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GRAFIT: A GENERALIZED GRAPHICS PACKAGE.(U)
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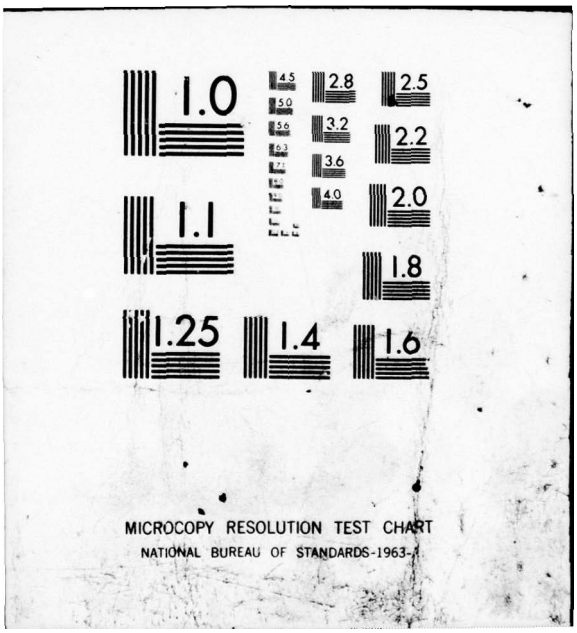
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NRL Memorandum Report 4027

GRAFIT: A Generalized Graphics Package

J. P. Boris, E. Dent, M. J. Fritts,
I. Haber, and W. W. Jones

Laboratory for Computational Physics
and
Plasma Physics Division

July 20, 1979

This work was supported by the Office of Naval Research
under Project Nos. RR-23-01-01 and RR014-03-02.

NAVAL RESEARCH LABORATORY
Washington, D.C.

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NRL Memorandum Report 4027
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE *(and Subtitle)*: GRAFIT: A GENERALIZED GRAPHICS PACKAGE

5. TYPE OF REPORT & PERIOD COVERED: Interim report on a continuing NRL problem.

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): J. P. Boris, E. Dent, M. J. Fritts, I. Haber and W. W. Jones

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS: Naval Research Laboratory, Washington, DC 20375

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: Program Element 61153N 14; Proj. Nos. RR-23-01-01 and RR014-03-02 (Continues)

11. CONTROLLING OFFICE NAME AND ADDRESS: Office of Naval Research, Arlington, VA 22203

12. REPORT DATE: July 20, 1979

13. NUMBER OF PAGES: 61

14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*: NRL-MR-4027

15. SECURITY CLASS. *(of this report)*: UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*: RR023-01-01, RR014-03-02

18. SUPPLEMENTARY NOTES

This work was supported by the Office of Naval Research under Project Nos. RR-23-01-01 and RR014-03-02 and the Defense Nuclear Agency under Subtask S99QAXHC062-38.

PE 62704H

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Computer graphics	Page plots
Stromberg-Carlson	Contour plots
Tektronix plotter	Surface plots
Calcomp plotter	Color movies

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report is a concise user Manual for the GRAFIT package of subroutines. GRAFIT is a simple system for generating computer-graphics magnetic tapes for the Stromberg-Carlson 4020 microfilm recorder, on-line Calcomp incremental plotter, page-plot graphs, or Tektronix plots. The system is designed to be very efficient so using it to generate movies on 16mm film is relatively inexpensive. Appendices A, B, C, and D discuss the use of GRAFIT with consideration of the necessary control language and with an example of rather general utility.

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

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10. Program Element, Project, Task Area & Work Unit Numbers (Continued)

NRL Problem H02-39

CONTENTS

Abstract

This report is a concise user Manual for the GRAFIT package of subroutines. GRAFIT is a simple system for generating computer-graphics magnetic tapes for the Stromberg-Carlson 4020 microfilm recorder, on-line Calcomp incremental plotter, page-plot graphs, or Tektronix plots. The system is designed to be very efficient so using it to generate movies on 16mm film is relatively inexpensive. Appendices A, B, C, and D discuss the use of GRAFIT with consideration of the necessary control language and with an example of rather general utility.

PROBLEM STATUS

This is an interim report on a continuing problem.

AUTHORIZATION

NRL Problems H02-27E and H02-39
DNA Subtask S99QAXHC062-38

LIST OF FIGURES

GRAFIT: A GENERALIZED GRAPHICS PACKAGE

GRAFIT GENERAL STRUCTURE

GRAFIT is a package of subroutines for forming graphics output. Its main function is the production of 16 or 35 mm movie frames on the Stromberg Carlson SC4020 film recorder. In order to accomplish this, GRAFIT produces a file which is used directly by the SC4020 film recorder. GRAFIT may also be used to produce hard-copy graphs and single slides, e.g. on a TEKTRONIX display unit.

The main routine of the graphics package is the subroutine GRAFIT. This subroutine does the general processing for the film, such as generating camera selection commands, frame advance commands, repeat of frames, and writing out the file. GRAFIT is called directly by the user. Subsidiary routines which perform special functions are:

BOXPLT, VBXPLT	- draws a rectangle.
CHAR	- draws a specified character at a given point.
CHDRAW	- draws a character of the specified character set.
CHPLOT	- draws specified charactron character at points in an array.
DEFINE	- defines the scale for other routines.
EFORMR	- plots a floating point number in FORTRAN E-type format (Set 1 characters).
FIDUCL	- draws reference marks on the corners and at the center of the frame.
GRAFIT	- executive routine.
LYNE, VLINE	- draws a line between two points.
LNPLOT	- draws lines between points in an array.
MOVEND	- prints number of frames generated and prints hex dump of plot file.
NMDRAW	- draws a floating point number in FORTRAN F-type format (Set 1 characters).
WDDRAW	- draws a character string (Set 1 characters)

Other routines which are called by GRAFIT to perform specialized functions:

Note: Manuscript submitted May 14, 1979.

TOTAPE	- outputs the plot file.
ISSUE	- gives color and filter commands.
SET 1, SET 2, SET 3 ...	- character sets.
IDENT, IDCODE, IDCHAR	- character identification.
LNPACK, VLNPCK	- packs data.
PTPACK, VPTPCK	- packs data.
BUFPAK, VBUFPK	- packs data.

There is a first frame routine, DRWNRL, which draws the word "NRL" and input text on the first frame. There is also a last frame routine, DRWEND, which draws the word "END" on the last frame. These two logos appear only on the SC4020 output. Several of the graphics routines have been vectorized and optimized for the NRL ASC computer. The subroutines TOTAPE, BUFPAK, LYNE, and BOXPLT have been completely optimized. They are called TOTAPE, VBUFPK, VLINE, and VBXPLT. New versions of BUFST1 and BUFST2 (BUFST3 and BUFST4, respectively) have been added for vectorizable operations such as curve plotting.

Several graphics packages are available which use GRAFIT. These are found on the ASC system library. They perform such functions as contour plotting (CUNTOR), surface plotting (SURFO), volume contour plotting (VOLUME) and general gridding for GRAFIT output (GRIGEN). Listings of these routines, as well as their calling sequences, modes of operation and examples of their use can be found in the Scientific Program Library (SPL).

Appendix A contains a step-by-step definition for the required calls to GRAFIT and the corresponding arguments. Appendix B contains necessary JSL control statements for the graphics output files from GRAFIT. Appendix C contains an operational sequence for the various modes of GRAFIT and Appendix D presents a useful set of examples of GRAFIT applications.

Figure (1) shows the interrelation of the various GRAFIT modules.

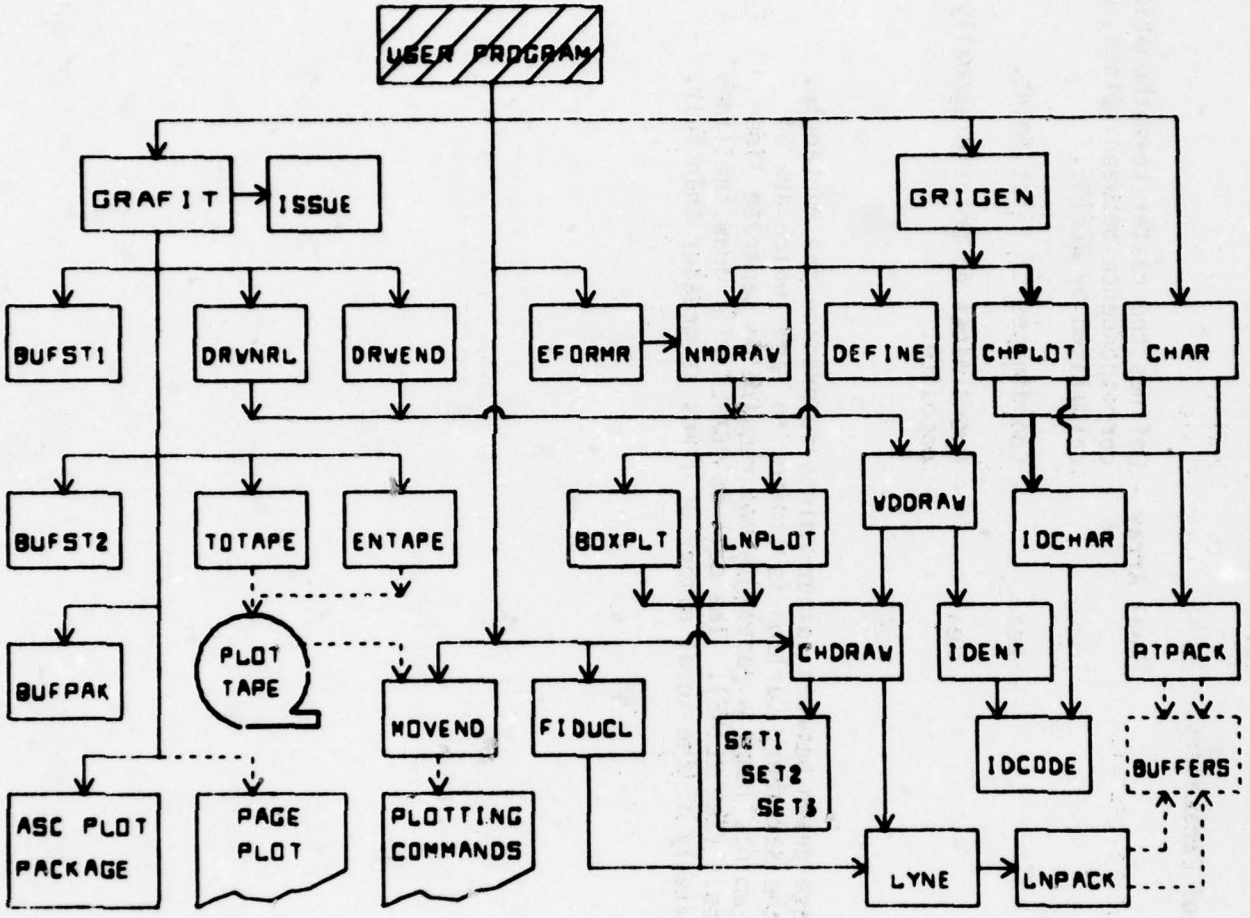


Figure 1. GRAFIT

BOXPLT, VBXPLT

Purpose: to draw a rectangle whose corners are (X1, Y1), (X2, Y1), (X2, Y2), and (X1, Y2).

Usage:

```
Call BOXPLT (Scale, X1, Y1, X2, Y2)
Call VBXPLT (Scale, X1, Y1, X2, Y2)
```

Description of Parameters:

SCALE	Real Array	- Defines the raster-to-mathematical correspondence between points, usually calculated by DEFINE.
X1, Y1	Real	- Coordinates of first point.
X2, Y2	Real	- Coordinates of point diagonally opposite.

Method:

Lines are drawn between corner points to produce the rectangle. Since the Stromberg Carlson is limited to lines which are 64 raster points long, a rectangle may require 64 separate line segments. (See VLINE). The call to VBXPLT will draw the lines more quickly if the total number of lines is greater than four.

BUFPAK, VBUFPK

Purpose: To strip off the 28 leading zeros from the 64 bit plotting commands and store as 36 bit commands in the same buffer.

Usage: CALL BUFPAK (OUT, J, K)

Description of parameters:

OUT	Integer Array	- location of the input data array and location where the packed data will be stored. For greatest speed "OUT" should start on a double-word boundary.
J	Integer	- number of words of input data.
K	Integer	- output - number of words of packed data (always a multiple of 9).

Method:

SC4020 plotting commands are 36 bits long. These are generated by GRAFIT in 2 32-bit words for efficiency and packed later by BUFPAK into the 36 bit word string. Commands are packed in blocks of eight (16 words input) by stripping off the leading 28 bits from each 2 word command. The last block is filled out with "BLANK" plot commands.

CHAR

Purpose: This routine uses the hardware character mode (Charactron) to plot data points at the location specified by (XCHAR, YCHAR) in the plotting region determined by SCALE.

Usage: CALL CHAR (SCALE, XCHAR, YCHAR, CHARAC)

Description of Parameters:

SCALE	Real Array	- defines the raster-to-mathematical correspondence between points.
XCHAR	Real	- X coordinate of data.
YCHAR	Real	- Y coordinate of data.
CHARAC	Integer	- literal character to be plotted, centered at (XCHAR, YCHAR), stored in the leftmost byte of the word (eg. 'A').

Method:

The character CHARAC is converted from a literal character to its equivalent plotting command by IDCHAR. The subroutine PTPACK is then called to pack the plotting command for the point to be plotted.

Example: Figure 2A (SC4020 Charactron Character Set) depicts the set of charactron characters available on the SC 4020. The equivalent keypunch characters are displayed in the same relative positions in Figure 2B (Charactron Equivalent Keypunch Characters).

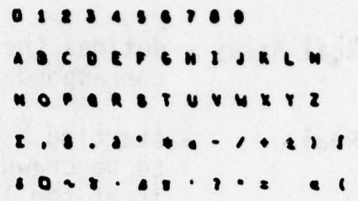


Figure 2A. SC4020 Charactron Character Set

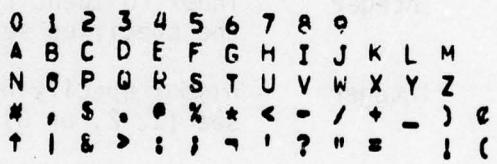


Figure 2B. Charactron Equivalent Key Punch Characters

CHDRAW

Purpose: To draw a particular character of the specified character set.

Usage: CALL CHDRAW (SCALE, XCHAR, YCHAR, SX, SXY, SY, CHNUMB, SET)

Description of Parameters:

SCALE	Real Array	- defines the raster-to-mathematical correspondence between points.
XCHAR	Real	- starting X coordinate of the character to be drawn. The starting coordinate is at the lower left-hand corner of the character.
YCHAR	Real	- starting Y coordinate of the character to be drawn.
SX	Real	- X scale multiplier for characters.
SXY	Real	- slant modifier for characters.
SY	Real	- Y scale multiplier for characters.
CHNUMB	Integer	- index to identify the character within the specified set.
SET	Integer	- number specifying a particular character set (1, 2, or 3).

Method:

CHDRAW draws a character identified by CHNUMB, which is usually found by a prior call to IDENT. The character is drawn as a series of straight line segments. CHDRAW calls the routines SET1, SET2, or SET3 which generate the end-points of these line segments. The character will be drawn within a rectangle SX wide by SY high with its lower left corner at XCHAR, YCHAR. The character will not fill the rectangle, but will allow for spacing in both the X and Y directions. The rectangle may be slanted to form a parallelogram by raising and lowering the right hand boundary by an amount SXY * SX, depending on the sign of SXY. XCHAR, YCHAR, SX, SY and SXY are all in the same units, and are scaled to raster units through SCALE, which is usually found by a previous call to DEFINE.

CHPLOT

Purpose: To plot a specified character at the positions specified by the X, Y elements of an input array.

Usage: CALL CHPLOT (SCALE, XARRAY, YARRAY, CHARAC, I1, I2, I3)

Description of Parameters:

SCALE	Real Array	- defines the raster-to-mathematical correspondence between points.
XARRAY	Real Array	- X coordinates of data.
YARRAY	Real Array	- Y coordinates of data.
CHARAC	Literal	- character to be plotted.
I1	Integer	- increment at which points are to be selected for plot.
I2	Integer	- index of first point to be plotted.
I3	Integer	- index to last point in the data array.

Method:

The character CHARAC is converted from a literal character to its equivalent plotting command by IDCHAR. Subroutine PTPACK is called to generate a plotting command for each point to be plotted. On the Tektronix display the internal character set is employed. On the Calcomp characters are actually drawn. If I1 = 1 and I2 = 1, this routine may be replaced by the vectorized version of PTPACK which is VPTPCK.

Characters are drawn centered at the coordinates X, Y given in XARRAY, YARRAY. As shown in figure 2A, the character ".", a period, will be drawn below the point specified in XARRAY, YARRAY. A centered dot can be drawn at the coordinate using an EBCDIC ":", as shown in Figure 2B.

DEFINE

Purpose: This routine defines the raster-to-mathematical correspondence for operating with Real*4 data where margins are specified.

Formulae of the form

$$X_{raster} = SCALE(1) * X_{math} + SCALE(2)$$

$$Y_{raster} = SCALE(3) * Y_{math} + SCALE(4)$$

are used for each of the mathematical spaces defined.

Usage:

```
CALL DEFINE (SCALE, X1, X2, X1R, X2R, Y1, Y2, Y1R,
             Y2R)
```

Description of Parameters:

SCALE	Real*4 Array	- four word buffer to be filled with the scaling modifiers used to transform points from the mathematical to the raster space.
X1	Real	- left limit of the mathematical space.
X2	Real	- right limit of the mathematical space.
X1R	Real	- left limit of the corresponding raster space region.
X2R	Real	- right limit of the corresponding raster space region.
Y1	Real	- bottom limit of the mathematical space.
Y2	Real	- top limit of the mathematical space.
Y1R	Real	- bottom limit of the corresponding raster space region.
Y2R	Real	- top limit of the corresponding raster space region.

Method:

The differences X2-X1 and Y2-Y1 are checked. If either of the differences are equal to zero, the difference is set equal to one. The scale factors are then calculated as follows:

SCALE (1) = (X2R-X1R)/(X2-X1)

SCALE (2) = X1R-X1 *SCALE (1)

SCALE (3) = (Y2R-Y1R)/(Y2-Y1)

SCALE (4) = Y1R-Y1 *SCALE (3)

Example: See Figure 3A (DEFINE listings) and Figure 3B (DEFINE SC4020 Frame). For the large circle the raster space is defined as 200.0 to 800.0 in both X and Y directions. The mathematical space is defined as -5.0 to 5.0. The same circle is drawn in the upper left corner by defining the raster space as 150.0 to 250.0 for X and 750.0 to 850.0 for Y. Similarly the circle is drawn in the lower left corner by defining the raster space as 150.0 to 250.0 for X and 150.0 to 250.0 for Y.

```
C       DEFINE, SHOWS SAME FIGURE PLOTTED IN THREE AREAS OF A FRAME.
C
        REAL X(33), Y(33)
        INTEGER OTAPE
        LOGICAL LAST1
C
        N = 33
        NFRAME=0
C
C     COMPUTE DATA.
C
        DO 5 I = 1, 32
        THETA = 3.1415926*FLOAT(I)/16.0
        X(I) = 5.0*SIN(THETA)
    5   Y(I) = 5.0*COS(THETA)
        X(N) = X(1)
        Y(N) = Y(1)
C
C     DO PLOTS.
C
        LAST1 = .TRUE.
        NFRAME = NFRAME + 1
        OTAPE = 11                                                    C
        CALL PLOTSD(N, OTAPE, NFRAME, LAST1, X, Y)
        STOP
      END

        SUBROUTINE PLOTSD(N, OTAPE, NFRAME, LAST1, X, Y)
C
        REAL X(N), Y(N)
        REAL SC1(4), SC2(4)
        INTEGER OTAPE
        LOGICAL LAST1
        INTEGER STUFF(10), BUFFER(10000)
C
        IT = OTAPE
C
C     DO INITILIZATION ON FIRST CALL.
C
        IF(NFRAME .NE. 1) GO TO 19
        CALL GRAFIT(0, IT, BUFFER, 'PPD E. DENT#.')
        DO 10 I = 1, 10
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(3, IT, BUFFER, STUFF)
   10 IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
   19   CONTINUE
C
C     ASSIGN BUFFER AND ITS LENGTH.
C
        CALL GRAFIT(1, IT, BUFFER, 10000)
C
C     DRAW A BOX AS FRAME OF REFERENCE.
        CALL DEFINE(SC1, 1.0, 1023.0, 1.0, 1023.0, 1.0, 1023.0,
     1    1.0, 1023.0)
        CALL BOXPLT(SC1, 100.0, 100.0, 900.0, 900.0)
C
C     DRAW LARGE GRAPH CENTERED.
C
        CALL DEFINE(SC2, -5.0, 5.0, 200.0, 800.0, -5.0, 5.0,
     1    200.0, 800.0)
        CALL LNPLOT(SC2, X, Y, 1, 1, N)
C
C       DRAW SAME FIGURE IN UPPER LEFT CORNER.
C
        CALL DEFINE(SC2, -5.0, 5.0, 150.0, 250.0, -5.0, 5.0,
     1    750.0, 850.0)
        CALL LNPLOT(SC2, X, Y, 1, 1, N)
C
C       DRAW FIGURE AGAIN IN LOWER LEFT CORNER.
C
        CALL DEFINE(SC2, -5.0, 5.0, 150.0, 250.0, -5.0, 5.0,
     1    150.0, 250.0)
        CALL LNPLOT(SC2, X, Y, 1, 1, N)
        CALL GRAFIT(2, IT, BUFFER, STUFF)
        CALL GRAFIT(3, IT, BUFFER, STUFF)
        CALL GRAFIT(4, IT, BUFFER, 0)
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(3, IT, BUFFER, STUFF)
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(3, IT, BUFFER, STUFF)
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
C
        IF(.NOT. LAST1)RETURN
C
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
        CALL GRAFIT(9, IT, BUFFER, 'NRL PPD E.DENT#.')
C
        RETURN
      END
```

Figure 3A. Define Listing

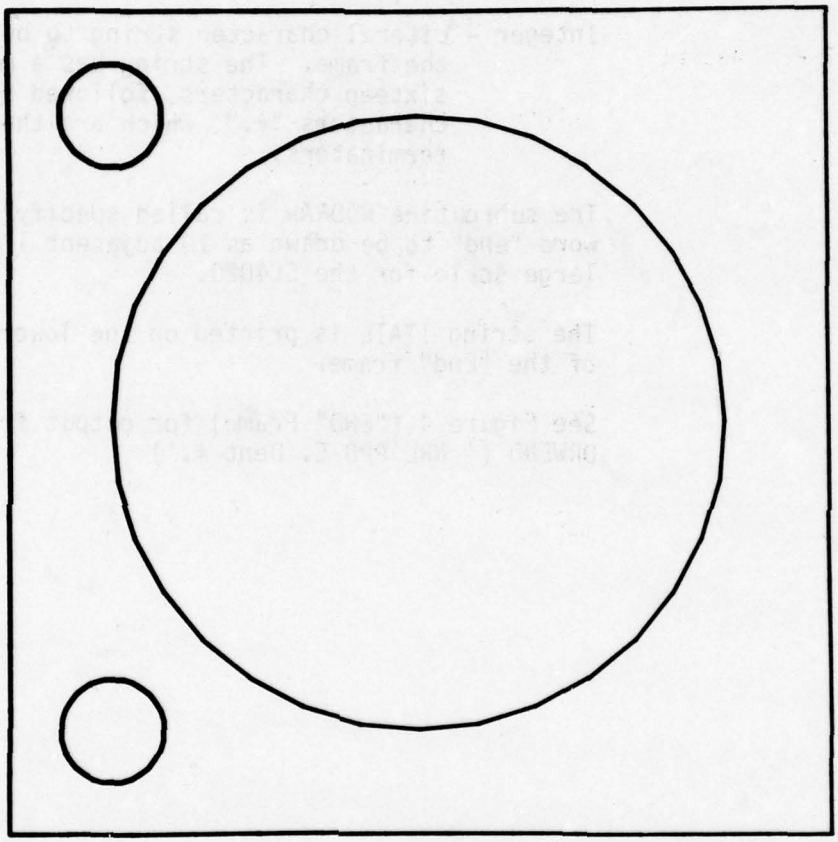


Figure 3B. Define Frame

DRWEND

Purpose: to draw the word "END" on the last frame in large heavy type. This routine is called by the close-out call to GRAFIT (9,...) in SC4020 mode. It is not called in the Tektronix or Calcomp mode.

Usage: call DRWEND (ITAIL)

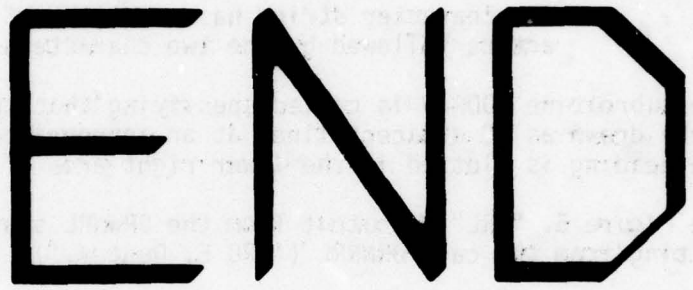
Description of Parameter:

ITAIL: Integer - Literal character string to be printed on the frame. The string has a maximum of sixteen characters, followed by the two characters "#.", which are the string terminators.

Method: The subroutine WDDRAW is called specifying the word "end" to be drawn as 10 adjacent lines on a large scale for the SC4020.

The string ITAIL is printed on the lower right area of the "End" frame.

Example: See Figure 4 ("END" Frame) for output from the call DRWEND (' NRL PPD E. Dent #.')



NRL PPD E. DENT

Figure 4. "END" Frame

DRWNRL

Purpose: to draw the word NRL on the first frame in large heavy type. This routine is called by the initialization CALL to GRAFIT with MODE = 0 in SC4020 mode. It is not drawn in Tektronix or Calcomp mode.

Usage: call DRWNRL(NHEAD)

Description of Parameter:

NHEAD	Integer -	Literal character string to be printed on the frame. The character string has a maximum of sixteen characters followed by the two characters "#.".

Method: The subroutine WDDRAW is called specifying that the word NRL is to be drawn as 10 adjacent lines at an appropriately large scale. The heading is plotted in the lower right area of the frame.

Example: See Figure 5. "NRL" is output from the DRWNRL subroutine resulting from the call DRWNRL ('PPD E. Dent #.')

PPD E. DENT

Figure 5. "NRL" Frame

EFORMR

Purpose: To draw a real decimal number expressed with powers of 10 such that the mantissa is between 1 and 10; i.e., = $y.10^n$ and $1 < |y| < 10$. The E-Format number number is plotted in a 10 digit wide field.

Usage: Call EFORMR (RNUMB, XR1, XR2, YR1, YR2)

Description of Parameters:

RNUMB	Real	- Real Number to be plotted.
XR1	Real	- Starting raster X coordinate of the first digit in the number (lower left corner).
YR1	Real	- Starting raster Y coordinate of the first digit in the number (lower left corner).
XR2	Real	- Terminating raster X coordinate of the number field.
YR2	Real	- Terminating raster Y coordinate of the number field.

Method: A real number, not equal to zero, is normalized between 0 and 10. Then NMDRAW plots this portion as scaled by the input position. The characters "10*" are then plotted, followed by a superscript containing the normalizing power of 10. Figure 6B shows a number plotted in decreasing sizes.

```
C          EFORMP, EXAMPLE OF DECREASING BOX SIZE FOR A E-FORMAT NUMBER.
C
           REAL X1(5), X2(5), Y1(5), Y2(5), NUMBER
           INTEGER NB,NFRAME,OTAPE
           LOGICAL LAST1
C
           DATA NUMBER/1234.567/, X1/150.0, 150.0, 150.0, 150.0, 150.0/,
     1             X2/350.0, 325.0, 300.0, 275.0, 250.0/,
     2             Y1/750.0, 600.0, 450.0, 300.0, 150.0/,
     3             Y2/790.0, 636.0, 482.0, 328.0, 170.0/
C
           NFRAME = 1
           N6 = 5
           OTAPE = 11                                                    C
           LAST1 = .TRUE.
           CALL PLOTSE(NB, NFRAME, OTAPE, LAST1, NUMBER, X1, X2, Y1, Y2)
           STOP
      END



           SUBROUTINE PLOTSE(NB, NFRAME, OTAPE, LAST1, NUMBER, X1, X2,
     1     Y1, Y2)
C
           REAL X1(NB), X2(NB), Y1(NB), Y2(NB), NUMBER
           REAL SCALE(4)
           INTEGER NFRAME, OTAPE
           INTEGER STUFF(10), BUFFER( 5000)
           LOGICAL LAST1
C
           IT = OTAPE
           N = NB
C
C     DO INITILIZATION ON FIRST CALL.
C
           IF(NFRAME .NE. 1) GO TO 19
           CALL GRAFIT(0, IT, BUFFER, 'PPD E. DENT#.')
           DO 10 I = 1, 10
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(3, IT, BUFFER, STUFF)
   10 IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
   19      CONTINUE
C
C     ASSIGN BUFFER AND ITS LENGTH.
C
           CALL GRAFIT(1, IT, BUFFER,  5000)
C
C
           DO 30 I = 1, N
   30      CALL EFORMR(NUMBER, X1(I), X2(I), Y1(I), Y2(I))
C
           CALL GRAFIT(2, IT, BUFFER, STUFF)
           CALL GRAFIT(3, IT, BUFFER, STUFF)
           CALL GRAFIT(4, IT, BUFFER, 0)
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(3, IT, BUFFER, STUFF)
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(3, IT, BUFFER, STUFF)
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
C
           IF(.NOT. LAST1)RETURN
C
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
      IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
           CALL GRAFIT(9, IT, BUFFER, 'NRL PPD E.DENT#.')
C
           RETURN
      END
```

Figure 6A. E-Format Listing

$1.23*10^{3}$

$1.23*10^{3}$

$1.23*10^{3}$

$1.23*10^{3}$

$1.23*10^{3}$

Figure 6B. E-Format Frame

ENTAPE

Purpose: To block and write out the last buffer of the plot file.

Usage: CALL ENTAPE (OTAPE)

Description of Parameter:

OTAPE	Integer	- output device number.

Method: A partially filled buffer is completed with "blank" commands and the buffer is blocked and written on the output device. If the buffer is empty, no fill or output is done.

FIDUCL

Purpose: To draw reference marks on the four corners of the picture, center edges, and on the center of the picture.

Usage: CALL FIDUCL

Description of Parameters:

NONE

Method:

LINE is called with the raster units describing the lines to be drawn.

Example: See Fig. 7 (Fiducial Marks).

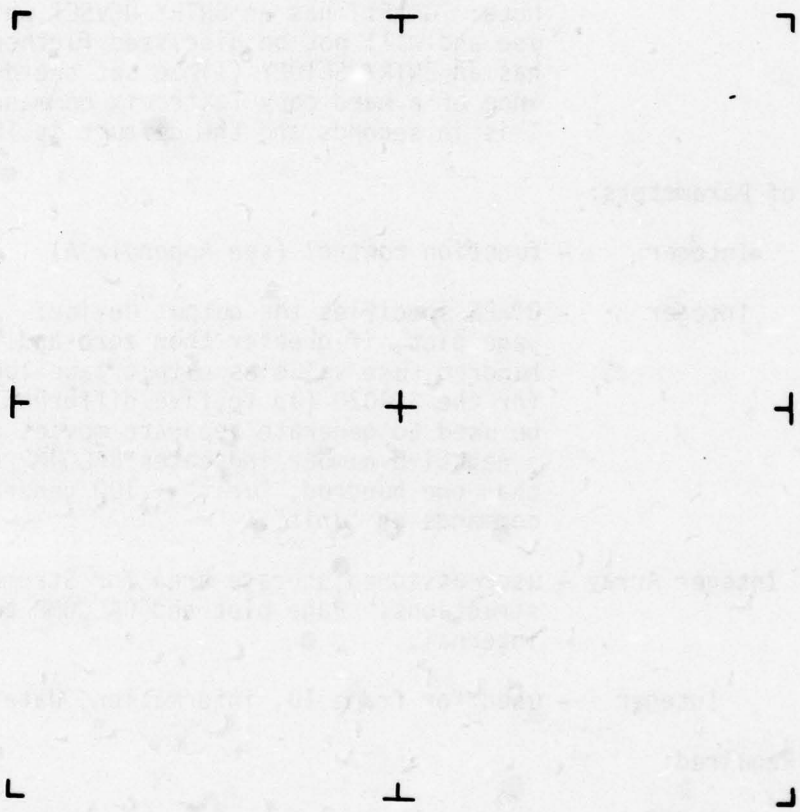


Figure 7. Fiducial Marks

GRAFIT

Purpose:

This is the executive program of the GRAFIT package. This subroutine controls the output media page plot, incremental plotter, Tektronix graphics display or Stromberg tape. It performs general processing of media controls such as generating camera selection commands, frame/page advance commands, repeat of frames, color and filter selection and output to appropriate external device.

Usage:

CALL GRAFIT (MODE, OTAPE, BUFFER, NDATA)

Note: GRAFIT has an ENTRY DEVSET which is of limited use and will not be discussed further. GRAFIT also has an ENTRY SETDLY (I) to set the delay after issuance of a hard copy Tektronix command. The argument I is in seconds and the default is 18 seconds.

Description of Parameters:

MODE	Integer	- function control (see Appendix A)
OTAPE	Integer	- OTAPE specifies the output device: zero indicates page plot; if greater than zero and less than one hundred, use value as output tape logical unit number for the SC4020 (up to five different tape numbers may be used to generate separate movies simultaneously); a negative number indicates CALCOMP plot; if greater than one hundred, "unit" + 100 generates Tektronix commands on "unit".
BUFFER	Integer Array	- user assigned storage area for Stromberg plot instructions. Page plot and CALCOMP buffers are internal.
NDATA	Integer	- used for frame ID, information, data strings, etc.

Subroutines Required:

PLOTS
FACTOR
ORIGIN
DRWNRL
DRWEND
ENDPLT
TOTAPE
BUFST1
BUFST2
BUFST3
BUFST4
ISSUE
BUFPAK, VBUFPK
WDDRAW
ENTAPE

Method:

The GRAFIT subroutine does the housekeeping such as initialization, selection of output (paper, Stromberg, Calcomp or Tektronix), colors, filters, framing and closing out buffers. Appendix A describes GRAFIT modes and arguments in detail.

Other requirements: JSL is required for file definition and file output - see Appendix B.

IDCHAR

Purpose: to convert a literal character to an equivalent SC4020 Charactron character

Usage: CHCODE = IDCHAR (CHAR)

Description of Parameter:

CHAR	Integer	- Literal character in left most byte (A1 format).
CHCODE	Integer	- Integer variable (IDCHAR is an Integer Function).

Method: The character number is obtained by a table look-up. This table is initialized by IDCODE on the first call to IDCHAR. IDCHAR is called by CHAR and CHPLOT.

IDCODE

Purpose: to assign identity numbers to the accepted keypunch characters.

Usage: CALL IDCODE (A, D)

Description of Parameters:

A	Integer array	- String of 64 keypunch characters.
D	Integer array	- Contains the identity numbers.

Method: IDCODE assign a unique integer, the identity number, to each accepted keypunch character. Subsequent reference to that character within GRAFIT is made through the identity number. IDCODE is called once by both IDENT and IDCHAR.

IDENT

Purpose: to convert a literal character in SET 1 to its equivalent, unique identity number

Usage: CHNUMB = IDENT (CHAR)

Description of Parameter:

CHAR	Integer	- Literal character in left most byte (8 bits - EBCDIC).
CHNUMB	Integer	- Integer variable in user's program (IDENT is an Integer Function).

Method: The character number is obtained by table look up. This table is generated by calling IDCODE on the first call to IDENT. IDENT is called by WDDRAW.

ISSUE

Purpose: To insert color and/or filter instructions into the Stromberg command string.

Usage: Used exclusively by GRAFIT.

Method: Upon GRAFIT's intercepting color or filter changes this information is passed to ISSUE which inserts appropriate Stromberg-Carlson commands into the buffer.

LYNE, VLINE

Purpose: To draw a line between two given points.

Usage:

```
CALL LYNE (SCALE, X1, Y1, X2, Y2)
CALL VLINE (SCALE, X1P, Y1P, X2P, Y2P, NL)
```

Description of Parameters:

SCALE	Real Array	- defines the raster-to-mathematical correspondence between points. (See DEFINE subroutine)
X1, Y1	Real	- coordinates of first point.
X2, Y2	Real	- coordinates of second point.
X1P, Y1P	Real array	- starting coordinates of the lines.
X2P, Y2P	Real array	- ending coordinates of the lines.
NL	Integer	- Length of arrays X1P, Y1P, X2R and Y2P; ie., NL lines will be drawn, NL $\leq$ 200.

Method:

The routine transforms the points from the mathematical space to the raster space. If the length of the line is greater than 64 raster units, the line is broken into segments equal to or less than 64 raster units in length. The program then generates plotting commands to generate one or more line segments to connect the points.

For VLINE scratch space is limited to arrays with lengths less than or equal to 200 words. To plot arrays with lengths greater than 200, VLINE must be called for blocks of 200 lines or the scratch space in VLINE increased.

LNPLOT

Purpose: To draw lines between selected points of an array.

Usage: CALL LNPLOT (SCALE, XARRAY, YARRAY, I1, I2, I3)

Description of Parameters:

SCALE	Real Array	- defines the raster-to-mathematical correspondence between points.
XARRAY	Real Array	- X coordinates of data.
YARRAY	Real Array	- Y coordinates of data.
I1	Integer	- index of first point to be connected.
I2	Integer	- increment at which points are to be selected to plot.
I3	Integer	- index of the last point in the data array.

Method:

The subroutine LYNE is called for each of the points which are to be connected. If I2 is unity a vectorized version, VLINE, may be used.

MOVEND

Purpose: to print a HEX dump of the plot tape.

Usage: call MOVEND (OTAPE, NBUFF)

Description of Parameters:

OTAPE	Integer	- Output device specification.
NBUFF	Integer	- Maximum number of records to dump from tape.

Method: Output tape 'OTAPE' is rewound and each record is read and printed until one of three condition is met: the EOF is read;
an error occurs;
the count 'NBUFF' is satisfied.

NMDRAW

Purpose: To plot Real*4 numbers in FORTRAN F-type format.

Usage: CALL NMDRAW (SCALE, XSTART, YSTART, DX, DY, SX, SXY, SY, NUMBER, WIDTH, DIGITS)

Description of Parameters:

SCALE	Real Array	- defines the raster-to-mathematical correspondence between points.
XSTART	Real	- X coordinate (mathematical space) of the first character to be drawn.
YSTART	Real	- Y coordinate (mathematical space) of the first character to be drawn.
DX	Real	- increment to the X coordinate to be added for each character drawn.
DY	Real	- increment to the Y coordinate to be added for each character drawn.
SX	Real	- X scale multiplier for characters.
SXY	Real	- slant modifier for characters.
SY	Real	- Y scale multiplier for characters.
NUMBER	Real	- number to be plotted in F format.
WIDTH	Integer	- total width of field including decimal point.
DIGITS	Integer	- number of fractional places to be drawn.

Method:

The input "NUMBER" is scaled to include the number of fractional places specified. Each digit in the number is converted to a literal character. Leading zeros are converted to blanks and the decimal point is inserted if DIGITS is greater than zero. The subroutine WDDRAW is called to process the literal data string. The parameters XSTART, YSTART, DX, DY, SX, SXY, and SY have the same meaning as in WDDRAW.

Example: See Fig. 8A and Fig. 8B. The real number 1234.567 is plotted from top to bottom in the following formats:

F9.2

F3.1

F5.4

F8.0

F10.5

Note that when the field is not wide enough, the high order digits are truncated.

```
C          NMDRAW, F-FORMAT NUMBERS.
C
           REAL NUMBER(5), XSTART, YSTART
           INTEGER WIDTH(5), DIGIT(5), NB, OTAPE
           LOGICAL LAST1
           DATA NUMBER/1234.567, 1234.567, 1234.567, 1234.567, 1234.567/
           DATA WIDTH/10, 8, 5, 3, 9/, DIGIT/5, 0, 4, 1, 2/
C
           NFRAME = 1
           NB = 5
           XSTART = 5.0
           YSTART = 3.0
           OTAPE = 11                                                    C
           LAST1 = .TRUE.
           CALL PLOTSN(NB, NFRAME, OTAPE, LAST1, NUMBER, WIDTH, DIGIT,
     1     XSTART, YSTART)
           STOP
       END



           SUBROUTINE PLOTSN(NB, NFRAME, OTAPE, LAST1, NUMBER, WIDTH,
     1     DIGIT, XSTART, YSTART)
C
           REAL NUMBER(NB), XSTART, YSTART
           REAL SCALE(4)
           INTEGER WIDTH(NB), DIGIT(NB), OTAPE
           INTEGER STUFF(10), BUFFER( 5000)
           LOGICAL LAST1
C
           IT = OTAPE
C
C     DO INITILIZATION ON FIRST CALL.
C
           IF(NFRAME .NE. 1) GO TO 19
           CALL GRAFIT(0, IT, BUFFER, 'PPD E. DENT#.')
           DO 10 I = 1, 10
       IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(3, IT, BUFFER, STUFF)
    10 IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
    19     CONTINUE
C
C     ASSIGN BUFFER AND ITS LENGTH.
C
           CALL GRAFIT(1, IT, BUFFER,  5000)
C
C     DRAW NUMBERS.
C
           CALL DEFINE(SCALE, 0.0, 30.0, 0.0, 1023.0, 0.0, 15.0, 0.0,
     1     1023.0)
           DO 5 I = 1, 5
           CALL NMDRAW(SCALE, XSTART, YSTART, 1.0, 0.0, 1.0, 0.0,
     1     1.0, NUMBER(I), WIDTH(I), DIGIT(I))
     5     YSTART = YSTART + 2.0
C
           CALL GRAFIT(2, IT, BUFFER, STUFF)
           CALL GRAFIT(3, IT, BUFFER, STUFF)
           CALL GRAFIT(4, IT, BUFFER, 0)
       IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(3, IT, BUFFER, STUFF)
       IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
       IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(3, IT, BUFFER, STUFF)
       IF(IT .GT. 0 .AND. IT .LT. 100)CALL GRAFIT(4, IT, BUFFER, -1)
C
           IF(.NOT. LAST1)RETURN
C
           IF(IT .GT. 0) CALL GRAFIT(4, IT, BUFFER, 0)
           CALL GRAFIT(9, IT, BUFFER, 'NRL PPD E.DENT#.')
C
           RETURN
       END
```

Figure 8A. F-Format Listing

1234.57

4.6

.5668

1235

1234.56688

Figure 8B. F-Format Frame

SET 1

Purpose: To generate X, Y points and pen commands for drawing the specified character.

Usage: CALL SET 1 (CHNUMB, X, Y, PEN, N)

Description of Parameters:

CHNUMB	Integer	- character identifier between 1 and 64.
X	Real Array	- area for storage of X plotting points.
Y	Real Array	- area for storage of Y plotting points.
PEN	Integer Array	- area for storage of pen commands. Pen = 1 implies draw a line from the last point to the present point. Pen = 0 implies the last point is not connected to the present point.
N	Integer	- number of elements in X, Y and Pen arrays. N is always = 13 for SET 1.

Method:

X, Y points and Pen commands are generated by unpacking the data from the array S (3, 64) which describes the 64 characters in 3 data words each.

Example: Figure 9 depicts the characters available in SET 1. Equivalent keypunch characters are used to generate the SET 1 characters. A superscript 2 is represented by the 0-8-2 keypunch character. CHNUMB is found by a prior call to IDENT.

Figure 9. Set 1 Characters

SET 2

Purpose: To generate X, Y points and Pen commands for drawing special characters. This set is empty and may be defined by the user.

Usage: CALL SET 2 (CHNUMB, X, Y, PEN, N)

Description of Parameters:

CHNUMB	Integer	- character identifier between 1 and 64.
X	Real Array	- area for storage of X plotting points.
Y	Real Array	- area for storage of Y plotting points.
PEN	Integer Array	- area for storage of pen commands. PEN = 0 implies position only (do not connect the last point). PEN = 1 implies connect the last point to the present point. The first PEN command should always be 0.
N	Integer	- number of elements in the X, Y and PEN arrays. N must be $\leq$ 200.

Subroutines Required: Defined by the User.

Method:

This routine is generally called from CHDRAW. The X, Y and PEN commands must be stored into the buffers supplied by the calling routine. N, the number of X, Y and PEN elements, must be set N $\leq$ 200, the dimension of the X, Y and PEN arrays. CHNUMB is passed to CHDRAW and specifies the desired character number.

SET 3

Purpose: To generate X, Y points and pen commands for drawing the specified characters.

Usage: CALL SET 3 (CHNUMB, X, Y, PEN, N)

Description of Parameters:

CHNUMB	Integer	- character identifier between 1 and 64.
X	Real Array	- area for storage of X plotting points.
Y	Real Array	- area for storage of Y plotting points.
PEN	Integer Array	- area for storage of pen commands. PEN = 0 implies position only (do not connect the last point), PEN = 1 implies connect the last point to the present point.
N	Integer	- number of elements in X, Y and PEN arrays.

Method:

X, Y points and PEN commands for the specified characters are passed back in the arrays X, Y, PEN for the particular character.

WDDRAW

Purpose: To convert a literal data string to equivalent characters to be plotted.

Usage:

```
CALL WDDRAW (SCALE, XSTART, YSTART, DX, DY, SX,
             SXY, SY, WORD)
```

Description of Parameters:

SCALE	Real Array	- defines the raster-to-mathematical correspondence between points.
XSTART	Real	- X coordinate (mathematical space) of the first character to be drawn (lower left corner).
YSTART	Real	- Y coordinate (mathematical space) of the first coordinate to be drawn (lower left corner).
DX	Real	- increment to be added to the X coordinate for each character drawn.
DY	Real	- increment to be added to the Y coordinate for each character drawn.
SX	Real	- X scale multiplier for characters.
SXY	Real	- slant modifier for characters.
SY	Real	- Y scale multiplier for characters.
WORD	Integer Array	- character string to be drawn plus special control characters:

"#1" Select characters from Set 1. Set 1 is chosen by default.

"#2" Select characters from Set 2.

"#3" Select characters from Set 3.

"##" Plot the character #.

"#B" Backspace.

"#." End of the character string.

Method:

The literal string is processed from left to right. If a control character (#) is encountered, the next character is processed as a special operation. All other characters are "identified" (call to IDENT). CHDRAW is called to select the specified character from the character Set 1, 2, or 3 and generate plotting commands which will draw that character. Processing stops when a "#." is encountered.

Remarks:

If an illegal character is encountered, a diagnostic is printed, "CHARACTER X NOT PART OF SET N", where X is the illegal character and N is the character set. Processing of the character string stops when an illegal character is encountered. As an example, the literal string

"#1X+#B_1##A.#."

generates on the SC4020 the following:

X±1#A.

Since CHDRAW is called for each character in the string WORD, the meaning of the parameters SX, SY and SXY are the same as described for CHDRAW. The parameters XCHAR and YCHAR used in calling CHDRAW are just XSTART + n* DX and YSTART + n* DY, where n is the number of characters in the string which were already drawn (except if overstruck).

WDRAST

Purpose: To write a literal string on the screen.

Usage: CALL WDRAST (CHARS, XLEFT, XRIGHT, YBOTTM, YTOP)

Description of Parameters:

CHARS	Integer Array	- see WDDRAW.
XLEFT	Real	- left side of character string in raster units.
XRIGHT	Real	- nominal right side of character string (for 10 characters), in raster units.
YBOTTM	Real	- bottom of character string in raster units.
YTOP	Real	- top of character string in raster units.

Method:

WDRAST is an interface routine to WDDRAW. The scaling is done automatically in the call to WDDRAW so that the user does not have to worry about scaling, magnification, etc. All constraints which apply to the character string in WDDRAW also apply to WDRAST since this character string is passed along untouched. The variables XLEFT, XRIGHT, YBOTTM AND YTOP are all in raster units. The spacing, DX=XRIGHT - XLEFT, is nominally designed for ten characters, so characters will be spaced at intervals of DX/10 raster points starting at XLEFT. Since (YTOP - YBOTTM) is passed as the factor SY to WDDRAW, the characters will not fill the space (YTOP-YBOTTM), but will allow for spacing between lines. That is, only slightly more than half of (YTOP-YBOTTM) will be filled. Typical calls to WDRAST use ((XRIGHT-XLEFT) /10)/ (YTOP-YBOTTM) = 0.8. The lower left-hand corner of the screen is the origin and the SC4020 screen is 1023 x 1023 raster units wide.

ACKNOWLEDGEMENTS

Parts of this report were taken from NRL Memorandum Report 2356, MOVIE by P.A. Fothergil and J. P. Boris.

Appendix A

GRAFIT

In this description the Stromberg-Carlson 4020 will be referred to as the Stromberg or simply as S; the Calcomp Incremental Plotter will be referred to as the Calcomp or simply as C; the page plotter will be referred to as page or simply as P; the Tektronix CRT plotter is referred to as T. The GRAFIT subroutine is invoked by

```
CALL GRAFIT (MODE, OTAPE, BUFFER, STUFF)
```

Description of Parameters:

MODE	INTEGER	Designates operation to be performed
OTAPE	INTEGER	If equal 0(zero), do page plot; if negative do Calcomp plot (on logical unit 59), if greater than 100 do plot for the Tektronix and put output on FTNNF001 where NN = OTAPE-100; otherwise, use positive Integer at Stromberg tape output logical unit number. Up to five separate tape unit numbers may be used simultaneously.
BUFFER	INTEGER ARRAY	Intermediate storage area for Stromberg instructions. (Note: C and P Buffers are fixed internal to GRAFIT).
STUFF	INTEGER	Used for frame ID, Data, etc.

The structure of GRAFIT is such that the calling program may be set up for its final usage of Stromberg plots while initially the program flow can be checked with page, Calcomp or Tektronix plots. The advantage of this is that one can immediately get an idea of the plot lay-out without waiting for a film to be processed. While a page plot is faster for the initial trials, a Calcomp plot gives more details and accuracy. The closest resemblance to the SC4020 is the Tektronix CRT plotter which is set up as a 768x768 raster point plotter. It is also faster than the Calcomp pen plotter. It must be noted however, that page, Calcomp and Tektronix plots are relatively slow, thus fewer plots should be made than with Stromberg which utilizes vectorized computer code. Frequently movies are made on Stromberg which require two or more printings of the same frame. If one provides that multiple frames be allowed only when OTAPE is greater than zero the program can be expeditiously checked without multiple output.

The feature which allows the versatility to GRAFIT is the variable MODE. Each medium, S, C, P, or T is assigned functions by MODE that it can perform. For example, P cannot change colors or filters therefore this function is bypassed except to note that a particular color or filter was selected. Appendix C gives a concise description of operations for each medium for the various values of MODE.

To use GRAFIT an initialization call must be issued for each output; i.e., S, C, P, or T. An attempt to use an output medium before initialization results in an error printout of non-initialization for S, C, P, or T as determined by OTAPE.

Therefore, the first call to GRAFIT must be an initialization call (MODE = 0).

MODE = 0.

Call GRAFIT (0, OTAPE, BUFFER, 'PPD E. DENT #.')

1. If OTAPE = 0, Initialize page plot (P).
2. If OTAPE < 0, Initialize Calcomp plot (C).
3. If OTAPE > 0, Initialize Stromberg plot (S).
4. If OTAPE > 100, Initialize Tektronix plot (T). Output is on logical unit (OTAPE-100).

For OTAPE = 0, a message is printed out that page plot initialized PPD E. DENT #. Otherwise, a frame is generated with NRL in large letters and PPD E. DENT is printed in lower right corner. For S we may generate additional identical frames by pairs of calls to GRAFIT with MODE = 3 and MODE = 4.

MODE = 1. BUFFER INITIALIZATION

Call GRAFIT (1, OTAPE, BUFFER, LBUFF)

This call must be done for S and P to initialize the BUFFER COUNTER which contains the location of the last filled word in the BUFFER. For S the location of BUFFER and its length LBUFF is saved within GRAFIT. The location of the last word to be used is stored (saved) in BUFFER (1).

It is obvious that this call must be made before any call that uses the BUFFER area. This call must also be made after a call with MODE = 2 prior to storing additional information in BUFFER. For P the print area is set to blanks surrounded by broken lines. Additionally this call must be made at the end of each graph otherwise the new plot will be superimposed on the earlier plot.

MODE = 2. BUFFER PACK

Call GRAFIT (2, OTAPE, BUFFER, 0)

This call must be done for S. It has no effect on C, P and T. Information in BUFFER is packed into a continous string of Stromberg 36-BIT instructions. Thus the "holes" which are left during generation of the instructions are closed.

MODE = 3. WRITE OUT FRAME

Call GRAFIT (3, OTAPE, BUFFER, 0)

Writes out P and S, has no effect on C or T. This write is non-clearing for P and non-reset for S. By holding the BUFFER intact more than one frame can be made for movies. P non-clearing allows a view of a partial graph where further plots will be superimposed.

MODE = 4. FRAME ADVANCE

Call GRAFIT (4, OTAPE, BUFFER, STUFF)

Advances the film for S or advances the paper for C. There is no effect on P. If STUFF (1) is greater than or equal to zero, the first 3 characters passed by STUFF when MODE = 0 is written on the lower right of each frame. For the Tektronix, hard copy is generated and the screen is cleared. If no hard copy is wanted the hard copy unit may be turned off. After the hard copy and erase commands are issued, "FRAME nnn" is written on the screen where "nnn" is the frame number of the previous frame. A frame directory can therefore be otained through a "find string all" (FSA) command on the word "FRAME".

MODE = 5. CAMERA SELECT

Call GRAFIT (5, OTAPE, BUFFER, STUFF)

A camera select command is issued for S; there is no effect on C, P, or T. The camera is selected according to the following integer value in STUFF (1).

1 = Camera 1 (hard copy)

2 = Camera 2 (35mm or 16mm)

3 = Camera 1 and camera 2

A camera remains selected until a new camera select command is issued. Generally the camera selection is a manual operation on the S-C 4020. Specific instructions must be given to the S-C 4020 operator to allow the plotting tape to select cameras under program control.

MODE = 6. COLOR SELECT

Call GRAFIT (6, OTAPE, BUFFER, 'Colors')

Selects the colors for S and prints the color selected. Only print the color selected for C, P, and T. After ten frames no print is made for C, P, or T. The colors are: CLEAR, RED, ORANGE, YELLOW, GREEN, TURQUOISE, BLUE and PURPLE. The colors may be entered as shown but only the first four letters are used and must be exactly as shown (for RED three letters are sufficient).

A restriction is placed on the use of colors by the hardware used to change color on the Stromberg-Carlson. A check of the actual position of the color wheel can only be made for CLEAR. To avoid hardware problems, it is strongly suggested that CLEAR be selected at the beginning and end of every frame. For maximum efficiency the sequence of colors used within a frame should follow the actual color sequence on the color wheel being used.

MODE = 7. FILTER SELECT

Call GRAFIT (7, OTAPE, BUFFER, 'Filter')

Selects the FILTERS for S and prints the filter level selected. Prints the filter level for C, P, and T; after ten frames no print is made. The Filter levels are CLEAR, 2 LE, 3 LE, 4 LE, 5 LE, 6 LE, 7 LE, and 8 LE (Note a space is the second character in levels after Clear).

Filter levels used may be full word data items using four characters. Thus CLEAR becomes CLEA.

MODE = 8

Call GRAFIT (8, OTAPE, BUFFER, ARG)

For S and C ARG is a real number, REALNO; REALNO is the number of frames to advance for S, and a multiplicative factor for the length of the x-axis for C. For the Tektronix ARG is an integer. It has no effect on P.

Normally one film frame is advanced for each call to GRAFIT 4. However, there are times when it is desirable to isolate plotted frames. A call to GRAFIT (8,...) with REALNO greater than zero sets an internal counter for the number of additional frame advance commands to be issued on the next call to GRAFIT (4,...). The counter is just REALNO rounded to the next highest integer. Therefore 1 > REALNO $\geq$ 2.0 will cause GRAFIT (4,...) to insert one blank frame and 2.< REALNO $\leq$ 3.0 will cause two blank frames to be inserted. Up to five additional blank frames may be inserted in this manner.

The length of the x-axis for C is 11 inches and the increment is .01. The length of the x-axis may be increased by REALNO up to a factor of two. At two the increment is changed to .02.

In both S or C no change is performed for a zero. However, an error message is noted on the printed output.

For the Tektronix call GRAFIT (8, OTAPE, BUFFER, - 1) will reset the screen correspondence to 1024 x 1024. Since the physical screen is only 768 high, the top quarter is lost in this mode. However, the right portion of the screen is now addressable. Note that in this mode the last argument is an integer.

MODE = 9.

Call GRAFIT (9, OTAPE BUFFER, 'PPD E. DENT #.')

The BUFFERS are flushed for S, C, P, or T. In addition, for S the frame count is printed and reset, the color and filter is reset to clear, and end-of-file written on tape. For C ENDPLT is called. For T, the cursor is reset to the upper left corner.

Appendix B

GRAFIT is available from SPL. The programmer must define the GRAFIT Tape File (yy) using the following JSL:

For SC4020 / FD FTYYF001, BAND = INIT/MAX/INCR. Where yy is the file number, which is OTAPE in GRAFIT calls for SC4020.

The following JSL must be executed in order to output the magnetic tape.

/ FOT FTYYF001, LABL = 1/NL/ADD, DEN = 556, TRKS = 7, RCTL = C, EFID = XXXXXX. Where XXXXXX is the tape VSN.

To output multiple files onto one magnetic tape, the FOT comments must be enclosed by a MFR/MFRE pair. For example

/ MFR, LABL = 1/NL/ADD, DEN = 556, TRKS = 7, RCTL = C, EFID = XXXXXX/XXXXXX2

/ FOT FTAAF001

/ FOT FTBBF001

/ MFRE

Where/XXXXX2 specifies the VSN of the tape volume used to continue output if the first volume is insufficient.

For the Tektronix, use / FD FTNNF001, BAND = INIT/MAX/INCR where NN = OTAPE-100. After running the job this file can be cataloged for later retrieval from a Tektronix terminal through the ASC interactive system.* To plot the file, it must be assigned to the terminal. Control U & Control N must be sent; the file can then be listed with an L, A. A FSA on the literal "FRAME" will list the frame number of each preceding frame.

Note there is a possible conflict between file numbers for SC4020 and TEKTRONIX devices since only two digits are available for the unit specification in FTnn F001. For example OTAPE = 120 for the TEKTRONIX and OTAPE = 20 for the SC 4020 would require identical file numbers on the FD statement.

*See "ASC Keyboard Concentrator System User's Guide" (# 934732)

APPENDIX C

CALLING SEQUENCE OR OPERATIONAL PROCEDURE:

GRAFIT (MODE,OTAPE,BUFFER,STUFF)
ARGUMENTS (TYPE AND SIGNIFICANCE) AND/OR INITIAL CONDITIONS:
MODE - INTEGER DESIGNATOR OF FUNCTION TO BE PERFORMED
(WHERE C, P AND S DENOTE THE ACTION TAKEN FOR CALCOMP, PAGE AND STROMBERG PLOTS RESPECTIVELY, AND T INDICATES ACTION TAKEN FOR A TEKTRONIX CRT TERMINAL.)

= 0, INITIALIZE AND PRINT NECESSARY IDENTIFICATION
- C - ADVANCE AFTER INITIALIZING
- P - WRITE HEADING
- S - CALL DRWNRL AND ADVANCE AFTERWARD
- T - INITIALIZATION CLEAR SCREEN. SET CRT TO GRAPHIC MODE.

= 1, SET UP FOR SINGLE GRAPH AND RETURN
- C - HAS NO EFFECT
- P - CLEAN THE PAGE
- S - SET THE BUFFER COUNTER
- T - CLEARS THE SCREEN

= 2, PACK THE BUFFER, IF NECESSARY
- C - HAS NO EFFECT
- P - HAS NO EFFECT
- S - PACK THE BUFFERS IN PLACE
- T - HAS NO EFFECT

= 3, WRITE OUT THE PLOTTING COMMANDS
- C - HAS NO EFFECT, CALL ADVANCE AFTER
- P - PRINTS THE PAGE BUT DOES NOT CLEAR
- S - WRITES OUT THE TAPE FROM BUFFER
- T - HAS NO EFFECT

= 4, ADVANCE FILM OR PAPER
- C - FILM ADVANCES
- P - HAS NO EFFECT
- S - FILM ADVANCES, FRAME ID IN STUFF (1)
- T - ISSUES A HARD COPY COMMAND

= 5, PERFORM A CAMERA SELECT
- C - HAS NO EFFECT
- P - HAS NO EFFECT
- S - SELECTS CAMERA IN STUFF (1)
- T - HAS NO EFFECT

= 6, COLOR SELECTION
- C - HAS NO EFFECT
- P - PRINTS THE SELECT COMMAND
- S - SELECTS THE DESIRED COLOR
- T - HAS NO EFFECT

= 7, FILTER SELECTION
- C - HAS NO EFFECT
- P - PRINTS THE SELECT COMMAND
- S - SELECTS THE DESIRED FILTER
- T - HAS NO EFFECT

= 8, ABSCISSA CHANGE FOR PLOT
- C - INITIALIZES THE LENGTH OF X-AXIS
- P - HAS NO EFFECT
- S - NUMBER OF FRAMES TO ADVANCE
- T - RESETS FRAME SIZE.

= 9, CLOSE OUT THE PLOTTING FILE AND FLUSH BUFFERS
C - PLOTS END AND TERMINATES
P - WRITES OUT PAGE WITH TERMINATION
S - PLOTS END AND TERMINATES
T - TERMINATES THE PLOT ROUTINES.

OTAPE - INTEGER VALUE DESIGNATING OUTPUT DEVICE OR TYPE
= 0, DO PAGE PLOT ON LINE PRINTER
> 0, OUTPUT TAPE UNIT NUMBER
UP TO FIVE TAPES MAY BE OUTPUT SIMULTANEOUSLY.
OUTPUT FOR EACH IS FTNNF001, 7<NN=OTAPE<100.
EACH HAS FORG=PS,BKSZ=2880, LREC = 2880, RCFM=FB.
< 0, DO CALCOMP PLOT
> 100, DO TEKTRONIX PLOT. OUTPUTS TO FTNNF001 WHERE
NN=OTAPE-100.

BUFFER - INTEGER ARRAY IN WHICH TO STORE STROMBERG INSTRUCTIONS
(PAGE PLOT, CALCOMP AND TEKTRONIX BUFFERS ARE INTERNAL).

STUFF - INTEGER USED FOR FRAME ID, INFORMATION, DATA. MAY BE AN
ARRAY.

ENTRY POINTS (WITH ARGUMENTS):

DEVSET (MDEVIC) - SETS THE DEVICE TYPE
= 1, CALCOMP PLOTTER
= 2, LINE PRINTER
= 3, STROMBERG-CARLSON 4020
= 4, TEKTRONIX

SETDLY (SECONDS) - SETS THE DELAY (INTEGER VALUE OF SECONDS) FOR THE TEKTRONIX
HARD COPY COMMAND.

THE FOLLOWING IS A LIST OF ROUTINES WHICH MAY BE CALLED BY THE
USER, THEY ARE NOT ACTUALLY ENTRY POINTS, BUT MAY BE CONSIDERED
SO. THEIR DOCUMENTATION IS CONTAINED IN THE GRAFIT SOURCE
CODE IN THE SPL STANDARD STYLE:

BOXPLT (S, X1, Y1, X2, Y2)
CHAR (SCALE, XCHAR, YCHAR, CHARAC)
CHDRAW (SCALE, XCHAR, YCHAR, SX, SXY, SY, CHNUMB, SET)
CHPLOT (SCALE, XARRAY, YARRAY, CHARC, I1, I2, I3)
DEFINE (SCALE, X1, X2, X1R, X2R, Y1, Y2, Y1R, Y2R)
EFORMR (REALNO, XR1, XR2, YR1, YR2)
LYNE (SCALE, X1, Y1, X2, Y2), VLINE (SCALE, X1, Y1, X2, Y2, NL)
LNPLOT (SCALE, DARRAY, YARRAY, I1, I2, I3)
NMDRAW (SCALE, XSTART, YSTART, DX, DY, SX, SXY, SY, NUMBER, WIDTH, DIGITS)
WDDRAW (SCALE, XSTART, YSTART, DX, DY, SX, SXY, SY, WORD)

APPENDIX D

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      PROGRAM BOT
C     PROGRAM TO TEST THE SURFACE PLOTTING AND CONTOUR ROUTINES.
C
C     INTERCHANGE THE COMMENTED AND UNCOMMENTED PARAMETER CARDS TO GO
C     FROM THE STROMBERG-CARLSON TO PAGE PLOTS AND BACK.
C          PARAMETER NX = 31, NY = 21, ITAPE = 11, NP = 9
           PARAMETER NX = 11, NY = 9, ITAPE = 0, NP = 5
C
C     THIS TEST PROGRAM USES THE GRAFIT PLOTTING PACKAGE AND ILLUSTRATES THE
C     NECESSARY CALLS TO INITIALIZE GRAFIT AND CONSTRUCT PLOTS.  THE FOLLOWING
C     TABLE EXPLAINS BRIEFLY THE 10 MODES OF GRAFIT (THE FIRST ARGUMENT IS A
C     MODE WHICH TELLS GRAFIT WHAT OPERATION TO PERFORM).
C
C     CALL GRAFIT (0, ITAPE, BUFFER, 'RUN LABEL#.')
C          INITIALIZES GRAFIT PACKAGE, HOLLERITH RUN LABEL ON OUTPUT
C     CALL GRAFIT (1, ITAPE, BUFFER, LENBUF)
C          INITIALIZES GRAFIT FOR EACH NEW PLOT.  BUFFER IS LENBUF WORDS LONG.
C     CALL GRAFIT (2, ITAPE, BUFFER, 'PACK BUFFER')
C          BUFFER MUST BE REORGANIZED AFTER PLOTTING, BEFORE WRITE
C     CALL GRAFIT (3, ITAPE, BUFFER, 'WRITE OUT BUFFER')
C          WRITE OUT THE BUFFER FULL OF PLOTTING COMMANDS TO ITAPE.
C     CALL GRAFIT (4, ITAPE, BUFFER, IDFRAM)
C          WRITE ADVANCE FILM INSTRUCTION TO COMPLETE THE PLOT.
C     CALL GRAFIT (5, ITAPE, BUFFER, DUMMY)
C          CURRENTLY NO OPERATION.
C     CALL GRAFIT (6, ITAPE, BUFFER, 'COLOR')
C          SELECTS A NEW COLOR WHEN USED WITH STROMBERG-CARLSON 4020.
C          THE CHOICES ARE (EIGHT CHARACTER HOLLERITH STRINGS), 'RED', 'ORANGE',
C          'YELLOW', 'GREEN', 'TURQUOIS', 'BLUE', 'PURPLE', 'CLEAR'
C     CALL GRAFIT (7, ITAPE, BUFFER, 'FILTER')
C          SELECTS A FILTER.  THE SC4020 HAS 7 LEVELS OF LIGHT INTENSITY AS WELL
C          AS CLEAR, 8 IS THE DARKEST.  HOLLERITH STRINGS 'CLEAR', '1 LEVEL',
C          '2 LEVEL', '3 LEVEL', '4 LEVEL', '5 LEVEL', '6 LEVEL', '7 LEVEL'
C     CALL GRAFIT (8, ITAPE, BUFFER, DUMMY)
C          CURRENTLY NO OPERATION.
C     CALL GRAFIT (9, ITAPE, BUFFER, 'RUN LABEL #.')
C          CLOSES OUT GRAFIT PACKAGE, HOLLERITH RUN LABEL ON OUTPUT
C

           REAL*8       COLORS(7)
           REAL         Z(NX, NY), BUFFER(15100), XP(8,9), YP(8,9)
           REAL         FL(7), TEST (NX, NY)
           DATA         COLORS/'RED', 'ORANGE', 'YELLOW', 'GREEN', 'TURQUOIS',
     1                  'BLUE', 'PURPLE'/
           DATA         FL/-0.90, -0.60, -0.30, 0.0, 0.30, 0.60, 0.90/
           DATA         XP/
     1                  100., 800., 250., 900., 100., 800., 250., 900.,
     2                  100., 900., 200., 800., 100., 900., 200., 800.,
     3                  200., 900., 100., 750., 200., 900., 100., 750.,
     4                  100., 800., 250., 900., 100., 800., 250., 900.,
     5                  100., 900., 200., 800., 100., 900., 200., 800.,
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     6               200., 900., 100., 750., 200., 900., 100., 750.,
     7               100., 800., 250., 900., 100., 800., 250., 900.,
     8               100., 900., 200., 800., 100., 900., 200., 800.,
     9               200., 900., 100., 750., 200., 900., 100., 750./
          DATA       YP/
     1               100., 100., 250., 250., 800., 800., 900., 900.,
     2               100., 100., 250., 250., 800., 800., 900., 900.,
     3               100., 100., 250., 250., 800., 800., 900., 900.,
     4               100., 100., 200., 200., 900., 900., 800., 800.,
     5               100., 100., 200., 200., 900., 900., 800., 800.,
     6               100., 100., 200., 200., 900., 900., 800., 800.,
     7               200., 200., 100., 100., 900., 900., 750., 750.,
     8               200., 200., 100., 100., 900., 900., 750., 750.,
     9               200., 200., 100., 100., 900., 900., 750., 750.,
C
C
C    INITIALIZE THE DATA
          AX = 6.283185*FLOAT(MX)/FLOAT(NX-1)
          AY = 6.283185*FLOAT(MY)/FLOAT(NY-1)
          DO 20 J = 1, NY
          DO 20 I = 1, NX
          Z(I,J) = 0.5*(ZMAX + ZMIN)
     1        + SIN(AX*FLOAT(I-1))*SIN(AY*FLOAT(J-1))
    20    CONTINUE
C
C    INITIALIZE GRAFIT
C         CALL GRAFIT (0, ITAPE, BUFFER, 'GRAFIT TEST#.')
C    LOOP OVER THE VARIOUS PERSPECTIVE PLOTS.
          DO 100 IP = 1, NP
C
C    PLOT THE UPPER PART OF THE SURFACE WITH FRONT SKIRT
          CALL GRAFIT (1, ITAPE, BUFFER, 15000)
          CALL GRAFIT (6, ITAPE, BUFFER, 'CLEAR')
          CALL SURF0 (XP(1,IP), YP(1,IP), ZMIN, ZMAX, NX, NY)
          CALL GRAFIT (6, ITAPE, BUFFER, 'RED')
          CALL SURF3 (Z, NX, NY, +1)
          CALL GRAFIT (6, ITAPE, BUFFER, 'ORANGE')
          CALL SURF2 (Z, NX, NY, +1)
          CALL GRAFIT (6, ITAPE, BUFFER, 'YELLOW')
          IF (XP(3,IP).GT.XP(1,IP)) CALL SURF2 (Z, NX, NY, -4)
          IF (XP(3,IP).LT.XP(1,IP)) CALL SURF2 (Z, NX, NY, +4)
          IF (XP(4,IP).LT.XP(2,IP)) CALL SURF2 (Z, NX, NY, -2)
          IF (XP(4,IP).GT.XP(2,IP)) CALL SURF2 (Z, NX, NY, +2)
          CALL SURF2 (Z, NX, NY, -3)
          CALL GRAFIT (6, ITAPE, BUFFER, 'GREEN')
          CALL SURF1 (2)
          CALL GRAFIT (2, ITAPE, BUFFER, 'PACK BUFFER')
          CALL GRAFIT (3, ITAPE, BUFFER, 'WRITE BUFFER')
          CALL GRAFIT (4, ITAPE, BUFFER, -IP)
```

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C
C     PLOT THE LOWER PART OF THE SURFACE.
      CALL GRAFIT (1, ITAPE, BUFFER, 15000)
      CALL SURF0 (XP(1,IP), YP(1,IP), ZMIN, ZMAX, NY, NY)
      CALL SURF3 (Z, NX, NY, -1)
      CALL GRAFIT (6, ITAPE, BUFFER, 'TURQUOIS')
      CALL SURF2 (Z, NX, NY, -1)
      CALL GRAFIT (6, ITAPE, BUFFER, 'BLUE')
      IF (XP(3,IP).GT.XP(1,IP)) CALL SURF2 (Z, NX, NY, +4)
      IF (XP(3,IP).LT.XP(1,IP)) CALL SURF2 (Z, NX, NY, -4)
      IF (XP(4,IP).LT.XP(2,IP)) CALL SURF2 (Z, NX, NY, +2)
      IF (XP(4,IP).GT.XP(2,IP)) CALL SURF2 (Z, NX, NY, -2)
      CALL SURF2 (Z, NX, NY, +3)
      CALL GRAFIT (6, ITAPE, BUFFER, 'PURPLE')
      CALL SURF1 (2)
      CALL GRAFIT (2, ITAPE, BUFFER, 'PACK BUFFER')
      CALL GRAFIT (3, ITAPE, BUFFER, 'WRITE BUFFER')
      CALL GRAFIT (4, ITAPE, BUFFER, -IP)
C
C     PLOT BOTH PARTS OF THE SURFACE WITH SIDE SKIRTS.
      CALL GRAFIT (1, ITAPE, BUFFER, 15000)
      CALL SURF0 (XP(1,IP), YP(1,IP), ZMIN, ZMAX, NX, NY)
      CALL GRAFIT (6, ITAPE, BUFFER, 'CLEAR')
      CALL SURF3 (Z, NX, NY, +1)
      CALL GRAFIT (6, ITAPE, BUFFER, 'RED')
      CALL SURF3 (Z, NX, NY, -1)
      CALL GRAFIT (6, ITAPE, BUFFER, 'GREEN')
      IF (XP(3,IP).GT.XP(1,IP)) CALL SURF2 (Z, NX, NY, +4)
      IF (XP(3,IP).GT.XP(1,IP)) CALL SURF2 (Z, NX, NY, -4)
      IF (XP(4,IP).LT.XP(2,IP)) CALL SURF2 (Z, NX, NY,+2)
      IF (XP(4,IP).LT.XP(2,IP)) CALL SURF2 (Z, NX, NY, -2)
      CALL GRAFIT (6, ITAPE, BUFFER, 'BLUE')
      CALL SURF2 (Z, NX, NY, -3)
      CALL SURF2 (Z, NX, NY,  3)
      CALL SURF1 (2)
      CALL GRAFIT (2, ITAPE, BUFFER, 'PACK BUFFER')
      CALL GRAFIT (3, ITAPE, BUFFER, 'WRITE BUFFER')
      CALL GRAFIT (4, ITAPE, BUFFER, -IP)
C
C     NOW TEST THE CONTOUR PLOTTER USING ONE LEVEL PER COLOR.
      CALL GRAFIT (1, ITAPE, BUFFER, 15000)
      CALL GRAFIT (6, ITAPE, BUFFER, 'CLEAR')
      XXMIN =    0.0 + FLOAT(IP*30)
      XXMAX = 1000.0 - FLOAT(IP*30)
      YYMIN =  300.0 - FLOAT(IP*30)
      YYMAX =  700.0 + FLOAT(IP*30)
      CALL CNTSET (XXMIN, YYMIN, XXMAX, YYMAX)
      CALL CNTFRM
      DO 50 IL = 1, 7
      CALL GRAFIT (6, ITAPE, BUFFER, COLORS(IL))
50    CALL CUNTOR (Z, TEST, NX, NY, FL(IL))
      CALL GRAFIT (2, ITAPE, BUFFER, 'PACK BUFFER')
      CALL GRAFIT (3, ITAPE, BUFFER, 'WRITE BUFFER')
      CALL GRAFIT (4, ITAPE, BUFFER, -IP)
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C
  100   CONTINUE
C
C     CLOSE-OUT GRAFIT.
      CALL GRAFIT (9, ITAPE, BUFFER, 'END OF TEST#.')
      STOP
      END
```