 for a complete list of error messages.

Figure 2.1 Sample arrangements of (X, Y) coordinates for three curves using LRCPLT.

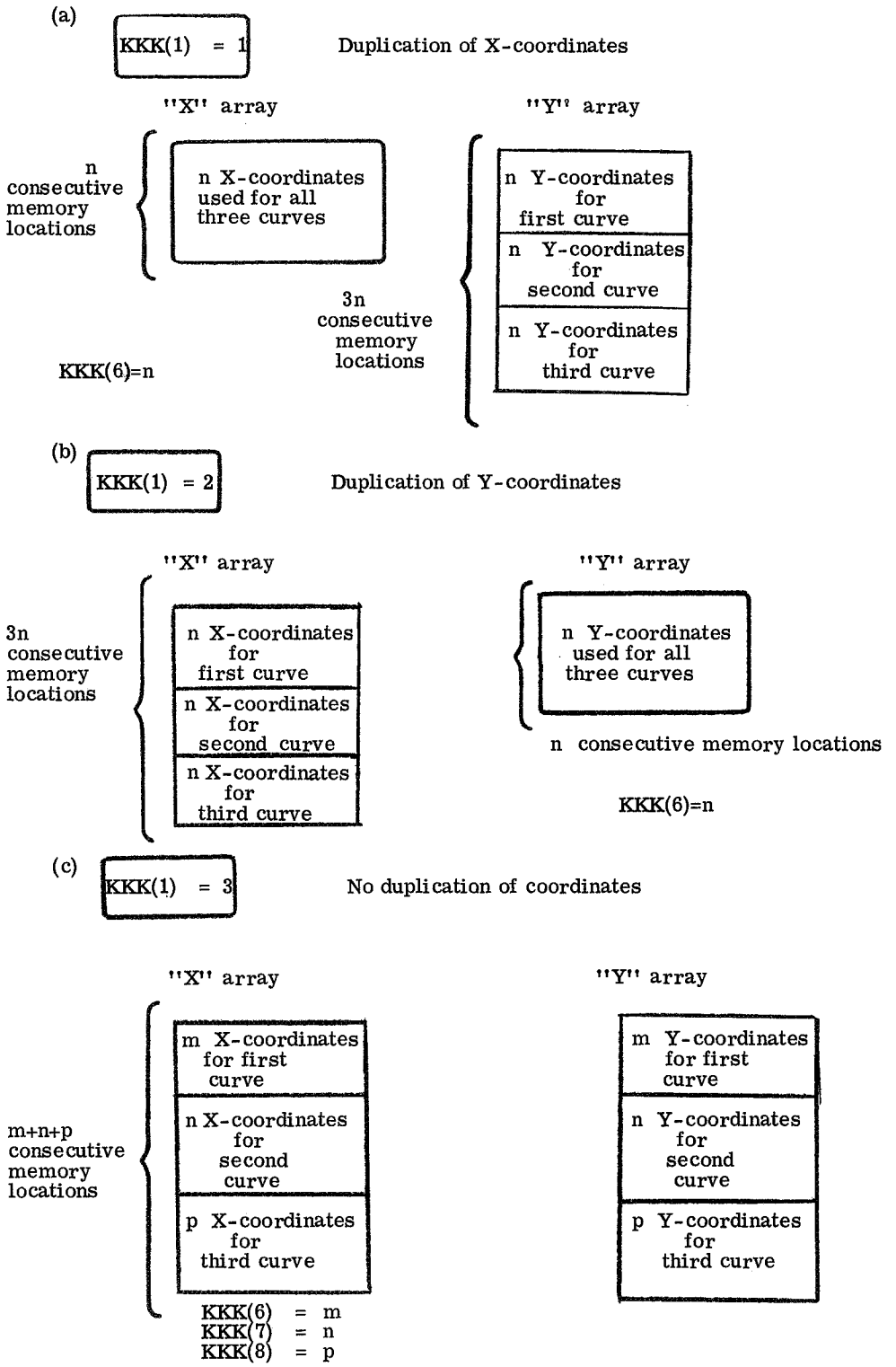
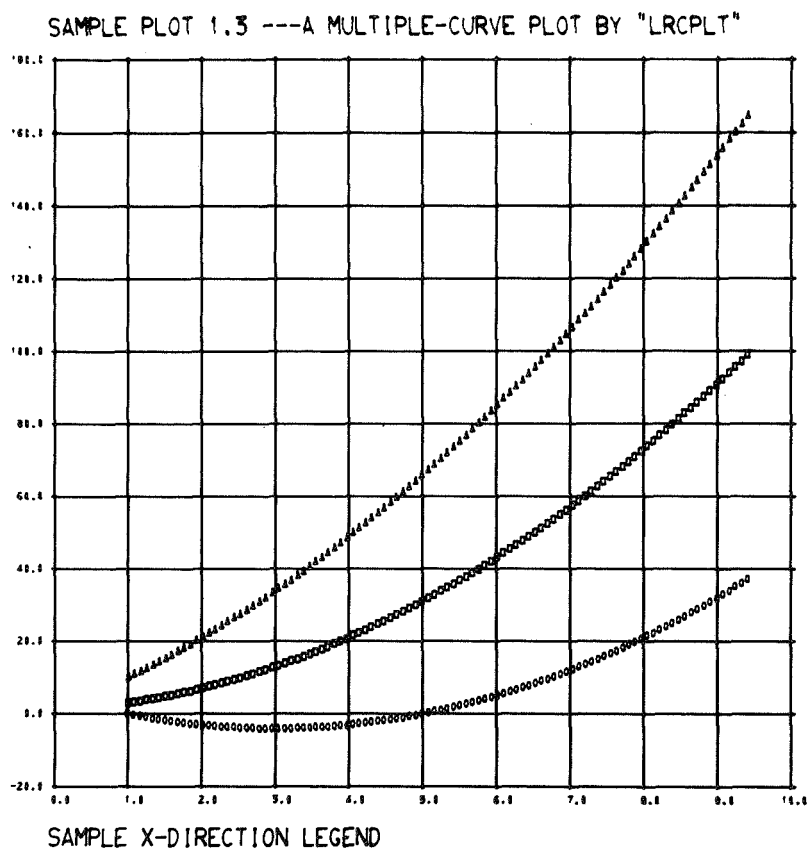


Figure 2. 2: Plot Symbols Used By "LRCPLT"

0	□	8	Z	16	C	24	J
1	○	9	Y	17	D	25	K
2	△	10	⊃	18	E	26	L
3	+	11	∩	19	F	27	M
4	×	12	A	20	G	28	2
5	◇	13	1	21	%	29	3
6	⌂	14	B	22	>	30	4
7	▽	15	-	23	H	31	



```
C       SAMPLE  PLOT 1.3  ---  A MULTIPLE-CURVE PLOT MADE WITH  =LRCPLT=
C
        DIMENSION  X(100, Y(300), KKK(10), P(10)
        REAL TCHAR (15)/'SAMPLE PLOT  1.3 ---A MULTIPLE-CURVE PLOT BY 'LRCPLT' '/
        REAL XCHAR (7)/'SAMPLE X-DIRECTION LEGEND '/
C
C       PRINT LEGEND AND TITLE
C
        CALL LRTLEG(TCHAR, 54)
        CALL LRXLEG(XCHAR, 28)
C
C       SET UP DATA POINTS FOR THREE CURVES
C       CREATE ONE SET OF X POINTS AND THREE SETS OF Y POINTS
C       THERE ARE 100 X VALUES
C       THERE ARE 100 Y VALUES FOR EACH CURVE
C
        XDIFF = 0.085
        XBEGIN =  1.0
        DO 10 I=1, 100
        X(I) = XBEGIN
        Y(I) = XBEGIN*XBEGIN + XBEGIN + 1.0
        Y(I+100) = XBEGIN*XBEGIN - 6.0*XBEGIN + 5.0
        Y(I+200) = XBEGIN*XBEGIN + 8.0*XBEGIN + 1.0
   10   XBEGIN=XBEGIN + XDIFF
C
C       SET UP  KKK ARRAY
C       THE DUPX OPTION IS DESIRED
C
        KKK (1) = 1
C       EVERY POINT IS REPRESENTED BY A SYMBOL
        KKK(2) = -1
        KKK(3) = 3
        KKK(4) = 0
        KKK(5) = 0
        KKK(6) = 100
C
C
C
C       DRAW CURVES AND GRID SYSTEM
C
        CALL LRCPLT(X, Y, KKK)
        STOP
        END
```

2.3

IDENTIFICATION: LRCURV

PURPOSE: Greater flexibility in drawing curves.

USAGE: CALL LRCURV (X, Y, N, ITYPE, SYMBOL, EOP)

where X (floating point) is an array of X-coordinates for the curve.

Y (floating point) is an array of Y-coordinates for the curve.

N (fixed point) the number of (X, Y) points to be plotted.

ITYPE is a switch that indicates the type of plot desired.

= 1 specifies a dot plot. Each (X, Y) point is represented by a dot.

= 2 specifies a vector plot. Successive (X, Y) points are joined by straight lines.

= 3 specifies a symbol plot. Each (X, Y) point is represented by a symbol. The FORTRAN character in "SYMBOL" specifies the symbol used.

= 4 specifies a special symbol plot. Each (X, Y) point is represented by a special symbol taken from the SPECIAL CHARACTER TABLE (Figure 6.2). The special symbol used is the one corresponding to the FORTRAN character in "SYMBOL".

= 5 same as "3" except that a smaller size symbol is used.

= 6 same as "4" except that a smaller size symbol is used.

SYMBOL Specifies the plotting symbol when ITYPE = 3 or 4. When ITYPE = 1 or 2, SYMBOL must appear in the call list, but is not used by LRCURV. The following FORTRAN statement can be used to set SYMBOL.

```
DATA SYMBOL  /1H*/
```

EOP is a switch that indicates when the last subroutine call for a given plot is being made.

=0.0 The current plot is not yet complete. More subroutine calls for this plot will follow.

=1.0 The current plot is complete. No more printing or plotting subroutines will be called for this plot.

Example: Sample plot 1.4.

METHOD:

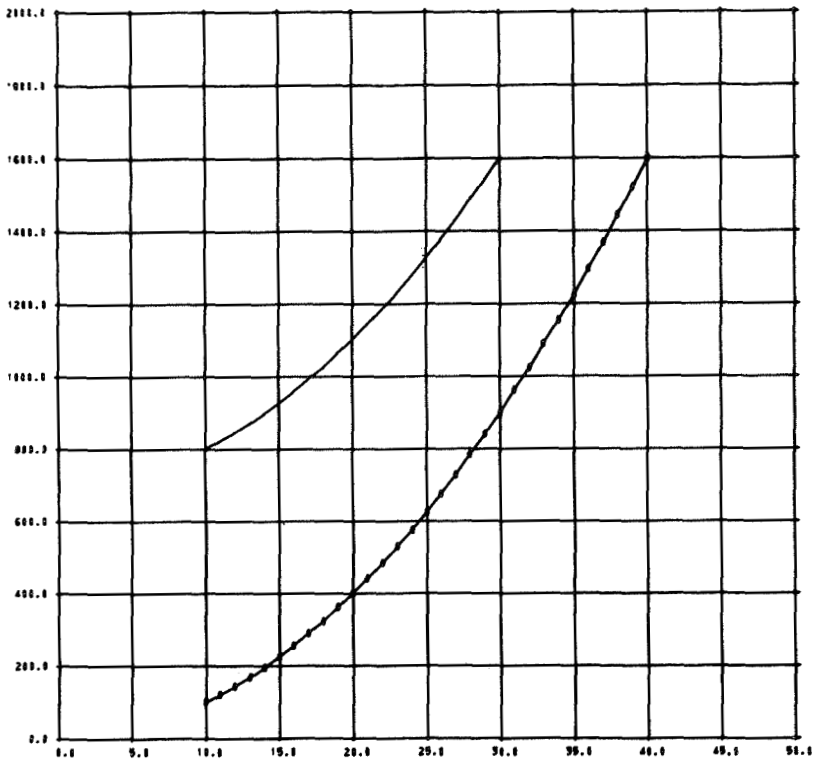
Greater flexibility in drawing curves: LRCURV is useful for the plotting situation in which all of (X, Y) points for a plot are not in the computer memory at the same time. Several calls to LRCURV may be made for the same plot.

Scaling: The X and Y arrays are in whatever units the user is working with. LRCURV scales his data range to fit the size of the plot on film. The user should call LRANGE (Sec. 4.1) before LRCURV to supply the range of his data points to CINEMATIC. If the user does not call LRANGE, LRCURV will take the user's data range from the first call to LRCURV for any given plot.

Grid, Margins, Plot Size, Sorting: Same as LRCPLT (Sec. 2.2).

LRCURV does not destroy the contents of X, Y, N, ITYPE, SYMBOL or EOP during plotting.

SAMPLE PLOT 1.4 --- USING 'LRCURV'



TOP CURVE: A VECTOR PLOT
BOTTOM CURVE: SYMBOLS ADDED AT EACH POINT

```
C       SAMPLE PLOT 1.4 --- USING 'LRCURV'
C
        DIMENSION XCHAR (20)
        DIMENSION X(31), Y(31)
        REAL TCHAR/10/'SAMPLE PLOT 1.4 --- USING ''LRCURV'' '/
        DATA XCHAR/'TOP CURVE : A VECTOR PLOT  $C1BOTTOM CURVE: SYMBOL
       XS ADDED AT EACH POINT  '/
        DATA SYMBOL/'0'/
C
C       PRINT TITLE AND LEGEND
C
        CALL LRTLEG (TCHAR, 38)
        CALL LRXLEG (XCHAR, 75)
C
C       GENERATE Y DATA POINTS FOR LOWER CURVE
C
        X(1) = 10.0
        DO 2 I=2, 31
    2   X(I) = X(I-1) + 1.0
        DO 3 I=1, 31
    3   Y(I) = X(I) *X(I)
        ITYPE=2
        EOP=0.0
        N=31
C
C       PLOT LOWER CURVE
C
        CALL LRCURV(X, Y, N, ITYPE, SYMBOL, EOP)
C       PLOT THE SYMBOL AT EACH POINT.
```

```
      ITYPE = 3
      CALL LRCURV (X, Y, N, ITYPE, SYMBOL, EOP)
C     GENERATE X AND Y DATA POINTS FOR UPPER CURVE
C
      DO 5 I=1, 21
    5 Y(I)=Y(I)+700. 0
      ITYPE=2
      N=21
      EOP = 1. 0
C
C     PLOT UPPER CURVE
C     INDICATE THE PLOT IS COMPLETE
C
      CALL LRCURV(X, Y, N, ITYPE, SYMBOL, EOP)
      STOP
      END
```

3. 1

IDENTIFICATION: LRXLEG

PURPOSE: To print a horizontal legend below a plot.

USAGE: CALL LRXLEG (CHARS, N) where

CHARS is an array of characters to be printed. CHARS must be dimensioned large enough for the number of characters desired. (4 characters per word on the 360/67, 6 characters per word on the 7090-7040 series direct couples)

N (fixed point) the number of characters to be printed.

Example: Sample plots 1. 1 and 1. 2.

RESTRICTIONS: $N \leq 116$. Two lines may be printed. The second starts with the 59^{th} character. The user may change where the second line starts by means of the TABBING CHARACTERS "$C1". (See Sec. 6. 2)

LRXLEG must be called before LRPLOT, LRCPLT or LRCURV.

3. 2

IDENTIFICATION: LRYLEG

PURPOSE: To print a vertical legend (bottom to top) to the left of a plot.

USAGE: CALL LRYLEG (CHARS, N) where

CHARS is an array of characters to be printed. CHARS must be dimensioned large enough for the number of characters desired. (4 characters per word on the 360/67, 6 characters per word on the 7090-7040 series direct couples)

N (fixed point) the number of characters to be printed.

Example: Sample plot 1. 1

RESTRICTIONS: $N \leq 58$. One line is printed.
LRYLEG must be called before LRPLOT, LRCPLT or LRCURV.

3.3

IDENTIFICATION: LRTLEG

PURPOSE: To print a title above a plot.

USAGE: CALL LRTLEG (CHARS, N) where

CHARS is an array of characters to be printed. CHARS must be dimensioned large enough for the number of characters desired. (6 characters per word on the 7090-7040 series direct couples)

N (fixed point) is the number of characters to be printed.

Example: Sample plot 1.1

RESTRICTIONS: $N \leq 58$. One line is printed.
LRTLEG must be called before LRPLOT, LRCPLT or LRCURV.

3.4

IDENTIFICATION: LRLEGN

PURPOSE: To print a legend anywhere on a plot.

USAGE: CALL LRLEGN (CHARS, N, IORIEN, X, Y, EOP)

where

CHARS is an array of characters to be printed. CHARS must be dimensioned large enough for the number of characters desired. (4 characters per word on the 360/67, 6 characters per word on the 7090-7040 series direct couples)

N (fixed point) is the number of characters to be printed.

IORIEN (fixed point) is a switch. IORIEN=0 causes horizontal printing. IORIEN=1 causes vertical printing. (bottom to top).

X (floating point) X-coordinate of starting point in absolute positioning units.

Y (floating point) Y-coordinate of starting point in absolute positioning units.

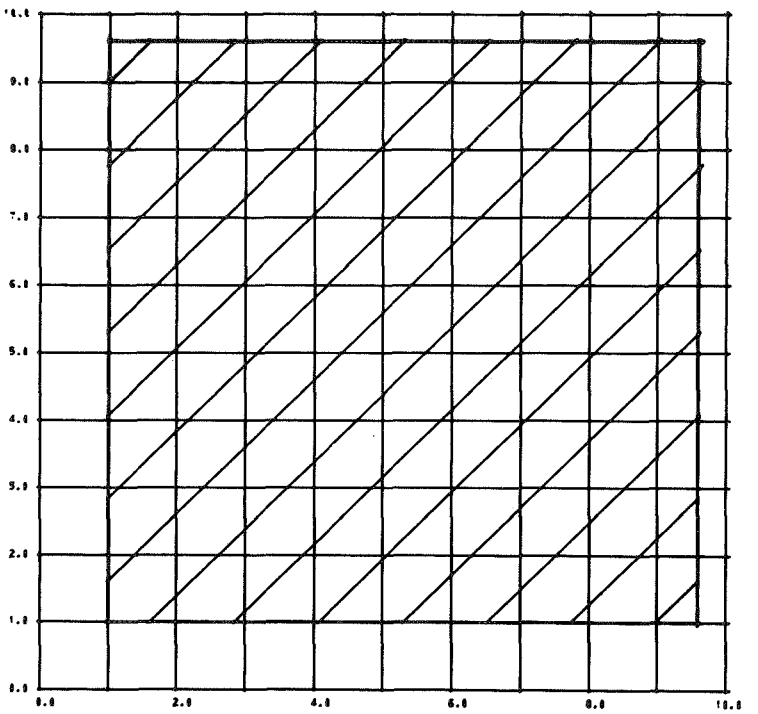
EOP (floating point) is a switch. EOP= 0.0 indicates the current plot is not yet complete. EOP=1.0 indicates the current plot is complete. No more calls to plotting or printing subroutines for this plot will occur.

METHOD: Absolute positioning units: The user expresses the (X, Y) starting point of a line of printing in absolute positioning units. Absolute positioning units range from 0.0 to 10.0 in both the X and Y directions for one frame of film. (See Figure 3.1) Absolute positioning units give the user a coordinate system to specity (X, Y) points independent of points on a curve.

If the user wishes to give the starting (X, Y) point of a print line in the same units as his curve points, he should use LRLABL (Sec. 5. 1).

Character Size: LRLEGN prints medium size characters. Section 6 describes how to get other character sizes, italics, lower case and special symbols.

FIGURE 3.1: ABSOLUTE POSITIONING UNITS



ABSOLUTE POSITIONING UNITS FOR ONE FRAME OF FILM
CURVE-DRAWING TAKES PLACE IN SHADED AREA

4. 1

IDENTIFICATION: LRANGE

PURPOSE: To set the range of (X, Y) curve points.

USAGE: CALL LRANGE (XLEFT, XRIGHT, YBOTM, YTOP)

where XLEFT is the lefthand endpoint of a plot in the user's units

XRIGHT is the righthand endpoint of a plot in the user's units

YBOTM is the lower endpoint of a plot in the user's units

YTOP is the upper endpoint of a plot in the user's units

METHOD:

The curve-plotting subroutines LRPLOT, LRCPLT and LRCURV search the (X, Y) coordinates for maximums and minimums and scale the rest of the user's points to fit between them. A call to LRANGE before LRPLOT, LRCPLT or LRCURV suppresses the search.

The settings of LRANGE remain in effect for all successive plots until changed by another call to LRANGE. XLEFT = XRIGHT = 0.0 can be used to remove the LRANGE X-settings without providing new ones. YBOTM = YTOP = 0.0 does the same for Y -settings.

Grid adjustment: If necessary, CINEMATIC will adjust the user's curve endpoints slightly when grid line frequency rather than a grid line interval is needed. (See LRGRID Sec. 4.2)

RESTRICTIONS:

LRANGE must be called before the curve plotting routine it applies to. The settings of LRANGE remain in effect until changed by the user.

4.2

IDENTIFICATION:

LRGRID

PURPOSE:

To specify grid line changes.

USAGE:

CALL LRGRID (IXCODE, IYCODE, DX, DY)

where

IXCODE (fixed point) is a switch used as follows. It applies to vertical grid lines.

- = 0 means return to using CINEMATIC's built-in grid format. (11 grid lines)
- = ± 1 DX specifies how many grid lines, -1 suppresses grid labels.
- = ± 2 DX specifies grid intervals, -2 suppresses grid labels.
- = ± 3 DX specifies how many "tick marks" instead of grid lines, -3 suppresses grid labels.
- = ± 4 DX specifies interval between "tick marks" rather than grid lines, -4 suppresses grid labels.
- DX (floating point) specifies grid line or "tick mark" frequency or intervals depending on how IXCODE is set.
- IYCODE (fixed point) is the same as IXCODE but it applies to horizontal grid lines.
- DY (floating point) same as DX but for horizontal grid lines.

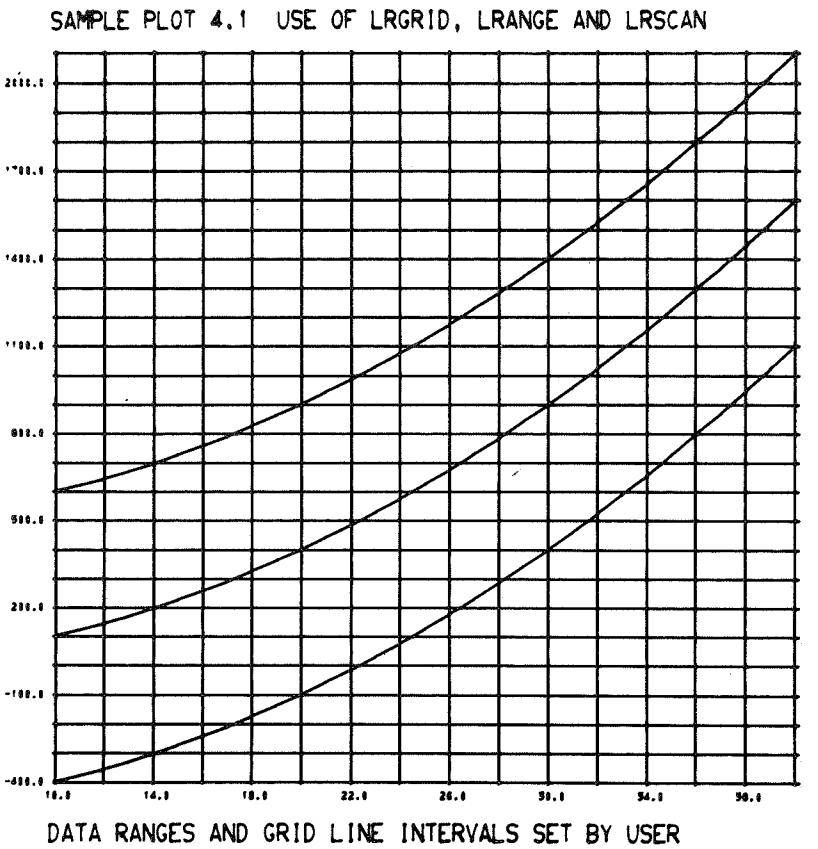
Example: Sample plots 4.1 and 4.3

METHOD:

CINEMATIC puts eleven horizontal and eleven vertical grid lines on every plot, unless LRGRID is called.

When a grid line frequency is specified, CINEMATIC sets the interval between the specified number of grid lines to be equal to $Z \times 10^n$ Z=1.0, 2.0, 2.5, or 5.0. "n" depends on the magnitude of the user's data. To get these intervals, CINEMATIC will adjust the endpoints of the plot, if necessary. This adjustment occurs only when a grid line frequency is specified. To avoid any adjustments, specify grid intervals.

RESTRICTIONS: LRGRID must be called before the plotting routine it applies. The settings of LRGRID remain in effect until changed by another call to LRGRID.




```
C       SAMPLE PLOT  4. 1---USE OF LRSCAN, LRANGE,  AND LRGRID
C
        DIMENSION  XCHAR (15)
        DIMENSION X(31),  Y(31),  TCHAR(15)
        DIMENSION YY(31), ZZ(31)
        DATA TCHAR/'SAMPLE PLOT 4. 1 USE OF LRGRID, LRANGE AND LRSCAN '/
        DATA XCHAR/'DATA RANGES AND GRID LINE INTERVALS SET BY USER '/
C       PRINT TITLE AND LEGEND
        CALL LRXLEG  (XCHAR, 48)
        CALL LRTLEG  (TCHAR, 49)
        X(1)=10. 0
        DO 2 I=2, 31
    2   X(I)=X(I-1)+1. 0
        DO 4 I=1, 31
    3   Y(I)=X(I)*X(I)
        ZZ(I)=Y(I)+500. 0
    4   YY(I)=Y(I)-500. 0
C
C       THE CONTENTS OF  'X',  'Y', 'YY',  and 'ZZ'  ARE ASSUMED TO BE
C       UNKNOWN TO PROGRAMMER.  USE LRSCAN TO FIND THEM.
C
        CALL LRSCAN (X, 31, XMIN, XMAX)
```

```
      CALL LRSCAN (Y, 31, YMIN, YMAX)
      CALL LRSCAN (YY, 31, YYMIN, YYMAX)
      CALL LRSCAN (ZZ, 31, ZZMIN' ZZMAX)
      YMIN = AMIN1(YMIN, YYMIN, ZZMIN)
      YMAX = AMAX1(YMAX, YYMAX, ZZMAX)
C
C     SET DATA RANGES
C
      CALL LRANGE (  XMIN, XMAX, YMIN, YMAX)
C
C     SPECIFY X  GRID LINES AT INTERVALS OF 2. 0
C     SPECIFY Y  GRID LINES AT INTERVALS OF 100. 0
C
      CALL LRGRID  (2, 2, 2. 0, 100. 0)
C
C
      N=31
      ITYPE=2
      EOP=0. 0
      CALL LRCURV (X, Y, N, ITYPE, SYMBOL, EOP)
      CALL LRCURV(X, YY, N, ITYPE, SYMBOL, EOP)
C     INDICATE THE PLOT IS COMPLETE
      EOP = 1. 0
      CALL LRCURV (X, ZZ, N, ITYPE, SYMBOL, EOP)
      STOP
      END
```

4. 3

IDENTIFICATION: LRSIZE

PURPOSE: To change the size of a plot.

USAGE: CALL LRSIZE (XLEFT, XRIGHT, YBOTM, YTOP)

where XLEFT is the lefthand end point of a plot in absolute positioning units.

XRIGHT is the righthand end point of a plot in absolute positioning units.

YBOTM is the lowe r end point of a plot in absolute positioning units.

YTOP is the upper end point of a plot in absolute positioning units.

Example: Sample plots 4. 2 and 4. 3

METHOD: CINEMATIC uses one frame of film as the size of a plot (including margins). A call to LRSIZE before a curve plotting routine will change the size of the plot. Plot size may be expanded in the X (horizontal) direction to be several frames wide. (See Figure 1. 2). A plot expanded over several frames is called a butted plot or a continuous - strip plot.

Absolute positioning units: Each frame of film contains 10 absolute positioning units in both the X direction (horizontal) and in the Y direction (vertical). (See Figure 3. 1)

CALL LRSIZE (0. 0, 55. 0, 0. 0, 10. 0) specifies a plot that covers 5-1/2 frames of film.

Choice of plot size: A good plot size depends on how the curve points are distributed along the X-axis. It also depends on the plotter resolution desired. As a rule of thumb, 1000 curve points will fit on one frame of film.

RESTRICTIONS:

A plot can be expanded in the X-direction (horizontal) only.

LRSIZE must be called before the plotting routine it applies to. The settings of LRSIZE remain in effect until changed by another call to LRSIZE.

CALL LRSIZE (0.0, 10.0, 0.0, 10.0) will set the size back to one frame of film.

4.4

IDENTIFICATION: LRMRGN

PURPOSE: To change the width of plot margins.

USAGE: CALL LRMRGN (XLEFT, XRIGHT, YBOTM, YTOP)

where XLEFT (floating point) is the lefthand margin width in absolute positioning units.

XRIGHT (floating point) is the righthand margin width in absolute positioning units.

YBOTM (floating point) is the lower margin width in absolute positioning units.

YTOP (floating point) is the upper margin width in absolute positioning units.

Example: Sample plot 4.2

METHOD: CINEMATIC sets margins around the plotting area as follows:

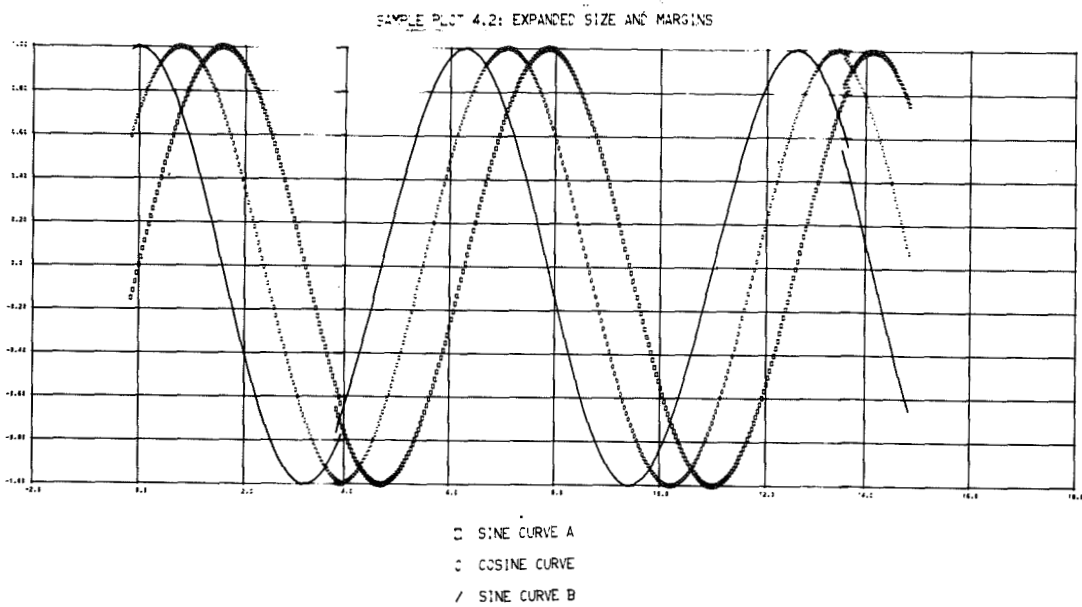
LEFT and BOTTOM 1.0 absolute positioning units
RIGHT and TOP 0.4 absolute positioning units

A call to LRMRGN before LRPLOT, LRCPLT or LRCURV will change the width of the margins.

Absolute positioning units: A frame of film contains 10 absolute positioning units in the horizontal and in the vertical directions. Thus a margin of 1.0 absolute positioning unit is 1/10 of a frame wide.

RESTRICTIONS: LRMRGN must be called before the plotting routine it applies to. The settings of LRMRGN remain in effect until changed by another call to LRMRGN.

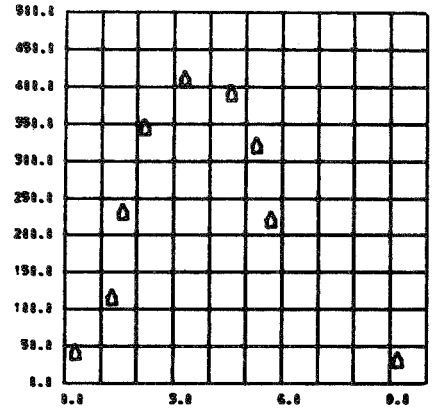
Margins less than 0.4 absolute positioning unit wide do not allow enough room for grid line labels.



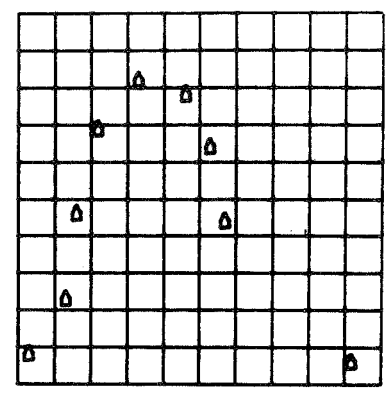

```
C       SAMPLE PLOT 4.2 --- EXPANDED PLOT SIZE AND MARGINS
C
        DIMENSION X(401), Y(401), YY(401), YYY(401)
        DIMENSION XLEG(9), ZLEG(9), TLEG(13)
        DIMENSION YLEG1(12), YLEG2(12), YLEG3(12)
        DATA TLEG /'SAMPLE PLOT 4.2 : EXPANDED SIZE AND MARGINS   '/
        DATA YLEG1 /' $GNX$GF  SINE CURVE  A          '/
        DATA YLEG2 /' $C2$GNW$GF  COSINE CURVE     '/
        DATA YLEG3 /' $C4/  SINE CURVE  B          '/
        DATA SQUARE /'X'/, CIRCLE/'W'/
C
C       EXPAND PLOT SIZE IN X-DIRECTION TO TWO AND ONE HALF FRAMES
C
        XMAX = 25.0
        CALL LRSIZE (  0.0, XMAX, 0.0, 10.0)
C
C       EXPAND BOTTOM MARGIN
C       NEGATIVE ARGUMENTS LEAVE OTHER MARGINS THE SAME
C
        YBOT = 2.0
        CALL LRMRGN  ( -1.0, -1.0, YBOT, -1.0)
C
        CALL LRTLEG (  TLEG, 44)
        ZX = 11.0
        ZY = 1.5
        CALL LRLEGN (  YLEG1,  28,  0,  ZX, ZY, 0.0)
        CALL LRLEGN (  YLEG2,  28,  0,  ZX, ZY, 0.0)
        CALL LRLEGN (  YLEG3,  28,  0,  ZX, ZY, 0.0)
C       GENERATE DATA POINTS FOR SINE CURVE  A  IN ARRAYS  X  AND  Y
        X(1)=-.15
        DO 2 I=2,401
    2   X(I)=X(I-1)+.0375
        DO 3 I=1,401
    3   Y(I)=SIN(X(I))
C       GENERATE DATA POINTS FOR COSINE CURVE IN ARRAYS  X  AND  YY
        DO 4 I=1,401
    4   YY(I)=COS(X(I))
C       GENERATE DATA POINTS FOR SINE CURVE  B  IN ARRAYS  X  AND  YYY
        DO 5 I=1,401
    5   YYY(I)=SIN(X(I)+.7854)
        CALL LRSPIL
```

```
C       PLOT SINE CURVE  A
        CALL LRCURV (X, Y, 401, 4, SQUARE, 0. 0)
C       PLOT COSINE CURVE
        CALL LRSPIL
        CALL LRCURV (X, YYY, 401, 4, CIRCLE, 0. 0)
        CALL LRSPIL
C       PLOT SINE CURVE  B
        CALL LRCURV (X, YY, 401, 2, SYMBOL, 1. 0)
        STOP
        END
```

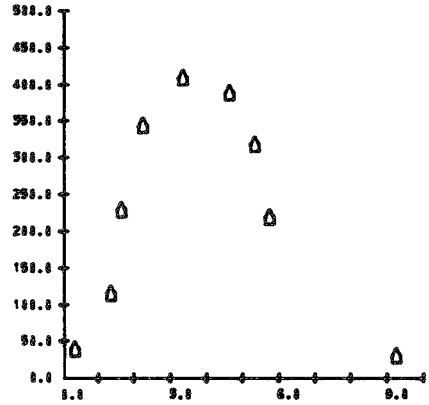
SAMPLE PLOT 4.3: FOUR PLOTS ON ONE FRAME OF FILM



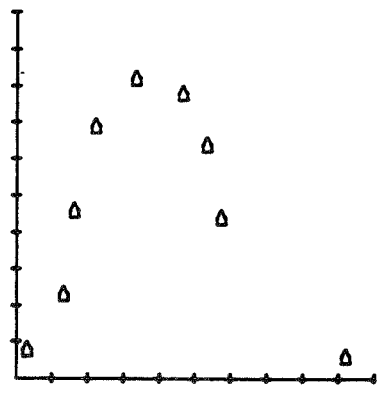
TOP LEFT PLOT



TOP RIGHT PLOT



BOTTOM LEFT PLOT



BOTTOM RIGHT PLOT

```
DIMENSION TITLE(13), X(9), Y(9), LEG1(5), LEG2(5), LEG3(5), LEG4(5)
DATA TITLE/'SAMPLE PLOT 4. 3:  FOUR PLOTS ON ONE FRAME OF FILM'/
DATA SYMBOL/'2'/
DATA X  / 0. 3, 1. 3, 1. 6, 2. 2, 3. 3, 4. 6, 5. 3, 5. 7, 9. 2/
DATA  Y  /40., 115., 230., 345., 410., 390., 320., 220., 30./
DATA LEG1/'TOP LEFT PLOT'/
DATA LEG2/'TOP RIGHT PLOT '/
DATA LEG3/'BOTTOM LEFT PLOT  '/
DATA LEG4/'BOTTOM RIGHT PLOT  '/
```

```
      CALL LRANGE(0.0, 10.0, 0.0, 500.0)
C     PUT TITLE ON TOP OF FRAME
      CALL LRTLEG(TITLE, 48)
C     EOP IS SET TO INDICATE PLOT IS NOT YET COMPLETE
      EOP = 0.0
C***  SET PLOT SIZE FOR TOP LEFT PLOT
      CALL LRSIZE (0.0, 5.0, 5.0, 10.0)
      CALL LRLEGN(LEG1, 13, 0, 1.0, 5.5, EOP)
      CALL LRCURV (X, Y, (, 4, SYMBOL, EOP)
C***  SET PLOT SIZE FOR TOP RIGHT PLOT
      CALL LRSIZE(5.0, 10.0, 5.0, 10.0)
C     REMOVE GRID LABELS FOR TOP RIGHT PLOT
      CALL LRGRID(-1, -1, 11.0, 11.0)
      CALL LRLEGN(LEG2, 14, 0, 6.0, 5.5, EOP)
      CALL LRCURV(X, Y, 9, 4, SYMBOL, EOP)
C***  SET PLOT SIZE FOR BOTTOM LEFT PLOT
      CALL LRSIZE (0.0, 5.0, 0.0, 5.0)
C     USE TICK MARKS INSTEAD OF GRID LINES FOR BOTTOM LEFT
      CALL LRGRID(3, 3, 11.0, 11.0)
      CALL LRLEGN(LEG3, 16, 0, 1.0, 0.5, EOP)
      CALL LRCURV(X, Y, 9, 4, SYMBOL, EOP)
C***  SET PLOT SIZE FOR BOTTOM RIGHT PLOT
      CALL LRSIZE (5.0, 10.0, 0.0, 5.0)
C     REMOVE TICK MARK LABELS FOR BOTTOM RIGHT PLOT
      CALL LRGRID(-3, -3, 11.0, 11.0)
      CALL LRLEGN(LEG4, 17, 0, 6.0, 0.5, EOP)
C     SET EOP TO INDICATE ENTIRE PLOT IS COMPLETE
      EOP = 1.0
      CALL LRCURV(X, Y, 9, 4, SYMBOL, EOP)
      STOP
      END
```

4.5

IDENTIFICATION: LRSCAN

PURPOSE: To find the maximum and minimum values of an array of real numbers.

USAGE: CALL LRSCAN (ARRAY, N, AMIN, AMAX)

where ARRAY (floating point) is any array of numbers.

N (fixed point) is a count of how many numbers in ARRAY.

AMIN (floating point) contains the minimum value of ARRAY after a call to LRSCAN.

AMAX (floating point) contains the maximum value of ARRAY.

Example: Sample plot 4.1

5.1

IDENTIFICATION: LRLABL

PURPOSE: To label a plotted point.

USAGE: CALL LRLABL (CHARS, N, IORIEN, X, Y, EOP)

where CHARS is an array of characters to be printed. CHARS must be dimensioned large enough for the number of characters desired. (4 characters per word on the 360/67, 6 characters per word on the 7090-7040 series direct couples)

N (fixed point) is the number of characters to be printed.

IORIEN (fixed point) is a switch. IORIEN=0 causes horizontal printing. IORIEN=1 causes vertical printing. (bottom to top).

X (floating point) X-coordinate of label's starting point in user's units.

Y (floating point) Y-coordinate of label's starting point in user's units.

EOP (floating point) is a switch. EOP=0.0 means the current plot is not yet complete. EOP=1.0 means the current plot is complete. No more calls to plotting or printing subroutine will occur for this plot.

Example: Sample plot 5.1

METHOD:

User's units: LRLABL allows the user to specify the starting point of a line of printing in the same units he uses to draw a curve.

Character Size: LRLABL prints small size characters. Section 6 describes how to get other character sizes, italics, lower case and special symbols.

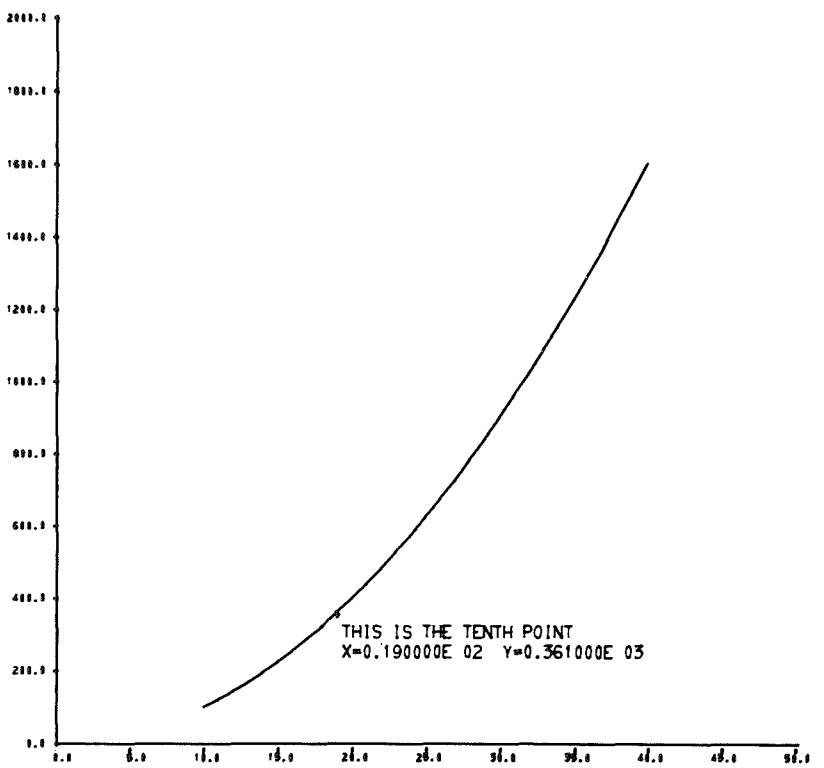
RESTRICTIONS:

LRLABL must be called after LRCPLT or LRCURV for any one plot. LRLABL cannot label a plot made with LRPLOT.

CHARS must contain printable characters. To convert a fixed point or floating point number into printable characters use LRCNVT (Sec. 5.2).

LRLABL starts printing right at the (X, Y) point. Use TABBING CHARACTERS (Sec. 6.2) to position printing in the neighborhood of an (X, Y) point.

SAMPLE PLOT 5.1: LABELING A DATA POINT




```
C       EXAMPLE PLOT 5.1 ---  LABELING A PLOTTED POINT
C
        DIMENSION TENTH (15), XVALUE (10), YVALUE(10)
        DIMENSION X(31), Y(31), TCHAR(15)
C
C       SPECIAL CHARACTER MODE AND TABBING CHARACTERS ARE USED TO FORMAT
C       THE LABEL
C
        DATA TENTH/'$GNV$GF$D1THIS IS THE TENTH POINT '/
        DATA XVALUE/'$D2$R1X='/
        DATA YVALUE/'$D2$R8$R8  Y='/
        DATA TCHAR/' SAMPLE PLOT 5.1    LABELING A DATA POINT  '/
        DATA SYMBOL/'X'/
        CALL LRTLEG (TCHAR, 41)
```

```
      X(1)=10. 0
      DO 2 I=2, 31
    2 X(I) = X(I-1)+1. 0
      DO 3 I=1, 31
    3 Y(I) = X(I) * X(I)
      CALL LRANGE (  10. 0, 40. 0, 10. 0, 1600. 0)
      CALL LRGRID (3, 3, 11. 0, 11. 0)
      N=31
      ITYPE=2
      EOP=0. 0
      CALL LRCURV(X, Y, N, ITYPE, SYMBOL, EOP)
C
C     CONVERT TENTH X AND Y VALUES FROM BINARY FLOATING POINT
C     NUMBERS TO PRINTABLE CHARACTERS
      CALL LRCNVT (X(10), 3, XVALUE(3), 4, 13, 6)
      CALL LRCNVT (Y(10), 3, YVALUE(4), 4, 13, 6)
C
C     NOW LABEL THE TENTH X-Y POINT WITH THE WORDS 'THIS IS THE
C     TENTH POINT' AND WITH THE NUMERICAL VALUES OF X(10) and Y(10)
C
      CALL LRLABL (TENTH, 34, 0, X(10), Y(10), 0. 0)
      CALL LRLABL ( XVALUE, 20, 0, X(10), Y(10), 0. 0)
      EOP=1. 0
      CALL LRLABL (YVALUE, 24, 0, X(10), Y(10), EOP)
      STOP
      END
```

5. 2

IDENTIFICATION: LRCNVT

PURPOSE: To convert a fixed or floating point number into printable characters.

USAGE: CALL LRCNVT (X, ITYPE, CHARS, IFORM, N, M)

where X is the number to be converted.

ITYPE=1 means X is fixed point.

ITYPE=2 means X is INTEGER*2 (used on 360 only).

ITYPE=3 means X is floating point.

CHARS array to receive printable characters. CHARS must be dimensioned large enough to hold the N characters requested.

IFORM is a switch that describes the format of the characters

=1 convert to FORTRAN "I" format
=2 convert to FORTRAN "Z" format (used on 360 only)
=3 convert to FORTRAN "F" format
=4 convert to FORTRAN "E" format

N total number of characters desired

M number of characters to right of decimal point. M=0 for "I" or "Z" format.

Example: Sample plot 5. 1

RESTRICTIONS: If IFORM =4, N must be at least M+7.
If ITYPE=1 or 2, IFORM may equal 1 or 2 only.
If ITYPE=3, IFORM may equal 2, 3, or 4 only.

6.1

IDENTIFICATION: LRCHSZ

PURPOSE: To change the size of printed characters.

USAGE: CALL LRCHSZ (ISIZE) where

ISIZE (fixed point) gives the size.

= 0 let CINEMATIC resume selecting the size
= 1 miniature characters
= 2 small characters
= 3 medium characters
= 4 large characters

Example: Figure 6.3

METHOD: LRCHSZ changes the character size for all character printing that follows. The specified size remains in effect until changed by another call to LRCHSZ.

Large	43 char/line	22 lines/frame
Medium	64 char/line	32 lines/frame
Small	86 char/line	43 lines/frame
Miniature	128 char/line	64 lines/frame

RESTRICTION: LRCHSZ must be called before the printing subroutine it applies to.

FIGURE 6.1: DD280 CHARACTER SET

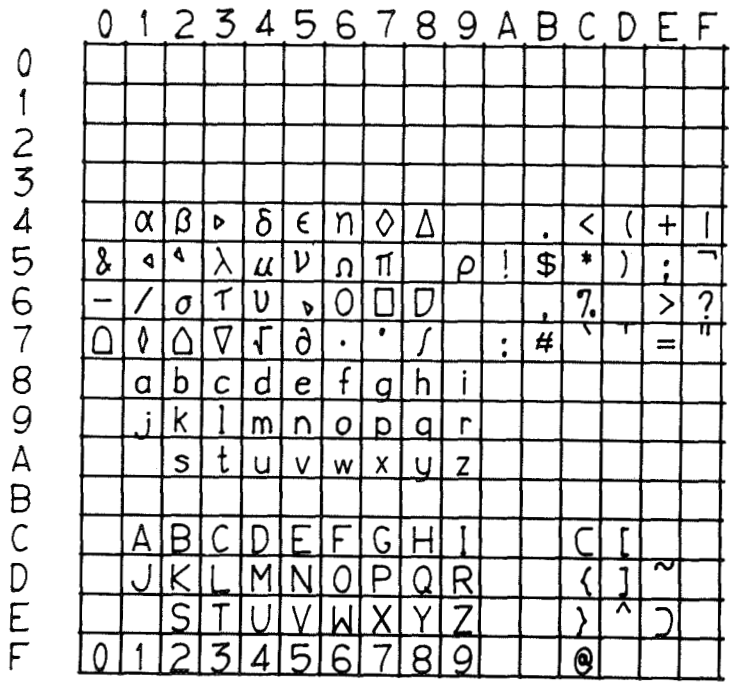


FIGURE 6.2: SPECIAL CHARACTER TABLE

FORTRAN	SPECIAL	LOWER	FORTRAN	SPECIAL	LOWER
A	α	a	S	σ	s
B	β	b	T	τ	t
C	$\supset$	c	U	υ	u
D	δ	d	V	$\subset$	v
E	ϵ	e	W	$\cap$	w
F	η	f	X	$\sqsubset$	x
G	$\diamond$	g	Y	$\sqsupset$	y
H	Δ	h	Z		z
I		i	0	$\sqcap$	0
J	$\triangleleft$	j	1	$\diamond$	1
K	$\triangleleft$	k	2	$\sqcap$	2
L	λ	l	3	∇	3
M	μ	m	4	$\sqrt{}$	4
N	ν	n	5	∂	5
O	$\cap$	o	6	$\cdot$	6
P	π	p	7	$\cdot$	7
Q		q	8	$\int$	8
R	ρ	r	9		9

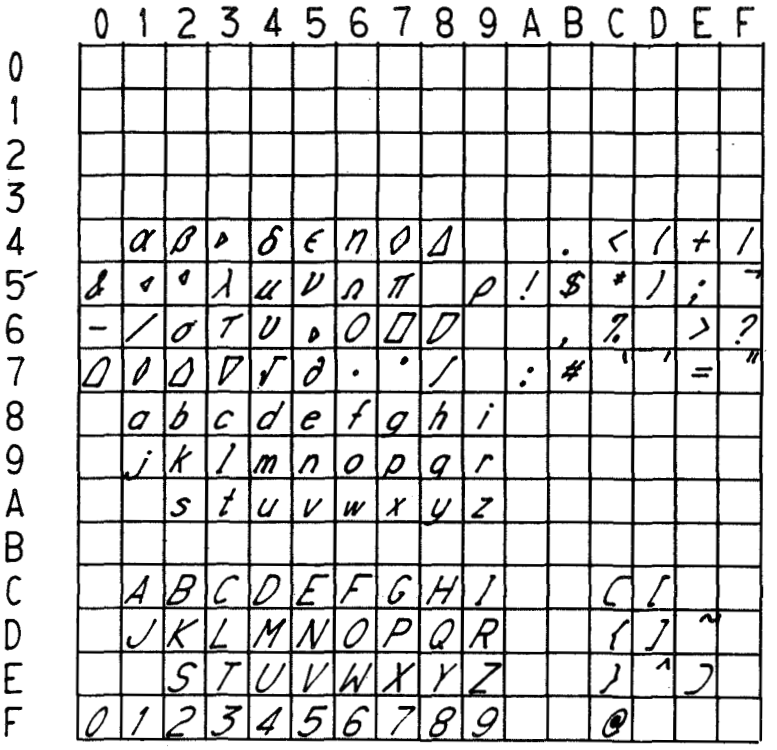
FIGURE 6.3: CHARACTER SIZES AND ITALICS

AN EXAMPLE OF LARGE CHARACTERS
AN EXAMPLE OF MEDIUM CHARACTERS
AN EXAMPLE OF SMALL CHARACTERS
AN EXAMPLE OF MINIATURE CHARACTERS

AN EXAMPLE OF ITALICIZED CHARACTERS
AN EXAMPLE OF ITALICIZED CHARACTERS
AN EXAMPLE OF ITALICIZED CHARACTERS
AN EXAMPLE OF ITALICIZED CHARACTERS

an example of lower case characters
an example of lower case characters
an example of lower case characters
an example of lower case characters

FIGURE 6.4: DD280 CHARACTER SET IN ITALICS



6.2 TABBING CHARACTERS

Tabbing (positioning) characters may be included in the array of characters specified by the "CHARS" argument of LRLEGN, LRLABL, LRXLEG, LRYLEG or LRTLEG. Three characters are used for each positioning order. The first of the three is always a "$". (See sample plots 4.2 and 5.1)

'$Ln' ($1 \leq n \leq 9$) implies space "n" character positions to the left of the current character position.

'$Rn' space "n" positions to the right

'$Un' space "n" positions up

'$Dn' space "n" positions down

'$Cn' implies return to the beginning of the line and do "n" line feeds

For very precise character positioning, the following may be used:

'$Mn' space "n" raster units to the left

'$Sn' space "n" raster units to the right

'$Vn' space "n" raster units up

'$En' space "n" raster units down

A raster unit is smallest X or Y increment recognized by the microfilm recorder. Each absolute positioning unit contains 102.4 rasters.

A MINIATURE character is 8 rasters wide and 16 raster high

A SMALL character is 12 rasters wide and 24 rasters high

A MEDIUM character is 16 rasters wide and 32 rasters high

A LARGE character is 24 rasters wide and 48 rasters high

6.3 LOWER CASE AND SPECIAL CHARACTERS

Many of the special characters that can be printed on film are not in the FORTRAN character set. (See figure 6.1 for complete microfilm recorder character set and hexadecimal equivalents). To enable a FORTRAN programmer to use FORTRAN characters to specify non-FORTRAN special characters, two mode-setting capabilities are available. If "Greek mode" is turned on, characters in the second column of the SPECIAL CHARACTER TABLE (See figure 6.2) are substituted for the FORTRAN characters in column 1. "Lower case mode" uses the third column of the SPECIAL CHARACTER TABLE. Greek mode is turned on by putting the three characters "$GN" into the array of BCD characters just before the characters to be translated into Greek mode. "$GF" turns off Greek mode. "$WN" turns on lower case mode. "$WF" turns it off. For example, the array of characters '$GNABD$GFXYZ' is printed as $\alpha\ \beta\ \delta$ XYZ.

Greek mode stays on only during the subroutine call in which it appears. Lower case mode works the same as Greek mode. The FORTRAN character set is not limited to the characters appearing in the first column of the "SPECIAL CHARACTER TABLE". Any character that appears on a keypunch (except "$\not$") can be printed directly by the DD280.

6.4

IDENTIFICATION: LRION, LRIOFF

PURPOSE: To italicize printed characters.

USAGE: CALL LRION causes all printed characters that follow to be italicized.

CALL LRIOFF turns off italicized mode of printing.

Example: Figures 6.3 and 6.4

RESTRICTION: Vertical printing cannot be italicized.

6.5

IDENTIFICATION: LRTON, LRTOFF

PURPOSE: To cause printed or plotted characters to be rotated 90 degrees.

USAGE: CALL LRTON turns on orientation mode

CALL LRTOFF turns off orientation mode

METHOD: When orientation mode is on, all printed and plotted characters are oriented with a 90 degree rotation. For example,

'A' becomes '$<$'

Once, turned on, orientation mode stays on until turned off by a call to LRTOFF.

The primary use of orientation mode is to rotate characters used as plotting symbols on a curve.

7.1

IDENTIFICATION: LRNON, LRNOFF

PURPOSE: To highlight part of a plot.

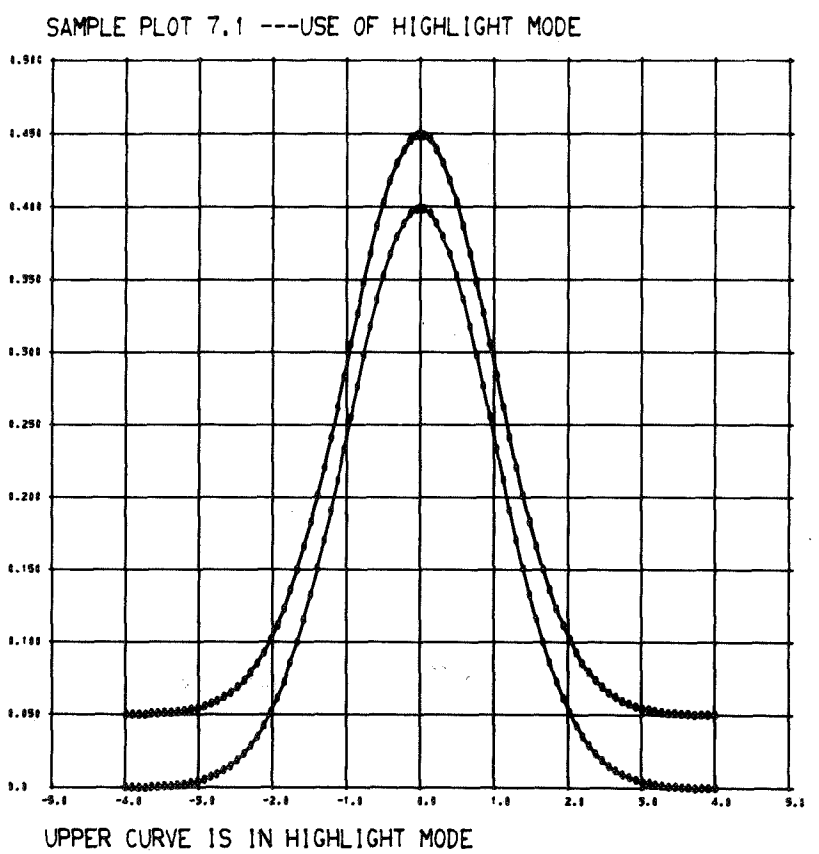
USAGE: CALL LRNON turns on highlight mode.

CALL LRNOFF turns off highlight mode.

Example: Sample plot 7.1

METHOD: Turning on "highlight mode" causes all images that follow (points, lines and characters) to appear more intense than images produced with highlight mode off.

Once turned on, highlight mode stays on until turned off by LRNOFF.



```
C       SAMPLE PLOT 7.1 --- USE OF 'HIGHLIGHT MODE'
C
        DIMENSION X(100), Y(100)
        REAL TCHAR (15)/'SAMPLE PLOT 7.1 ---USE OF HIGHLIGHT MODE
        REAL XCHAR (12)/'UPPER CURVE IS IN HIGHLIGHT MODE    '/
C
C       PRINT LEGENDS AND TITLE
C
        CALL LRTLEG (TCHAR, 41)
        CALL LRXLEG (XCHAR, 34)
C
C       GENERATE X AND Y POINTS FOR A HAYSTACK CURVE
C
        XDIFF = 8.0/89.0
        CON = 1.0/SQRT (2*3.14)
        X(1) = -4.0
        Y(1) = CON*EXP (-0.5*X(1)*X(1))
        DO 10 I=2, 90
        X(I) = X(I-1) + XDIFF
   10   Y(I) = CON*EXP(-0.5*X(I)*X(I))
C
C       DRAW LOWER CURVE AND GRID
C
        CALL LRCURV (X, Y, 90, 2, 1HO, 0.0)
        CALL LRCURV (X, Y, 90, 3, 1HO, 0.0)
C
C       DRAW UPPER CURVE WITH HIGHLIGHT MODE ON
C
        DO 20 I=1, 90
   20   Y(I) = Y(I)+0.05
        CALL LRNON
        CALL LRCURV (X, Y, 90, 2, 1HO, 0.0)
        CALL LRCURV (X, Y, 90, 3, 1HO, 1.0)
        STOP
        END
```

7.2

IDENTIFICATION: LRMON, LMOFF

PURPOSE: To produce movie-compatible film.

USAGE: CALL LRMON turns on movie mode

CALL LRMOFF turns off movie mode

METHOD: Turning on "movie mode" orients the frames of film to be movie compatible.

Once turned on, movie mode stays on until turned off by LRMOFF.

8.1 ERROR MESSAGES

ERR001 OFF-PLOT PRINT COORDINATES

N	X	Y	XMIN	XMAX	YMIN	YMAX
nn	xx.x	yy.y	xx.x	xx.x	yy.y	yy.y

Attempt to print off the plot. The X-Y coordinates (absolute positioning units) of the off-plot character is given along withlimits it should fall into. N gives the faulty characters' location in the array of characters being printed.

ERR002 CALL NUMBER. nn TO PRINT CONTAINS A TOTAL OF mmm CHARACTERS OFF THE PLOT

Calls to LRXLEG, LRYLEG, LRLEGN give this message. Message "ERR001" precedes this message unless the printing started off the plot. The point at which characters went off the plot is given by message "ERR001".

ERR003 CALL NUMBER nn to LRLABL CONTAINS A TOTAL OF mmm CHARACTERS OFF THE PLOT

Message "ERR001" precedes this message unless the labeling started off the plot. The point at which characters went off the plot is given by message "ERR001".

ERR004 CALL NUMBER nn TO LRLABL ATTEMPTS TO LABEL A DATA POINT FOR WHICH RANGE IS UNKNOWN

LRLABL must be called after LRCURV or LRCPLT.

ERR005 CALL NUMBER nn TO PLOT A CURVE CONTAINS A TOTAL OF mmm POINTS OUT OF RANGE

This message is preceded by "ERR007" which gives the coordinates of the first ten points out range. Points are out of range when they do not fall within the maximum and minimum values established for scaling.

ERR007 FIRST TEN OUT OF RANGE COORDINATES FOR PLOTTING A CURVE

N X Y XMIN XMAX YMIN YMAX

The N^{th} point (X, Y) in a request to draw a curve is out of range. The first ten out of range coordinates are printed. Total number of out of range points given by "ERR005".

ERR008 CALL NUMBER nn TO PLOT A CURVE HAS AN ILLEGAL PLOT TYPE. A POINT PLOT WAS USED INSTEAD: See description of "ITYPE" argument to LRCURV.

RESTRICTION: Only one line prints page of error messages will appear. Subsequent error messages are not reported.

8.2

IDENTIFICATION: LRSPIL

PURPOSE: To print out all of CINEMATIC's current plot settings.

USAGE: CALL LRSPIL

Example: Figure 8.1

METHOD: The current plot settings include the plot size, user's data ranges, margin sizes, character sizes, etc.

Figure 8.1: Table of CINEMATIC Plot Settings

*TABLE DUMP ROUTINE CALL 1

ORD CONTAINING...,	VALUE	WORD CONTAINING...,	VALUE
1 DEVICE	2	2 DEVICE TYPE	2
3 X A.P.U.	0.1023E 03	4 Y A.P.U.	0.1023E 03
5 SCREEN SIZE X-MAX	0.1023E 04	6 SCREEN SIZE Y-MAX	0.1023E 04
7 SCREEN SIZE X-MIN	0.0	8 SCREEN SIZE Y-MIN	0.0
9 X ORIGIN	0.0	10 Y ORIGIN	0.0
11 LEFTMARGIN	0.1000E 01	12 RIGHT MARGIN	0.4000E 00
13 TOP MARGIN	0.4000E 00	14 BOTTOM MARGIN	0.1000E 01
15 GRAPH LENGTH	0.0	16 POINT DENSITY	0.0
17 DATA RANGE MAXX	0.4000E 02	18 DATA RANGE MAXY	0.2100E 04
19 DATA RANGE MINX	0.1000E 02	20 DATA RANGE MINY	-0.4000E 03
21 X GRID INTERVAL	0.2000E 01	22 Y GRID INTERVAL	0.1000E 03
23 X-RANGE SET	1	24 Y-RANGE SET	1
25 X GRID TYPE	2	26 DEBUG REQUEST	0
27 NO. WORDS INSCOPE	0	28 X SCALE FACTOR	0.0
29 Y SCALE FACTOR	0.0	30 RIGHT PLOT LIMIT	0.0
31 TOP PLOTLIMIT	0.0	32 LEFT PLOT LIMIT	0.0
33 LOWER PLOT LIMIT	0.0	34 X ADD FACTOR	0.0
35 Y ADD FACTOR	0.0	36 MODES	0
37 Y GRID TYPE	2	38 SPARE	0
39 CHARACTER SIZE	0.0	40	0.0

The following words are of interest to the user:

5-8	Plot size (0.0 - 1023.0 for each frame)
11-14	Plot margins (in absolut e positioning units)
17-20	The user's data ranges in his units
21-22	Grid intervals or frequencies
23-24	Are non-zero when LRANGE was called
25-37	Type of grid options requested by LRGRID
39	Character size as set by LRCHSZ (0-4)

8.3

IDENTIFICATION: LRBON, LRBOFF

PURPOSE: To turn debug mode on or off.

USAGE: CALL LRBON turns on debug mode

CALL LRBOFF turns off debug mode

METHOD: Turning debug mode on causes the following messages to be printed:

"MICROFILM PLOTTING STARTED" when the first call to a CINEMATIC subroutine is made. "END OF PLOT" at the completion of every plot. Once turned on, debug mode stays on until turned off by a call to LRBOFF.

9.1 FORTRAN line-printer output on film

IDENTIFICATION: FPRINT

PURPOSE: To send FORTRAN program printer output to the film recorder instead of to a line printer.

USAGE: Use of FPRINT requires two job control cards on the 7090-7040 series direct couple systems:

```
C. C. 1                    16
$DECK                      FILMID
        (immediately after the $ID card)
$DECK                      FPRINT
        (immediately after the $IBJOB card)
```

When these two job control cards are used, the output generated by the FORTRAN statements:

```
      WRITE (6, n) list
    n FORMAT
```

goes to the film recorder instead of the line printer.

Examples:

```
$ID       JOHN SMITH
$DECK     FILMID
$TCP      TIME=1
$IBJOB
$DECK     FPRINT
```

causes the information written on FORTRAN tape 6 to go to film

```
$ID       JOHN SMITH
$DECK     FILMID
$TCP      TIME=1
$IBJOB
$DECK     FPLOT
$DECK     FPRINT
```

allows plotting on film and sends FORTRAN tape 6 output to film.

METHOD: One frame of film replaces one page of paper on the line printer. The use of carriage controls is the same on the film recorder as on the line printer.

RESTRICTIONS: A printed line may contain up to 129 characters including the carriage control character. Characters in excess of 129 are lost. When the user is calling several plotting subroutines to make a plot, he may not generate printed output until he has finished all the subroutine calls for that plot. Otherwise the line-printing may appear on the same frame as the plot.

9.2 Program listings and diagnostics on film.

IDENTIFICATION: FLIST

PURPOSE: To send FORTRAN listings, diagnostics and error messages to the film recorder instead of to a line printer.

USAGE: Use of FLIST requires two job control cards on the 7090-7040 series direct couple systems:

```
C.C.1        16
$DECK        FILMID
$DECK        FLIST
```

(immediately after the $ID card)

Examples:

```
$ID      JOHN SMITH
$DECK    FILMID
$DECK    FLIST
$TCP     TIME=1
$IBJOB   NOGO
$IBFTC
```

causes program listings, diagnostics, and error messages to go to the film recorder instead of the line printer.

METHOD: One frame of film replaces one page of paper on the printer.

RESTRICTIONS: The "NOGO" must be used on the $IBJOB control card. The job cannot continue into execution after the compiler listing has been sent to film.

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