TRS-80®

Model 100 Portable Computer

FUNCTION PLOTTER

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FUNCTION PLOTTER

Radio Shack®
A DIVISION OF TANDY CORPORATION
FORT WORTH, TEXAS 76102

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TABLE OF CONTENTS

INTRODUCTION

The Model 100 Function Plotter program allows you to graph algebraic functions of one or two variables, using the Model 100 Portable Computer and a Radio Shack Plotter. Almost any function of one or two variables that can be expressed in Model 100 BASIC syntax may be plotted.

Required Equipment

- TRS-80® Model 100 Portable Computer with at least 16K of memory
- AC Power Supply (26-3804) or four AA batteries
- Cassette recorder such as the CCR-81 (26-1208)
- Model 100 printer cable (26-1409)
- One of the following Radio Shack Plotters:

  CGP-115 Color Graphic Printer (26-1192)
  FP-215 Flatbed Plotter/Printer (26-1193)
  Single-Pen Plotter (26-1190)
  TRS-80 Multi-Pen Plotter (26-1191) (requires an RS-232 cable (26-1408) rather than the Model 100 printer cable)

Before You Begin

The Function Plotter program contains several options. Each of these options is explained in its own section of the manual. After reading the explanations, you may feel that you are ready to begin entering your own data. If you would like some practice before venturing out on your own, examples are included at the back of this manual.

Make a copy of the Function Plotter tape according to the instructions in "Model 100 Applications Quick Reference." Store the original Function Plotter tape in a safe place. Using the duplicate Function Plotter tape, load and save the Function

Plotter program according to the instructions in "Model 100 Applications Quick Reference."

Warning: The Function Plotter program uses self-modifying BASIC code. Although the program may safely reside anywhere in memory, it assumes that certain segments of code are in fixed positions relative to each other. Any edits or alterations may change the relative locations of critical routines causing the program to fail and possibly resulting in destruction of the program or corruption of other memory space.

For CGP-115 Users

The Function Plotter program requires that the CGP-115 Color Graphic Printer is properly connected. Connect the printer cable according to the instructions in the Owner's Manual. The DIP switches on the CGP-115 should be set for parallel input. We recommend using 80 characters per line. No further setup is required.

For Other Radio Shack Plotters

The Function Plotter program is designed for the CGP-115. However, several MERGE modules are provided to modify the program for use with other Radio Shack plotters. After the program is modified by inclusion of a MERGE file, it will only work with the plotter for which it has been modified.

MERGE modules should be used ONLY with the original CGP-115 version of the program. Modified copies of the program cannot be modified again by use of additional MERGE modules. It is always wise to retain the original CGP-115 version of the program and to modify copies of the original version.

The following modules are provided:

FP215 — for FP-215 Flatbed Plotter (26-1193)
SIXPEN — for Multi-Pen Plotter (26-1191)
ONEPEN — for Single-Pen Plotter (26-1190)

Make copies of the MERGE modules before you apply a merge. A MERGE module must be saved to tape in ASCII format. If you wish to save a MERGE module, enter:

CSAVE "filename",**A**

To apply a MERGE overlay, CLOAD the original program (PLOT), then enter:

MERGE "**CAS**:filename"

where filename is the name of the merge file you are using.

MODEL 100 FUNCTION PLOTTER MENU

After loading and saving the Function Plotter program, use the arrow keys to move the cursor over PLOT.BA and then press (ENTER). The screen shows:

```
      TRS-80 Model 100 Software
xx    Function Plotter v01.00.00
Copyright 1983  Tandy Corporation
        All rights reserved
```

xx specifies the printer the program is set to use.

The version number indicates how many and what type of revisions have been made to the program. Refer to it when requesting information or help from Radio Shack. Do not be concerned if the number on the screen is not identical to the one in the manual.

The notice displays for approximately five seconds or until you press any key.

Note: The Function Plotter program does not operate unless a Radio Shack plotter is connected to the computer.

The Model 100 Function Plotter menu is displayed after the copyright notice screen. The menu contains:

Select:
- (M) Set plot mode
- (F) Set function to plot
- (P) Plot function
- (S) Store function
- (L) Load function
- (D) Display function

To exit the Function Plotter program from the menu, press (SHIFT) (*). The screen shows: End program? (Y/N). Pressing (Y) returns the Model 100 Main Menu.

If you do not wish to exit the Function Plotter program, press (N). The Model 100 Function Plotter menu returns to the screen.

To select any of the six available options, press the appropriate letter and then press (ENTER). Each option is explained in its own section of the manual.

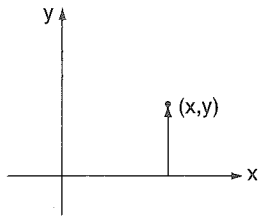
(M) Set plot mode

Option M is used to specify a coordinate system for use by the program. This program can plot using any of six available methods. At the Model 100 Function Plotter menu, press (M) (ENTER). The screen shows:

```
      Plot Mode Selection
(1)  2-D Cartesian
(2)  2-D Polar
(3)  3-D Cartesian
(4)  3-D Polar (cylindrical, grid)
(5)  3-D Polar (cylindrical, rings)
(6)  3-D Polar (cylindrical, radii)
```

2-D Cartesian

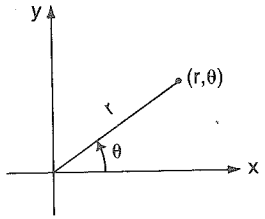
Using a pair of numbers, the Cartesian or rectangular coordinate system describes where points are placed on a grid. The first number describes the distance of the point from the y-axis, which is a vertical line. The second number describes the distance of the point from the x-axis, which is a horizontal line.



Functions plotted in a 2-D Cartesian coordinate system are represented as a line. The plotter program assumes that Y = F(x).

2-D Polar

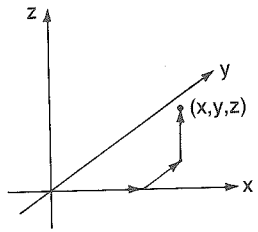
The polar coordinate system uses a pair of numbers to describe a point in terms of a line drawn from a center to the point. The first number is the length of the line labeled r. The second number is the angle the line is from the horizontal labeled theta. In this program, all angles are measured in radians.



Functions plotted in a 2-D polar coordinate system are represented as a line. The plotter program assumes that R = F(theta).

3-D Cartesian

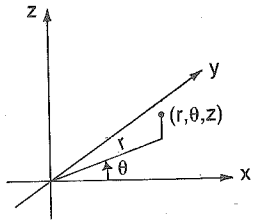
Cartesian coordinates may also be used to plot points in space. Points in space are described using the numbers x, y, and z.



Functions plotted in a 3-D Cartesian system are represented as a plane of parallel or gridded lines, rotated into perspective. The plotter program assumes that Z = F(x,y)

3-D Polar (cylindrical)

Polar coordinates may be used to plot points in space. Points in space are described using r, theta, and z.



Functions plotted in a 3-D polar system are represented as a plane, rotated into perspective. The plane may be drawn as parallel or gridded lines, a series of concentric rings, or as divergent rays depending upon the option chosen. The plotter program assumes that Z = F(r,theta).

Each of the four 3-D plots uses exactly the same scale and rotation allowing images to be superimposed accurately.

After you select the coordinate system, the Model 100 Function Plotter menu returns to the screen.

(F) Set function to plot

The set function option is used to enter the function you wish to plot. At the Model 100 Function Plotter menu, press (F) (ENTER). The screen shows:

```
                Function Entry

F(parameters)=
```

(parameters) is a combination of x, y, r, and theta depending upon the coordinate system chosen. For example, if you select the 2-D Cartesian coordinate system, the Function Entry screen shows F(x)=.

Enter the function text (the right side of the equation) in legal Model 100 BASIC syntax. The function text should use only the variables upon which the function is dependent — x, y, r, and/or theta (T).

The function's text must not exceed 240 characters. Pressing (ENTER) without entering text cancels function entry and returns the Model 100 Function Plotter menu without affecting a previously defined function.

The function may contain any of the following mathematical operators as long as the function is syntactically correct.

+	–	*	/	^
( )	SQR	SIN	COS	TAN
ATN	LOG	EXP	INT	FIX
AND	OR	XOR	EQV	IMP
MOD	SGN	ABS	INP	>
<	=	NOT	RND	

The constants pi and e are also recognized by this program. Spaces between operators and variables are ignored by the program. The spaces do count toward the 240 character length limit, however.

The operator heirarchy and symbol evaluation are the same as for any BASIC statement. See the Model 100 Owner's Manual for details on BASIC operator heirarchy.

After you enter the function, the program processes it and then displays the Model 100 Function Plotter menu.

(P) Plot function

The screen prompts for the scale limits of x, y, z, radius, and/or theta, depending upon the plot method chosen. Each request is made by displaying the name of the parameter and its present value. For example, if you select the 2-D Cartesian coordinate system, the screen shows: X start = 0: change? Enter a new value if a change is desired, or press (ENTER) to retain the displayed parameter. The prompts continue until all parameters necessary for the coordinate system chosen are entered.

You are next asked for the plot resolution. Resolution is the number of steps into which the plot space or volume is to be broken. A resolution of 100 divides each axis into 100 segments; a resolution of 15 divides each axis into 15 segments. Higher resolution numbers give more detailed plots but are much slower than the low resolution graphs. The following resolutions are recommended as good general purpose values:

Coordinate option	Resolution
2-D Cartesian	100
2-D Polar	100-300
3-D Cartesian	20-50
3-D Polar	20-50

You are next asked for F(error). The parameter, F(error), is the value the program is to assign to the function if it cannot be evaluated at a particular point, such as at a discontinuity or singularity.

This value must be selected according to the particular function, coordinate system, and scale in use.

Next, if you selected the 3-D Cartesian system or the 3-D Polar (cylindrical, grid), you are asked whether you want the function plane drawn in one or two passes. Planes drawn in one pass are represented as adjacent parallel line segments; planes drawn in two passes are represented as a grid of perpendicular lines.

You are next asked "`Superimpose plot? (Y/N).`" If the program is to advance the paper to draw the graph, press (N) (ENTER). If you wish the graph drawn over the previous graph, press (Y) (ENTER). The 3-D coordinate systems all use the same relative scaling, rotation, and perspective; functions drawn in different coordinate systems may be superimposed accurately. When superimposing plots on a plotter without paperfeed capability, only the formula for the first plot is printed. No text is ever printed by the single-pen plotter.

If you are using a plotter that does not have multi-color capability, the Plot Color Selection prompt is skipped. If you are using a plotter that has multi-color capability, the screen shows:

```
          Plot Color Selection

(for CGP-115)          (for Multi-Pen Plotter)
(0)  Black             (1)  Black
(1)  Blue              (2)  Red
(2)  Green             (3)  Blue
(3)  Red               (4)  Green
                       (5)  Violet
                       (6)  Orange
```

Press the number corresponding to the color in which you wish your graph to be drawn and then press (ENTER).

The screen shows:

```
All parameters as desired? (Y/N)
```


If you need to change any of the parameters you entered, press (N). The program returns to the first parameter question. Enter the correct information. When all of the parameters are correct, press (Y). The function is drawn. When the plot is completed, the Model 100 Function Plotter menu returns to the screen.

If you wish to cancel the plot, press (ESC). After a few seconds, the plotter stops and the Model 100 Function Plotter menu returns to the screen.

(S) Store function

The store function option allows you to save a defined function to the computer memory (RAM). To select the store function, press (S) (ENTER) at the Model 100 Function Plotter menu. The screen shows: `File name?`

Enter a name of up to six characters. The first character has to be a letter. To cancel the save function, press (ENTER) without a name. After the function is stored, the Model 100 Function Plotter menu returns to the screen.

The function file name appears on the Model 100 Main Menu with the .DO extension.

Note: The Store function saves the function only. It does not save the parameters.

(L) Load function

To load a function from the computer memory to the plotter program, press (L) (ENTER) at the Model 100 Function Plotter menu. The screen shows: `File name?`

Enter the name (up to six characters) of the function to be loaded. To cancel the load function, press (ENTER) without typing a name. After the

function is loaded, the Model 100 Function Plotter menu returns to the screen.

Note: The Load function does not load the parameters.

(D) Display function

To display the function currently defined in the plotter program, press (D) (ENTER) at the Model 100 Function Plotter menu. After viewing the current function, press any key to return to the Model 100 Function Plotter menu.

EXAMPLES

Before beginning the examples, load the program following "Model 100 Applications Quick Reference." The examples in this manual were done on the CGP-115. If you use a different plotter, expect the program to perform slightly differently.

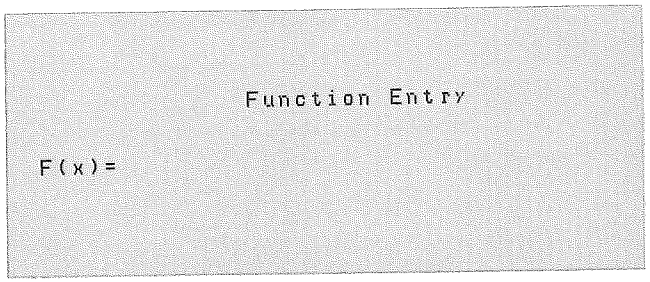
2-D Cartesian

Plot the function $F(x) = x^2$ in 2-D Cartesian coordinates over the interval $-2 <= x <= 2$. By inspection, F(x) will lie between 0 and 4 for this interval. There are no points at which this function is undefined, so F(error) is unimportant. Use a resolution of 100.

At the Model 100 Main Menu, use the arrow keys to move the cursor over PLOT.BA and then press (ENTER). The copyright notice screen appears. Press any key to display the Model 100 Function Plotter menu.

At the Model 100 Function Plotter menu, press (M) (ENTER) to set the plot mode. The Plot Mode Selection screen appears. Press (1) (ENTER) to select the 2-D Cartesian coordinate system. After you select the coordinate system, the Model 100 Function Plotter menu returns to the screen.

Next, at the Model 100 Function Plotter menu, press (F) (ENTER) to set the function to be plotted. The screen shows:

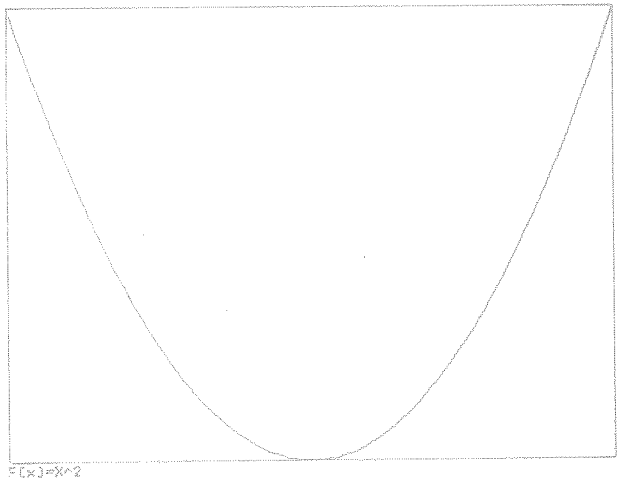


Type the function text as follows: x^2 (ENTER). The program processes the function and then returns the Model 100 Function Plotter menu to the screen.

Press (P) (ENTER) at the Model 100 Function Plotter menu to begin plotting the function.

The screen shows:	You respond:
X start = 0: change?	−2 (ENTER)
X end = 0: change?	2 (ENTER)
Y start = 0: change?	(ENTER)
Y end = 0: change?	4 (ENTER)
Resolution = 1: change (1-1000)?	100 (ENTER)
F(error) = 0: change?	(ENTER)
Superimpose plot? (Y/N)	N (ENTER)
Plot Color Selection	
(0) Black	
(1) Blue	
(2) Green	
(3) Red	0 (ENTER)

Your graph should look like the following. If it does not, begin again, following the instructions exactly.



2-D Polar

Plot the function F(T) = COS (2T) in 2-D Polar coordinates over the interval 0 <= T <= 2pi (6.28) radians. By inspection, F(T) will lie between −1 and 1 for this interval. Use a resolution of 100. There are no points at which this function is undefined, so F(error) is unimportant.

At the Model 100 Function Plotter menu, press (M) (ENTER) to set the plot mode. At the Plot Mode Selection screen, press (2) (ENTER) for the 2-D Polar coordinate system.

Next, enter the function to be plotted. At the Model 100 Function Plotter menu, press (F) (ENTER) to set the function. The screen shows:

```
                Function Entry

F(theta)=
```

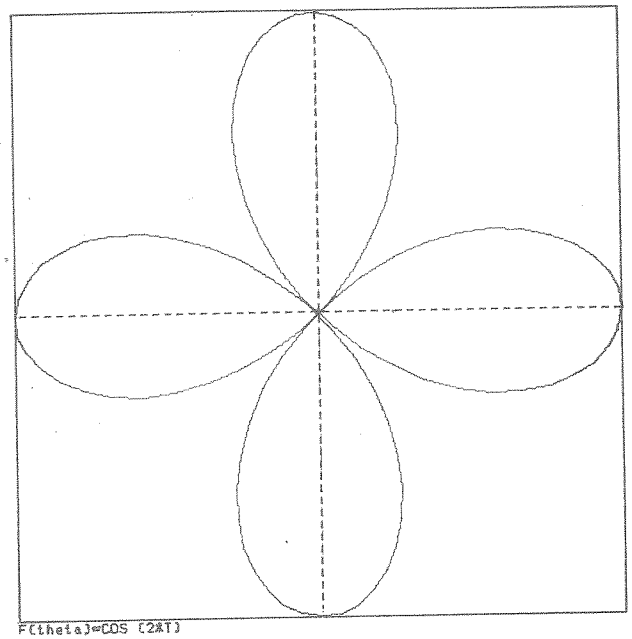
Type the function text as follows: COS (2*T) (ENTER). After the function is processed, the Model 100 Function Plotter menu returns to the screen.

Press (P) (ENTER) to begin plotting the function.

The screen shows:	You respond:
Theta start = 0 radians: change?	(ENTER)
Theta end = 0 radians: change?	6.28 (ENTER)
Plot radius = 0: change?	1 (ENTER)
Resolution = 1: change (1-1000)?	100 (ENTER)
F(error) = 0: change?	(ENTER)
Superimpose plot? (Y/N)	N (ENTER)
Plot Color Selection	
(0) Black	

```
(1)  Blue
(2)  Green
(3)  Red                    Ø (ENTER)
```

Your graph should look like the following. If it does not, begin again, following the instructions exactly.



3-D Cartesian

Plot the function F(x,y) = X/Y in 3-D Cartesian coordinates over the interval $-1 <= X <= 1$ and $-1 <= Y <= 1$. This function is discontinuous at Y = Ø, so define F(error) to be Ø. Since this function tends toward very large magnitudes near Y = Ø use a vertical scale of +/− 5. Use a resolution of 16. Plot the function in one pass.

At the Model 100 Function Plotter menu, press (M) (ENTER) to set the plot mode. At the Plot Mode

Selection screen, press (3) (ENTER) to select the 3-D Cartesian coordinate system.

Next, press (F) (ENTER) at the Model 100 Function Plotter menu. The screen shows:

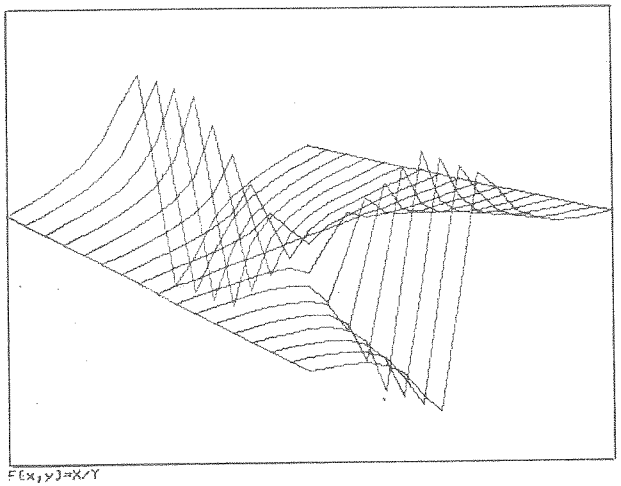
```
                Function Entry

F(x,y)=
```

Type the function text as follows: **x/y (ENTER)**. The program processes the function and then returns the Model 100 Function Plotter menu to the screen.

Press (P) (ENTER) to begin plotting the function.

The screen shows:	You respond:
`X start = Ø: change?`	**−1 (ENTER)**
`X end = Ø: change?`	**1 (ENTER)**
`Y start = Ø: change?`	**−1 (ENTER)**
`Y end = Ø: change?`	**1 (ENTER)**
`Z start = Ø: change?`	**−5 (ENTER)**
`Z end = Ø: change?`	**5 (ENTER)**
`Ø Passes: change (1 or 2)?`	**1 (ENTER)**
`Resolution = 1: change? (1-1ØØØ)?`	**16 (ENTER)**
`F(error) = Ø: change?`	**(ENTER)**
`Superimpose plot? (Y/N)`	**N (ENTER)**
`Plot Color Selection`	
`(Ø) Black`	
`(1) Blue`	
`(2) Green`	
`(3) Red`	**Ø (ENTER)**

Your graph should look like the following. If it does not, begin again, following the instructions exactly.



3-D Polar

Plot the function F(r,theta) = R*COS(4*T+.5) in cylindrical coordinates over the interval Ø <= r <= 1. Draw the function plane as a set of parallel lines. By inspection, this function will lie over the interval −1 <= F(r,t) <= 1 for all possible values of r and t within the range selected for r. Since this function represents a fairly complex plane, select a large range for the Z scale in order to reduce the apparent relief of the plot and make it more presentable. This function is continuous, so F(error) is unimportant. Because of the function plane's complex shape, select a fine resolution of 5Ø which yields great detail at the expense of slow plotting. (This plot takes approximately 35 minutes.) Plot the function in one pass.

At the Model 100 Function Plotter menu, press (M) (ENTER) to set the plot mode. At the Plot Mode

Selection screen, press (4) (ENTER) to select 3-D Polar (cylindrical, grid).

Next, press (F) (ENTER) at the Model 100 Function Plotter menu. The screen shows:

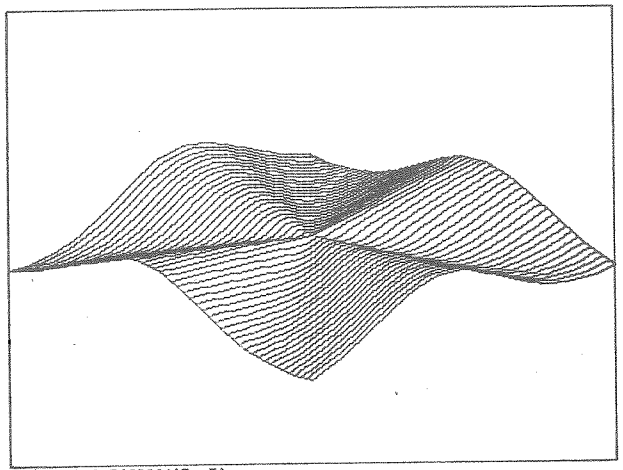
```
                Function Entry

F(r,theta)=
```

Type the function text as follows: **R*COS(4*T+.5)** (ENTER). The program processes the function and then returns the Model 100 Function Plotter menu to the screen.

Press (P) (ENTER) to begin plotting the function.

The screen shows:	You respond:
`Plot radius = Ø: change?`	1 (ENTER)
`Z start = Ø: change?`	−4.5 (ENTER)
`Z end = Ø: change?`	4.5 (ENTER)
`Ø passes: change (1 or 2)?`	1 (ENTER)
`Resolution = 1: change? (1-1ØØØ)?`	5Ø (ENTER)
`F(error) = Ø : change?`	(ENTER)
`Superimpose plot? (Y/N)`	N (ENTER)
`Plot Color Selection`	
`(Ø) Black`	
`(1) Blue`	
`(2) Green`	
`(3) Red`	Ø (ENTER)

Your graph should look like the following. If it does not, begin again, following the instructions exactly.



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