HUMAN SYSTEMS DYNAMICS

STATISTICAL ANALYSIS SOFTWARE

equation plotter


HSD
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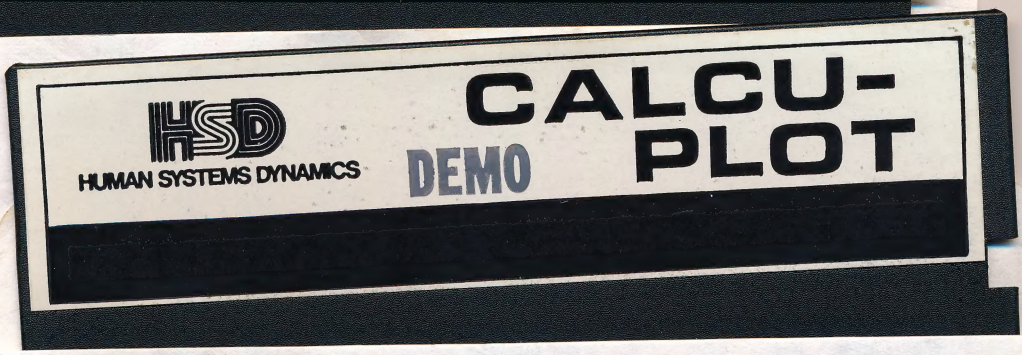
CALCU-
PLOT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HUMAN SYSTEMS DYNAMICS

CALCU-PLOT

The Equation Solver And Plotter For The Apple II/IIe

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Suite 222
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CALCU-PLOT

THE EQUATION SOLVER AND PLOTTER FOR THE APPLE II/IIE

by

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System Requirements. The CALCU-PLOT package requires an Apple II or IIe with ROM Applesoft,48K, one or two disk drives and a printer for hard copy output. You can also use CALCU-PLOT with the Franklin Ace or an Apple III in Apple II Emulation Mode.

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This disk contains a high-speed operating system called Diversi-Dos(tm), which is licensed for use with this program only. To legally use Diversi-Dos with other programs, you may send $30 directly to:
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Rockford, IL 61111

You will receive a Diversi-Dos utility disk with documentation.

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1.0 INTRODUCTION

CALCU-PLOT from Human Systems Dynamics is a program package designed to plot both Cartesian and Polar equations. In addition, the program presents a table of solutions to your equation.

The CARTESIAN PLOT program offers sixteen standard cartesian equations including three common double valued ones. You can plot from one to three functions or a combination of functions and first and second derivitives or the integral of the function.

The POLAR PLOT program plots only one equation but allows many revolutions of the function. Nine standard polar equations are offered.

Program options include tabulation of points calculated, creative graphics such as adding titles, notes and other information to a graph and high resolution printing of graphs. With CALCU-PLOT, you can create your own equation files, review, edit and test those files and then add them to the plotting programs.

In addition, you can enter empirical data by keyboard and save the data to a disk file. Then select the data file and plot the data. You can even plot empirical data on the same graph with an equation curve. This provides a visual comparison of data against a theoretical function.

CALCU-PLOT is a menu-driven, easy to use program. While this manual includes descriptions of each program and procedure, you can quickly become familiar with the two plotting programs by working through the DEMONSTRATIONS Program discussed in Section 1.3.

1.1 EQUIPMENT

The CALCU-PLOT Program requires an Apple II, Apple II+ or Apple IIe with 48K memory, one or two disk drives, and a printer if you want hardcopy. The program can print graphics automatically with an Epson MX-80 or MX-100 with GRAFTRAX.

If you have a different printer, the program can save graphs to data disk for later printing. You can use a Grappler interface for printing the graphs or use a software printer dump routine. We have found the software package GRAF-PAK inexpensive and easy to use. It is available directly from Human Systems Dynamics.

1.2 LOADING & BOOTING the DISK

To begin, simply insert the CALCU-PLOT disk into the disk drive. Close the door and turn on the Apple power switch. If the Apple is already on, type <PR#6> and press <RETURN>.

NOTE

> In this manual, Apple keys are shown inside brackets. For example, <S> denotes the S key; <RETURN>, the return key.

After the clacking and whirring stop, and the light on the disk drive goes out, the monitor displays the program title block. In a few seconds the screen changes to the CALCU-PLOT MAIN MENU.

```
                CALCU-PLOT
                 MAIN MENU

          <1> DEMONSTRATIONS
          <2> ORIENTATION
          <3> PLOT EQUATION(S)
          <4> WORK ON NEW EQUATION
          <5> ENTER EMPIRICAL DATA
          <6> INIT. DATA DISK
          <X> TO END
          ENTER YOUR OPTION --< >
```

NOTES

On the screen and in this documentation, the position of the cursor for entry is usually shown by the characters --< >.

The character <X> on various screen displays and menus of the program has two meanings:

1. EXIT - Program returns to nearest logical point.

2. END - Program terminates.

To select an option, simply press the key for that option. For example, pressing <X>, the END option key, terminates the program.

Most menus of CALCU-PLOT have a default option indicated by *. To choose the default option, press <RETURN>.

Should you find yourself in an option you don't want, discover an error too late to be corrected or that the program seems to have hung itself or stopped, you can restart CALCU-PLOT by these means:

1. Push <RESET>, <RUN>. The nearest logical menu will appear.

2. Enter <RESET>, <PR#6>. The program will reboot and the MAIN MENU re-appear.

3. Turn the power switch off and on.

1.3 SHORT DEMONSTRATION

To become familiar with CALCU-PLOT capabilities and graph formats, select DEMONSTRATIONS by pressing <1>. Instantly the DEMONSTRATIONS MENU appears on the screen.

```
                CALCU-PLOT
           DEMONSTRATIONS MENU
     <1> SHORT (GRAPHS ONLY)
     <2> COMPLETE STEPS
     ENTER YOUR OPTION --< >
```

Choose the SHORT (GRAPHS ONLY), option key <1>, to see a few quick examples of CALCU-PLOT's possibilities.

The following display appears:

```
                CALCU-PLOT
           SHORT DEMONSTRATION

        THIS BRIEF DISPLAY OF TYPICAL GRAPHS
     PLOTTED BY CALCU-PLOT SHOWS A FEW OF THE
     VAST POSSIBILITIES AVAILABLE TO THE USER.

        THE COMPLETE DEMONSTRATION WILL STEP
     THROUGH ALL THE OPTION MENUS.

     HIT ANY KEY TO SEE GRAPH SELECTIONS.
```

Depress any key and you get the menu for five graph examples.

SHORT DEMONSTRATION

<1> FIG. 1 DEMO
<2> PARABOLA FAMILY
<3> SINE AND DERIVITIVES
<4> LOG-LOG PLOT
<5> POLAR PLOT
<6> RETURN TO MAIN MENU
ENTER YOUR OPTION --< >

AFTER THE GRAPH IS SHOWN,
HIT ANY KEY TO CONTINUE.

To display a graph, press the key corresponding to the number of your choice. When satisfied, press <RETURN> to display the list again. When you've seen enough graphs, press <6> to return to the CALCU-PLOT MAIN MENU.

NOTE

Appendix B contains these and other examples of graphs.

1.4 COMPLETE STEPS

Your next step in this familiarization course is a COMPLETE DEMONSTRATION tour which shows how the graphs are put together. From the MAIN MENU, select option <1> for the DEMONSTRATIONS MENU, then option <2> for COMPLETE STEPS to display the instructions for the tour.

To take the tour of the CARTESIAN PLOT program, simply press <RETURN> at each step until you have the completed graph.

During COMPLETE STEPS, the following screen displays, with references to an 'OTHER' DATA DISK, first appear:

First Screen

```
ENTER DRIVE # (1 or 2) TO BE USED FOR
          'OTHER' DATA DISK.
  OR    *<0> IF NO 'OTHER' DATA DISK.
        ENTER YOUR OPTION --< >
```

Second Screen

```
IF 'OTHER' EQUATIONS ARE DESIRED, INSERT
DATA DISK INTO SLOT #1 AT THIS TIME!

AND PRESS <RETURN>
```

To clarify this term of 'OTHER', a few introductory remarks are now appropriate:

PURPOSE - 'OTHER' DATA DISKS store 'OTHER' EQUATIONS created by you under the FILE MAKER program.

CREATION - Section 4 explains how to initialize and create these disks.

USE - The use of the 'OTHER' DATA DISK and creation of 'OTHER' EQUATIONS are outlined in Section 5.

** ACTION REQUIRED NOW - Since we are using only standard program functions, press <RETURN> when these screens appear.

The screen shows default values as numbers under the flashing cursor. A default option has an * beside it. By simply pressing <RETURN> at each step you enter the default option or default value. This gives you a quick review of the plotting.

The final result is the same as you saw in the FIG. 1 DEMO in the SHORT DEMONSTRATION. After you have viewed the graph to your satisfaction, press <RETURN> to display the OPTION MENU.

```
                    CART-PLOT
                  OPTION MENU
  <1> TABULATION              <8> SAVE PLOT
 *<2> ADD AXIS TITLES         <9> PRINT PLOT
  <3> DISPLAY AGAIN
  <4> REPLOT NEW Y
  <5> REPLOT NEW X & Y
  <6> DIFFERENT EQS
  <7> CALCU-PLOT MAIN MENU
                              <X> END
       ENTER YOUR OPTION --< >
```

Choose Option <7> to return to the CALCU-PLOT MAIN MENU. (Other options on this menu are explained in Section 4.)

Foe a similar review of the POLAR-PLOT demonstration, select option <1> for the DEMONSTRATION MENU. Then, select <2> COMPLETE STEPS and then <2> POLAR (RADIAL).

Pressing <RETURN> at each step automatically gives you the default values and selections. The final result is the Polar Plot graph seen in the Short Demonstration. Again, press <RETURN> to display the OPTION MENU, then <7> for the MAIN MENU.

These demonstrations provide a foundation for using the CALCU-PLOT programs. However, before plotting your own equations, you might find it helpful to follow the ORIENTATION program.

1.5 ORIENTATION

The ORIENTATION program gives some important details and limitations for constructing graphic plots. It includes guidelines for preserving the true shape of figures, range restrictions for linear and log scales, procedures for creating and adding new functions and the procedure for empirical data entry plots.

To view the ORIENTATION on your monitor select

option <2> from the MAIN MENU. Appendix A provides a complete hardcopy of this program for later reference.

At the bottom of each ORIENTATION screen, the following options are offered:

FOR <N>EXT <L>AST <M>ENU HIT KEY

Pressing <N>, <L> or <M> will give you the next page, previous page or MAIN MENU respectively.

After you complete these learning exercises, you are ready to step out on new and uncharted ground.

2.0 STANDARD CARTESIAN EQUATIONS

You are about to venture into the vast realm of infinite shapes and curves. To use the CARTESIAN PLOT program, select <3> PLOT EQUATIONS from the MAIN MENU.

```
          CALCU-PLOT
          MAIN MENU

     <1> DEMONSTRATIONS
     <2> ORIENTATION
     <3> PLOT EQUATION(S)
     <4> WORK ON NEW EQUATION
     <5> ENTER EMPIRICAL DATA
     <6> INIT. DATA DISK
     <X> TO END
     ENTER YOUR OPTION --< >
```

The PLOT PROGRAM MENU appears:

```
          PLOT PROGRAM MENU

    *<1> CARTESIAN (RECTANGULAR)
     <2> POLAR (RADIAL)
     <X> TO EXIT
     ENTER YOUR OPTION --< >
```

Next choose the coordinate system by selecting the CARTESIAN PLOT program. Press <1> or <RETURN> since * denotes this as the default option.

The program first prompts you to provide a drive number for an 'OTHER' DATA DISK. For plotting your own equations and using an 'OTHER' DATA DISK, see Section 5 for a more detailed explanation of this option. Since we are using the program's standard set of equations in this part of the discussion, press <RETURN> for the default option <0>. Then, when the disk drive is quiet, press any key to view the CARTESIAN COORDINATE PLOTTING PROGRAM MENU.

```
          CARTESIAN COORDINATE
          PLOTTING PROGRAM MENU

     *<1> ONE FUNCTION
      <2> TWO FUNCTIONS
      <3> THREE FUNCTIONS

      ENTER YOUR OPTION -- < >
         <P> PRINTER OPTION
         <X> END
```

As the menu shows, you can plot up to three functions on the same graph. After you select a desired number of functions, the program offers certain subsequent options, shown on Table 2-1. The following paragraphs explain them in more detail.

TABLE 2-1

If your first choice is:	Then subsequent choices are:
<1> ONE FUNCTION	<4> FUNCTION ONLY (any equation)
	or
	<5> FNC & 2 DERIVITIVES (single only)
	or
	<6> FNC & INTEGRAL (any equation)
<2> TWO FUNCTIONS	<7> FUNCTION ONLY (at least one single)
	or
	<8> ONE FNC & 1ST DER & 2ND FNC (single only)
	or
	<9> FUNCTIONS AND INTEGRAL (single only)
<3> THREE FUNCTIONS	FUNCTIONS ONLY (single only)

2.1 ONE FUNCTION

When you select <1> ONE FUNCTION, the default option, you have several plotting options. You can plot the function alone, with the first and second derivitive or with the integral of the function. (See Appendix B, SINE AND DERIVITIVES, and LOG-LOG PLOT for examples of the first and second derivitive and the integral of the function, respectively.)

NOTE

> The derivitive of a function is the value of the slope of the function. The integral is the value of the accumulated area between the curve and the X axis. With two curves, it is the accumulated area between the curves. Consult your college math books for more details.

2.2 TWO FUNCTIONS

Selecting <2> TWO FUNCTIONS limits your choice of equations since the program can only plot a total of three curves. You do have several plotting options: the two functions alone, with the first derivitive of your first equation or with the integral between the curves you select.

For option <7> FUNCTIONS ONLY, you may select one double valued equation, designated by CALCU-PLOT as such by "/2" at the end of its name. Your other slection must be single valued. Double valued equations will be missing from the equation selection for your second function.

You may ask "Why is this so?" It is so because the program calculates and plots equations whose names end in "/2" as two functions disguised as one. For example, the equation for a circle is:

$$radius = x^2 + y^2$$

In Cartesian coordinates it is given in terms of y as a function of x and is expressed as:

$$y = + sqroot(r-x) \quad and \quad y = - sqroot(r-x).$$

Therefore, two values of y exist for each value of x, and double valued equations count as two curves when determining the total of three available.

When you choose either option <8> ONE FNC, 1ST DER, AND 2ND FNC, or <9> FUNCTIONS AND INTEGRAL, then both equations must be single valued.

NOTE

> You may wonder "What do you mean by function? Equation? What is the difference?"
>
> Usually, you can apply the terms interchangeably. A double valued function is the exception. It can be expressd as the sum of two equations: one with a plus value, the other a negative. The combined result, the function, is plotted as two curves or equations.

2.3 THREE FUNCTIONS

With <3> THREE FUNCTIONS, all equations must be single valued. The PARABOLA FAMILY example in Appendix B illustrates this latter case.

2.4 EQUATION MENU

After selecting the number of functions and subsequent option(s), you choose from the following list of standard equations and other options:

```
                    CART-PLOT
                1ST EQUATION MENU

     <A> CMPHRMNC          <J> SINE
     <B> COSINE            <K> SINH
    *<C> DMPDOSC1          <L> TANGENT
     <D> DMPDOSC2          <M> TROCHOID
     <E> EXP               <R> CIRCLE/2
     <F> NATLOG            <S> CONICS/2
     <G> PARABOLA          <T> TRDROP/2
     <H> POLYN3
     <I> PROBLTY           <N> NEW EQUATION
                           <O> OTHER EQUAT.
       <X> EXIT            <U> UNCHANGED
                           <V> EMPIRICAL DATA
          ENTER YOUR OPTION --< >
```

Table 2-2, STANDARD CARTESIAN EQUATION SET, shows the full title, equation and one set of constants and ranges that result in a reasonable graphical plot. Using other values is where the challenge and fun of learning begin.

TABLE 2-2 STANDARD CARTESIAN EQUATION SET

TITLE / EQUATION	CONSTANTS A	B	C	D	X RANGE LFT	RGT	Y RANGE TOP	BTM
<A> Compound Harmonic $y = A(\sin B(x)) + C(\cos D(x))$	3	1	1.5	4	-10	20	5	-5
<B> Cosine $y = A(\cos B(x))$	8	.5			-5	10	10	-10
<C> Damped Oscillation #1 $y = A(\exp^{-B(x)})(\cos(2\pi(\frac{x}{C})))$	2	.1	4		-10	20	6	-6
<D> Damped Oscillation #2 $y = A + (B - C(x))(C(\pi(x))$	3	5	.3		-10	15	10	-5
<E> Exponential $y = A(\frac{\exp^{B(x)}}{x})$	1	1			-2	4	10	-5
<F> Natural Logarithmic Curve $y = A(x \ln(x))$	1				0	3	0	-3
<G> Parabola $y = A(x^2) + B(x) + C$	2.5	0	0		-4	4	40	0

<H> 3rd Order Polynomial 1 .5 1 .5 -2 2 15 -10

$$y = A(x^3) + B(x^2) + C(x) + D$$

<I> Probability Curve 100 -4 4 40 0

$$y = A\left(\frac{\exp^{-x^2/2}}{\text{sqroot}(2\pi)}\right)$$

<J> Sine Function 1 1 0 6 1 -1

$$y = a(\text{Sin } B(x))$$

<K> Hyperbolic Sine of x 2 3 -3 3 400 -400

$$y = A\left(\frac{\exp^{B(x)} - \exp^{-B(x)}}{2}\right)$$

<L> Tangent 1 1 -2 5 4 -4

$$y = A(\text{Tan } B(x))$$

<M> Trochoid 15 5 0 150 25 5

$$y = A - B(\text{Cos } x)$$

<R> Circle 0 0 R=5 -10 10 6 -6

$$y = -A \pm \text{sqroot}((R^2) - (x-B)^2)$$

<S> Special Conic 3 -2 2 2 -2

$$y = 2x \pm \text{sqroot}((4 - A)(x^2) + 8x + 4)$$

<T> Tear Drop 3 4 -3 3 8 -8

$$y = \pm \text{sqroot}((A + x)^2)(B - (x^2))$$

Examination of this list of the more popular equations used in higher mathematics reveals that Equations <A> through <M> are single valued functions always available for selection. However, as discussed above, equations <R>, <S> and <T> are double valued and only appear for your choice where appropriate. Section 4.10 explains options <N>, <O>, <U> and <V>.

NOTE

Option <X> Exit moves you directly to the OPTION MENU. See Section 4 for the discussion of that menu.

2.5 PROCEDURE

2.5.1 SELECTION OF FIRST EQUATION

To begin, select your first equation. In this discussion, we are working with <G> PARABOLA.

Enter the letter corresponding to your choice and the following display appears:

```
YOUR FIRST EQUATION IS:
    PARABOLA

                2
    Y = A(X ) + B(X) + C

WHERE:  A = SHAPE
        B = X FACTOR
        C = Y OFFSET

ENTER VALUE FOR 'A':?
```

The first line, YOUR 1ST EQUATION IS:, indicates that this is either the first or only equation selected. If we had chosen to graph more than one function, 2ND or 3RD would appear as appropriate.

On the second line, the name of the equation

is shown, and is followed by the function's mathematical formula. These two lines are always present for the standard equations.

The information on the next three lines is optional, depending on the equation selected, and usually provides additional explanation about the constants.

2.5.2 ENTRY OF CONSTANTS

The last line prompts you to enter the first constant. Sample constants are provided on Table 2-2. Use these or make up your own. Press <RETURN> as each value is complete. After each <RETURN>, you are prompted to enter the next constant:

```
ENTER VALUE FOR 'B':
```

Then, when you have entered all required constants, press <RETURN> to access the verification routine:

```
OK?   *<Y>ES OR <N>O: < >
```

A <N>O response allows you to change the constants. Note that you must key in all constants or the program will assign default values.

2.5.3 CHOICE OF AXIS SCALES

When the constants are correct, press <RETURN> or <Y> to proceed to the next step:

```
      SELECT AXIS SCALES
*<1> X + Y LINEAR
 <2> X LOG, Y LINEAR
 <3> X LINEAR, Y LOG
 <4> X + Y LOG

ENTER YOUR OPTION --< >
          <U> UNCHANGED
```

Here you have four options for the type of axes: both X and Y linear; X logarithmic and Y linear; X linear and Y logarithmic; and both X and Y logarithmic. An additional option, <U>NCHANGED, allows you to repeat options selected for your most recently plotted equation. For our demonstration choose the default option <1> X + Y LINEAR.

2.5.4 RANGE OF X

After you pick the type of axes, the program prompts you to enter values for the range of X.

```
SELECT THE RANGE OF X
   ENTER INTEGER
VALUES AND PRESS <RETURN>:

LEFT LIMIT (E.G.-10):
RIGHT LIMIT (E.G.20):
```

Note that the numbers must be integer values. For linear plots, the largest values of X and Y are +/- 9E7 or 90,000,000. If you select logarithmic scales, the maximum practical value is five cycles. The program prompts you to enter an integer power of 10.

In addition, the graphic field for CALCU-PLOT programs is 250 horizontal points for the X axis and 150 points for the vertical Y axis.

To plot a figure accurately to scale, you must select X and Y ranges carefully. Remember that the ratio of the display is 5 by 3 (X to Y). Therefore, to preserve the true shape of figures such as a circle, the ranges chosen must be in that ratio.

If your limits are greater than +/- 1000, the range should be at least .01 times either limit, maximum or minimum. This is to allow for the increment marks and values automatically placed on the axes.

For real values consisting of more than four characters, the factor symbol E with appropriate values appears on your graph in the lower right corner. Thus, if your X limits are -6000 and 4000, the points displayed are -600, -400, -200, 0, 200, 400 with the designation "*E+1".

For linear plots, simply key in integer values representing the left and right limits of the X axis. For the beginner, the Standard Cartesian Equation Set presents X and Y ranges for its suggested constants. We have chosen <-4> and <4> for the left and right limits respectively.

Again, when you complete entry of the ranges, the program shows the verification/correction routine.

NOTES

If your entry is non-numeric, the program evaluates it as a zero (0) value. However, if you enter incorrect values (left greater than right), the program prompts you to try again in a proper sequence.

Default values appear at the flashing cursor. If these are acceptable, simply press <RETURN> to record them.

If you enter a decimal number, the program drops the decimal part of the number entirely. For example, 4.9 becomes 4.

After you enter the X Axis Range, the computer calculates the 250 points for each function and axis of the graph. The changing numbers at the bottom of the screen represent a count of the 250 points. Note that the more complex the equation, the more slowly the numbers change.

NOTE

The counting process does require just a few minutes, so please be patient. If the counting stops, an unlikely occurence, the program has "hung" itself. To restart press <RESET>, then type <RUN> and press <RETURN>. Retrace your steps or re-examine the equation if it is an "OTHER" to determine what caused the program to stop.

In addition to the values of X and Y, the program determines the maximum and minimum ranges of the Y axis.

2.5.5 RANGE OF Y

When the calculation is complete, the program beeps once and the following display appears:

```
        Y RANGE OF FUNCTIONS ARE:
              PARABOLA
  MAX Y          40
  MIN Y           0

          CART-PLOT
    ENTER INTEGER VALUES FOR
  Y LIMITS & PRESS <RETURN>

    TOP LIMIT (E.G.6):? 40
 BOTTOM LIMIT (E.G.-6):? 0
```

The program shows the calculated Y ranges of functions for your equation. These are presented as a possible guide in choosing the Y range, the next step to completion of your graph.

On the lower portion of the screen the program requires you to record top and bottom limits for the Y range. After you enter these, the correction/verification routine is presented again.

In our example, enter 40 for the TOP and 0 for the BOTTOM LIMITS as shown above..

NOTE

> If you select two or three functions, the program follows the same sequence as described for one equation with the following exception.
>
> You enter only one Y range for either both or all equations. After it calculates the points for the first function, the program returns to the CART-PLOT EQUATION MENU for you to select the next equation.

2.5.6 NAME OF GRAPH

Next, you enter a graph name, which will appear in the lower left corner of the plot. If that location is not suitable, you can place the title elsewhere later by using the option ADD AXIS TITLES (see Section 4.2).

The display for title addition is as follows:

```
                ENTER GRAPH TITLE

TYPE TITLE UP TO 36 CHARACTERS LONG
!!! (NO COMMAS OR COLONS PLEASE) !!!
IN THE SPACE SHOWN BELOW:

          **********************
          *                    *
          *                    *
          **********************

     THEN PRESS <RETURN>
IF NO TITLE, HIT </> AND PRESS <RETURN>.
```

2.5.7 DISPLAY OF GRAPH

Now you are ready to see your graph!!! Two beeps tell you that the basic graph is complete. Remember, after viewing your work of art to your satisfaction, hit any key to access the OPTION MENU. This will enable you to save the graph and select from other options.

Therefore, we suggest that you go on to Section 4 OPTIONS for an explanation of the choices on the OPTION MENU. Later you can return to Section 3 which describes the POLAR-PLOT Program.

NOTES

You may notice a gap between axes at the lower left corner of your display. This is caused by an origin which is not on the plotting field. The axes affected are moved outside to the left or down slightly to produce the gap. See Appendix B for graphic examples.

CAUTION! Always reboot after using CALCU-PLOT if you leave the CART-PLOT program by any way other than <X> END or a normal option listed on the menus. The reason? CART-PLOT sets MAXFILES to a value of 2, which sets HIMEM to 38982, which may prove fatal for other programs. Any normal EXIT or END will reset these parameters to their default values.

3.0 STANDARD POLAR EQUATIONS

To access POLAR Equations, select <3> PLOT EQUATION(S) from the MAIN MENU. Then choose <2> POLAR (RADIAL) OPTION.

As in the CART-PLOT Program, POLAR-PLOT first requests a drive number. Again, if you are plotting your own equations and using an 'OTHER' DATA DISK, supply the appropriate number. However, if you are using the program's standard set of equations, press <0> or <RETURN.>

Simply press <RETURN> when prompted to insert a data disk. In a few seconds the whirring stops and the POLAR COORDINATE PLOTTING PROGRAM menu appears:

```
          POLAR COORDINATE
       PLOTTING PROGRAM MENU

    *<1> PLOT POLAR FUNCTION
     <2> PRINTER OPTION
     <X> END
      ENTER YOUR OPTION--< >
```

The POLAR COORDINATE PLOTTING PROGRAM menu gives you the choice of creating a polar graph or printing one already stored in memory or on disk. (Section 4.9 provides details on this option.) Press <1> or <RETURN> for the default option, PLOT POLAR FUNCTION.

```
                    POLAR-PLOT
                  EQUATION MENU

  *<A> ARCHISPL
   <B> ASTROID
   <C> EQUISPL          <N> NEW EQUATION
   <D> HYPRSPL          <O> OTHER EQUAT.
   <E> LEMNISCT         <U> UNCHANGED
   <F> LIMACON          <V> EMPIRICAL DATA
   <G> LITUUS
   <H> CONICS
   <I> PETALS           <X> EXIT
             ENTER YOUR OPTION --< >
```

The POLAR-PLOT EQUATION menu presents nine standard equations, shown in further detail on Table 3-1. Although the program plots only one equation at a time, you may select many revolutions of that function with results of as many as 600 points.

NOTES

Table 3-1 presents the full title, equation, and one set of constants and ranges that result in a reasonable graphical plot. Again, the challenge and fun of learning come when you venture on your own with different values.

This part of the documentation relates to Options <A> through <I>. The other options are discussed in Section 4.10.

TABLE 3-1 STANDARD POLAR EQUATION SET

TITLE / EQUATION	CONSTANTS A	B	C	T RANGE * STRT/END	X RANGE LFT	RGT	Y RANGE TOP	BTM
<A> Archimedean Spiral $r = A\ (T)$	.5			-180/720	-10	10	**	-6
<B> Astroid $r = A + \text{sqroot}((\text{Cos}(T))^6 + (\text{Sin}(T))^6)$	5			-180/360	-10	10		-6
<C> Equiangular Spiral $r = A\ \exp^{B(T)}$	3	.2		-180/360	-10	16		-10
<D> Hyperbolic Spiral $r = \frac{A}{(T)}$	3			-180/360	-10	10		-6
<E> Lemniscate $r = A(\text{sqroot}(\text{Cos } 2(T)))$	5			-180/360	-5	5		-3
<F> Limacon $r = A\ (\text{Cos}(T)) + B$	5	5		-180/180	-6	20		-8
<G> Lituus $r = \text{sqroot}\ (A^2/(T))$	3			-45/900	-3	10		-3
<H> Conics $r = \frac{A}{(B - C\ (\text{Cos}\ (T)))}$	4	1	.5	0/360	-10	10		-3
	4	1	1	0/360	-10	10		-2
	4	1	2	0/360	-10	10		-6
<I> Petals $r = A\ (\text{Sin } B\ (T))$	5	4		-180/180	-10	10		-6

* (T) (the angle Theta) is in Radians,

BUT ---- T RANGE is given in Degrees.

(360 Degrees = 2 Pi or 6.28318 Radians)

** This is not an entered value, but is calculated for you.

3.1 PROCEDURE

The POLAR-PLOT PROGRAM operates in a manner similar to that of CART-PLOT. The same correction/verification routine appears as you complete entry of constants, ranges and limits.

First, select an equation and enter the requested constants. Here we have selected <I> PETALS for our example. This is the screen which the program presents for PETALS:

```
YOUR EQUATION IS:
                    PETALS

            R = A(SIN B(THETA))
  (WHERE : THETA IS IN RADIANS)

  B = EVEN INTEGER GIVES 2 TIMES B LOOPS
  B = ODD INTEGER GIVES B LOOPS
          (TRACED TWICE)

ENTER VALUE FOR 'A':?
```

The display is essentially the same as the one in CART-PLOT. First, the equation name appears, followed by its mathematical formula and finally, some explanatory information.

In response to the prompt, key in the constant A; for our sample, enter <5>. The program then adds to the display:

```
ENTER VALUE FOR 'B':?
```

The example B value is <4>.

When you have recorded all constants, the verification/correction routine appears:

```
OK? *<Y>ES or <N>O: < >
```

Since this is the same as in CART-PLOT, refer to Section 2.5.2 for any assistance you

require.

After you record <Y> or <RETURN> for the OK? signal, the program asks for the range of the angle in degrees:

```
SELECT THE RANGE OF ANGLE
ENTER INTEGER VALUE IN DEGREES
AND HIT <RETURN>

NOTE: 0 DEGREES @ + X AXIS
INCREASING ANGLE IS CCW

STARTING ANGLE (E.G. -180):?
```

These numbers must be integer values. Note that the zero degree line is along the plus X axis, and the degrees increase (positive angle) in a counter clockwise direction of rotation. Although the beginning angle may be negative, the ending angle must always be larger than the beginning one. If not, you must try again.

First, key in THE STARTING ANGLE. Simply press <RETURN> to accept the default value, -180, for our example. The program then asks you for the ENDING ANGLE. Rather than the default value, enter <180> for the example. The verification/correction routine appears next.

After you OK your entry, you set the range of the radial limits by entering the left, right and bottom limits of the X and Y axes. Following is the screen display for entering these values:

```
SELECT THE RANGE OF RADIAL LIMITS.

ENTER INTEGER VALUES AS SHOWN,
AND HIT <RETURN>

LEFT LIMIT:?
```

Again, these must be integer values. Like

CART-PLOT, POLAR-PLOT will drop any decimal value. If you enter incorrect values (left greater than right), the program prompts you to try again in a proper order. If default values, appearing at the flashing cursor, are acceptable, simply press <RETURN>.

As entry of the LEFT LIMIT is complete, the program adds the RIGHT LIMIT and then the BOTTOM LIMIT. In our sample, these values are -10, 10 and -6 respectively.

Upon entry of the BOTTOM LIMIT, the program calculates the top limit and presents it for your information. This value, based on a 3 by 5 ratio of Y to X, provides equal scales in both X and Y directions so that circles are round.

By the verification/correction routine, you can change Left, Right, and Bottom limits, but not the Top limit.

After you press <Y> or <RETURN>, the program computes the values of angle and radius. Again, be patient while the numbers count up.

NOTE

> If the counting stops, strike <RESET>, type in <RUN>, and press <RETURN>. Retrace your steps or re-examine the equation, if an OTHER, to determine what caused the halt..

If the range of the angle and radius results in more than 600 points, the following display appears:

```
SORRY!   THE RANGE OF ANGLE SELECTED IS
TOO LARGE! YOU MAY:
          <1> PLOT AS-IS TO 507.641035
     OR
          <2> RESELECT ANGLES
     (REDUCE BY ABOUT 212.358965 DEGREES)

WHICH < >?
```

As shown you have two options:

<1> Plotting fewer than 600 points. The number appearing on the display shows you how far the program was able to calculate. When you select this option, the program moves to the next step: ENTER GRAPH NAME.

<2> Reselecting the total range of angles. The program provides guidelines for you to follow in resetting angles. For option <2>, the program returns to the SELECT THE RANGE OF ANGLE display.

Next, you are prompted to enter a graph name which will appear in the lower left corner of the graph. See Section 2.5 for the procedure for entering the title. If you don't like that location, you can place it elsewhere later by using the option ADD AXIS TITLES, described in Section 4.2.

With two beeps the program announces to you that the graph is completed. After viewing it to your satisfaction, press any key to access the OPTION MENU. This menu permits you to save, print, or replot your equation(s) and offers additional choices: a table of solutions or a return to the CALCU-PLOT MAIN MENU. Section 4 OPTIONS provides an explanation of the OPTION MENU.

NOTE

On your graphic display, the program places radial marks at ten degree intervals around the border.

4.0 OPTIONS

This section describes various other options appearing both on the OPTION MENU and other menus in the program. Note that the function and operation of these options are the same on all menus from which they can be accessed. They provide for saving and printing graphs, recalling equations previously stored to disk, replotting a graph with different axes, moving to and from various menus and putting additional titles on your graph.

The OPTION MENU appears when you press any key after viewing a graph. For the CART-PLOT program, the menu is:

```
                    CART-PLOT
                  OPTION MENU

     <1> TABULATION            <8> SAVE PLOT
    *<2> ADD AXIS TITLES       <9> PRINT PLOT
     <3> DISPLAY AGAIN
     <4> REPLOT NEW Y
     <5> REPLOT NEW X & Y
     <6> DIFFERENT EQS
     <7> CALCU-PLOT MAIN MENU
                               <X> END
           ENTER YOUR OPTION --< >
```

The POLAR-PLOT program OPTION MENU is the same except that selections <4> and <5> offer the following choices:

```
     <4> REPLOT NEW X & Y
     <5> REPLOT NEW ANGLES
```

4.1 TABULATION <1>

The first option, TABULATION, presents a table of the points calculated:

X	PARABOLA
-4	40
-3.68	33.856
-3.36	28.224
-3.04	23.104
-2.72	18.496
-2.4	14.4
-2.08	10.816
-1.76	7.744
-1.44	5.184
-1.12	3.136
-.8	1.6
-.48	.576
-.16	.064
.16	.064
.48	.576
.8	1.6
1.12	3.136
1.44	5.184
1.76	7.744
2.08	10.816
2.4	14.4
2.72	18.496
3.04	23.104
3.36	28.224
3.68	33.856
4	40

It presents solutions of all functions plotted. You can select to view either a SUMMARY table which shows every tenth value as shown above. If you prefer, you can opt for ALL VALUES and see every point for every function:

```
                TABULATION MENU
     <1> TABULATE ALL VALUES?
    *<2> SUMMARY TABULATION?
     <X> EXIT
     ENTER YOUR OPTION --< >
```

NOTE

Here, Option <X> EXIT returns to the OPTION MENU.

After you make your selection, the program prompts you to enter <0> to <4>, the number of decimal places desired:

```
        TABULATION MENU
ENTER NUMBER OF DECIMAL PLACES
DESIRED (0 to 4):
```

Be careful here to consider the width of the screen in selecting decimal places. If there are more than five digits to the left of the decimal point, the columns may not line up properly or may roll over to another line.

The program next presents a choice of screen or printer output:

```
TO SCREEN ONLY?      <0>*
TO PRINTER?, SLOT NUMBER --> < >
    ENTER YOUR OPTION --< >
```

If you choose printer, you can move your output to the right side of the paper.

After you key in the slot number for printed output, the program prompts you:

```
HORIZONTAL TAB POSITION? <    >
```

Key in the value of the horizontal position you desire for the leftmost column. For printed output, the table will then be printed on hardcopy as you chose it.

If you select screen display, the program displays the tabulation in sets of ten values. At the end of the set, simply press <RETURN> for the next set or <X> to Exit to the OPTION MENU. After displaying all data, the program prompts you to press <RETURN> for the OPTION MENU.

4.2 ADD AXIS TITLES *<2>

With this option, the default option on the OPTION menu, you can add titles to both x and y axes, include notes on your graph, reposition the graph title or add other features to your graph. You can add as much or as little as you like to the display.

After you select ADD AXIS TITLES by pressing <2> or <RETURN>, the program presents you with a choice of the following:

```
*<A>DD TO EXISTING GRAPH
 <E>RASE AXIS TITLES
 <X>EXIT

  ENTER YOUR OPTION --< >
```

Select the default choice of <A>DD and your graph appears on the screen. In response to program prompts, enter your X and Y coordinates for the horizontal title position. For X, you can select from 1 to 266; for Y, from 1 to 164. The origin (X and Y = 0) is in the upper left corner of the screen.

After you enter your choices, a position marker, > , appears briefly; the marker indicates the starting position for the title. From this point the title will appear to the right.

The program then asks:

```
OK? <Y>ES, <N>O, <?>: < >
```

If the position is acceptable, press <Y>. If not, press <N> and the screen returns to the point where you can re-enter coordinates. Should you be unsure, key in <?> and and the position marker will re-appear.

For a <Y>ES response, the program then prompts you to enter the HORIZONTAL TITLE or </> (slash):

```
ENTER HORZ TITLE OR </> FOR NONE:
TIME
```

The slash, </>, represses the appearance of a title for this axis. Key in your choice over the default title, TIME. When finished, press <RETURN>. To accept the default, simply press <RETURN> without entering any other characters.

After you press <RETURN>, the title appears in place on your graph. Again the program gives you a choice of accepting or rejecting the title. Choices are as above. A response of <?> has no effect on the display. <N>O lets you try again.

If you respond <Y>ES, the program goes into the same routine for the Vertical Axis. The VERT title is added vertically, straight up from the position chosen. Note that the VERT Y position offers placement coordinates from 14 to 164.

When both vertical and horizontal axes titles have been entered and approved, the OPTION MENU will re-appear. To enter additional titles, simply re-select ADD AXIS TITLES.

Besides adding titles to your graph, ADD AXIS TITLES allows you to delete titles already saved. To remove titles, select <E>RASE from the ADD AXIS TITLES option page. All titles will be erased from the graph currently in memory.

NOTES

To repress entry for one of the titles, simply press <RETURN> twice. Then enter the </> for a null entry in response to the TITLE prompt.

If you enter a title that falls off the graph, the program requests you to enter a new position. To keep the position and shorten the title, press <RETURN> twice to retain the current coordinates, and enter a new title.

You cannot delete the original lower left corner title. However, you may change it to show whatever you want.

4.3 DISPLAY AGAIN <3>

This choice shows you the graph presently stored in memory. Depress <RETURN> to get back to the OPTION menu.

4.4 REPLOT NEW Y <4> or REPLOT NEW X & Y <5> (CART-PLOT)

These options for CART-PLOT allow you to rerun the program with new entries.

For REPLOT NEW Y, the program returns to the screen display for entering the minimum and maximum range for Y. You can then enter new values without being required to recalculate the other values. Thus, you obtain a quick replotting of your graph in a better presentation of an area of particular interest.

If you choose <5> REPLOT X & Y, the program returns to the CART-PLOT 1ST EQUATION menu. To replot the same equation, select option <U> UNCHANGED which is described in Section 4.10.3.

4.5 REPLOT NEW X & Y <4> or REPLOT NEW ANGLES <5> (POLAR-PLOT)

These two options provide for resetting radial limits and range of angle of your POLAR-PLOT graph. With OPTION <4> REPLOT NEW X & Y, the program returns to the screen allowing you to enter new radial limits. OPTION <5> takes you back one step further so that both new angle range and new radial limits can be set.

4.6 DIFFERENT EQS <6>

With this option, you return to the PLOTTING program menu corresponding to the equation most recently displayed, either CARTESIAN or POLAR. Then, you can select new equations or a new combination of functions.

4.7 CALCU-PLOT MAIN MENU <7>

This selection is a simple method for getting back to the start of the CALCU-PLOT program and the friendly MAIN MENU. You may use it to shift from CART-PLOT to POLAR-PLOT, review the ORIENTATION, initialize a data disk, etc.

4.8 SAVE PLOT <8>

SAVE PLOT allows you to name and save a finished graph on disk. After you select OPTION <8>, the program prompts you to insert a data disk and enter the appropriate drive number.

NOTE

> The disk used must be initialized first. See Section 4.10.5 <6> INIT. DATA DISK for specific instructions about initializing data disks.
>
> You can also use any DOS initialized disk to store graphic images.

Next you supply a filename for the graph; the title presently on file appears as the DEFAULT OPTION. To use this name, simply press <RETURN>. To save the graph under another name, key the desired name over the default name. Your name may contain up to 30 characters. For some important tips and cautions on disk management, we recommend that you review Appendix C.

4.9 PRINT PLOT <9>

With this option you access the routine to print the graph on an EPSON MX (-80 or -100) with GRAFTRAX (80 or Plus). It assumes a parallel interface.

NOTE

> If you are using another printer or interface system, simply save the completed graph on disk using the SAVE PLOT option (see Section 4.8). Then print the HIRES page #1 image using the procedures associated with your system.

To print a graph, select option <9>. The program first asks:

> IS THE GRAPH IN MEMORY?(Y OR N)

A <Y> response results in a brief display of the graph currently in memory and a second query:

> IS THIS THE GRAPH? <Y> OR <N>

The program, through a series of questions and prompts, moves through a sequence of five screen presentations. With <Y>ES or <N>O responses, for most, the displays weave through and around one another.

To help you move through this small "maze",

this discussion presents the screen displays numbered one to five. For the different responses, directions are provided, frequently in the form of "Go to Screen # ".

Screen 1

```
     IS THE GRAPH IN MEMORY? <Y> OR <N>
```

<Y> results in a brief display of the graph and a movement to Screen 2.

<N> results in a display of Screen 3.

Screen 2

```
     IS THIS THE GRAPH? <Y> OR <N>
```

<Y> moves you to Screen 4.
<N> goes to Screen 5.

Screen 3

```
     TO RETRIEVE GRAPH FROM DISK
     INSERT DATA DISK AND ENTER DRIVE#:(1-2)
             ENTER YOUR OPTION --< >
     OR <X> EXIT
```

From this screen you can load another graph into the Plotting Program. After you enter the drive #, the program prompts you:

```
     ENTER FILENAME:
     ?
```

Record the filename of the graph to be printed. After entry,

```
     LOADING GRAPH -- PLEASE WAIT!!
```

When the load is complete, Screen 2 appears. If unable to locate your graph, the program displays an appropriate error message.

Remember, you can always see a catalog of your disk by pressing <?>, <RETURN>. Then enter the desired filename.

<X> EXIT By this entry, you return to the OPTION MENU.

Screen 4

WHAT SIZE <R>EGULAR OR <L>ARGE?

<R>EGULAR results in a graph printout of
3 1/4" by 4 1/4".

<L>ARGE produces a graph of size
6 1/2" by 8 1/2".

In either case, the program instructs you:

TURN PRINTER ON
SLOT NUMBER (1 to 7)

After you specify the slot number, your printer presents you with the chosen graph.

Screen 5

TRY AGAIN? <Y> or <N>

<Y> moves the program to Screen 3.
<N> returns to the OPTION MENU.

NOTES

After printing a graph, the program asks:

ANOTHER GRAPH? <Y or N>

<Y> returns to Screen 1.
<N> goes to OPTION MENU.

You may remember seeing the PRINT option earlier on the first menu of each Plotting Program. If your graph is already created and stored on disk, you can select it then.

4.10 OPTIONS APPEARING on OTHER MENUS

In addition to the options given on the OPTION MENU, other menus present different options throughout the programs. Descriptions of these appear below.

4.10.1 WORK ON NEW EQUATION <4> and NEW EQUATION <N>

These options appear on the MAIN MENU and the EQUATION menus, respectively. Both provide direct access to the FILE MAKER program. With this program, you can create new equation files and add them to the appropriate plotting program. Details and instructions for this process are in Section 5 NEW/OTHER EQUATIONS.

4.10.2 OTHER EQUATION <O>

This option, occuring on EQUATION menus, displays for your selection the list of "OTHER EQUATIONS" presently residing in the plot program. These equations are those you created with the FILE MAKER program and then added to the appropriate plotting program.

In addition to selecting one of the equations, you may choose to <R>eturn to the EQUATION menu or <X> exit to the OPTION menu.

4.10.3 UNCHANGED <U>

If you are recycling back through the program from the OPTION menu to either EQUATION (POLAR- OR CART-PLOT) menu, you can use this EQUATION menu option. It allows you to retain the same equation with the following additional choices:

<C>HANGED OR <U>NCHANGED CONSTANTS?:

For a <C> choice, the program prompts you to enter new constant values and then moves

through all remaining plotting steps. If you choose <U>, the program starts with the SELECT AXIS SCALES display.

NOTE

This option does not apply to the EMPIRICAL DATA option.

4.10.4 ENTER EMPIRICAL DATA <5> and EMPIRICAL DATA <V>

These options appear on the MAIN MENU and on the EQUATION menus, respectively. From the MAIN MENU, you may access the EMPIRICAL DATA entry program directly. From an EQUATION menu, you choose between creating a data file or plotting one that has already been entered and saved on disk.

Section 6.0 contains the instructions for entering experimental/empirical data into a disk file for later retrieval by the appropriate plotting program.

4.10.5 INIT. DATA DISK <6>

This MAIN menu option initializes a blank disk and stores on the disk the programs necessary for creating OTHER equations. The procedure is simple and requires only two or three minutes of DOS running time.

Just follow the 3 steps that appear on the screen:

```
   TO INITIALIZE A 'DATA DISK' ON WHICH
'OTHER EQUATION FILES MAY BE SAVED AND
RETRIEVED, PERFORM THE FOLLOWING STEPS:

      (1) HIT <RETURN> WHEN READY

      (2) WHEN PROMPTED, INSERT DISK
      TO BE INITIALIZED, & HIT <RETURN>

      (3) REMOVE DATA DISK & RE-INSERT
      CALCU-PLOT DISK WHEN PROMPTED,
      & HIT <RETURN>

OR <X> TO EXIT
        ENTER YOUR OPTION --< >
```

When you press <RETURN>, the program adds to your display instructions to place a DATA DISK into a drive and press <RETURN>. Next it whirrs and clatters as the program performs its initialization and storage routine.

For the final step, the program prompts you to reinsert your program disk and press <RETURN>. The MAIN MENU then reappears on the screen.

NOTE

Option <X> to EXIT returns the program to the MAIN MENU.

You must use a CALCU-PLOT initialized DATA DISK when creating and storing NEW EQUATIONS for later recall with the OTHER OPTION. (See Section 5.) However, when just storing EMPIRICAL data files and/or graphs, any DOS initialized disk is sufficient. Of course you can always use the CALCU-PLOT disk alone, but this limits you to the standard equation sets.

4.10.6 FOR PRINTER OPTION <P>

This choice appears on the first menu of both plotting programs. You can use it to go directly to the printer routine as described in Section 4.9.

4.10.7 EXIT or END <X>

<X> EXIT sends you to the nearest logical menu.

<X> END terminates the program and returns control to Applesoft.

5.0 NEW/OTHER EQUATIONS

By now you should be familiar with the CART-PLOT and POLAR-PLOT Programs and at least a few of the standard equations, if not all of them. Since the variety of equations is infinite, it is impossible to store them all in the program at one time or even on a reasonable number of disks. Therefore, we include a FILE MAKER Program which lets you add your own equations to the Plot Programs.

The FILE MAKER program is easy to use. Do not be intimidated by the somewhat lengthy discussions of its options. You can quickly learn all the detailed steps with one or two sample equations even if you don't quite understand the basic procedures. This brief introduction prepares you with a general outline of how FILE MAKER works.

With your 'OTHER' DATA DISK, you are ready to use the FILE MAKER option CREATE A FILE for a new equation file. Just follow the prompts and insert the disk when prompted. In a short while you will become adept at completing the programming entries necessary for adding your own equations to the CALCU-PLOT equation files.

Other program options let you edit your file for errors, do test plots, and save the equation on disk. The final step is adding the new file to the appropriate plotting program on the 'OTHER' DATA DISK. Then you can easily select the new equation for plotting by pressing <O> OTHER EQUAT. from either EQUATION MENU.

Both the CART-PLOT and POLAR-PLOT programs store up to five OTHER equations at one time. But you can move OTHER equations back and forth between the CALCU-PLOT program disk and 'OTHER' DATA DISK(S) by simply following the instructions in the FILE MAKER program.

Thus, you can build a handy library of equation files by storing equations on disk and saving them under different names. Later just transfer them to the OTHER EQUATION list to use when needed.

After this brief introduction to the FILE MAKER program, you are ready to examine it in more detail and enter your own equations. We assume here that you have some familiarity with basic computer operation, keyboard entry and editing. If not, you may wish to briefly review the APPLE TUTORIAL and the appropriate parts of the BASIC PROGRAMMING REFERENCE MANUAL.

NOTE

Before using the FILE MAKER, create a data disk for your NEW/OTHER EQUATIONS - the 'OTHER' DATA DISK. This disk stores certain programs and files for later retrieval during loading of the plotting program. A separate disk is necessary because the CALCU-PLOT MASTER disk is almost full.

To prepare an 'OTHER' DATA DISK, select Option <6> INIT. DATA DISK from the MAIN MENU. Then simply follow the instructions to change a blank disk into an 'OTHER' disk. If you find you need help, refer to Section 4.10 for an explanation of this procedure.

Appendix C contains a summary of disk management and certain cautions and options that may help you when using additional data disks.

The first step in creating, testing and adding new equations is to access the FILE MAKER program. There are two ways to do this:

1. Select <4> WORK ON OTHER EQUATIONS from the CALCU-PLOT MAIN MENU.

2. Select <N> NEW EQUATION from the EQUATION MENU the CART PLOT or POLAR PLOT program.

Either option gives the following menu:

FILE MAKER

THIS PROGRAM LETS YOU ADD EQUATIONS TO THE PLOT PROGRAMS WHERE THEY MAY BE CHOSEN BY SELECTING THE <O>THER EQUATION OPTION ON THE EQUATIONS SELECTION MENU.

OPTIONS:

<1> CREATE A FILE
<2> ADD FILE FROM DISK
<3> TEST & EDIT DISK FILE
<4> CALCU-PLOT MAIN MENU
<X> END
ENTER YOUR OPTION --< >

5.1 CREATING A FILE

Select Option <1> CREATE A FILE from the FILE MAKER MENU to experience how simple it is to create your own equation file. All necessary steps and instructions appear both in the manual and on the screen for your convenience. To show you the correct format for entering the information, examples have been included.

After you choose Option <1>, the program prompts you to insert an 'OTHER' DATA DISK and enter the disk drive number you are using. If you need to make an OTHER disk, press <X> to return to the FILE MAKER MENU, then <4> for the CALCU-PLOT MAIN menu for option <6> INIT.

DATA DISK routine.

After you specify the drive number, the next frame asks you to choose the plotting system to which your equation will be added. Select either <1> CARTESIAN (Rectangular) or <2> POLAR (Radial). In this part of the discussion, we will be working with Cartesian equations.

After you enter <1>, the following display is visible:

THE PRESENT LIST OF OTHER EQUATIONS IS:

<1> UNUSED
<2> UNUSED
<3> UNUSED
<4> UNUSED
<5> UNUSED

SELECT THE NUMBER YOU WISH TO ENTER OR REPLACE WITH YOUR EQUATION:

This screen shows the OTHER equations currently stored in the selected program. Key in your choice (1 to 5) for the location of your new equation.

NOTE

UNUSED locations contain no equations. If you choose one of these, you will not affect any data already on file. However, when you pick a location already showing an equation name, the old equation is overwritten when you add your new file to that program.

To avoid losing any useful files, we strongly urge you to save them on your 'OTHER' DATA DISK when the opportunity first arises as described in Section 5.2.1. It is difficult to retrieve them from the Plot Program.

After entering a location number, you are asked to provide a name for your equation.

```
ENTER THE EQUATION #<1> NAME OR MNEMONIC
IN EIGHT CHARACTERS OR LESS:-->
AND HIT <RETURN>
                    -OR-
IF NO CHANGE, HIT <RETURN> FIRST

              ***NOTE***

IF DUAL FUNCTION (A ROOT WHICH REQUIRES
TWO EQUATIONS ON THE RIGHT SIDE) END
NAME WITH:
                    /2
```

Inventing a short name or mnemonic with fewer than eight characters, requires some ingenuity from you in the creation of a brief description which adequately identifies the function.

To change the equation but not the name, just press <RETURN> and the current name remains.

If the equation is a dual function or contains a root which must be entered as two equations, you must end the title with /2. This leaves you only six characters to describe your function. (Refer to Section 2.2 for an explanation of dual function equations.)

After giving the short name, press <RETURN>. The program displays your choice of number and name and prompts you to verify the display. A simple press of <Y> registers your satisfaction. <N> returns you to the screen showing the present list of OTHER equations, ready for you to re-select the proper location.

The <Y> response signals your readiness to begin the careful work of entering the equation.

5.1.1 ENTERING THE EQUATION

The screen, prompting you to enter the right side of the equation, appears as follows:

```
ENTER THE RIGHT SIDE OF YOUR EQUATION:

E.G.: Y = A(S)*X^2 + B(S)*X + C(S)

CAUTION! USE PROPER SYNTAX AND
PRECEDENCE. (SEE THE MANUALS)

    Y =
```

On the second line, an example showing a correctly entered equation appears. The third and fourth lines provide a reminder that proper Applesoft syntax and precedence must be followed. Order of precedence and appropriate symbols are summarized below.

	Symbol	Explanation
1.	-	Minus sign indicating negative number.
2.	^	Exponentiation, evaluated left to right.
3.	*/	Multiplication and division, again left to right.
4.	+-	Addition and subtraction, from left to right.

You can override the usual order by using parentheses and nested parentheses. The program executes expressions from inner to outer parentheses in a left to right sequence.

NOTE

For additional guidance on syntax and precedence, please refer to the section on Order or Precedence in THE APPLESOFT TUTORIAL and the chapters on Getting Started, Definitions, Editing and

especially Math Functions in the Applesoft BASIC PROGRAMMING REFERENCE MANUAL.

In addition, you can use the Apple's built-in functions in your equations. See page 102 of the BASIC PROGRAMMING REFERENCE MANUAL.

Another important point to consider in entering your equations is the naming of variables. Since the left side of the equation is predetermined with the variable name Y, the right side should contain a function of X.

Section 5.4 provides more information and restrictions on naming variables. In addition, examples in Appendix B show alternative methods for handling variables.

There is one last consideration in entering your equation. You may have noticed the (S) appearing after variables in the screen sample. This is a required entry for Cartesian variables whose values you select later during the plotting program. Thus, you enter variable A as A(S). This format allows the Cartesian program to distinguish to which of the three allowed curves a variable belongs when it performs calculations.

With these guidelines in mind, enter the right side of your equation. If you wish to follow the sample provided here, key in:

```
A(S)*X + B(S)
```

When you finish the equation, press <RETURN> and proceed to Section 5.1.2 for entering the equation name.

NOTE

If you select a /2 function requiring two equations, the program next prompts you to enter the second (or negative)

equation. For example, if the equation is that of a simple circle as described in Section 2, the first equation is:

```
Y = SQR ((R(S) ^ 2) - (X ^ 2))
```

and the second equation is:

```
Y(NEG) = - SQR ((R(S) ^ 2) - (X ^ 2))
```

The only difference on the right side of the equal sign is the minus sign in front of the expression. In other functions the minus sign may be found in different locations.

5.1.2 ENTERING THE EQUATION NAME

After you enter the equation and press <RETURN>, the program asks for the FULL name or title of the equation or function by adding the following to your screen:

```
ENTER THE FULL EQUATION TITLE:

E.G.: LN#2: PRINT"SECOND ORDER
POLYNOMIAL"

TYPE LN#2:
```

This name can be quite lengthy - as many as 256 characters. Do not include any commas or colons as all characters following these will not appear in the name.

Since the FULL name will appear on the screen when you run the plotting program and select the equation, you must use a specific format:

```
PRINT" information here "
```

Note that PRINT and both quotation marks must be included when you have information such as a title, which will appear later in a program. The function title appears in place of

information here.

You may use a question mark ? for PRINT.

There can be no space between either PRINT or ? and the quotation mark. Again, commas and colons cause information entered after them to be dropped from the display.

Thus, for our sample equation, at the prompt TYPE LN#2:, your response is:

```
PRINT"  SIMPLE LINE"  or
    ?"  SIMPLE LINE"
```

The blank spaces following the left quotation mark cause an indentation of the name when it appears later.

Press <RETURN> when LN#2: is complete and you are ready for the next step.

5.1.3 ENTERING THE EQUATION DISPLAY & EXPLANATORY NOTES

By providing additional entry lines, this step offers you an opportunity to be inventive in setting up your equation display frame. You can use these lines to present the equation in a more familiar form. You can also include any explanatory notes which might be useful or necessary in selecting values for the variables when the program is later run.

To enter display and explanation lines, the program changes your screen to the following after you press <RETURN> (Section 5.1.2):

```
                FILE MAKER
        LN#2 PRINT"SECOND ORDER POLYNOMIAL"

    TYPE LN#2: PRINT"     SIMPLE LINE"

    ENTER LINES TO DISPLAY AND EXPLAIN THE
    EQUATION IN FORM DESIRED: --E.G.

          LN#3: PRINT"           2"
          LN#4: PRINT"  Y = A(X)  + B(X) + C"
          LN#5: PRINT"WHERE 'C' IS A CONSTANT
      Y OFFSET"

     TYPE LN#3:

     HIT <RETURN> FIRST WHEN FINISHED.
```

NOTE

At the bottom of this display, the message:

HIT <RETURN> FIRST WHEN FINISHED

indicates that the number of lines allowed for this set of equation entries may vary. You signal that you have finished with the section by pressing <RETURN>. This causes the next LN# to appear on the monitor.

The message will appear on other screens with a variable number of lines to be entered.

On the display example, LN#3 and LN#4 provide for the future display of an equation in a format more familiar to most users. Note how LN#3 is used to include the exponent 2 for the value of X.

For reasons of clarity, we suggest that you use the same names for the variables and constants as when you entered the equation. Do not include the qualifier (S) after constants.

Just remember that the purpose of these lines is to inform the user of the type and nature of the function and the representation of the constants and variables.

The format for these lines is:

```
PRINT" information here"
```

Press <RETURN> as each line is completed. The program moves up to present that next line for your entry.

To obtain double spacing in your display, simply key in <PRINT> and press <RETURN>.

To continue with the sample provided with this documentation, enter the following:

```
LN#3: PRINT
LN#4: PRINT"   Y = A(X) + B"
LN#5: PRINT
```

When you finish all lines, press <RETURN> to move to the next section. Note that LN#6 appears on your screen.

5.1.4 ENTERING LINES TO REQUEST VALUES FOR CONSTANTS (OR VARIABLES)

```
                FILE MAKER
ENTER LINES TO REQUEST VALUES FOR
SELECTABLE CONSTANTS:

IF CONSTANTS ARE A,B,C,D THEN TYPE:
      LN#6: CV = N
      LN#7: GOSUB 12100
REPLACING N WITH THE NUMBER USED

IF OTHER LETTERS ARE DESIRED, OR THERE
ARE MORE THAN 4, TYPE AS - - - E.G.

      LN#6: PRINT "ENTER VALUE FOR "R"
      (RADIUS):";
      LN#7: INPUT R(S)

TYPE LN#6:
HIT <RETURN> FIRST WHEN FINISHED
```

This display prompts you to specify the number of constants for which values will be entered when the function is plotted. You may also assign variables in this way since their value can vary each time you plot the function.

There are two ways to accomplish this: one is very simple and the other slightly more complicated.

1. If there are fewer than four constants and the constant names are A, B, C, D, key in the following two lines of instruction:

```
CV = n (enter the number of values
        needed for n)
GOSUB 12100
```

When later plotting the equation, the program will automatically request values for the number of constants specified.

For our sample, n=2. So, go ahead and enter

the two lines required. Remember to press <RETURN> again when you finish.

```
TYPE LN#6: CV = 2
TYPE LN#7: GOSUB 12100
TYPE LN#8:
```

2. However, if you have more than four constants or different labels, your entry is a bit more difficult. You specifically instruct the program to request values for each of these constants.

The proper format, two lines for each constant, appears on the screen as follows:

```
   LN#6: PRINT "ENTER VALUE FOR "R" (R
ADIUS):";
      LN#7: INPUT R(S)
```

NOTE

The punctuation must be exactly as shown. Note the semi-colon represses the normal carriage return. This forces the flashing cursor to appear on the same line for entry of the constant named on LN#7.

Also you may NOT use the following constant labels.

```
CART-PLOT:  U(S), V(S), X(S), Y(S)
POLAR-PLOT:  E, I, J, K, M, N, P, T,
                  W, Z
```

See Section 5.4 for more information on variable names.

5.1.5 ENTERING PERMANENT CONSTANTS

Your equation may contain permanent constants, which are in fact not changeable or variable. For example, PI = 3.141596. You can define these and any other factors in the remaining lines. The format for entry of these constants is:

```
Constant Name = Numeric Value
```

Thus, you enter the constant PI as PI = 3.141596 as shown on the following display:

```
ENTER ADDITIONAL CONSTANTS OR FACTORS TO
BE USED IN CALCULATIONS OF THE EQUATION
E.G.:
     LN#8: PI = 3.14159

TYPE LN#8:
     HIT <RETURN> FIRST WHEN FINISHED
```

With these lines you are at the end of creating your equation. After you press the last <RETURN> for entering permanent constants, the program provides for review and edit of your function.

5.1.6 REVIEW AND SAVE THE EQUATION

This display screen asks you to review the file which you have created:

```
PLEASE REVIEW YOUR FILE:

LN#0 A(S)*X + B(S)
LN#2 PRINT"   SIMPLE LINE"
LN#3 PRINT
LN#4 PRINT" Y = A(X) + B"
LN#5 PRINT
LN#6 CV = 2
LN#7 GOSUB 12100

CHANGE A LINE? <N>O -OR- YES, LN#< >
```

Check the display for spelling and syntax errors, number of parentheses and the overall format you wish to create. To change a line, enter the line number.

For example, to change LN#5, in response to CHANGE A LINE?, enter <5>. The program next inserts the command:

TYPE LN#5:

At this point, you have two options:

1. Re-enter the entire line, after the colon. Press <RETURN> when you complete the line.

2. Use Apple editing commands and features to enter your corrections directly onto the display of the equation. Note that you must move the cursor to the position of your first entry and not the LN#n position.

Check your Tutorial or Programming Reference Manual for specific characters and keys for editing as these do vary among the different Apple II versions.

When you are satisfied with your equation file, press <N> and the program saves the file in prepartion for the next step.

5.2 SECOND FILE MAKER OPTION MENU

This second option menu allows six choices:

```
<1>  TEST & EDIT FILE
<2>  ADD TO PLOT PROG. (ONLY)
<3>  SAVE TO DISK (ONLY)
<4>  ADD AND SAVE (BOTH)
<5>  CALCU-PLOT MAIN MENU
<X>  EXIT
 ENTER YOUR OPTION --< >
```

In most instances, the most suitible option is <1> TEST & EDIT FILE. This choice provides you with a chance to try out your equation and record corrections if required.

5.2.1 TEST & EDIT FILE <1>

The FILE TEST program tests your file for errors and operability. In addition, the program demonstrates the composition of the file display which you created. Finally, it allows you to change your display.

To access the TEST & EDIT FILE, enter <1>. If the program finds no errors, for the sample equation, Simple Line, this presentation appears on your monitor:

```
                FILE TEST
   THIS ROUTINE WILL TEST YOUR FILE FOR
MOST ERRORS IN SYNTAX & COMPOSITION.
      HERE IS YOUR DISPLAY:

      SIMPLE LINE

      Y = A(X) + B

ENTER VALUE FOR "A":?
```

The portion below "HERE IS YOUR DISPLAY:" appears when you later select the equation from a Plot Program. It shows the name of your equation and the equation itself. If you had any note lines in your input, these also appear.

In response to the prompt, enter a numeric value for A and press <RETURN>. The program adds this line (if appropriate):

```
ENTER VALUE FOR "B"?
```

Key in your response and press <RETURN>. The program continues to request variable values for as many constants as you specified in

creating the file.

When you complete entering all constant values, the program next asks:

CHANGE A LINE? <N>O or <Y>ES --< >:

Here you can correct programming errors or simply reposition the display of your equation.

If you press <Y>ES, your equation appears again. Follow the guidelines of Section 5.1.6 for changing the lines.

When you edit any lines, the program enters the correction both in computer memory and on disk file and performs its syntax test routine. As long as it finds no errors, the program prompts you: "CHANGE A LINE?"

Upon completing all changes, respond <N>O. The program returns to the display shown at the beginning of this Section 5.2.1 for you to perform a test.

After you enter the constant values and respond <N> to the CHANGE A LINE prompt, you enter a value for X:

NOW FOR A TEST!

INPUT A VALUE OF "X" ?

Enter a value and <RETURN>. The program displays the Y solution of your equation for the entered value of X:

X	Y
5	16

On the lower portion of the display:

```
<1> ANOTHER TEST POINT?
<2> START TEST OVER?
<3> CHANGE A LINE
<4> FILE OK?
      ENTER YOUR OPTION --< >
```

Choosing options results in the following:

OPTION CHOSEN	RESULT
<1>	Program prompts you to enter another value of X.
<2>	Program returns to the point for you to re-enter constant value(s).
<3>	You can re-edit your file as explained in Section 5.1.6.
<4>	You are ready for the next step.

Depending on your equation and level of confidence, perform a number of trials. When you are satisfied that the function solution is operating correctly, choose option <4>.

The FILE MAKER program then saves your file in a special format so that you can add it later to the CALCU-PLOT program. In addition, you may choose to save the file to an 'OTHER' DATA DISK for later recall:

```
YOU WILL BE RETURNED TO THE FILE MAKER
PROGRAM FROM WHICH YOU MAY ADD THE FILE
TO THE HOST PROGRAM.

BUT FIRST!, DO YOU WANT TO ALSO SAVE
THE FILE ON DISK?  <Y>ES OR <N>O...< >
```

If you reply <Y>ES, the program prompts you to enter a file name. For our example, key in

SIMPLE LINE, or another title if you wish, and press <RETURN>. The program returns to the FILE MAKER MENU.

The <N>O response returns to the same menu.

NOTE

If, during the testing process, the program finds an error in your equation entry, it will beep and display an error message. Some commonly occurring problems with possible causes appearing under them are:

CODE	ERROR TYPE
16	Syntax

Missing parenthesis, incorrect punction, etc.

42	Out of Data

Only if used a READ statement and did not supply enough data.

53	* Illegal Quantity

Some equations will cause this error type but are in fact legitimate. The Plot Program will not quit but will declare a zero value.

During the FILE TEST you should verify by a test of a few key values to ensure that the results are correct. The "errors" are usually due to: a log with a zero or negative argument, a square root (SQR) with a negative argument, or raising a negative number to a non-integer power.

69	** Overflow

The value calculated is too large so a * is shown in the tabulation of the value of Y. No value is plotted.

Again, these may be legitimate values and will not stop the program, but check with FILE TEST.

90 Undefined Statement
You may have put in an extra or incorrect GOSUB. The correct one is GOSUB 12100.

133 ** Division by zero
Division by zero. The program reacts to this in the same way as to #69.

* Tabulated and plotted as zero.
** Tabulated as * and not plotted.
(Both may be legitimate conditions!)

To correct the problem (if required), key in <Y>ES in response to the prompt. Proceed with editing as described in Section 5.1.6.

5.2.2 ADD TO PLOT PROG.(ONLY) <2>

A choice of Option <2>, ADD TO PLOT PROGRAM (ONLY) results in the following screen display:

```
THE PRESENT LIST OF OTHER EQUATION IS :
      <1> SIMPLINE
      <2> UNUSED
      <3> UNUSED
      <4> UNUSED
      <5> UNUSED

YOUR EQUATION WILL BE ADDED TO THE
CARTESIAN PLOT PROGRAM
POSITION <2>
WITH SHORT NAME :  SIMLNE 3

      <1> OK?
      <2> CHANGE POS. #?
      <3> CHANGE NAME ?
```

For your choice of option the following results occur:

OPTION	RESULT
<1>	Program adds file to Plot Program Position 2 and returns to the FILE MAKER OPTIONS MENU.
<2>	Program displays screen to change position by entry or replacement with different number.
<3>	Screen for entry of short name (eight characters) appears.

NOTE

After entering changes for options <2> or <3>, the program returns to the ADD TO PLOT PROG.(ONLY) display so that you can add your equation to the program.

5.2.3 SAVE TO DISK (ONLY) <3>

This option <3>, is useful if the plot program, Cartesian or Polar, is full or you do not want to replace any equation on file yet. Or, if you do not have enough time to test and edit your file, Option <3> saves your file to disk for later recall for testing or addition to a Plot Program.

After you enter <3>, the program prompts you for a filename. Key in your chosen name and press <RETURN>. The DOS whirring indicates its saving action. When complete, the FILEMAKER OPTIONS MENU re-appears.

5.2.4 ADD AND SAVE (BOTH) <4>

Useful if you want to save and add your equation to both disk and plot program, Option

<4> first prompts you for a filename.

After you key in your choice, the program presents the same screen as Section 5.2.2, ADD TO PLOT PROGRAM. Follow that procedure and the program returns to the FILE MAKER OPTION MENU.

5.2.5 CALCU-PLOT MAIN MENU <5>

This option <5> returns to the MAIN MENU so that you can plot your new equation.

5.2.6 EXIT <6>

If you choose <6>, you exit from the program.

5.3 OTHER FILE MAKER OPTIONS

The first FILE MAKER OPTION MENU contains four additional options as shown on the following:

```
THIS PROGRAM LETS YOU ADD EQUATIONS TO
THE PLOT PROGRAMS WHERE THEY MAY BE
CHOSEN BY SELECTING THE <O>THER EQUATION
OPTION ON THE EQUATION SELECTION MENU.

        OPTIONS:
    <1> CREATE A FILE
    <2> ADD FILE FROM DISK
    <3> TEST & EDIT DISK FILE
    <4> CALCU-PLOT MAIN MENU
    <X> END
    ENTER YOUR OPTION ---< >
```

In general these correspond to options appearing on the second OPTION MENU under CREATE A FILE. However, there are a few differences, which are described below.

5.3.1 ADD FILE FROM DISK <2>

Option <2>, ADD FILE FROM DISK, adds to, or replaces on, a Plot Program, a different equation. This is the option that provides the ability to store a large number of equations

on an 'OTHER' DATA DISK and then add them to a Plot Program when needed.

The program first prompts you to insert a DATA DISK and enter a drive number (1 or 2) for that disk.

After you do this, the program asks:

```
IS FILE <1> ON DISK?
- OR - <2> FROM TEST?
TYPE WHICH - < >
```

If you choose <1>, the program prompts you:

```
ENTER FILENAME
?
```

Note that this is the full long name under which your equation is stored on disk. Enter the name required and press <RETURN>. The program then searches for the equation. When it locates the equation, you will see the screen display discussed in Section 5.2.2:

```
THE PRESENT LIST OF OTHER EQUATONS IS:

      <1> SIMPLINE
      <2> SIMLINE 2
      <3> UNUSED
      <4> UNUSED
      <5> UNUSED

YOUR EQUATION WILL BE ADDED TO THE
CARTESIAN PLOT PROGRAM
POSITION <2>
WITH SHORT NAME  : SIMLINE 3

      <1> OK?
      <2> CHANGE POS. # ?
      <3> CHANGE NAME ?
```

Refer to Section 5.2.2 for continuing with this option.

Option <2> FROM TEST allows you to add the file most recently tested to a Plot Program. For a choice of <2>, the same display, THE PRESENT LIST OF OTHER EQUATIONS, will appear.

5.3.2 TEST & EDIT DISK FILE <3>

This option <3> allows you to change an equation previously stored on disk and then test your editing. You can store the revised equation with a different filename or with the same one.

After you select <3>, the program requests you to insert a DATA DISK and enter a drive number for that disk. After it verifies that the disk is in the proper location, the program prompts you to enter the filename of the equation to be tested.

Then it searches for the file. Once found, the TEST & EDIT FILE display shown in Section 5.2.1 appears. Refer to that section for further instructions.

5.3.3 CALCU-PLOT MAIN MENU <4>

Option <4> allows you to return to the CALCU-PLOT MAIN MENU. After you enter <4>, the program prompts:

> INSERT CALCU-PLOT DISK AND HIT <RETURN>
> <X> to EXIT

If you are using a one-drive set up, remove the 'OTHER' DATA DISK, replace it with the CALCU-PLOT disk and press <RETURN>. With a two-drive system, simply press <RETURN>.

Option <X> EXIT goes back to the FILE MAKER OPTION MENU.

5.3.4 END <5>

Option <5> END terminates the program as

always.

NOTE

If your equation doesn't operate after you load it to run in a plotting program and you did not save it on a disk, do not lose hope. You may still avoid the task of typing the whole equation again.

If you didn't create another file after the one in question, it is stored on the 'OTHER' DATA DISK under the name OEADD. Go back to the FILE MAKER OPTION MENU and select <3> TEST & EDIT DISK FILE. Then using <1> ON DISK, enter the filename <OEADD>. Correct the errors and proceed as before.

5.4 VARIABLE NAMES

When creating NEW/OTHER EQUATION files, you must use variable names to define numerical values or strings of characters which comply with Applesoft rules. The most important of these appear below.

1) First character must be a letter.
2) Other characters must be alphanumeric.
3) Only the first two characters are significant.
4) You must avoid "reserved" words such as IF, AT, GR, FN, ON, OR, TO, etc.

Variables come in three types:

	TYPE	SYMBOL FOLLOWING NAME
1)	REAL VALUE	NONE
2)	INTEGER	%
3)	STRING	$

Each significant name can have each of these three types. Each type can be defined as an array by adding parentheses which enclose the

subscript(s) of the array for predefined size. For more information, refer to the Applesoft BASIC PROGRAMMING MANUAL.

We suggest that you use simple one character variable names/labels for OTHER equation. If this is not sufficient for your application and you require more, then use two character names.

However, in addition to the above restrictions, there are other names you should avoid since they are already used in the CALCU-PLOT Programs. Table 5-2 lists these names and the program(s) in which they appear.

Although most variable names can be "re-used" without harm, it is better practice to use different ones. In particular, if some variables are shared, the UNCHANGED option may be impacted by your equation file re-defining a parameter vital to this re-cycle function.

BUT WAIT! There are a number of variables in the program which CAN be shared by your functions/files. They define constant values and remain unchanged throughout the program. These "fixed" variables are noted in Table 5-2 by an "F" in the "USE" column. They are also listed in numerical order in Table 5-3. For example, if an expression such as 10*2 appears in the function, you should enter it as V7*V2, to save time and space in the processing/computation process.

TABLE 5-2 VARIABLES USED IN CALCU-PLOT

NAME	USE*	NAME	USE*	NAME	USE*	NAME	USE*	NAME	USE*	NAME	USE*
AB	B	EF	F	LS	C	PS	B	TL$	C	YA	B
AC	B	EI	B	LT	B	PS$	B	TM	B	YF	P
AD	P	EL	B	LV	C	PT	B	TN	B	YH	P
AD$	B	EM	B	LW	C	PT$	B	TN$	B	YL	P
AE	B	EN	B	LX	C	PX	P	TS	B	YP	B
AF$	B	ER	B	LX(	C	PY	B	TX	B	YR	B
AM	B	ES$(	C	LY(	C	-------		TY	B	YT	B
AO	P	ET$(	B	LZ	C	QU$	B	TZ	B	-------	
AQ	B	EV	F	-------		-------		-------		Z	B
AR	P	-------		M	B	R$	F	V1	F		
AR(	P	F$	B	MC	C	RF$	B	V2	F		
AX$	B	FF	B	MD	P	RL	B	V3	F		
A$(	B	FI	P	MD(	C	RL$	B	V4	F		
-------		FX	B	MF$	B	RM	P	V5	F		
BL	B	FY	B	MH	B	RR(	P	V6	F		
BL$	B	-------		MJ	P	RX	P	V7	F		
-------		GL	B	MN$	C	RY	P	V9	PF		
C	C	GN$	B	MS	B			VA	PF		
CI	B	GS	B	MV	B	-------		VB	PF		
CL	B	GT	B	MX	C	S	F	-------			
CM	P	G$	F			SD	C	W	B		
CM$	B			-------		SI	B	W1	B		
CS	P	-------		N	B	SK	B	WC	B		
CV	F	IC	B	N$	P	SL	B	WD	B		
CX	B	ID	B	N$(	C	SM	B	WF	B		
CY	B	ID$	B	NN	B	SM$	B	WI	B		
-------		IE	P	NN$	P	SN	P	WL	B		
D	C	IE$	P	NP	P	SN(	C	WL$	B		
D$	F	IO	P	-------		SN$	B	WT	C		
DB	B	IO$	P	OE	B	SS$	B	-------			
DD	B	IR	B	OE$	B	SR	P	X$	C		
DE	B	IR$	B	O$(	B	SX%	P	XA	B		
DI$	B	IV	B	-------		SY%	P	XF	P		
DL	B	-------		P	F	-------		XH	P		
DM	B	LA	P	PB	B	T1$	B	XL	P		
DP	B	LF	C	PC	P	TA	B	XP	B		
DP$	B	LI	B	PD	B	TC	P	XR	B		
DS	B	LK	C	PI	PF	TE	B	XR$	C		
DV$	B	LL	B	PN	B	TI	B	XT	B		
DY	P	LL$	B	PN$	B	TL	B	XX$	B		

* C = CART PLOT P = POLAR PLOT B = BOTH F = FIXED VALUE

TABLE 5-3 PRE-DEFINED FIXED VALUE VARIABLES

NAME	CART PLOT	POLAR PLOT
EF	1-.1E-8	1-.1E-8
V1	1	1
V2	2	2
PI	-	3.14159
V7	10	10
V5	27	27
V9	-	57.217 (180/PI)
VA	-	100
P	100	100
V3	150	150
V6	152	152
V4	250	-
VB	-	277
NP	-	600
EV	9.9E7	9.9E7

ALSO:	d$ = CHR$ (4)	DOS control
	G$ = CHR$ (7)	Bell (Beep?)
	R$ = CHR$ (13)	RETURN

6.0 EMPIRICAL DATA

With the EMPIRICAL DATA option, you can create a file of real data for plotting. You can plot it alone or with the curve of an equation for a visual camparison of your data against a theoretical function. Your data can originate from the CALCU-PLOT program, another program such as VISICALC or any standard Applesoft sequential file.

The procedure is simple, and the routines flexible. There are only 4 steps.

1. Enter the data to a disk file. Alternatively, you can record your data directly by using the EMPIRICAL DATA option.

2. Select the EMPIRICAL DATA option from either EQUATION MENU or from the MAIN MENU.

3. Enter the filename of your data file.

4. Answer the usual range selection queries.

After entering all the information, you receive a screen plot of all data points within the range of the graph. An individual lower case x represents each data point. To see an example now, turn to Appendix B.

Although you may use a CALCU-PLOT initialized disk, you can save empirical data on any ordinary DOS initialized disk. You can place the data disk in either drive #1 or drive #2 during data file reading and writing. You can change your initial choice of data disk number at any time. Appendix C summarizes additional information on Data Disk use.

6.1 FILE CREATION - CARTESIAN AND POLAR

To create an Empirical Data file on disk, select <5> the EMPIRICAL DATA option from the MAIN MENU. Option <V> from either EQUATION PLOTTING MENU, differs slightly and is discussed in Section 6.2.1

After the EMPIRICAL DATA program is loaded, you see the following menu:

```
                    EMPIRICAL DATA

          THIS PROGRAM LETS YOU ENTER SINGLE
          FUNCTION DATA SETS INTO FILES FOR USE
          BY THE PLOTTING PROGRAMS.

                        OPTIONS:

                <1> CARTESIAN COORDINATES
                <2> POLAR COORDINATES
                <3> EDIT/PRINT DATA FILE
                <4> CALCU-PLOT MAIN MENU
                <X> END
                 ENTER YOUR OPTION --< >
```

To enter data into your file, first select your coordinate system: <1> CARTESIAN or <2> POLAR. Since both systems operate in the same way, with only two differences, this discussion concerns both.

The differences are:

1. Names of Variables - In Cartesian, X is the independant variable and Y the dependant. The Polar system uses T, the angle Theta and R, radius.

2. Number of Points Plotted - As many as 600 data values can be recorded. But for Cartesian coordinates, you may plot only 250 at one time. Your selection for the range of X will determine which part of the data file will appear on your graph.

Polar Plot can plot all 600 points.

For this description, we will refer to X and Y only. Just remember that T and R apply for Polar Plots.

6.1.1 ENTERING DATA

There are three easy steps for getting data into your file:

1. Selection of entry method.
2. Selection of number of decimal places.
3. Actual entry.

You can record data for X by three methods:

1. Auto Increment
2. Keyboard
3. Disk File

For Y, your options are:

1. Keyboard
2. Disk File

NOTE

Auto increment is provided for X since X values must be entered in ascending order. In addition, the interval between its values must be greater than or equal to the range of X selected divided by 250.

Although T values must be entered in ascending order, there is no restriction on the interval size.

After you choose the coordinate system, the program presents this display:

```
SELECT DATA ENTRY MODE FOR
  X VALUES:

     <1> AUTO INCREMENT
     <2> KEYBOARD
     <3> DISK FILE
     <X> EXIT
      ENTER YOUR OPTION --< >
```

Except for <1> AUTO INCREMENT and <X> EXIT, after you record your choice, the program prompts:

```
SELECT DATA SOURCE FOR
  Y VALUES:

     <1> KEYBOARD
     <2> DISK FILE
     <X> EXIT
     ENTER YOUR OPTION --< >
```

NOTES

OPTION <X> EXIT restores the first EMPIRICAL DATA MENU.

Any combination of X and Y data sources is possible.

After you record the source for both X and Y, your next entries are:

```
ENTER NUMBER OF DECIMAL PLACES (0-6)
FOR X VALUES-< >

ENTER NUMBER OF DECIMAL PLACES (0-6)
FOR Y VALUES-< >
```

Press <RETURN> after each entry.

Should you choose fewer places for your variables than stored on your disk file or

specified for AUTO INCREMENT, the program will round off the values when creating your file.

A. AUTO INCREMENT

A choice of Option <1> AUTO INCREMENT results in the following display:

```
ENTER STARTING (SMALLEST) VALUE
OF X:
```

After you key in the starting value and press <RETURN>, this line is added to the screen:

```
ENTER INCREMENT VALUE
FOR X:
```

Either value may contain as many as six decimal places. When your entry is complete, (don't forget <RETURN>), the program requests you to SELECT DATA SOURCE FOR Y VALUES.

B. DISK FILE

Next, if you opted for DISK FILE for either or both X and Y, you are asked, first for X and then for Y, as required by your choices:

```
INSERT DATA DISK & ENTER DRIVE #:(1-2)
     ENTER YOUR OPTION --< >
```

After you specify the drive number, the program requests:

```
ENTER NAME OF X VARIABLE:
?
```

If you forget the filename, press <?> to display the catalog of the Data Disk currently in the drive. The program prompts you again for a filename after it has presented the entire catalog.

Next, after you record the filename and press <RETURN>, the program adds to the display:

ENTER FILE LENGTH --< >

In the event you know the number of records in the file, key in the appropriate number. Otherwise press <?>. Strike <RETURN> in either case; the program will then load your file.

If you had selected DISK FILE for Y, the program then presents the same routine for that variable.

C. KEYBOARD ENTRY

The last step in the entry process is KEYBOARD. For this the program presents the following display:

```
ENTER VALUES:     (<X>EXIT, <B>ACK SET)

    SET NO.       X VALUE      Y VALUE
     /   /       /        /  /     /
        1
```

Note that values already determined by disk file or auto increment are displayed.

Simply key in required values as prompted and press <RETURN>. The program moves the cursor to the next column or adds the next set, if already loaded by AUTO INCREMENT or disk file, for your entry.

NOTES

The slashes (/) under the column headings indicate field widths: three for SET NUMBER and eight each for X and Y VALUES.

Any non-numeric entry results in a value of 0 applied to the entry.

A feature to observe is the program's facility for filling in zeroes and decimal points for incompletely entered values. Thus, if you have

four decimal places and enter <3>, <RETURN>, the resulting display is 3.0000.

You may ask, "What if I enter a wrong number? Can I correct this?" Yes, the program provides a routine - <B>ACKSET. Each time you push <B> the program moves back one set. You can move back as many sets as you require.

When you reach the problem set, enter the correct value(s) and press <RETURN>. If you go back more than one set, you must re-enter the sets backed over. Be sure to see Section 6.2.3 EDIT/PRINT DATA FILE which covers the other editing feature of EMPIRICAL DATA.

After entering all values, press <X>EXIT.

6.1.2 SAVING THE FILE

After you press <X> EXIT, the program prompts you to enter the short name for your curve:

```
      PLEASE ENTER THE CURVE NAME IN
   8 OR LESS ALPHANUMERIC CHARACTERS
          >>>          >>>
```

Press <RETURN> when complete; the next step comes into view:

```
   TO SAVE DATA FILE TO DISK
   OR <X> TO EXIT

   INSERT DATA DISK & ENTER DRIVE #: (1-2)
            ENTER YOUR OPTION --< >
```

After you specify the drive number, the program requests you to enter the FILENAME. This can be any name, beginning with a letter and containing as many as 30 characters.

Be sure to avoid using a duplicate of a name already stored on that disk. To check, enter <?> to view the Catalog of filenames already stored. Key in <X> to return to enter your new

filename.

Again, press <RETURN> when you complete the filename. The program stores the file and then presents the EMPIRICAL DATA OPTION MENU. For the explanation of selections and purpose of this menu, proceed to Section 6.2.

6.2 EMPIRICAL DATA OPTIONS

After you save your file, the EMPIRICAL DATA OPTION MENU appears:

```
YOU MAY NOW CHOOSE FROM THE FOLLOWING:
     <1> RUN PLOT PROGRAM
     <2> ANOTHER DATA FILE
     <3> EDIT/PRINT DATA FILE
     <4> CALCU-PLOT MAIN MENU
     <X> END
     ENTER YOUR OPTION --< >
```

6.2.1 RUN PLOT PROGRAM <1> and EMPIRICAL DATA <V>

The first option, <1> RUN PLOT PROGRAM is a direct route to the plotting program which matches the coordinates just entered. First, you specify a drive number for an 'OTHER' DATA DISK. If you are not using OTHER equations, simply press <RETURN> for thses prompts. This is true even if your empirical data is stored on an 'OTHER' DATA DISK.

Next, the program presents the COORDINATE PLOTTING PROGRAM MENU related to the data just entered. After you choose the number of functions, these selections appear:

```
<1> CREATE NEW FILE
<2> DATA FILE ON DISK
<X> EXIT
ENTER YOUR OPTION:
```

At this point, had you selected <V> EMPIRICAL DATA, the program presents the same display.

The remainder of the discussion covers both options <V> and <1>.

Your entry of option creates the following results.

<1> CREATE NEW FILE returns to the first EMPIRICAL DATA menu:

```
<1> CARTESIAN COORDINATES
<2> POLAR COORDINATES
<3> EDIT/PRINT DATA FILE
<4> CALCU-PLOT MAIN MENU
<X> END
ENTER YOUR OPTION --< >
```

<2> DATA FILE ON DISK allows you to transfer empirical data files to the plotting program. This option will be discussed below.

<X> EXIT moves you to the COORDINATE PLOTTING PROGRAM MENU, for you to enter the number of functions.

Since we covered options <1> and <X> in Sections 6.1 and 2.0 or 3.0 respectively, we will be concerned only with option <2>.

First, the program asks you to :

```
PLEASE SELECT AXIS SCALES & X RANGE
BEFORE RETRIEVING DATA
```

When you have selected these criteria, the program prompts:

```
TO RETRIEVE DATA FILE FROM DISK
INSERT DATA DISK & ENTER DRIVE #: (1-2)
          ENTER YOUR OPTION --< >

OR <X>EXIT
```

Keying in the drive number results in this addition to the screen display:

```
ENTER FILENAME:
?
```

As usual, you can press <?> to see a catalog of the disk files.

After the program loads your file, proceed through the remaining plot program steps for plotting. If you require help, refer to the chapters on CART-PLOT and POLAR-PLOT.

NOTE

Option <U>NCHANGED on the EQUATION MENU is not available for Empirical Data.

6.2.2 ANOTHER DATA FILE <2>

This option returns you to the first EMPIRICAL DATA MENU to enter another file.

6.2.3 EDIT/PRINT DATA FILE <3>

With this selection, you can elect to edit or print the data file in memory. Choosing option <3> results in the following prompt:

```
SELECT <E>DIT OR PRINT TO SLOT#-< >
```

If you press <E>DIT, the program presents a display of the file just entered:

```
 FILENAME: EXPER.DATA
CURVENAME: EX.DATA
   SET NO.     X VALUE     Y VALUE
    /    /    /        /    /        /
        1          -4.0             0
        2          -3.8             0
        3          -3.6             2
        4          -3.4             0
        5          -3.2             0
        6          -3.0             2
        7          -2.8             4
        8          -2.6             1
        9          -2.4             0
       10          -2.2             0
 <N>EXT, E<X>IT, OR EDIT SET #< >
```

The program displays sets in groups of ten. Pressing <N>EXT reveals the next ten sets.

To record a change, key in the set number of the corresponding value. The program prompts you:

```
ENTER NEW X VALUE =>
```

Key in the new variable and <RETURN> and a line to change Y appears.

```
ENTER NEW Y VALUE =>
```

If only one of the variables requires a change, enter <RETURN> over the correct variable. The original value reurns to the top display.

Upon completion of all corrections, push <X>EXIT. The following display is presented.

```
CHANGE CURVENAME? <Y>ES OR *<N>O
          ENTER YOUR OPTION--< >
```

Choosing the option <Y>ES, results in a return

to the screen requesting you to enter a short name for your data file. See Section 6.1.2 for the description of entry required.

For a selection of the default option <N>O, you return to the second screen of that same procedure.

To print your data file, key in the appropriate slot number, turn on the printer and the data is printed in hardcopy.

6.2.4 CALCU-PLOT MAIN MENU <4>

This option presents the MAIN MENU again.

6.2.5 END <X>

As usual <X> END terminates the program.

6.3 OTHER CHOICES - First EMPIRICAL DATA MENU

In addition to choosing coordinate systems, the first EMPIRICAL DATA MENU provides for:

<3> EDIT/PRINT DATA FILE
<4> CALCU-PLOT MAIN MENU
<X> END

Options <4> and <X> result in the usual - a return to the MAIN MENU and a termination of the program respectively.

As you might suppose, <3> EDIT/PRINT DATA FILE is similar to the EDIT/PRINT option presented already in Section 6.2.3. However, there are a few preliminary steps.

First, since the primary feature of this option is to allow you access to EMPIRICAL DATA files already created and saved, the program prompts:

```
TO RETRIEVE DATA FILE FROM DISK
OR <X> TO EXIT

INSERT DATA DISK & ENTER DRIVE #:(1-2)
        ENTER YOUR OPTION --< >
```

After you respond, the program requests:

```
ENTER FILENAME
?
```

Record either the FILENAME or ? to view the catalog. The program loads the file and then presents this prompt:

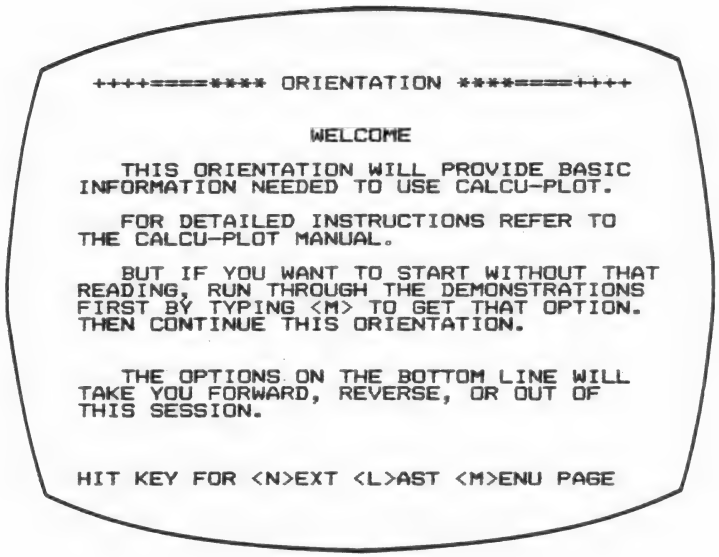
```
SELECT <E>DIT OR PRINT TO SLOT # --< >
```

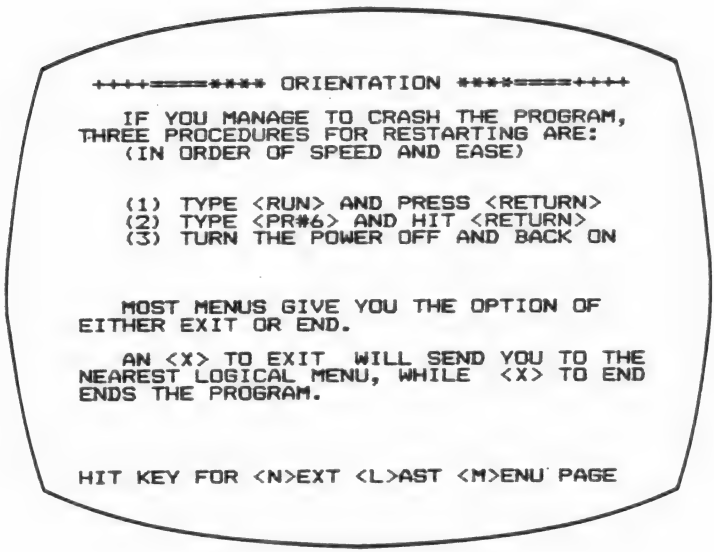
From this point, the program follows the same sequence outlined in Section 6.2.3.

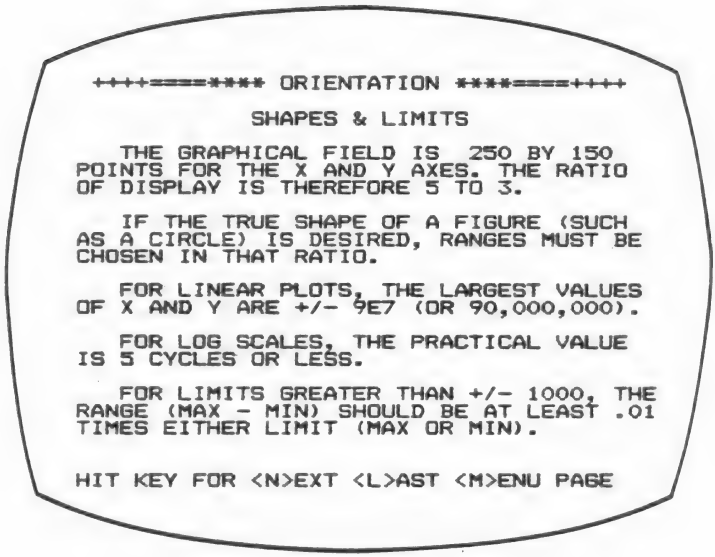
Appendix A

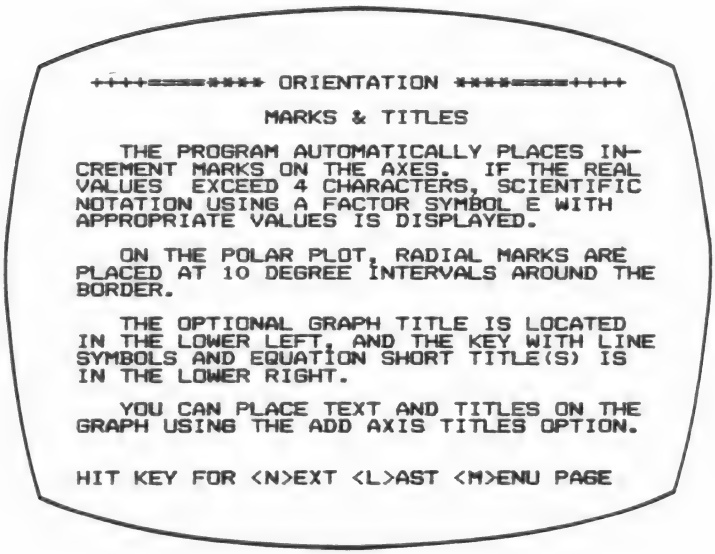
ORIENTATION

This Appendix is a hardcopy of the ORIENTATION, OPTION <2> on THE MAIN MENU.


++++====**** ORIENTATION ****====++++
WELCOME
THIS ORIENTATION WILL PROVIDE BASIC INFORMATION NEEDED TO USE CALCU-PLOT.
FOR DETAILED INSTRUCTIONS REFER TO THE CALCU-PLOT MANUAL.
BUT IF YOU WANT TO START WITHOUT THAT READING, RUN THROUGH THE DEMONSTRATIONS FIRST BY TYPING <M> TO GET THAT OPTION. THEN CONTINUE THIS ORIENTATION.
THE OPTIONS ON THE BOTTOM LINE WILL TAKE YOU FORWARD, REVERSE, OR OUT OF THIS SESSION.
HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE


++++====**** ORIENTATION ****====++++
IF YOU MANAGE TO CRASH THE PROGRAM, THREE PROCEDURES FOR RESTARTING ARE: (IN ORDER OF SPEED AND EASE)
(1) TYPE <RUN> AND PRESS <RETURN>
(2) TYPE <PR#6> AND HIT <RETURN>
(3) TURN THE POWER OFF AND BACK ON
MOST MENUS GIVE YOU THE OPTION OF EITHER EXIT OR END.
AN <X> TO EXIT WILL SEND YOU TO THE NEAREST LOGICAL MENU, WHILE <X> TO END ENDS THE PROGRAM.
HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE


++++====**** ORIENTATION ****====++++
SHAPES & LIMITS
THE GRAPHICAL FIELD IS 250 BY 150 POINTS FOR THE X AND Y AXES. THE RATIO OF DISPLAY IS THEREFORE 5 TO 3.
IF THE TRUE SHAPE OF A FIGURE (SUCH AS A CIRCLE) IS DESIRED, RANGES MUST BE CHOSEN IN THAT RATIO.
FOR LINEAR PLOTS, THE LARGEST VALUES OF X AND Y ARE +/- 9E7 (OR 90,000,000).
FOR LOG SCALES, THE PRACTICAL VALUE IS 5 CYCLES OR LESS.
FOR LIMITS GREATER THAN +/- 1000, THE RANGE (MAX - MIN) SHOULD BE AT LEAST .01 TIMES EITHER LIMIT (MAX OR MIN).
HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE


++++====**** ORIENTATION ****====++++
MARKS & TITLES
THE PROGRAM AUTOMATICALLY PLACES INCREMENT MARKS ON THE AXES. IF THE REAL VALUES EXCEED 4 CHARACTERS, SCIENTIFIC NOTATION USING A FACTOR SYMBOL E WITH APPROPRIATE VALUES IS DISPLAYED.
ON THE POLAR PLOT, RADIAL MARKS ARE PLACED AT 10 DEGREE INTERVALS AROUND THE BORDER.
THE OPTIONAL GRAPH TITLE IS LOCATED IN THE LOWER LEFT, AND THE KEY WITH LINE SYMBOLS AND EQUATION SHORT TITLE(S) IS IN THE LOWER RIGHT.
YOU CAN PLACE TEXT AND TITLES ON THE GRAPH USING THE ADD AXIS TITLES OPTION.
HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE

++++========**** ORIENTATION ****========++++

WHEN THE ORIGIN IS NOT ON THE GRAPH FIELD BECAUSE THE 0 VALUE IS NOT WITHIN THE SELECTED RANGE, YOU WILL NOTICE A GAP AT THE AXIS JUNCTION.

THERE IS A COUNTER DISPLAYED WHICH INCREMENTS WHILE YOU'RE WAITING FOR THE CALCULATIONS. IT IS THE COUNT OF THE 250 POINTS BEING CALCULATED FOR EACH FUNC-TION OF THE GRAPH (UP TO 600 FOR POLAR PLOTS).

IT SHOWS THAT THE PROGRAM IS STILL RUNNING. IF IT STOPS, PRESS <RESET> AND RESTART. HOWEVER, THE MORE COMPLEX THE EQUATION THE SLOWER IT RUNS/COUNTS!

HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE

++++========**** ORIENTATION ****========++++

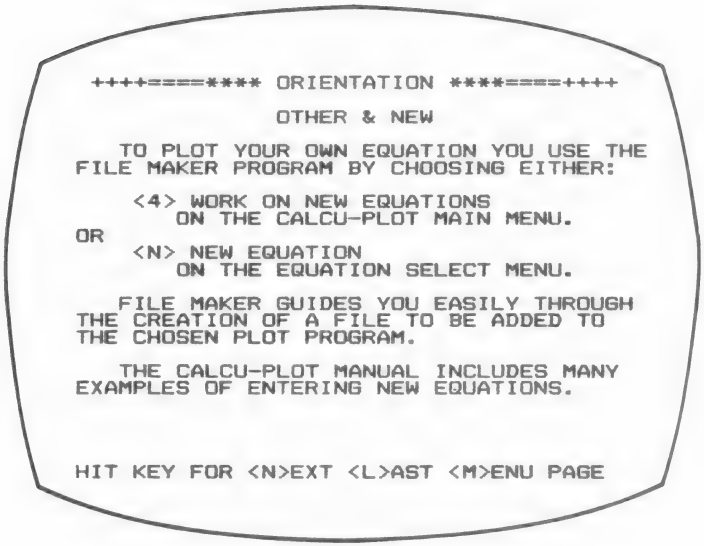
USUALLY 'FUNCTION' AND 'EQUATION' ARE USED INTERCHANGEABLY.

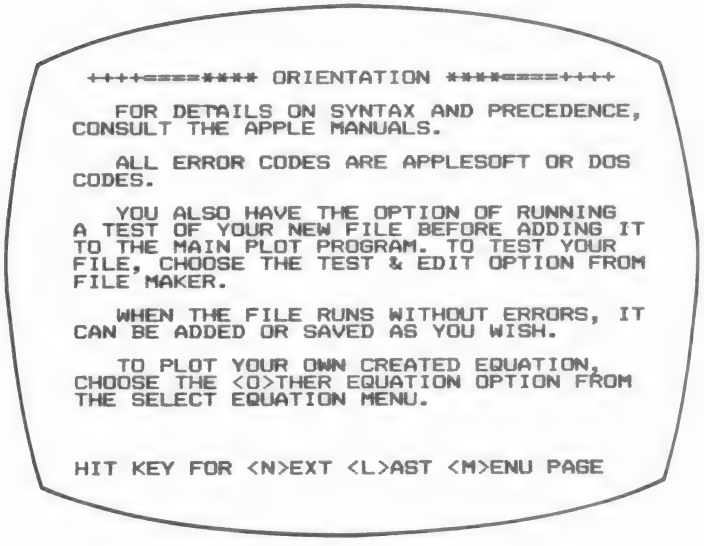
THE EXCEPTION IS WHEN AN EQUATION HAS MORE THAN ONE VALUE OF Y FOR ANY VALUE OF X. USUALLY THIS MEANS THAT FOR Y THERE IS A ROOT OF X.

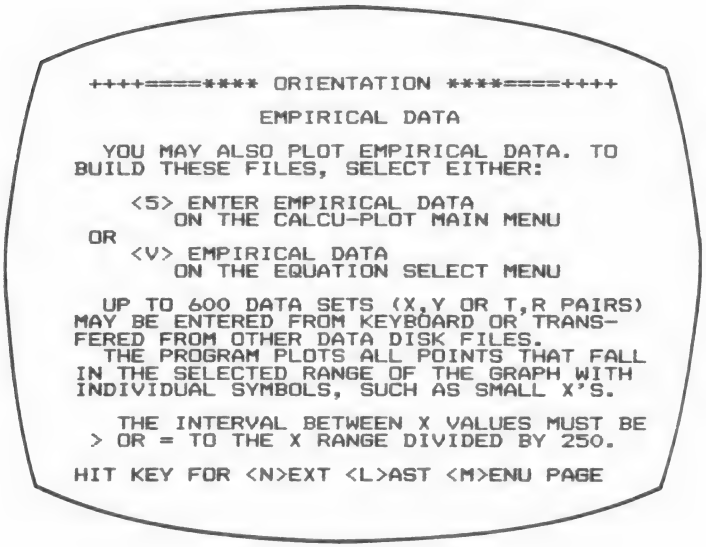
THESE FUNCTIONS CAN BE EXPRESSED AS THE SUM OF TWO EQUATIONS, ONE WITH THE + AND THE OTHER WITH THE - VALUE. THE COMBINED RESULT IS THE 'FUNCTION' BUT PLOTTED AS TWO CURVES (OR EQUATIONS).

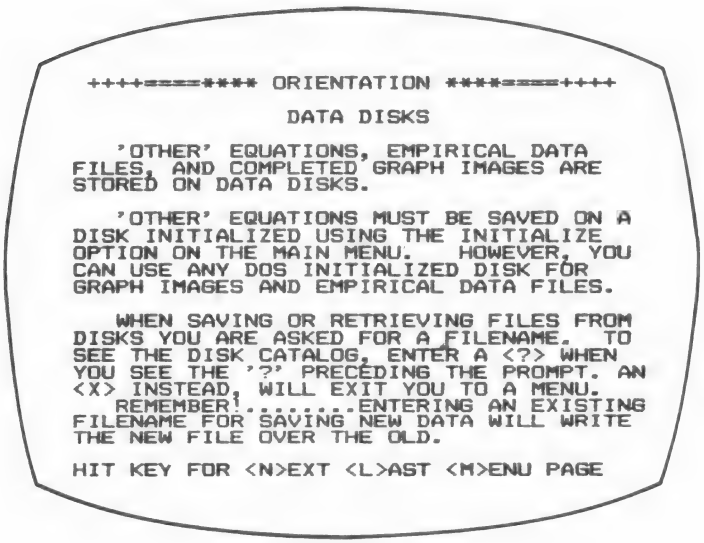
THE EQUATION SELECT MENU DENOTES SUCH FUNCTIONS WITH A '/2' AT THE END OF THE SHORT TITLE.

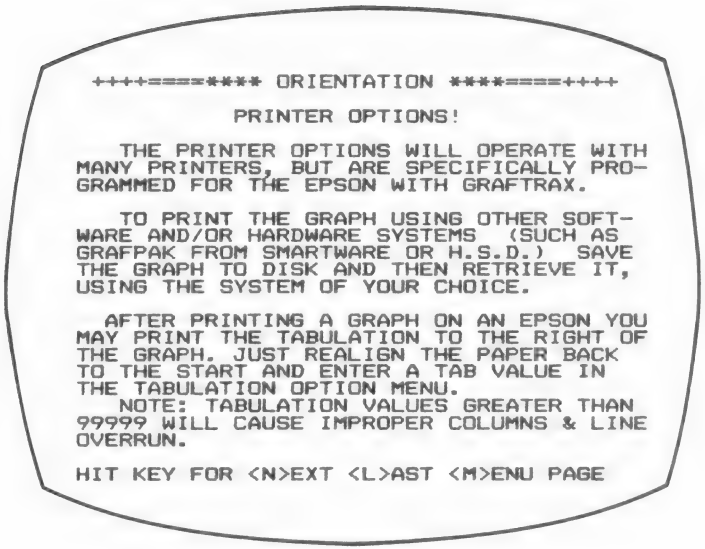
HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE

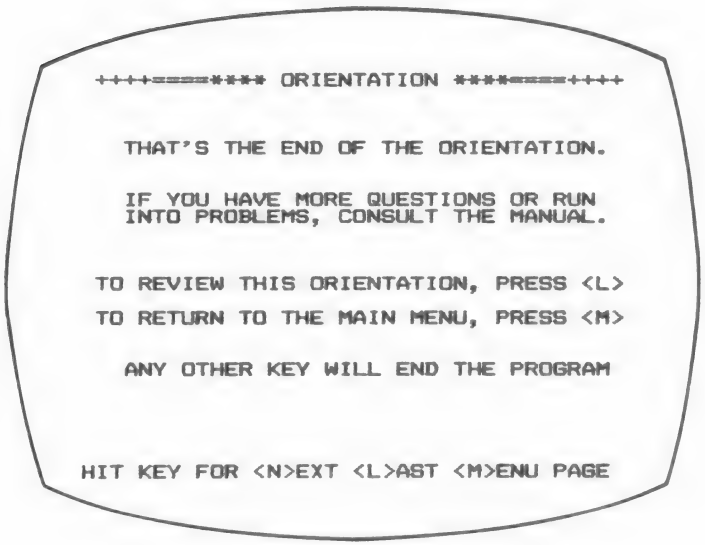

++++====**** ORIENTATION ****====++++
OTHER & NEW
TO PLOT YOUR OWN EQUATION YOU USE THE FILE MAKER PROGRAM BY CHOOSING EITHER:
<4> WORK ON NEW EQUATIONS
ON THE CALCU-PLOT MAIN MENU.
OR
<N> NEW EQUATION
ON THE EQUATION SELECT MENU.
FILE MAKER GUIDES YOU EASILY THROUGH THE CREATION OF A FILE TO BE ADDED TO THE CHOSEN PLOT PROGRAM.
THE CALCU-PLOT MANUAL INCLUDES MANY EXAMPLES OF ENTERING NEW EQUATIONS.
HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE


++++====**** ORIENTATION ****====++++
FOR DETAILS ON SYNTAX AND PRECEDENCE, CONSULT THE APPLE MANUALS.
ALL ERROR CODES ARE APPLESOFT OR DOS CODES.
YOU ALSO HAVE THE OPTION OF RUNNING A TEST OF YOUR NEW FILE BEFORE ADDING IT TO THE MAIN PLOT PROGRAM. TO TEST YOUR FILE, CHOOSE THE TEST & EDIT OPTION FROM FILE MAKER.
WHEN THE FILE RUNS WITHOUT ERRORS, IT CAN BE ADDED OR SAVED AS YOU WISH.
TO PLOT YOUR OWN CREATED EQUATION, CHOOSE THE <O>THER EQUATION OPTION FROM THE SELECT EQUATION MENU.
HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE


++++====**** ORIENTATION ****====++++
EMPIRICAL DATA
YOU MAY ALSO PLOT EMPIRICAL DATA. TO BUILD THESE FILES, SELECT EITHER:
<5> ENTER EMPIRICAL DATA ON THE CALCU-PLOT MAIN MENU
OR
<V> EMPIRICAL DATA ON THE EQUATION SELECT MENU
UP TO 600 DATA SETS (X,Y OR T,R PAIRS) MAY BE ENTERED FROM KEYBOARD OR TRANS-FERED FROM OTHER DATA DISK FILES. THE PROGRAM PLOTS ALL POINTS THAT FALL IN THE SELECTED RANGE OF THE GRAPH WITH INDIVIDUAL SYMBOLS, SUCH AS SMALL X'S.
THE INTERVAL BETWEEN X VALUES MUST BE > OR = TO THE X RANGE DIVIDED BY 250.
HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE


++++====**** ORIENTATION ****====++++
DATA DISKS
'OTHER' EQUATIONS, EMPIRICAL DATA FILES, AND COMPLETED GRAPH IMAGES ARE STORED ON DATA DISKS.
'OTHER' EQUATIONS MUST BE SAVED ON A DISK INITIALIZED USING THE INITIALIZE OPTION ON THE MAIN MENU. HOWEVER, YOU CAN USE ANY DOS INITIALIZED DISK FOR GRAPH IMAGES AND EMPIRICAL DATA FILES.
WHEN SAVING OR RETRIEVING FILES FROM DISKS YOU ARE ASKED FOR A FILENAME. TO SEE THE DISK CATALOG, ENTER A <?> WHEN YOU SEE THE '?' PRECEDING THE PROMPT. AN <X> INSTEAD, WILL EXIT YOU TO A MENU.
REMEMBER!.....ENTERING AN EXISTING FILENAME FOR SAVING NEW DATA WILL WRITE THE NEW FILE OVER THE OLD.
HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE


++++====**** ORIENTATION ****====++++
PRINTER OPTIONS!
THE PRINTER OPTIONS WILL OPERATE WITH MANY PRINTERS, BUT ARE SPECIFICALLY PRO-GRAMMED FOR THE EPSON WITH GRAFTRAX.
TO PRINT THE GRAPH USING OTHER SOFT-WARE AND/OR HARDWARE SYSTEMS (SUCH AS GRAFPAK FROM SMARTWARE OR H.S.D.) SAVE THE GRAPH TO DISK AND THEN RETRIEVE IT, USING THE SYSTEM OF YOUR CHOICE.
AFTER PRINTING A GRAPH ON AN EPSON YOU MAY PRINT THE TABULATION TO THE RIGHT OF THE GRAPH. JUST REALIGN THE PAPER BACK TO THE START AND ENTER A TAB VALUE IN THE TABULATION OPTION MENU.
NOTE: TABULATION VALUES GREATER THAN 99999 WILL CAUSE IMPROPER COLUMNS & LINE OVERRUN.
HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE


++++====**** ORIENTATION ****====++++
THAT'S THE END OF THE ORIENTATION.
IF YOU HAVE MORE QUESTIONS OR RUN INTO PROBLEMS, CONSULT THE MANUAL.
TO REVIEW THIS ORIENTATION, PRESS <L>
TO RETURN TO THE MAIN MENU, PRESS <M>
ANY OTHER KEY WILL END THE PROGRAM
HIT KEY FOR <N>EXT <L>AST <M>ENU PAGE

Appendix B EXAMPLES

CONTENTS

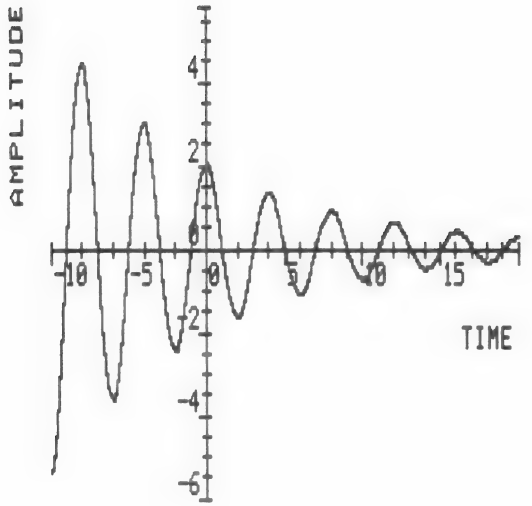
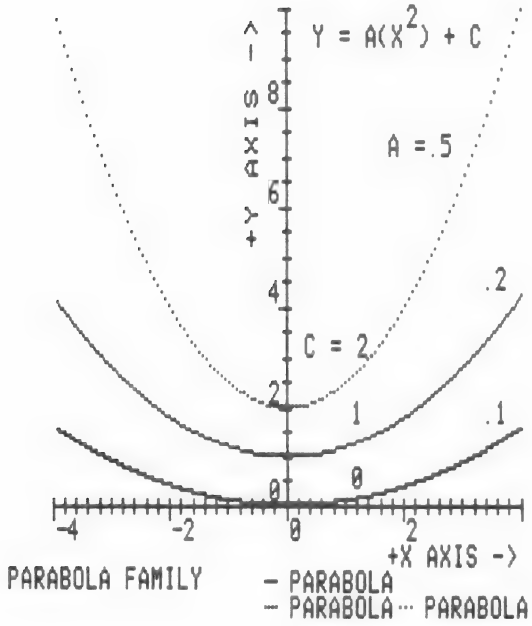
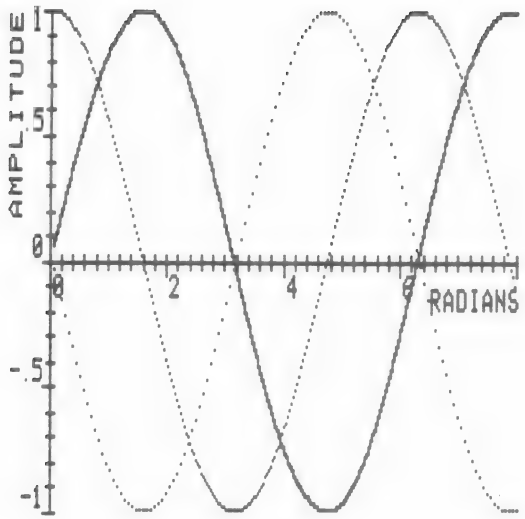


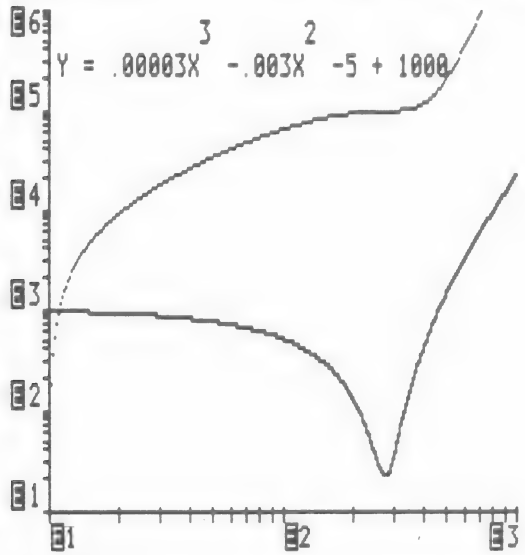
FIG.1 DEMO - DMPDOSC1





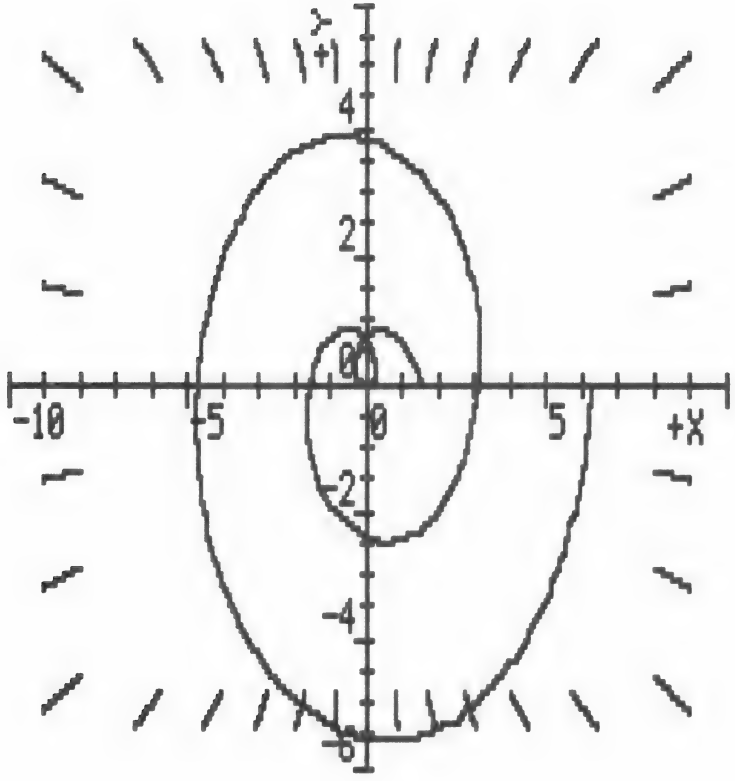
SINE AND DERIVITIVES

- SINE
- 1ST DER ··· 2ND DER



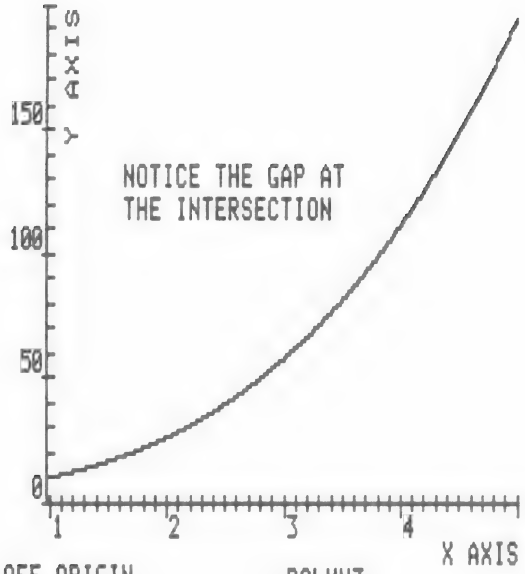
LOG-LOG PLOT

- POLYN3
- INTEGRAL

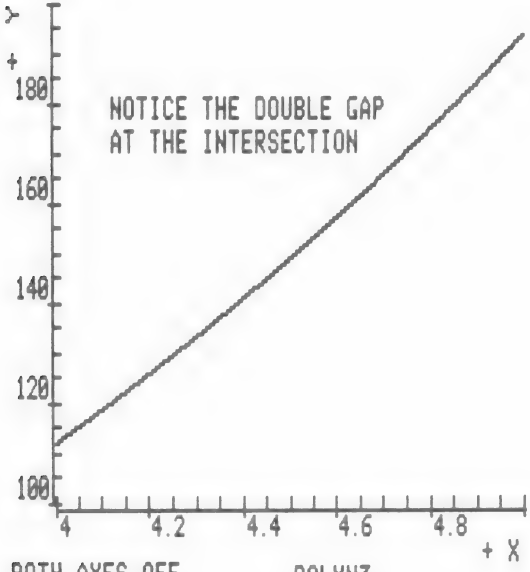


POLAR PLOT DEMO

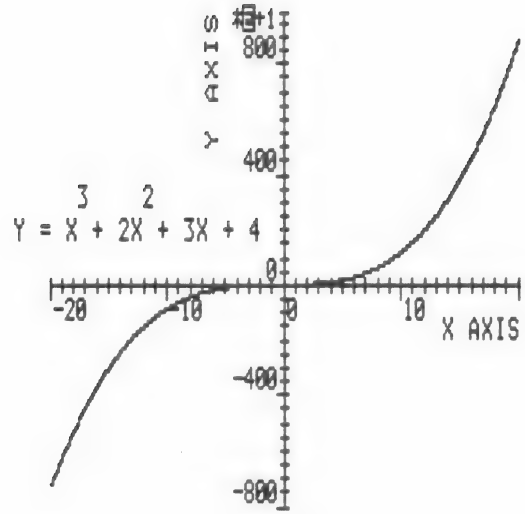
- ARCHISPL



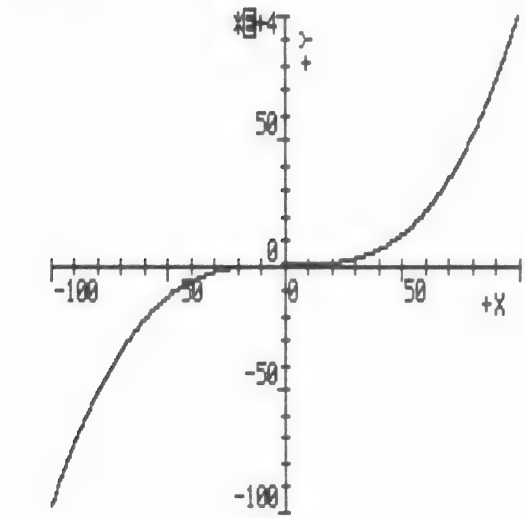
OFF ORIGIN EXAMPLE — POLYN3



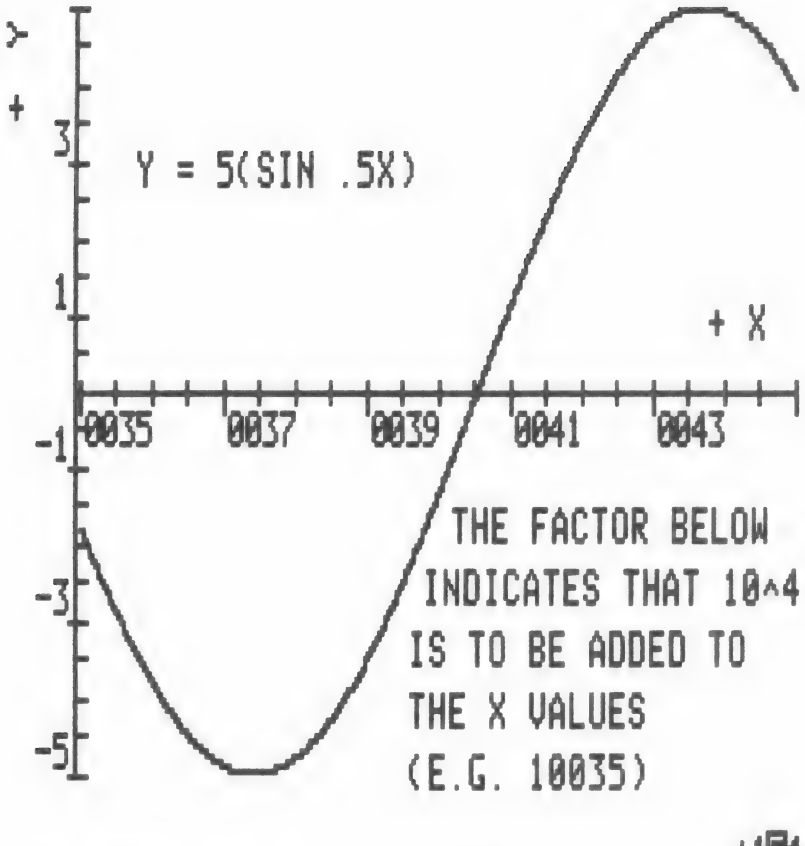
BOTH AXES OFF ORIGIN EXAMPLE — POLYN3



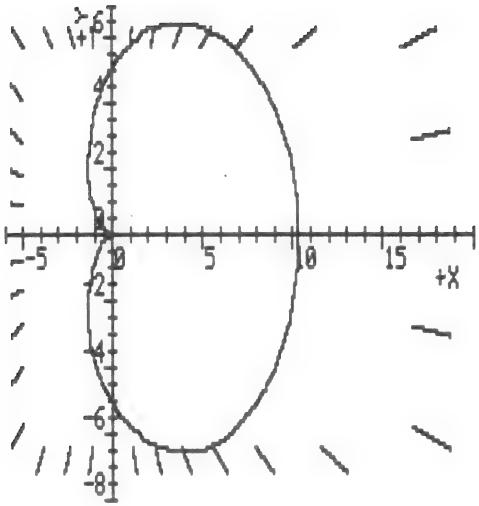
RANGE VALUE EXAMPLE - POLYN3



A 2ND RANGE VALUE EXAMPLE - POLYN3

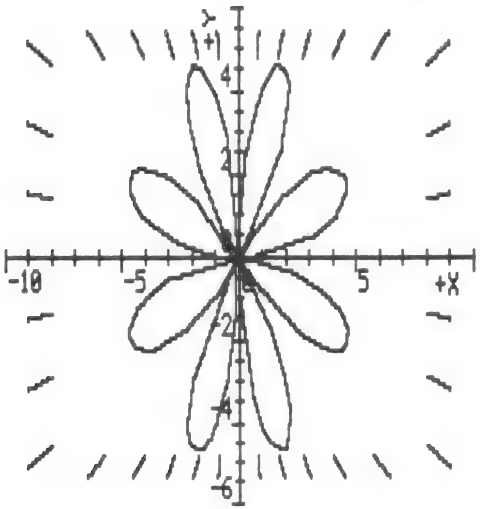


3RD RANGE VALUE — SINE
EXAMPLE



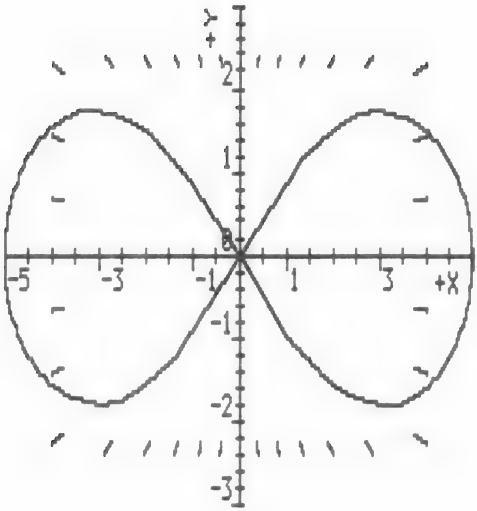
CARDIOD

– LIMACON



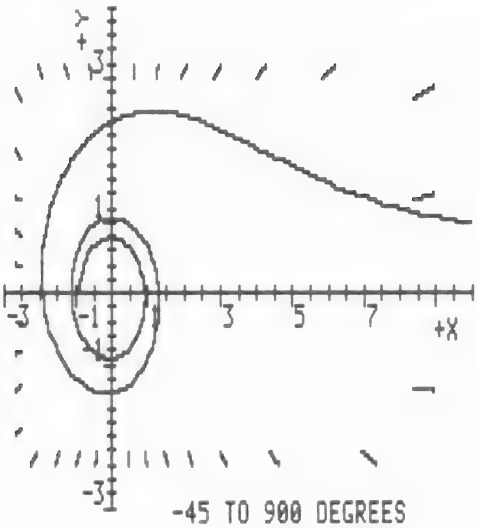
8 PETALS

– PETALS



LEMNISCATE
(A = 5)

- LEMNISCT



-45 TO 900 DEGREES

LITUUS

- LITUUS

EXAMPLE OF "OTHER" EQUATION CREATION

The following example of creating a NEW equation using FILE MAKER shows some additional features and techniques which may simplify the process. The problem assumed is the creation of a BODE plot of a second-order transfer function amplitude response. This type of equation is found in control theory filter problems. Consider the function:

$$A(s) = \frac{f_n^2}{s^2 + dw_n s + w_n^2}$$

Where: w_n = natural frequency
d = damping factor
s = jw (the imaginary part of the complex variable s)
f_n = normal frequency = w/w_n

With the above substitutions gives:

$$A(jf_n) = \frac{1}{(1 - f_n^2) + j2df_n}$$

Solving for the absolute value of A gives:

$$A(f_n) = 1/ ((1 - f_n^2)^2 + (2df_n)^2)^{1/2}$$

The constants used by FILE MAKER are as follows:

$$Y = A(f_n)$$
$$X = f_n$$
$$D(S) = d$$

After selecting Option <4> on the MAIN MENU and <1> CREATE A FILE on the FILE MAKER MENU, choose CARTESIAN PLOT. Next, record the location (1 to 5) on the list for the new function and a short name of eight or fewer characters.

You are now set to enter the equation. We assume here that you have already entered at least one equation by the FILE MAKER program. Therefore, the following discussion will not cover all aspects but will simply point out additional methods used.

FIRST SCREEN

FILE MAKER

ENTER THE RIGHT SIDE OF YOUR EQUATION :

E.G.: Y = A(S)*X^2 + B(S)*X + C(S)

! CAUTION ! USE PROPER SYNTAX AND PRECENDENCE. (SEE THE MANUALS)

Y = LK*LOG(1/SQR((1-X^2)^2+(2*D(S)*X)
2))

This display is shown after the equation has been entered.

In this example, we care only about positive values of Y so the equation is not a double valued one and requires only one entry.

Note that LK*LOG converts the amplitude value from a voltage to a voltage ratio in dB. We will define LK as a constant equal to 20 divided by LOG 10. LOG is the natural log function. Thus, LK = (20/LOG)*LOG provides the factor for the LOG function to the base ten for an amplitude function (as opposed to a power function).

SECOND SCREEN

FILE MAKER

ENTER THE RIGHT SIDE OF YOUR EQUATION :

E.G.: Y = A(S)*X^2 + B(S)*X +C(S)

! CAUTION ! USE PROPER SYNTAX AND PRECEDENCE. (SEE THE MANUALS)

```
Y = LK*LOG(1/SQR((1-X^2)^2+(2*D(S)*X)
2))
```

ENTER THE FULL EQUATION TITLE:

E.G.:

```
LN#2: PRINT"SECOND ORDER POLYNOMIAL"
```

```
TYPE LN #2: ?"     AMPLITUDE RESPONSE"
```

There is nothing unusual about the entry of the name for later display. You may recall that you can use ? for PRINT and that the spaces before the name will center the title.

THIRD SCREEN

```
                    FILE MAKER

     ENTER LINES TO DISPLAY AND EXPLAIN THE
     EQUATION IN FORM DESIRED: - - E.G.:

          LN#3: PRINT"           2"
          LN#4: PRINT"    Y = A(X) + B(X) + C"

          LN#5: PRINT" WHERE 'C' IS A CONSTANT
      Y OFFSET"

     TYPE LN#3: ?
     TYPE LN#4: ?"                    1"
     TYPE LN#5: ?"  AR = --------------------
     --"
     TYPE LN#6: ?"                      2 2
     2"
     TYPE LN#7: ?"          SQROOT((1-X ) +(2DX)
      )"
     TYPE LN#8: ?
     TYPE LN#9:

     HIT <RETURN> FIRST WHEN FINISHED
```

For this equation display, we have selected AR to represent amplitude response. The use of the dotted line to indicate division is more easily seen than a simple slash.

FOURTH SCREEN

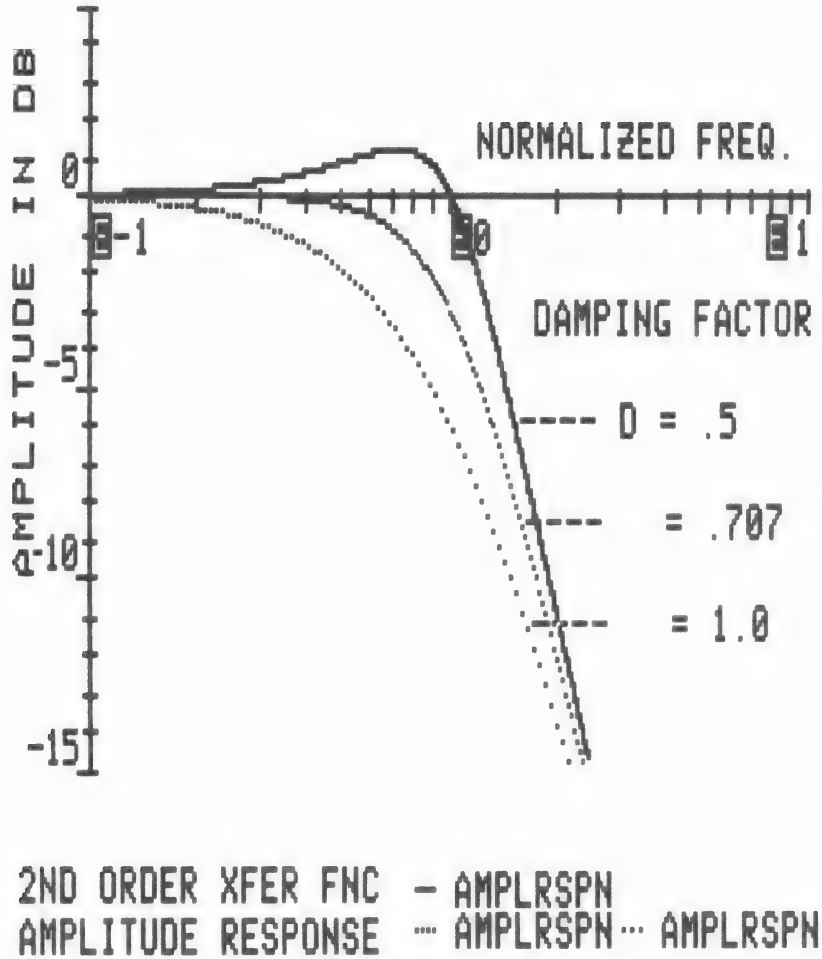
FILEMAKER

```
LN#9: PRINT "ENTER VALUE FOR 'R' (R
ADIUS) ";
LN#10: INPUT R(S)

TYPE LN#9: ?"ENTER VALUE FOR DAMPING FAC
TOR 'D' ";
TYPE LN#10: INPUT D(S)
TYPE LN#11:

ENTER ADITIONAL CONSTANTS OR FACTORS TO
BE USED IN CALCULATIONS OF THE EQUATION
E.G.:
     LN#11: PI = 3.14159

TYPE LN#11: LK = 20/LOG(10)
TYPE LN#12:

HIT <RETURN> FIRST WHEN FINISHED
```

Since our constant D, the DAMPING FACTOR, is more understandable expressed in those terms, we have chosen the alternate method of requesting entry of constants.

In addition, LN#11 defines the constant LK.

After listing, editing, saving, plotting, adding titles and printing, the equation result is:



OTHER EXAMPLE - SQUARE WAVE

This example of an OTHER Equation demonstrates some more variations in FILE MAKER entry. The function to be graphed is a general square wave.

Below is a printout of the function as it appears in the FILE MAKER or FILE TEST displays. Note the exception of the three most significant figures (on the left) of the line numbers.

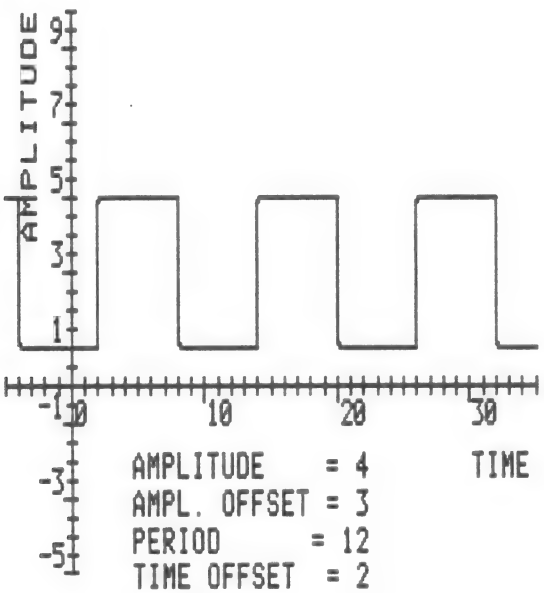
```
12200  DEF  FN A(X) = A(S) + F *
     (X > =  L + G *  INT ((X - L
     ) / G) AND X < L + H + G *  INT
     ((X - L) / G)) - F * (X > =
     L + H + G *  INT ((X - L) /
     G) AND X < L + G + G *  INT
     ((X - L) / G))
12202  PRINT "    SQUARE WAVE"
12203  PRINT
12204  PRINT "WHERE  A = Y OFFSET
     "
12205  PRINT "       B = AMPLITUD
     E"
12206  PRINT "       C = PERIOD (
     MUST BE > 0)"
12207  PRINT "       D = X OFFSET
     "
12208  PRINT
12209 CV = 4
12210  GOSUB 12100
12211 F = B(S) / 2
12212 G = C(S)
12213 H = G / 2
12214 L = D(S)
12215  RETURN
```

The key points are the use of the fixed constant lines to simplify the equation line and speed up the calculation process, and the use of "assertion" statements in the equation line.

NOTE

If you wish to display your own files, simply boot your 'OTHER' Data Disk. Then, enter <LOAD>, <CPP3> for CART-PLOT or <PPP3> for POLAR-PLOT and then <RETURN>. After then keying <LIST> and <RETURN>, you will see your file listed between 12x00 and 12xzz. X is one more than the file's position in your PRESENT LIST OF OTHER EQUATIONS and zz is one more than the number of the line used in FILE MAKER.

Here is the resulting graph with values used as shown.



SQUARE WAVE - SQRWAVE

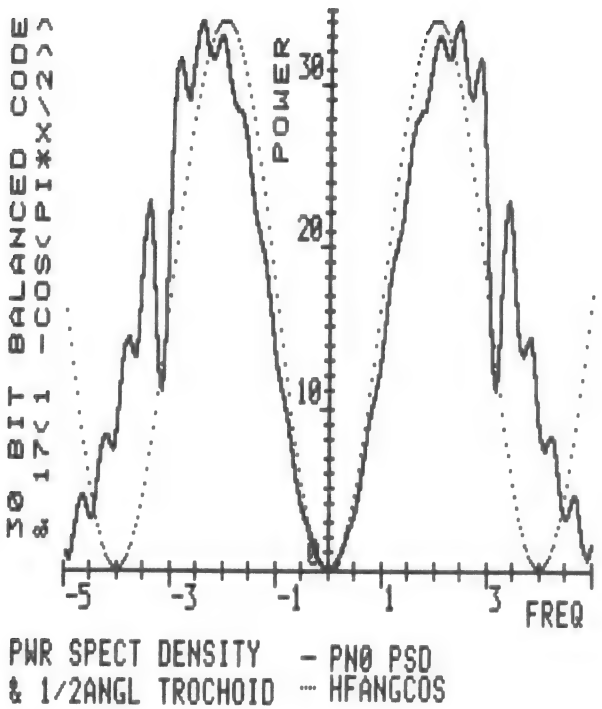
COMPLEX EQUATION EXAMPLE

Another example of an OTHER Equation is given below for a fairly complex function. The equation represents the power spectral density of a 15 bit pseudo noise (PN) code interleaved with an inverted replica. The result is a 30 bit balanced PN code useful as a synchronization code in communication systems.

The function was created with the FILE MAKER Program, tested with FILE TEST, and added to the CART-PLOT Program. A listing of the file is shown below:

```
  DEF  FN A(X) = (Z1 * (( SIN
(X / Z2)) ^ Z2) / X ^ Z2) -
(Z4 *  SIN (Z2 * X) / X) + (
Z9 * ( COS (Z2 * X) -  COS (
X)) / X ^ Z2) + (Z4 * ( SIN
(X * Z5) +  SIN (X * Z7)) /
X) + (Z8 * ( COS (X * Z5) -
 COS (X * Z7)) / X ^ Z2) + (
Z4 *  COS (X * Z8) *  SIN (X
 * Z6) /  SIN (X)) * ((Z4 *
(( SIN (X / Z2)) ^ Z2) / X ^
Z2) -  SIN (X) / X)
  PRINT "POWER SPECTRAL DENS
ITY"
  PRINT
  PRINT "A 15 BIT CODE INTER
LEAVED WITH AN INVERT-TED RE
PLICA"
  PRINT "A 30 BIT BALANCED C
ODE"
  PRINT
  PRINT "NO INPUTS REQUIRED"

Z1 = 176
Z2 = 2
Z4 = 4
Z5 = 15
Z6 = 6
Z7 = 14
Z8 = 8
```

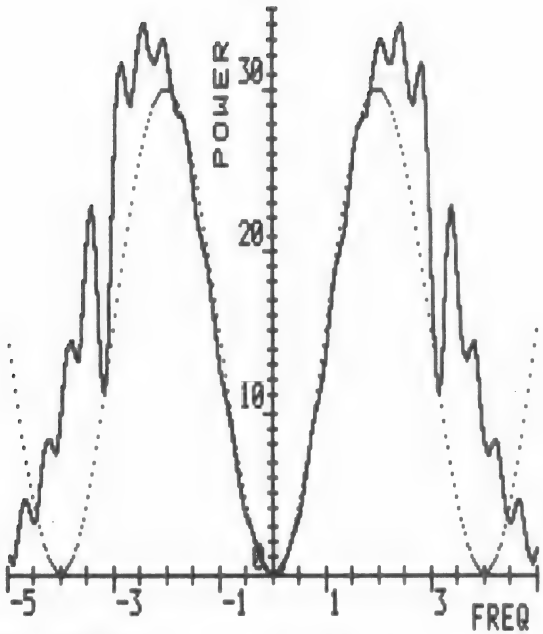
```
Z9 = 24
 FOR ZQ = 1 to 2000
 NEXT
 RETURN
```



Here is the graph of the equation plotted with a 1/2 angle Cosine function with peak to peak amplitde of 34. The tabulation below is an example of the summary tabulation option (every tenth point).

TABULATION SUMMARY

X	PNO PSD	HFANGCOS
-5	1.595	16.999
-4.6	4.095	7.007
-4.2	8.28	.832
-3.8	14.363	.832
-3.4	22.678	7.008
-3	22.198	17
-2.6	30.127	26.993
-2.2	31.67	33.168
-1.8	28.672	33.168
-1.4	21.91	26.992
-1	13.269	17
-.6	5.346	7.008
-.2	.628	.832
.2	.628	.832
.6	5.346	7.008
1	13.269	17
1.4	21.91	26.992
1.8	28.672	33.168
2.2	31.67	33.168
2.6	30.127	26.993
3	22.198	17
3.4	22.678	7.008
3.8	14.363	.832
4.2	8.28	.832
4.6	4.095	7.007
5	1.595	16.999



Another plot of the function is shown with a half angle Cosine function of 15(1 - COS (PI * x/2)) and shows a better match to the PN power Spectral Density out to about 2 radians. The tabulation at the right is a part of the complete set of points plotted.

PARTIAL SUMMARY - COMPLETE SET

X	PNO PSD	HFANGCOS
-5	1.595	15
-4.96	1.013	14.058
-4.92	.678	13.12
-4.88	.76	12.189
-4.84	1.293	11.269
-4.8	2.164	10.364
-4.76	3.144	9.478
-4.72	3.97	8.613
-4.68	4.434	7.773
-4.64	4.451	6.962
-4.6	4.095	6.183
-4.56	3.576	5.438
-4.52	3.169	4.731
-4.48	3.121	4.065
-4.44	3.568	3.442
-4.4	4.482	2.864
-4.36	5.682	2.335
-4.32	6.888	1.855
-4.28	7.82	1.427
-4.24	8.291	1.053

EMPIRICAL DATA EXAMPLE

Since empirical data combined graphically with a theoretical curve can be a powerful analytic tool, we have included the creation of such a graph here.

The example chosen is the comparison of the normal distribution curve with a set of measured data. The test data represent the distribution of a certain dimension of a machined part. Let the specified dimension be D and the difference between that value (0 reference) and the actual measured value be the deviation.

We wish to compare the measured distribution against the normal distribution to identify variations in the machine process. Assume a standard deviation value has been established from known tolerance variations, and that the measured values of deviation have been normalized to that quantity.

The Y axis of the normal distribution curve represents the probability density or percentage of units from the sample population which fall into each of the deviation intervals selected for the test criteria.

To plot, from the MAIN MENU, select <5> ENTER EMPIRICAL DATA. When the program is loaded and the first menu displayed, choose <1> CARTESIAN COORDINATES.

Next, since the intervals of deviation are constant, select <1> AUTO for the data entry mode for the X values. Enter <-4> for the starting value of X, and <.2> for the increment value. Select <1> KEYBOARD for the data source of the Y values.

For the number of decimal places we chose 1 for the X values and 0 for the Y values. (If your data dictates other precision, choose

values which satisfy the resolution desired.)

Now enter the values of Y, the quantity or percentage of units whose measured dimension lies in the range of each of the deviation cells. The values used in the example appear on this table, columns read top to bottom, then left to right:

Y VALUES

0	2	2	22	37	30	3	1	0
0	4	6	25	39	25	5	3	
2	1	8	32	42	15	5	0	
0	0	13	35	40	9	3	1	
0	0	21	37	36	4	0	0	

After you enter the last value (0 for X = 4.0), press <X>. Next, enter a descriptive short name for the data symbol identifier in the lower right hand corner of the final graph. (The example uses EX.DATA.) Save the file on any DATA DISK with a filename such as EXPER.DATA.

Next, from the OPTION MENU on the screen, choose option <1> RUN PLOT PROGRAM. Of course, you can review, edit, or print the tabulated file before plotting. See Section 6.0 EMPIRICAL DATA for these other options.

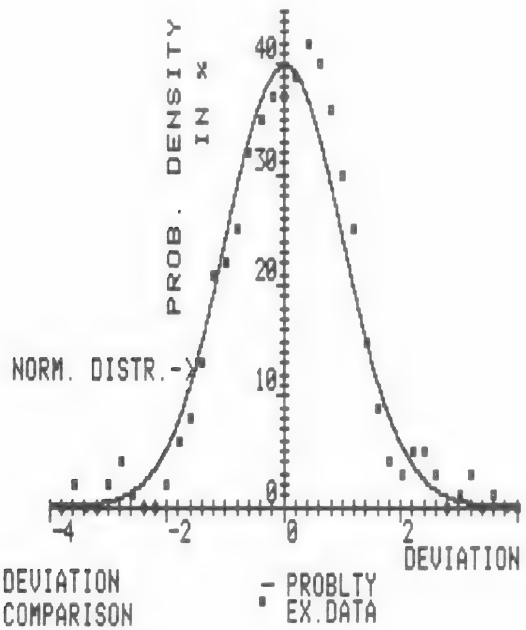
When the Plotting Program is fully loaded, CARTESIAN COORDINATE PLOTING PROGRAM MENU appears. Select <2> TWO FUNCTIONS, and then <7> FUNCTIONS ONLY.

At the FIRST EQUATION MENU, select <I> PROBLTY and enter a value of <100> for the constant A. Choose linear X and Y axes and enter <-4> and <4> for the left and right X limits, then wait patiently for the calculation of the functions.

From the SECOND EQUATION MENU, select <V> EMPIRICAL DATA option and option <2> DATA FILE

ON DISK. Enter the proper drive number and the filename (EXPER.DATA for this example) to retrieve the values of the experimental data file. When finished, the program asks for the Y limits. For the example, key in <45> and <0> for the top and bottom limits. Enter the graph name, such as DEVIATION COMPARISON.

Then watch the graph unfold before your eyes. With the addition of a few axis titles and note, the finished product should look like the graph below:



The graph illustrates a skew and offset of the distribution of the measured values in relation to the standard curve. It indicates a need to adjust the machining process and a re-evaluation of the contributors to the various errors.

VISICALC DATA PLOTTING EXAMPLE

You can easily transfer empirical data from VISICALC spread sheets into CALCU-PLOT compatible files by using the sequences described in this example. The spread sheet used is a tabulation of wind chill temperatures for various wind velocities as shown below:

WIND CHILL FACTOR TABLE

VEL MPH	0	5	10	15	20	25	30	35	40
TEMP 'F									
	0	-5	-22	-31	-39	-44	-49	-52	-53
	5	0	-16	-24	-32	-37	-41	-44	-45
	10	6	-9	-18	-24	-29	-33	-36	-37
	15	11	-3	-11	-17	-22	-25	-28	-29
	20	16	3	-4	-10	-14	-18	-20	-21
	25	21	9	3	-3	-7	-10	-12	-13
	30	27	16	9	5	1	-2	-4	-5
	35	32	22	16	12	8	6	4	3
	40	37	28	23	19	15	14	12	11
	45	43	35	29	27	23	22	20	19
	50	48	41	36	34	30	30	28	27
	55	53	47	43	41	38	37	36	35
	60	58	53	50	48	45	45	44	43
	65	64	60	56	56	53	53	52	51
	70	69	66	63	63	60	61	60	59
	75	74	72	70	70	67	69	68	67

The plot will display sets of wind chill temperature points for three wind velocities, 10, 20 and 40 MPH. With the example spread sheet displayed on the screen, the following steps apply to the VISICALC program.

To use VISICALC files with CALCU-PLOT, you must create Print Format Files (/PF command). This command saves your worksheet to a disk file, a standard Apple DOS file, which can be used by the program.

There are two points to note before you create your file:

The new file must contain only data. Headings, formulas, column width information cannot be converted.

Files must be created separately on a row by row or column by column basis.

To create files for use by CALCU-PLOT, you need only follow a few simple steps:

1. With a data diskette in your drive, access the VISICALC Worksheet to be converted.

2. Move the cursor to the uppermost data point (of a column) or leftmost data point (of a row) of the file to be converted.

3. Key in /P. The system will respond PRINT: FILE, PRINTER, #(OF SLOT).

4. Key in F. System response is PRINT: FILENAME.

5. Then key in the name of the file being created. Use any descriptive name of not more than 30 characters.

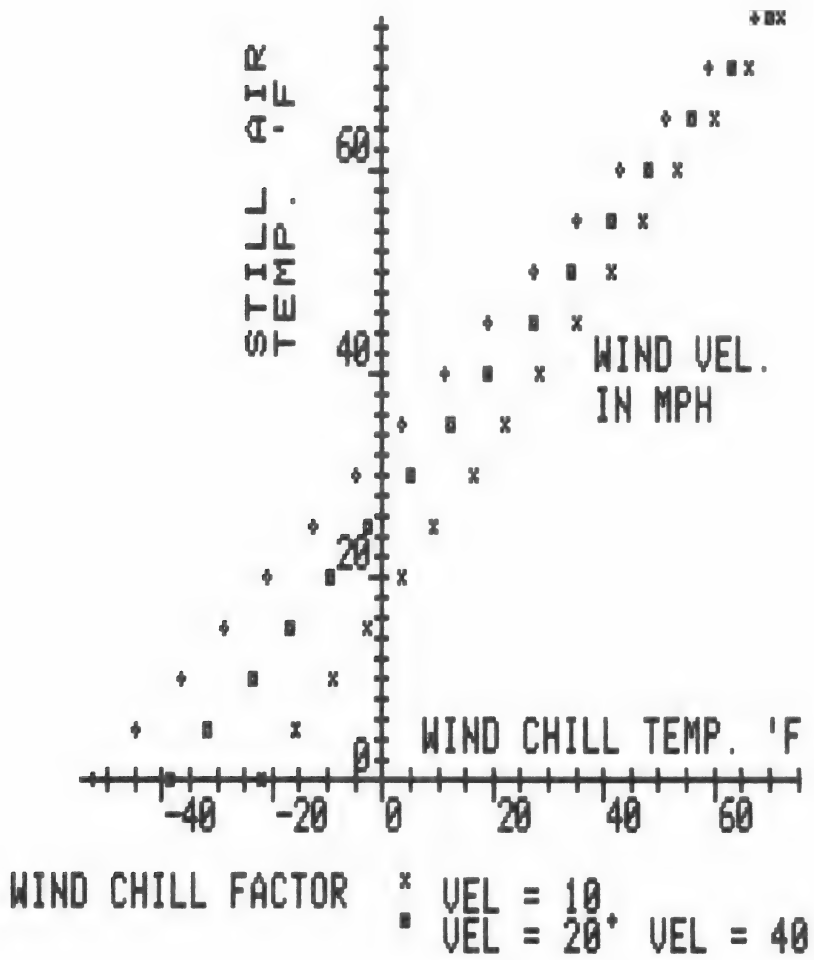
6. Depress RETURN.

7. Move the cursor to the lowermost (column) or rightmost (row) data point and press RETURN. The system will save the worksheet column or row in a format accessible to the HSD programs.

After creating data files in this way, you are ready to use them in the EMPIRICAL DATA program. For this example, we transferred VELOCITY COLUMNS 0, 10, 20 and 40 MPH. VEL 0

became the Y variable, the others X variables for creating the three disk files required for plotting the three functions. See Section 6 for the specific steps to follow.

The resultant graph appears below:



Appendix C DATA DISK USE

C.1 INTRODUCTION

For CALCU-PLOT, the Disk Operating System (DOS) stores the programs, data files, and completed graph images. This appendix provides a summary of information pertinent to DOS as it relates to the CALCU-PLOT programs.

C.2 DISK TYPES

There are three types referenced in this Manual:

1) The CALCU-PLOT Disk
   The disk that comes in the CALCU-PLOT Program package.

2) 'OTHER' DATA DISKS
   Disks, initialized and preloaded with programs needed for adding 'OTHER' equations to the plotting programs. (Refer to Section 5 for details). These can also store and retrieve Empirical Data and graph images.

3) Data Disks
   Ordinary DOS initialized disks used to store and retrieve Empirical Data files and graph images only.

C.3 DRIVE NUMBER

When the program requires recording to or retrieval from a disk, it first asks (or sometimes specifies) which DOS drive will apply to that function. The program operates on 1 or 2 drives.

However, in the initial plot program loading, you have a <0> option when no 'OTHER' DATA DISK is to be used. In this case the CALCU-PLOT Disk must be in drive #1.

The Slot number is always assumed to be #6, and the Volume number to be #254.

C.4 FILENAME

The request for filename can be answered by one of four replies:

1) <X> exits to the nearest logical menu or selection.

2) <?> displays the CATALOG for the disk in the last selected drive. If you decide that the disk is the wrong one, replace it and try again.

   If you desire to change the drive # at this point, enter any number (an invalid filename). The error routine returns to the drive select option for choosing another drive number.

   The FILE TEST Program does not have this drive change feature and assumes the 'OTHER' DATA DISK is in the same drive as during the FILE MAKER Program. If a disk change is desired, insert a different disk into the drive in current use.

3) If a name is displayed after the <?> prompt, press <RETURN> to select that name, or,

4) Type in a name of your choice, being careful to:

   a) avoid duplicate names which will over-write the old file.

   b) avoid a non-alphabetical first character.

   c) avoid commas.

   d) use fewer than 30 characters.

   e) keep a record of file contents.

If you select an improper filename you get an appropriate message. However, if the filename is allowable but one not on the current disk, or if there is a mismatch of file type, or if any other error occurs in the attempt to read or write the file, a DOS message with an error number appears. See Table C-1 for a list of the most likely errors. You can still correct and try again.

C.5 TYPE vs DRIVE

Into which drive should you insert which disk?

1) CALCU-PLOT Disk: drive #1 only.

2) 'OTHER' DATA DISK: drive #1 or #2 (But always in drive #1 to initialize).

3) Data Disk: drive #1 or #2.

TABLE C-1 DOS ERROR CODES

Code	Error	Code	Error
4	Write Protected	9	Disk Full
6	File Not Found	10	File Locked
7	Wrong Volume #	11	Syntax Error
8	I/O Error (door open?)	14	Program Too Large

DOS Error #5 (End of Data) may be the result of an incorrect filename.

NOTE

If you attempt to retrieve Empirical Data using a non-existing filename, the result will be an empty 001 sector text file with the improper filename on disk. A check of the catalog listing will confirm this. Delete this file in the usual manner prescribed in the DOS Manual.

APPENDIX D

COMPUTER SPACE

Alas! There is a limit to the space available in the computer memory. If you have a 48K system, there are about 1500 bytes left over for OTHER equation files in the CART-PLOT Program. POLAR-PLOT does not have a space problem and should pose no problem with space.

Since you can add up to five equations, this allows about 300 bytes per equation file. This should be sufficient for most new entries. To give an idea of relative complexity and size, the following data are given for the examples given in Appendix B.

EQUATION	BYTES
Square Wave	322
Amplitude Response 2nd order Xfer Fnc	303
Cissoid of Diocles	245
Simple Line	73
Complex Equation	449

If your equation files are too large, you have three options.

(a) Add fewer than 5 equations to any one CART-PLOT Program at one time.

(b) Start with a clean fresh disk and initialize it using the initialize option from the MAIN MENU. If you use this method on an old disk it will erase all files and reload only the basic programs

needed for creating other equation files.

(c) The best way to pick up space is to use a 16K RAM card in slot #0. When you have a RAM card and Applesoft in ROM, the DIVERSI-DOS on the CALCU-PLOT disk can go to work for you. The DIVERSI-DOS mover can automatically move the DOS to your RAM card, freeing up about 10K of memory. This should be enough memory for any new and exotic equations you want to add.

If you have a language card you can get more data disk space than usual by using a modified initialization procedure. The result will be a non-bootable data disk, which is completely compatible with the way CALCU-PLOT uses data disks. The benefit is about 36 more free sectors, two more than one graph image.

To initialize an 'OTHER' DATA DISK, follow six steps.

1) From the MAIN MENU, select <3> PLOT EQUATION(S).

2) Press <RETURN> three times as prompted to load the CART-PLOT Program.

3) Press <RETURN> twice more to get to the SELECT EQUATION MENU.

4) Press <X> TO EXIT, to get to the OPTION MENU.

5) Press <7> CALCU-PLOT MAIN MENU.

6) Now select <6> INIT. DATA DISK, and follow the directions.

If you want even more space for EMPIRICAL DATA files and graph images only, you can delete the files loaded by this routine.

Deleting the files gives you 54 more sectors

of disk space. You can use such disks only for data and graph images, not for 'OTHER' Equations.

NOTE

When you replace equations the process does not remove all the leftover lines, so it may be necessary to clean house once in a while. A simple method to use the DOS-FID Program to copy the <CPP3> and <OCEF> Programs from the CALCU-PLOT DISK onto your 'OTHER' DATA DISK to be purged. This will give you a clean slate but will also delete any files already added, so be sure you have any wanted files saved under a different filename for later recovery if desired.