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# A 3800 Computer Subroutine Package to Produce Line Printer Plots

DIANNA L. DENTON

Research Computation Center Mathematics and Information Sciences Division

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CLEAPINGHOUSE





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# NAVAL RESEARCH LABORATORY Washington, D.C.

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#### ABSTRACT

A computer subroutine package written at the University of Wisconsin to produce line printer plots has been modified to run on NRL's CDC 3800 Computer. Line printer plots are valuable for scientists who want a fast and economical method of producing plots but who do not require a high resolution capability.

#### PROBLEM STATUS

A final report on one phase of the problem; work is continuing on other phases.

#### AUTHORIZATION

#### MRL General and Administrative Function 78-1601

#### ACKNOWLEDGMENTS

The Research Computation Center of the Naval Research Laboratory is indebted to the Computing Center of the University of Wisconsin for supplying the original line printer plot subroutine package and its documentation. The author of this report takes credit only for making modifications, compatibility changes, and documentation changes.

The author is indebted to Doris E. Gossett, Gay H. Rogers, and Douglas P. Shannon of the Research Computation Center for their assistance in preparing this publication. A 3800 Computer Subroutine Package to Produce Line Printer Plots

#### INTRODUCTION

A computer subroutine package written to produce line printer plots for the Control Data Corporation 3600 Computer by personnel of the Computing Center of the University of Wisconsin, Madison, Wisconsin has been modified for NRL's CDC 3800 Drum SCOPE Computer System. The following subroutine description contains many excerpts from the original documentation received from the University of Wisconsin (Section 3.15, Reference (1)).

The line printer plot subroutine, GRAPH2, is intended to be valuable for scientists who want a fast and economical method of producing plots of their data but who do not require the high resolution (100 points per inch) of the CALCOMP plotter (Section 3.15, Reference (2)).

Throughout this report, a "plot" will mean one set of axes (abscissa and ordinate) and all the curves to be plotted on this set of axes (e.g. - five curves plotted on one set of axes would be one plot). A "curve" will mean that which is generated from one set of data points by one call to GRAPH2.

The remainder of this report describes the use of the line printer plot subroutine, GRAPH2.

### SUBROUTINE DESCRIPTION

- 1.0 IDENTIFICATION
  - L.L Title

Line Printer Plot

1.2 Identification Name

J5-NRL-PRPLOT

1.3 Classification Code

J5 - Output, Plotting

1.4 RCC Identification Number

J5002R00

1.5 Entry Points

GRAPH2 GRAPH2X GRAPH2Y GRAPH2XY PICTURE

# 1.6 Programming Language

Language: 3600 FORTRAN and COMPASS 5.3

Routine Type: Subroutine

Operating System: DRUM SCOPE 2.0

1.7 Computer and Configuration

CDC 3800

1.8 Contributor or Programmer

Dianna L. Denton, Code 7817DD, Research Computation Center, Mathematics and Information Sciences Division

1.9 Contributing Organization

NRL - Naval Research Laboratory - Washington, D. C., 20390

#### 1.10 Program Availability

1.10.1 Submittal: Program write-up, Fortran and Compass source deck, source listing

- 1.10.2 On File: RCC Program Library
- 1.11 Verification

See Section 7.0, Test Method and Results

1.12 Date

10 June 1969

#### 2.0 PURPOSE

2.1 Description of the Routine

GRAPH2 produces a plot(s) on the line printer from user specified data (two data arrays). In addition to producing the plot, GRAPH2 performs the following functions:

- (a) Prints a special symbol for all points on a curve (optional), or uses a standard symbol.
- (b) Prints plot title (optional).
- (c) Prints abscissa and ordinate axes with fitles (titles are optional).
- (d) Prints numeric labeling of the axes to indicate magnitudes.
- (e) Allows overlay curves (multiple curves) on one set of axes.
- (f) Determines shifting and scaling so that the data will fit the user specified plot dimensions, or allows the user to specify the shifting and scaling factors.
- (g) Provides for multiple copies of a given plot (entry point PICTURE).
- (h) Allows plots to vary in size between the limits of 5 x 5 inches to 25 x 10 inches, where the abscissa length is specified first.

# 2.2 Problem Background

GRAPH2 was acquired to meet the need of those scientists who want a less expensive and faster method for plotting but who do not require a high resolution capability.

#### 3.0 USAGE

The physical appearance of the axes, the axes labels, the axes titles, and the plot title is described in Section 3.8, Output.

Described below (Parts A, B, C, and D) are the four basic calling sequences (Standard, Expanded, Standard Overlay, and Expanded Overlay) for GRAPH2, which assume that the two data arrays (abscissa and ordinate values) to be plotted are TYPE REAL. Part E below gives the entry points to be used when one or both of the data arrays are TYPE INTEGER. Part F below describes the PICTURE subroutine calling sequence.

> A. <u>Standard GRAPH2 Calling Sequence (GRAPH2 Computes</u> Scaling and Shifting).

> > CALL GRAPH2 (X, Y, N, ISIZE, ISCALE, ITITLE, IXTITLE, ISYMBOL)

The above call is used when the

- (1) scaling and shifting factors are to be computed by GRAPH2, and
- (2) the curve is not to be overlaid on the preceding set of axes.

The above call will cause

- (1) the preceding plot (if any) to be printed (unless PICTURE has been called since the previous call to GRAPH2), and
- (2) the new axes, titles, and curve to be generated, but not printed.
- B. Expanded GRAPH2 Calling Sequence (User Supplied Scaling and Shifting Factors).
  - CALL GRAPH2 (X, Y, N, ISIZE, ISCALE, XSHIFT, XSCALE, YSHIFT, YSCALE, ITITLE, IXTITLE, IYTITLE, ISYMBOL)

The above call is used when

- (1) the user specifies the scaling and shifting factors, and
- (2) the curve is not to be overlaid on a previous set of axes.

ISCALE must be equal to 4HEXIN (See Section 3.2, ISCALE).

The above call will cause:

- (1) The preceding plot (if any) to be printed (unless PICTURE has been called since the previous call to GRAPH2), and
- (2) the current axes, titles, and curve to be generated, but not printed.
- C. Standard Overlay Calling Sequence:

CALL GRAPH2 (X, Y, N, 7HØVERLAY, ISCALE, ISYMBØL)

The above call is used when the

- (1) scaling and shifting factors are to be computed by GRAPH2, and
- (2) the curve is to be overlaid on the preceding set of axes.

The first curve and the axes of the plot must have been generated using the Standard or Expanded GRAPE2 calling sequence.

The above call causes the current curve to be generated, but not plotted.

All curves of an overlay plot, except the first, must be generated using an Overlay Calling Sequence. Any number of overlay curves may be generated for a particular plot. However, the number of different symbols which may be used to distinguish between the curves is restricted to ten (See Section 3.2, ISYMBØL).

D. Expanded Overlay Calling Sequence:

CALL GRAPH2 (X, Y, N, 7HØVERLAY, ISCALE, XSHIFT, XSCALE, YSHIFT, YSCALE, ISYMBØL)

The above call is used when the

(1) user specifies the scaling and shifting factors, and

(2) the curve is to be overlaid on a previous set of axes.

ISCALE must be equal to 4HEXIN (See Section 3.2, ISCALE).

The above call will cause the current curve to be generated, but not plotted.

All curves of an overlay plot, except the first, must be generated using an Overlay Calling Sequence. Any number of overlay curves may be generated for a particular plot. However, the number of different symbols which may be used to distinguish between the curves is restricted to ten (See Section 3.2, ISYNBØL).

#### E. Calling Sequence for Integer Data Array(s):

If one or both of the data arrays are TIPE INTEGER, different entry points of GRAPH2 must be used. The entry point to be used is chosen according to the following table:

| Abscissa Array(X) | Ordinate Array(Y) | Entry Point |
|-------------------|-------------------|-------------|
| TYPE REAL         | TYPE REAL         | GRAPH2      |
| TYPE INTEGER      | TYPE REAL         | GRAPH2X     |
| TYPE REAL         | TYPE INTEGER      | GRAPH2Y     |
| TYPE INTEGER      | TYPE INTEGER      | GRAPH2XY    |

The parameter lists are the same as described in the calling sequences to GRAPE2. For example, if the abscissa values of the data to be plotted are in the TYPE REAL array X, and the ordinate values are in the TYPE INTEGER array IY, then the Standard Calling Sequence (See A above) is:

CALL GRAPH2Y(X, IY, N, ISIZE, ISCALE, ITITLE, IXTITLE, IXTITLE, ISYMBOL).

#### F. PICTURE Galling Sequence:

CALL PICTURE

The above call is necessary to

- (1) print the last plot produced in a sequence of one or more calls to GRAPH2, or
- (2) print multiple copies of a plot produced by the previous GRAPH2 call (n calls to PICTURE will produce n copies of the last plot generated by GRAPH2).

For example,

CALL GRAPH2 (appropriate parameters)

CALL PICTURE

will generate the plot in the call to GRAPH2 and print the plot in the call to PICTURE. If PICTURE were now called n more times, n more copies of the plot would be printed.

A call to GRAPH2 causes the preceding plot (if any) to be printed. This is true except when PICTURE has been called prior to calling GRAPH2.

#### 3.2 Arguments, Parameters, and/or Initial Conditions

#### Initial Conditions:

Before calling GRAPH2 (or GRAPH2X, GRAPH2Y, or GRAPH2XI), 2 one-dimensional arrays, containing the data to be plotted, must be stored in the computer (one array containing the abscissa values, the other the ordinate values). Each of these arrays can be either TYPE REAL or TYPE INTEGER (See the X and Y parameters below). In Section 3.1 Parts A, B, C, and D, calling sequences are described for the TYPE REAL case only. In Section 3.1, Part E, the use of GRAPH2 when one or both of the coordinate arrays are TYPE INTEGER, is described.

Parameters:

- X TYPE REAL array containing the abscissa values to be plotted. To use a TYPE INTEGER array, see Section 3.1.
- Y TYPE REAL array containing the ordinate values to be plotted. To use a TYPE INTEGER array, see Section 3.1.

N - integer number which specifies both

- (1) the number of points to be plotted, and
- (2) the plotting mode.

If N is positive, the effect of a continuous line is produced by use of linear interpolation to fill in values between successive data points. (Since this is analogous to pen-down plotting mode on a plotter, it will hereafter be referred to as "pen-down" mode). If N is negative only those points contained in the arrays are plotted. (This will be referred to as "pen-up" mode). The first |N| points of the X and Y arrays are plotted; |N| must be  $\leq$  the size of the X and Y arrays.

ISIZE - a Hollerith designator which specifies the dimension (in inches) of the plot.

ISIZE = 5HLARGE for an  $8 \times 16$  inch plot

- ISIZE = 5HSMALL for a  $6 \times 8$  inch plot
- ISIZE = 5ExXyy for a user specified plot size where,
  - xx = X-axis length in inches  $(5 \le xx \le 25)$
  - yy = Y-axis length in inches (5 <  $yy \le 10$ )

#### ISCALE - a Hollerith designator which specifies the type of scaling to be used on the data.

(1) Automatic Scaling: ISCALE = 4HAUTØ

Automatic scaling causes the program to fit the data points into the plot size as specified by the parameter ISIZE. To locate the origin, the plot is classified into one of three types in each direction. This classification depends upon the signs of the maximum and minimum values of each of the two coordinate arrays.

The position of the origin-point of the plot within the defined plotting rectangle is shown in Figures 1a. and 1b. Combinations of the two sets of figures are permitted.







Figure 1b: Position Of The Abscissa Origin As a Function Of The Sign Of The Abscissa Data.

> Scaling of the curve data is by powers of two such that the resultant curve occupies at least one-half of the allowable plotting length for each coordinate axis. For best results, if M is the maximum of the absolute values of the data for one axis, the length of that axis in inches, as specified by the parameter ISIZE, should be slightly greater than (or exactly equal to) one of the terms of the sequence . . . 1/4M, 1/2M, M, 2M, 4M, . . . .

For example, suppose that the abscissa coordinate values of the points to be plotted range from 31.5 to 46.0, so that M = 46.0. Then the best choices of abscissa axis length, in inches are: 23 (exactly 1/2M), 12 (slightly greater than 1/4M, and 6 (slightly greater than 1/8M).

# (2) **Biased Scaling:** ISCALE = 4HBIAS

Under this option, the minimum value of each coordinate array is subtracted from the corresponding coordinate of each data point before the point is plotted. For each axis, scaling is by powers of two, as above, except that the difference between the maximum and minimum values of the data for that axis (rather than the maximum of the absolute values of the data for that axis) is used to determine the scale factor. For best results, the corresponding axis length as specified by the parameter ISIZE should be equal to or slightly greater than this difference times a power of two.

#### (3) Repeated Scaling and Shifting Factors:

ISCALE = 4ESAME

With this option, the scaling and shifting factors used in the previous plot are also to be used in producing the current plot. This option should be used with the Standard Overlay Calling Sequence if each curve is to be shifted and scaled by the same values as the immediately preceding curve. If the shifting and scaling is to be different, see the other ISCALE options. However, it should be remembered that the numeric values written on each axis are based on the scaling and shifting factors used for the first curve plotted on those axes.

(4) Unscaled Data: ISCALE = 4HNONE

This option is provided to plot the data with no scaling or shifting. When using this option the user must be sure that his data is properly "called and centered to fit into the plot size.

#### (5) User Specified Scaling and Shifting:

ISCALE = 4HEXIN

This option causes the four real parameters, XSHIFT, XSCALE, YSHIFT, and YSCALE, to be used for shifting and scaling the data. This option can only, and must, be used in the Expanded GRAPH2 calling Sequence (See Section 3.1, Part B), and in the Expanded Overlay Calling Sequence (See Section 3.1, Part D).

If  $X_1$  and  $Y_1$  are unscaled abscissa and ordinate values respectively, then the corresponding plotted values in inches, relative to the lower left hand corner of the plot rectangle after rotation (see Section 3.8) will be:

| X <sub>1</sub> - XSHIFT | and | Y <sub>1</sub> - YSHIFT |
|-------------------------|-----|-------------------------|
| XSCALE                  |     | YSCALE                  |

XSHIFT - A real value which specifies the amount of shift for the abscissa values. The point on the x-axis at the lower left-hand corner of the plot rectangle after rotation (see Section 3.8) will be annotated by XSHIFT.

- XSCALE a real value which specifies the scale factor for the shifted abscissa values. This is the increment used to increase XSHIFT to calculate the annotation value and the plotted value for each tick mark after the first tick mark (where a tick mark occurs every inch). Thus, the annotation and the value plotted at the nth tick mark will be XSHIFT + (n-1) XSCALE.
- YSHIFT a real value which specifies the amount of shift for the ordinate values. The point on the y-axis at the lower left-hand corner of the plot rectangle after rotation (see Section 3.8) will be annotated by YSHIFT.
- YSCALE A real value which specifies the scale factor for the shifted ordinate values. This is the increment used to increase YSHIFT to calculate the annotation value and the plotted value for each tick mark after the first tick mark (where a tick mark occurs every inch). Thus, the annotation and the value plotted at the nth tick mark will be YSHIFT + (n-1) YSCALE

Example of shifting and scaling:

If the abscissa values range from 15.0 to 17.0 and the abscissa axis length as specified by the parameter ISIZE is 5 inches then setting XSHIFT =15.0 and XSCALE =0.4 would cause the abscissa values to be shifted and scaled into the range 0.0 to 5.0 inches, which is the greatest possible range which will contain the data within the axis length of 5 inches.

- ITITLE specifies the plot title in one of the following two ways:
  - (1) a list of characters following a Hollerith designator.
  - (2) the name of an integer variable or array in which are stored the internal BCD codes of the characters of the desired title, packed eight codes per word, left adjusted if less than eight characters.

Regardless of the way in which the title is specified, it may be at most 48 characters in length. If less than 48 characters are desired, the last two characters must be periods. GRAPH2 will remove the terminating periods and the desired characters will be centered appropriately before plotting. If no title is desired, the corresponding parameter may be given the value zero. Or, if none of the subpoutine parameters following ITITLE are to be used, the ITITLE parameter and those parameters which follow it may be omitted from the calling sequence.

Four examples of the various ways of specifying titles, and the corresponding output they produce, follow:

(1) ITITLE = 48H GRAPHL SAMPLE, EXPANDING SINE WAVE

will produce the title

GRAPHI SAMPLE, EXPANDING SINE WAVE

Since the title, which includes seven blanks following WAVE, is a full 48 characters in length, the last two characters are not periods.

(2) ITITLE = 7 HANGLE.

will produce the title

ANGLE

Since the title is less than 48 characters in length, the last two characters must be periods.

(3) ITITLE = 0

will produce no title. When the title parameter is zero, no title is produced.

- (4) ITITLE = IL where the variable IL contains 62436074533433338 will produce the title SL (\$) since IL contains the BCD codes for SL (\$) followed by two periods.
- IXTITE specifies the abscissa axis title in the same form and with the same rules as for ITITLE above, with the following

#### exception:

The maximum abscissa axis title length depends on the length of the abscissa axis. If the abscissa axis length is greater than or equal to 8 inches the maximum title length is 48 characters, as given under ITITLE. However, if the axis length is less than 8 inches, the maximum number of characters in the abscissa axis title is equal to 6\* (axis length).

- ITTILE specifies the ordinate axis title in the same form and with the same rules as for ITITLE above.
- ISYMBØL is an optional parameter (Hollerith) used to specify the character to be used by the printer to represent a given set of data points. For example, if ISYMBØL = 1HA, the letter A would be used to plot the curve. If ISYMBØL is not present as the last parameter in the calling sequence, GRAPH2 automatically uses an asterisk (\*) for pen-down plotting and a plus sign (+) for pen-up plotting (See description of parameter N above).

When producing an overlay plot, the number of different characters that may be used to differentiate between the various curves is restricted to ten (e.g. - to produce 11 curves on one plot, only ten different symbols can be used; two curves would have to use the same symbol).

- 3.3 Space Required (Decimal and Octal)
  - 3.3.1 Unique Storage:

4112 octal (2122 decimal) locations excluding the common block and system library routines.

3.3.2 Common Blocks:

COMMON/18273645/

Length: 11031 octal (4633 decimal) locations

#### 3.3.3 Temporary Storage:

None

|  | 3.4 | + Message | es and | Instructions | to | the | Operato |
|--|-----|-----------|--------|--------------|----|-----|---------|
|--|-----|-----------|--------|--------------|----|-----|---------|

None

#### 3.5 Error Returns, Messages, and Codes

Each of the following error messages are preceded by the identifier #GRAPE2/.

(1) Error Message BAD SIZE/USED ABSCISSA = 25

Cause The length of the X-axis as specified by ISIZE was less than 5 inches or greater than 25 inches.

- Action GRAPH2 will generate the current plot using an abscissa length of 25 inches.
- (2) Error Message BAD SIZE/USED ORDINATE = 10

Cause The length of the Y-axis as specified by ISIZE was less than 5 inches or greater than 10 inches.

Action GRAPH2 will generate the current plot using an ordinate axis length of 10 inches.

(3) Error Message N EQUAL ZERØ

Cause The number of data points was specified as zero.

- Action Current call to GRAPH2 will be ignored.
- (4) Error Message ALL X ESSENTIALLY ZERO

Cause This generally means that all abscissa data had absolute values of less than 10<sup>-200</sup>. When Bias Scaling is specified, this measage may also mean that the range of the data was less than 10<sup>-200</sup>.

Action Current call to GRAPE2 will be ignored.

- (5) Error Message ALL Y ESSENTIALLY ZERØ
  - Cause This generally means that all ordinate data had absolute values of less than 10<sup>-200</sup>. When Bias Scaling is specified, this message may also mean that the range of the data was less than 10<sup>-209</sup>.
  - Action Current call to GRAPE2 will be ignored.
- (6) Error Message OVERLAY ERROR
  - Cause An attempt has been made to generate an overlay curve prior to generating a set of axes by using either the Standard or Expanded GRAPH2 calling sequence.
  - Action Current call to GRAPE2 will be ignored.
- (7) Error Message MORE THAN 10 UNIQUE SYMBOLS

Cause This message occurs when an overlay call specifies an eleventh unique symbol to be used on one set of axes.

- Action The current call to GRAPH2 and all preceding calls pertaining to this set of axes will be ignored.
- (8) Error Message THIS PLOT OR OVLAY NOT DONE

Cause This message follows all error messages of the type which cause the current call to GRAPH2 to be ignored.

#### 3.6 Informative Messages to the User

None

3.7 Input

None

# 3.8 Cutput

See the sample plots in Section 7.0.

The generated line printer plot will have the following automatic features:

(1) Axes

- (a) The axes will be drawn the length specified by the ISIZE parameter.
- (b) Each axis will be numerically labeled at every inch along the axis.
- (c) Each axis is composed of periods (.) and plus signs (+) with the plus signs occuring only at each inch increment along the axis. The periods are written between the plus signs.
- (d) The abscissa axis will be parallel to the paper sprocket holes.
- (e) The ordinate axis will be perpendicular to the sprocket holes.

If the line printer page is rotated counterclockwise  $90^{\circ}$ , the axes will be in the normal X, Y axis arrangement.

- (f) All numeric labeling of the axes is written with either an F or E Fortran I/O format (depending on the size of the values) giving 3 places to the right of the decimal point.
- (2) Titles
  - (a) The abscissa axis title is written parallel to the abscissa axis.
  - (b) The ordinate axis title is written parallel to the ordinate axis.
  - (c) The plot title is written parallel to the ordinate axis, above the ordinate axis title.
- (3) Data Curves

Unless specified otherwise by the ISYMBØL parameter, the plotted curves will have an asterisk (\*) at each coordinate if the parameter N is positive (pen-down mode), or a plus sign (+) if the parameter N is negative (pen-up mode). The pen mode is defined in Section 3.2, in the N parameter description.

3.9 Formats

Not applicable

3.10 External Routines and Symbols

GRAPH2A GRAPH2B GRAPHZ J5002ROO Package Deck Q8QG2PRT SEARCH

GRAPH2X, GRAPH2Y, GRAPH2XY, and PICTURE are

entry points in GRAPH2.

| LOGF   | <b>Q1Q04100</b>  | DEC.     | STH. |                |
|--------|------------------|----------|------|----------------|
| MAXIF  | 01010100         | QNSINGL. | ENC. |                |
| XMAXOF | <b>QBQEF.RØR</b> | THEND    | SLÓ. | system library |
| XMINOF | Q8QDIST          | 92007110 | IÓP. |                |

3.11 Timing

See the timing for the sample plots in section 7.0

3.12 Accuracy

The resolution of the line printer is 10 points per inch for the ordinate axis and 6 points per inch for the abscissa axis.

- 3.13 Cautions to Users
  - (1) If you want the plots to be printed on plain white printer paper, you should write "FINAL FORM" at the top of your Job Request Form. Otherwise, you will get whatever paper is on the line printer at the time of your run. Jobs asking for "FINAL FORM" usually are not run until the night shift.
  - (2) If the papameter ISCALE equals 4HAUTY or 4HBIAS, it is required that both the coordinate arrays contain some non-zero data. If all the data in either of the arrays is zero, an error message is printed and no curve (or

plot) is produc-d.

- (3) Any attempt to plot data outside the selected plot size will result in the data point in question being plotted on the inside edge of the plot perimeter.
- 3.14 Program Deck Structure
- 7 JØB card 7 FIN card Main Program deck (contains call to GRAPE2) Subroutine GRAPH2 Subroutine GRAPH2A Subroutine GRAPH2B Subroutine GRAPHZ J5-NRL-PRPLOT Subroutine Q8QG2PRT Subroutine SEARCH SCOPE card 7 LOAD card 7 RUN card 9 Data (if any) 77 (end-of-file card) 3.15 References - Literature - Appendices
  - (1) GRAPH PLOTTING VIA CALCOMP 570 DIGITAL PLOTTER, The University of Wisconsin Computing Center Users Manual, Revisions A and B, 24 May 1965 and 1 December 1966.
  - (2) 3800 CALCOMP PLOTTER SUBROUTINE PACKAGE, PRELIMINARY VERSION, RCC Memorandum 7810-5:ABB:pj, 18 September 1967.

#### 4.0 METHOD OR ALGORITHM

See the author

5.0 SOURCE LANGUAGE LISTING

Available in the RCC Program Library

6.0 COMPARISON

None

7.0 TEST METHOD AND RESULTS

Following are the listings of three sample programs which use GRAFH2. The approximate timing for each call is given.

Sample 1: Program ESW below was used as a test program.

See Figure 1 for the resulting output. Timing: Call to GRAFH2: 0.21 seconds Call to FICTURE: 0.21 seconds

Sample 2: Program SSCP below illustrates the overlay capabilities of GRAFH2. The output simulates the output in the sample given in the CalComp Flotter Subroutine Package description (Section 3.15, Reference 2).

> PR@GRAM SSCP DIMENSION FEX(71),FXCUBE(71),FXLINEAR(71),XPLOT(71) X = 1,0 D0 100 I=1,71 FEX(1) = EXPF(X)/10,0 FXCUBE(1) = (X\*\*3\*7,0)/10,0 FXLINEAR(I) = (X\*\*3\*7,0)/10,0 100 X = X\*0,05 XPLOT(1) = 0 D0 200 I=2,71 200 XPLOT(I) = XPLOT(I=1)\*0,1 CALL GRAPH2(XPLOT,FEX,-71,4H7X10,4HAUTO, 1 31HSIMULATED SAMPLE CALCOMP PLOT,,10HADSCISSA..,10HORDINATE,,) CALL GRAPH2(XPLOT,FXCUBE,71,7HOVERLAY,4HSAME,1H,) CALL GRAPH2(XPLOT,FXLINEAR,71,7HOVERLAY,4HSAME,1H,) CALL PICTURE END

See Figure 2 for the resulting output. Timing: First call to GRAFH2: 0.09 seconds Second call to GRAFH2: 0.05 seconds Third call to GRAFH2: 0.04 seconds Call to FICTURE: 0.36 seconds

Sample 3: Program LPPLØT below illustrates overlay calls and the use of the expanded calling sequence.

PREGRAM LP PLOT DIMENSION A(3), 0(40), J(3), X(81), Y(81) DATA (A=2,0,4,0,6,0), (J=1HA,1HB,1HC) K # 1 X(1) = -2.0 D0 100 I=1.40 B(I) = SQRTF(X(1)++2+(4.0-X(1)++2)) x(82=1) = x(1) 100 x(1+1) = x(1)+0.1 X(41) = 2.0 200 D3 300 I=1,40 Y(1) = A(K)+B(I) 300 Y(82-1) = A(K)-B(1) Y(41) = A(K) G0 T0 (400,500) K 400 CALL GRAPH2(X,Y,81,3H6X8, HEXTN.=3,0,1,0,0,1,0,0,3HX,,,SHY,,,J(K)) GO TO 600 500 CALL GRAPH2 (X, Y, 81, 7HOVERLAY, 4HSAME, J(K)) 600 K = K+1 GO TO (200,200,700) K=1 700 CALL PICTURE END See Figure 3 for the resulting output. Timing: 0.12 seconds First call to GRAPH2: Second call to GRAPH2: 0.07 seconds Third call to GRAPH2: 0.07 seconds Call to PICTURE: 0.32 seconds

#### 8.0 REMARKS

None

EXPANDING SINE WAVE

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8

MAGNITUDE

-

< z o \_ u

Figure 1

SIMULATED SAMPLE CALCOMP PLOT

BRDINATE



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