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PLOT300 - A Tektronics PLOT10 Emulator for HP 9000 Series 200/300 Computers

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ABSTRACT

A software package which emulates the Tektronics PLOT10 Graphics package on Hewlett–Packard 9000 Series 200/300 computers is described. The software is written in HP Rocky Mountain BASIC and can be run under BASIC revisions 3.0 and 4.0. Although this subroutine library emulates a subset of PLOT10, several subroutines have been added which enhance basic plot generation. Example codes using PLOT300 and descriptions of the subroutines are included in the text.

INTRODUCTION

Although the primary function of the existing NASA–Langley wind tunnel complex is the same as that of its predecessor NACA, the capabilities of the existing facilities are far superior to those of its predecessor with regard to the relative speeds obtainable, Reynolds number range, and the types and quality of data that can be acquired. The recent advances in electronics have created a wide variety of micro–processor controlled instrumentation systems and desk–top micro–computers that can interface with these systems. The capability for computer control of data acquisition systems has led to a large increase in the volume of experimental data acquired. However, this proliferation in micro–processor technology has created a wide variety of computer operating systems and languages in which the test engineer must be fluent, in order to efficiently acquire, reduce and analyze experimental data.

A typical wind–tunnel test program includes the acquisition of experimental data, real–time data reduction, to verify the quality of the acquired data, and off–line data analysis. This process can include a variety of computers, operating systems and languages. An example of this is the Basic Aerodynamics Research Tunnel at NASA–Langley Research Center. Data acquisition and real–time data display are performed by a desktop computer system using the BASIC computer language, off–line data analysis is performed on the desktop computer system, and two different mini–computers. The mini–computers both use the FORTRAN language but have entirely different operating systems. Software for displaying data on these computer systems also widely varies.

The purpose of this report is to describe the features and application of a BASIC software package which emulates the Tektronics PLOT10 graphics software package which is widely used throughout government research laboratories and industry.

EXAMPLES OF USE OF PLOT300

In the following text, examples of the use of PLOT300 are presented to show the various methods for producing a usefull plot. The subroutine library PLOT300 was formulated to emulate the Tektronics PLOT10 graphics package on HP 9000 Series 200/300 computers equipped with Rocky Mountain BASIC revision 3.0 or 4.0. This software emulates a subset of the PLOT10 graphics package, but includes the subroutines required for typical engineering applications and several additional subroutines which enhance the PLOT300 graphics package. The discussion in the text assumes a fundamental knowledge of the Rocky Mountain BASIC (see references 1 thru 3) and Tektronics PLOT10 (see references 4 and 5). Descriptions of the subroutine calls and the purpose of the subroutine are presented in the next section. A listing of the PLOT300 subroutine library is presented in the appendix.

Example Code 1

This code represents the simples method for displaying data graphically using PLOT300 and the plot produced is presented in figure 1.

```
10   OPTION BASE 1                ! Required by PLOT300
20   DIM X(100),Y(100)
30   Npoints = 11
40   FOR I = 1 TO Npoints
50     X(I) = I-1
60     Y(I) = (I-1)^2
70   NEXT I
80   CALL Initt("CRT")
90   CALL Binitt
100  CALL Npts(Npoints)
110  CALL Dsplay(X(*),Y(*))
120  END
```

Example Code 2

This sample code adds a second and third curve to the previous example plot and uses different line types and symbols to help distinguish between them. The plot produced by this code is presented in figure 2.

```
10   OPTION BASE 1                ! Required by PLOT300
20   DIM X(100), Y(100), Z(100), T(100)
30   Npoints = 11
40   FOR I = 1 TO Npoints
50     X(I) = I-1
60     Y(I) = (I-1)*7.5+10
70     Z(I) = I*10+5
80     T(I) = (I-1)*3.5+3
90   NEXT I
100  CALL Initt("CRT")
110  CALL Binitt
120  CALL Npts(Npoints)
130  CALL Symbl(1)
140  CALL Line(-1)
150  CALL Dsplay(X(*),Y(*))
160  CALL Symbl(2)
170  CALL Line(2)
180  CALL Npts(Npoints)
190  CALL Cplot(X(*),Z(*))
200  CALL Symbl(3)
210  CALL Line(0)
220  CALL Npts(Npoints)
230  CALL Cplot(X(*),T(*))
240  END
```

Example Code 3

Example code 3 illutsrates the addition of labels on the x and y axes and plot titles. The plot produced is presented in figure 3.

```
10   OPTION BASE 1                ! Required by PLOT300
20   DIM X(100), Y(100), Z(100), T(100)
```

```
30    Npoints = 11
40    FOR I = 1 TO Npoints
50      X(I) = I-1
60      Y(I) = (I-1)*7.5+10
70      Z(I) = I*10+5
80      T(I) = (I-1)*3.5+3
90    NEXT I
100   CALL Initt("CRT")
110   CALL Binitt
120   CALL Npts(Npoints)
130   CALL Symbl(1)
140   CALL Line(-1)
150   CALL Hlabel("X")
160   String$ = "Y"
170   CALL Vlabel(String$)
180   CALL Title("Example code 3")
190   CALL Ptitle("Sample Plot Title")
200   CALL Dsplay(X(*),Y(*))
210   CALL Symbl(2)
220   CALL Line(2)
230   CALL Npts(Npoints)
240   CALL Cplot(X(*),Z(*))
250   CALL Symbl(3)
260   CALL Line(0)
270   CALL Npts(Npoints)
280   CALL Cplot(X(*),T(*))
290   END
```

Example Code 4

Changing the size of the plot and setting the minimum and maximum for the x and y axes is illustrated in example code 4. The plot produced is presented in figure 4.

```
10    OPTION BASE 1                ! Required by PLOT300
20    DIM X(100), Y(100), Z(100), T(100)
30    Npoints = 11
40    FOR I = 1 TO Npoints
50      X(I) = I-1
60      Y(I) = (I-1)*7.5+10
70      Z(I) = I*10+5
80      T(I) = (I-1)*3.5+3
90    NEXT I
100   CALL Initt("CRT")
110   CALL Binitt
120   CALL Npts(Npoints)
130   CALL Symbl(1)
140   CALL Line(-1)
150   CALL Hlabel("X")
160   String$ = "Y"
170   CALL Vlabel(String$)
180   CALL Title("Example code 4")
190   CALL Ptitle("Sample Plot Title")
200   CALL Slimx(.3,.7)
210   CALL Slimy(.3,.7)
```

```
220   CALL Dlimx(-5,15)
230   CALL Dlimy(10,70,10,2)
240   CALL Dsplay(X(*),Y(*))
250   CALL Symbl(2)
260   CALL Line(2)
270   CALL Npts(Npoints)
280   CALL Cplot(X(*),Z(*))
290   CALL Symbl(3)
300   CALL Line(0)
310   CALL Npts(Npoints)
320   CALL Cplot(X(*),T(*))
330   END
```

Example Code 5

The addition of a legend for the lines and symbols used is presented in example code 5. The plot produced is presented in figure 5.

```
10    OPTION BASE 1                ! Required by PLOT300
20    DIM X(100), Y(100), Z(100), T(100)
30    Npoints = 11
40    FOR I = 1 TO Npoints
50      X(I) = I-1
60      Y(I) = (I-1)*7.5+10
70      Z(I) = I*10+5
80      T(I) = (I-1)*3.5+3
90    NEXT I
100   CALL Initt("CRT")
110   CALL Binitt
120   CALL Npts(Npoints)
130   CALL Symbl(1)
140   CALL Line(-1)
150   CALL Hlabel("X")
160   String$ = "Y"
170   CALL Vlabel(String$)
180   CALL Title("Example code 5")
190   CALL Ptitle("Sample Plot Title")
200   CALL Slimx(.3,.7)
210   CALL Slimy(.3,.7)
220   CALL Dlimx(-5,15)
230   CALL Dlimy(10,70,10,2)
240   CALL Dsplay(X(*),Y(*))
250   CALL Symbl(2)
260   CALL Line(2)
270   CALL Npts(Npoints)
280   CALL Cplot(X(*),Z(*))
290   CALL Symbl(3)
300   CALL Line(0)
310   CALL Npts(Npoints)
320   CALL Cplot(X(*),T(*))
330   CALL Legend(1,1.1,.9,1,-1,1,"Line 1")
340   CALL Legend(2,1.1,.9,2,2,1,"Line 2")
350   CALL Legend(3,1.1,.9,3,0,1,"Line 3")
360   END
```

Example Code 6

Placing multiple plots on the same page is illustrated in example code 6. The plot produced is presented in figure 6.

```
10   OPTION BASE 1                ! Required by PLOT300
20   DIM X(100), Y(100), Z(100), T(100)
30   Npoints = 11
40   FOR I = 1 TO Npoints
50     X(I) = I-1
60     Y(I) = (I-1)*7.5+10
70     Z(I) = I*10+5
80     T(I) = (I-1)*3.5+3
90   NEXT I
100  CALL Initt("CRT")
110  CALL Binitt
120  CALL Npts(Npoints)
130  CALL Symbl(1)
140  CALL Line(-1)
150  CALL Place(2)
160  CALL Title("Example code 6")
170  CALL Hlabel("X")
180  CALL Vlabel("Y")
190  CALL Ptitle("Sample Plot Title")
200  CALL Dsplay(X(*),Y(*))
210  CALL Binitt
220  CALL Symbl(2)
230  CALL Line(2)
240  CALL Npts(Npoints)
250  CALL Place(6)
260  CALL Dsplay(X(*),Z(*))
270  CALL Binitt
280  CALL Symbl(3)
290  CALL Line(0)
300  CALL Npts(Npoints)
310  CALL Place(7)
320  CALL Dsplay(X(*),T(*))
330  END
```

SUMMARY OF PLOT300 SUBROUTINES

The following subroutines are available in PLOT300 and are briefly discussed in the following pages.

DESCRIPTION OF PLOT300 SUBROUTINES

A short description of each PLOT300 subroutine follows. The PLOT10 subroutines CHECK and FINITT are not used in PLOT300.

AOUTST -

Call:

CALL AOUTST(String$, X, Y, Ilorg, C_size)

Parameters:

String$ - String variable up to 15 characters lon

Optional Parameters:

X, Y - Location on plot to write String$. Given as a fraction of the X and Y axes.

Ilorg - Specifies relative origin of label with respect to X and Y. See LORG in reference 2.

C_size - Specifies character size to label with

Purpose:

Allows additional labels to be written on the plot. If optional parameters are not present , label is written at current pen position. If the optional parameters are present, the label is written at the X, Y supplied using LORG Ilorg. The character size can be made larger or smaller by specifying C_size.

BINITT - See example code 1, figure 1

Call:

CALL Binitt

Parameters:

None

Purpose:

Sets constants in the PLOT300 common blocks to their default settings.

CPLOT - See example code 2, figure 2

Call:

CALL Cplot(X(*), Y(*))

Parameters:

X(*), Y(*) Arrays that contain the independent and dependent variables to be plotted

Purpose:

Allows the PLOT300 user to add additional curves to an existing plot.

DLIMX – See example code 4, figure 4

Call:

CALL Dlimx(Xmin, Xmax, OPTIONAL X_major_tic, X_minor_tic)

Parameters:

Xmin – x axis minimum

Xmax – x axis maximum

Optional Parameters:

X_major_tic – Major tic mark spacing for x axis
(major tic marks are labeled)

X_minor_tic – Minor tic mark spacing for x axis
(minor tic marks are not labeled)

Purpose:

Allows the PLOT300 user to specify the minimum and maximum values for the x axis. These values are not necessarily used as the plot maximum and minimum, but are used for target values (plotted minimum might be lower, plotted maximum might be higher). If the optional parameters are supplied, then Xmin and Xmax are used as the x axis minimum and maximum with the specified major and minor tic mark spacing.

DLIMY – See example code 4, figure 4

Call:

CALL Dlimy(Ymin, Ymax, OPTIONAL Y_major_tic, Y_minor_tic)

Parameters:

Ymin – y axis minimum

Ymax – y axis maximum

Optional Parameters:

Y_major_tic – Major tic mark spacing for y axis
(major tic marks are labeled)

Y_minor_tic – Minor tic mark spacing for y axis
(minor tic marks are not labeled)

Purpose:

Allows the PLOT300 user to specify the minimum and maximum values for the y axis. These values are not necessarily used as the plot maximum and minimum, but are used for target values (plotted minimum might be lower, plotted maximum might be higher). If the optional parameters are supplied, then Ymin and Ymax are used as the x axis minimum and maximum with the specified major and minor tic mark spacing.

DSPLAY – See example code 1, figure 1

Call:

CALL Dsplay(X(*), Y(*))

Parameters:

X(*), Y(*) – Arrays that contain the independent
and dependent variables to be plotted

Purpose:

This subroutine draws the x and y axes, frames, labels, and plots the X and Y arrays.

HLABEL – See example code 3, figure 3

Call:

CALL Hlabel(String$)

Parameters:

String$ – String variable up to 10 characters long

Purpose:

This subroutine allows the PLOT300 user to specify the horizontal axis label written by DSPLAY

INITT - See example code 1, figure 1

Call:

CALL Initt(String$)

Parameters:

String$ - String variable specifying plot device

Purpose:

This subroutine allows the PLOT300 user to specify the plot device and also sets default plot limits

Values for String$ are:

"CRT" - plot device is CRT

"7475" - plot device is HPGL plotter
located at HPIB address 705

Note: If the CRT is monochromatic, the line 110 will need to be changed to PLOTTER IS CRT. If the HPGL plotter is located at another HPIB address then lines 70 and 910 will need to be modified to the correct HPIB address.

LEGEND - See example code 5, figure 5

Call:

CALL Legend(N, X, Y, Isym, Lintyp, Pen, Legen$)

Parameters:

N - Line number of the legend

X, Y - Position of legend. Giveb in fraction of X, Y axes.

Isym - Specifies symbol number of legend

Lintyp - Specifies linetype of legend

Pen - Specifies pen number of legend

Legen$ - string variable containing legend description

Purpose:

This subroutine allows the PLOT300 user to programatically create a plot legend.

LINE - See example code 2, figure 2

Call:

CALL Line(Lintyp)

Parameters:

Lintyp - Line type to be used for current curve

Values for Lintyp are:

-1 - no line

0 - solid line (default)

1 - dotted line

2 - dot dash

3 - dash

4 - long dash

Purpose:

This subroutine allows the PLOT300 user to specify the line type to be drawn between data points.

NEWPAG

Call:

CALL Newpag

Parameters:

None

Purpose:

Clears plot area without affecting common block constants

NPTS(Npoints) - See example code 1, figure 1

Call:

CALL Npts(Npoints)

Parameters:

Npoints - Number of data points in X and Y arrays

Purpose:

Specifies the number of data points to be plotted by the DSPLAY and CPLOT subroutines.

PEN_COLOR

Call:

CALL Pen_color(Pentyp)

Parameters:

Pentyp - Pen number used for curve

Purpose:

Allows the PLOT300 user to use different pen colors for different curves

PEN_DEF

Call:

CALL Pen_def(Defpen)

Parameters:

Defpen - Pen number used for axes and labels

Purpose:

Allows the PLOT300 user to use different pen colors for the plot axes and labels

PLACE - See example code 6, figures 6 and 7

Call:

CALL Place(Iplace)

Parameters:

Iplace - Variable specifying plot location

Values for Iplace are:

1 - default plotting area
2 - left half of plotting area (see figure 7a)
3 - right half of plotting area (see figure 7a)
4 - upper left quadrant of plotting area (see figure 7b)
5 - lower left quadrant of plotting area (see figure 7b)
6 - upper right quadrant of plotting area (see figure 7b)
7 - lower right quadrant of plotting area (see figure 7b)

Purpose:

Allows the PLOT300 user to place multiple plots on the same page

PTITLE - See example code 3, figure 3

Call:

CALL Ptitle(String$)

Parameters:

String$ - String variable up to 40 characters long

Purpose:

This subroutine allows the PLOT300 user to specify the plot title located below the horizontal axis.

SLIMX – See example code 5, figure 5

Call:

CALL SLIMX(X_min_gdu, X_max_gdu)

Parameters:

X_min_gdu – plot area x axis minimum

X_max_gdu – plot area x axis maximum

Purpose:

Allows the PLOT300 user to specify the plotting area. These values are given as fractions of the entire plotting area.

SLIMY – See example code 5, figure 5

Call:

CALL SLIMY(Y_min_gdu, Y_max_gdu)

Parameters:

Y_min_gdu – plot area y axis minimum

Y_max_gdu – plot area y axis maximum

Purpose:

Allows the PLOT300 user to specify the plotting area. These values are given as fractions of the entire plotting area.

SYMBL – See example code 2, figure 2

Call:

CALL Symbl(Isym)

Parameters:

Isym – Symbol type to be used for current curve

Values for Lintyp are:

0 – no symbol (default)

1 – circle

2 – square

3 – diamond

4 – triangle

5 – upside–down triangle

6 – star

Purpose:

Allows the PLOT300 user to specify the symbol type to be drawn at each data point.

TITLE – See example code 3, figure 3

Call:

CALL Title(String$)

Parameters:

String$ – String variable up to 40 characters long

Purpose:

Allows the PLOT300 user to specify the plot title located above the plot.

VLABEL – See example code 3, figure 3

Call:

CALL Vlabel(String$)

Parameters:

String$ – String variable up to 10 characters long

Purpose:

Allows the PLOT300 user to specify the vertical axis label written by DSPLAY.

OTHER SUBROUTINES USED BY PLOT300

ASCALE – Calling subroutine – PFRAME
This subroutine sets the major and minor tick mark spacing.

MAX - Calling subroutine – DSPLAY
This subroutine find the largest value in an array.

MIN – Calling subroutine – DSPLAY
This subroutine find the smallest value in an array.

PFRAME – Calling subroutine – DSPLAY
This subroutine draws the plot axes and grid and labels.

SYMBL – Calling subroutine – DSPLAY, CPLOT
This subroutine draws the specified symbol at a specific point.

REFERENCES

1. BASIC 4.0 Programming Techniques for HP 9000 Series 200/300 Computers. Hewlett-Packard Manual No. 98613-90011, 1985.

2. BASIC 4.0 Language Reference for HP 9000 Series 200/300 Computers. Hewlett-Packard Manual No. 98613-90051, 1985.

3. BASIC 4.0 Graphics Techniques for HP 9000 Series 200/300 Computers. Hewlett-Packard Manual No. 98613-90031, 1985.

4. PLOT 10 Terminal Control System. Tektronics Part No. 070-5711-00, 1986.

5. PLOT 10 Advanced Graphing II. Tektronics Part No. 070-5713-00, 1986.

APPENDIX – PLOT300 LISTING

```
10      END                  ! Required by BASIC
20 Initt:SUB Initt(Plotter$)
30        OPTION BASE 1
40        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
50        IF Plotter$="7475" THEN
60          Plotdev=1
70          PLOTTER IS 705,"HPGL"
80          GRAPHICS INPUT IS 705,"HPGL"
90        ELSE
100         Plotdev=0
110         PLOTTER IS 3,"INTERNAL";COLOR MAP
120         SET PEN 15 INTENSITY .3,.3,.3
130         GRAPHICS INPUT IS KBD,"ARROW KEYS"
140       END IF
150       X_gdu=100*MAX(1,RATIO)
160       Y_gdu=100*MAX(1,1/RATIO)
170       GCLEAR
180       IF SYSTEM$("SYSTEM ID")="9836C" THEN
190         Xhgdu=.9*X_gdu
200         Xlgdu=.25*X_gdu
210         Yhgdu=.80*Y_gdu
220         Ylgdu=.2*Y_gdu
230       ELSE
240         IF Plotdev=0 THEN PRINT CHR$(12)
250         Xhgdu=.85*X_gdu
260         Xlgdu=.25*X_gdu
270         Yhgdu=.85*Y_gdu
280         Ylgdu=.3*Y_gdu
290       END IF
300       VIEWPORT Xlgdu,Xhgdu,Ylgdu,Yhgdu
310     SUBEND
320   !*****************************************************************
330   !*****************************************************************
340 Binitt:SUB Binitt
350       OPTION BASE 1
360       COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
370       COM /Plot2/ Ndx,Incx,Rincx,Ndy,Incy,Rincy
380       COM /Labels/ Hlabel$[10],Vlabel$[10],Ptitle$[40],Header$[40]
390     ! ZERO EVERYTHING
400       GRAPHICS ON
410       Hlabel$="        "
420       Vlabel$="        "
430       Ptitle$="                                "
440       Header$="                                  "
450       Lintyp=100
460       Isym=0
470       Xlow=0
480       Xhigh=0
490       Ylow=0
```

```
500         Yhigh=0
510         Pentyp=1
520         Defpen=1
530         Ndx=0
540         Incx=0
550         Rincx=0
560         Ndy=0
570         Incy=0
580         Rincy=0
590       SUBEND
600   !*****************************************************************
610   !*****************************************************************
620 Pframe:SUB Pframe(Xmin,Xmax,Ymin,Ymax)
630         OPTION BASE 1
640         DEG
650         COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
660         COM /Plot2/ Ndx,Incx,Rincx,Ndy,Incy,Rincy
670         COM /Labels/ Hlabel$[10],Vlabel$[10],Ptitle$[40],Header$[40]
680         COM /Syms/ Xcir(17),Ycir(17),Xsq(5),Ysq(5),Xdi(5),Ydi(5),
Xtr(4),Ytr(4),Xutr(4),Yutr(4),Xst(6),Yst(6)
690         PEN Defpen
700         CLIP ON
710         Csize_init=MIN((Yhgdu-Ylgdu),(Xhgdu-Xlgdu))*.025+1.2
720         IF Xlow=0 AND Xhigh=0 THEN GOTO 750
730         Xmin=Xlow
740         Xmax=Xhigh
750         IF Ndx=0 THEN
760           Xmin=Xmin+.01*(Xmax-Xmin)
770           Xmax=Xmax-.01*(Xmax-Xmin)
780           CALL Ascale(Xmin,Xmax,Xlow,Xhigh,Ndx,Incx,Rincx)
790         END IF
800         IF Ylow=0 AND Yhigh=0 THEN GOTO 830
810         Ymin=Ylow
820         Ymax=Yhigh
830         IF Ndy=0 THEN
840           Ymin=Ymin+.01*(Ymax-Ymin)
850           Ymax=Ymax-.01*(Ymax-Ymin)
860           CALL Ascale(Ymin,Ymax,Ylow,Yhigh,Ndy,Incy,Rincy)
870         END IF
880         LINE TYPE 1
890         WINDOW Xlow,Xhigh,Ylow,Yhigh
900         IF Plotdev=1 THEN
910           PRINTER IS 705
920           PRINT "VS10;"
930           FRAME
940           PRINT "VS30;"
950           PRINTER IS 1
960         ELSE
970           FRAME
980         END IF
990         AXES Incx/Rincx,Incy/Rincy,Xlow,Ylow,Rincx,Rincy,INT(.05* (Yhgdu-Ylgdu))
1000 ! LABEL AXES
```

```
1010      CSIZE Csize_init
1020      LORG 6
1030      CLIP OFF
1040      Ylow1=Ylow-(Yhigh-Ylow)*(.5+.025*(Yhgdu-Ylgdu))/ (Yhgdu-Ylgdu)
1050      FOR J=1 TO Ndx+1
1060        X1=Xlow+(J-1)*Incx
1070        IF INT(X1)=0 THEN
1080          Maxdig=1
1090          GOTO 1130
1100        END IF
1110        Maxdig=INT(LGT(ABS(INT(X1))))+1
1120        IF X1<0 THEN Maxdig=Maxdig+1
1130        IF FRACT(Incx)=0 THEN
1140          Mindig=1
1150          GOTO 1180
1160        END IF
1170        Mindig=ABS(INT(LGT(ABS(FRACT(Incx)))))
1180        IF Maxdig+Mindig+1<6 THEN
1190          Form$=""&RPT$("D",Maxdig)&"."&RPT$("D", Mindig)&""
1200        ELSE
1210          PRINT Maxdig,Mindig
1220          Form$="MD.2DE"
1230        END IF
1240        PENUP
1250        MOVE X1,Ylow1
1260        LABEL USING Form$;X1
1270      NEXT J
1280      REM LABEL Y AXES
1290      LORG 8
1300      Xlow1=Xlow-(Xhigh-Xlow)*(.01923*(Xhgdu-Xlgdu))/ (Xhgdu-Xlgdu)
1310      FOR I=1 TO Ndy+1
1320        Y1=Ylow+(I-1)*Incy
1330        IF INT(Y1)=0 THEN
1340          Maxdig=1
1350          GOTO 1390
1360        END IF
1370        Maxdig=LGT(ABS(INT(Y1)))+1
1380        IF Y1<0 THEN Maxdig=Maxdig+1
1390        IF FRACT(Incy)=0 THEN
1400          Mindig=1
1410          GOTO 1440
1420        END IF
1430        Mindig=ABS(INT(LGT(ABS(FRACT(Incy)))))
1440        IF Maxdig+Mindig+1<6 THEN
1450          Form$=""&RPT$("D",Maxdig)&"."&RPT$("D", Mindig)&""
1460          Y_digits=6
1470        ELSE
1480          Form$="MD.2DE"
1490          Y_digits=11
1500        END IF
1510        PENUP
1520        MOVE Xlow1,Y1
1530        LABEL USING Form$;Y1
```

```
1540        NEXT I
1550        !  X AXES TITLE
1560        Xmid=(Xhigh+Xlow)/2
1570        Y1=Ylow-(Yhigh-Ylow)*(1+.08*(Yhgdu-Ylgdu))/(Yhgdu-Ylgdu)
1580        LORG 6
1590        PENUP
1600        CSIZE 1.5*Csize_init
1610        MOVE Xmid,Y1
1620        CALL Aoutst(Hlabel$)
1630        REM LABEL Y AXES
1640        Ymid=(Yhigh+Ylow)/2
1650        X1=Xlow-(Xhigh-Xlow)*(1.875+.2*Y_digits* .09615*(Xhgdu-Xlgdu))/(Xhgdu-Xlgdu)
1660        LORG 8
1670        PENUP
1680        MOVE X1,Ymid
1690        CALL Aoutst(Vlabel$)
1700        !  PLOT TITLE
1710        Y1=Yhigh+(Yhigh-Ylow)*(2+(Yhgdu-Ylgdu)*.15)/(Yhgdu-Ylgdu)
1720        Xmid=Xlow+(.5*(Xhgdu+Xlgdu)-Xlgdu)*(Xhigh-Xlow)/ (Xhgdu-Xlgdu)
1730        LORG 6
1740        CSIZE 1.8*Csize_init
1750        PENUP
1760        MOVE Xmid,Y1
1770        CALL Aoutst(Header$)
1780        Y1=Ylow-(Yhigh-Ylow)*(.20*(Yhgdu-Ylgdu)+4.5)/ (Yhgdu-Ylgdu)
1790        LORG 4
1800        CSIZE 1.6*Csize_init
1810        PENUP
1820        MOVE Xmid,Y1
1830        CALL Aoutst(Ptitle$)
1840        LINE TYPE INT(Lintyp/100),Lintyp MOD 100
1850        Rad=(.75+.011*(Yhgdu-Ylgdu))*(Yhigh-Ylow)/(Yhgdu-Ylgdu)
1860        Tratio=(Yhigh-Ylow)/(Xhigh-Xlow)*(Xhgdu-Xlgdu)/(Yhgdu-Ylgdu)
1870 Circle: Trad=Rad*.7071
1880        Narc=17
1890        FOR Arc=1 TO Narc
1900           Ang=(Arc-1)*360/(Narc-1)
1910           Xcir(Arc)=Trad*COS(Ang)/Tratio
1920           Ycir(Arc)=Trad*SIN(Ang)
1930        NEXT Arc
1940 Square: FOR Arc=1 TO 5
1950           Ang=45+(Arc-1)*90
1960           Xsq(Arc)=Rad*COS(Ang)/Tratio
1970           Ysq(Arc)=Rad*SIN(Ang)
1980        NEXT Arc
1990 Diamond:FOR Arc=1 TO 5
2000           Ang=(Arc-1)*90
2010           Xdi(Arc)=Rad*COS(Ang)/Tratio
2020           Ydi(Arc)=Rad*SIN(Ang)
2030        NEXT Arc
2040 Triangle:FOR Arc=1 TO 4
2050           Ang=90+(Arc-1)*120
2060           Xtr(Arc)=Rad*COS(Ang)/Tratio
```

```
2070          Ytr(Arc)=Rad*SIN(Ang)
2080        NEXT Arc
2090 Utriangle:FOR Arc=1 TO 4
2100          Ang=-90+(Arc-1)*120
2110          Xutr(Arc)=Rad*COS(Ang)/Tratio
2120          Yutr(Arc)=Rad*SIN(Ang)
2130        NEXT Arc
2140 Star:   FOR Arc=1 TO 6
2150          Ang=90+(Arc-1)*144
2160          Xst(Arc)=Rad*COS(Ang)/Tratio
2170          Yst(Arc)=Rad*SIN(Ang)
2180        NEXT Arc
2190     SUBEND
2200 !*****************************************************************
2210 !*****************************************************************
2220 Dsplay:SUB Dsplay(X_(*),Y_(*))
2230        OPTION BASE 1
2240        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
2250        COM /Labels/ Hlabel$[10],Vlabel$[10],Ptitle$[40],Header$[40]
2260        Npts=Npoints
2270        CALL Max(X_(*),Xmax)
2280        CALL Min(X_(*),Xmin)
2290        CALL Max(Y_(*),Ymax)
2300        CALL Min(Y_(*),Ymin)
2310 !  PRINT "MIN,MAX",Xmin,Xmax,Ymin,Ymax
2320        CALL Pframe(Xmin,Xmax,Ymin,Ymax)
2330        PEN Pentyp
2340        CLIP ON
2350        J=0
2360        FOR I=1 TO Npts
2370           IF X_(I)<Xlow THEN GOTO 2470
2380           IF X_(I)>Xhigh THEN GOTO 2480
2390           J=J+1
2400           IF J=1 THEN
2410              PENUP
2420              MOVE X_(I),Y_(I)
2430           ELSE
2440              PLOT X_(I),Y_(I),-1
2450           END IF
2460           IF Isym>0 THEN CALL Symbol(X_(I),Y_(I),Isym)
2470        NEXT I
2480        PEN Defpen
2490     SUBEND
2500 !*****************************************************************
2510 !*****************************************************************
2520 Cplot:SUB Cplot(X_(*),Y_(*))
2530        OPTION BASE 1
2540        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
2550        Npts=Npoints
2560        CLIP ON
2570        LINE TYPE INT(Lintyp/100),Lintyp MOD 100
```

```
2580        PEN Pentyp
2590        FOR I=1 TO Npts
2600          IF X_(I)<Xlow THEN GOTO 2700
2610          IF X_(I)>Xhigh THEN GOTO 2710
2620          J=J+1
2630          IF J=1 THEN
2640            PENUP
2650            MOVE X_(I),Y_(I)
2660          ELSE
2670            PLOT X_(I),Y_(I),-1
2680          END IF
2690          IF Isym>0 THEN CALL Symbol(X_(I),Y_(I),Isym)
2700        NEXT I
2710        LINE TYPE 1
2720        PEN Defpen
2730      SUBEND
2740 !*************************************************************
2750 !*************************************************************
2760 Symbol:SUB Symbol(A,B,Isymbl)
2770        OPTION BASE 1
2780        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
2790        COM /Syms/ Xcir(17),Ycir(17),Xsq(5),Ysq(5),Xdi(5),Ydi(5),
Xtr(4),Ytr(4),Xutr(4),Yutr(4),Xst(6),Yst(6)
2800        LINE TYPE 1
2810        SELECT Isymbl
2820        CASE 1              !CIRCLE
2830          FOR Arc=1 TO 17
2840            IF Arc=1 THEN
2850              MOVE Xcir(Arc)+A,Ycir(Arc)+B
2860            ELSE
2870              PLOT Xcir(Arc)+A,Ycir(Arc)+B,-1
2880            END IF
2890          NEXT Arc
2900        CASE 2              !SQUARE
2910          FOR Arc=1 TO 5
2920            IF Arc=1 THEN
2930              MOVE Xsq(Arc)+A,Ysq(Arc)+B
2940            ELSE
2950              PLOT Xsq(Arc)+A,Ysq(Arc)+B,-1
2960            END IF
2970          NEXT Arc
2980        CASE 3              !DIAMOND
2990          FOR Arc=1 TO 5
3000            IF Arc=1 THEN
3010              MOVE Xdi(Arc)+A,Ydi(Arc)+B
3020            ELSE
3030              PLOT Xdi(Arc)+A,Ydi(Arc)+B,-1
3040            END IF
3050          NEXT Arc
3060        CASE 4              !TRIANGLE
3070          FOR Arc=1 TO 4
3080            IF Arc=1 THEN
```

```
3090              MOVE Xtr(Arc)+A,Ytr(Arc)+B
3100            ELSE
3110              PLOT Xtr(Arc)+A,Ytr(Arc)+B,-1
3120            END IF
3130          NEXT Arc
3140        CASE 5              ! UPSIDE DOWN TRIANGLE
3150          FOR Arc=1 TO 4
3160            IF Arc=1 THEN
3170              MOVE Xutr(Arc)+A,Yutr(Arc)+B
3180            ELSE
3190              PLOT Xutr(Arc)+A,Yutr(Arc)+B,-1
3200            END IF
3210          NEXT Arc
3220        CASE 6              ! STAR
3230          FOR Arc=1 TO 6
3240            IF Arc=1 THEN
3250              MOVE Xst(Arc)+A,Yst(Arc)+B
3260            ELSE
3270              PLOT Xst(Arc)+A,Yst(Arc)+B,-1
3280            END IF
3290          NEXT Arc
3300        END SELECT
3310        PENUP
3320        MOVE A,B
3330        LINE TYPE INT(Lintyp/100),Lintyp MOD 100
3340      SUBEND
3350 Max:SUB Max(A_(*),Amax)
3360        OPTION BASE 1
3370        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
3380        Temp=SIZE(A_,1)
3390        REDIM A_(1:Npoints)
3400        Amax=MAX(A_(*))
3410        REDIM A_(1:Temp)
3420      SUBEND
3430 !*****************************************************************
3440 !*****************************************************************
3450 Min:SUB Min(A_(*),Amin)
3460        OPTION BASE 1
3470        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
3480        Temp=SIZE(A_,1)
3490        REDIM A_(1:Npoints)
3500        Amin=MIN(A_(*))
3510        REDIM A_(1:Temp)
3520      SUBEND
3530 !*****************************************************************
3540 !*****************************************************************
3550 Ascale:SUB Ascale(Xmin,Xmax,Xlow,Xhigh,Nd,Inc,Rinc)
3560        OPTION BASE 1
3570        DATA 2,4,5,10
3580        ALLOCATE Cval(4)
3590        READ Cval(*)
```

```
3600        Ndiv=5
3610        Inc=(Xmax-Xmin)/Ndiv
3620        IF Inc=0 THEN
3630           Xmax=Xmax+.05
3640           Xmin=Xmin-.05
3650           Inc=(Xmax-Xmin)/Ndiv
3660        END IF
3670        Np=INT(LGT(ABS(Inc)))
3680        Inc=Inc*10^(-Np)
3690        J=1
3700        IF Inc>Cval(J) THEN GOTO Step1
3710        Inc=Cval(J)
3720        Rinc=Inc
3730        GOTO Step2
3740 Step1: J=J+1
3750        GOTO 3700
3760 Step2: IF Np<0 THEN GOTO Step3
3770        FOR K=1 TO Np
3780           Inc=Inc*10
3790        NEXT K
3800        GOTO Step4
3810 Step3: FOR K=1 TO -Np
3820           Inc=Inc/10
3830        NEXT K
3840 Step4: Xlow=INT(Xmin/Inc)*Inc
3850        Nd=INT((Xmax-Xlow)/Inc)+1
3860        Xhigh=Xlow+Nd*Inc
3870        DEALLOCATE Cval(*)
3880     SUBEND
3890 !************************************************************
3900 !************************************************************
3910 Symbl:SUB Symbl(Isymbl)
3920        OPTION BASE 1
3930        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
3940        Isym=Isymbl
3950     SUBEND
3960 !************************************************************
3970 !************************************************************
3980 Npts:SUB Npts(Npts)
3990        OPTION BASE 1
4000        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
4010        Npoints=Npts
4020     SUBEND
4030 !************************************************************
4040 !************************************************************
4050 Hlabel:SUB Hlabel(String$)
4060        OPTION BASE 1
4070        COM /Labels/ Hlabel$[10],Vlabel$[10],Ptitle$[40],Header$[40]
4080        Number=LEN(String$)
4090        Hlabel$[1,Number]=String$
4100     SUBEND
```

```
4110 !*****************************************************************
4120 !*****************************************************************
4130 Vlabel:SUB Vlabel(String$)
4140         OPTION BASE 1
4150         COM /Labels/ Hlabel$[10],Vlabel$[10],Ptitle$[40],Header$[40]
4160         Number=LEN(String$)
4170         Vlabel$[1,Number]=String$
4180       SUBEND
4190 !*****************************************************************
4200 !*****************************************************************
4210 Ptitle:SUB Ptitle(String$)
4220         OPTION BASE 1
4230         COM /Labels/ Hlabel$[10],Vlabel$[10],Ptitle$[40],Header$[40]
4240         Number=LEN(String$)
4250         Ptitle$[1,Number]=String$
4260       SUBEND
4270 !*****************************************************************
4280 !*****************************************************************
4290 Title:SUB Title(String$)
4300         OPTION BASE 1
4310         COM /Labels/ Hlabel$[10],Vlabel$[10],Ptitle$[40],Header$[40]
4320         Number=LEN(String$)
4330         Header$[1,Number]=String$
4340       SUBEND
4350 !*****************************************************************
4360 !*****************************************************************
4370 Line:SUB Line(Linetype)
4380         OPTION BASE 1
4390         COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
4400         L=0
4410         IF Linetype=-1 THEN L=200
4420         IF Linetype=0 THEN L=100
4430         IF Linetype=1 THEN L=301
4440         IF Plotdev=0 THEN
4450           IF Linetype=2 THEN L=705
4460           IF Linetype=3 THEN L=400
4470           IF Linetype=4 THEN L=500
4480         ELSE
4490           IF Linetype=2 THEN L=705
4500           IF Linetype=3 THEN L=402
4510           IF Linetype=4 THEN L=508
4520         END IF
4530         Lintyp=L
4540       SUBEND
4550 !*****************************************************************
4560 !*****************************************************************
4570 Dlimx:SUB Dlimx(Xmin,Xmax,OPTIONAL Major_tic_x,Minor_tic_x)
4580         OPTION BASE 1
4590         COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
4600         COM /Plot2/ Ndx,Incx,Rincx,Ndy,Incy,Rincy
4610         Xlow=Xmin
```

```
4620        Xhigh=Xmax
4630        IF NPAR=2 THEN SUBEXIT
4640        IF Minor_tic_x=0 THEN Minor_tic_x=Major_tic_x
4650        Incx=Major_tic_x
4660        Rincx=Major_tic_x/Minor_tic_x
4670        Ndx=INT((Xhigh-Xlow)/Major_tic_x)
4680     SUBEND
4690  !*****************************************************************
4700  !*****************************************************************
4710 Dlimy:SUB Dlimy(Ymin,Ymax,OPTIONAL Major_tic_y,Minor_tic_y)
4720        OPTION BASE 1
4730        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
4740        COM /Plot2/ Ndx,Incx,Rincx,Ndy,Incy,Rincy
4750        Ylow=Ymin
4760        Yhigh=Ymax
4770        IF NPAR=2 THEN SUBEXIT
4780        IF Minor_tic_y=0 THEN Minor_tic_y=Major_tic_y
4790        Incy=Major_tic_y
4800        Rincy=Major_tic_y/Minor_tic_y
4810        Ndy=INT((Yhigh-Ylow)/Major_tic_y)
4820     SUBEND
4830  !*****************************************************************
4840  !*****************************************************************
4850 Slimx:SUB Slimx(X_low,X_high)
4860        OPTION BASE 1
4870        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
4880        Xlgdu=X_low*MAX(1,RATIO)*100
4890        Xhgdu=X_high*MAX(1,RATIO)*100
4900        VIEWPORT Xlgdu,Xhgdu,Ylgdu,Yhgdu
4910     SUBEND
4920  !*****************************************************************
4930  !*****************************************************************
4940 Slimy:SUB Slimy(Y_low,Y_high)
4950        OPTION BASE 1
4960        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
4970        Ylgdu=Y_low*MAX(1,1/RATIO)*100
4980        Yhgdu=Y_high*MAX(1,1/RATIO)*100
4990        VIEWPORT Xlgdu,Xhgdu,Ylgdu,Yhgdu
5000     SUBEND
5010  !*****************************************************************
5020  !*****************************************************************
5030 Aoutst:SUB Aoutst(String$,OPTIONAL X_per_cent,Y_per_cent,Ilorg, C_size)
5040        OPTION BASE 1
5050        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
5060        PEN Defpen
5070        LINE TYPE 1
5080        CLIP OFF
5090        SELECT NPAR
5100        CASE 1
```

```
5110          LABEL TRIM$(String$)
5120          SUBEXIT
5130        CASE 3
5140          LORG 3
5150        CASE 4
5160          LORG Ilorg
5170        CASE 5
5180          LORG Ilorg
5190          CSIZE C_size
5200        END SELECT
5210        MOVE Xlow+X_per_cent*(Xhigh-Xlow),Ylow+Y_per_cent* (Yhigh-Ylow)
5220        LABEL TRIM$(String$)
5230        CLIP ON
5240      SUBEND
5250 !*****************************************************************
5260 !*****************************************************************
5270 Place:SUB Place(Iplace)
5280        OPTION BASE 1
5290        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
5300        X_gdu=100*MAX(1,RATIO)
5310        Y_gdu=100*MAX(1,1/RATIO)
5320        SELECT Iplace
5330        CASE 1
5340          Xhgdu=.85*X_gdu
5350          Xlgdu=.25*X_gdu
5360          Yhgdu=.85*Y_gdu
5370          Ylgdu=.30*Y_gdu
5380        CASE 2
5390          Xhgdu=.45*X_gdu
5400          Xlgdu=.10*X_gdu
5410          Yhgdu=.75*Y_gdu
5420          Ylgdu=.30*Y_gdu
5430        CASE 3
5440          Xhgdu=.95*X_gdu
5450          Xlgdu=.60*X_gdu
5460          Yhgdu=.75*Y_gdu
5470          Ylgdu=.30*Y_gdu
5480        CASE 4
5490          Xhgdu=.5*X_gdu
5500          Xlgdu=.25*X_gdu
5510          Yhgdu=.80*Y_gdu
5520          Ylgdu=.60*Y_gdu
5530        CASE 5
5540          Xhgdu=.5*X_gdu
5550          Xlgdu=.25*X_gdu
5560          Yhgdu=.40*Y_gdu
5570          Ylgdu=.20*Y_gdu
5580        CASE 6
5590          Xhgdu=.9*X_gdu
5600          Xlgdu=.65*X_gdu
5610          Yhgdu=.80*Y_gdu
5620          Ylgdu=.60*Y_gdu
```

```
5630        CASE 7
5640          Xhgdu=.9*X_gdu
5650          Xlgdu=.65*X_gdu
5660          Yhgdu=.40*Y_gdu
5670          Ylgdu=.20*Y_gdu
5680        END SELECT
5690        VIEWPORT Xlgdu,Xhgdu,Ylgdu,Yhgdu
5700      SUBEND
5710 !*****************************************************************
5720 !*****************************************************************
5730 Newpag:SUB Newpag
5740        OPTION BASE 1
5750        GCLEAR
5760      SUBEND
5770 !*****************************************************************
5780 !*****************************************************************
5790 Pen_color:SUB Pen_color(Ipen)
5800        OPTION BASE 1
5810        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
5820        Pentyp=Ipen
5830      SUBEND
5840 !*****************************************************************
5850 !*****************************************************************
5860 Pen_def:SUB Pen_def(Ipen)
5870        OPTION BASE 1
5880        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
5890        Defpen=Ipen
5900      SUBEND
5910 !*****************************************************************
5920 !*****************************************************************
5930 Set_pens:SUB Set_pens(Start_pen,OPTIONAL Re_set)
5940        OPTION BASE 1
5950        DIM Red(15),Green(15),Blue(15)
5960        SELECT NPAR
5970        CASE 1
5980          DATA 0  ,  0,  0,  0,  0,  0, .67,  1,  1,  1,  1,  1,  1, 1,  1
5990          READ Red(*)
6000          DATA 0  , .33, .67,  1,  1,  1,  1,  1,.82,.53,.29,  0,.33,.67, 1
6010          READ Green(*)
6020          DATA 1  ,  1,  1,.67,.33,  0,  0,  0,  0,  0,  0,  0,.33,.67, 1
6030          READ Blue(*)
6040          SET PEN 0 COLOR 0,1,0
6050          FOR I=1 TO 15
6060            J=Start_pen+I
6070            IF J>15 THEN J=J-15
6080            SET PEN I INTENSITY Red(J),Green(J),Blue(J)
6090          NEXT I
6100        CASE 2
6110          PLOTTER IS 3,"INTERNAL";COLOR MAP
6120        END SELECT
6130      SUBEND
```

```
6140 Legend:SUB Legend(N,X1,Y1,Sym,Linetype,Pen,Legen$)
6150        OPTION BASE 1
6160        DIM String$[20]
6170        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
6180        CLIP OFF
6190        X1=Xlow+X1*(Xhigh-Xlow)
6200        Y1=Ylow+Y1*(Yhigh-Ylow)
6210        IF N=1 THEN MOVE X1,Y1
6220        Xscale=(Xhigh-Xlow)/(Xhgdu-Xlgdu)
6230        Yscale=(Yhigh-Ylow)/(Yhgdu-Ylgdu)
6240        X2=X1+5*Xscale
6250        Xp=X1-3*Xscale
6260        Xn=X1+3*Xscale
6270        IF Linetype=-1 THEN L=200
6280        IF Linetype=0 THEN L=100
6290        IF Linetype=1 THEN L=301
6300        IF Plotdev=0 THEN
6310           IF Linetype=2 THEN L=705
6320           IF Linetype=3 THEN L=400
6330           IF Linetype=4 THEN L=500
6340        ELSE
6350           IF Linetype=2 THEN L=708
6360           IF Linetype=3 THEN L=404
6370           IF Linetype=4 THEN L=508
6380        END IF
6390        Csize_init=(Yhgdu-Ylgdu)*.030+1.2
6400        CSIZE Csize_init
6410        Y2=Y1-(N-1)*3.5*Yscale
6420        PEN Pen
6430        CALL Symbol(X1,Y2,Sym)
6440        IF Line type=-1 THEN 6480
6450        LINE TYPE INT(L/100),L MOD 100
6460        MOVE Xp,Y2
6470        DRAW Xn,Y2
6480        LINE TYPE 1
6490        LORG 2
6500        PEN Defpen
6510        MOVE X2,Y2
6520        LABEL Legen$
6530        CLIP ON
6540     SUBEND
6550 Disvec:SUB Disvec(X(*),Y(*),Vx(*),Vy(*),Iscale)
6560        OPTION BASE 1
6570        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
6580        Npts=Npoints
6590        CALL Max(X(*),Xmax)
6600        CALL Min(X(*),Xmin)
6610        CALL Max(Y(*),Ymax)
6620        CALL Min(Y(*),Ymin)
6630        CALL Pframe(Xmin,Xmax,Ymin,Ymax)
6640        ! CALCULATE XSCALE AND YSCALE TO TAKE CARE OF
```

```
6650        ! VARYING ASPECT RATIOS
6660        Xscale=(Xhigh-Xlow)/(Xhgdu-Xlgdu)
6670        Yscale=(Yhigh-Ylow)/(Yhgdu-Ylgdu)
6680        PEN Pentyp
6690        FOR I=1 TO Npts
6700          PENUP
6710          MOVE X(I),Y(I)
6720          RPLOT Iscale*Xscale*Vx(I),Iscale* Yscale*Vy(I),-1
6730          ! DRAW ARROWHEAD
6740          PENUP
6750          R=SQR((Vx(I)*Xscale)^2+(Vy(I)*Yscale) ^2)*Iscale
6760          Theta=ATN((Yscale*Vy(I))/(Xscale*Vx(I)))
6770          Xtip=X(I)+Vx(I)*Xscale*Iscale*.95
6780          Ytip=Y(I)+Vy(I)*Yscale*Iscale*.95
6790          Theta1=Theta+4.76364
6800          X1=COS(Theta1)*.07*R+Xtip
6810          Y1=SIN(Theta1)*.07*R+Ytip
6820          PENUP
6830          MOVE X1,Y1
6840          Theta2=Theta-4.76364
6850          X2=COS(Theta2)*.07*R+Xtip
6860          Y2=SIN(Theta2)*.07*R+Ytip
6870          PLOT X2,Y2,-1
6880          X3=COS(Theta)*.2*R+Xtip
6890          Y3=SIN(Theta)*.2*R+Ytip
6900          PLOT X3,Y3,-1
6910          PLOT X1,Y1,-1
6920        NEXT I
6930        PEN Defpen
6940      SUBEND
6950 !*****************************************************************
6960 !*****************************************************************
6970 Finitt:SUB Finitt
6980        OPTION BASE 1
6990        GRAPHICS OFF
7000        ALPHA ON
7010        PEN 0
7020      SUBEND
7030 !*****************************************************************
7040 !*****************************************************************
7050      SUB Polyfit(X(*),Y(*),D,Coef(*),Coef_of_det, Corr_coef,
St_err_est,OPTIONAL Fit_sym,Fit_lin,Fit_col)
7060        OPTION BASE 1
7070        COM /Plot1/ Xhgdu,Xlgdu,Yhgdu,Ylgdu,Xlow,Xhigh,Ylow,Yhigh,
Isym,Npoints,Lintyp,Plotdev,Pentyp,Defpen
7080        DIM A(13),R(7,8),T(8)
7090        N=Npoints
7100        A(1)=N
7110        FOR I=1 TO N
7120          FOR J=2 TO 2*D+1
7130            A(J)=A(J)+X(I)^(J-1)
7140          NEXT J
7150          FOR K=1 TO D+1
```

```
7160          R(K,D+2)=T(K)+Y(I)*X(I)^(K-1)
7170          T(K)=T(K)+Y(I)*X(I)^(K-1)
7180       NEXT K
7190       T(D+2)=T(D+2)+Y(I)^2
7200    NEXT I
7210    FOR J=1 TO D+1
7220       FOR K=1 TO D+1
7230          R(J,K)=A(J+K-1)
7240       NEXT K
7250    NEXT J
7260    FOR J=1 TO D+1
7270       FOR K=J TO D+1
7280          IF R(K,J)<>0 THEN 7320
7290       NEXT K
7300       PRINT "NO UNIQUE SOLUTION"
7310       GOTO 7830
7320       FOR I=1 TO D+2
7330          S=R(J,I)
7340          R(J,I)=R(K,I)
7350          R(K,I)=S
7360       NEXT I
7370       Z=1/R(J,J)
7380       FOR I=1 TO D+2
7390          R(J,I)=Z*R(J,I)
7400       NEXT I
7410       FOR K=1 TO D+1
7420          IF K=J THEN 7470
7430          Z=-R(K,J)
7440          FOR I=1 TO D+2
7450             R(K,I)=R(K,I)+Z*R(J,I)
7460          NEXT I
7470       NEXT K
7480    NEXT J
7490    FOR J=0 TO D
7500       Coef(J+1)=R(J+1,D+2)
7510    NEXT J
7520    P=0
7530    FOR J=2 TO D+1
7540       P=P+R(J,D+2)*(T(J)-A(J)*T(1)/N)
7550    NEXT J
7560    Q=T(D+2)-T(1)^2/N
7570    Z=Q-P
7580    I=N-D-1
7590    J=P/Q
7600    IF ABS(Z)<1.E-6 THEN Z=0
7610    Coef_of det=J
7620    Corr_coef=SQR(J)
7630    St_err_est=SQR(Z/I)
7640    IF NPAR<8 THEN SUBEXIT
7650    ALLOCATE Af(N),Bf(N),F(D+1)
7660    FOR I=1 TO N
7670       Bf(I)=0
7680       Af(I)=X(I)
```

```
7690          F(1)=1
7700          FOR L=2 TO D+1
7710             F(L)=Af(I)^(L-1)
7720          NEXT L
7730          FOR L=1 TO D+1
7740             Bf(I)=Bf(I)+Coef(L)*F(L)
7750          NEXT L
7760       NEXT I
7770       CALL Symbl(Fit_sym)
7780       CALL Line(Fit_lin)
7790       CALL Pen_color(Fit_col)
7800       CALL Npts(N)
7810       CALL Cplot(Af(*),Bf(*))
7820       DEALLOCATE Af(*),Bf(*),F(*)
7830    SUBEND
```

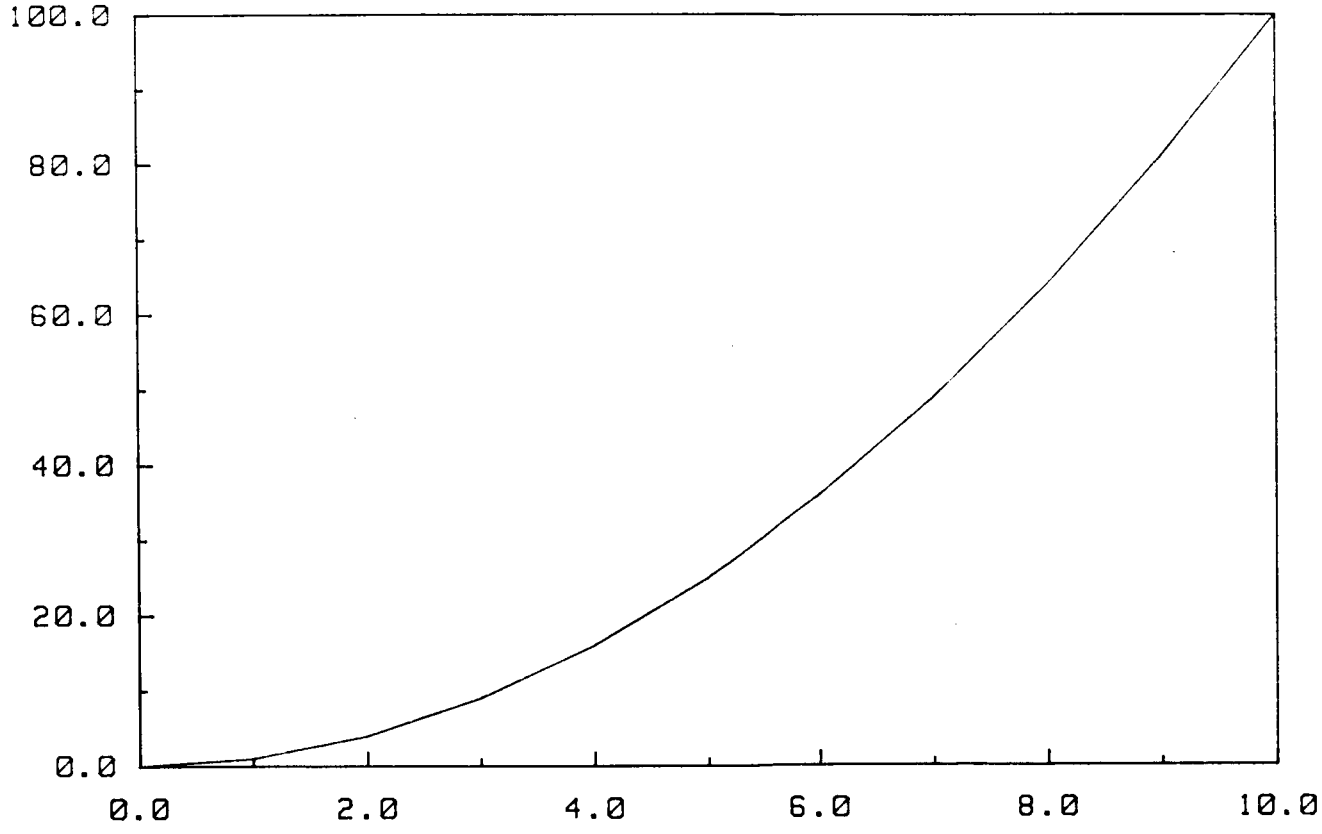


Figure 1. Plot produced by Example Code 1.

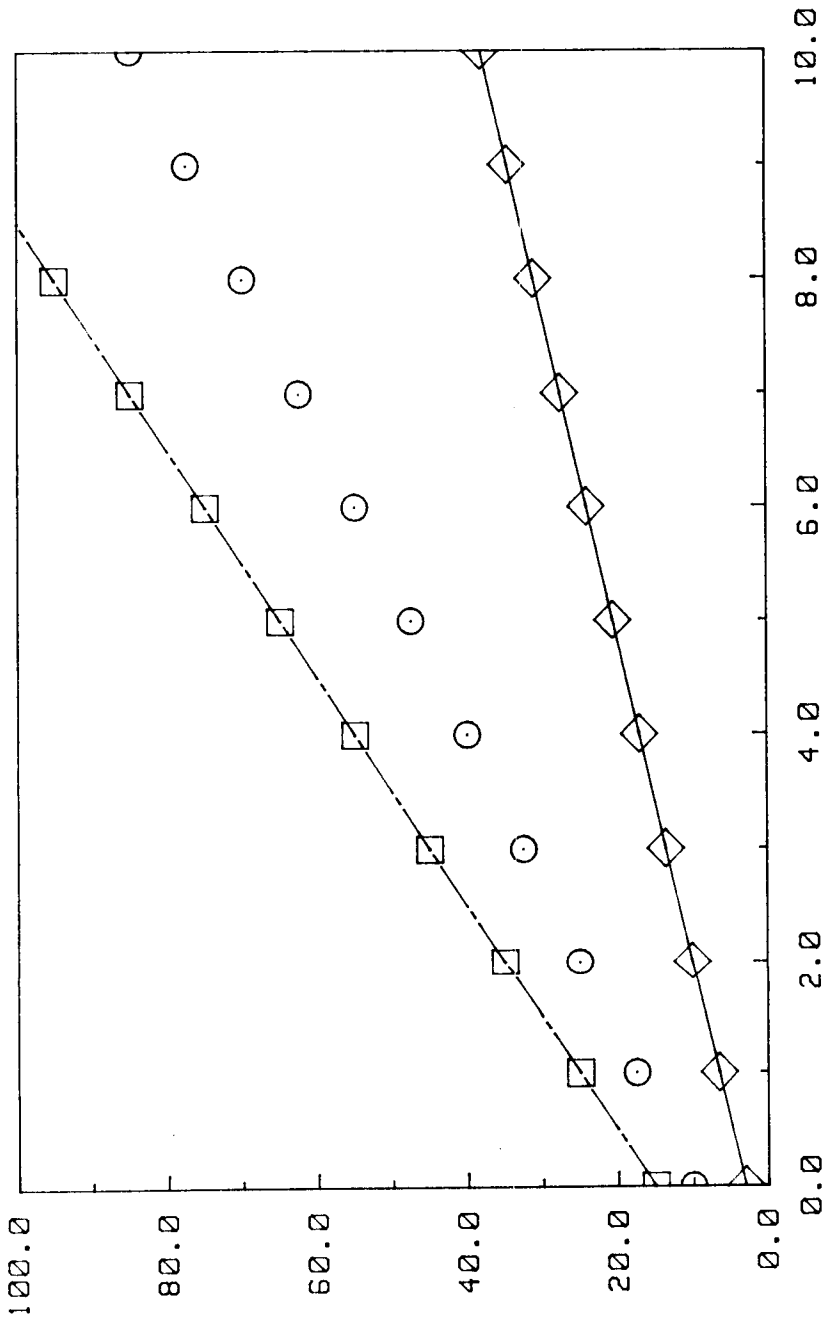


Figure 2. Plot produced by Example Code 2.

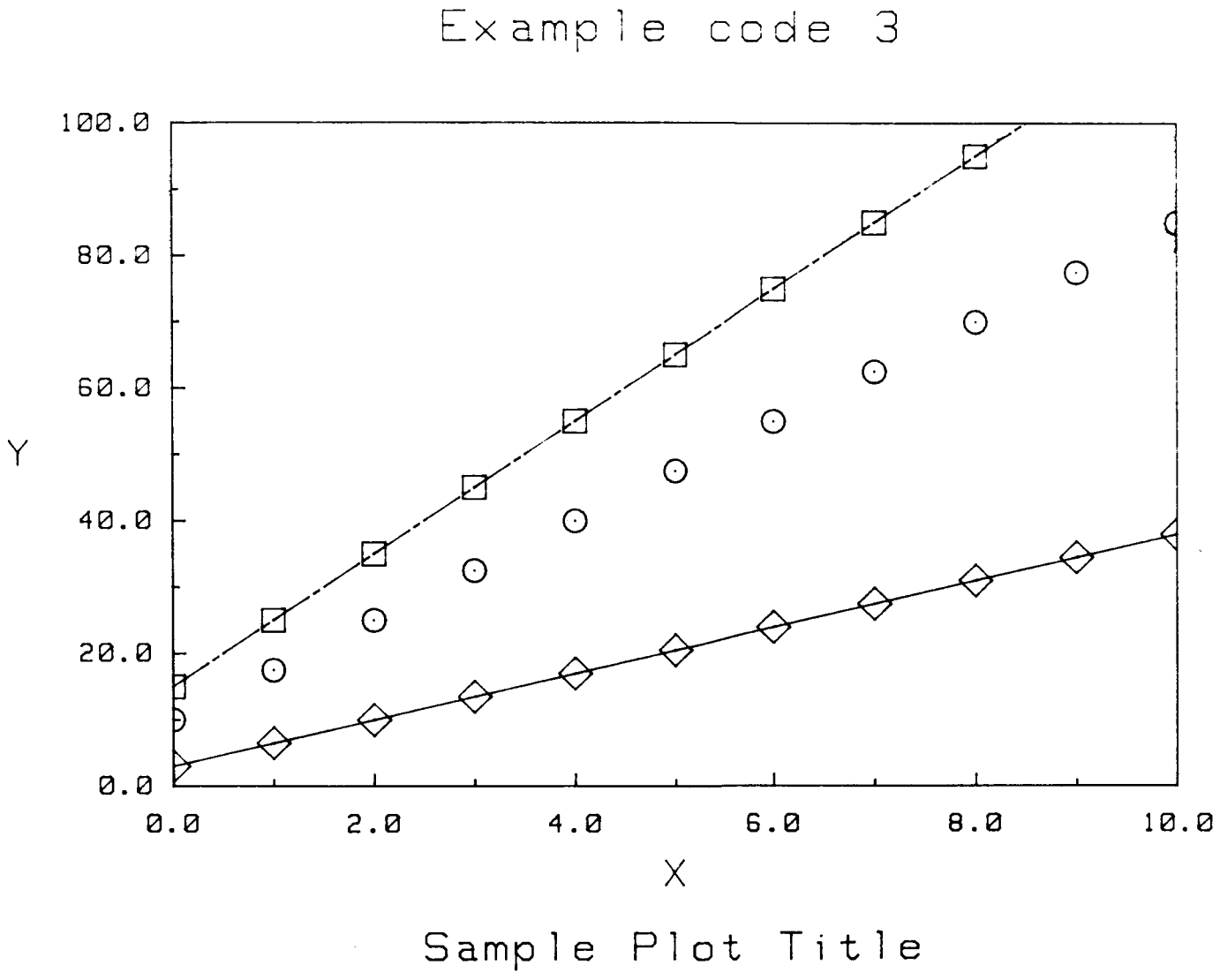


Figure 3. Plot produced by Example Code 3.

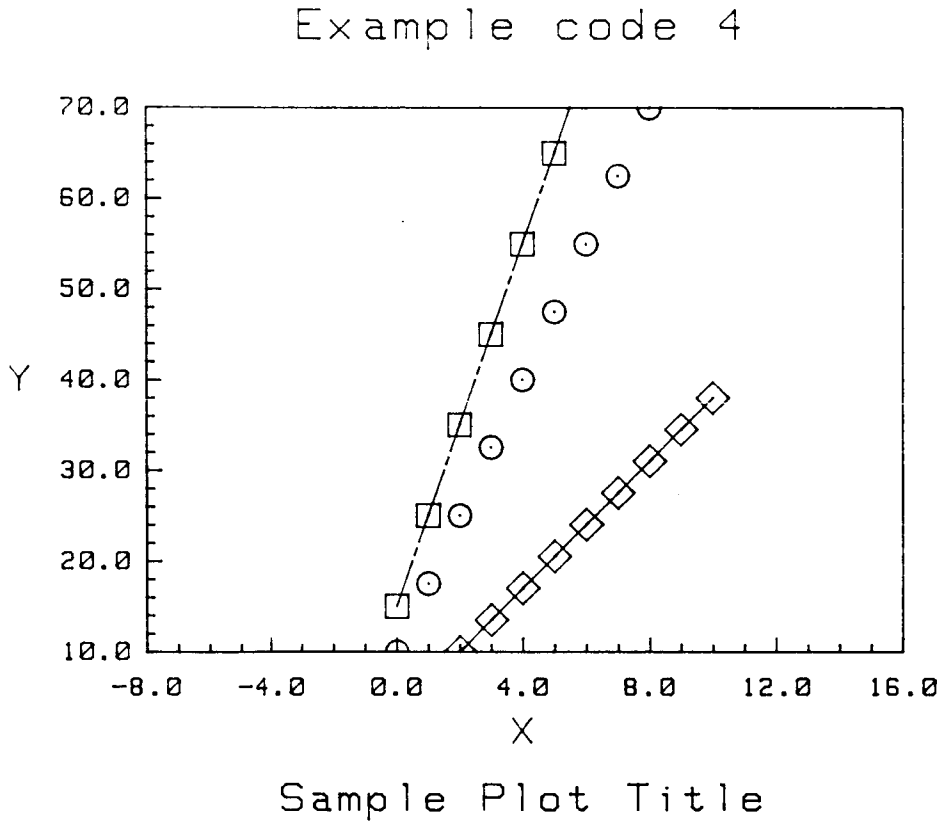


Figure 4. Plot produced by Example Code 4.

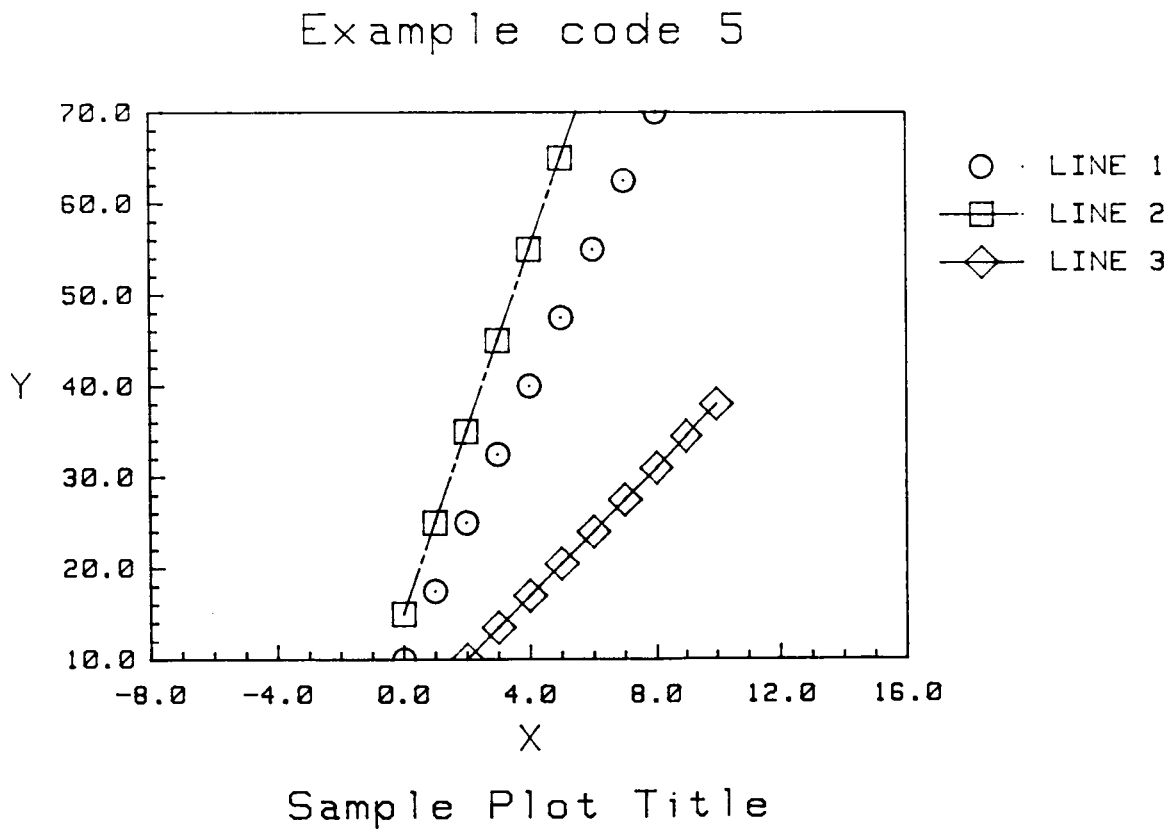


Figure 5. Plot produced by Example Code 5.

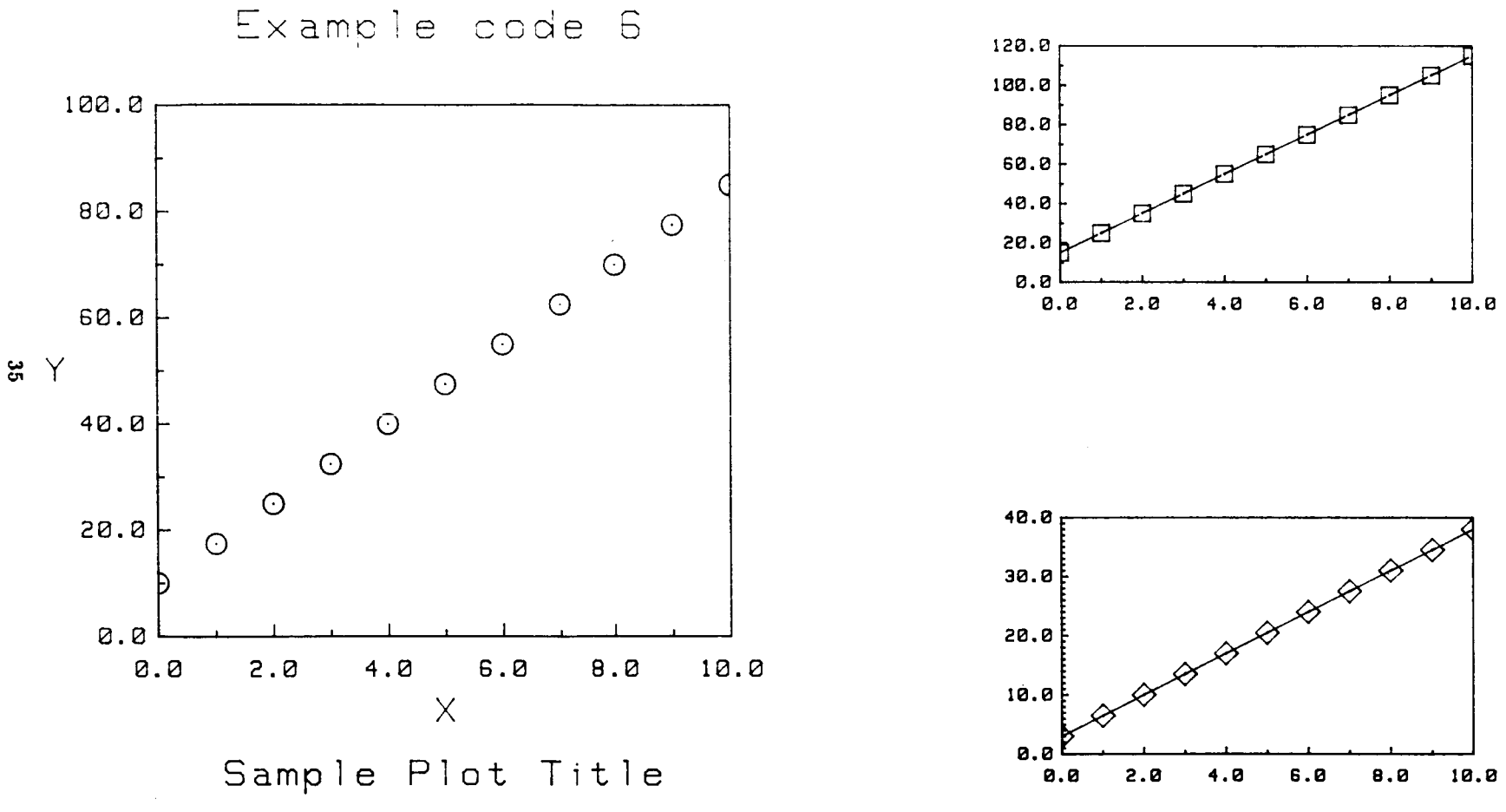
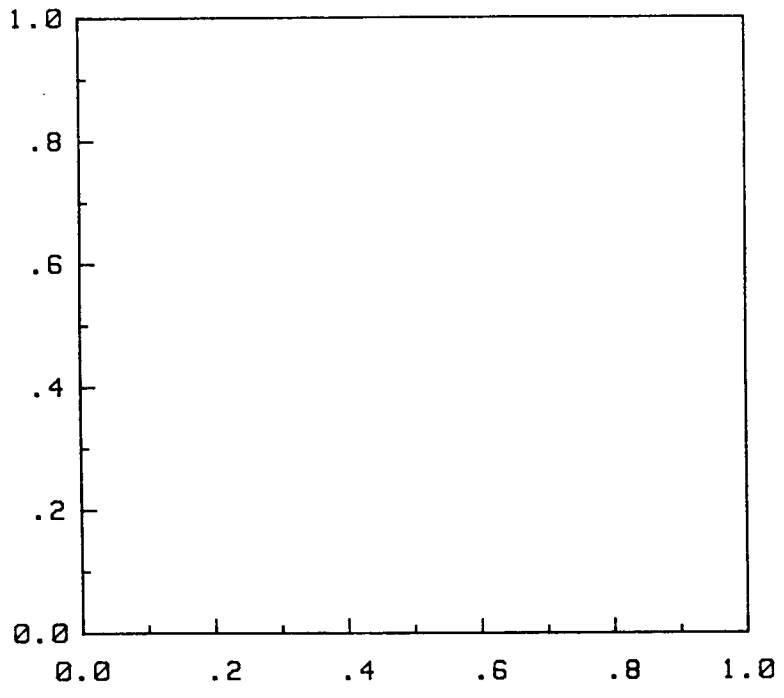


Figure 6. Plot produced by Example Code 6.



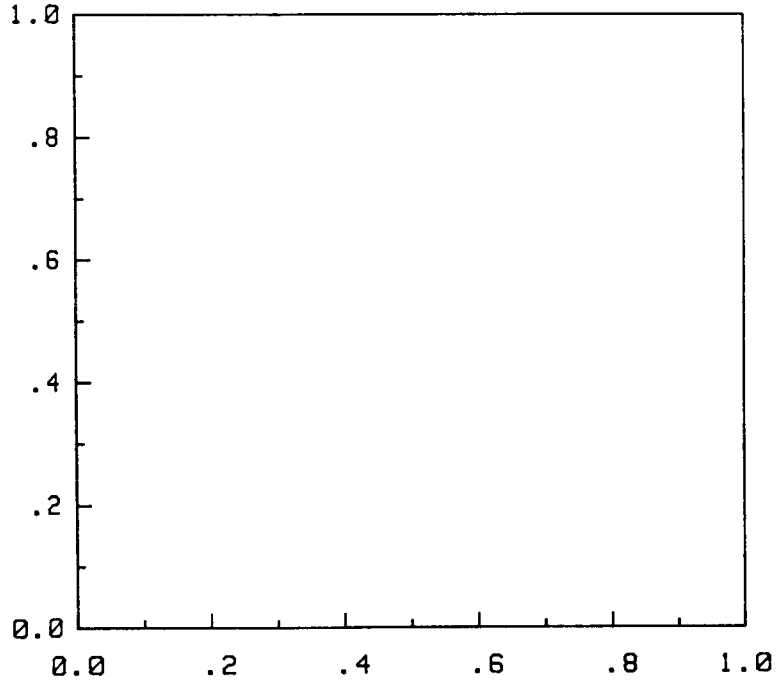


Figure 7a. Location and size of plots produced using Place(Iplace).

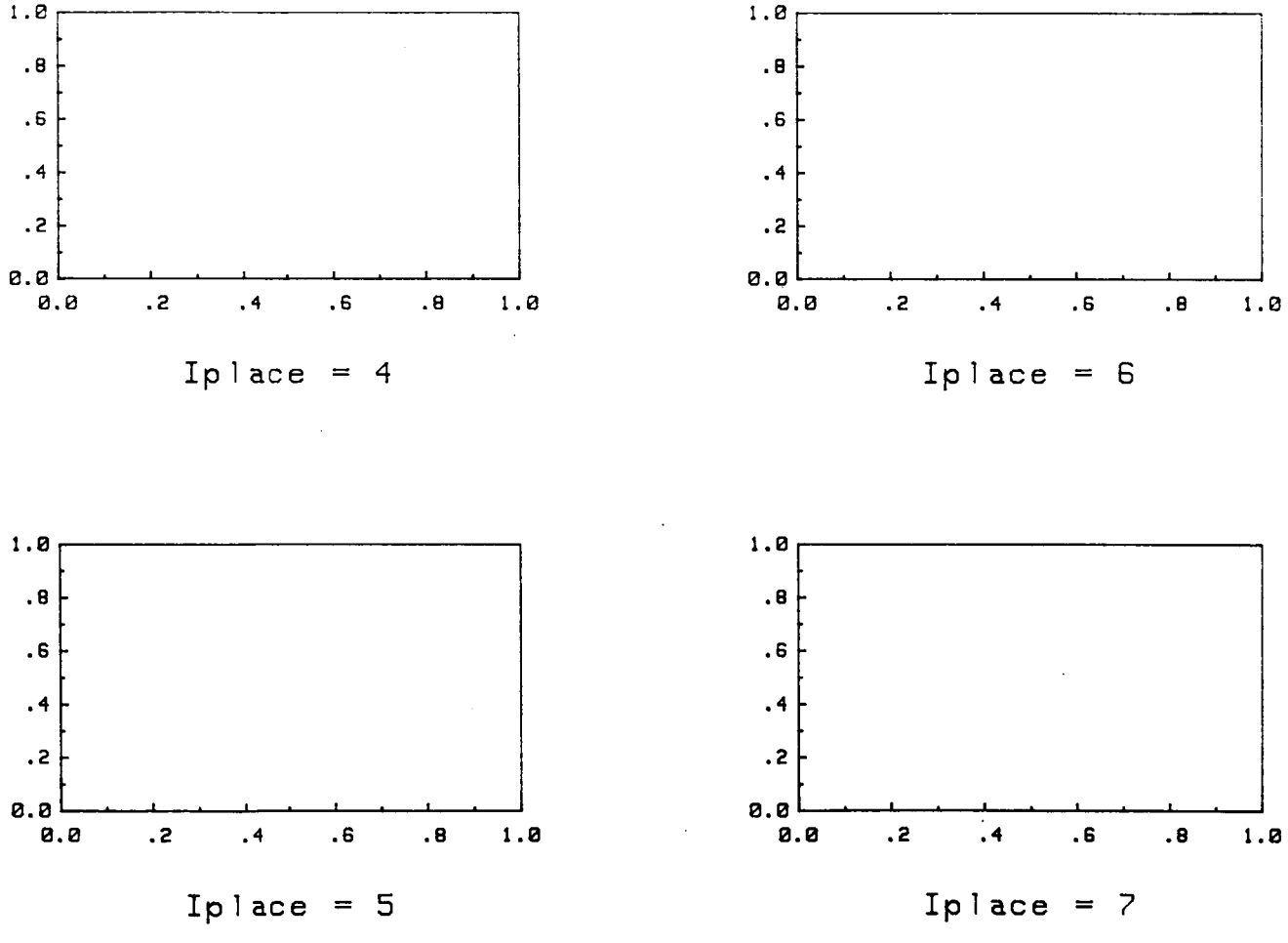


Figure 7b. Location and size of plots produced using Place(Iplace).

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15. Supplementary Notes

16. Abstract

A software package which emulates the Tektronics PLOT10 Graphics package on Hewlett-Packard 9000 Series 200/300 computers is described. The Software is written in HP Rocky Mountain BASIC and can be run under BASIC revisions 3.0 and 4.0. Although this subroutine library emulates a subset of PLOT10, several subroutines have been added which enhance basic plot generation. Example codes using PLOT300 and descriptions of the subroutines are included in the text.

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