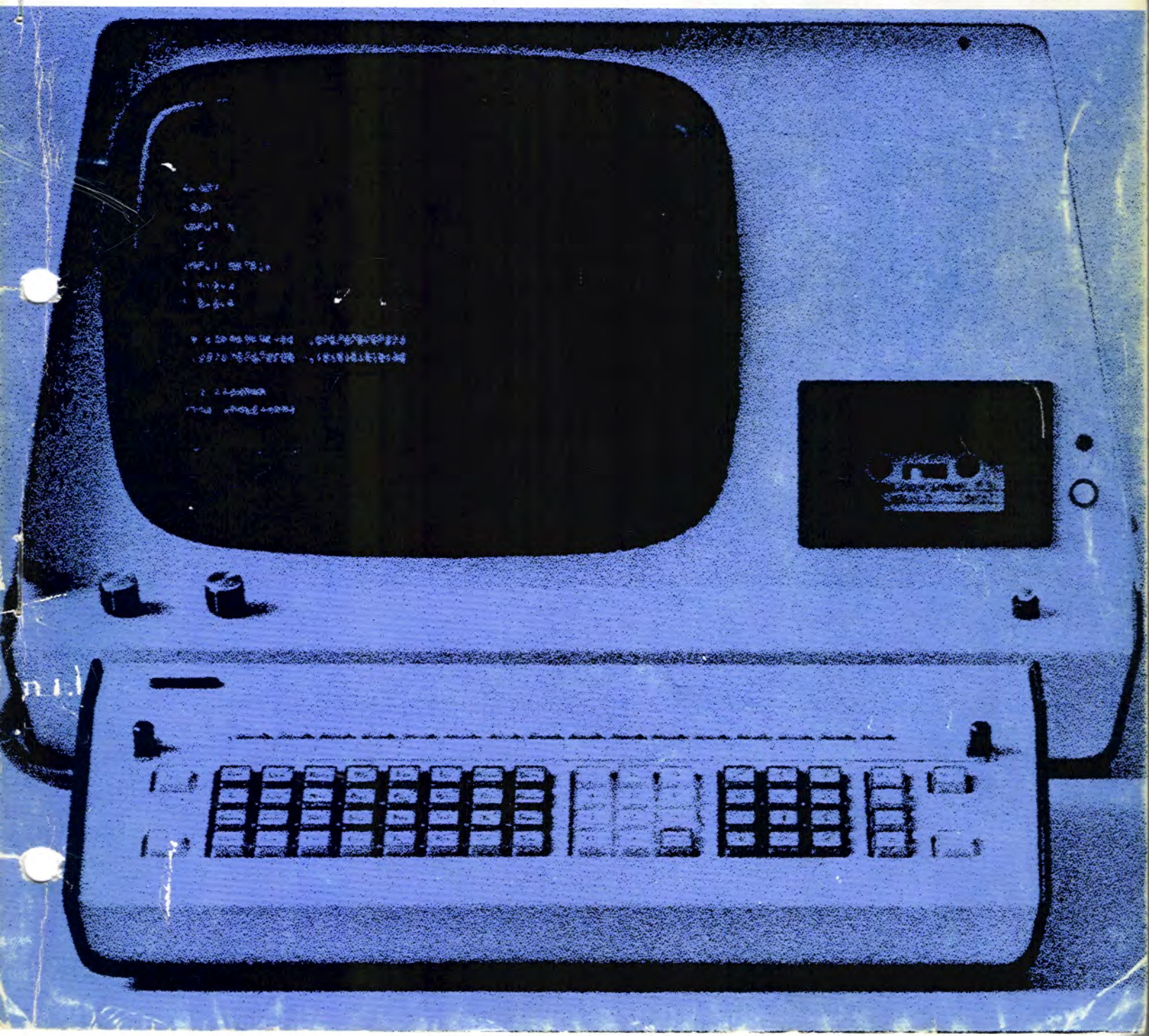
WANG

2232 A DIGITAL FLATBED PLOTTER REFERENCE MANUAL

SYSTEM 2200



2232A

Digital Flatbed Plotter Reference Manual

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HOW TO USE THIS MANUAL

This manual provides the user with a concise reference to the operational features of the Model 2232A Digital Flatbed Plotter. The Model 2232A can be used both to print alphanumeric characters and, in conjunction with the WANG System 2200B, to operate as an accurate plotter of mathematical functions. This manual has been arranged in four sections in order to assist the user in answering questions that may arise. It is assumed that the user of the WANG Model 2232A is familiar with the BASIC language of the System 2200B. A discussion of System 2200B BASIC commands and statements can be found in the System 2200A/B Reference Manual. Specifications are provided in Appendix A; cleaning and maintenance procedures are found in Appendix B.

TABLE OF CONTENTS

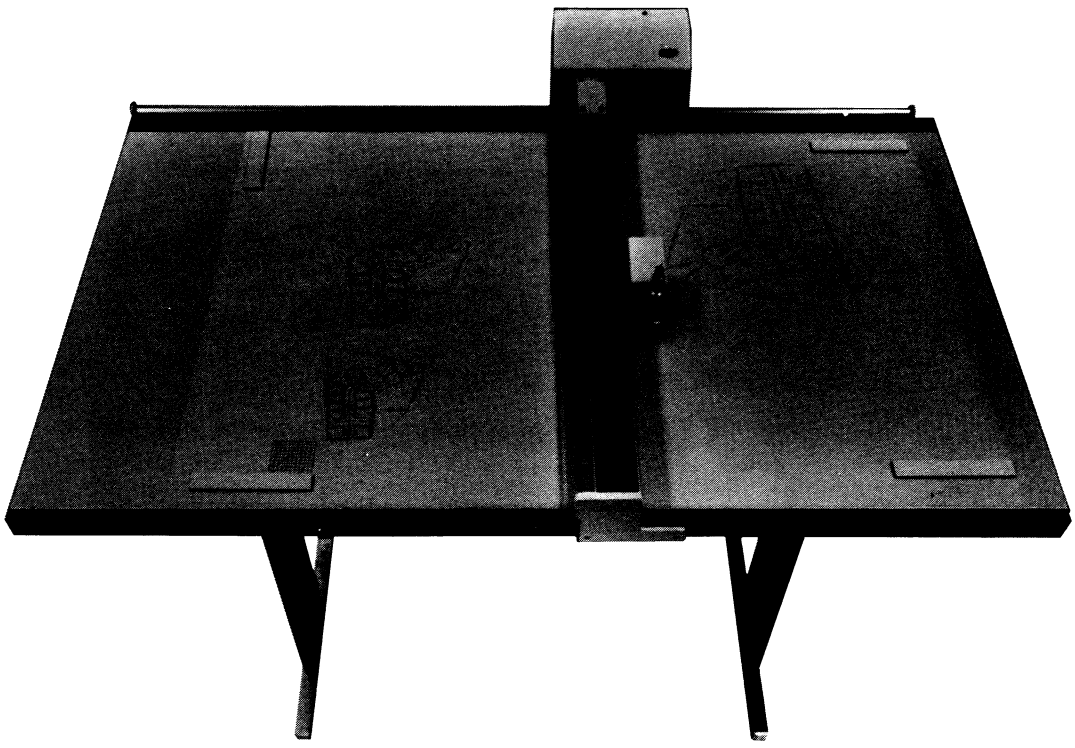
Section I
Introduction

INTRODUCTION

The Model 2232A Digital Flatbed Plotter provides continuous line or print plotting of curves and data. It also provides full alphanumeric labeling of plots. Circle charts, bar graphs, subdivisional plans and highway plans may be plotted. The Model 2232A uses any kind of paper, including linen, vellum, and mylar and has the option of using fiber tip, ball point, or drafting pens.

The plotting table measures 59 1/2" (151.13 cm) x 36" (91.44 cm); the actual plotting surface is 48" (121.92 cm) x 31" (78.74 cm). Smaller plots may be positioned anywhere within the plotting surface boundaries.

Alphanumeric character generation is not built into the Model 2232A, but is provided by software.



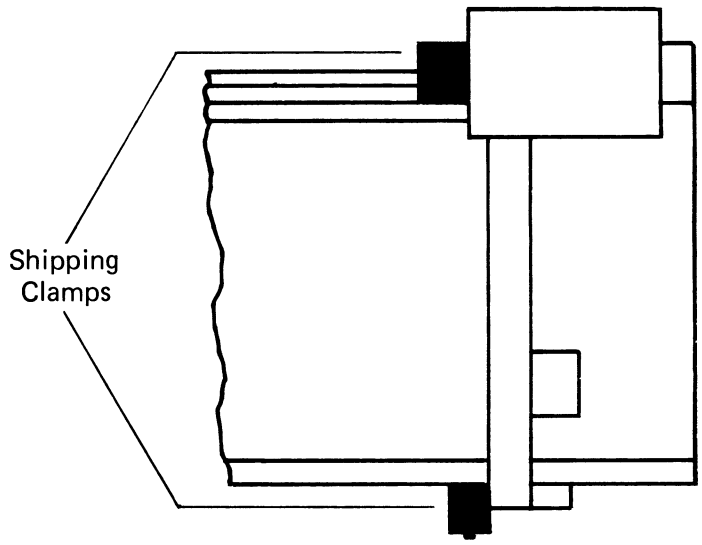
SECTION I – INTRODUCTION

UNPACKING AND PACKING INSTRUCTIONS

When installing or replacing a Model 2232A plotter, do not destroy the packing material. Do not discard the packing material until a full checkout procedure has been performed.

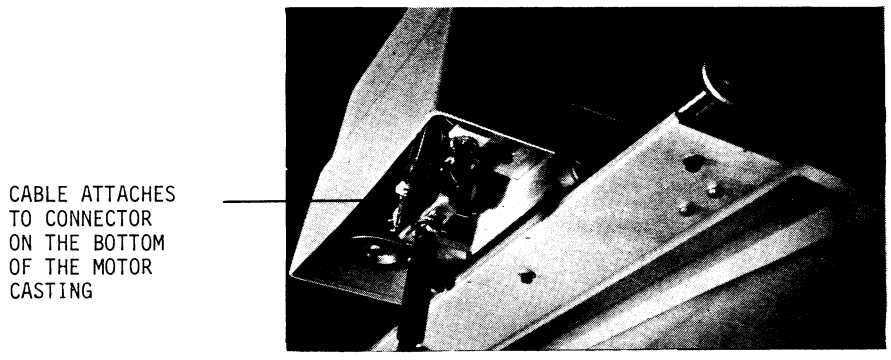
To install a plotter, lay the carton containing the table and arm flat on the floor with the arrows pointing up. Remove the package tapes and cover. Remove the top layer of Instapak foam; this will reveal the plotting table. With the aid of another person lift the table vertically from the carton. If no clamps are to be installed simply lay the plotting table on your table with the gearfence extending over one edge approximately three inches.

There are two shipping clamps on the Model 2232A. One is in the X railof the table which keeps the arm forced against the right margin of the table. The wooden clamp is held by a bolt through its center. Loosen this bolt and then slide the clamp to left until it leaves the X rail. The other wooden clamp is at the opposite end of the arm. It also forces the arm against the right margin of the table. It is to the left of the arm clamped around the X gearfence. To remove it, loosen the bolt in the center of the block and pull the block away from the gearfence. See illustration below for clamp location. For packing a Model 2232A, reverse the above procedure.



INSTALLATION PROCEDURE

1. Plug in the peripheral connectors to the peripheral board located in the CPU. All peripheral boards are labeled (2216, 2222, etc.)
2. Plug in the electronic package to the Model 2232A Flatbed Plotter.



Connecting Package Cable to Plotting Table

3. Plug in power cords for all peripherals.
4. Plug in power connector of CPU to power supply unit.
5. Plug in connector of power supply unit to power source.

POWER ON PROCEDURE

1. Turn power switches ON for all peripherals, including the CRT.
2. Move the main switch on the Power Supply to the ON position (light on the Power Supply illuminates). This step Master Initializes the System 2200B.

Paper – Any type of paper may be used along with linen, vellum and mylar.

Pens – Various types of pens are usable including rapidograph, fiber tip, Esterbrook's Vega Pen with Synaflex tips and ballpoint pen (Lindy).

PREVENTIVE MAINTENANCE PROCEDURES

The Model 2232A should have visual and performance checks, and lubrication at least three (3) times annually.

LUBRICATION

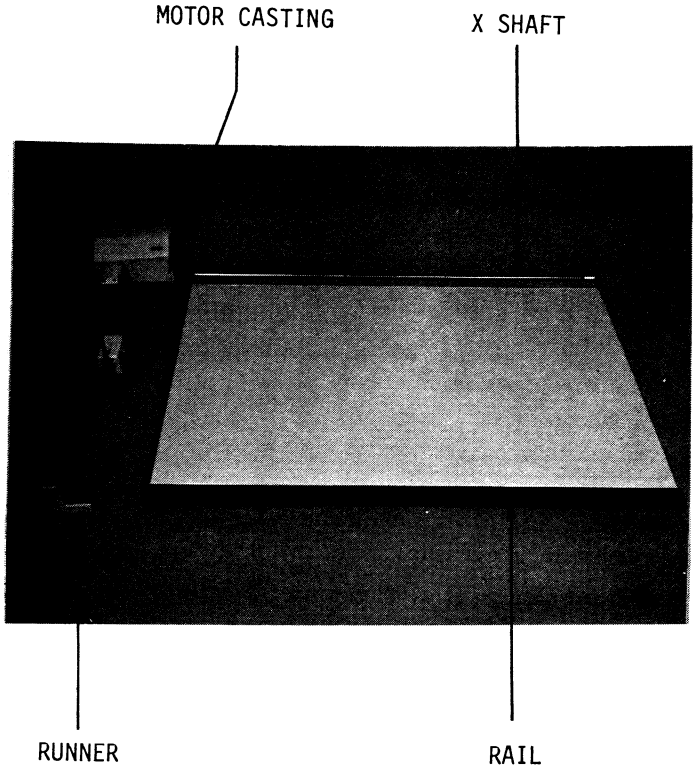
The X shaft should be lubricated after being cleaned with a light coat of silicon grease.

CLEANING

Clean the X shaft by wiping it with a cloth or paper towel.
Do not moisten the towel.

Remove any dust or foreign material from the X rail.

Check for any loose components, screws or bolts.



SQUARING X SHAFT

The rack should be parallel to the edge of the X shaft over 10" to within 0.002" and a maximum of 0.005" over the entire length of the rack.

To adjust this, loosen the 6 screws directly beneath the X shaft and move the shaft to the specified position. See Figure 1 .

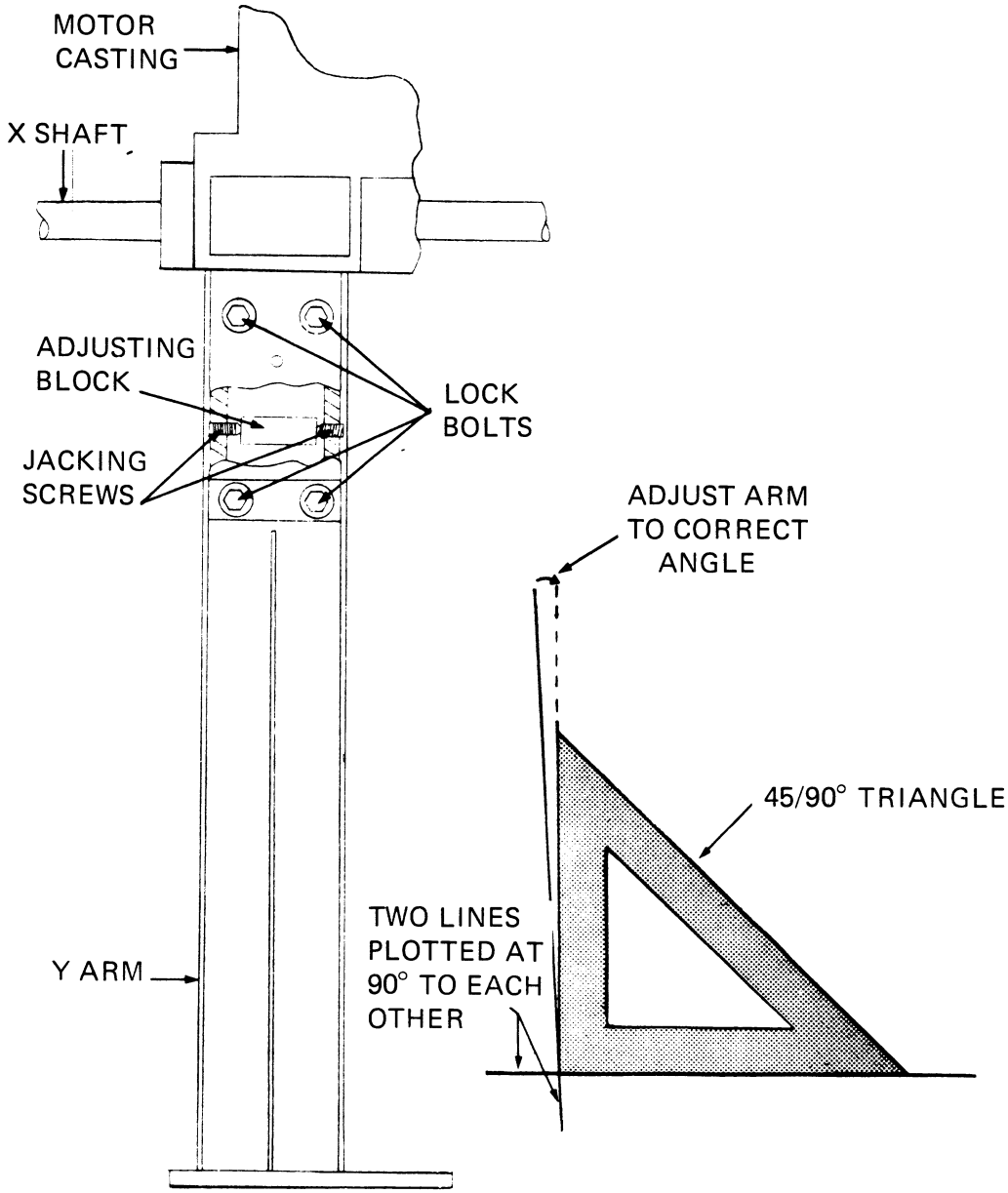


Figure 1. Plotting Arm

MAKING Y ARM PERPENDICULAR TO THE X SHAFT

The Y arm must be square to the X shaft within 0.010" over a 30" length. This is checked with a large triangle placed on a 90° plot as shown in Figure 1 . The trial plot may be generated by subroutine 0014 on tape #8560.

To adjust the Y arm, loosen the lock bolts on the motor casting where it connects to the Y arm, and shift the adjusting block by loosening one jacking screw and tightening the other. See Figure 1 .

Section II
Plot Statements

SELECTING THE MODEL 2232A

The Device Address for the Model 2232A is factory set at 413. All PLOT statements and commands (Section II), and the Utility Routines (Section III) operate directly on a Model 2232A with a Device Address of 413; selecting is unnecessary (i.e., a System 2200B PLOT command will assume an address of 413 if no other address has been selected). However, a few Model 2232A Plotters were shipped with the Device Address set at 414. Check your 2232A Plotter Controller Board. If the address is 414, the Plotter can be activated by the following procedure:

1. Master Initialize the System 2200B.
2. Place the Model 2232A POWER switch in the ON position.
3. Key in SELECT PLOT 414 on the Keyboard.
4. SELECT PLOT 414 must be keyed in each time the System 2200B or the Model 2232A is turned OFF, then ON again.

The Plotter Utility Package (Section III) operates only with the Device Address 413. To operate with a Plotter set as Device Address 414, all SELECT PLOT 413 statements in the program must be changed to 414.

At customer request, your WANG Service Representative can change a controller board with a Device Address of 414 to 413.

ROUND-OFF ERROR

The Model 2232A is an incremental plotter and plots only at regular plot positions. When programming the System 2200 to plot, round-off error must be taken into account. The Plotter Utility Package in the next section shows how to compensate for a round-off error. The procedure is: If a curve is being plotted, either the ΔX or ΔY increments, or both, are not generally integer values. Since the plotter can accept only integer values, the increments are rounded off to the nearest integer value. The fractional differences between the actual and rounded increments are then saved and added into the next increments. This is repeated for all successive points in the curve.

PLOT

2232A DIGITAL FLATBED PLOTTER (31" x 48") SYSTEM 2200B ONLY

General Form:

PLOT [expression 0] < [expression 1],[expression 2], {'null' / U / D / R} > [,<....]

where: expression 0 represents the replication factor, or the number of times the values enclosed in < > are plotted
(1 ⩽ expression 0 < 1000)
If omitted, expression 0 is assumed to be 1.

expression 1 represents Δx increments of .0025"
(–1000 < expression 1 < 1000)
If omitted, expression 1 is assumed to be 0.

expression 2 represents Δy increments of .0025"
(–1000 < expression 2 < 1000)
If omitted, expression 2 is assumed to be 0.

All 3 expressions are truncated to integer values.

For Plotting

'null' (i.e., no argument) and U imply move the Δx and Δy distance, specified in expression 1 and expression 2, with the pen up.

D implies draw a line while moving the Δx and Δy distance specified in expression 1 and expression 2.

R (RESET) moves the pen to the zero position on the plotter.

Purpose

When used with plot arguments this statement moves the plot pen from its current position to a position a distance x (expression 1; to the right if positive, to the left if negative) and y (expression 2; up if positive, down if negative) from the current position. The movement can be made with the pen up (U, 'null') or down (D).

One additional plotter control argument is available. R resets the plotter to the 0,0 position with the pen up.

Examples:

Moving the plot pen

PLOT < 10, 20, D >	Plot (pen down) moving Δx = 10 (times .0025") and Δy = 20 (times .0025").
PLOT < A, B, U >	Advance (pen up) Δx = integer value of A (times .0025") and Δy = integer value of B (times .0025")
PLOT <, , R >	Reset to 0,0 position

Replication and multiple arguments on one line

10 PLOT 10 < X, Y, D >	Plot x and y 10 times
10 N = 30 20 PLOT N <–10, 20, U >	Advance Δx = – 10 and Δy = 20 thirty times
10 PLOT < X, Y, U >, < 10, 20, D>, < A + 10, –B, U >, <, , R >	The above is an example of multiple arguments in one PLOT statement. They are processed sequentially from left to right.

Section III

Utility Routines

INTRODUCTION

WANG Laboratories, Inc. has designed a set of Utility Routines to provide users of the Model 2232A Analog Flatbed Plotter with full plotting capabilities. The routines are divided into two sections: the Plotter Program Package and the Plotter Utility Package.

The Plotter Program Package is a group of stand-alone programs, furnished on a tape cassette, which scale, plot and alphanumerically label rectangular, parametric, or polar equations; bar charts; pie charts; point plots; and line graphs. The user can select either linear, logarithmic or polar scales for special plots. No technical programming background is necessary to produce the graphs. Full instructions are provided.

For the user with knowledge of System 2200B BASIC programming techniques, the Plotter Utility Package is a listing and description of the various internal subroutines used in the Plotter Program Package to perform the plotting functions. It is provided as an aid to the programmer who wants to develop a custom program package. A listing of the source tape also is included at the end of the section. Users without technical programming knowledge can skip the Plotter Utility Package subsection.

The entire program package requires 16K bytes of memory. However, through program chaining, the Plotter Program Package can operate on a System 2200B with a 12K CPU.

PLOTTER PROGRAM PACKAGE

The Plotter Program Package, furnished on a tape cassette, provides full plotting capabilities for the Model 2232A Analog Flatbed Plotter (source tape = 701-0203, compressed = 0202).

Each step of the graph generation process is controlled by depressing a Special Function Key (the row of gray keys across the top of the Model 2215 or 2222 Keyboard). The steps and their Special Function Key numbers are:

STEP	SPECIAL FUNCTION KEY
Choose Options	'0
Enter Data	'1
Review/Correct Data	'2
Scaling	'3
Draw Graph	'4
Draw and Number Axes	'5
Print A Character String	'6
Character String Centered	'7
Find Limits on X And Y	'8
Move Pen Lower Left	'14
Move Pen Upper Right	'15

SECTION III—UTILITY ROUTINES

Special Function Keys '0 through '7 control the basic operating procedure for almost all the graphs generated by the Plotter Program Package. Special Function Keys '14 and '15 are used to move the plotting arm (see page 38 for a detailed explanation of their use). The use of Special Function Key '8, for finding the limits on X and Y in a computed function, is detailed on pages 30 and 33.

Preparing The System

1. Install the Special Function Strip provided with the Plotter Program Package.
2. Master Initialize the System 2200B and place the POWER switch on the Model 2232 in the ON position.
3. The CRT power switch must be placed in the "ON" position, located in the rear left corner of the unit.

Preparing Your Information

The System 2200B with the Model 2232A is prepared for use. Now you must prepare your information for entry into the Plotter Program Package.

The Plotter Program Package offers a number of options as to the type of graph, type of scale, the kind of axes, and the labelling format. You must know what you want to plot before you begin. Collect your data, decide on the type of options you want to work with, and make a rough hand-drawing of the graph you want to generate.

LOADING UTILITY ROUTINES INTO SYSTEM

Insert the Plotter Program Package program tape into the Model 2217 Tape Cassette Drive receiver door, and close the door. Key in LOAD.

When loading is complete (colon and cursor appear on line below LOAD command), touch the RUN and EXECUTE keys. The tape initialization program is loaded into memory, and the CRT screen displays the following requests, one at a time:

CHOOSE UTILITY PROGRAMS

LINE GRAPH?
POINT GRAPH?
LINEAR REGRESSION?
BAR CHART?
COMPUTED FUNCTION?
PIE CHART?
X- AND Y-AXES?
HORIZONTAL LINES?
HATCHED AXES?
ALPHA LABELING?
DRAW GRAPH?
DRAW AXES?
PRINT CHARACTERS?
*THREE DIMENSIONAL PLOTTING?

NOTE:

Key 1 and the EXECUTE to load in option. To by pass option just key EXECUTE.

The tape initialization program enables the 16K memory Plotter Utility Package also to be used on a 12K CPU, by selecting only the programs necessary to generate a specific graph. The method is called program chaining.

Users with a 16K machine can load the entire package into memory, by keying in 1 and touching the EXECUTE key after each request. The System 2200B searches the tape and loads in the appropriate programs, in this case all of them. While loading the programs, the CRT screen displays: SEARCHING THE TAPE. All plots now can be generated and the program does not need to be cleared to generate a different plot. Reloading is necessary only after system shutdown or Master Initialization.

*When the "Three-D Plot" is loaded, the core will clear and only store the three dimensional plotting program.

SECTION III—UTILITY ROUTINES

Users with a 12K CPU, however, can load only the programs necessary for generating one type of plot at a time. For example, to generate a titled line graph, linear/linear scale, with labeled X- and Y- axes, key in 1 and touch the EXECUTE key after:

LINE GRAPH?
X- AND Y-AXES?
ALPHA LABELING?
DRAW GRAPH?
DRAW AXES?
PRINT CHARACTERS?

After all other requests, touch EXECUTE only. If later you want to generate a point graph, linear/linear scale, with X- and Y-axes and no labeling, the procedure is:

1. Touch CLEAR and EXECUTE
2. Key in REWIND, touch EXECUTE
3. Key in LOAD, touch EXECUTE
4. Touch RUN and EXECUTE
5. Key in 1 and touch EXECUTE for the requests:

   POINT GRAPH?
   X- AND Y-AXES?
   DRAW GRAPH?
   DRAW AXES?

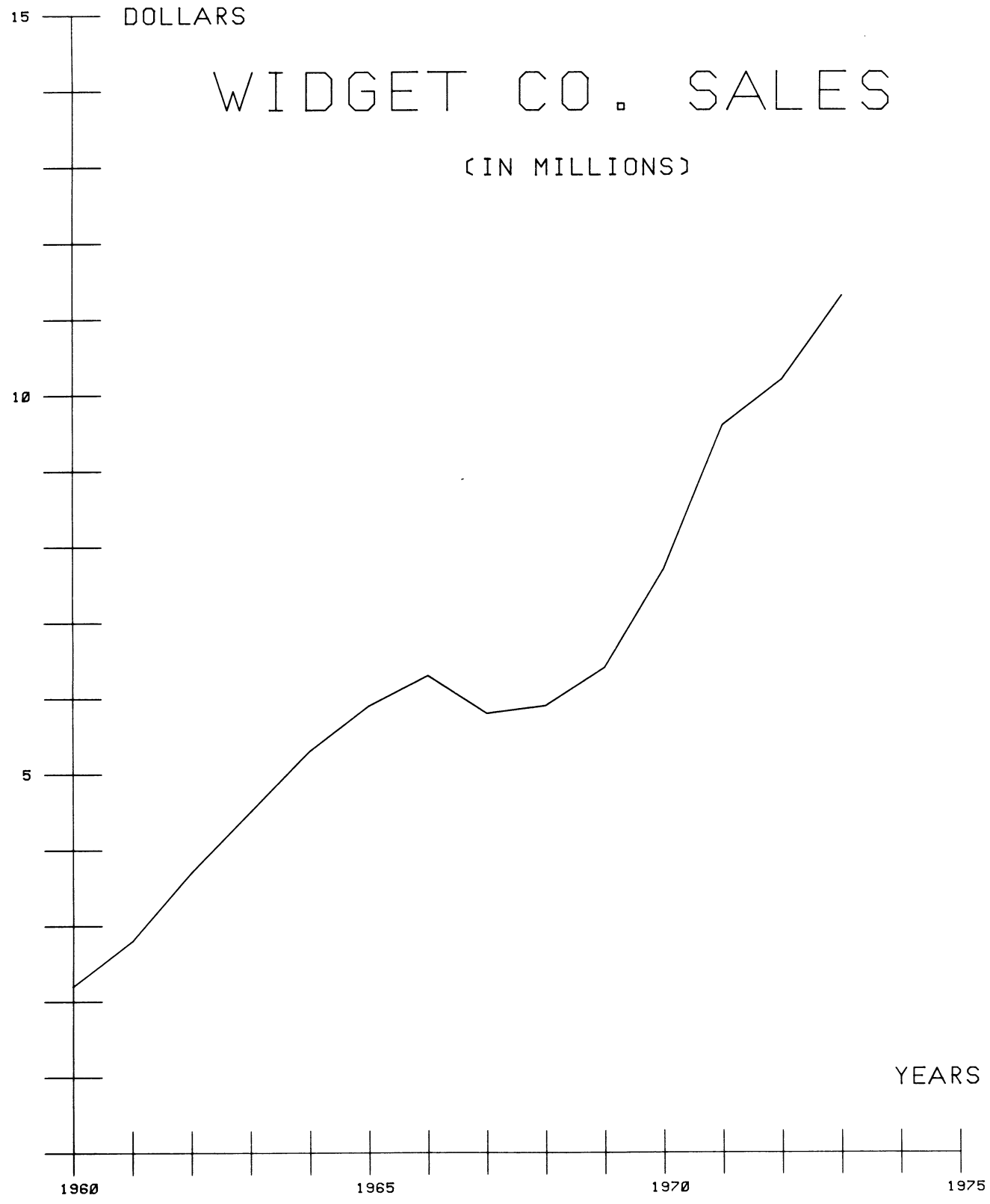
6. Touch EXECUTE for all other requests.

Each time you want to generate a different type of graph, the memory first must be cleared. Then rewind and reload the tape, and select the appropriate programs.

If you load more programs than your memory can handle, after displaying SEARCHING THE TAPE, the CRT screen will display either ERR 01 (Text Overflow) or ERR 02 (Table Overflow). Clear the memory, rewind and reload the tape, and reselect fewer program options.

Once you have initialized the program tape, you are ready to generate graphs. Included in this section are examples of each type of graph the package generates, with full instructions for operating procedures. The first example a labeled line graph, linear/linear scale with X- and Y-axes, explains, step by step in detail, the basic operating procedures for Special Function Keys '0 through '7. The procedures are used to generate all types of graphs. Any additional unique instructions are included in the examples of the other types of graphs. All examples in this section assume the use of a 16K CPU. If your System 2200B has a smaller CPU, you must initialize the tape and select the proper programs before generating each of the example graphs.

The entire tape takes approximately 3½ minutes to load.



Example 1 Line Graph, Linear/Linear Scale

EXAMPLE 1
LINE GRAPH
LINEAR/LINEAR SCALE
X- AND Y-AXES

This example explains, step by step, the use of Special Function Keys '0 through '7, by generating a graph, appropriately labeled, of the sales of Widget Co. from 1960 through 1973 (Example 1). The sales data are:

1960	2.2	1967	5.8
1961	2.8	1968	5.9
1962	3.7	1969	6.4
1963	4.5	1970	7.7
1964	5.3	1971	9.6
1965	5.9	1972	10.2
1966	6.3	1973	11.3

A. CHOOSING THE OPTIONS
(Special Function Key '0)

Several options are available as to the type of graph you want to draw, the type of scale to use, and the labeling information.

1. When program initialization is complete (STOP appears on the CRT screen), depress Special Function Key '0. The CRT screen displays:

SEARCHING TAPE
STOP

> **NOTE:**
>
> *If, at any time, you depress the wrong Special Function Key, touch the RESET key, followed by the correct Special Function Key.*

CHOOSING THE TYPE OF GRAPH
ENTER OPTION NUMBER
?_

NO.	TYPE OF GRAPH
1	LINE GRAPH
2	POINT GRAPH
3	LINEAR REGRESSION
4	BAR CHART
5	COMPUTED FUNCTION
6	PIE CHART

2. Enter the graph option number desired by touching the numeric key indicated in the chart. If, when choosing any of the options, you key in an invalid option number (for this example, 27, 8), the CRT displays:

CHOOSING THE TYPE OF GRAPH
ENTER OPTION NUMBER
?_
ERROR – ILLEGAL OPTION NUMBER

Key in the valid option number. For this example, to generate a line graph, key in 1 and touch EXECUTE. After selecting the type of graph, the CRT screen displays:

```
CHOOSING THE TYPE OF GRAPH
ENTER OPTION NUMBER
?_

NO.   TYPE OF SCALE
1     LIN/LIN
2     LIN/LOG
3     LOG/LIN
4     LOG/LOG
5     POLAR
```

3. Enter the scale option number desired by touching the numeric key indicated on the chart. For the example, to generate a linear/linear scale, key in 1 and touch EXECUTE. After selecting the scale option, the CRT screen displays:

```
CHOOSING THE TYPE OF GRAPH
ENTER OPTION NUMBER
?_

NO.   TYPE OF AXES
1     X- AND Y-AXES
2     HORIZONTAL LINES
3     HATCHED AXES
```

4. Enter the axes number option desired by touching the numeric key indicated on the chart. To generate a X- and Y- axes, key in 1 and touch EXECUTE. After selecting the type of axes, the CRT screen displays:

> **NOTE:**
>
> *The format option selects the size and format of the numbers used to label the axes of the graph. Format 1 will set the character size equal to 2% of the range on X. Formats 2 and 3 will set the character size equal to 1% of the range on X. These are the only available format options for labeling the axes.*

```
CHOOSING THE TYPE OF GRAPH
ENTER OPTION NUMBER
?_

NO.   SIZE #   FORMAT
1     2        (-##)
2     1        (-#####)
3     1        (-##.##)
```

5. Enter the format option desired by touching the numeric key indicated on the chart. For this example, key in 2 and touch EXECUTE. After selecting the format option, the CRT screen displays:

```
END OF PROGRAM
:_
```

The END OF PROGRAM message appears each time you are ready to go on to the next key, in this example, Special Function Key '1.

The options specified under Special Function Key '0 are used in all plots until the program is re-run to specify new options. Special Function Key '0 must be depressed, and all options selected, before running any other programs in the Plotter Utility Package.

B. ENTERING DATA
(Special Function Key '1)

Special Function Key '1 is used to store data in the System 2200B memory to be used for plotting at a later time.

1. Depress Special Function Key '1. The CRT screen displays:

```
ENTERING THE DATA
NUMBER OF POINTS TO BE ENTERED
?_
```

2. Enter the number of points (pairs of numbers) you want to graph. For this example, key in 14 and touch EXECUTE.

> **NOTE:**
>
> *The program currently allows up to 50 points to be stored. The number can be increased by changing the DIM of X( ) and Y( ) in statement 140 of the program (see Plotting Utility Package, page 38). However, you cannot change the statement to exceed the memory capacity of your System 2200B.*

After entering the number of points the CRT screen displays:

```
ENTERING THE DATA
NUMBER OF POINTS TO BE ENTERED
 1          ?
 I          X(I)          Y(I)
---    --------      --------
```

3. The number 1 is a counter for the points you are to enter. The display screen visually keeps track of each entered value of X and Y. The first pair of points to be entered in the example have a value of (1960, 2.2). Key in 1960 and touch EXECUTE. The CRT screen displays:

```
ENTERING THE DATA
NUMBER OF POINTS TO BE ENTERED
 1          ?1960      ?_
 I          X(I)       Y(I)
---    --------  --------
```

4. Key in 2.2 and touch EXECUTE. The CRT screen displays:

```
ENTERING THE DATA
NUMBER OF POINTS TO BE ENTERED
 2          ?_

 I         X(I)          Y(I)
---    --------      --------

 1         1960          2.2
```

5. Enter your data in order. If you make an entry error, do not stop. Continue on to the next value. Key in the values:

1961	EXECUTE	2.8	EXECUTE
1962	EXECUTE	3.7	EXECUTE
1963	EXECUTE	4.5	EXECUTE
1964	EXECUTE	5.3	EXECUTE
1965	EXECUTE	5.9	EXECUTE
1966	EXECUTE	6.3	EXECUTE
1967	EXECUTE	5.8	EXECUTE
1968	EXECUTE	5.9	EXECUTE
1969	EXECUTE	6.4	EXECUTE
1970	EXECUTE	7.7	EXECUTE
1971	EXECUTE	9.6	EXECUTE
1972	EXECUTE	10.2	EXECUTE
1973	EXECUTE	11.3	EXECUTE

When all the points are entered, the CRT screen displays:

```
END OF PROGRAM
:_

 I         X(I)          Y(I)
---    --------      --------

 11        1970          7.7
 12        1971          9.6
 13        1972          10.2
 14        1973          11.3
```

The data is now in the System 2200B memory and can be used for plotting.

C. REVIEW/CORRECT DATA
(Special Function Key '2)

Special Function Key '2 allows you to review and, if necessary, correct the data stored in the System 2200B memory.

1. Fourteen items of data were entered, each with two values. To review the data for errors, depress Special Function Key '2. For the example, if item 6 was entered incorrectly, the CRT screen displays:

DATA REVIEW/CORRECTION
CORRECTION ?
?_

I	X(I)	Y(I)
1	1960	2.2
2	1961	2.8
3	1962	3.7
4	1963	4.5
5	1964	5.3
6	1975	5.9
7	1966	6.3
8	1967	5.8
9	1968	5.9
10	1969	6.4

2. The data entered into memory is displayed on the CRT screen, 10 items at a time. Verify the data against the CRT screen. If you made an entry error, it can be corrected now. In this example, to change line 6, key in the item number and the correct data as follows:

   6 and EXECUTE
   1965 and EXECUTE
   5.9 and EXECUTE

The line is changed on the CRT screen and the corrected data replaces the erroneous data in memory. Continue correcting any other errors by entering the line number and the two correct data values, each separated by EXECUTE.

3. When no more corrections are necessary, key in 0 and touch EXECUTE.

4. The next 10 items are displayed on the CRT screen. In this example, the CRT should display:

DATA REVIEW/CORRECTION
CORRECTION?
?_

I	X(I)	Y(I)
11	1970	7.7
12	1971	9.6
13	1972	10.2
14	1973	11.3

Again make any necessary corrections.

5. After completing all necessary corrections, key in 0 and touch EXECUTE. The END OF PROGRAM message is displayed on the screen. The data is now ready for use.

D. SCALING
(Special Function Key '3)

This program scales the plot. In order for the Plotter Program Package to be as useful as possible, it must work with numbers over either a very small range or a very large range. The program called by Special Function Key '3 requests the range of numbers you are working with.

1. Depress Special Function Key '3. The CRT screen displays:

```
SCALING
X-MIN
?_
```

2. In this example, the range of X is from 1960 to 1973 (years) and the range of Y is from 2.2 to 11.3 ($ billions). For asthetic purposes, round off the numbers, and Key in:

```
1960      EXECUTE      (X-MIN)
1975      EXECUTE      (X-MAX)
0         EXECUTE      (Y-MIN)
15        EXECUTE      (Y-MAX)
```

```
SCALING

  X RANGE IN INCHES
    30, EXECUTE

  Y RANGE IN INCHES
    20, EXECUTE
MARGIN
    5, EXECUTE
```

You are now ready to go on to the next step.

NOTE:

For most graphs, use round numbers for the limits on X and Y. For example, if the range of values for X are 8 to 92, give the limits on X as 0 to 100. It makes the graph more readable. Also, if you draw axes for the graph, hash marks are placed at regular intervals along the axes starting at the minimum value. It is easier reading a graph labeled 0, 10, 20, etc. than one labeled 8, 18, 28, etc.

E. DRAWING THE GRAPH
(Special Function Key '4)

Once the plotting options have been selected, the data (if any) entered, and the scaling completed, this program draws the desired graph on the plotter. For line graphs, pie charts, point graphs, and linear regressions, the only action required is to depress Special Function Key '4.

1. Since the example is a line graph, depress Special Function Key '4. The CRT screen displays:

```
DRAWING THE GRAPH
_
```

and the plotter pen moves on the paper, producing the graph. Upon completion of the graph, the END OF PROGRAM message is displayed. You are ready to go on to the next step.

F. DRAWING AND NUMBERING THE AXES (Special Function Key '5)

If you use plain paper for your graph, this program draws and numbers the axes, as specified when you chose the plotting options.

The program for drawing the X- and Y- axes draws the X-axis from X-Min to X-Max, with hash marks, starting at X-Min, at intervals of Delta X. It draws the Y-axis from Y-Min to Y-Max with hash marks, starting at Y-Min, at intervals of Delta Y. The point of intersection of the axes can be specified so the axes do not have to intersect at the origin.

1. Depress Special Function Key '5. The CRT screen displays:

```
DRAW X- AND Y- AXES INTERSECTING
                          AT (X,Y)
X
?_
```

The program asks first for X, then Y, then Delta X and Delta Y. You must key in the value of the abscissa of the intersection of the axes, the ordinate of the intersection of the axes, the value of the increment of X and the value of the increment of Y. The values of X-Min, X-Max, Y-Min and Y-Max are not requested, since they were entered into memory during the Scaling procedure.

2. In this example, X ranges from 1960 to 1975, and Y ranges from 0 to 15. The axes are to intersect at point (1960, 0). Hash marks are used for each year and each million. Key in:

1960	EXECUTE
0	EXECUTE
1	EXECUTE
1	EXECUTE

The plotter pen now draws the X and Y axes, with hash marks at one unit intervals.

This program also numbers the axes just drawn, using the letter size and format chosen in the plotting options.

After the axes are drawn, the CRT screen displays:

```
NUMBER THE AXES?
```

1. If you want to number the axes, key in 1 and touch EXECUTE; if not, just touch EXECUTE. If you choose to number the axes, the CRT screen displays:

```
NUMBERING THE AXES
FIRST X
?_
```

2. The program asks for First X, then Last X, Delta X, First Y, Last Y, and Delta Y. In the example, X (years) goes from 1960 to 1975. The numbers are to be printed in five year intervals. Y (millions) goes from 0 to 15, again to be printed in five million intervals. Key in:

1960	EXECUTE
1975	EXECUTE
5	EXECUTE
0	EXECUTE
15	EXECUTE
5	EXECUTE

The CRT screen now displays:

```
NUMBERING THE AXES
ENTER LETTER SIZE OPTION FOR THE
     Y-AXIS (IF DIFFERENT FROM X-).
?_
```

3. If the range of Y is much larger than the range of X, a format allowing more digits is needed. If you want the format letter size option on the Y-axis different from the X-axis, key in the desired option and touch EXECUTE (consult the chart to the right).

OPTIONS

OPTION	LETTER SIZE	FORMAT
1	2	-##
2	1	-#####
3	1	-##.##

Since the same format for X and Y is used in the example, touch EXECUTE. The plotting pen labels the axes. You are ready to go on to the next step.

NOTE:

If plotting on four quadrants, and the point Y=0 is being labeled on the X-axis, the number 0 is drawn over the X-axis. If Option 1 is used, the point X=0 is labeled on the Y-axis. If you do not want to label the point (0,0), run the program twice. The first time label the third quadrant and the second time label the first quadrant.

G. PRINTING A CHARACTER STRING
(Special Function Key '6)

For labeling purposes, this program prints a character string (words or characters), starting at the location (X,Y). It can be used to label any part of the graph you choose: the X and Y axes; a point on the plot; the top of a bar chart; et cetera.

The character string can contain only legal Model 2232 characters. They are the letters A through Z; the digits 0 through 9; and the 14 special characters ( ) & . , / + – ' = space ↑ " and ".

1. Depress Special Function Key '6. The CRT screen displays:

PRINT A CHARACTER STRING STARTING AT THE LOCATION (X,Y).
STRING
?_

2. To label the X-axis with YEAR, key in:

   YEAR and EXECUTE

NOTE:

If the character string includes a comma or a leading blank, you must enclose it in quotation marks.

3. The program now asks for the X and Y values at which the first letter of the character string is to be printed, and the size of the characters. In deciding what character size to use, consult the table to the right, which shows how many characters will fit on a line 900 plot positions long (the length of the X-axis). For the example, key in:

1974	and EXECUTE
1	and EXECUTE
.5	and EXECUTE
0	and EXECUTE

The plotter pen writes YEAR at the specified position (above the end of the X-axis).

> **NOTE:**
>
> *If more than 28 characters are used to label an axis, the extra characters disappear from the screen when the location of X is entered. They are, however, kept in memory.*

4. Since the program accepts only one character string at a time, to print DOLLARS at the top of the Y-axis, again depress Special Function Key '6. For the example, key in:

DOLLARS	and EXECUTE
1961	and EXECUTE
15	and EXECUTE
.5	and EXECUTE
0	and EXECUTE

The plotter pen prints DOLLARS at the specified position. You are ready to go on to the next step.

H. PRINTING A CHARACTER STRING CENTERED

(Special Function Key '7)

For labeling purposes, this program prints a character string, using any character size, centered at the location (X,Y). Again, it can label any part of the graph, but is used to print a centered title on the graph. The operating procedures are identical to Special Function Key '6.

1. Depress Special Function Key '7. The CRT screen displays:

PRINT A CHARACTER STRING CENTERED AT THE LOCATION (X,Y).

STRING
?_

2. In this example, title the graph WIDGET CO. SALES, in large letters. Key in:

WIDGET CO. SALES	EXECUTE
1967.5	EXECUTE
14	EXECUTE
.75	EXECUTE
0	EXECUTE

The pen prints the heading, centered over the graph.

3. To print the subheading IN MILLIONS, again depress Special Function Key '7 and key in:

IN MILLIONS	EXECUTE
1967.5	EXECUTE
13	EXECUTE
.5	EXECUTE
0	EXECUTE

The plotter pen prints the subheading centered underneath the heading, in the next smaller character size. The graph is now complete.

EXAMPLE 2
LINE GRAPH
LINEAR/LINEAR SCALE
X- AND Y-AXES
HATCHED AXES

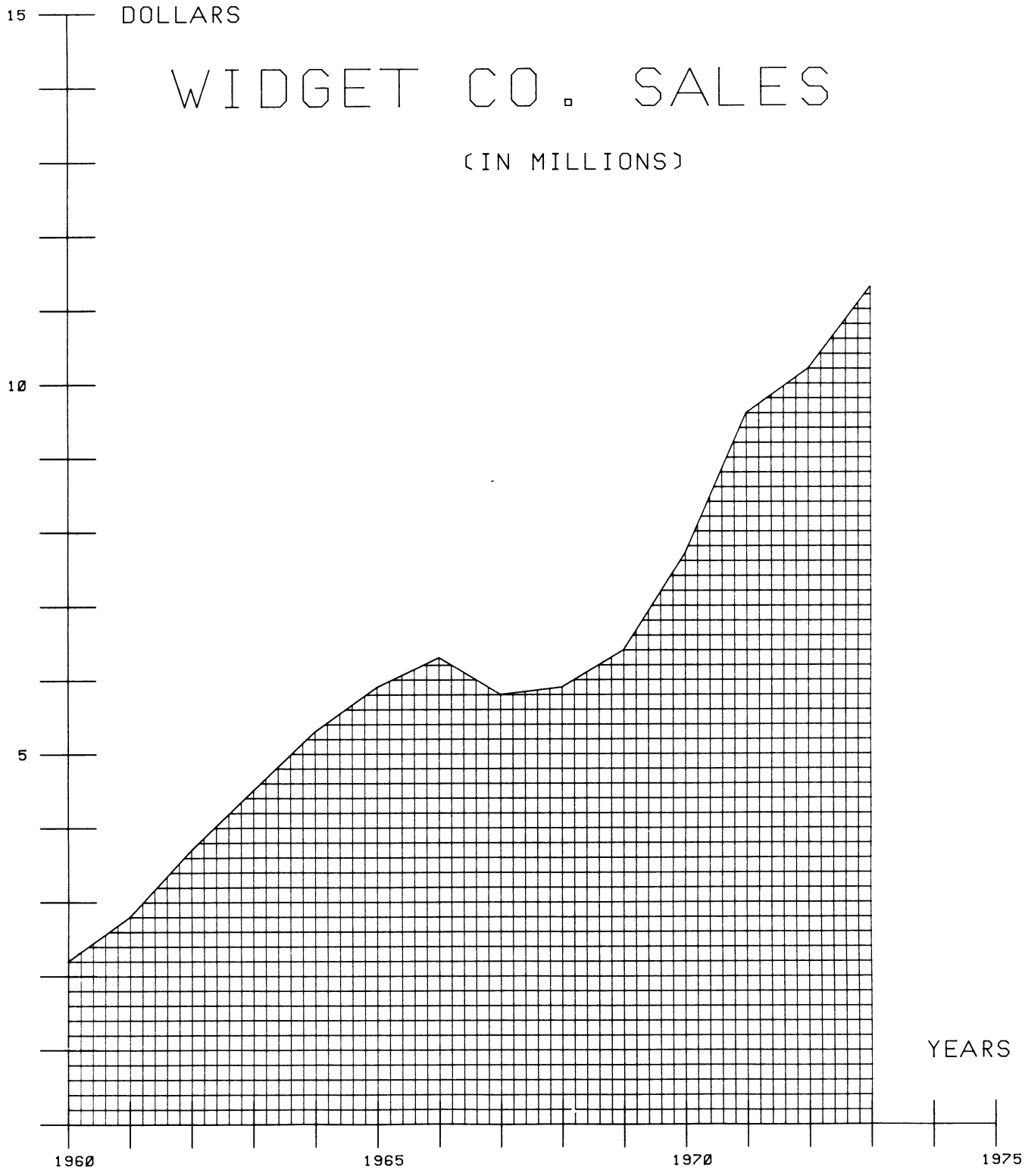
The hatched axes subroutine draws a hatched network of horizontal and vertical lines underneath a line graph (see Example 2). The four restrictions on the use of this subroutine are:

1. It can be used effectively only with a line graph.
2. The data points must be stored in order according to the values stored in X( ).
3. X(1) must be used for X-Min and X(last) must be used for X-Max when scaling.
4. X and Y must be linear scales.

This example again generates the graph in Example 1, adding hatched axes. Go through each of the steps in Example 1, making only one change: for the location of the character string YEAR, enter X=1974, Y=–.5, and Char Size = 1. With hatched axes, the label looks better under the X-axis.

Again, depress Special Function Key '0. Key in 1 for Type of Graph, 1 for Type of Scale, 3 for Type of Axes, and 2 for Format. Depress Special Function Key '3. X-Min = 1960, X-Max = 1975, Y-Min = 0, and Y-Max = 15. Enter the values. X RANGE IN INCHES 30, Y RANGE IN INCHES 20, MARGIN 5.

Depress Special Function Key '5. Delta X is the separation between vertical lines, and Delta Y is the separation between horizontal lines. For this example, Delta X = .2, Delta Y = .1. Key in the values. The plotter draws the hatched axes. The graph is complete.



Example 2 Hatched Line Graph Linear/Linear Scale

EXAMPLE 3
BAR CHART
LINEAR/LINEAR SCALE
X- AND Y-AXES
HORIZONTAL LINE AXES

To plot a bar chart of the way people travel to work, in percentages, with X- and Y-axes and horizontal lines (see Example 3), use the data:

Ride Alone	42%
Mass Transit	38%
Car Pool	18%
Walk	2%

Depress Special Function Key '0. Key in 4 for Type of Graph, 1 for Type of Scale, 1 for Type of Axes, and 1 for Format.

Depress Special Function Key '1. Key in 4 for Number of Points To Be Entered. When generating bar charts, X(I) requested in this program is the location of the center of the bar, and Y(I) is the height of the bar. Key in:

X(I)	Y(I)
1	42
2	38
3	18
4	2

If necessary, depress Special Function Key '2; review and correct the data.

Depress Special Function Key '3. To make sure the bar chart sits entirely on the line (X-axis), the plot must be scaled properly. Allow at least one unit on each side of the minimum and maximum ranges of the bar locations. Since the graph is four bars, located at 1, 2, 3, and 4, X-Min=0 and X-Max=5. None of the percentages are greater than 50 percent, so Y-Min=0 and Y-Max=50. Key in the values. X RANGE IN INCHES 30, Y RANGE IN INCHES 20, MARGIN 5.

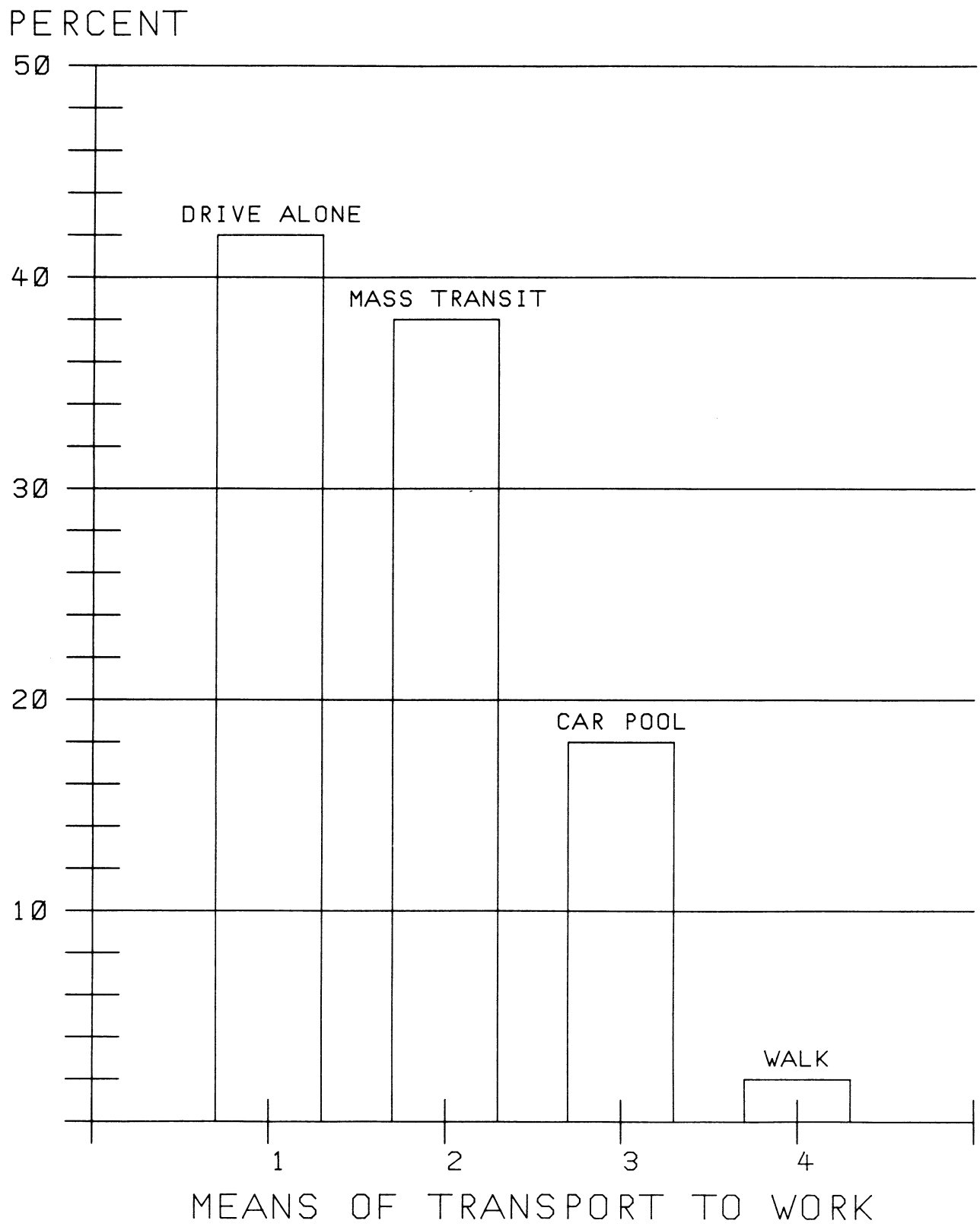
Depress Special Function Key '4. When producing a bar chart, this program does not immediately plot the graph. The CRT screen displays:

```
DRAWING THE GRAPH
INPUT WIDTH OF BAR
?
```

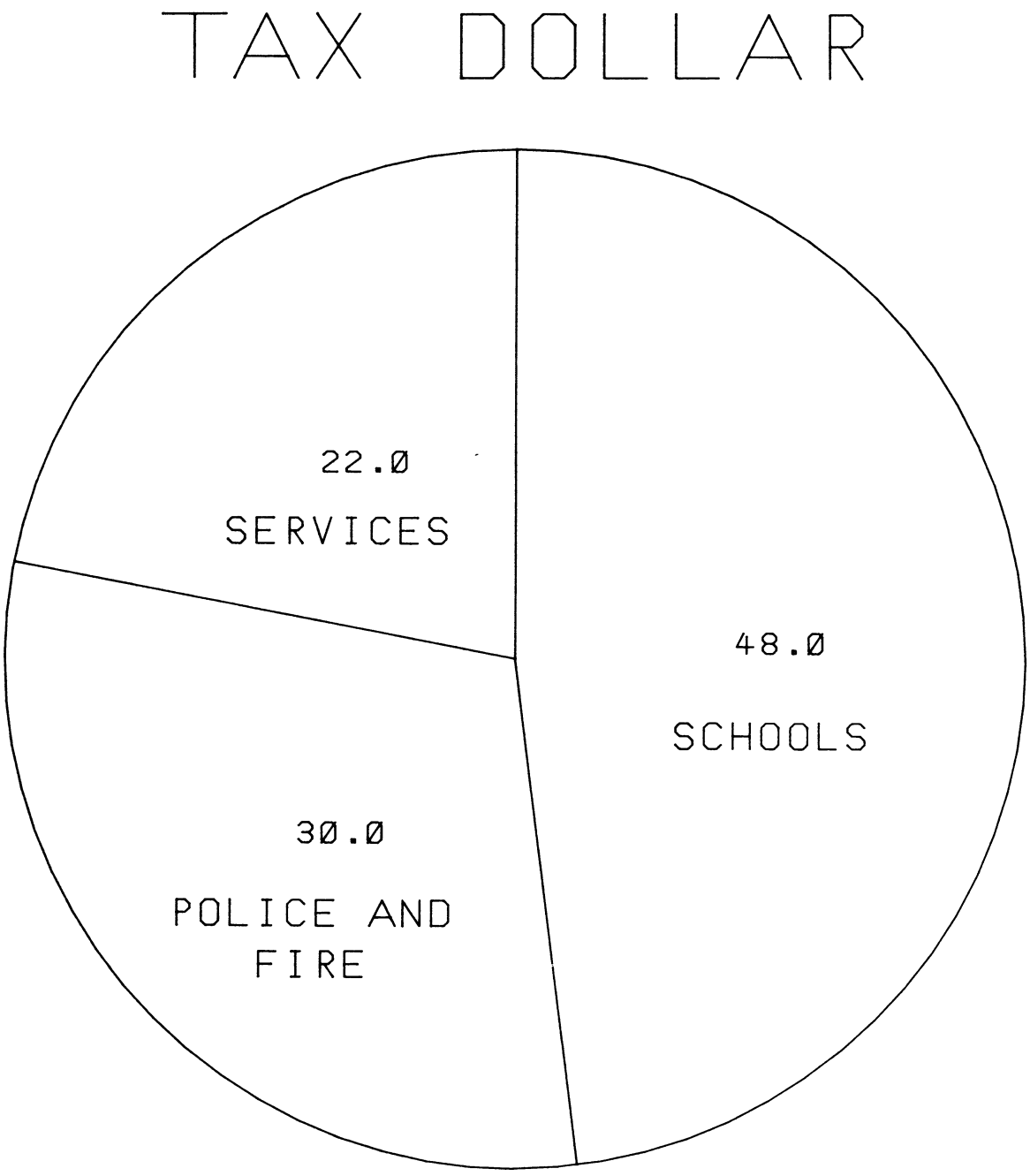
You can select any width in X-units that looks esthetically pleasing with your graph. For this example, since the scale is from 1 to 5, with four bars, key in .5. The plotter now draws the graph.

Depress Special Function Key '5. Since Option 1 was selected initially, draw the X- and Y-axes first. X and Y intersect at 0,0. Delta X is 1, and Delta Y, for appearance, is 2. Key in the values. Number the axes, 1 execute. The graph has four bars; the first X=1, last X=4, and Delta X=1. Because the percentages range from 0 to 50, first Y=0, last Y=50, and Delta Y, again for appearance, equals 10. Key in the values. Since the size of the lettering on the X- and Y-axes is the same, touch EXECUTE after the CRT displays the request for the Y-axis letter size option. X=1, X=4, DX=1, Y=0, Y=50, DY=10.

To draw the horizontal lines on the graph, depress Special Function Key '0 again, and key in 4 for Type of Graph, 1 for Type of Scale, *2* for Types of Axes, and 1 for Format. Your data is still in memory.



Example 3 Bar Chart Linear/Linear Scale Horizontal Axis



Example 4 Pie Chart Linear/Linear Scale

Depress Special Function Key '5. The subroutine for horizontal lines draws the lines from X-Min to X-Max. The bottom line is Y-Min and the top line is Y-Max, with the separation between lines as Delta Y. Hash marks are drawn at intervals of Delta X. Horizontal lines for axes are most effective with bar charts; they sometimes can be used with a line graph. They are never used with other graphs. In the example, Delta X for the hash marks in X direction must be the same as the Delta X used when drawing the X- and Y-axes, in this case 1. Delta Y for separation of lines should be the same as the Delta Y of the numbering for the Y-axis, 10. Key in the values.

To label the graph, depress Special Function Key '6. You want to label the X-axis PERCENT. Key in the string PERCENT. The location of X and Y, the beginning of the string, is X=1, Y=51, the character size = .5, angle 0. Key in the values.

To center titles over each bar, depress Special Function Key '7. For the first bar, use the information DRIVE ALONE, X=1, Y=43, character size = .1, angle = 0. Repeat the process for each bar. The values are:

BAR 2	BAR 3	BAR 4
MASS TRANSIT	CAR POOL	WALK
X=2	X=3	X=4
Y=39	Y=19	Y=3
Char Size = .4	Char Size = .4	Char Size = .4
Angle 0	Angle 0	Angle 0

Again, depress Special Function Key '7 to create a title for the graph. For our example, enter MEANS OF TRANSPORT TO WORK, X=2.5, Y=–5, Char Size = .75, Angle = 0. The graph is complete.

EXAMPLE 4
PIE CHART
LINEAR/LINEAR SCALE

This graph is a typical pie chart showing how a tax dollar is spent (see Example 4).

Depress Special Function Key '0. Key in 6 for Type of Graph. Since no other options are necessary, the CRT screen displays:

```
END OF PROGRAM
:_
```

Depress Special Function Key '1 and enter 3 for the Number of Points, and the values 48, 30, and 22. When generating a pie chart, the program does not ask for the values of Y.

```
DEPRESS SPECIAL FUNCTION KEY '3

  SCALING
  DIA. 15, MARGIN 10
```

Depress Special Function Key '4. The plotter draws the pie chart and prints the appropriate percentages.

Labelling the pie chart is done by estimating the values of X and Y. The ranges of the pie chart are illustrated in Figure III-4.

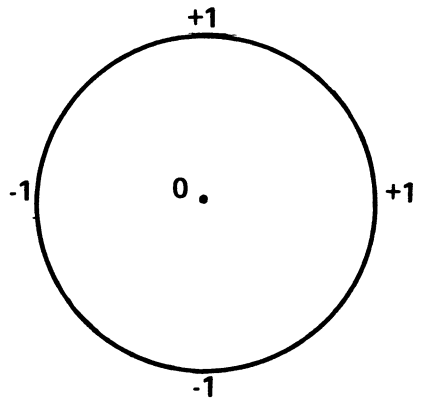


Figure 2. Ranges of the Pie Chart

To label this example, use Special Function Key '7 and key in the values:

STRING	X	Y	CHAR SIZE	ANGLE
SCHOOLS	.5	–.15	.3	0
POLICE AND	–.4	–.5	.3	0
FIRE	–.4	–.6	.3	0
SERVICES	–.35	.25	.3	0

Also use Special Function Key '7 to title the graph. Key in the values:

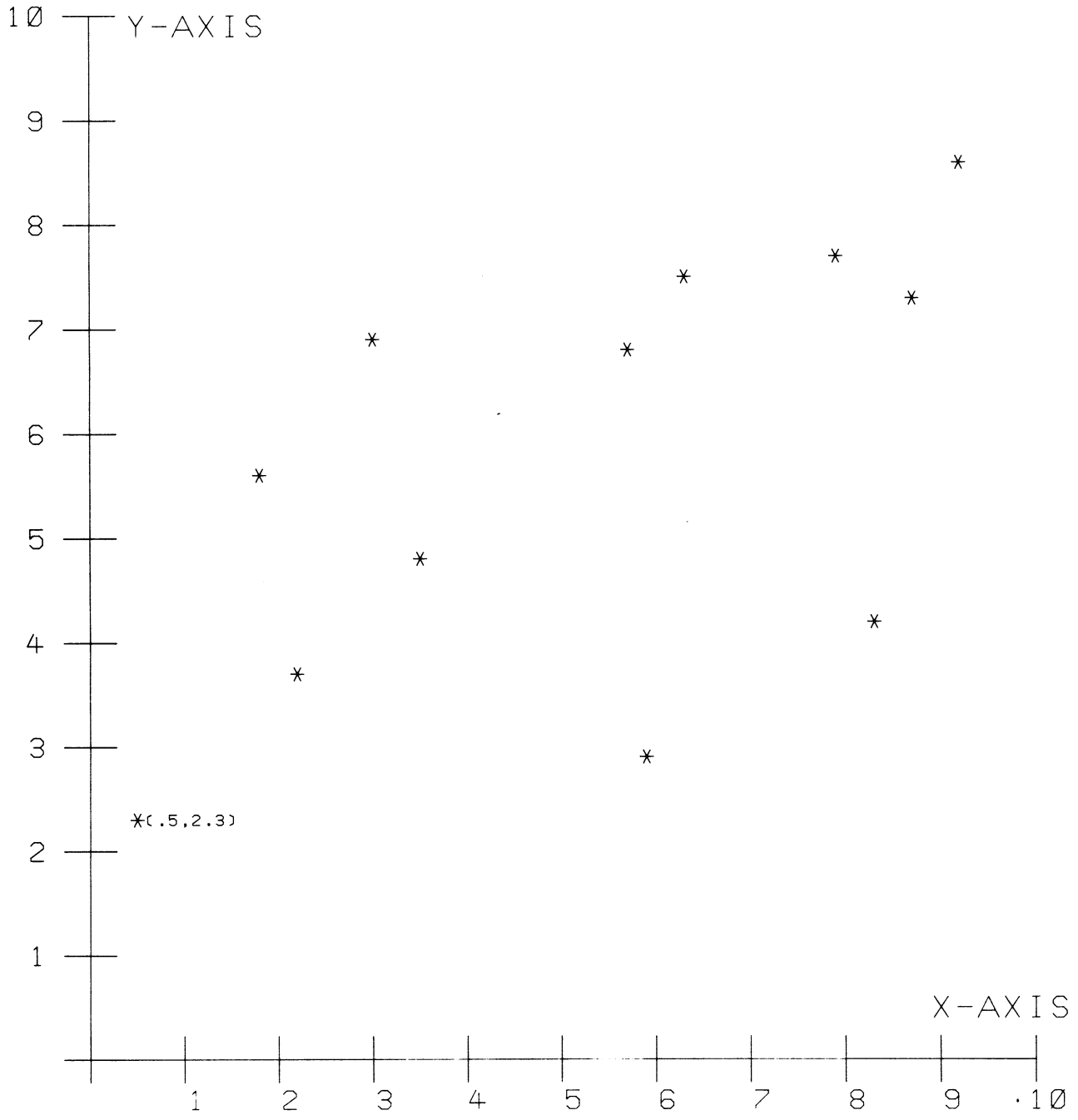
STRING	X	Y	CHAR SIZE	ANGLE
TAX DOLLAR	0	1.10	3	0

The example is complete.

EXAMPLE 5
POINT GRAPH
LINEAR/LINEAR SCALE
USING GRAPH PAPER

Example 5 (see Example 5) generates on graph paper a point graph, with linear/linear scale, of the points:

X	Y
.5	2.3
1.8	5.6
2.2	3.7
2.3	4.8
3.0	6.9
3.5	4.8
5.9	2.9
6.3	7.5
5.7	6.8
7.9	7.7
8.3	4.2
9.2	8.6
8.7	7.3



Example 5. Labeled Point Graph, Linear/Linear Scale

SECTION III—UTILITY ROUTINES

Depress Special Function Key '0 and select the proper options. Key in 2 for the Type of Graph, 1 for the Type of Scale, 1 for the Type of Axes, and 1 for the Format. When using graph paper you do not need to draw the axes; they are provided by the lines on the paper. The axes cannot be labelled in the normal manner, because of the necessary scaling procedure. But you must select an option for Type of Axes and Format to complete the program.

Enter the data into memory by depressing Special Function Key '1 and key the values. Use Special Function Key '2 to review and, if necessary, correct the data.

Special scaling is needed when using graph paper. First, depress Special Function Key '3 and run the scaling program. The values for the example are:

X-Min = 0 Y-Min = 0
X-Max = 10 Y-Max = 10

RANGE IN INCHES
X 30, Y 20, MARGIN 5

Depress Special Function Key '4. Draw x- and y-axes intersecting at 0,0.
Depress Special Function Key '5. Delta x is 1 and delta y is 1.

Numbering the axis
1, Execute
First X=1, Last X=10, Delta X=1, First Y=1, Last Y=10, Delta Y=1.

You can label the graph paper by hand, or use Special Function Keys '6 and '7, which print both alpha and numeric strings (see Figure III-8). For example, using Special Function Key '6, enter each Y-axis point:

STRING	X	Y	CHAR SIZE	ANGLE
0	.1	.1	1	0
1	.1	1	1	0
2	.1	2	1	0
3	.1	3	1	0
.				
.				0
.				
10	.1	9.8	1	

You must label 10 at(.1, 9.8) because the pen cannot go outside the range of Y-Max. The points on the X-axis can be labelled in the same manner. Likewise, you can label the axes. Depress Special Function Key '6, and enter the values:

STRING	X	Y	CHAR SIZE	ANGLE
Y-AXIS	.5	9.9	.4	0
X-AXIS	9	.5	.4	0

You also can label each point, depending on where the points fall. For example, using Special Function Key '6, enter:

STRING	X	Y	CHAR SIZE	ANGLE
" (.5, 2.3)"	.5	2.3	.2	0

Be sure to leave one space between the quotation mark and the parenthesis.

EXAMPLE 6
LINEAR REGRESSION
LINEAR/LINEAR SCALE
X- AND Y- AXES

This example plots the linear regression of the points in Example 5, using plain paper (see Example 6).

Depress Special Function Key '0. Key in 3 for Type of Graph, 1 for Type of Scale, 1 for Type of Axes, and 1 for Format.

Enter the data (see page 40) into memory by depressing Special Function Key '1 and keying in the values. Review and correct the data, if necessary (Special Function Key '2).

Depress Special Function Key '3. X-Min = 0, X-Max = 10, Y-Min = 0, and Y-Max = 10. Key in the values.

RANGE IN INCHES

X	Y	MARGIN
30	20	5

Depress Special Function Key '4. The plotter draws the graph.

To draw and label the axes, depress Special Function Key '5. The axes intersect at X = 0, Y = 0. Delta X and Delta Y for the hash marks = 1. Key in the values. The plotter draws the axes. To label the axes, First X=0, Last X=10, Delta X=1, First Y=0, Last Y=10, and Delta Y=1. Key in the values. Since the letter size is the same for both axes, touch EXECUTE. The plotter labels the axes.

Depress Special Function Key '7 to title the graph. Enter the values:

STRING	X	Y	CHAR SIZE	ANGLE
LINEAR REGRESSION	5	9.5	.75	0

The graph is complete.

EXAMPLE 7
COMPUTED FUNCTION
LINEAR/LOGARITHMIC SCALE
X- AND Y- AXES

This example is a graph of the loan balance versus time, using linear/logarithmic scale, of a $5,000 loan, with $150 monthly payments, 7-1/2 percent interest rate, over 36 months (see Example 7).

Before running the program to plot Y as a function of X, the following lines must be keyed in:

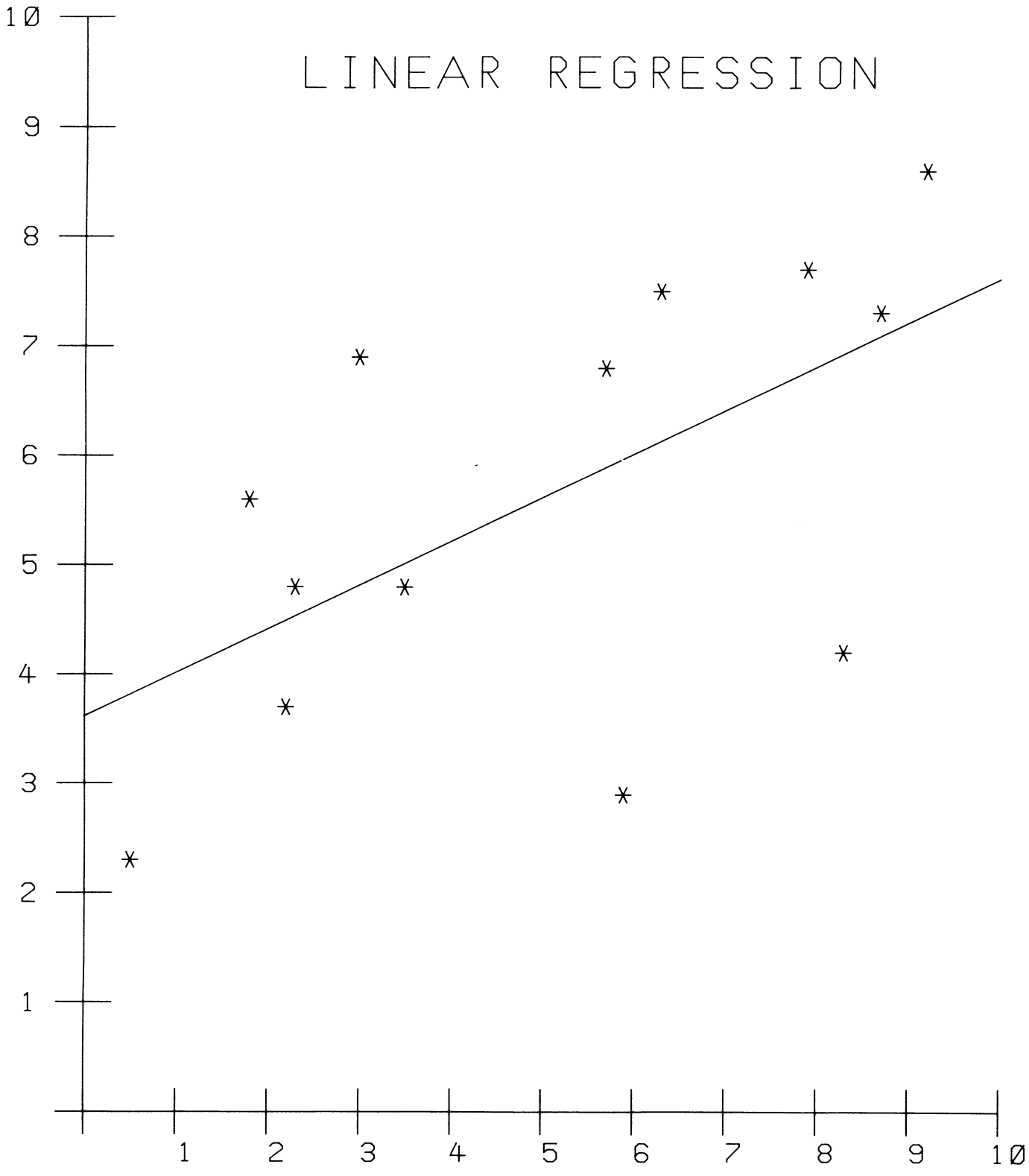
930 Y = Expression Involving X

For this example, key in:

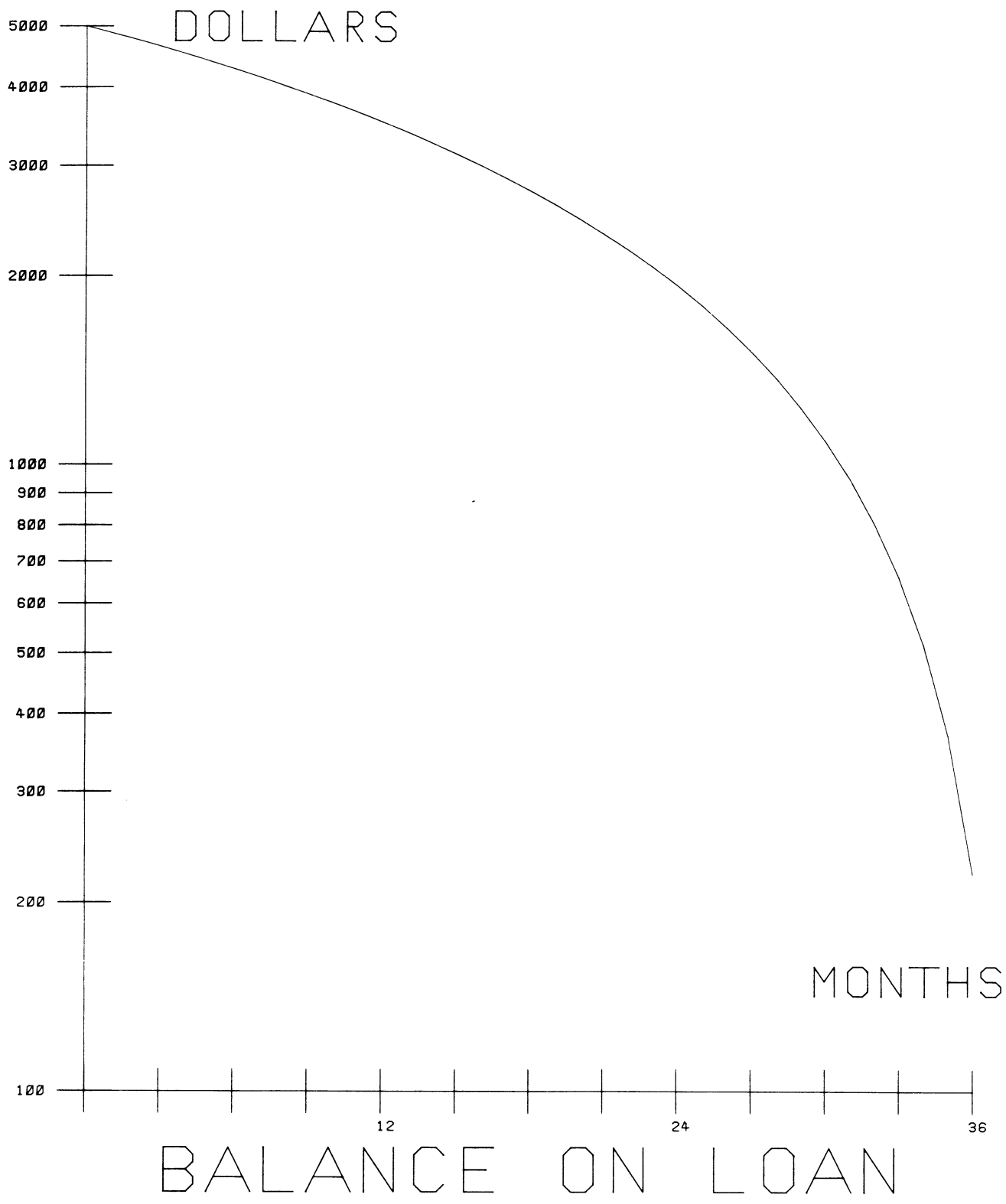
```
930 Y=5000* (1+7.5/1200)↑X-150*(((1+7.5/1200)↑X-1)/(7.5/1200))
```

1. Depress Special Function Key '0 and key in 5 for Type of Graph, 2 for Type of Scale, 1 for Type of Axes, and 1 for Format.
2. For plotting a computed function, three items of information are needed: T-Min, T-Max, and Delta T, where T is the range for the values to be computed. For example, if plotting Y as a function of X, then Y is computed for values of X starting with T-Min and going to T-Max in increments of Delta T.
3. Depress Special Function Key '8. The CRT screen displays:

FIND LIMITS ON X AND Y



Example 6 Linear Regression Linear/Linear Scale



Example 7 Computed Function Linear/Logarithmic Scale

The CRT asks for the values of T-Min, T-Max, and Delta T. In this example, the range of the time of the loan is from 0 to 36 months, in increments of one month. Enter the values:

T-Min = 0
T-Max = 36
Delta T = 1

After a short pause, the CRT screen displays the END OF PROGRAM message and the values for X-Min, X-Max, Y-Min and Y-Max. In the example, the values are:

X-Min = 0
X-Max = 36
Y-Min = 222.5234255
Y-Max = 5000

4. Depress Special Function Key '3. To scale the example graph, X-Min = 0, X-Max = 36, Y-Min = 100 and Y-Max = 5000. Key in the values. RANGE IN INCHES X30, Y20, MARGIN 5.
5. Depress Special Function Key '4. The CRT screen asks for the values of T-Min, T-Max and Delta T. For the example, enter the values T-Min = 0, T-Max = 36, Delta T = 1.
6. To draw and number the axes, depress Special Function Key '5. X and Y intersect at X = 0, Y = 100. Delta X = 3, Delta Y = 100. Key in the values. The plotter draws the axes. To label the axes, First X=0, Last X=36, Delta X=12, First Y=100, Last Y=5000, Delta Y=100. The Letter Size Option=2. Key in the values. The plotter labels the axes.

> **NOTE:**
>
> *When using the logarithmic scale Y-Min (or X-Min if logarithmic on the X-axes) should be a power of 10, and Delta Y (Delta X) should be one, three or nine times a power of 10. This is necessary if the logarithmic scale is multi-phased.*

7. To title the axes, depress Special Function Key '6 for each string and enter the values:

STRING	X	Y	CHAR SIZE	ANGLE
MONTHS	30	150	.5	0
DOLLARS	3	5000	.5	0

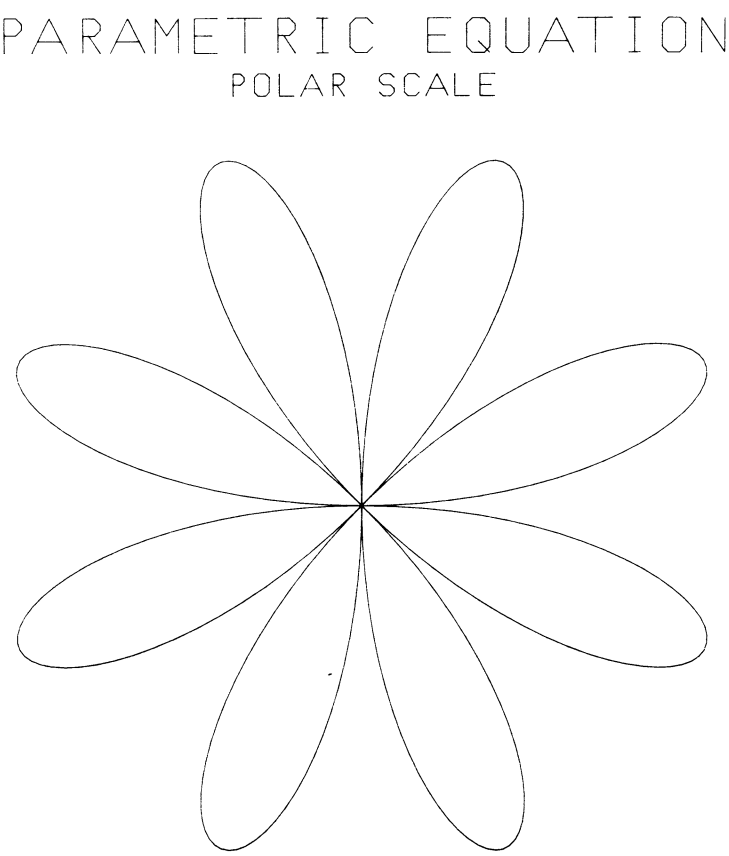
8. Depress Special Function Key '7 to title the graph. Key in the values:

STRING	X	Y	CHAR SIZE	ANGLE
BALANCE ON LOAN	18	65	.75	0

The graph is complete.

EXAMPLE 8
COMPUTED FUNCTION
POLAR SCALE

This example is a plot of a pair of parametric equations, using polar scale (see Example 8).



Example 8 Computed Function, Polar Scale

1. Depress Special Function Key '0 and key in 5 for Type of Graph and 5 for Type of Scale. The END OF PROGRAM message appears on the CRT screen; no other options are necessary.
2. Before running the program to plot the curve of a pair of parametric equations, it is necessary to key in the following lines:

920 X = Expression Involving T
930 Y = Expression Involving T

NOTE:

RESET
LIST 920, 930

In this example, key in the lines:

920 X = SIN (4*T) press "EXECUTE"
930 Y = T press "EXECUTE"

X = the radius and Y = the angle.

NOTE:

In this example we work in Radians. Therefore, the command SELECT R must be executed before the next step. If working in Degrees, you must execute the command SELECT D.

3. Depress Special Function Key '3. The CRT requests the value for the MAXIMUM value of the RADIUS. Key in 1. MAX. RADIUS IN INCHES 10, MARGIN 5.
4. To draw the graph, depress Special Function Key '4. In this example, T-Min = 0, T-Max = 6.28 and Delta T = .02. Key in the values.
5. Depress Special Function Key '7 to title the graph. Key in the values:

STRING	X	Y	CHAR SIZE	ANGLE
"PARAMETRIC EQUATION, POLAR SCALE"	1.05	90	.5	0

The graph is complete.

EXAMPLE 9
THREE-DIMENSIONAL PLOTTING

The program for generating a three-dimensional figure is achieved by instructing the system to draw a network of lines on the surface and project them onto a plane (see Example 9).

Any surface in three-dimension can be expressed by three parametric equations involving the two parameters r and s.

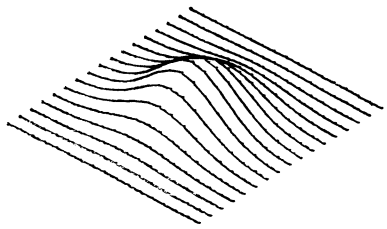
$$x = f(r,s)$$
$$y = g(r,s)$$
$$z = h(r,s)$$

Example:

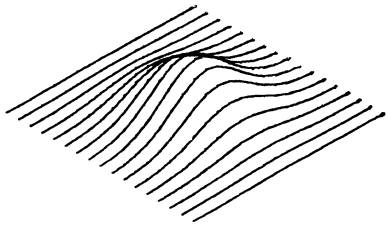
$$x = r$$
$$y = s$$
$$z = e^{-(r^2+s^2)} \text{ or } z = e^{-(x^2+y^2)}$$

A line on the surface can be generated by holding r constant and letting s assume all values for which the surface is defined.

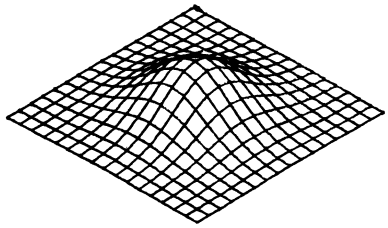
If a value, called the grid spacing is added to r and this procedure is repeated, we get another line on the surface. If we repeat this several times we get a grid on r.



We can do the same thing with s and get a grid on s.



When both are complete we get a complete drawing.

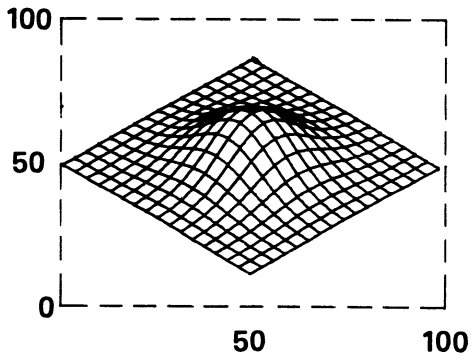


When tracing a grid line for r, s assumes an original value, s-min, and is incremented by a small value, delta-s. Delta-s should be less than or equal to the grid spacing on s and should divide into it evenly.

The following is an example of how to plot a drawing of a three-dimensional surface. The first set of values (X-min, X-max, etc.) reflect the range of numeric values to be assumed by X, Y, and Z while plotting. The last set of values is the desired length in inches of the X, Y, and Z axes that are used to make the plot. In the following example a margin of five inches is left going down the left-hand side and across the bottom of the plot.

Labeling of a three dimensional drawing is similar to the labeling of a regular two dimensional plot. Subroutines '1 and '2 will print a character string starting at a given location or centered about a given location respectively. The input required for these subroutines is the same as that for subroutines '6 and '7 described earlier in the manual. The input is the character string, x (horizontal) coordinate, y (vertical) coordinate, letter size, and rotation angle.

For labeling, a scale from 0 to 100 is assigned to the horizontal direction and vertical direction for X and Y. When labeling, these scales are used and not the three dimensional scales that were used for generating the drawing. Below is a drawing showing a plot and the corresponding number scales written in. Thus a title that you wanted printed at the top of the drawing would have coordinates (50,100).



THREE DIMENSIONAL PLOTTING

Operating Instructions

1. Select 3-D Plot } SEARCHING TAPE
2. 1 EXECUTE } STOP

:

```
995     X = R* COS(S)
1000    Y = R* SIN(S)
1005    Z = COS(100*R)/R
1010    RETURN
```

SELECT D (for degrees)

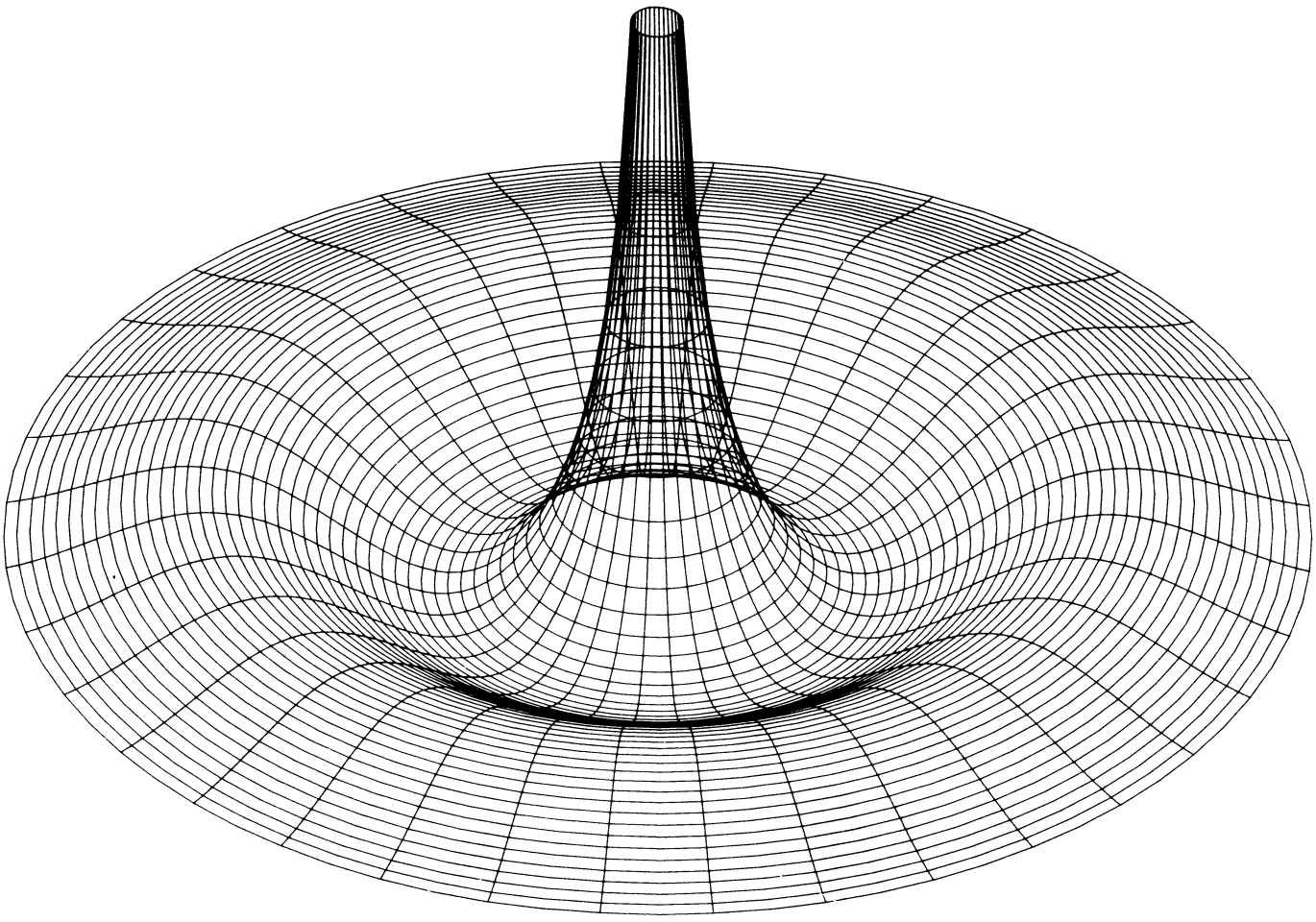
DEPRESS SPECIAL FUNCTION KEY '0

X min	X max	Y min	Y max	Z min	Z max
–5	+5	–5	+5	–5	+5

R min	R max	Grid Space on R	Delta R
.2	5	.1	.1

S min	S max	Grid Space on S	Delta S
0	360	15	5

X range	Y range	Z range	Margin
16	16	16	12



Example 9. Three Dimensional Plotting

(Special Function Key '14)

When completing any one of the plotting steps, the plotting bar might stop at a position which obscures part of the graph. In order to inspect the graph, you must move the plotting bar.

If you move the plotting bar with the zero reference check button or dials, or the scale adjust check button or dials, the program "loses" the current position of the plotting pen; it no longer knows where the plotting pen is located. Any further plots will not be positioned properly on the graph.

Special Function Key '14 moves the plotting pen to the lower left-hand corner of the plotter bed, and retains a record of the new position of the plotting pen.

MOVE PEN UPPER RIGHT

(Special Function Key '15)

Special Function Key '15 is identical in purpose to Special Function Key '14, except it moves the plotting pen to the upper right-hand corner of the plotter bed, instead of the lower left-hand corner.

PLOTTER UTILITY PACKAGE

The Plotter Utility Package is a listing and description of the internal subroutines utilized in the Plotter Program Package. It is provided to assist the programmer who wants to write a custom plotter program.

The following subroutines are described in the Plotter Utility Package:

Subroutine Number	Function
'10	Calculates the distance the plotter is to move.
'11	Moves plotter to a point with the pen up.
'12	Moves plotter to a point with the pen down.
'13	Converts the point to be plotted into linear scale point.
'16	Draws a pie chart showing the relative amounts for the numbers stored in the X array.
'18	Performs scaling and plotter initialization.
'19	Plots a curve with points that can be computed by a subroutine.
'20	Draws intersecting X and Y axes.
'21	Labels the X and Y axes.
'23	Prints the contents of a character string on a graph.
'24	Prints a character string centered about a point.
'25	Prints a bar chart of data stored in arrays X and Y.
'26	Prints a point graph of data stored in arrays X and Y.
'27	Same as (26), then computes and draws the "best fit" straight line.
'28	Draws a line graph of data stored in arrays X and Y.
'29	Draws horizontal lines for axes with evenly spaced hash marks along bottom line.
'30	Draws hatched axes under a line graph curve.

GOSUB' 10 (X,Y)

PURPOSE:

This subroutine has two purposes; it calculates Delta X and Delta Y, the distance to the right and up that the plotter is to move from its present position (source point). It also calculates and saves the new position (destination point) of (X,Y) in the units that the plotter uses.

GOSUB' 10 provides the basic bookkeeping required by the plotter. It is used by many other subroutines in the Plotter Program Package and should be transparent to the user. It must be core resident when using the Plotter Program Package.

INPUT:

X = Abscissa of the destination point (X,Y).
Y = Ordinate of the destination point (X,Y).
06 = The scale option. 06 must be set once, before calling subroutine '10. This determines the type of scale being used (e.g., lin/lin or lin/log). If 06 is not specified, the default is lin/lin.

```
200 REM ----------------------------------------
205 REM *     THIS SUBROUTINE COMPUTES DELTA X AND DELTA Y
210 REM *     INPUT TO THIS SUBROUTINE IS THE POINT (X,Y) TO
215 REM *          WHICH YOU WANT THE PLOTTER TO MOVE.
220 REM *
225 REM *     OUTPUT IS (X1,Y1), THE # OF PLOT POSITIONS TO THE
230 REM *          RIGHT AND UP THAT THE PLOTTER IS TO MOVE;
235 REM *          AND (X0,Y0), THE CURRENT PLOTTER POSITION
240 REM *          AFTER THE MOVE TAKES PLACE.
245 REM
250   DEFFN'10(X,Y)
255     GOSUB '13(X,Y)
260     X1 = INT(F1*X - X0 + .5)
265     Y1 = INT(F2*Y - Y0 + .5)
270     X0 = X0 + X1
275     Y0 = Y0 + Y1
280   RETURN
```

OPTION	FUNCTION
1	Linear on X and Y.
2	Linear on X and logarithmic on Y.
3	Logarithmic on X and linear on Y.
4	Logarithmic on X and Y.
5	Polar Co-ordinates.

OUTPUT:

X0 = Current X-plotter position.
Y0 = Current Y-plotter position.
X1 = Delta X.
Y1 = Delta Y.

GOSUB' 11 (X,Y)

PURPOSE:

This subroutine causes the plotter to move to the point (X, Y) with the pen up.

INPUT:

X = The abscissa of the destination point. If polar coordinates are being used, the radius.
Y = The ordinate of the destination point. If polar coordinates are being used, the angle.

OUTPUT:

The plotter moves the point (X,Y) with the pen up.
X is converted to a linear scale.
Y is converted to a linear scale.

```
400 REM ------------------------------
405 REM *     MOVE PLOTTER TO THE LOCATION (X,Y)
410 REM *          WITH THE PEN UP.
415 REM
420   DEFFN'11(X,Y)
425     GOSUB '10(X,Y)
430   DEFFN'33
435     U = ABS(X1)
440     IF U >= ABS(Y1) THEN 450
445     U = ABS(Y1)
450     IF U <= 999 THEN 485
455     X2 = INT(900/U*X1 + .5)
460     Y2 = INT(900/U*Y1 + .5)
465     PLOT (X2,Y2,U)
470     X1 = X1 - X2
475     Y1 = Y1 - Y2
480     GOTO 435
485     PLOT (X1,Y1,U)
490     RETURN
```

GOSUB' 12 (X,Y)

PURPOSE:

This subroutine causes the plotter to move to the point (X,Y) with the pen down.

INPUT:

X = The abscissa of the destination point. If polar coordinates are being used, the radius.
Y = The ordinate of the destination point. If polar coordinates are being used, the angle.

OUTPUT:

The plotter moves to the point (X,Y) with the pen down.
X is converted to a linear scale.
Y is converted to a linear scale.

```
500 REM ------------------------------
505 REM *     MOVE PLOTTER TO THE LOCATION (X,Y)
510 REM *          WITH THE PEN DOWN.
515 REM
520   DEFFN'12(X,Y)
525     GOSUB '10(X,Y)
530   DEFFN'34
535     U = ABS(X1)
540     IF U >= ABS(Y1) THEN 550
545     U = ABS(Y1)
550     IF U <= 999 THEN 585
555     X2 = INT(900/U*X1 + .5)
560     Y2 = INT(900/U*Y1 + .5)
565     PLOT (X2,Y2,D)
570     X1 = X1 - X2
575     Y1 = Y1 - Y2
580     GOTO 535
585     PLOT (X1,Y1,D)
590   RETURN
```

SECTION III—UTILITY ROUTINES

GOSUB' 13 (X,Y)

PURPOSE:

Since the Model 2232 is an X-Y-plotter that uses linear scales on X and Y, it is necessary that points being plotted be given in a coordinate system that is linear in X and Y. Therefore, this subroutine converts the given X and Y to a linear scale X and Y.

INPUT:

X = Actual value of X, or if polar coordinates are being used, the radius.
Y = Actual value of Y, or if polar coordinates are being used, the angle.

OUTPUT:

X = The linear scale value of X.
Y = The linear scale value of Y.

```
300 REM ------------------------------
305   DEFFN'13(X,Y)
310     ON 06 GOTO 315,320,330,325,335
315     RETURN
320     Y = LOG(Y) : RETURN
325     Y = LOG(Y)
330     X = LOG(X) : RETURN
335     V9 = X * COS(Y)
340     Y  = X * SIN(Y)
345     X = V9       : RETURN
```

GOSUB' 16

PURPOSE:

This subroutine draws a pie chart showing the relative amounts for the numbers stored in the X() array. Each section of the pie is labeled with the percent it represents.

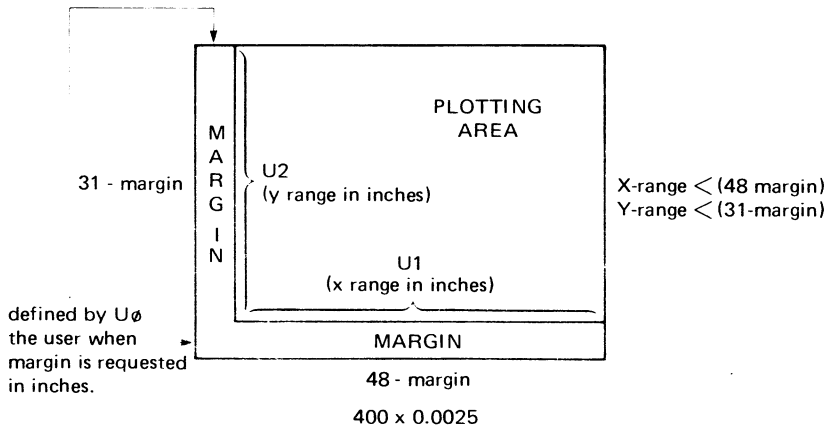
INPUT:

The X( ) array must contain the values the user is comparing and the scalar 0ø must contain the number of points stored in X() before calling the subroutine.

OUTPUT:

A pie chart is drawn with each section labeled with a percentage to show its relative size.

GOSUB' 18 (01,02,03,04, U1, U2, U0)



GOSUB' 18 computes the scaling factors F1 and F2 which are used to compute the corresponding plotter positions for a pair of coordinates (X,Y). It also selects the plotter so it will receive commands from the calculator. Since the plotter physically can be located anywhere on the page, the subroutine moves the plotter to the fixed point (X-min, Y-min) and stores the value of these points in X0, Y0.

INPUT:

- 01 = X-min, the smallest value that X will ever have.
- 02 = X-max, the largest value that X will ever have.
- 03 = Y-min, the smallest value that Y will ever have.
- 04 = Y-max, the largest value that Y will ever have.
- U1 = range of X in inches.
- U2 = range of Y in inches.
- U0 = margin in inches.

OUTPUT:

- F1 = The scaling factor for X.
- F2 = The scaling factor for Y.

The plotter moves to the point (01,03) with the pen up. The System 2200 now "knows" where the plotter is located. If the plotter is moved by anything other than the utility subroutines, or if a user tries to plot outside of the range specified by the scaling subroutine (physical plotting area on 2232A), the plotter can become "lost". That is, the internal pointers of the program located the plotter at one position when it actually is located at another position. Running the scaling subroutine corrects this situation.

```
600 REM ------------------------
605 REM *     SCALING & PLOTTER INITIALIZATION
610 REM *          01 = X-MIN
615 REM *          02 = X-MAX
620 REM *          03 = Y-MIN
625 REM *          04 = Y-MAX
630 REM *          U0 = MARGIN (IN INCHES)
635 REM *          U1 = RANGE OF X (IN INCHES)
640 REM *          U2 = RANGE OF Y (IN INCHES)
645 REM
650   DEFFN'18(01,02,03,04,U1,U2,U0)
651     RESTORE
652     FOR V = 1 TO 52
653     READ X9(V), Y9(V)
654     NEXT V
655     GOSUB '13(02,04)
660     X2 = X
665     Y2 = Y
670     GOSUB '13(01,03)
675     F1 = U1*400/(X2-X)
680     F2 = U2*400/(Y2-Y)
685     SELECT PLOT 413
690     PLOT <,,R>        : REM ZERO REFERENCE
695     X1,Y1 = 400*U0
700     GOSUB '33
705     GOSUB '10(01,03)
710   RETURN
```

GOSUB' 19 (V1, V2, V3)

RESTRICTION:

Before using this subroutine, the user must either enter a single statement defining Y as a function of X, or a pair of statements defining X and Y as functions of a parameter T.

Examples:

```
930 Y = (3*X + 5)*(2*X - 7)
```

or

```
920 X = EXP(T)
930 Y = EXP(T)/T
```

PURPOSE:

The purpose of the subroutine is to plot any type of curve with points that can be computed by a subroutine. It computes the curve when given either a statement defining Y as a function of X, or a pair of statements defining X and Y as functions of a parameter T.

INPUT:

V1 = The starting (minimum) value of T.
V2 = The limit (maximum value) of T.
V3 = The increment on T.

OUTPUT:

A curve is drawn connecting the computed points going from the starting value of T to the limit of T.

GOSUB' 20 (V1, V2, V3, V4)

PURPOSE:

This subroutine draws intersecting X- and Y-axes.

INPUT:

V1 = Abscissa of the intersection of the axes.
V2 = Ordinate of the intersection of the axes.
V3 = Separation of the hash marks on the X-axis.
V4 = Separation of the hash marks on the Y-axis.

OUTPUT:

The plotter draws a pair of axes intersecting at the point (V1,V2). First, hash marks are placed on the X-axis every V3 units of X starting with X-min. Then hash marks are placed on the Y-axis every V4 units of Y starting with Y-min.

> **NOTE:**
>
> *For the most esthetically pleasing results, the difference between X-min and X-max must be divisible by V3 and the difference between Y-min and Y-max must be divisible by V4.*

GOSUB' 21 (V1, V2, V3, V4, V5, V6, V7, V8, 08, 09)

PURPOSE:

This subroutine labels the axes that just have been plotted.

INPUT:

V1 = Abscissa of the intersection of the axes.
V2 = Ordinate of the intersection of the axes.
V3 = First number to be printed on the X-axis.
V4 = Last number to be printed on the X-axis.
V5 = Difference between consecutive numbers written. V4–V3 must be divisible by V5.
V6 = First number to be printed on the Y-axis.
V7 = Last number to be printed on the Y-axis.
V8 = Difference between consecutive numbers written. V7–V6 must be divisible by V8.
08 = Numbering option for the X-axis.
09 = Numbering option for the Y-axis.

OPTION	LETTER SIZE	FORMAT
1	2	-##
2	1	-#####
3	1	-##.##

OUTPUT:

The X- and Y-axes are numbered.

> **NOTE:**
>
> *If plotting on four quadrants, and the point Y=0 is labeled on the Y-axis, the number 0 is drawn over the X-axis. Also, if option #1 is used, the point X=0 is labeled on the Y-axis. In this case, it is desirable not to label the point (0,0). This can be done by running the program twice; the first execution labels the third quadrant and the second execution labels the first quadrant.*

GOSUB' 23 (X, Y, V$, U3, U4)

PURPOSE:

This subroutine prints the contents of the character string V$, starting at the location (V1, V2) and using letter size V3. The characters are printed horizontally, from left to right.

INPUT:

X = Abscissa of the starting letter of the character string.
Y = Ordinate of the starting letter of the character string.
V$ = Character string to be printed.
U3 = Letter size to be printed in inches .5 = 1/2 inch height.

To help select the proper letter size, the following table shows how many letters can be printed in a space the length of the X-axis (900 plot positions).

U4 = Angle of which string is to be printed.
(Angle, in degrees, is measured counterclockwise to horizontal)

OUTPUT:

The character string V$ is printed out on the plotter.

```
5600 REM ---------------------------------
5605 REM DATA ROUTINE FOR CHARACTER SET
5610 REM PLOTTING
5615 REM *
5620 REM *
5625     X = X + 400*U3*X3/6
5630     Y = Y + 400*U3*Y3/6
5635     X1 = INT(X*Y6 - Y*X6 - X4 + .5)
5640     Y1 = INT(X*X6 + Y*Y6 - Y4 + .5)
5645     X4 = X4 + X1
5650     Y4 = Y4 + Y1
5655     RETURN
5660     X3 = INT(10*X5)
5665     X5 = 10*X5 - X3
5670     Y3 = INT(10*Y5)
5675     Y5 = 10*Y5 - Y3
5680    IF X3 <= 5 THEN 5690
5685    X3 = X3 - 10
5690    IF Y3 <= 5 THEN 5700
5695    Y3 = Y3 - 10
5700     RETURN
5705     GOSUB 5660
5710     GOSUB 5625
5715     GOSUB '33
5720     GOSUB 5660
5725     IF Y3 <> 5 THEN 5740
5730     X5 = .98901: Y5 = .90111
5735     GOTO 5720
5740     IF ABS(X3) + ABS(Y3) = 0  THEN 5765
5745     IF X3 = 5  THEN 5705
5750     GOSUB 5625
5755     GOSUB '34
5760     GOTO 5720
5765     X = 450*U3
5770     Y = 0
5775     GOSUB 5625
5780     GOSUB '33
5785     X0 = X0 + X4
5790     Y0 = Y0 + Y4
5795     RETURN
5800     DEFFN'23(X,Y,V$,U3,U4)
5801      GOSUB '11(X,Y)
5802      IF SIN(90) = 1 THEN 5810
5803      SELECT D
5804      GOSUB 5810
5805      SELECT R
5806    RETURN
5810       X6 = SIN(U4)   :   Y6 = COS(U4)
5815      GOSUB '11(X,Y)
5820      FOR U5 = 1 TO LEN(V$)
```

```
5825        U6 = VAL(STR(V$,U5,1))
5830        GOSUB '35
5835        X5 = X9(U6)   :   Y5 = Y9(U6)
5840        X,Y,X4,Y4 = 0
5845        GOSUB 5705
5850      NEXT U5
5855    RETURN

5900 REM ------------------------------
5905 REM *    FIND TABLE INDEX
5910 REM *
5915    DEFFN'35
5920      IF U6 > 64    THEN 5965
5922      IF U6 = 61 THEN 5962
5925      IF U6 < 32    THEN 5945
5930      IF U6 < 48    THEN 5940
5932      IF U6 > 57 THEN 5945
5935      U6 = U6 - 21      :   RETURN
5940      IF U6 = 33 THEN 5945
5941      IF U6 = 35 THEN 5945
5942      U6 = U6 + 5
5945      U6 = 37          :   REM SET NO MATCH BE BLANK.
5950    RETURN
5955      U6 = U6 + 36
5960    RETURN
5961      U6 = 40 : RETURN
5962      U6 = 38 : RETURN
5965      IF U6 = 94 THEN 5961
5966      IF U6 >= 91 THEN 5945
5970      U6 = U6 - 64
5975    RETURN
```

GOSUB' 24 (X, Y, V$, U3, U4)

PURPOSE:

This subroutine prints out the character string V$ centered about the point (V1, V2) using letter size V3. GOSUB' 24 is particularly useful in printing headings for graphs with all subsequent lines centered beneath the first line.

INPUT:

X = Abscissa of the center of the character string.
Y = Ordinate of the center of the character string.
V$ = Character string to be printed.
U3 = Letter size to be printed, input in inches .5=1/2 inch in height.
U4 = Angle of which string is printed.
(Angle, in degrees, is measured counterclockwise from horizontal)

OUTPUT:

The character string V$ is printed out on the Plotter.

```
1600 REM ------------------------------
1605 REM *     PRINT THE CHARACTER STRING V$
1610 REM *     CENTERED ABOUT THE POINT (V1,V2)
1615 REM *     USING CHARACTER SIZE U3 AND THE
1616 REM *     ANGLE OF U4 DEGREE.
1620 REM *
1625   DEFFN'24(X,Y,V$,U3,U4)
1630      X0 = X0 + INT(225*U3*(LEN(V$)-1)*COS(U4))
1631      Y0 = Y0 + INT(225*U3*(LEN(V$)-1)*SIN(U4))
1635      GOSUB 5805
1640      X0 = X0 - INT(225*U3*(LEN(V$)-1)*COS(U4))
1641      Y0 = Y0 - INT(225*U3*(LEN(V$)-1)*SIN(U4))
1645   RETURN
```

GOSUB' 25 (V1)

PURPOSE:

This subroutine prints a bar chart of the data stored in the arrays X() and Y(). For the most pleasing visual effect, the width of the bar printed out is variable and can be set to any size selected by the user.

INPUT:

V1 = Width of bar.
X() contains the abscissa for the center of each bar.
Y() contains the height of each bar.
00 = the number of items stored in X() and Y().
X(), Y(), and 00 are contained in common and must have the data stored in them before the subroutine is called.

OUTPUT:

A bar chart of the data stored in the X() and Y() arrays is drawn on the plotter.

> **NOTE:**
>
> *In order to prevent the bars at each end of the graph from "hanging over" the end of the axes, it is necessary that X-min be at least the width of one bar less than the smallest value of X, and X-max be at least the width of one bar greater than the largest value of X.*

GOSUB' 26

PURPOSE:

This subroutine draws a * graph of the points stored in the arrays X() and Y().

INPUT:

The data points must have been stored in the X() and Y() arrays before calling the subroutine, and the scalar 00 must contain the number of points stored in the arrays.

OUTPUT:

A point graph of the points stored in the X() and Y() arrays is drawn on the plotter.

GOSUB' 27

PURPOSE:

This subroutine plots the * stored in the X() and Y() arrays in a point graph. It then computes and draws the "best fit" straight line by the method of least squares on Y.

INPUT:

The data points must have been stored in the X() and Y() arrays before calling the subroutine, and the scalar 00 must contain the number of points stored in the arrays.

OUTPUT:

A point graph of the * stored in the X() and Y() arrays is drawn on the plotter. The "best fit" straight line then is drawn through these points.

A = Slope of the "best fit" straight line.
B = Y-intercept of the "best fit" straight line.
S1 = Sum of X.
S2 = Sum of X squared.
S3 = Sum of Y.
S4 = Sum of X * Y.

GOSUB' 28

PURPOSE:

This subroutine plots a line graph through the points stored in the X() and Y() arrays. The graph is made by connecting the points with line segments in the order that the points are stored. By storing the points in a particular order, it is possible to graph any desired polygon or figure made up of continuous line segments.

INPUT:

The data points must have been stored in the X() and Y() arrays before calling the subroutine, and the scalar 00 must contain the number of points contained in the arrays.

OUTPUT:

A line graph connecting the given data points is drawn on the plotter.

GOSUB' 29 (V1, V2)

PURPOSE:

This subroutine draws horizontal lines for the axes with evenly spaced hash marks along the bottom line. It is used effectively with the bar chart and sometimes a line graph.

INPUT:

V1 = The distance between hash marks on the X-axis.
V2 = The horizontal separation between lines.

OUTPUT:

Horizontal lines are drawn on the plotter to be used for axes.

SECTION III – UTILITY ROUTINES

GOSUB' 30

PURPOSE:

This subroutine draws hatched axes under a line graph curve.

INPUT:

The same data points that are used to draw the line graph must be in the X() and Y() arrays and the number of points stored in the arrays must be stored in the scalar 0.

V1 = The separation between vertical lines.
V2 = the separation between horizontal lines.

OUTPUT:

Hatched axes under the curve are drawn on the plotter.

RESTRICTIONS:

GOSUB' 30 should be utilized with a line graph. The output is meaningless with other graphs.

The data points must be stored in order, according to the values in X().

X(1) should be X-min and X(0) should be X-max when scaling.

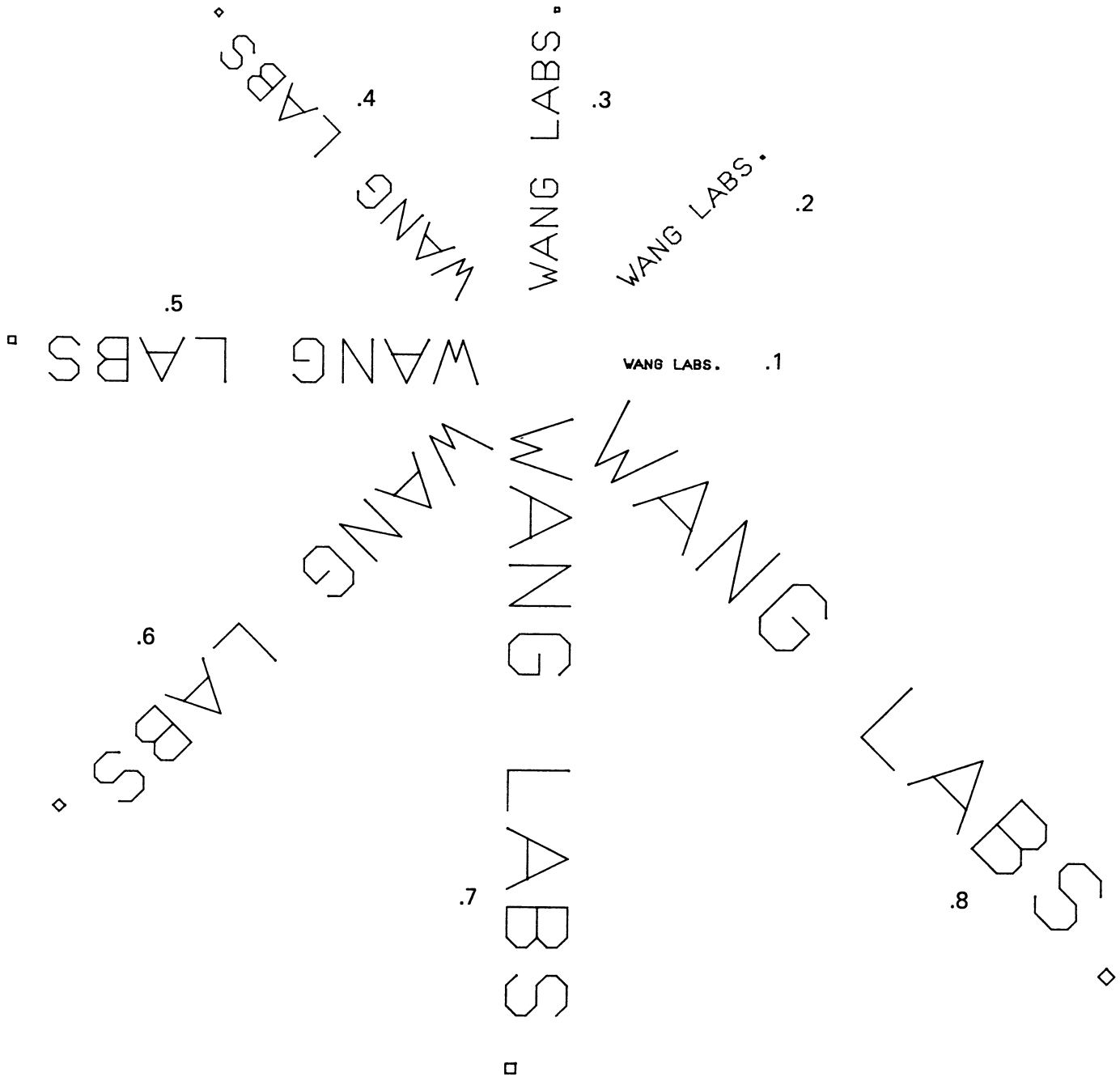
X and Y must be linear scales.

Section IV
Appendix

DATA FOR GENERATING THE 2232 CHARACTER SET

```
6000 DATA . 72121596, . 7426802, . 17031091097, . 003099999903, . 29890121, . 21096901, . 800
31097, . 7330969, . 26004597, . 3077003
6005 DATA . 1750004, . 000742, . 2989012108, . 210969012, . 8005045, . 3770300377, . 92590059
2, . 300077, . 7011100584, . 9990132
6010 DATA . 800504573, . 377024077, . 8004, . 377, . 80022, . 7337377, . 80022, . 7337733, . 2989
0121, . 210969014, . 90021098, . 7330999
6015 DATA . 110989012592, . 714109690028, . 92109800538, . 00111077003, . 812109890121, . 8
901111011109, . 0005733, . 733
6020 DATA . 800121, . 37890132, . 81111, . 37733, . 7111111, . 3773733, . 8225622, . 3770033, . 0
08522, . 733073, . 84884, . 3077
6025 DATA . 8121098905022, . 890141096093 3, . 910092, . 2177, . 81210604, . 2109979, . 812109
8210989, . 2109990099901, . 984158, . 36000378
6030 DATA . 2601210989, . 3071098901, . 298901210989, . 210969011109, . 8406, . 30969, . 1109
890121090, . 011109990995
6035 DATA . 298901210989, . 190111096901, 0, 0, . 26504, . 1008, 0, 0, . 91159, . 0370377, . 9109
015710901, . 3090110909011, . 0109015110901, . 111090091109
6040 DATA . 26011170112, . 74110979902, . 010901, . 111090, . 1802, . 3969, . 9208, . 3969, . 845
98502, . 00026046, . 848, . 00026
6045 DATA . 190109, . 701099, . 84, 0, . 0109, . 80901, . 288, . 377
9999 REM $
```

MODEL 2232 PLOTTER CHARACTER SET WITH ASCII CODES

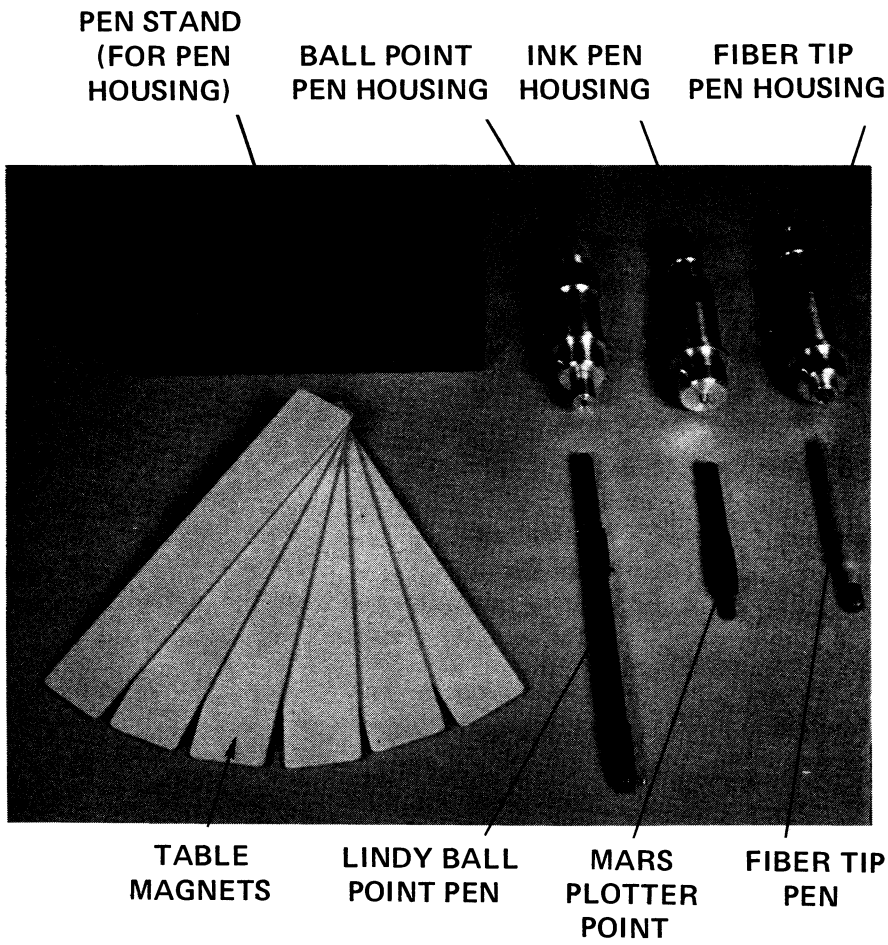


Various Point Sizes and Angles of Alpha Characters.

SECTION IV – APPENDIX

STANDARD EQUIPMENT ENCLOSED WITH EACH MODEL 2232A

ITEM	PART NUMBER
1 pen stand	478-0257
1 ball point pen housing	279-0083
1 ink pen housing	279-0084
1 fiber tip pen housing	279-0085
1 black ball point pen	725-0471-0
1 plotting point MARS #757-PL3-C3	725-0464-0
1 package of 5 black fiber tip pens	725-0466-0
1 8 oz. bottle black ink MARS #747-25T	725-0467
1 8 oz. bottle pen cleaner MARS #746-25	725-0466
6 magnets	458-0198
6 plates (for magnets)	660-0508



Accessories to Model 2232A

SECTION IV – APPENDIX

OPTIONAL PACKAGE OF ACCESSORY EQUIPMENT FOR THE MODEL 2232A

ITEM	PART NUMBER
1 ball point pen - black	725-0471-0
1 ball point pen - blue	725-0471-6
1 ball point pen - red	725-0471-2
1 fiber tip plotter point - black	725-0466-0
1 fiber tip plotter point - blue	725-0466-6
1 fiber tip plotter point - red	725-0466-2
1 MARS 746 25, 8 oz. bottle pen cleaner	725-0466
1 MARS plotter point 757-PL2C3, size 00	725-0464-00
1 MARS plotter point 757-PL3C3, size 0	725-0464-0
1 MARS plotter point 757-PL4C3, size 1	725-0464-1
1 MARS plotter point 757-PL5C3, size 2	725-0464-2
1 MARS plotter point 757-PL6C3, size 2.5	725-0464-25
1 MARS plotter point 757-PL8C3, size 3	725-0464-3
1 MARS plotter point 757-PL10C3, size 3.5	725-0464-35
1 MARS 747 25T, 8 oz. black ink	725-0467
1 MARS 745 25T, 2/3 oz. blue ink	725-0469
1 MARS 745 25T, 2/3 oz. red ink	725-0468

All of the items listed under standard or accessory equipment are stocked in General Services (c/o Wang Labs, Tewksbury, MA.). Any single item may be purchased by specifying the correct part number; please see your Wang salesman for prices.

PAPER RECOMMENDATIONS

1. Paper - Opaque
2. Tracing Paper - 100% Rag Vellum
3. Mylar - Formulated for ink
   a. Suggest for minimum pen wear
   Dupont Cronaflex Drafting Film (VC-4 & VC-7).
4. Acetate - Treated for ink

SECTION IV – APPENDIX

INK RECOMMENDATIONS

The following inks are recommended for use with the Model 2232A:

1. Black ink, 8 oz. bottle, MARS 747-25T (Wang part number = 725-0467).
2. Blue ink, 2/3 oz. bottle, MARS 745-25T (Wang part number = 725-0469).
3. Red ink, 2/3 oz. bottle, MARS 745-25T (Wang part number = 725-0468).

Different types and qualities of ink are available at most drafting supply houses and are supplied by:

Staedtler - MARS Ink
P.O. Box 68
1 Mars Court
Montville, New Jersey 07045
Phone 201-335-1800

NOTE:

a) Some variables that effect quality of line are paper, ink, humidity and speed of machine.
b) Other inks can be tried to see if line is of higher quality.
c) Waterproof ink tends to clog more readily than non-waterproof ink.

PLOTTER POINTS

The points recommended for use with the Model 2232A are provided by the MARS plotter point series, 750-PL3-C3 (Wang part number = 725-0465-0).

CARE AND CLEANING

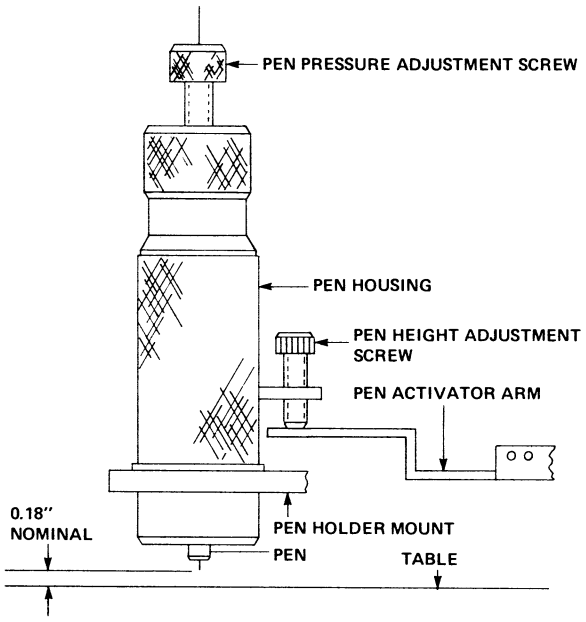
1. Recommend MARS 746 25 pen cleaner (Wang part number = 725-0466) for plotter points.
2. Replace cap on all pens to insure remaining ink in pen will not dry.

PEN PRESSURE ADJUSTMENT

1. Turn pen pressure adjustment screw clockwise to increase pen pressure and c'clockwise to decrease pressure.
2. Check pen to see it is not clogged or dried up.
3. Test pen over entire plotting area to insure that pen will write properly.

PEN HEIGHT ADJUSTMENT

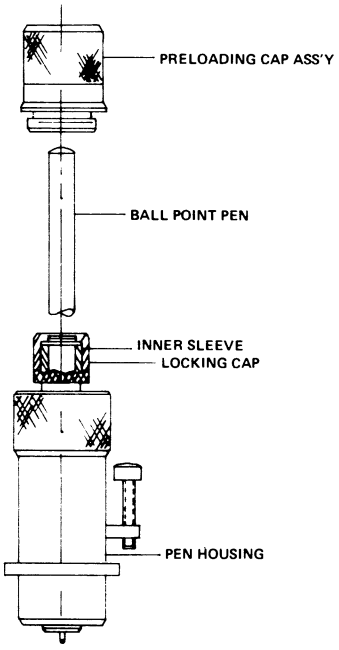
1. Turn pen height adjustment screw clockwise to raise pen and c'clockwise to lower pen.
2. Pen should be adjusted high enough to avoid hitting paper holddown magnet, and still be able to plot over the entire area when it is actuated.



SECTION IV – APPENDIX

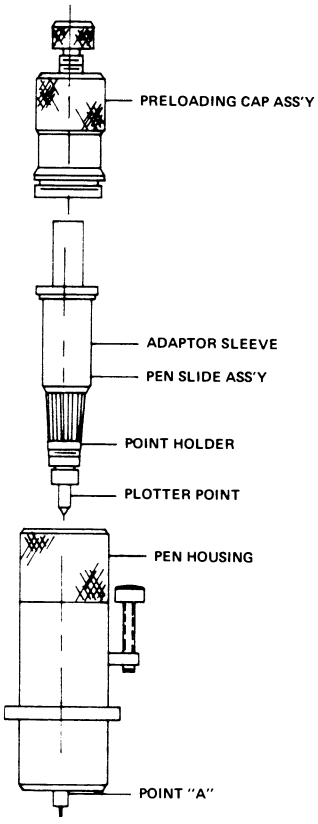
LOADING PROCEDURE FOR BALL PEN

1. Turn locking cap to position where grooved hole in locking cap lines up with hole in inner sleeve.
2. Insert ball pen so as it bottoms on inner sleeve.
3. Turn locking cap in either direction till grooved hole in cap locks ball pen in position.
4. Screw preloading cap assembly to pen housing.



LOADING PROCEDURE FOR INK PEN

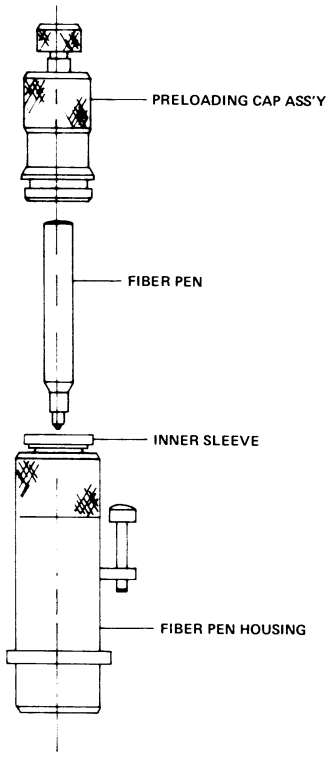
1. Lift adaptor sleeve from pen housing – screw plotter point into point holder – screw point holder assembly into adaptor sleeve.
2. Load pen slide assembly in pen housing so that pen point protrudes through hole at point "A".
3. Screw preloading cap assembly to pen housing.



SECTION IV – APPENDIX

LOADING PROCEDURE FOR FIBER PEN

1. Push fiber pen into inner sleeve of pen housing until it bottoms.
2. Screw preloading cap assembly to pen housing.



SECTION IV – APPENDIX

SPECIFICATIONS

Paper Capacity
59½ inches (151.13 cm) x 36 inches (91.44 cm)

Plotting Area
48 inches (121.92 cm) x 31 inches (78.74 cm)

Plotting Accuracy and Repeatability
± (0.01 inches + 0.001 inch/inch)
± (0.0254 cm + 0.0025 cm/cm)

Stepping Increments:
0.0025 inch (0.00635 cm) per step, max. 999 steps
(Plotting increment is two times the stepping increment.)

Stepping Rate
300 to 500 steps/sec

Plotting Time
60 inches/min (152.4 cm/min) average; depends on calculator program being executed

Operating Environment
50° F to 104° F (10° C to 40° C)
30% to 80% relative humidity

Size – Table

Height	9½ inches (24.130 cm)
Width	60¼ inches (153.035 cm)
Depth	46 inches (116.840 cm)
Net Weight	112 lbs (50.08 kg)

Size – Control Unit

Height	19 inches (48.260 cm)
Width	18 inches (45.720 cm)
Depth	10 inches (25.400 cm)
Net Weight	30 lbs (13.60 kg)

Power Requirements
115 or 230 VAC ± 10%; 50 or 60 Hz ± ½ cycle

Connecting Cables
12-ft (3.66 m) cable with connector to calculator output jack

EQUIPMENT MAINTENANCE

GUARANTEE

The Model 2232A is guaranteed from defects in materials and workmanship for a period of ninety days (one year for State and Federal Governments).

MAINTENANCE

It is recommended that the Model 2232A be serviced Semi-Annually. A Maintenance Agreement is available to automatically assure this servicing. If no Maintenance Agreement is acquired, any servicing must be arranged for by the customer. A Maintenance Agreement protects your investment and offers the following benefits:

Preventive Maintenance: Semi-Annually, your Model 2232A is inspected for worn parts, lubricated, cleaned and updated with engineering changes, if any. Preventive maintenance minimizes "downtime" by anticipating repairs before they are necessary.

Fixed Annual Cost: When you buy a Maintenance Agreement, you issue only one purchase order for service for an entire year and receive one annual billing, or, more frequent billing if desired.

Further information regarding Maintenance Agreement can be acquired from your local Sales Service Office.

NOTE:

Wang Laboratories, Inc. will not guarantee or honor Maintenance Agreements for any equipment modified by the user. Damage to equipment incurred as a result of this will be the financial responsibility of the user.

INDEX

The Wang PROGRAMMER is the official publication of Wang Laboratories Users Society, SWAP. The PROGRAMMER has been issued monthly at Tewksbury, Massachusetts since July 1967 and is now published quarterly and mailed to all SWAP members. Its prime objective is to provide useful information to users of Wang equipment and computing systems throughout the world. Readers who have programs, applications or articles which may be shared with other users are invited to submit them to the Editor. Readers interested in joining the Society for Wang Applications and Programs should write to SWAP, c/o Wang Laboratories, 836 North Street, Tewksbury, Massachusetts 01876.

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